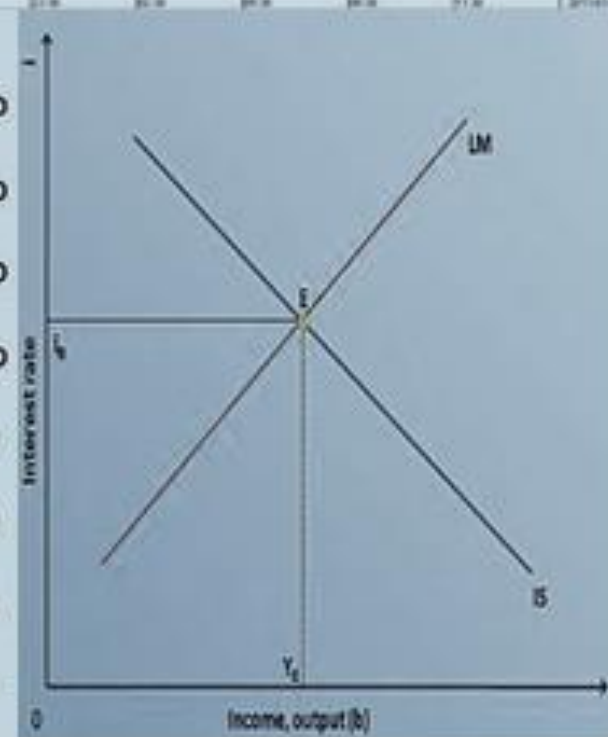


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THE BEVERIDGE CURVE: TENSION ON LABOUR MARKET IN THE REPUBLIC OF MOLDOVA

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ABSTRACT: *The purpose of this article is to analyze the labour market in the Republic of Moldova by constructing and explaining the Beveridge Curve. The article includes: analysis of the Beveridge Curve for 2014-2024, study of the current supply and demand on labour market in the Republic of Moldova, comparison of Beveridge Curves for 2014-2024 and 2008-2018, Beveridge Curves in Moldova, EU, USA. The conducted analysis of labour market allowed to conclude that the national labour market in the Republic of Moldova is sustainable and can confront both external shocks and internal factors negatively affecting it. At the same time, there is a trend after 2018 - reduction of demand on labour market by employers. The use of the Beveridge Curve in the analysis of labour market allows to identify differences in labour market during the periods of overcoming crises and to compare the timeframe of labour market recovery in the Republic of Moldova. 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: *Unemployment, Beveridge Curve, Labour Market, Employment*

JEL Classification: *J62, J63, J68*

1. INTRODUCTION

The assessment of the impact of disproportions on the supply and demand of labour force is of interest in the analysis of the modern labour market. The problems of demographic, associated with changes in the structure of the population, and economic nature, such as inflationary processes, differences in wages between sectors of the economy, changes in labour productivity, etc., affect the state of labour market and lead to the emergence of imbalances in labour market. The problem of ensuring its stable development, evaluation of the leading trends, dynamics of the main indicators characterizing the labour market, causes the search for relevant evaluations the state of labour market, allowing to analyze the current situation on labour market. The search for assessments that allow on their basis to develop proposals to improve labour market policies and measures to improve the state of labour market in the country.

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One such type of assessment is the application of the Beveridge Curve, which allows for the analysis of labour market. The Beveridge Curve makes it possible to evaluate the activity of economic agents and the opportunities of placement market. As well, the empirical data of the Beveridge Curve allows to assess the state of the economy under conditions of structural shocks.

2. LITERATURE REVIEW

The Beveridge Curve is a graphical representation of the relationship between unemployment rate and share of work vacancies. It is named after the well-known English economist William Henry Beveridge. It was presented in the work by Dow J.C.R. and Dicks-Mireaux L.A., “The excess demand for labour. A study of conditions in Great Britain, 1946–56” [Dow J.C.R., Dicks-Mireaux L.A., 1958], published in 1958 as an illustration of statistics on unemployment and unfilled vacancies when analysing trends in *excess demand for labour* and *potential labour supply* by sector (sectoral shocks).

Thus, in the scientific literature until the 1980s, explanations of the Beveridge Curve supposed the ***existence of excess demand in labour market***³; as one hypothesis, this excess demand was defined by the presence of unfilled vacancies and was not linked to the number of unemployed workers.

In the 1970s and 1980s, representatives of the neoclassical school - later Nobel laureates, scientists P. Diamond, D. Mortensen and Ch. Pissarides, proposed an alternative approach: the *Search and Matching Model*. The main hypothesis was an ***equilibrium between vacancies and unemployment***, with any imbalance being the phenomenon in question. The authors theoretically based the origin of the Beveridge Curve through the creation and destruction of working places: unemployment and vacancies coexist due to the large number of working places being created and destroyed, despite the fact that working places and workers are effectively matched [Mortensen, D., Pissarides, Ch., 1994].

I.e., in labour market, despite the fact that the majority of working places are filled by workers, there are always vacancies and unemployed workers, as the process of creating the working places and destruction the working places is constant. Unemployment is always present and cannot be zero.

The Beveridge curve is a topic of active research by leading economists in the fields of labour economics and macroeconomics. W.H. Beveridge’s theory [Beveridge W.H., 1944] on vacancies, the unemployment rate and labour demand is reflected in a number of scientific publications on the negative correlation between unemployment and vacancies. These countries differ significantly in time and level of development (for 16 countries in the studies of Layard R., Nickell S., Jackman R. [Layard R., Nickell S., Jackman R., 2005], Hobijn B., Şahin A. [Hobijn B., Şahin A., 2013], Nickell S., Nunziata L., Ochel W. and Quintini G. [Nickell S., Nunziata L., Ochel W. and Quintini G., 2001]). A detailed analysis based on the Beveridge Curve, for example for the USA in conditions of the global crisis of 2008 - 2010, is described in the works of Blanchard O.J. and Diamond P., “The Beveridge Curve” [Blanchard O.J., Diamond P., 1989] and Diamond P., Sahin A., “Shifts in the Beveridge Curve” [Diamond P., Sahin A., 2014]; for the United Kingdom – Pissarides Ch. [Pissarides Ch., 1986]; for Germany – Börsch-Supan A. H. [Börsch-Supan A. H., 1991], Australia – Webster E. [Webster E., 1997], and Egypt – Kasrin Z., Lang G. [Kasrin Z., Lang G., 2010].

The Beveridge Curve can point to potential changes in labour market, including the structure of employed population.

³ The number of vacant working places exceeds the number of unemployed.

Factors influencing shifts in the Beveridge Curve may include labour force characteristics, types of unemployment, institutional factors, the mismatch between place of residence and place of work, etc.

In the Republic of Moldova, the analysis of labour market using the Beveridge Curve is presented by researchers Savelieva G., Zaharov S. in works “Causes of intensity of labour market in Moldova” [Zaharov S., 2017], “Assessment of labour market tightness in the municipality of Chişinău” [Savelieva G., Zaharov S., 2019] and “Analysis of labour market tightness in the Republic of Moldova” [Savelieva G., Zaharov S., 2024].

3. RESEARCH METHODOLOGY

The purpose of this research is to construct the Beveridge Curve using statistical (National Bureau of Statistics of the Republic of Moldova) and departmental data (National Employment Agency) for the period 2014–2024 and evaluate it, including using the tension coefficient on labour market of the Republic of Moldova, and compare Beveridge Curves in Moldova, the EU, the USA.

The research was based on the main hypothesis that, in accordance with the principles of neoclassical theory, a long-term equilibrium relationship between the number of unemployed and the number of vacancies in the Republic of Moldova’s labour market.

The article utilized a comprehensive and systematic approach, as well as scientific methods, including the analysis of monographs, comparative, quantitative and qualitative analysis, graphical, and Beveridge Curve modelling, etc.

The relationship between the share of vacancies and the registered unemployment rate, located between the coordinate axes (ordinate y-axis and abscissa x-axis), was analyzed using by constructing the Beveridge Curve. *Movement up or down of the curve* is explained by changes in the level of aggregate (excess labour) demand at various stages of the economic cycle: an upward or downward shift ($\uparrow\downarrow$ in labour demand), low unemployment and a large number of vacancies, or high unemployment and a small number of vacancies. *A shift of the curve to the left* is explained by changes in the structural component of unemployment. It should be noted that the Beveridge Curve can point potential changes in the structure of employed population.

The Beveridge Curve shows that, the labour market at different stages of the business cycle, in accordance with changes in the level of aggregate demand, tends towards two starting points: if demand increases (*growth*) – low unemployment and a large number of vacancies; and if demand decreases (*drop*) – high unemployment rate and a small number of vacancies.

The analyses were carried out on the basis of official statistical data of the National Bureau of Statistics of the Republic of Moldova (NBS RM), National Employment Agency (NEA), as well as the author’s calculations of the secondary indicators necessary for the research. All indicators are comparable in dynamics, as they are calculated on the basis of the population with usual place of residence, defined as the place where a person lived predominantly during the last 12 months, regardless of temporary absence (for recreation, leaves, visits to relatives and friends, business, medical treatment, religious pilgrimages, etc.).

Thus, the Beveridge Curve for 2014–2024 is presented in Figure 1. This curve is calculated using employment indicators based on the population with a usual place of residence. Therefore, the research period is limited to 2014–2024, which has a uniform methodology for calculating employment indicators of the NBS RM based on the population with a usual place of residence (in 2015, the methodology changed). While, Figure 6. presents the Beveridge Curve for the period 2008–2018, where employment indicators based on the resident population (stable population). The values of the two Beveridge Curves (Figure 1 and Figure 6) cannot be compared.

4. RESULTS AND DISCUSSION

To analyse the labour market, a Beveridge Curve (scatterplot graph) was constructed in a rectangular coordinate system. In a standard two-dimensional graph, the abscissa x (x-axis) - shows the registered unemployment rate, the ordinate y (y-axis) - the share of registered vacancies. The points represent the years from 2014 to 2024. The Beveridge Curve turned out to be difficult to perceive (Figure 1). The Beveridge Curve for 2008-2018 (Figure 6) constructed by the authors is much simpler to understand and the movement - change of the curve down-right, right, left, up-left is marked in red.

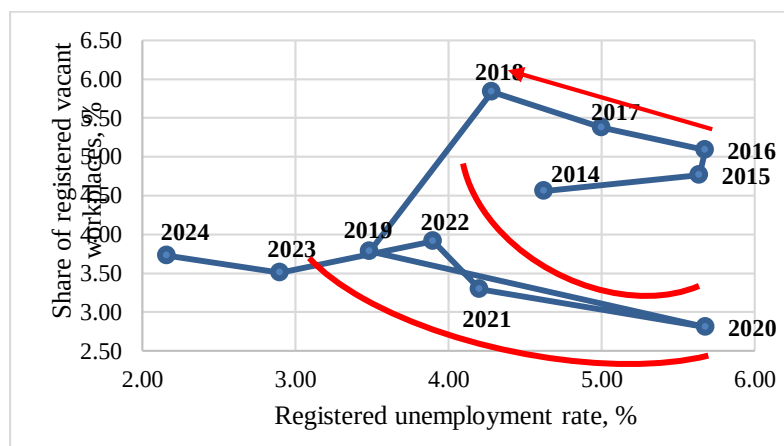
4.1. Beveridge curve dynamics

In general, the Beveridge Curve can be broken down into three stages: 2014-2018, 2018-2020, 2020-2022-2024.

2014-2018

The Beveridge Curve rises upwards and goes to the left. The explanation is that in 2015-2016 there was a drop in world oil prices, i.e. due to these external shocks the number of unemployed in the Republic of Moldova increased by over 5.5%, including migrants from Russia. Then the oil price rises and the situation stabilizes, unemployment on labour market in the Republic of Moldova gradually decreases by 4.3%.

Figure 1. Beveridge Curve, RM, 2014-2024, %



Source: author' calculations based on data from NBS RM and NEA, www.statistica.md, www.anofm.md

2018-2020

In 2019 a fall in labour demand.

2020- pandemic (COVID-19) spike in unemployment above 5.5% and a further drop in demand to 2.75%.

I.e., a classic downward movement along the Beveridge Curve - this corresponds to the economic cycle, cyclical contraction, cyclical change, i.e. unemployment rises and demand falls.

2020-2022-2024

There is an upward movement of the Beveridge Curve, the curve has shifted to the left. The upward movement of the classical Beveridge Curve indicates a change in the structural component of employed population. Quantitative change in the proportion of economic sectors in labour market.

A fall in registered unemployment to almost 2 per cent and lack of growth in the share of vacant working places. Which contradicts the classical Beveridge Curve. In 2022, labour migration increased by almost 20 %.

The main conclusion is that the national labour market in the Republic of Moldova can confront both external shocks and internal factors negatively affecting it. The labour market, according to the Beveridge Curve, despite the fluctuations returns to the initial state and is stable.

4.2. Explanation of changes in the position of the Beveridge Curve

The changes in the position of the Beveridge Curve are explained through the dynamics of unemployment and vacancies, presented in Figure 2. (Current Supply and Demand).

The graphical evaluation of the indicators (Figure 2) represents one of the statistical methods for interpreting the relationship between the number of vacancies and the number of unemployed people seeking for them over time. A comparison of the points where the lines intersect shows the periods (in years) when the number of vacancies coincided with the number of unemployed people registered with the regional offices of the National Employment Agency.

In 2015-2016, the gradual growth of demand in labour market, the number of vacancies is gradually increasing. The growth in unemployment and a sharp fall in 2018 and 2019.

In 2018, the demand on labour market reached its maximum value of 49.2 thousand persons with an unemployment about 35.5 thousand persons, the gap between the current demand and supply was almost 15 thousand persons. This is almost 33% **unsatisfied demand**.

After 2018. The demand on labour market began to fall and does not increase above 35 thousand persons.

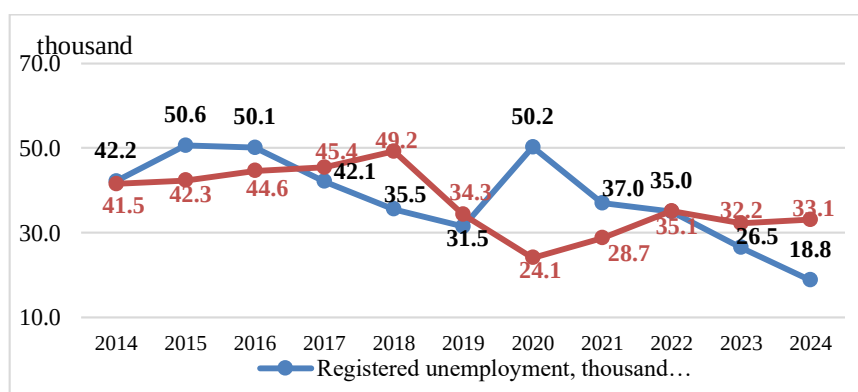
The total conclusion - is that the demand for labour market is no longer growing above 35 thousand vacancies as despite the increase in unemployment. I.e., the trend in labour market - **a decrease in the demand for the labour market by employers**. This trend started after 2018, also due to external shocks.

This is confirmed by the decline in GDP values after 2019 (Figure 4).

Another conclusion that can be observed is the **decline in the number of registered unemployed**. If to exclude the 2020 data (COVID-19 pandemic) from the unemployed dynamics, that the trend of a gradual decline in the number of registered unemployed can be observed after 2016. This is evident in the Beveridge Curve (Figure 1) for the periods 2016–2019 and 2020–2024.

As noted above, the decline in the number of registered unemployed following the COVID-19 pandemic is compensated by an increase in the number of labour migrants.

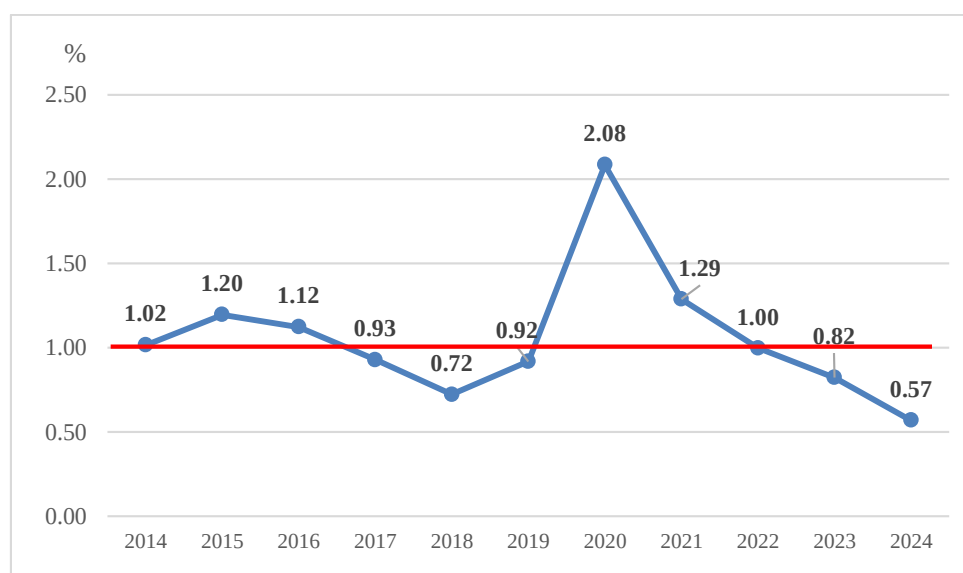
Figure 2. Current Supply and demand, 2014-2024, thousand persons



Source: data NEA, www.anofm.md

The ratio between the number of registered unemployed and the number of vacant working places characterises the tension of labour market. The tension coefficient presented in Figure 3 fluctuates and returns to equilibrium (1.00). The dynamics of the tension coefficient has peak of maximum value in 2020 (COVID-19 pandemic) to 2.08. In 2020, the fall in vacancies is explained by the COVID-19 pandemic, lower exports, and slower supply chains, while in 2023 it is explained by high energy prices. And the trend of **reduced demand on labour market from employers** will continue in the future due to the maintenance of high energy prices and high interest rates on loans, which slow down the growth of investment in the country's economy, and increase the minimum wage in the country (strengthening the institution of minimum wage).

Figure 3. Tension coefficient, 2014-2024, %



Source: author's calculations

Starting from 2020, the labour market has experience **insufficient demand** from employers. In the conditions of **unsatisfied labour supply**, some of the unemployed will not be employed at all. This situation leads to increased labour migration of the population. And if in this situation foreign labour force is imported (PricewaterhouseCoopers (PwC) Moldova Analysis of the Labor Market in the Republic of Moldova)⁴, the rate of labour migration will increase. This conclusion should be taken into account when elaborating labour market policies.

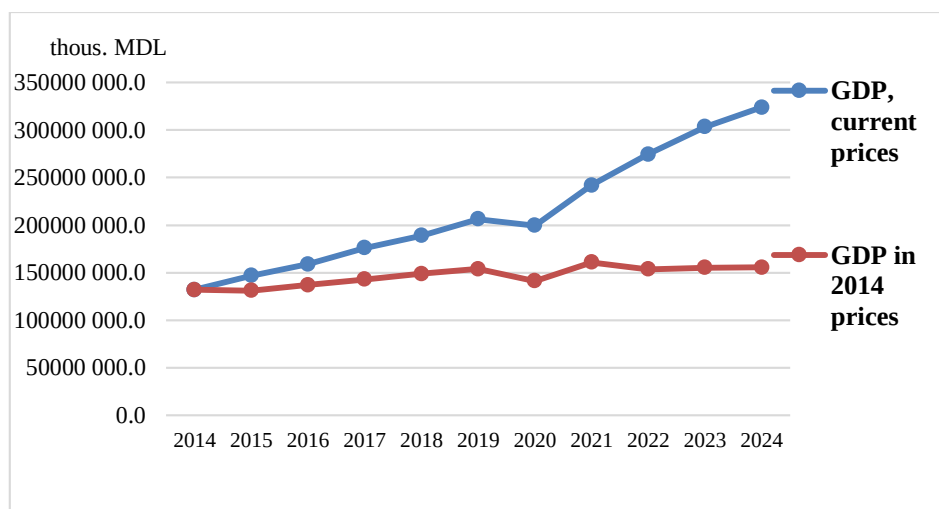
⁴ **The analysis of the labor market in the Republic of Moldova and of the economic impact of the labor force deficit provides an overview of the labor market's structure and evolution in recent years. It also estimates the additional labor force needed for the Republic of Moldova to support economic growth objectives.**

The objective of this AmCham initiative is to identify the most appropriate measures to reduce the human capital deficit in the short, medium, and long term and to recommend them to responsible decision-makers and the private sector, for which ensuring the necessary labor force is one of the most significant challenges faced in the Republic of Moldova.

The analysis was conducted for AmCham Moldova by PricewaterhouseCoopers (PwC) Moldova, based on publicly available data from the National Bureau of Statistics and the General Inspectorate for Immigration. The analysis is structured into four components: (i) a description of the current context of the labor market, (ii) an estimation of the labor force deficit, (iii) an estimation of the economic impact of the labor force deficit, and (iv) policy recommendations based on models of best practices from other states. Methodological specifications are included within the analysis.

To explain the *insufficient demand*, will consider the dynamics of GDP and the number of employed population (Figure 4 and Figure 5). An analysis of the dynamics of the GDP indicator in current prices (NBS data) shows a continuous growth of the indicator for the whole period, except for 2020, which is connected with the COVID-19 pandemic. Particularly high growth was observed in 2022-2024 due to the increase in energy prices. Absolutely contrasting dynamics is demonstrated by the GDP indicator, deflated in 2014 prices: by 2019 there is a gradual growth of the indicator up to 150 000 mln MDL, after 2019 the values of the GDP indicator practically do not increase. This confirms the decrease in employer demand on labour market (Figure 2).

Figure 4. GDP, RM, 2014-2024, current prices and in 2014 prices, mln MDL



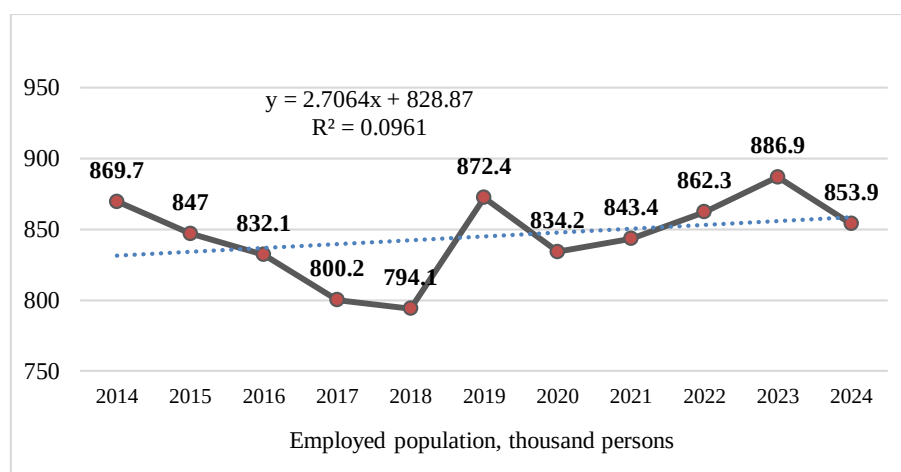
Source: NBS, www.statistica.md, author' calculations

If to consider the lack of GDP growth since 2019 (Figure 4. GDP), i.e., the deterioration in the economic situation, the declining share of vacancies in labour market (demand for labour from employers), the declining registered unemployment rate (Figure 1 Beveridge curve), the rise in the number of labour migrants, and also the decline in the country's population, which migrates abroad during working age, observing an unfavorable situation, anticipating another economic crisis.

The analysis of the dynamics of employed population (Figure 5) reveals that the decline in the employment indicator was until 2019, then indicator after 2020, after the pandemic is slowly recovering. The increase in employed population is not accompanied by GDP growth, as the employer demand does not recover to the level of 2018 (Figure 2).

Thus, from 2014 to 2019, the value of GDP increases to a value of 150 000 mln MDL, then the value of GDP fluctuates around the achieved value. The increase in employment in the period 2021-2023 did not affect the growth of the GDP value for this period.

Figure 5. Employed population, 2014-2024, thousand persons



Source: NBS RM, www.statistica.md

Changes in the Beveridge curve after 2020 indicate structural changes in labour market. Table 1 presents the structure of employed population for the period 2014-2024: the share of the employed population in Agriculture, forestry and fisheries, in hospitality and trade decreased, the share in industry, construction, and the budget sector administration-education-medicine-social assistance increased, and the share of other as a type of employment recovered compared to 2014 (including the national lottery of the country).

The fact of disparity the tax revenues in Kazakhstan is noteworthy: bookmaker offices contribute up to 36% of all taxes collected in the country, more than the oil and gas industry, whose share in tax revenues is 30%.

Table 1. Structure of employed population by main types of economic activity, 2014-2024, %

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total, RM	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, forestry and fisheries	23.7	23.2	24.2	22.6	39.3	21.0	21.1	21.5	20.8	20.9	18.1
Industry	13.5	13.8	13.8	13.4	11.0	14.8	14.5	14.4	14.7	14.4	13.4
Constructions	6.1	6.2	5.8	5.4	4.6	7.0	7.2	7.7	7.7	7.1	7.5
Wholesale and retail trade; Accommodation and public catering activities	18.2	17.1	18.1	19.3	14.5	18.8	17.8	17.5	17.7	17.7	17.6
Transport and storage. Information and communications	7.1	7.2	7.2	6.9	5.5	6.9	7.4	7.1	7.4	7.1	7.6
Public administration. Education, Health and Social assistance	21.7	22.5	21.5	22.8	17.8	22.6	23.1	22.9	23.0	23.0	24.7
Other service activities	9.7	10.0	9.4	9.6	7.3	8.9	8.9	8.9	8.7	9.8	11.1

Source: author's calculations

The greatest deficit of workers is observed in such types of economic activity as public administration (13.4% of total number of working places in 2024), art (6.5%), health (6.9%), transport (8.9%).

At the same time, it should be noted that high labour migration increases the presence of vacant working places. This may be a research question in the future.

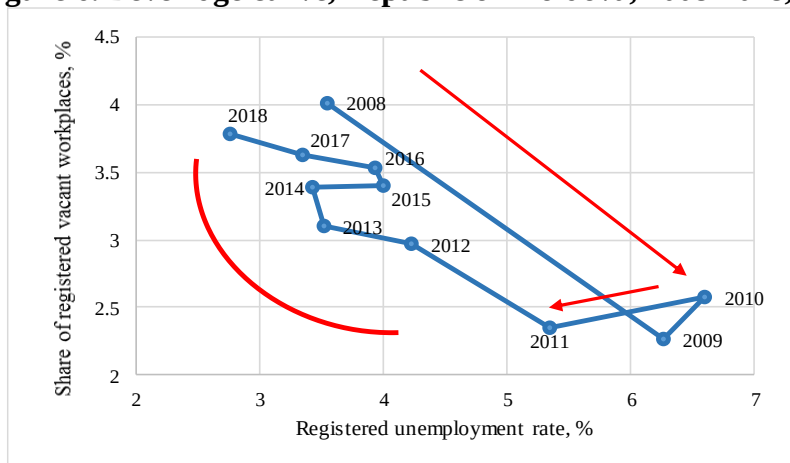
**Table 2. Vacant working places by main types of economic activity
(% total number of working places), at the end of the year, 2015-2024**

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total, RM	4.0	4.3	4.5	4.7	5.2	4.7	3.9	3.9	3.8	3.4
Agriculture, forestry and fisheries	3.0	2.9	3.1	2.9	2.8	3.0	2.0	2.2	1.3	0.3
Industry	4.9	4.8	4.5	4.6	6.0	5.3	4.2	3.5	2.9	2.7
Constructions	3.	2.7	3.5	3.5	2.4	3.1	1.4	1.5	2.1	0.8
Wholesale and retail trade; aintenance and repair of motor vehicles and motorcycles	2.6	2.3	2.1	2.4	2.4	2.0	1.6	1.7	1.5	1.5
Transport and storage	3.8	4.3	5.5	6.2	6.7	5.6	7.2	6.0	6.0	8.9
Accommodation (hotel complex) and public catering activities	4.2	4.9	4.2	2.9	4.0	4.1	1.9	2.6	2.8	1.6
Information and communications	2.9	2.3	2.9	2.1	3.9	3.1	2.4	2.5	2.3	2.3
Financial and insurance activities	3.2	3.1	2.9	3.2	3.2	2.5	4.1	5.1	4.5	5.0
Real estate transactions	6.1	5.1	3.8	6.5	5.4	4.5	3.5	3.0	2.8	5.0
Professional, scientific and technical activities	3.8	4.6	5.2	3.7	4.6	4.3	4.2	3.9	3.5	3.4
Administrative service activities and support service activities	4.4	4.1	3.5	3.7	3.7	3.4	3.0	3.2	3.8	3.1
Public administration and defense; obligatory social insurance	8.6	10.2	11.2	12.0	12.9	9.9	9.1	10.6	11.4	13.4
Education	2.0	1.9	2.8	3.0	3.4	3.5	2.8	2.7	2.5	3.4
Health and Social assistance	5.7	7.4	6.7	7.9	8.3	7.7	6.5	6.5	6.3	6.9
Art, recreation and leisure activities	4.3	5.4	5.9	5.8	7.6	7.8	4.8	5.4	6.4	6.5
Other service activities and services	2.9	1.3	2.1	2.7	2.3	2.7	2.7	1.8	1.7	0.3

Source: author' calculations

Comparison of the Beveridge Curve for 2008-2018 (Figure 6) and for 2014-2024 (Figure 1) showed that the recovery of labour market in the Republic of Moldova after the fall in demand and increase in unemployment took 10 years (2008-2018).

Figure 6. Beveridge curve, Republic of Moldova, 2008-2018, %



Source: author' calculations based on data from NBS RM and NEA, www.statistica.md, www.anofm.md

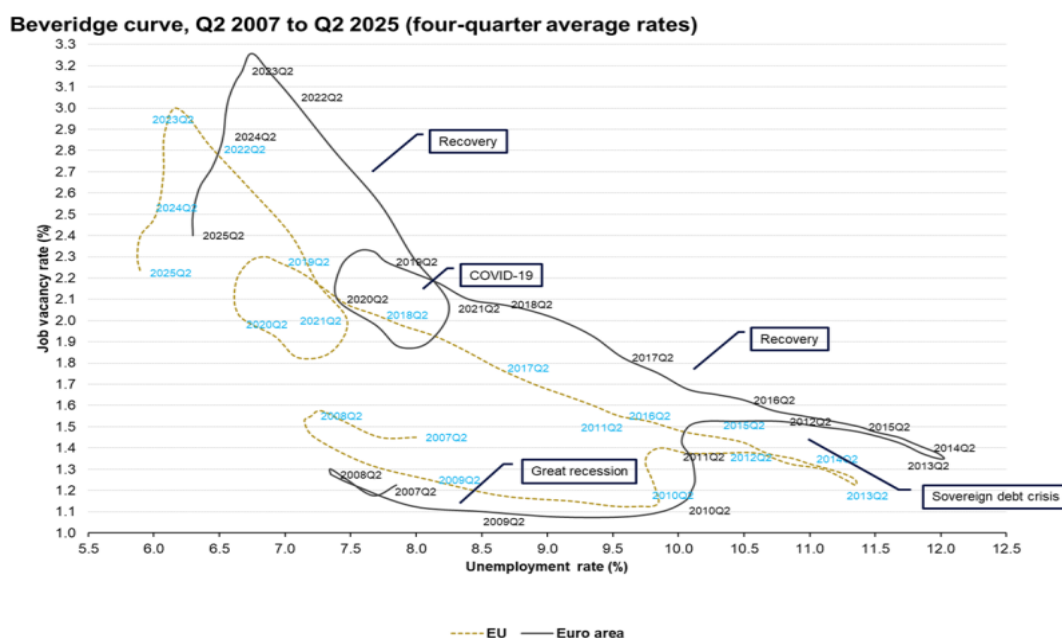
In 2020 the unemployment rate was lower than in 2008-2010 and demand was higher. The recovery took 1-2 years, the demand in 2022 reached the level of 2019, if it was higher, the Beveridge Curve could be equal to 2018. There are a set of factors in labour market, the actions of which does not allow employer demand to be restored to 2018 levels. This may be investigated in the future.

4.3. Comparison of the Beveridge Curve in Moldova, US and EU

Using the possibility to compare the Beveridge Curve in Moldova with the Beveridge Curve in the EU (Figure 7 and Figure 8) and in Moldova and the USA (Figure 9).

The recovery of demand indicators in the EU after the Great Depression was about 5 years (2011-2016) and of unemployment indicator 10 years (2011-2021). The period of the COVID-19 pandemic in the EU was characterised by a 0.5 pp decrease in employer demand and a 0.5 pp increase in the unemployment rate to 7.5%. This significantly differs the EU from the changes in the US and in the Republic of Moldova. Thus, in 2020 in Moldova, unemployment increased in 2008-2010 to 6.5% and in 2020 to 5.5%. The recovery from the pandemic was 1-2 years. The presence of the Beveridge Curve loop is noteworthy. At the same time, it should be noted that the values of the vacancy rate in the EU are low compared to the Republic of Moldova and the USA, which may have a negative impact on increasing economic growth in the EU countries. In turn, the values of unemployment and vacancies represent average values in the EU.

Figure 7. Beveridge Curve, EU, Q2 2007-Q2 2025, %



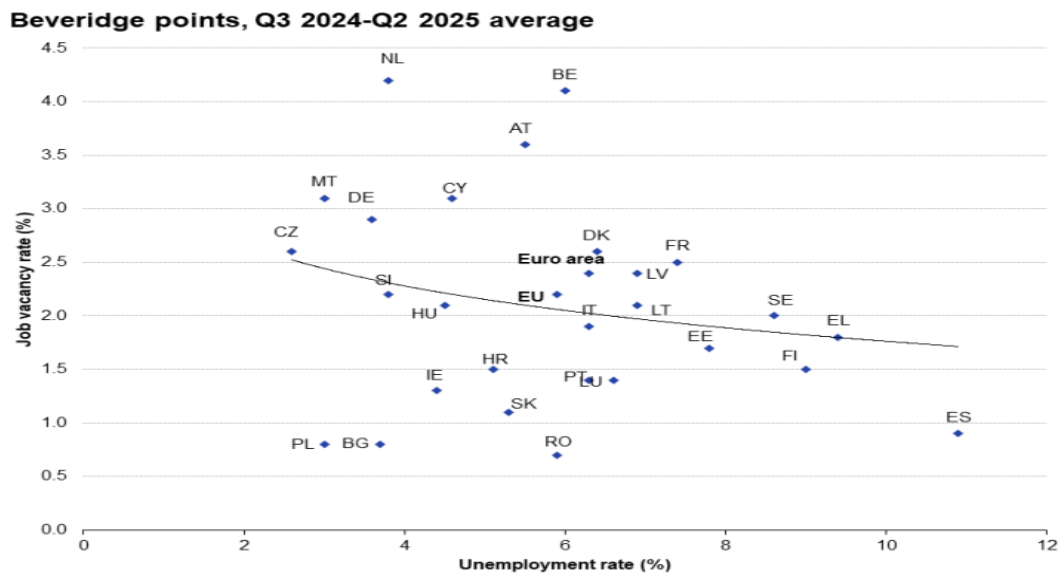
Source: Eurostat (online data codes: jvs_q_nace2, lfsq_urban)

eurostat

Source: Eurostat, data codes (jvs_q_nace2) and (lfsq_urban), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Job_vacancy_and_unemployment_rates_-_Beveridge_curve#cite_ref-1

The examination of the EU member states, in 2023-2024 the following countries are at risk: Estonia – 11-12% unemployment, Italy – 6-8%, Lithuania - 7%, France – 7-8%. Countries with insufficient demand: Romania, Bulgaria, Estonia, Poland have below 1% vacancies. The most favourable countries are the Czech Republic, Germany, Holland, Austria and Belgium, with demand above 3.5% and unemployment below 6.0%.

Figure 8. Beveridge points, EU, Q3 2024- Q2 2025, %



Source: Eurostat (online data codes: jvs_q_nace2, lfsq_urban)

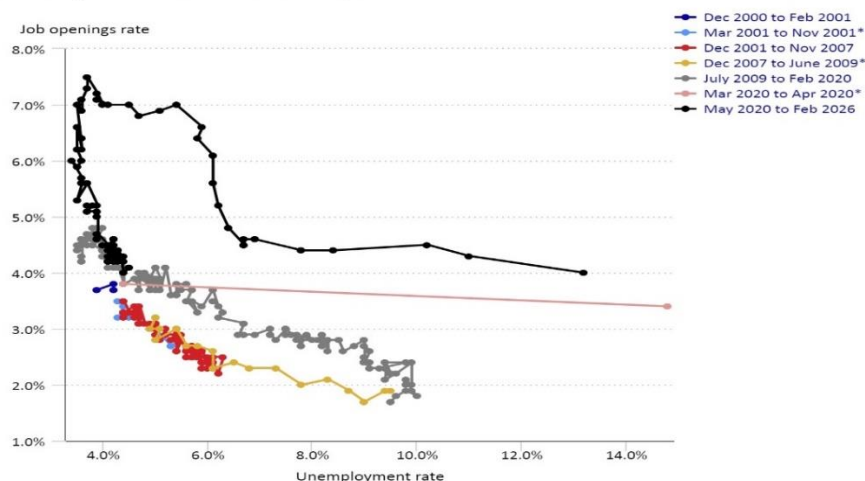
eurostat

Source: Eurostat, data codes (jvs_q_nace2), (lfsq_urban), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Job_vacancy_and_unemployment_rates_-_Beveridge_curve#cite_ref-1

Beveridge Curve analysis of the US in 2008-2011 showed that unemployment rose to 10% and the gradual recovery took 10 years. In 2019-2020, the unemployment rate rised to 12%. The country has adopted an unprecedented package of measures, such as increasing the duration of unemployment benefits and its amount by \$800, compensating utility payments to the unemployed, allocating money to the population in two tranches in 2020 and 2021, etc. Adoption of these measures allows to recover the US economy and stabilise the labour market. At the same time, it should be noted that pensioners left the US labour market during the pandemic, and later some pensioners did not return to labour market.

Figure 9. Beveridge Curve, USA, 2000-2026, %

The Beveridge Curve (job openings rate vs. unemployment rate), seasonally adjusted
Click and drag within the chart to zoom in on time periods



Source: U.S. Bureau of Labor Statistics.



Source: U.S. Bureau of Labor Statistics, <https://www.bls.gov/charts/job-openings-and-labor-turnover/job-openings-unemployment-beveridge-curve.htm#>

5. CONCLUSION

The conducted analysis of labour market in the Republic of Moldova for the period 2014-2024 allowed to highlight the following trends and conclusions:

- The national labour market in the Republic of Moldova is sustainable and can withstand both external shocks and internal factors negatively affecting it. The labour market, according to the Beveridge Curve, tends to equilibrium despite the fluctuations.

- Demand in the labour market does not exceed 35,000 vacancies despite the increase in unemployment. The trend in labour market is that employers are reducing their demand in labour market. This trend started after 2018, also as a consequence of external shocks.

- The shift of the Beveridge curve after 2020 indicates structural changes in labour market. The analysis of the employed population and vacancies by types of labour activity identified the sectors in which the share of employed workers decreased and the share of vacancies increased.

Comparison of the Beveridge Curve for 2008-2018 and for 2014-2024 allowed to determine that the labour market recovery in the Republic of Moldova was 10 years. The labour market in the EU recovered for 5 years and 10 years in the USA.

In the Republic of Moldova, the labour market has improved the unemployment indicators and has not reached the vacancy rate of 2018. There are a number of factors at play in labour market, the effects of which do not allow to restore the demand from employers to the 2018 level. This could be future research.

The analysis of the labour market, using the Beveridge Curve, allows developing proposals for improving labour market policies in Moldova and measures to improve the state of the labour market in the Republic of Moldova.

REFERENCES

1. Beveridge W.H. (1944). Full employment in a Free Society. London: George Allen and Unwin.
2. Blanchard O.J., Diamond P. (1989). The Beveridge Curve. *Brookings Papers on Economic Activity*, nr. 1, pp. 1-76.
3. Börsch-Supan A. H. (1991). Panel Data Analysis of the Beveridge Curve: Is There a Macroeconomic Relation between the Rate of Unemployment and the Vacancy Rate? *Economica*, New Series, Vol. 58, No. 231 (Aug., 1991), pp. 279-297.
4. Cheremukhin A. Revisiting the odd behavior of the Beveridge curve as unemployment stays low. <https://www.dallasfed.org/research/economics/2024/0305>
5. Diamond P., Şahin A. (2014). Shifts in the Beveridge Curve. *Staff Reports* (Federal Reserve Bank of New York), nr. 687, august 2014. 15 p.
6. Dow, J.C.R. and Dicks-Mireaux, L. (1958). The Excess demand for labour: A study of conditions in Great Britain, 1946–1956. *Oxford Economic Papers*, 10: pp. 1–33.
7. Hobijn B., Şahin A. (2013). Beveridge curve shifts across countries since the great recession. *IMF Economic Review*, Dec. 2013, Vol. 61, Issue number 4, pp. 566-600.
8. Kasrin Z., Lang G. (2010). Estimating the Beveridge Curve of Egypt: An Econometric Study for the Period 2004 to 2010. GUC Working Paper Series, nr. 21, 24 p.
9. Layard R., Nickell S., Jackman R. (2005). Unemployment: Macroeconomic performance and the labour market. United Kingdom: Oxford University Press, 626 p.

10. Mortensen, D., Pissarides, Ch. (1994). Job Creation and Job Destruction in the Theory of Unemployment. *Review of Economic Studies*, 1994, Vol. 61, nr. 3, 397-415.
11. Nickell S., Nunziata L., Ochel W. and Quintini G. (2001). The Beveridge Curve, Unemployment and Wages in the OECD from the 1960s to the 1990s. Bank of England (Conference at the Bank of Portugal). <https://www.bankofengland.co.uk/-/media/boe/files/speech/2001/the-beveridge-curve-unemployment-and-wages-in-the-oecd>
12. Pissarides Ch. (1986). Unemployment and vacancies in Britain. *Economic Policy*, nr. 1, pp. 499-559.
13. Webster E. (1997). Labour market programs and the Australian Beveridge curve: 1978 to 1996*. *Melbourne Institute Working Paper*, 1997, nr. 25, 36 p. https://melbourneinstitute.unimelb.edu.au/downloads/working_paper_series/wp1997n25.pdf
14. Savelieva G., Zaharov S. (2019). Assessment of labour market tightness in the municipality of Chişinău. In: Economic Growth in Conditions of Globalization: welfare and inclusion: the 14th edition of the international conference on theoretical and applied economic practices, 10-11 october 2019. National Institute for Economic Research (NIER). Chişinău: INCE, 2019. p. 77-90. DOI: <https://doi.org/10.36004/nier.cdr.2019.14-10>, https://ince.md/uploads/Conferinta_2019/Sesiunea_stiintifica_Demografie_Conferinta_2019.pdf. . (in Russian).
15. Savelieva G., Zaharov S. (2024). Analysis of labour market tightness in the Republic of Moldova. In: Economic growth in the face of global challenges. Consolidation of national economies and reduction of social inequalities: Conference proceedings: International Scientific-Practical Conference, XVIIIth edition, October 10-11, 2024, Chisinau. Chisinau: [S. n.], SEP ASEM, vol. IV: Scientific session managing demographic processes: innovative approaches, pp. 117-135. <https://doi.org/10.36004/nier.cdr.18.2024.15>, <https://doi.org/10.36004/nier.cdr.18.2024>. (in Russian).
16. Zaharov S. (2017). Causes of intensity of labour market in Moldova. *ЕКОНОМІКА. ФІНАНСИ. МЕНЕДЖМЕНТ: актуальні питання науки і практики, ECONOMY. FINANCES. MANAGEMENT: actual issues of science and practical activity*, nr. 10(26), pp. 35-46. ISSN 2411-4413. <http://efm.vsau.org/files/pdfa/3956.pdf>

GLOBAL DYNAMICS OF MERGERS AND ACQUISITIONS AND THE ROLE OF DIGITAL SECTORS: EMPIRICAL EVIDENCE FROM SOFTWARE AND IT CONSULTING

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ABSTRACT: *Mergers and acquisitions have become increasingly connected to the expansion of digital technologies and the growing strategic importance of software and IT-related activities. This paper investigates the relationship between global M&A activity and transactions in the software and IT consulting & services sectors using monthly data covering the 2018–2025 period. The empirical analysis relies on an ARDL framework combined with co-integration techniques, error correction modeling, and several diagnostic and causality tests. The findings reveal a stable long-run association between worldwide M&A activity and the digital sector analyzed, with IT consulting & services showing the strongest impact on global transaction dynamics. The inclusion of a COVID-19 dummy variable improves the model specification and confirms the disruptive effect of the pandemic on merger and acquisition activity. The study highlights the growing relevance of digital sectors in explaining changes in the global M&A environment and emphasizes the importance of technological capabilities in contemporary corporate restructuring strategies.*

Keywords: *Mergers and Acquisitions; Global M&A; Digital Economy; Software Industry; IT consulting; ARDL model; cointegration*

JEL Classification: *G34, L86, O33, C32, F23*

1. INTRODUCTION

Mergers and acquisitions (M&A) transactions are widely used by firms seeking rapid expansion, access to strategic assets, and organizational restructuring opportunities. Through these transactions, companies can access new markets, acquire financial and technological resources, integrate specialized competencies, and strengthen their competitive position within a shorter timeframe than would be possible through organic growth. For this reason, global M&A activity is closely linked to investment dynamics, the evolution of financial markets, and the processes of globalization and value chain reorganization.

The increasing integration of digital technologies into business activity has altered the strategic motivations behind many acquisition decisions. Digital assets such as software, IT services, data infrastructure, and technological capabilities have become strategic elements in

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corporate decision-making processes. In this context, M&A transactions no longer aim exclusively at expanding market share, but also at rapidly acquiring technologies, human capital, and know-how necessary for adaptation to the digital economy. Recent literature highlights that digitalization can influence both the frequency of M&A transactions and the value created or destroyed through these operations (Tang, Fang și Jiang 2022), (Jiang, și alții 2023), (Maisenhelder, și alții 2025), (Shi, și alții 2026).

Against this background, the article analyzes the relationship between global mergers and acquisitions activity and the dynamics of transactions in two digital-intensive sectors: software and IT consulting & services. The study is based on the premise that these sectors are not only components of the digital economy, but also relevant indicators of companies' strategic orientation toward digital transformation.

The main contribution of the study consists in the empirical analysis of this relationship using monthly data for the 2018–2025 period, as well as in assessing the impact of a major exogenous shock represented by the COVID-19 pandemic. The methodology employed allows for the identification of co-integration, causality, and long-run adjustment relationships among the analyzed variables.

2. MERGERS AND ACQUISITIONS IN THE CONTEXT OF THE DIGITAL ECONOMY

The transformations generated by digitalization have changed not only the way the economy functions, but also the strategic behavior of companies. In this context, mergers and acquisitions represent an essential instrument through which firms adapt their structure, strengthen their market position, and gain access to technological and organizational resources.

Analyzing the relationship between global M&A activity and the digital economy requires an integrated approach that includes both the traditional determinants of transactions and the role of digital sectors. In this regard, the present section outlines the main directions in the literature concerning M&A dynamics, the digital economy, and the specific characteristics of transactions in technology-related sectors.

2.1. Global Mergers and Acquisitions Activity

Mergers and acquisitions activity is characterized by a cyclical evolution, influenced by macroeconomic factors, financing conditions, and capital market dynamics. Periods of economic growth, financial stability, and high liquidity are generally associated with an intensification of transactions, as companies benefit from easier access to financing and display a greater tolerance for risk. Conversely, periods marked by economic uncertainty, financial volatility, or external shocks lead to a decline in M&A activity, as investors and companies become more cautious regarding expansion and investment decisions. The specialized literature shows that the evolution of M&A activity is closely linked to global economic cycles, being influenced both by monetary conditions and interest rate levels, as well as by investor confidence and expectations regarding economic growth.

In addition to these traditional determinants, recent literature highlights that mergers and acquisitions represent an essential mechanism for adapting to the structural transformations of the global economy. In the context of globalization and accelerating technological progress, companies use M&A transactions to reorganize activities, strengthen competitive advantages, and gain rapid access to strategic resources, technologies, and new competencies. M&A transactions enable firms to enter international markets, optimize value chains, and respond more efficiently to competitive pressures generated by the digital economy (Keenan și Wójcik 2023). At the same time, in recent years, digitalization has become an important factor driving the intensification of transactions, as numerous companies pursue acquisitions to obtain digital

capabilities and access to technologies based on artificial intelligence, big data, or digital platforms (Hao 2025).

From this perspective, mergers and acquisitions are no longer viewed exclusively as instruments of economic growth or market share expansion, but also as means through which companies accelerate their digital transformation and innovation processes. The literature shows that firms increasingly resort to acquisitions to integrate innovative technologies, digital resources, and specialized human capital, since the internal development of such capabilities may involve high costs and a longer time horizon. In this context, M&A transactions contribute to increasing competitiveness and facilitating companies' adaptation to the new conditions of the global digital economy (Maisenhelder, și alții 2025).

Mergers and acquisitions can also be analyzed from a spatial perspective, as they redistribute corporate control and reshape international economic relations through cross-border capital flows. M&A activity is unevenly distributed across sectors and regions, with technology and digital services accounting for an increasing share of global transactions.

Recent literature increasingly highlights the importance of non-financial factors in M&A success. Besides financial considerations, sustainability, corporate governance, cultural integration, and technological compatibility can strongly influence post-merger performance. In cross-border transactions, regulation, data protection, and compliance standards also play a key role in determining transaction success (González-Torres, et al. 2020), (Feng, Li and Nie 2024).

2.2. The Digital Economy and the Role of the Software and IT Consulting Sectors

The emergence of the digital economy has increased the importance of data, software infrastructure, and technological capabilities in corporate value creation. At the same time, the expansion of technologies such as artificial intelligence, cloud computing, big data, and digital platforms has significantly transformed both organizational structures and business processes. In this context, digitalization has evolved beyond a purely technological phenomenon and has become a strategic factor influencing competitiveness and firms' long-term adaptability (Ren, Liu și Hao 2024).

The software and IT consulting & services sectors play a central role in this process, as they provide the infrastructure and expertise necessary for implementing digital solutions. These sectors contribute to the development of software applications, digital platforms, and consulting services that enable process automation, activity optimization, and the integration of digital technologies into corporate strategies. The literature highlights that firms increasingly use investments and M&A transactions to rapidly acquire digital capabilities, access to innovative technologies, and specialized human resources, particularly in the software and IT services fields (Hao 2025).

Empirical research shows that digitalization can reduce financing constraints and improve informational transparency, thereby contributing to greater market efficiency. By improving reporting processes and information transmission, digital transformation reduces information asymmetry between firms and investors, facilitating companies' access to capital and lowering financing costs. At the same time, digitalization contributes to improving the quality of information available on the market and increasing investor confidence in corporate activity (Guo, și alții 2024), (Cheng, Li și Zhao 2024).

Moreover, the development of digital infrastructure contributes to reducing information costs and facilitating coordination among firms, which may stimulate mergers and acquisitions activity. The expansion of broadband infrastructure and the development of digital ecosystems enable faster information flow and reduce geographical constraints in investment processes. Therefore, digitalization influences not only firm performance, but also the dynamics of

corporate transactions and the process of economic reorganization within the global economy (Sun, Kong și Tao 2023).

2.3. Mergers and Acquisitions in Digital Sectors

Transactions in digital sectors display distinct characteristics compared to traditional ones, being primarily driven by access to technology, data, and specialized human capital. In the digital economy, mergers and acquisitions are used not only for market share expansion, but also for the rapid acquisition of technological capabilities that can support innovation and firms' digital transformation. Thus, M&A has become a strategic instrument through which companies respond to competitive pressures and the acceleration of technological change.

Companies use these transactions to quickly integrate innovative technologies, digital platforms, and specialized human resources, since the internal development of such capabilities may involve high costs and a slower adaptation process. In particular, the software and IT consulting & services sectors are characterized by a high level of dynamism and innovation, making them attractive fields for investors and corporate consolidation strategies. The literature highlights that, in the digital economy, firms pursue through M&A access to technologies based on artificial intelligence, cloud computing, big data, and integrated digital ecosystems (Hao 2025).

The specialized literature shows that digital acquisitions can generate positive effects on market value and company performance, especially when they allow the efficient integration of technological resources and the development of competitive advantages. However, transaction outcomes largely depend on the strategic compatibility between firms, post-acquisition integration capacity, and the effective use of the human and technological capital acquired through the transaction. Cultural differences, organizational integration difficulties, and technological incompatibility may reduce transaction efficiency and negatively affect long-term performance (Tang, Fang și Jiang 2022), (Maisenhelder, și alții 2025).

Furthermore, the development of digital finance and the process of digital transformation may stimulate M&A activity by reducing financing constraints and improving access to information. The literature emphasizes that digitalization contributes to reducing information asymmetry and increasing transparency, thereby facilitating firms' access to capital and supporting investment and innovation processes. In this context, digital transformation influences not only firm performance, but also the intensity and structure of corporate transactions within digital sectors (Jiang, și alții 2023), (Shi, și alții 2026), (Xu, și alții 2025).

Within the FinTech and RegTech sectors, the literature indicates the existence of specific valuation models influenced by transaction characteristics and the nature of the digital assets involved. Transactions in these fields are evaluated not only through the lens of traditional financial assets, but also according to the value of technologies, digital platforms, data, and innovation capacity. These particularities highlight the need for a differentiated approach to mergers and acquisitions in the digital economy, especially in sectors characterized by rapid innovation and high technological intensity (Seitanidis, Aggelopoulos și Grypeos 2026).

3. CASE STUDY: EMPIRICAL ANALYSIS OF M&A ACTIVITY

The findings highlighted in the specialized literature require empirical validation in order to analyze the relationships between global mergers and acquisitions activity and digital sectors. For this purpose, the research hypotheses are defined, the dataset used is described, and the econometric methodology is presented, followed by the analysis and interpretation of the obtained results.

3.1. Research Objectives and Hypotheses

Building on the literature concerning digital transformation, technological infrastructure, and acquisitions in digital sectors, the empirical analysis aims to investigate the relationship between global mergers and acquisitions activity and the dynamics of transactions in the software and IT consulting & services sectors. In this context, the following research hypotheses are formulated:

H1: There is a positive long-run relationship between the global value of M&A transactions and the value of transactions in the IT consulting & services sector.

H2: There is a positive long-run relationship between the global value of M&A transactions and the value of transactions in the software sector.

H3: The COVID-19 pandemic shock had a negative and significant effect on the global value of M&A transactions during the March 2020 – December 2020 period.

3.2. Data Sources and Description of Variables

The empirical analysis uses data provided by the Institute for Mergers, Acquisitions and Alliances (IMAA 2026) regarding the value of M&A transactions at global and industry levels. Three monthly series were used: the global value of M&A transactions (WW_Value), the value of M&A transactions in the software sector (Software_Value), and the value of M&A transactions in the IT consulting & services sector (IT_Value). The analyzed period covers January 2018 – December 2025, resulting in 96 observations for each series.

Table 1. Model Variables Regarding Mergers and Acquisitions in Digital Sectors

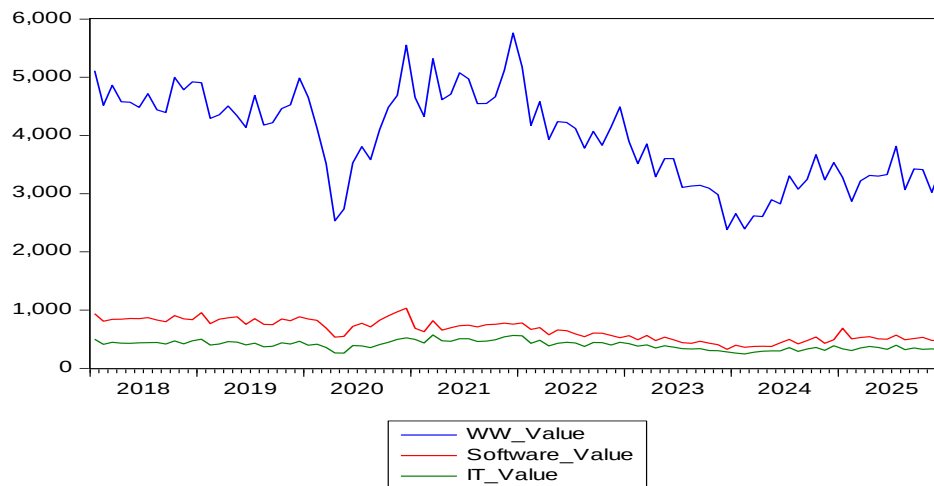
Variable	Description	Unit of Measurement	Role in the Model
WW_Value	Value of global M&A transactions	billion USD	Dependent variable
Software_Value	Value of M&A transactions in the software sector	billion USD	Explanatory variable
IT_Value	Value of M&A transactions in the IT consulting & services sector	billion USD	Explanatory variable
COVID	Dummy variable for March 2020 – December 2020	0/1	Control variable

Source: author's own processing based on (IMAA 2026)

To highlight the evolution over time of mergers and acquisitions activity and to observe the dynamics of the relationship between global transactions and those in digital sectors, the analyzed series were graphically represented. Visual representation allows for the identification of general trends, fluctuations, and possible structural changes associated with the economic context and the digitalization process.

It can be observed that the WW_Value series records the highest values and significantly greater volatility compared to the sectoral series, reflecting the sensitivity of global M&A activity to international economic and financial changes. At the same time, the Software_Value and IT_Value series exhibit lower fluctuations, suggesting a relatively more stable evolution of transactions within the digital sectors.

Figure 1. Evolution of the Real Series WW_Value, Software_Value, and IT_Value

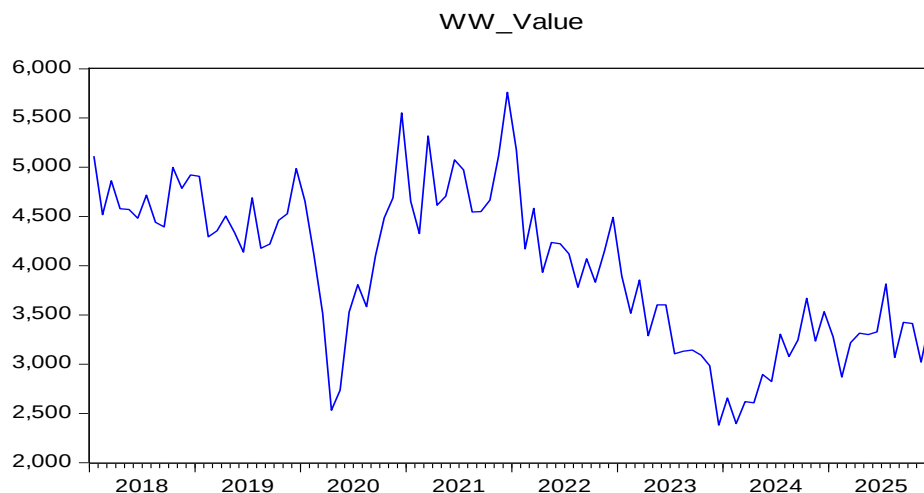


The graph indicates a pronounced decline in transaction values around 2020, associated with the effects generated by the COVID-19 pandemic and the increase in global economic uncertainty. Subsequently, a period of recovery and adjustment in M&A activity can be observed, both at the global level and within the software and IT consulting sectors. At the same time, the evolution of the series suggests the existence of a relationship between the dynamics of global transactions and those of transactions in digital fields, which justifies the inclusion of the Software_Value and IT_Value variables in the empirical model.

It can also be noted that the software sector records higher values than the IT consulting & services sector throughout the entire period analyzed, which may reflect the growing importance of software solutions and digital technologies in global mergers and acquisitions strategies.

To capture more clearly the dynamics of the dependent variable, the evolution of the global value of M&A transactions (WW_Value) was analyzed separately.

Figure 2. Evolution of the Global Value of M&A Transactions (WW_Value))

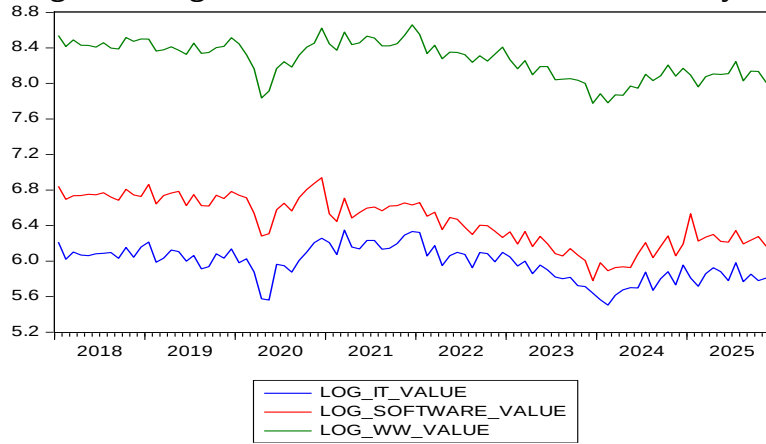


The graphical analysis highlights a sharp decline in March 2020, associated with the outbreak of the COVID-19 pandemic, suggesting the existence of a possible structural break. For a comparative perspective, the real series of the variables used in the model are also represented.

3.3. Data Processing and Testing of Statistical Properties

Since the analyzed series are expressed in monetary values and may present significant scale differences, the variables were logarithmically transformed. The logarithmic transformation facilitates the interpretation of coefficients as elasticities and reduces the effect of extreme values. Before estimating the model, the stationarity of the series was tested using the Augmented Dickey-Fuller (ADF) test. For the WW_Value and Software_Value series, both trend and intercept components were included, as the graphical representations indicate a slight downward trend. For the IT_Value series, the model with intercept was used.

Figure 3. Log-Transformed Series Used in the Analysis



The ADF test results indicate that WW_Value and Software_Value are trend-stationary, while IT_Value becomes stationary after first-order differencing. This combination of I(0) and I(1) variables justifies the use of the ARDL methodology, provided that none of the series is integrated of order two.

3.4. Model Estimation and the Co-integration Relationship

The ARDL (Auto Regressive Distributed Lags) approach was selected because it allows the estimation of long-run relationships in models combining variables integrated at different orders, while also remaining appropriate for limited sample sizes.

In the first stage, an ARDL model with a deterministic trend was estimated, in the following form:

$$\text{LOG_WW_VALUE} = C(1)*\text{LOG_WW_VALUE}(-1) + C(2)*\text{LOG_IT_VALUE} + C(3)*\text{LOG_SOFTWARE_VALUE} + C(4)*\text{LOG_SOFTWARE_VALUE}(-1) + C(5) + C(6)*\text{@TREND}$$

Subsequently, the co-integration relationship was tested using the F-bounds test

Figure 4. Results of the F-bounds Test for the ARDL Model

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic k	31.83951 2	10%	3.38	4.02
		5%	3.88	4.61
		2.5%	4.37	5.16
		1%	4.99	5.85

When the calculated F-statistic is higher than the upper critical bound associated with I(1) variables, the null hypothesis of no long-run relationship is rejected, supporting the use of the VECM specification. In the present analysis, the F-statistic exceeds the upper bound value, confirming the existence of a co-integration relationship between the variables.

Figure 5. Estimation of the Co-integration Relationship (VECM)

Levels Equation Case 4: Unrestricted Constant and Restricted Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_IT_VALUE	0.819114	0.060218	13.60249	0.0000
LOG_SOFTWARE_VALUE	0.183534	0.062561	2.933696	0.0043
@TREND	-0.000315	0.000450	-0.700704	0.4853
EC = LOG_WW_VALUE - (0.8191*LOG_IT_VALUE + 0.1835 *LOG_SOFTWARE_VALUE -0.0003*@TREND)				

The model equation is:

$$EC = LOG_WW_VALUE - (0.8191*LOG_IT_VALUE + 0.1835 \\ *LOG_SOFTWARE_VALUE -0.0003*@TREND)$$

A 1% increase in IT_Value leads to a 0.81% increase in WW_Value. A 1% increase in Software_Value leads to a 0.18% increase in WW_Value. The deterministic trend was initially included in the model, considering that two of the three series exhibit trend-stationary characteristics. Although the trend coefficient is not statistically significant, its inclusion may contribute to a more appropriate model specification. Both coefficients are significant (p-value < 5%), indicating the existence of a significant long-run effect on the dependent variable.

Next, the error correction form is analyzed. According to the results presented in the figure below, the coefficient associated with the CointEq(-1) term is negative and significant, which means that there is long-run causality. At the same time, it measures the speed of adjustment from any disequilibrium toward the long-run equilibrium state. In our case, the adjustment speed is 75.5%, which represents a high value.

Figure 6. Error Correction Form for the Initial Model

ECM Regression Case 4: Unrestricted Constant and Restricted Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.666059	0.145254	11.46994	0.0000
D(LOG_SOFTWARE_...	0.251133	0.049923	5.030371	0.0000
CointEq(-1)*	-0.755271	0.065825	-11.47393	0.0000
R-squared	0.821952	Mean dependent var	-0.004170	
Adjusted R-squared	0.818082	S.D. dependent var	0.106758	
S.E. of regression	0.045534	Akaike info criterion	-3.309627	
Sum squared resid	0.190751	Schwarz criterion	-3.228978	
Log likelihood	160.2073	Hannan-Quinn criter.	-3.277038	
F-statistic	212.3575	Durbin-Watson stat	1.963507	
Prob(F-statistic)	0.000000			

* p-value incompatible with t-Bounds distribution.

3.5. Extended Model with the COVID-19 Variable

In order to capture the effect of the pandemic, a dummy variable (COVID) was introduced, equal to 1 during the March–December 2020 period and 0 otherwise. The ARDL model without trend indicates the existence of a co-integration relationship, and a VECM model was subsequently estimated. The results highlight that a 1% increase in IT_Value leads to an approximately 0.71% increase in WW_Value, while for Software_Value the effect is 0.28%. The coefficient of the COVID variable is negative and statistically significant, indicating an average reduction of approximately 6.45% in the global value of M&A transactions during the analyzed period.

Figure 7. Estimation of the ARDL Model with the COVID Variable

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_SOFTWARE_VAL...	0.285913	0.034778	8.221085	0.0000
LOG_IT_VALUE	0.711483	0.050337	14.13435	0.0000
COVID	-0.064462	0.019033	-3.386933	0.0010
C	2.180609	0.169783	12.84353	0.0000
EC = LOG_WW_VALUE - (0.2859*LOG_SOFTWARE_VALUE + 0.7115 *LOG_IT_VALUE -0.0645*COVID + 2.1806)				
F-Bounds Test Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	91.08727	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Next, the error correction form is analyzed. The results presented in Figure 8 indicate that the coefficient of CointEq(-1) is negative and significant, which means that there is long-run causality. At the same time, it measures the speed of adjustment from any disequilibrium toward the long-run equilibrium state. In our case, the adjustment speed is 88.9%, which represents a high value. Compared to the initial model, the model including the COVID variable exhibits a higher adjustment speed, a higher R-squared, and a lower AIC criterion. Therefore, the model with the COVID variable is considered preferable.

Figure 8. Error Correction Form for the Final Model

ECM Regression Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.889693	0.040793	-21.81004	0.0000
R-squared	0.834740	Mean dependent var		-0.004170
Adjusted R-squared	0.834740	S.D. dependent var		0.106758
S.E. of regression	0.043400	Akaike info criterion		-3.426265
Sum squared resid	0.177051	Schwarz criterion		-3.399382
Log likelihood	163.7476	Hannan-Quinn criter.		-3.415402
Durbin-Watson stat	2.002072			

* p-value incompatible with t-Bounds distribution.

3.6. Additional Analyses and Evaluation of Result Robustness

To validate the existence of a structural break, the Chow test was applied. The selected month was March 2020, the month in which the pandemic was officially declared at the global level. The null hypothesis is rejected ($p\text{-value} < 0.05$), indicating the existence of a structural break in the selected month. The test result confirms the initial observation based on the graphical analysis, according to which the pandemic generated a structural break in the evolution of the WW_Value variable.

Figure 9. Chow Test for Structural Break (March 2020)

Chow Breakpoint Test: 2020M03			
Null Hypothesis: No breaks at specified breakpoints			
Varying regressors: All equation variables			
Equation Sample: 2018M01 2025M12			
F-statistic	7.638918	Prob. F(3,90)	0.0001
Log likelihood ratio	21.77675	Prob. Chi-Square(3)	0.0001
Wald Statistic	22.91675	Prob. Chi-Square(3)	0.0000

To investigate the causal relationships between the variables, the Granger test is applied. The null hypotheses are presented below, and the results highlight the existence of a causal relationship running from SOFTWARE_VALUE to WW_Value, as well as from WW_Value to IT_Value.

Figure 10. Results of the Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_SOFTWARE_VALUE does not Granger Cause LOG_IT_VALUE	94	1.82400	0.1674
LOG_IT_VALUE does not Granger Cause LOG_SOFTWARE_VALUE		1.59008	0.2096
LOG_WW_VALUE does not Granger Cause LOG_IT_VALUE	94	4.84489	0.0101
LOG_IT_VALUE does not Granger Cause LOG_WW_VALUE		0.35571	0.7017
LOG_WW_VALUE does not Granger Cause LOG_SOFTWARE_VALUE	94	0.91319	0.4050
LOG_SOFTWARE_VALUE does not Granger Cause LOG_WW_VALUE		3.31585	0.0408

The results of the Granger test highlight the existence of both bidirectional and unidirectional causal relationships. To verify the existence of short-run causality, the Wald test was applied to the model coefficients. The results indicate the rejection of the null hypothesis, confirming the existence of a short-run causal relationship.

Figure 11. Wald Test for Short-Run Causality

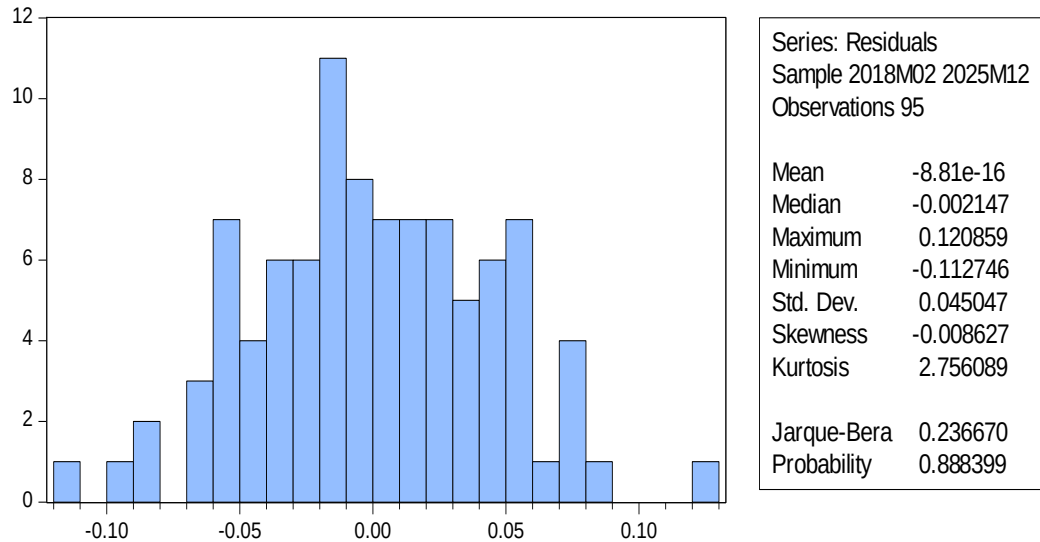
Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	242.9151	(4, 89)	0.0000
Chi-square	971.6604	4	0.0000
Null Hypothesis: C(1)=C(2)=C(3)=C(4)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value	Std. Err.	
C(1)	0.244729	0.069658	
C(2)	0.618652	0.062928	
C(3)	0.251133	0.058240	
C(4)	-0.112515	0.063103	

Restrictions are linear in coefficients.

3.7. Diagnostic and Stability Tests

To verify the normality assumption of the residuals, the Jarque-Bera test was used. The results indicate that the null hypothesis cannot be rejected, suggesting that the residuals are normally distributed. This finding supports the validity of the statistical inferences made within the model.

Figure 12. Jarque-Bera Test for Residual Normality



H0: There is no serial correlation among the residuals.

Figure 13. Residual Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.375736	Prob. F(2,87)	0.6879
Obs*R-squared	0.813545	Prob. Chi-Square(2)	0.6658

H0: The residuals are homoscedastic (have constant variance)

Figure 14. Residual Heteroskedasticity Test

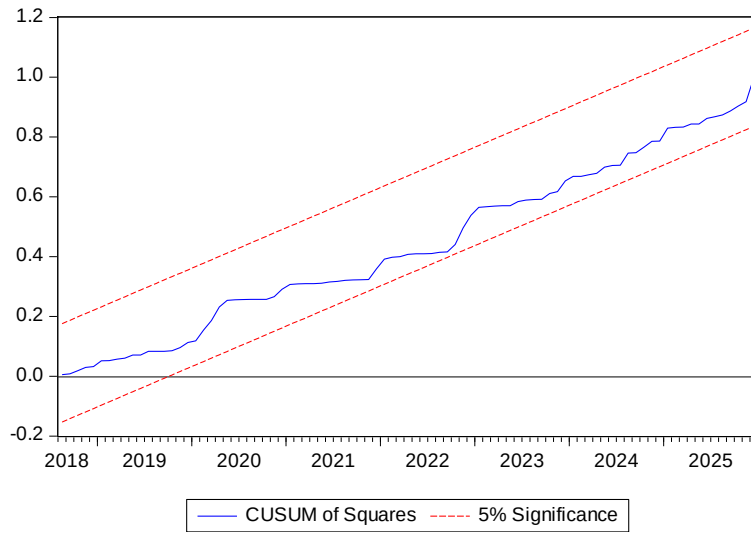
Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.018744	Prob. F(5,89)	0.0836
Obs*R-squared	9.676731	Prob. Chi-Square(5)	0.0849
Scaled explained SS	7.457238	Prob. Chi-Square(5)	0.1888

The results presented in the figures above indicate that the residuals are homoscedastic and that there is no serial correlation among them.

To verify the stability of the estimates, the CUSUM of Squares test was applied. Model stability is confirmed when the trajectory of the test statistic remains within the interval bounded by the confidence lines.

Figure 15. CUSUM of Squares Test



In conclusion, the results of the residual and stability analyses indicate that the IT_Value and Software_Value variables exert a positive effect on WW_Value, both in the short run and in the long run. The introduction of the variable associated with the pandemic highlights the role of a relevant external factor, the omission of which could have led to different coefficient estimates. Although their sign would likely have remained unchanged, the inclusion of the COVID variable results in a more appropriate model specification. The study is limited by the relatively small number of included variables and the sample size, aspects that may influence the interpretation and the degree of generalization of the results.

3.8. Interpretation of Results and Implications

The obtained results are consistent with the literature supporting the strategic role of digitalization in the dynamics of corporate transactions. The positive relationship between IT consulting, software, and global M&A activity suggests that digital sectors function as relevant indicators of the strategic direction of the market. In an economy where digital technologies influence productivity, innovation, and business models, transactions in software and IT consulting may reflect both the need for digital transformation and the competition for access to technological resources.

The higher coefficient of the IT_Value variable, compared to Software_Value, may be interpreted through the transversal role of IT consulting & services. These services facilitate the implementation of digital solutions, system integration, process transformation, and organizational adaptation. In contrast, the software sector may have a more specialized, yet still significant, effect on the global value of M&A transactions.

The negative effect of the pandemic confirms that external shocks can temporarily alter the dynamics of the M&A market. During the March–December 2020 period, global uncertainty, mobility restrictions, valuation difficulties, and investor caution affected transaction values. However, the rapid adjustment toward long-run equilibrium suggests that the M&A market had a relatively high recovery capacity, particularly through its orientation toward digital sectors.

4. CONCLUSIONS

The study examined the relationship between global mergers and acquisitions activity and transactions in the software and IT consulting & services sectors using monthly data covering the 2018–2025 period. The empirical findings indicate the existence of a positive and statistically significant long-run association between worldwide M&A activity and the analyzed digital sectors.

The extended ARDL model that incorporates the COVID-19 dummy variable provides a more appropriate specification than the initial version, as it captures the disruptive impact of the pandemic on global M&A dynamics and improves the overall performance of the model. The positive coefficients associated with the software and IT consulting & services sectors suggest that these industries are strongly connected to the evolution of the global M&A market. Moreover, the stronger coefficient estimated for IT consulting & services points to the growing strategic relevance of specialized digital services in corporate consolidation processes.

From a theoretical standpoint, the results reinforce the view that digital transformation is reshaping the motivations underlying mergers and acquisitions. Contemporary M&A strategies are increasingly oriented toward acquiring technological capabilities, digital expertise, and specialized human capital, rather than focusing exclusively on geographical expansion or market share growth. From a practical perspective, developments in the software and IT consulting sectors may serve as useful indicators for understanding broader tendencies in the international M&A environment.

Several limitations should nevertheless be acknowledged, including the relatively small number of variables included in the model, the restricted time horizon, and the use of aggregated global data. Future research could broaden the analysis by incorporating additional macroeconomic indicators, such as inflation, interest rates, stock market developments, or measures of economic uncertainty. Further comparative studies across regions or digital subsectors may also provide a more detailed understanding of the differences between developed and emerging economies.s.

REFERENCES

1. Cheng, Weixuan, Cheng Li, and Tianjiao Zhao. 2024. "The stages of enterprise digital transformation and its impact on internal control: Evidence from China." *International Review of Financial Analysis* 92: 103079. <https://doi.org/10.1016/j.irfa.2024.103079>.
2. Feng, Hongxia, Bowen Yang, and Pratikshya Bhandari. 2024. "The influence of CSR on cross-border mergers and acquisitions." *Finance Research Letters* 70 (2024) 106273. <https://doi.org/10.1016/j.frl.2024.106273>.
3. Feng, Yuan, Ying Li, and Changfei Nie. 2024. "Digital technology innovation and synergy of pollution control and carbon reduction: empirical evidence from digital patents in Chinese cities." *Economic Change and Restructuring* 57: 1-29. <https://doi.org/10.1007/s10644-024-09813-8>.
4. González-Torres, Thais, Jose-Luis Rodríguez-Sánchez, Eva Pelechano-Barahona, and Fernando-E. García-Muiña. 2020. "A Systematic Review of Research on Sustainability in Mergers and Acquisitions." *Sustainability* 12 (513): 1-18. <https://doi.org/10.3390/su12020513>.
5. Guo, Lei, Luying Xu, Junyi Wang, and Jingwen Li. 2024. "Digital transformation and financing constraints of SMEs: evidence from China." *Asia-Pacific Journal of Accounting & Economics* 31: 966–986. <https://doi.org/10.1080/16081625.2023.2257235>.

6. Hao, Anni. 2025. "Mergers and Acquisitions Models and Trends of Technology Enterprises in the Digital Economy Era." *Strategic Management Insights* 2 (1): 1-8. <https://soapubs.com/index.php/SMI>.
7. IMAA. 2026. *M&A Statistics*. Accessed 03 15, 2026. <https://imaa-institute.org/mergers-and-acquisitions-statistics/>.
8. Jiang, Ziyu, Xihao Sun, Yan Song, and Guojian Ma. 2023. "Digital finance and M&As: An empirical study and mechanism analysis." *PLOS ONE* 1-18. <https://doi.org/10.1371/journal.pone.0289845>.
9. Keenan, Liam , and Dariusz Wójcik. 2023. "The economic geographies of mergers and acquisitions (M&As)." *Economy and Space* 55 (6): 1618-1627. <https://doi.org/10.1177/0308518X231190091>.
10. Lu, Caimei , and Ruodan Li. 2026. "The integration of digital and real economy technologies and corporate value creation efficiency: Evidence from Chinese enterprise patent information." *Economic Analysis and Policy* 91: 967-986. <https://doi.org/10.1016/j.eap.2026.04.007>.
11. Maisenhelder, Fabian , Christian Baccarella, Lukas Maier, Julian M. Müller, and Kai-Ingo Voigt. 2025. "Digital mergers and acquisitions: Creating or destructing value?" *European Management Journal*. <https://doi.org/10.1016/j.emj.2025.08.002>.
12. Ren, Lijun, Jiajia Liu, and Qianyi Hao. 2024. "How digital transformation affects the cost of equity capital: the role of information disclosure quality and stock liquidity." *Industrial and Corporate Change* 33: 1098–1122. <https://doi.org/10.1093/icc/dtad053>.
13. Rohrer, Fabio E. G., Lebogang Mateane, and Christian R. Proaño. 2025. "The Perverse Valuation Effect on Mergers and Acquisitions in Europe." *Economic Modelling* 142: 105082. <https://doi.org/10.1016/j.econmod.2024.105082>.
14. Seitanidis, Panagiotis , Eleftherios Aggelopoulos, and Dimitrios Grypeos. 2026. "Mergers and Acquisitions: Analyzing Global FinTech and RegTech Trends over the Period 2008–2025." *FinTech* 5 (33). <https://doi.org/10.3390/fintech5020033>.
15. Shi, Mengyu , Qiong Xu, Yu Shi, and Jiamin Yan. 2026. "Digital transformation and enterprise mergers and acquisitions: Mechanism tests and empirical evidence." *Economic Modelling* 158: 107528. <https://doi.org/10.1016/j.econmod.2026.107528>.
16. Sun, Nan, Dongmin Kong, and Yunqing Tao. 2023. "Does broadband infrastructure affect corporate mergers and acquisitions? Quasi-natural experimental evidence from China." *International Review of Financial Analysis* 85: 102461. <https://doi.org/10.1016/j.irfa.2022.102461>.
17. Tang, Haodan , Senhui Fang, and Dianchun Jiang. 2022. "The market value effect of digital mergers and acquisitions: Evidence from China." *Economic Modelling* 116. <https://doi.org/10.1016/j.econmod.2022.106006>.
18. Xu, Jinhua , Xinran Xiong, Xiaoxia Li, and Shanmin Li. 2025. "Digital merger & acquisition and corporate innovation: Evidence from China." *Pacific-Basin Finance Journal* 102723. <https://doi.org/10.1016/j.pacfin.2025.102723>.

ENVIRONMENTAL TAXATION AND REGIONAL READINESS FOR THE GREEN TRANSITION IN ROMANIA: A DESCRIPTIVE ANALYSIS OF OFFICIAL STATISTICS

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ABSTRACT: *This study examines national environmental-tax trends and the economic and innovation characteristics of Romania's eight NUTS 2 development regions. It uses a transparent descriptive comparison of official European Commission and Eurostat indicators, without econometric estimation or an unobserved regional eco-efficiency index. Regional GDP per capita, real growth, employment, industrial specialisation and research and development (R&D) expenditure are reported alongside national EU environmental-tax trends. In 2024, GDP per head ranged from 48% of the EU average in Nord-Est to 188% in București–Ilfov; R&D intensity in 2023 ranged from 0.12% in Sud-Est to 1.18% in Vest. EU environmental-tax revenue increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, while its GDP share declined from 2.5% in 2014 to 2.1% in 2024. These indicators reveal unequal regional capacities to adapt to environmental policy, but do not measure regional emissions or establish causal policy effects. The study identifies policy priorities and a replicable data framework for subsequent environmental-performance research.*

Keywords: *Environmental Taxation; Green Transition; Regional Disparities; NUTS 2; Romania; Descriptive Statistics; Innovation Capacity.*

JEL Classification: *Q58, R11, O18, C82.*

1. INTRODUCTION

Romania's environmental transition combines common national and European rules with highly unequal regional economic structures. Environmental taxes change relative prices, but their effectiveness depends on technology, industrial composition, mobility, infrastructure and investment capacity. A regional comparison is useful even when causal estimation is neither feasible nor the aim of the study.

The study asks how environmental taxation has evolved at EU level, how economic and innovation capacities differ among Romania's eight NUTS 2 regions, and what these differences imply for the design of territorially sensitive environmental policy. It does not estimate the effect of taxation on emissions or eco-efficiency.

The contribution is a transparent cross-regional reading of economic resources, labour-market conditions, industrial specialisation and research capacity. The article distinguishes observable indicators from potential policy mechanisms: an economically advanced region is not automatically environmentally efficient, and national fiscal receipts cannot be assigned to

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individual regions. This separation is particularly relevant for an evidence-based discussion of the territorial green transition.

2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Eco-efficiency refers to economic value generated relative to resource use and environmental pressures. Its direct quantification requires matched economic and emissions observations for the same territorial units and years. The present database does not contain such a harmonised series; consequently, the analysis addresses regional readiness and structural conditions for the green transition rather than claiming to rank measured eco-efficiency.

Porter and van der Linde (1995) argue that carefully designed environmental regulation can stimulate innovation; Ambec et al. (2013) emphasise that empirical effects are conditional. The present article does not test the Porter hypothesis. It documents the structural differences that may shape regional adjustment to common policy instruments.

Environmental taxation belongs to a wider policy mix that also includes emissions trading, standards, public procurement, subsidies and infrastructure investment. The economic purpose of an environmental tax is to make an environmentally harmful activity more costly relative to its alternatives. Yet revenue is not a direct measure of environmental stringency: receipts can rise because taxable activity increases, tax rates change, or inflation affects nominal collections. Conversely, successful reductions in fuel consumption can erode the tax base even when incentives are effective.

The four conventional environmental-tax categories are energy, transport, pollution and resources. Energy taxes usually account for a substantial part of environmental-tax receipts in European economies. Their incidence depends on energy prices, the fuel mix and exemptions, while transport taxes may be linked to vehicle ownership or use. Pollution and resource taxes target narrower bases. A comprehensive assessment therefore needs both the revenue-to-GDP ratio and the composition of receipts, rather than a single aggregate interpreted as an environmental outcome.

For Romania, national tax aggregates should not be interpreted as eight independent regional observations. A uniform national rate may have unequal local implications because households and firms differ in transport dependence, income, industrial processes and access to substitutes. This article treats that variation as a reason for differentiated policy design, not as a measured regional tax burden.

Environmental taxation is a price-based instrument, whereas standards and public investment act through different channels. The analytical interest here lies in adjustment capacity: the ability of enterprises, workers and local institutions to respond to changing energy and pollution costs. Regional income, labour-market participation and innovation intensity may be informative about that capacity, but they remain indirect indicators.

The Porter hypothesis provides a conceptual motivation, not an empirical result of this article. Testing it would require policy exposure, innovation and environmental outcomes observed consistently through time. Accordingly, the findings below concern structural heterogeneity and possible policy design, rather than measured effects of regulation.

3. DATA SOURCES AND DESCRIPTIVE METHODOLOGY

The territorial unit is the NUTS 2 development region. The regional comparison relies on the European Commission's 2026 Romania country report. Indicators refer to different reference years, which are disclosed in every heading; the table is a structural snapshot, not a balanced panel. National environmental-tax indicators are drawn from Eurostat and European Commission publications. Values reported to one decimal place retain the source's rounding.

The study uses a cross-sectional descriptive design with indicators from several reference years. The reported figures are not pooled into an artificial single-year database. Comparisons are made in the original units, while simple differences and ratios are explicitly identified as author calculations. No regression, frontier efficiency measure or causal identification strategy is used.

Table 1. Geographic coverage

NUTS 2	Development region
RO11	Nord-Vest
RO12	Centru
RO21	Nord-Est
RO22	Sud-Est
RO31	Sud-Muntenia
RO32	Bucureşti–Ilfov
RO41	Sud-Vest Oltenia
RO42	Vest

Source and notes: Eurostat NUTS 2 regional classification

The eight codes exhaust the Romanian NUTS 2 development-region coverage used in the study. This geographic consistency prevents the inappropriate combination of county-level figures with region-level outcomes. The table is a classification reference rather than evidence of economic or environmental performance.

Source handling: the economic and innovation indicators are transcribed from the European Commission (2026); environmental-tax benchmarks are EU aggregates from Eurostat (2026). For every table, reference periods and denominators are retained.

4. REGIONAL ECONOMIC DISPARITIES IN ROMANIA

Bucureşti–Ilfov reaches 188% of the EU average for GDP per head, compared with 48% in Nord-Est: a difference of 140 index points and a ratio of approximately 3.92. The capital region also records the highest employment rate (81.1%) and lowest unemployment (1.8%). Sud-Est has the highest unemployment (11.3%), while Sud-Vest Oltenia has the highest industry share in gross value added (29.1%). These observations reveal uneven starting conditions, not a ranking of environmental performance.

Table 2. Development, employment and industrial structure across all eight regions

Region	GDP/head EU=100 (2024)	Real GDP growth % p.a. (2014–24)	Employment % (2025)	Unemployment % (2025)	Industry GVA % (2024)
Nord-Vest	71	3.9	70.3	5.9	20.5
Centru	71	3.3	70.0	4.1	24.6
Nord-Est	48	3.7	69.1	5.7	14.8
Sud-Est	59	1.4	62.1	11.3	21.8
Sud-Muntenia	55	1.0	68.3	8.6	27.1
Bucureşti–Ilfov	188	4.5	81.1	1.8	10.2
Sud-Vest Oltenia	60	3.6	61.7	6.9	29.1
Vest	78	2.9	66.5	5.1	24.3

Source and notes: European Commission (2026), Romania country report

The average real GDP growth column covers 2014–2024, while the other columns refer to 2024 or 2025. They should therefore be read as a set of complementary structural indicators rather than as simultaneous outcomes.

Industrial specialisation is markedly different in Sud-Vest Oltenia (29.1% of GVA), Sud-Muntenia (27.1%), Centru (24.6%) and Vest (24.3%). Vest also reports the highest industrial-employment share (34.0% in 2023) and the largest R&D intensity (1.18% of GDP in 2023) among the eight regions. Higher industrial exposure may imply greater adjustment requirements under energy and carbon policies; research capacity may facilitate technological adaptation, but these mechanisms are interpretative rather than estimated results.

Sud-Est records an 11.3% unemployment rate and a 62.1% employment rate in 2025. Nord-Est has the lowest GDP-per-head index, while Sud-Muntenia has the slowest average real GDP growth (1.0% annually over 2014–2024). These differences argue against treating all regions as if they faced identical economic conditions.

The income gradient in Table 2 is striking. Bucureşti–Ilfov reaches 188% of the EU GDP-per-head benchmark in 2024, whereas Nord-Est reaches 48%. The 140-point difference is economically meaningful as a descriptive measure of territorial disparity. However, the index is expressed in purchasing power standards and should not be equated with disposable household income, nominal wages or fiscal capacity. Commuting and the concentration of high-value-added headquarters activities can affect metropolitan production measures.

Employment rates and unemployment rates provide a complementary picture. Bucureşti–Ilfov combines an employment rate of 81.1% with unemployment of 1.8% in 2025, while Sud-Est records employment of 62.1% and unemployment of 11.3%. The employment-rate gap between these two regions is 19.0 percentage points. These are distinct labour-market indicators, and they do not add to 100 because their populations and definitions differ.

Growth over 2014–2024 further complicates the cross-sectional ranking. Bucureşti–Ilfov has the highest reported average annual real GDP growth, 4.5%, while Sud-Muntenia records 1.0%. An average growth rate does not describe the path of every intervening year, nor does it indicate how growth was distributed among households. For transition policy, growth matters primarily because it can affect the resources available for investment and the pace of capital-stock renewal.

The employment–income contrast is policy-relevant. Lower income can constrain household investment in efficient buildings or cleaner mobility, while weaker labour-market outcomes can complicate workforce retraining. These are plausible channels, not directly measured barriers. Public programmes should be designed with locally verified household and firm evidence before resources are allocated.

5. ENVIRONMENTAL TAXATION AND EU COMPARISONS

Environmental taxes are reported in national accounts for Romania as a whole. The European Commission’s and Eurostat’s environmental-tax series must be distinguished from the share of environmental taxes in all taxes: these are different denominators and cannot be interchanged. Eurostat reports that EU environmental-tax receipts were EUR 371.9 billion in 2024, and that their share of EU GDP was 2.1% in 2024 versus 2.5% in 2014 (rounded in its July 2026 publication).

Table 3 reports two different kinds of information: a share of EU GDP and the monetary value of EU environmental-tax receipts. The share falls from 2.5% in 2014 to 2.1% in 2024, a decline of 0.4 percentage points. Receipts increase from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, an increase of EUR 21.5 billion (difference calculated from rounded published totals), or approximately 6.1%. Both statements can hold simultaneously because the nominal tax base, price levels and GDP evolve.

Neither change identifies the impact of environmental taxation on emissions. In particular, a falling revenue share need not imply weaker tax incentives: the share may change with GDP, consumption patterns or tax design. Likewise, a nominal revenue increase does not

show that environmental damage increased. This is why the analysis avoids interpreting fiscal receipts as an environmental performance score.

EU aggregates are useful as context for Romania but cannot substitute for a Romania-specific series. The Eurostat environmental-tax dataset should be queried using explicit country, tax-category, unit and year filters before any national comparison is added. Until that extraction is documented, the article makes no claim about the full annual Romanian trajectory.

Table 3. Verified EU environmental-tax benchmarks

Indicator	2014	2023	2024
EU environmental taxes, % of GDP (Eurostat news, rounded)	2.5	—	2.1
EU environmental-tax receipts, EUR billion	—	350.4	371.9

Source and notes: Eurostat, “EU environmental tax revenue up 6.1% in 2024”, 22 July 2026. Dashes indicate values not reported in that specific news release, not zero

The reported EU environmental-tax revenue increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, a rise of EUR 21.5 billion when subtracting the published rounded totals (approximately 6.1%). Separately, the share of environmental taxes in EU GDP fell from 2.5% in 2014 to 2.1% in 2024, a decline of 0.4 percentage points. These comparisons use different metrics and periods; a higher nominal total does not contradict a lower GDP share. Neither figure describes Romanian regional tax receipts.

Environmental tax receipts depend on the tax base, statutory rates, economic activity and behavioural changes. Revenue alone is therefore an imperfect proxy for policy stringency. A fall in tax receipts could arise from lower consumption of taxed fuels, a reduction in rates or shifts in economic structure; these mechanisms cannot be distinguished using aggregate receipts alone.

6. INDUSTRIAL STRUCTURE AND INNOVATION CAPACITY

Vest records the largest industrial employment share (34.0%) and the highest R&D intensity (1.18% of GDP). Centru also has a large industrial workforce (30.0%). By contrast, Sud-Est reports the lowest R&D intensity (0.12%). The ratio between Vest and Sud-Est is approximately 9.8, illustrating substantial dispersion in recorded research effort. Research spending is not itself proof of clean innovation or successful technology transfer.

Table 4. Industrial employment and research capacity

Region	Industrial employment % (2023)	R&D % of GDP (2023)
Nord-Vest	24.4	0.29
Centru	30.0	0.41
Nord-Est	11.2	0.25
Sud-Est	20.7	0.12
Sud-Muntenia	24.0	0.4
Bucureşti–Ilfov	10.1	0.82
Sud-Vest Oltenia	19.9	0.17
Vest	34.0	1.18

Source and notes: European Commission (2026), Romania country report.

Industrial structure is one channel through which common national and European environmental requirements may generate different adjustment needs. Industry accounts for 29.1% of gross value added in Sud-Vest Oltenia and 27.1% in Sud-Muntenia, compared with 10.2% in Bucureşti–Ilfov in 2024. This does not establish that either industrial region is more polluting: sectoral emissions depend on the mix of activities, fuel use, technology and output.

Industrial employment offers a related but non-identical measure. In 2023, Vest records 34.0% of employment in industry and Centru 30.0%, compared with 10.1% in București–Ilfov and 11.2% in Nord-Est. A region can have a high industrial employment share without an equally high industrial value-added share, depending on productivity and sectoral composition. Because the two indicators refer to different years and denominators, they should not be subtracted to derive a productivity estimate.

Policy planning can nevertheless use these structural differences to identify where detailed energy audits, industrial electrification assessments and workforce-transition programmes may be most useful. Such prioritisation is preliminary and should be refined with plant-level or sector-level emissions and employment data.

R&D expenditure as a share of GDP is an indicator of recorded research effort, not a direct measure of green innovation. The regional range in Table 4 is wide: 1.18% in Vest versus 0.12% in Sud-Est in 2023, a difference of 1.06 percentage points. București–Ilfov follows at 0.82%, while several regions remain below 0.5%. The regional variation is relevant because the ability to develop, adopt and maintain cleaner technologies depends partly on engineering skills, research organisations and firms capable of absorbing innovation.

Nevertheless, expenditure intensity alone cannot determine whether research is commercially successful or environmentally beneficial. A regional research project may concern health, digital services or other fields with no immediate effect on emissions. Imported equipment and technology transfer may also enable rapid environmental improvements in places with low domestic R&D spending. For these reasons, the study uses R&D as a structural capacity indicator, not as a proxy for measured decarbonisation.

Future descriptive work could combine regional R&D expenditure with patent data, enterprise innovation surveys, tertiary education and sector-specific energy investments. These additions would strengthen the account of technological readiness without requiring causal modelling.

Research capacity also requires interpretation beyond a single spending ratio. Public research institutes, private laboratories, supplier networks and university–industry partnerships can have different local effects. The data in this article do not identify the environmental purpose of R&D expenditure, and therefore do not permit a direct ranking of green innovation.

7. COMPARATIVE REGIONAL ANALYSIS

Rather than assigning a composite score with arbitrary weights, the study proposes a qualitative typology based on observed characteristics. București–Ilfov is a high-income, service-oriented metropolitan region with high employment. Vest combines relatively strong income, the highest reported industrial-employment share and the highest R&D intensity. Centru and Nord-Vest display intermediate income levels and substantial manufacturing exposure, though their research intensities differ.

Nord-Est combines the lowest GDP-per-head index with relatively low industrial employment and modest R&D intensity. Sud-Est shows weak labour-market indicators and the lowest reported R&D intensity. Sud-Muntenia has a comparatively high industrial value-added share and the slowest average growth. Sud-Vest Oltenia has the highest industrial value-added share and relatively low R&D expenditure. These descriptions are not mutually exclusive categories and should not be treated as a ranking of environmental performance.

The practical advantage of a typology is transparency. Readers can trace each statement to the indicators in Tables 2 and 4. Its limitation is equally clear: structural proxies cannot replace information on emissions, energy poverty, public transport quality or the availability of clean electricity.

Table 5. Derived descriptive contrasts

Measure	Calculation	Result
GDP/head: Bucureşti–Ilfov minus Nord-Est	188 – 48	140 EU-index points
Employment: Bucureşti–Ilfov minus Sud-Est	81.1 – 62.1	19.0 percentage points
R&D: Vest minus Sud-Est	1.18 – 0.12	1.06 percentage points
EU environmental taxes, 2023–2024	371.9 – 350.4	EUR 21.5 billion

Source: author calculations and interpretations based on the verified descriptive indicators; no statistical model is estimated.

The derived comparisons express observable differences as gaps or ratios, without weighting them into a synthetic readiness score. Their principal value is interpretability: the reader can trace each contrast to a published regional indicator or EU tax benchmark. The contrasts should not be treated as causal estimates or as statistically tested differences.

The regional pattern is multidimensional. Bucureşti–Ilfov combines high income and employment with a comparatively small industrial share; Vest combines stronger industrial specialisation with relatively high R&D intensity; several southern and eastern regions face lower income, slower growth or weaker labour-market indicators. No single measure captures these different configurations.

A typology is more defensible here than a numerical ranking. It recognises that income, industrial exposure and research intensity can move in different directions. A region with a large manufacturing sector may have both greater decarbonisation requirements and a strong basis for technology upgrading. A metropolitan economy may have a smaller industrial share but substantial building and transport pressures. Because the database does not contain harmonised territorial emissions, these categories should be described as structural profiles. Terms such as “most eco-efficient” or “least polluting” would go beyond the evidence.

8. DISCUSSION AND POLICY IMPLICATIONS

The regional evidence points to different transition needs. Industrial regions may benefit from grid upgrades, energy efficiency and cleaner production technologies. Bucureşti–Ilfov faces a different set of potential priorities involving transport, buildings and urban infrastructure. Regions with weaker labour-market outcomes or lower R&D expenditure may require greater financing and institutional support to adopt low-emission technologies.

These are policy interpretations supported by observed structural differences, not causal estimates of the effects of taxes. A common national tax rate does not imply uniform regional incidence. Without a harmonised territorial emissions database, it is not possible to claim that a particular Romanian region is more eco-efficient than another.

In industrially specialised regions, a credible transition strategy may prioritise energy-efficiency retrofits, process heat electrification where technically feasible, grid reliability and worker reskilling. Public support should be assessed against measurable project outcomes such as verified energy savings or reduced emissions per unit of output. An industrial share by itself does not justify a subsidy; it identifies where more detailed diagnostics may be warranted.

In metropolitan areas, mobility and building stock are plausible priorities. Public transport integration, building renovation and urban planning can complement environmental price signals when households have limited short-run alternatives to private vehicles or inefficient heating. These recommendations reflect general policy mechanisms rather than evidence that a particular intervention has already succeeded in Bucureşti–Ilfov.

Regions with weaker employment outcomes and low recorded research expenditure may face greater constraints in co-financing and implementing clean investment. Technical

assistance, access to finance and project preparation capacity may therefore matter as much as nominal subsidy rates. A policy evaluation should separately monitor investment take-up, distributional impacts and environmental results.

Table 6. Descriptive regional policy considerations

Regional profile	Illustrative priorities	Evidence boundary
Metropolitan service concentration	Buildings, mobility, urban infrastructure	Not an emissions estimate
High industrial employment	Industrial energy efficiency, skills	Industry is not equivalent to emissions
Lower R&D intensity	Technology adoption and project support	R&D is not green innovation
Weaker labour-market outcomes	Affordable transition and inclusion	No causal effect estimated

Source: author calculations and interpretations based on the verified descriptive indicators; no statistical model is estimated.

The table translates structural indicators into differentiated policy considerations rather than evaluated interventions. Industrial profiles point to potential demand for cleaner process technology and energy infrastructure; weaker employment or research indicators point to possible needs for training and innovation support. These are policy hypotheses to be tested against local investment, emissions and social data before implementation.

A national fiscal instrument may have heterogeneous local consequences even when its legal rate is identical across the country. Sector composition, transport access, heating technology and investment finance influence adjustment options. Yet the present study cannot quantify those effects, because it does not observe regional tax liabilities or policy-induced behavioural responses.

Policy coordination should therefore combine national environmental objectives with territorially informed delivery. For industrial regions, public support could prioritise verifiable energy savings, grid readiness and workforce skills. For metropolitan regions, integrated mobility and building renovation may be relevant. In regions with weaker innovation capacity, access to technical assistance and co-financing deserves attention. These priorities are conditional recommendations rather than measured programme impacts.

A practical monitoring framework would publish, for each NUTS 2 region, consistent annual economic activity, greenhouse-gas emissions, energy consumption, environmental investment and social exposure. That information would make subsequent evaluation more informative than the structural snapshot presented here.

9. RESEARCH LIMITATIONS

The analysis is descriptive and cannot establish that taxes cause innovation, growth or emission reductions. The regional indicators are not a balanced time series and cannot support trend tests at NUTS 2 level. No regional greenhouse-gas data have been validated in the source manuscript. It would therefore be inappropriate to describe the regions as more or less eco-efficient on the basis of the current tables.

The use of EU-wide fiscal benchmarks creates a further boundary: these data show the broader policy context, not the tax payments of Romanian firms or households. R&D intensity measures total research expenditure rather than environmentally targeted research. Industry shares reflect economic structure rather than measured carbon intensity. These limitations do not invalidate the regional comparison, but they narrow the conclusions that can be drawn from it.

A logical next stage is to link annual NUTS 2 GDP data to consistent EDGAR greenhouse-gas estimates by region and year, calculate transparent emissions-intensity

indicators, and separately describe the Romanian environmental-tax mix. Such an extension would require a documented data extraction and should not be inferred from the present structural snapshot.

The principal source of regional figures is the European Commission 2026 Romania country report. The indicators are a multi-year structural snapshot: GDP per head and industrial gross value added refer to 2024; employment and unemployment to 2025; industrial employment and R&D to 2023; average real GDP growth covers 2014–2024. Mixing them into a fictitious single-year dataset would be methodologically misleading.

The GDP-per-head index is expressed relative to the EU average in purchasing power standards. It is not a nominal EUR measure. Percentages in the tables retain the source rounding, and simple differences calculated from them are approximate. This manuscript does not impute missing regional emissions or redistribute national tax receipts among the eight regions.

A reproducible update should archive the downloaded source table, retrieval date, indicator labels and metadata. Where Eurostat revisions alter earlier observations, authors should specify the data vintage. For EDGAR, documentation should cover greenhouse-gas species, territorial boundaries, sectoral coverage and the unit of emissions before a GDP-to-emissions ratio is constructed.

Table 7. Data dictionary for a future emissions-based extension

FIELD	Geography	Unit / rule	Source
YEAR	NUTS 2	calendar year	Eurostat / JRC
GEO	NUTS 2	RO11–RO42	Eurostat NUTS
GDP	NUTS 2	million EUR; consistent prices	nama_10r_2gdp
GHG	NUTS 2	kilotonnes CO ₂ -equivalent; consistent gases	EDGAR/JRC
EMISSIONS_INTENSITY	NUTS 2	kt CO ₂ e / million EUR	ghg divided by gdp
ENVIRONMENTAL_TAX	Romania	% GDP; national only	env_ac_taxind2

Source and notes: This is a variable dictionary, not a table of observed emissions. The two regional series must be downloaded and checked before computing intensities.

This table specifies the fields required for an emissions-intensity analysis but contains no observed emissions. A valid indicator would divide emissions and GDP only after confirming the same NUTS 2 boundary, calendar year, gas coverage and GDP price basis. The dictionary makes the missing empirical step explicit and prevents readers from mistaking a proposed database for completed results.

10. CONCLUSIONS

This study provides a descriptive assessment of the economic, industrial and innovation-related conditions shaping the readiness of Romania's eight NUTS 2 development regions for the green transition, while placing these regional differences within the broader context of European environmental taxation. By relying on official statistical indicators and explicitly acknowledging their methodological limitations, the analysis highlights the importance of territorial heterogeneity in the design and implementation of environmental and regional development policies. The findings demonstrate that the transition towards a more sustainable and resource-efficient economy cannot be approached as a uniform process, given the substantial differences in regional economic structures, labour-market conditions, industrial specialisation and technological capabilities.

The results reveal pronounced disparities in regional economic development. In 2024, GDP per capita in Bucureşti–Ilfov reached 188% of the European Union average, compared with only 48% in Nord-Est, indicating a difference of 140 index points and a ratio of

approximately 3.9 between the two regions. These disparities reflect unequal economic starting conditions that may influence the capacity of regional economies, businesses and households to finance investments associated with the green transition. Nevertheless, higher regional income should not automatically be interpreted as evidence of superior environmental performance, since economic prosperity does not necessarily imply lower emissions, greater resource efficiency or more sustainable production and consumption patterns.

Significant differences are also observed in industrial structures and innovation capacities. Regions such as Sud-Vest Oltenia and Sud-Muntenia exhibit relatively high industrial shares in gross value added, suggesting that industrial modernisation, energy efficiency and technological adaptation may represent important dimensions of their transition strategies. At the same time, Vest records the highest industrial employment share and the highest research and development intensity among the analysed regions, with R&D expenditure reaching 1.18% of regional GDP in 2023, compared with only 0.12% in Sud-Est. This substantial difference illustrates the uneven distribution of research resources and potential technological capabilities. However, R&D intensity remains an indirect indicator of innovation capacity and cannot independently establish the development or adoption of environmentally beneficial technologies.

Labour-market conditions further reinforce the differentiated character of regional transition challenges. The relatively high employment rate and low unemployment recorded in Bucureşti-Ilfov contrast with the weaker labour-market indicators observed in Sud-Est and other less economically developed regions. Such differences may influence the ability of regional economies to support workforce adaptation, occupational mobility and the acquisition of skills required by emerging low-carbon activities. Consequently, environmental transition strategies should be coordinated with employment, education and regional development policies, particularly in territories where structural economic vulnerabilities may constrain the adoption of cleaner technologies.

Regarding environmental taxation, the analysis confirms the importance of distinguishing fiscal indicators from environmental outcomes. At the European Union level, environmental-tax revenues increased from EUR 350.4 billion in 2023 to EUR 371.9 billion in 2024, while their share of GDP declined from 2.5% in 2014 to 2.1% in 2024. These developments illustrate that changes in environmental-tax revenues may reflect variations in economic activity, tax bases, prices and fiscal arrangements rather than changes in environmental effectiveness alone. Furthermore, national or European fiscal aggregates cannot be directly interpreted as measures of environmental-tax exposure at the Romanian regional level. The absence of harmonised regional tax and emissions data therefore prevents the identification of territorial differences in the environmental effectiveness of taxation.

From a policy perspective, the findings support the development of territorially differentiated approaches within a coherent national and European environmental policy framework. Industrially specialised regions may require targeted support for energy-efficient production processes, technological upgrading, industrial electrification and workforce retraining. Metropolitan areas may face different priorities, including sustainable urban mobility, building renovation and improvements in energy infrastructure. Regions characterised by lower income levels, weaker labour-market outcomes or limited research expenditure may benefit from improved access to financing, technical assistance, institutional capacity-building and technology-transfer mechanisms. These policy directions should be interpreted as potential priorities derived from observed structural characteristics rather than as interventions whose effectiveness has been empirically demonstrated by the present study.

An important implication is that environmental taxation should be considered part of a broader and coordinated policy mix. Fiscal instruments can provide economic incentives to reduce environmentally harmful activities, but their effectiveness may depend on the availability of technological alternatives, adequate infrastructure, access to finance and the

capacity of firms and households to adjust their behaviour. Consequently, the implementation of environmental taxation should be accompanied, where appropriate, by complementary measures supporting innovation, energy efficiency, sustainable transport and social inclusion. Such coordination may help address differences in regional adjustment capacity while maintaining consistency with national and European environmental objectives.

The scientific contribution of the study lies primarily in its transparent integration of official regional economic and innovation indicators with the broader fiscal context of environmental taxation. Rather than constructing a composite readiness index based on arbitrary weighting assumptions, the analysis identifies observable structural differences and interprets their potential relevance for the green transition. This approach provides a reproducible descriptive framework and avoids conflating economic development, innovation expenditure and industrial specialisation with directly measured environmental performance. The resulting regional profiles can serve as a preliminary analytical basis for identifying research priorities and informing more detailed territorial assessments.

Nevertheless, several limitations must be acknowledged. The analysis relies on indicators referring to different statistical years and does not constitute a harmonised regional panel dataset. Moreover, the absence of validated regional greenhouse-gas emissions, energy consumption and environmental-tax exposure data prevents the estimation of regional eco-efficiency or the assessment of causal relationships between taxation, innovation and environmental outcomes. The findings therefore describe structural conditions associated with potential transition capacity rather than measuring the actual environmental effects of public policies. These limitations are particularly important when interpreting regional disparities and formulating policy recommendations.

Future research should prioritise the construction of a consistent regional database integrating economic activity, greenhouse-gas emissions, energy consumption, environmental investment and innovation indicators at NUTS 2 level. Combining harmonised Eurostat regional statistics with appropriately validated emissions estimates from the European Commission's Joint Research Centre could enable the calculation of transparent emissions-intensity indicators and the examination of their evolution over time. A complementary analysis of Romania's environmental-tax structure, including the relative contributions of energy, transport, pollution and resource taxes, would further strengthen the national fiscal dimension of the research. Subject to data availability and methodological comparability, subsequent studies could investigate regional differences in adjustment patterns and evaluate the relationships between environmental policy instruments, technological change and environmental outcomes.

Overall, the study concludes that Romania's green transition takes place against a background of substantial territorial disparities that should be explicitly recognised in environmental and regional development strategies. Economic resources, industrial characteristics, labour-market conditions and innovation capacities differ considerably across the eight development regions, generating distinct potential opportunities and constraints. While these structural indicators do not establish regional environmental efficiency or the causal effects of environmental taxation, they provide a relevant empirical foundation for more territorially informed policy design. Strengthening regional environmental statistics, improving institutional coordination and aligning environmental objectives with regional economic and social conditions are therefore essential directions for supporting an inclusive and effective transition towards a more sustainable Romanian economy.

REFERENCES

1. Ambec, S., Cohen, M. A., Elgie, S., & Lanoie, P. (2013). The Porter hypothesis at 20: Can environmental regulation enhance innovation and competitiveness?

- Review of Environmental Economics and Policy, 7(1), 2–22. <https://doi.org/10.1093/reep/res016>
2. European Commission. (2026). 2026 country report – Romania (Commission Staff Working Document SWD(2026) 223 final, Annex Table A18.2). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52026SC0223>
 3. European Commission, Joint Research Centre. (n.d.). EDGAR subnational greenhouse-gas emissions dataset [Data set]. <https://edgar.jrc.ec.europa.eu/>
 4. Eurostat. (n.d.). Environmental tax revenues (env_ac_taxind2) [Data set]. <https://ec.europa.eu/eurostat/>
 5. Eurostat. (2026a). Gross domestic product (GDP) at current market prices by NUTS 2 region (nama_10r_2gdp) [Data set]. https://doi.org/10.2908/nama_10r_2gdp
 6. Eurostat. (2026b, July 22). EU environmental tax revenue up 6.1% in 2024. <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260722-1>
 7. OECD. (2024). OECD economic surveys: Romania 2024. OECD Publishing. <https://doi.org/10.1787/106b32c4-en>
 8. Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment–competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97–118. <https://doi.org/10.1257/jep.9.4.97>

ANALYSIS OF ROMANIA'S IMPORTS DURING 2020–2025: TRENDS AND ECONOMIC IMPACT

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ABSTRACT: *The article examines the evolution of Romania's imports over the 2020–2025 period, highlighting the main trends, the factors that shaped their dynamics, and their effects on the national economy. The analysis shows that imports have had a multifaceted impact on Romania's economic performance. On the one hand, they supported production, investment, and consumption by providing firms and households with access to raw materials, technologies, and goods that are not available in sufficient quantities on the domestic market. On the other hand, the relatively rapid growth of imports compared with exports contributed to a widening trade deficit and increased the economy's exposure to fluctuations in international prices and to potential disruptions in global supply chains.*

Keywords: *Competitiveness, international trade, imports, Romania.*

JEL Classification: *F10; F14.*

1. INTRODUCTION

International trade is a fundamental component of an open economy, while imports play an important role in securing access to raw materials, intermediate goods, technologies, equipment, and products intended for final consumption. In Romania's case, import developments in recent years reflect both the structural transformation of the domestic economy and the influence of external factors that have significantly affected trade flows. The 2020–2025 period is particularly relevant in this respect, as it was marked by major economic and geopolitical events with substantial effects on international trade, including the COVID-19 pandemic, disruptions to global supply chains, rising energy and commodity prices, mounting inflationary pressures, and heightened uncertainty at both regional and global levels.

Against this background, the dynamics of Romania's imports were shaped by both domestic demand and the resource and input requirements of firms. Imports made an important contribution to supporting production, investment, and consumption by providing access to goods and technologies that are either not produced domestically or are available only in insufficient quantities. At the same time, the high degree of dependence on certain categories of imported products highlights the limitations of domestic production capacity and the Romanian economy's exposure to changes in international market conditions.

The increase in imports therefore generates economic effects that need to be assessed from a broader perspective. On the one hand, imports can foster economic modernization, enhance productivity, and diversify the range of goods available on the domestic market. On the other hand, when import growth persistently outpaces export performance, the trade balance

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may deteriorate, with implications for the economy's external equilibrium. Romania's persistent trade deficit remains one of the main vulnerabilities associated with the structure of its foreign trade, particularly given that a substantial share of domestic demand is met through imported goods.

Building on these considerations, this article examines the evolution of Romania's imports over the 2020–2025 period, with particular emphasis on identifying the main trends and the factors underlying changes in both their volume and composition. It also seeks to assess the impact of imports on the national economy, considering both their contribution to economic activity and their implications for the trade deficit and the economy's exposure to external shocks. An analysis of this period therefore provides a clearer understanding of the relationship between domestic demand, Romania's productive capacity, and the country's integration into international trade flows.

2. EVOLUTION AND GENERAL CONTEXT OF ROMANIA'S IMPORTS (2020–2025)

The 2020–2025 period was marked by significant changes in Romania's international trade, driven by both domestic factors and broader economic and geopolitical developments. The COVID-19 pandemic, disruptions to global supply chains, rising commodity and energy prices, the war in Ukraine, intensifying inflationary pressures, and, subsequently, the slowdown in European economic activity all had a direct impact on the volume and composition of Romania's trade flows. Against this background, imports followed an uneven trajectory, alternating between periods of contraction and phases of rapid growth.

From an economic perspective, imports perform an essential function in an open economy by providing access to raw materials, intermediate goods, machinery, technologies, and consumer products that are either not produced domestically or cannot be supplied in sufficient quantities by domestic producers. In Romania's case, this role is particularly important given that a substantial share of industrial activity is integrated into European production networks and relies on imported components and intermediate inputs. At the same time, a high level of imports may become a source of vulnerability when the expansion of domestic demand is not accompanied by a corresponding increase in productive capacity and export performance.

In international merchandise trade statistics, Romania's imports are generally valued on a CIF basis (Cost, Insurance and Freight), meaning that the recorded value of imported goods includes not only their purchase price, but also transport and insurance costs up to the border of the importing country. From this perspective, changes in the nominal value of imports should be assessed not only in relation to the quantities purchased, but also in light of fluctuations in international prices and logistics costs. This consideration is particularly relevant when interpreting developments in 2022, when the increase in the value of imports was amplified by the sharp rise in energy prices and the higher cost of a wide range of raw materials (European Commission, 2023).

The evolution of Romania's imports in value terms over the period under review points to a broadly upward trend, interrupted only temporarily in 2020 and 2023. Imports of goods stood at approximately EUR 80.6 billion in 2020 and increased to around EUR 129.35 billion by 2025. This represents a nominal rise of roughly 60% between the beginning and the end of the analysed period, indicating a substantial expansion in the value of goods purchased from external markets.

This increase, however, should be interpreted with caution, as developments in nominal import values were strongly influenced by international price movements and domestic inflationary pressures. In particular, the sharp rise in energy, raw material, transport, and intermediate goods prices during parts of the period significantly increased the monetary value

of imports, even in cases where imported volumes did not expand at the same pace. As a result, the recorded growth in import values cannot be attributed entirely to a comparable increase in the physical quantity of goods imported.

At the same time, the upward trajectory reflects the continued dependence of the Romanian economy on external supplies of energy resources, industrial inputs, machinery, equipment, and consumer goods. The expansion of domestic demand, together with the recovery of investment and industrial activity following the pandemic-related downturn, also contributed to maintaining relatively high import levels. Consequently, the increase observed over 2020–2025 reflects a combination of price effects, stronger domestic absorption, and the structural reliance of the Romanian economy on imported inputs and final goods.

Table 1. The Evolution of Romania's Imports over the 2020–2025 Period

Year	CIF Imports (EUR billion)	Annual Change in Imports (%)	FOB/CIF Trade Deficit (EUR billion)
2020	80,6	-6,6	18,4
2021	98,4	+22,1	23,7
2022	126,0	+28,1	34,1
2023	122,0	-3,2	28,9
2024	126,1	+3,3	33,4
2025	129,4	+2,6	32,7

Source: Author's calculations based on data from the National Institute of Statistics (NIS, TEMPO-Online, 2026).

The year 2020 represented an exception to the broader upward trend. The outbreak of the COVID-19 pandemic, together with the measures introduced to contain its spread, disrupted economic activity, created logistical bottlenecks, and temporarily weakened demand. Romania's imports declined by approximately 6.6% compared with 2019, falling to around EUR 80.6 billion. However, the contraction in imports was less pronounced than the decline in exports, which fell by roughly 9.9%. This divergence contributed to a further widening of the trade deficit, which reached approximately EUR 18.4 billion (NIS, 2026).

The decline in imports in 2020 was driven primarily by the temporary contraction of industrial and commercial activity, reduced mobility, and a high degree of uncertainty, which affected both consumer behaviour and investment decisions. Nevertheless, the Romanian economy experienced a more moderate contraction than initially anticipated, while the recovery in household consumption during the second half of the year helped contain the decline in demand for imported goods. According to the European Commission, the economic shock was particularly severe in the second quarter of 2020, when public health restrictions, disruptions to production and supply chains, and weaker external demand placed significant pressure on economic activity (European Commission, 2021).

In 2021, as public health restrictions were gradually eased and economic activity resumed, imports returned rapidly to an upward trajectory. Their value reached approximately EUR 98.4 billion, representing a 22.1% increase compared with the previous year. Import growth outpaced export growth, contributing to a further widening of the trade deficit to around EUR 23.7 billion (NIS, 2026).

The increase recorded in 2021 can be attributed to the recovery in private consumption, the rebound in investment, and the rebuilding of corporate inventories following the heightened uncertainty of the previous year. The rapid recovery in demand, both in Romania and internationally, occurred in a context in which supply capacity had not adjusted at the same pace. As a result, supply bottlenecks, higher international transport costs, and shortages of certain industrial components placed upward pressure on the prices of imported goods. More

broadly, the recovery of the European economy in 2021 was accompanied by a significant rebound in both export and import flows across the European Union (Eurostat, 2022).

The strongest increase in imports over the period under review was recorded in 2022. Romania's imports exceeded EUR 126 billion, rising by approximately 28.1% compared with 2021. Over the same period, exports grew at a slower rate of 23.1%, causing the trade deficit to widen to around EUR 34.1 billion, one of the highest nominal levels recorded by Romania (NIS, 2026).

The developments observed in 2022 should, however, be interpreted with caution, as the increase in imports was driven not only by stronger demand but also by pronounced price effects. Russia's invasion of Ukraine and the subsequent disruption of European energy markets triggered substantial increases in the prices of natural gas, oil, electricity, and other key commodities. At the European Union level, the sharp rise in the value of energy imports was one of the main factors behind the deterioration of the trade balance in 2022. In Romania's case, the energy shock likewise contributed to widening external imbalances and significantly increased the cost of imported goods (European Commission, 2023; Eurostat, 2024).

The year 2023 marked a shift in direction. Imports declined by 3.2%, to approximately EUR 122.0 billion, while exports recorded a modest increase of 1.3%. As a result, the trade deficit narrowed to around EUR 28.9 billion, approximately 15% below the level recorded in the previous year (NIS, 2026). The decline in imports was supported by both the moderation of international energy prices and weaker demand, as well as by the partial normalisation of supply chains.

This development should not be interpreted solely as evidence of a reduced dependence of the Romanian economy on imports. Part of the adjustment was cyclical in nature, reflecting the decline in the value of energy imports and the moderation of several international prices that had reached exceptionally high levels in 2022. In addition, slower economic growth and tighter monetary conditions contributed to weakening demand for imported goods.

In 2024, imports returned to an upward trajectory, reaching approximately EUR 126.1 billion, 3.3% above the 2023 level. At the same time, exports recorded a slight decline of 0.4%, leading to a renewed deterioration in the trade balance. The trade deficit widened to approximately EUR 33.4 billion, more than EUR 4.4 billion above the level recorded in the previous year (NIS, 2026).

The developments observed in 2024 highlight one of the structural weaknesses of the Romanian economy: a significant share of the increase in domestic demand is absorbed by goods produced abroad. Recent research on the drivers of economic growth in Romania indicates that, during certain periods, expansionary fiscal and wage policies have contributed to shifting demand towards components with a relatively high import content. As a result, part of the increase in domestic income and expenditure did not translate into additional domestic output, but instead generated stronger demand for imported goods (Sterescu, 2026).

In 2025, the value of CIF imports reached approximately EUR 129.35 billion, the highest level recorded during the period under review and 2.6% above the 2024 level. Unlike in the previous year, however, exports expanded at a faster pace, increasing by 4.2%. This contributed to a slight narrowing of the trade deficit to approximately EUR 32.74 billion. Overall, these developments point to a moderation in the pace of deterioration in Romania's external trade position, although the underlying structural imbalance between imports and exports remained significant (NIS, 2026).

The more moderate growth of imports in 2025 should also be assessed against the backdrop of weaker economic activity. According to the European Commission, Romania's real GDP increased by only 0.7% in 2025, while the fiscal consolidation measures introduced during the year began to constrain the expansion of domestic demand. Under these conditions, import growth slowed compared with the strong expansion recorded in 2021–2022 (European Commission, 2026).

A consistent feature of Romania's international trade is its strong orientation towards the European Union market. Romania's economic integration into the Single Market, together with the presence of numerous companies involved in European production networks, explains the high share of intra-EU imports. In 2020, approximately 73.5% of Romania's imports originated from EU Member States. By the end of the period under review, this structure had remained broadly unchanged: in 2024, intra-EU trade accounted for around 72.1% of total imports, and the share remained at approximately 72.1% in 2025 (NIS, 2026).

This geographical concentration entails both advantages and potential risks. Membership in the EU Single Market facilitates the free movement of goods, lowers trade costs, and provides Romanian firms with access to a broad and diversified supplier base. At the same time, the high degree of economic integration increases Romania's exposure to cyclical developments in its main European trading partners, particularly Germany, Italy, Hungary, Poland, and France.

In terms of product composition, machinery and transport equipment represent one of the largest components of Romania's imports. In 2025, this category accounted for approximately 36.8% of total import value, while "other manufactured goods" represented around 28.1%. A broadly similar structure was recorded in 2024, when machinery and transport equipment accounted for 36.4% of imports and other manufactured goods for 28.6%. This composition reflects the strong integration of the Romanian economy into European industrial and production networks, as well as the continued reliance of domestic firms on imported capital goods, components, and intermediate manufactured inputs (NIS, 2026).

The high share of machinery, equipment, and manufactured goods indicates that imports should not be viewed solely from the perspective of final consumption. A substantial proportion consists of intermediate and capital goods used in industrial production. In this respect, imports can support investment, technological upgrading, and the integration of Romanian firms into international value chains. The main concern arises when imports for both consumption and production persistently grow faster than the economy's capacity to generate exports and domestic value added.

One of the most significant features of the 2020–2025 period is the persistence of a sizeable trade deficit. Imports exceeded exports in every year under review, while the gap widened considerably compared with the beginning of the period. The trade deficit increased from approximately EUR 18.4 billion in 2020 to more than EUR 34 billion in 2022. Following a temporary correction in 2023, it widened again to around EUR 33.4 billion in 2024 before narrowing moderately to EUR 32.74 billion in 2025.

The persistence of this imbalance points to the presence of structural factors that extend beyond the temporary effects of the pandemic or the energy crisis. The relatively limited capacity of domestic production to fully accommodate increases in demand, insufficient competitiveness in certain sectors, dependence on imported intermediate goods and technologies, and the orientation of a significant share of consumption towards foreign-produced goods all contribute to maintaining the trade deficit.

Sterescu (2026) shows that, in Romania's case, policies that strongly stimulate incomes and demand may have a more limited impact on domestic output when the import content of consumption and investment is high. Part of the impulse generated through aggregate demand is therefore transmitted to partner economies through higher imports. This mechanism helps explain situations in which consumption and public expenditure increase without being accompanied by a comparable acceleration in domestic production.

The trade imbalance is also closely linked to the economy's broader external position. In 2025, Romania's current account deficit remained at approximately 7.9% of GDP, a high level by European standards. The European Commission continues to identify the fiscal and external deficits as among Romania's main macroeconomic vulnerabilities, although some signs of adjustment became visible in 2025. (European Commission, 2026).

Taken as a whole, the 2020–2025 period reveals a substantial increase in the value of Romania’s imports, alongside a high degree of sensitivity to both the economic cycle and external shocks. The decline recorded in 2020 was followed by a strong rebound in 2021 and an exceptional increase in 2022, driven by a combination of robust domestic demand and sharply higher international prices. The correction observed in 2023 was largely cyclical in nature, while the renewed increase in imports in 2024 and the attainment of a new nominal peak in 2025 confirm that the Romanian economy continues to rely heavily on goods sourced from abroad.

From this perspective, rising imports should not automatically be interpreted as an adverse economic development. Imports of machinery, equipment, technologies, and intermediate goods can support economic modernisation, productivity gains, and the expansion of export capacity. By contrast, a persistent situation in which import growth exceeds export growth, particularly when driven primarily by consumption, can widen external imbalances and weaken the extent to which domestic demand translates into higher domestic output.

Romania’s main challenge, therefore, is not to reduce imports as such, but to improve the balance between imports, domestic production, and exports. Economic policies aimed at strengthening productive capacity, attracting investment into higher value-added sectors, improving the competitiveness of domestic firms, and deepening the integration of Romanian suppliers into European value chains could help reduce the structural nature of the trade deficit. In this respect, import developments over the 2020–2025 period illustrate not only the high degree of international integration of the Romanian economy, but also the need to reinforce the domestic productive base in order to support more balanced, sustainable, and resilient economic growth.

3. FUTURE TRENDS IN ROMANIA’S IMPORTS

The future trajectory of Romania’s imports will be shaped by the interaction between domestic demand dynamics, the fiscal consolidation process, investment financed through European funds, developments in industrial production, conditions on energy markets, and the capacity of the domestic economy to substitute some of the goods currently sourced from abroad. Following the significant increases recorded in recent years, the near-term outlook points to a moderation in import growth in 2026, followed by a possible gradual recovery from 2027 onwards, as macroeconomic conditions improve.

This outlook should be assessed against the backdrop of an economy undergoing fiscal adjustment and a slowdown in domestic demand. According to the latest estimates of the European Commission, Romania’s economic growth is expected to reach only 0.1% in 2026, before accelerating to approximately 2.3% in 2027. Fiscal consolidation, persistently high inflation, and the decline in real disposable income are likely to constrain household consumption and, consequently, demand for imported goods. The European Commission explicitly expects the weakening of domestic consumption to lead to a decline in merchandise imports over the course of 2026 (European Commission, 2026).

The main trend expected for 2026 is therefore one of stagnation or a moderate decline in imports, particularly those associated with final consumption. The fiscal consolidation process involves restraining the growth of certain categories of public expenditure, while higher taxation and persistently elevated inflation reduce households’ purchasing power. These developments are likely to weaken household consumption and, consequently, demand for imported goods.

In a scenario published in March 2026, the Organisation for Economic Co-operation and Development (OECD) projects a decline of approximately 0.3% in imports of goods and services in 2026, followed by an increase of around 1.4% in 2027. At the same time, the OECD

expects only modest growth in private consumption and a continuation of fiscal consolidation, thereby limiting the scope for a strong rebound in imports over the very short term (OECD, 2026a).

The forecasts published subsequently in the OECD Economic Outlook, Volume 2026 Issue 1 broadly confirm this trajectory, although the outlook for the Romanian economy was revised in a less favourable direction. The OECD projects an economic contraction of approximately 0.1% in 2026, followed by a recovery of 2.5% in 2027. Under this scenario, private consumption is expected to remain weak at least until mid-2026, while only modest import growth is projected, which should contribute to a gradual narrowing of the current account imbalance (OECD, 2026b).

In the immediate period ahead, a clearer divergence is therefore likely to emerge across the main categories of imports. Imports of consumer goods may be more strongly affected by weaker domestic demand, whereas imports of equipment, machinery, components, and intermediate goods could follow a more favourable trajectory, supported by the continuation of investment projects.

A second important trend for the coming years is the prospect of relatively sustained demand for capital goods and technological equipment. Although private consumption is expected to remain subdued in the short term, investment is likely to remain one of the main drivers of economic activity.

Romania continues to benefit from substantial volumes of European funding allocated to transport infrastructure, energy, digitalisation, energy efficiency, public administration modernisation, and the expansion of productive capacity. The OECD emphasises that EU-funded investment will represent one of the key factors supporting the Romanian economy in 2026. Resources available under the 2021–2027 cohesion policy framework, together with projects continuing beyond the completion of the Recovery and Resilience Facility, are expected to help maintain public investment at a relatively high level (OECD, 2026a).

This development may have important implications for the composition of imports. Infrastructure projects and the modernisation of industrial capacity often require the acquisition from abroad of machinery, equipment, installations, electrical systems, electronic products, and technological components. For this reason, even in a context in which total imports stagnate or expand only modestly, the component associated with investment goods may display stronger growth dynamics.

From an economic perspective, this import structure is more favourable than an increase driven exclusively by consumption. Imports of machinery, equipment, and technology can subsequently generate positive effects on productivity, productive capacity, and export competitiveness. However, the ultimate impact on the trade balance will depend on the extent to which these investments translate into higher domestic output and stronger export performance.

The outlook for 2027 points to a possible gradual recovery in imports as domestic economic conditions improve. Both the European Commission and the OECD expect economic growth to accelerate in 2027, supported by lower inflation, more favourable financing conditions, and a gradual recovery in private consumption and investment.

The European Commission projects GDP growth of approximately 2.3% in 2027, as declining inflation is expected to stabilise households' real incomes and support a recovery in consumption. At the same time, private investment is expected gradually to assume part of the role previously played by public investment financed through the Recovery and Resilience Facility (European Commission, 2026).

The recovery in private consumption will inevitably place some upward pressure on imports. Romania's economic experience suggests that stronger domestic demand tends to be accompanied by higher purchases of foreign goods, reflecting the limited capacity of domestic production to fully accommodate a rapid increase in consumption. Against this background, the

resumption of stronger economic growth in 2027 could lead to renewed growth in imports of passenger cars, electronic products, durable consumer goods, pharmaceuticals, and other categories of consumption goods.

Nevertheless, the pace of this increase may be more moderate than in previous periods of economic expansion. The continuation of fiscal consolidation, together with the need to reduce the current account deficit, is likely to constrain a return to a growth model driven predominantly by consumption.

Another expected trend is a gradual narrowing of Romania's external imbalance, although it is likely to remain substantial over the next few years. According to the European Commission's May 2026 forecast, Romania's current account deficit is projected to decline from approximately 7.9% of GDP in 2025 to 6.9% in 2026 and 6.4% in 2027 (European Commission, 2026).

A reduction in the deficit does not necessarily imply a permanent nominal decline in imports. A sustainable adjustment may also occur in a context of rising imports, provided that exports expand at a faster pace. From this perspective, Romania's main challenge lies in improving the balance between export and import dynamics.

Over the medium term, the development of export-oriented productive capacity, the attraction of foreign investment into higher value-added sectors, and the deeper integration of Romanian firms into European production networks could contribute to reducing the trade imbalance. The OECD considers that Romania still has significant potential to increase the domestic value added embedded in international trade; however, realising this potential will require sustained investment in innovation, digitalisation, human capital, and overall economic competitiveness (OECD, 2026a).

A distinct trend is expected in the case of energy imports. In the short term, these will continue to be influenced by volatility in international markets, developments in oil and natural gas prices, and broader geopolitical uncertainty. Increases in energy prices can quickly translate into higher nominal import values, even in the absence of a significant rise in the physical volumes purchased.

Over the medium term, however, the expansion of domestic production capacity may alter this pattern. One important factor is the Neptun Deep project in the Black Sea. According to information published by OMV Petrom in July 2026, the project remains on schedule, with natural gas production expected to begin in 2027. Once operational, this new capacity is expected to strengthen Romania's energy security and reduce the country's reliance on external natural gas supplies (OMV Petrom, 2026).

In parallel, the expansion of renewable energy generation capacity and the modernisation of energy infrastructure could help reduce Romania's dependence on certain categories of imports. The OECD considers that increasing renewable energy production and strengthening the integration of European energy infrastructure are important steps towards enhancing Romania's energy security (OECD, 2026b).

As a result, the structure of Romania's energy imports may change after 2027, with a potential decline in natural gas imports and a relative increase in imports of equipment required for the energy transition, such as electrical installations, energy storage technologies, grid equipment, and components used in renewable energy projects.

Another structural trend is the continued importance of intra-EU imports. Romania's economy is deeply integrated into European value chains, and this pattern is unlikely to change substantially in the coming years. The automotive industry, electrical and electronic equipment manufacturing, and other industrial sectors rely heavily on components and intermediate goods sourced from other European Union Member States.

Integration into these production networks has a dual effect. An expansion of export-oriented production may simultaneously lead to higher imports of components and intermediate inputs. Consequently, rising imports do not necessarily indicate a loss of competitiveness. In

internationally integrated sectors, imported inputs are often used in the production of goods that are subsequently exported.

The OECD emphasises that Romania's integration into international markets has contributed to productivity gains and technology transfer, while at the same time increasing the economy's exposure to shocks affecting European supply chains (OECD, 2026a).

This dependence is particularly relevant in relation to developments in the major European economies that are closely connected to Romanian industry. A recovery in industrial production in Germany and other Central and Western European countries could, from 2027 onwards, support both an increase in Romania's exports and higher imports of components and intermediate goods.

Over the medium and long term, the evolution of imports will also depend on Romania's ability to expand domestic production in areas where reliance on external supply is currently high. A broad-based substitution of imports would be neither realistic nor economically efficient, as the benefits of specialisation and international trade remain essential for an economy integrated into the European market. Nevertheless, there are specific sectors in which the development of domestic productive capacity could help reduce certain vulnerabilities.

Such a trend may emerge in energy, the agri-food industry, the chemical sector, construction materials, pharmaceuticals, and selected segments of industrial component manufacturing. Expanding domestic capacity in these areas could reduce import requirements while also creating new opportunities for export growth.

The impact on the trade balance, however, will depend not only on the substitution of imported goods, but more importantly on the competitiveness of the new productive capacity. An effective strategy should therefore not rely on artificial protection of domestic production, but rather on investment that enables Romanian producers to compete in both domestic and international markets at comparable levels of productivity, quality, and technological sophistication.

Forecasts for future import developments should be interpreted with caution, as they may be significantly affected by factors that are difficult to predict with precision. The main risks relate to energy prices, geopolitical tensions, developments in the European economy, domestic fiscal policy, exchange-rate movements, and the absorption of European funds.

A renewed shock to oil or natural gas prices could rapidly increase the value of energy imports. Conversely, a more severe economic slowdown could reduce imports through weaker consumption and investment, although such an adjustment would not necessarily represent a favourable economic development.

An additional risk concerns the absorption of European funds. Delays in the implementation of EU-funded projects would reduce imports of machinery and equipment, but would simultaneously weaken investment and the economy's medium-term growth prospects. The OECD emphasises that the timely implementation of European-funded projects is essential for sustaining investment and strengthening Romania's growth potential (OECD, 2026a).

Overall, the outlook points to two distinct stages in the future evolution of Romania's imports. The first stage, corresponding mainly to 2026, is likely to be characterised by fiscal consolidation, persistently high inflation, and weaker household consumption, all of which will constrain demand for foreign goods. Total imports may stagnate or decline slightly in real terms, while imports associated with investment are expected to benefit from the continued implementation of projects financed through European funds.

The second stage, beginning in 2027, may bring a gradual recovery in imports as inflation eases, financing conditions improve, and private consumption and investment begin to strengthen. The pace of this recovery will, however, depend on the extent to which domestic production and exports expand alongside the increase in demand.

At the same time, the composition of imports could gradually become more supportive of economic development if a larger share consists of capital goods, technological equipment,

and components used in productive processes. In parallel, the expansion of domestic energy production, including the start of production from the Neptun Deep project in 2027, may reduce Romania's dependence on certain categories of energy imports.

The fundamental issue for the Romanian economy is therefore not import growth in itself, but the relationship between imports, investment, domestic production, and exports. Under a favourable scenario, imports of technology and equipment can contribute to the expansion of productive capacity and, subsequently, to stronger export performance. Under a less favourable scenario, a recovery in consumption without a corresponding strengthening of domestic supply would lead to renewed growth in imports of final goods and could keep the trade deficit at elevated levels.

Over the medium term, the sustainability of Romania's external trade will therefore depend on the economy's ability to move away from a pattern in which stronger demand rapidly translates into additional imports and towards a model in which investment, productivity gains, and the expansion of domestic productive capacity support a more balanced growth of both imports and exports, while gradually reducing external vulnerabilities.

4. CONCLUSIONS

The analysis of Romania's imports over the 2020–2025 period reveals a complex pattern shaped by both domestic factors and changes in the international economic environment. The period under review encompassed markedly different economic phases: the contraction associated with the COVID-19 pandemic, the rapid recovery of economic activity in the following years, the intensification of inflationary and energy-related pressures in 2022, and, subsequently, a period of adjustment and slower import growth. Overall, however, the dominant trend was a substantial increase in the value of goods purchased from abroad.

Imports played an important role in supporting the functioning of the Romanian economy. A significant share consisted of machinery, transport equipment, manufactured goods, raw materials, and intermediate inputs, indicating that imports are not associated exclusively with final consumption. They contribute directly to industrial activity, investment, the modernisation of productive capacity, and the integration of Romanian firms into international value chains. From this perspective, imports represent an important component of economic development and competitiveness.

At the same time, the 2020–2025 period also highlights a number of structural vulnerabilities. Import growth at a pace exceeding or close to that of exports contributed to the persistence of a large trade deficit. This imbalance partly reflects the limited capacity of domestic production to satisfy demand for certain categories of goods, as well as Romania's dependence on externally sourced products, technologies, and resources. Particularly during periods of strong consumption growth, a considerable share of additional demand was directed towards imported goods, thereby reducing its impact on domestic production.

Another important finding is Romania's strong dependence on trade with other European Union Member States. The dominant share of intra-EU imports confirms the high degree of integration of the Romanian economy into the European Single Market and regional production networks. This integration provides significant benefits, including access to technology, components, and competitive suppliers, but it also increases Romania's exposure to cyclical developments and potential disruptions affecting its main European trading partners.

The period under review also demonstrated the sensitivity of imports to external shocks. The sharp increase in their value in 2022 was driven not only by stronger demand, but also by substantial rises in energy and commodity prices and logistics costs. This underlines the importance of distinguishing between changes in the value and the physical volume of imports. In an environment of high inflation, an increase in import value does not necessarily reflect a

proportional rise in the quantity of goods purchased, but may instead result from changes in international prices.

Developments during 2023–2025 point to a degree of normalisation following the severe shocks of previous years. The decline in imports in 2023, followed by more moderate increases in 2024 and 2025, suggests weaker demand pressures and a relative stabilisation of external conditions. In 2025, export growth exceeded import growth, allowing for a slight narrowing of the trade deficit. Nevertheless, its persistently high level confirms that Romania's external imbalance is largely structural and cannot be corrected solely through favourable cyclical developments.

From an economic policy perspective, the main objective should not be a broad reduction in imports, as such an approach could adversely affect investment, production, and competitiveness. A more appropriate direction would be to improve the composition of imports and strengthen the economy's capacity to transform imported technologies, machinery, and intermediate goods into higher value-added domestic production. At the same time, developing competitive domestic capacity in sectors where Romania is excessively dependent on foreign supply could contribute to a gradual reduction in the trade deficit.

Over the medium term, reducing the vulnerabilities associated with imports requires stronger productive investment, higher productivity, infrastructure development, support for innovation and digitalisation, and improved competitiveness among Romanian firms. In addition, deeper integration of domestic suppliers into European production networks could increase the domestic value added embodied in exports and reduce dependence on certain categories of imported inputs.

In conclusion, the 2020–2025 period confirms the dual role of imports in the Romanian economy. On the one hand, they are essential for supporting production, investment, and consumption; on the other hand, they may intensify external imbalances when their growth is not accompanied by a corresponding expansion of domestic production and exports. Romania's challenge, therefore, is not to restrict imports, but to develop an economic model in which imports contribute more effectively to modernisation, productivity, and competitiveness, while their impact on the trade deficit is reduced through a stronger productive base and greater export capacity.

REFERENCES

1. European Commission, 2021, Analysis of the recovery and resilience plan of Romania, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0276&utm>
2. European Commission, 2023, 2023 Country Report – Romania, https://economy-finance.ec.europa.eu/publications/2023-country-report-romania_en?utm
3. European Commission, 2026, Economic forecast for Romania, https://economy-finance.ec.europa.eu/economic-surveillance-eu-member-states/country-pages-including-country-reports/romania/economic-forecast-romania_en?utm
4. Eurostat, 2022, EU's GDP up by 5.4% in 2021 but still below 2019 level, <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220629-2?utm>
5. Eurostat, 2024, EU registered trade in goods surplus of €38 billion in 2023, <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240327-3?utm>
6. International Monetary Fund, 2025, Romania: 2025 Article IV Consultation, <https://www.elibrary.imf.org/view/journals/002/2025/294/article-A002-en.xml>
7. National Institute of Statistics, 2026, TEMPO-Online – *International Trade. Statistical Database*, http://statistici.insse.ro/shop/?page=catD&lang=ro&category_id=29

8. OECD, 2026a, OECD Economic Surveys: Romania 2026, https://www.oecd.org/en/publications/oecd-economic-surveys-romania-2026_4844067e-en.html
9. OECD, 2026b, Romania: OECD Economic Outlook, Volume 2026 Issue 1, https://www.oecd.org/en/publications/oecd-economic-outlook-volume-2026-issue-1_2d1956f0-en/full-report/romania_3f6b4b1c.html
10. OMV Petrom, 2026, *Progress on the Neptun Deep Project: The Offshore Production Platform Has Been Installed in the Black Sea*, <https://www.omvpetrom.com/ro/despre-noi/ce-facem/proiecte/neptun-deep>
11. Sterescu, A.-B, 2026, Romania's growth drivers and macroeconomic policy: An import-adjusted GDP decomposition approach, 2010–2024, https://economy-finance.ec.europa.eu/publications/romanias-growth-drivers-and-macroeconomic-policy-import-adjusted-gdp-decomposition-approach-2010_en?utm

MANAGING ORGANIZATIONAL CHANGE FOR SUSTAINABLE INDUSTRIAL TRANSFORMATION

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ABSTRACT: *This paper examines the role of organizational change management in supporting sustainable industrial transformation in the context of digitalization, Industry 4.0 and Industry 5.0. The analysis is based on the premise that technological adoption alone is not sufficient to generate sustainable organizational change. Effective transformation requires the alignment of technology with strategy, organizational processes, employee competencies, governance mechanisms and sustainability objectives. Based on the literature on organizational change, digital transformation and sustainable manufacturing, the paper proposes an integrated managerial framework structured around six components: diagnosis of the need for change and organizational readiness, strategic alignment, leadership mobilization and employee participation, the development of competencies, experimentation and scaling, and institutionalization combined with continuous learning. The analysis suggests that sustainable industrial transformation should be understood as a continuous process of coordinated reconfiguration of technologies, processes, competencies and management mechanisms. In this context, change management provides the link between strategic objectives and operational implementation, while organizational learning and adaptability become essential conditions for maintaining transformation over time.*

Keywords: *Change Management; Industrial Transformation; Sustainability; Industry 4.0; Industry 5.0; Digital Transformation; Leadership; Organizational Capabilities.*

JEL Classification: *M10, M14, O32, Q01, Q56*

1. INTRODUCTION

The industrial sector is currently undergoing a profound transformation that poses major managerial challenges. The acceleration of technological change, the development of artificial intelligence, the expansion of automation, the increasing use of the Internet of Things (IoT), together with growing pressures for decarbonization and more efficient resource use, are reshaping the ways in which organizations create and sustain economic value. At the same time, economic volatility, supply chain disruptions, and changes in consumer preferences require organizations to strengthen their adaptive capacity. Under these conditions, organizational transformation should be understood as a process through which the organizational system is reconfigured in order to operate effectively in an environment characterized by uncertainty, interdependence, and multiple pressures on performance.

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In this context, the concept of industrial transformation extends beyond technological modernization in the narrow sense. The acquisition of advanced equipment, the automation of processes or the introduction of digital solutions may generate specific improvements, but they do not, by themselves, guarantee sustainable transformation. Technology must be integrated into an organizational system that includes structures, responsibilities, competencies, decision-making processes, and a corresponding organizational culture.

The introduction of new technologies can reshape information flows, decision-making and organizational systems and the competencies required within the firm. In the absence of appropriate organizational adaptation, the benefits of technological change remain limited. Consequently, the success of industrial transformation cannot be assessed solely through the presence or adoption of new technologies, but rather through the coherent changes they generate within the management system and through the organizational outcomes achieved.

The literature on digital transformation supports this perspective, describing it as a process that involves strategic adaptation, managerial change, and the reconfiguration of the way in which value is created (Vial, 2019; Verhoef et al., 2021). This approach is further developed within the Industry 5.0 concept. The European Commission report by Breque et al. (2021) identifies sustainability, human-centricity, and resilience as three central pillars of industrial development.

Industry 5.0 does not reject digitalization; rather, it broadens the criteria used to assess its contribution to industrial performance. Instead of associating performance primarily with technical efficiency and productivity, this perspective also evaluates technology in terms of its contribution to prosperity, employee well-being, environmental protection, and the industrial resilience.

Sustainable industrial transformation therefore requires the simultaneous pursuit of several objectives: maintaining economic competitiveness, reducing environmental impact, developing human capital, and strengthening resilience. These objectives may be complementary, but they can also generate tensions. An investment with a longer payback period may be justified by lower environmental impact and reduced resource consumption; the automation of production processes may improve efficiency, while creating a need for employee reskilling; and a monitoring solution that enhances process control may be perceived by employees as a form of surveillance. Under these conditions, change management provides mechanisms through which such tensions can be identified, analyzed and resolved.

The literature on organizational change offers several concepts that are particularly relevant in this respect. Armenakis et al. (1993) examine readiness for change in terms of organizational members' beliefs, attitudes, and intentions regarding both the need for change and the organization's ability to implement it. Holt et al. (2007) show that readiness for change is a multidimensional construct that includes change appropriateness, management support, perceived efficacy and personal valence. At the collective level, Weiner (2009) argues that organizational readiness reflects both shared commitments to change and confidence in the collective ability to implement it. These perspectives are especially relevant to industrial transformation, where successful change requires the simultaneous cooperation of multiple organizational functions and professional groups.

The challenge for organizations becomes even more complex because sustainable transformation does not have a clearly defined endpoint. Digitalization, environmental standards, technologies, and work models continue to evolve. For this reason, change management models originally developed for projects with clearly defined starting and ending points need to be reconsidered. Lewin's (1947) contribution remains relevant to the extent that change involves altering the balance between the forces that maintain existing behaviors and those that support a new direction. Similarly, Kotter's (1995) model remains useful with its emphasis on a sense of urgency, coalition for change, vision, communication, and consolidation

of change, but its application to industrial transformation must be combined with continuous learning and adaptation.

2. ORGANIZATIONAL CHANGE MANAGEMENT IN THE CONTEXT OF SUSTAINABLE INDUSTRIAL TRANSFORMATION

Change management occupies an important place in organizational management; however, contemporary industrial transformations require a reconsideration of the way in which it is applied. In the current economic environment, stability is increasingly temporary: technologies evolve rapidly, sustainability requirements are becoming more stringent, and external disruptions can alter operating conditions within a relatively short period of time. Consequently, change management should support not only the implementation of specific change initiatives, but also the development of an organizational capacity for repeated and continuous change.

In sustainable transformation, creating a shared understanding of change serves a dual purpose. On the one hand, it explains the economic necessity of a project; on the other hand, it connects the transformation process with social and environmental objectives. This connection is essential because sustainability may remain a peripheral concern if it is treated separately from organizational performance. Satyro et al. (2022) show that, in the implementation of Industry 4.0, competitiveness and quality tend to receive greater attention than sustainability, while the social dimension is often insufficiently addressed. Under these conditions, sustainability-related objectives should be explicitly incorporated into the purpose of technological projects and into the criteria used to evaluate their performance.

Organizational readiness for change represents an important condition for the success of organizational transformation. Armenakis et al. (1993) distinguish readiness for change from resistance to change and emphasize the role of change agents in shaping the attitudes of organizational members. Industrial transformation involves at least four levels of readiness. The first is technological and concerns infrastructure, interoperability, security, and data quality. The second is organizational and refers to managerial processes and structures. The third is human and includes competencies, motivation, and learning capacity. The fourth is strategic and concerns the alignment between project objectives, sustainability goals, and the organization's overall vision.

The human dimension becomes central within the Industry 5.0 framework. Breque et al. (2021) argue that human-centric industry should place employee well-being at the core of the production process and use technology to support, rather than merely replace, human capabilities. In practice, this means that automation should be designed with consideration for both productivity and quality of work. Automating repetitive or hazardous tasks can improve safety; however, if new roles are poorly defined or place excessive cognitive demands on employees, the social outcomes may be unfavorable. Human orientation should therefore be translated into concrete criteria related to job design, employee autonomy, and professional development.

Organizational culture represents another important component of industrial transformation. Digitalization often requires greater transparency, data-driven decision-making, interdisciplinary collaboration, and a willingness to experiment. These characteristics may conflict with a rigid organizational culture in which information is closely controlled and errors are penalized. In such an environment, employees may avoid experimentation or selectively report information, which limits the organization's ability to fully exploit the potential of new technologies. Consequently, organizational culture cannot be changed merely through the formulation of aspirational values. It also requires adjustments to the mechanisms that shape employee behavior, including reward systems, promotion criteria, mechanisms for

handling errors, employee competencies development and the distribution of decision-making responsibilities.

The development of employee competencies is another essential component, particularly because Industry 4.0 technologies are changing the structure of skills required within industrial organizations. Production employees may need stronger capabilities in data interpretation and the use of digital interfaces, technicians may require new competencies related to sensors and diagnostics, while managers increasingly need the ability to use large volumes of data in decision-making. At the same time, sustainability requires an understanding of resource consumption, environmental impacts, circular economy principles, and the life-cycle implications of products. Under these conditions, organizations should integrate digital, technical, and sustainability-related competencies rather than treating them as separate areas of development.

Dynamic capabilities provide a theoretical framework for explaining how firms adapt, integrate, and reconfigure resources and competencies in environments characterized by rapid technological change and uncertainty. Initially developed by Teece et al. (1997), the theory extends the Resource-Based View (Barney, 1991). While the RBV emphasizes the importance of possessing valuable, rare, and difficult-to-imitate resources, Dynamic Capabilities Theory highlights the firm's ability to transform, reconfigure, and renew those resources in order to create value. Applied to industrial transformation, this perspective suggests that value does not derive simply from the use of a particular technology, but from the organization's capacity to identify opportunities, mobilize resources, and reconfigure processes. The same technology may generate substantial value in an organization that is capable of learning and adapting, while producing limited benefits in a rigid organization.

The literature on Industry 4.0 further confirms the need for an integrated perspective. Sony and Naik (2020) identify critical factors such as strategy, leadership, organizational culture, competencies, and infrastructure, highlighting the complexity of implementation. Kamble et al. (2018) propose a framework for sustainable Industry 4.0, while Ghobakhloo (2020) emphasizes the sustainability functions associated with digitalization and the interdependencies among them. Stock and Seliger (2016) discuss the opportunities created by Industry 4.0 for sustainable manufacturing. At the organizational level, Braccini and Margherita (2019), through the analysis of a manufacturing company, identify potential effects across the three dimensions of sustainability. Ching et al. (2022) further show that Industry 4.0 applications for sustainable manufacturing are interdependent and can support functions that go beyond isolated efficiency improvements. Taken together, these contributions support the view that sustainable transformation results from the coherent integration of technology, processes, and management.

From a management perspective, organizational change should not be treated as a set of auxiliary activities associated with the introduction of new technologies. Rather, it represents the mechanism through which technology is translated into behaviors, routines, and organizational outcomes. Sustainable industrial transformation therefore requires the simultaneous design and alignment of both the technical and organizational systems.

3. INTEGRATED MANAGEMENT FRAMEWORK TO ACHIEVE SUSTAINABLE INDUSTRIAL TRANSFORMATION

Sustainable industrial transformation can be managed through an integrated framework that connects organizational change with digitalization and sustainability. The integrated managerial framework for sustainable industrial transformation should not be understood as a rigid sequence of steps, but rather as a continuous management cycle. An organization may return to the diagnostic stage after a pilot project, adjust its strategy in light of the results obtained, or resume skills development as technologies evolves. This approach simultaneously

integrates the technological, economic, human, and environmental dimensions of transformation.

The first component in an organizational transformation process is to rigorously identify the need for change and assess the organization's readiness to undertake it. From a strategic management perspective, the adoption of new technologies should not be regarded as an objective in itself, but as a means of addressing specific operational, economic, or organizational problems. Such problems may include high energy costs, equipment downtime, quality variability, material losses, increasing traceability requirements, skill shortages, or vulnerabilities within supply chains.

A precise problem definition is an essential condition for selecting solutions capable of generating both economic and organizational value. In the absence of a clear connection between the identified need and the proposed technological solution, there is a risk that investments may be directed toward technologies that are poorly integrated into organizational processes or that have only a limited impact on performance. At the same time, the organization must assess its capacity to manage and sustain the change process. The evaluation of organizational readiness should include technical, managerial, and human dimensions. These dimensions include digital infrastructure maturity, data quality and availability, system interoperability, professional and digital competencies, resource availability, organizational culture, cross-functional collaboration, and senior management involvement.

Such an assessment should not be interpreted as a selection mechanism intended to exclude less mature organizations from transformation processes. Rather, it should be viewed as a managerial diagnostic tool used to identify gaps between existing capabilities and those required for successful change implementation. The results of this assessment can support the definition of preliminary interventions and the development of a realistic sequence of investments.

In some cases, the analysis may indicate that the immediate introduction of advanced technologies, such as artificial intelligence, does not represent the most appropriate priority. Data standardization, the strengthening of information governance mechanisms, the clarification of responsibilities, system integration, or the development of internal competencies may constitute essential preliminary steps. From this perspective, the assessment of organizational readiness becomes an important tool for supporting investment decisions. It helps organizations prioritize resources, reduce implementation risks, and increase the likelihood that the transformation process will generate sustainable outcomes.

The second component is strategic alignment. The transformation process should be closely linked to the organization's competitiveness and sustainability objectives. This alignment is particularly important because digitalization and sustainability projects are often managed separately. The IT department may focus on modernizing digital infrastructure, the production department may seek to improve Overall Equipment Effectiveness (OEE), while the sustainability function may prioritize emissions reduction. An integrated framework makes it possible to identify projects in which these objectives can reinforce one another and provides a common basis for coordination. Strategic alignment therefore requires a cross-functional approach, as transformation projects should not be owned exclusively by a single organizational function.

The third component is leadership mobilization and employee participation. Change must be translated into a credible message that explains why the organization is transforming, what objectives it seeks to achieve, and which principles will guide the process. This message must be supported by consistent managerial behavior. If management states that a project is intended to promote learning but penalizes every unfavorable outcome of an initiative, the organization is likely to become more reluctant to experiment. Likewise, if management claims that employees are at the center of the transformation while designing the system without consulting its users, the credibility of the message is undermined.

The fourth component is the development of competencies and organizational capabilities. Sustainable transformation requires an anticipatory analysis of organizational roles. The organization should identify the activities that are likely to disappear, those that will be modified, and the new activities that may emerge. On this basis, it can determine which competencies should be developed internally, which should be acquired through recruitment, and where external partnerships are necessary. This approach is preferable to a delayed response in which the company realizes, only after implementation, that it lacks a sufficient number of users able to interpret data or maintain the system.

The fifth component is experimentation, learning, and scaling. Industrial transformation involves both technological and organizational uncertainty, and pilot projects can help reduce this uncertainty. However, a pilot project should be designed to test relevant assumptions. Demonstrating that a technology works under ideal conditions is not sufficient; its integration with existing systems must also be tested. Only in this way can the organization realistically assess the costs and requirements associated with scaling.

The sixth component is institutionalization and continuous learning. Change becomes sustainable when new practices are embedded in routine management processes. This requires the updating of procedures, job descriptions, performance evaluation systems, budgets, and performance indicators. If a new digital system is used, only as long as the project team actively promotes it, the change has not been fully institutionalized. By contrast, when the data generated by the system are incorporated into performance meetings, influence managerial decisions, and are linked to clearly defined responsibilities, the technology becomes part of the organization's regular operating routines.

Table 1. Integrated management framework for sustainable industrial transformation

Component	Managerial question	Main mechanisms	Outcomes
1. Diagnosis and readiness assessment	Why is the change needed, and how prepared is the organization?	Benchmarking, readiness assessment, technological and organizational analysis	Clear problem definition and identification of key priorities.
2. Strategic alignment	How does the project contribute to competitiveness and sustainability??	Economic-financial analysis (business case), investment portfolio, organizational governance.	Coherence between strategy, investments and environmental, social and governance (ESG) objectives.
3. Mobilization	Who needs to be involved and how to build employee commitment?	Leadership, communication, participation, change agents.	Acceptance and distributed responsibility.
4. Competencies	What competencies and organizational capabilities are required?	Retraining advanced training, interdisciplinary teams, partnerships.	Enhanced internal implementation and learning capacity.
5. Experimentation, learning, and scaling	What works and how do we scale the solution?	Pilot projects, feedback, lessons learned, selective standardization.	Risk reduction and controlled scaling.

Component	Managerial question	Main mechanisms	Outcomes
6. Institutionalization and continuous learning	How can the changes introduced by the project become sustainable organizational practices?	Integrated Key Performance Indicators (KPIs), responsibilities, budgets, periodic review	Sustainable change and continuous adaptation.

Source: Author's elaboration based on the reviewed literature

A cross-cutting element of the proposed model is the performance measurement system associated with the transformation process. In practice, organizations frequently use implementation-oriented indicators, such as the number of equipment units deployed, the number of processes digitalized, or the number of employees trained. Considered individually, such indicators do not provide sufficient information about the value generated by transformation. From this perspective, a mature performance management system should link implementation indicators to economic, environmental, and social outcomes. This approach allows management to distinguish between the level of activity undertaken and the actual impact generated within the organization.

The economic dimension of performance may be assessed through indicators such as productivity, unit cost, Overall Equipment Effectiveness (OEE), defect rates, downtime, and service quality. The environmental dimension may include energy intensity, water consumption, emission levels, material losses, waste generated, and the waste recycling rate. The social dimension may focus on occupational safety, the development of competencies, employee engagement, and internal mobility. Such an indicator framework is consistent with the Industry 5.0 perspective, in which organizational performance is no longer reduced to technical efficiency alone, but is assessed through a balance between competitiveness, sustainability, and human-centricity. Within this framework, the performance measurement system becomes a mechanism of managerial integration, as it enables the simultaneous evaluation of objectives that have traditionally been considered separately.

The relationship between digitalization and the circular economy represents one of the relevant applications of this integrated framework. Internet of Things technologies can provide real-time information on the use, condition, and performance of assets, while advanced data analytics can help anticipate equipment degradation and optimize maintenance interventions. Ching et al. (2022) show that Industry 4.0 applications can support multiple functions of sustainable manufacturing and that the relationships among these functions are interdependent. From this perspective, digitalization should not be viewed exclusively as a means of improving efficiency; it can also provide the informational and operational infrastructure required for the transition toward circular production models. However, this contribution can be fully realized only when circularity objectives are explicitly integrated into the design of technological architectures and decision-making processes.

This perspective is also supported by the literature on industrial policy and sustainable industrialization. UNIDO (2024) highlights the role of digitalization, innovation, and decarbonization in shaping contemporary industrial policies and emphasizes the importance of capabilities, access to finance, and institutional consensus in implementing change. For organizational management, the main implication is that transformation processes do not take place in an institutional vacuum. Regulations, available infrastructure, labor market conditions, access to skills, public policies, financing mechanisms, and innovation ecosystems can directly influence the pace, cost, and feasibility of transformation.

4. CONCLUSIONS

Sustainable industrial transformation cannot be reduced to the adoption of new technologies or the digitalization of isolated processes. The introduction of artificial intelligence, automation, IoT solutions, or other Industry 4.0 technologies can generate sustainable results only when accompanied by coherent changes in strategy, processes, competencies, organizational structures, and governance mechanisms. From this perspective, change management represents a central component of industrial transformation because it creates the link between technological investment and the actual outcomes achieved by the organization.

Organizational readiness for change must be assessed from several perspectives. Technological infrastructure and data quality are important, but they are not sufficient. Employee competencies, organizational culture, management involvement, cross-functional collaboration, and the organization's capacity to learn directly influence transformation outcomes. Consequently, an organization's level of maturity should be assessed before major investments are undertaken in order to identify both opportunities and potential gaps that may constrain implementation.

The proposed managerial framework integrates six components: diagnosing the need for change and the level of organizational readiness, strategic alignment, leadership and employee mobilization, the development of competencies, experimentation and scaling, and the institutionalization of change combined with continuous learning. These components should not be viewed as a rigid sequence, but rather as an iterative process. Organizations need to be able to revisit initial decisions, adapt projects in response to the results obtained, and continuously develop their competencies and implementation capacity.

An important implication is the need to integrate competitiveness objectives with sustainability goals. Technological, economic, and environmental projects should not be developed in isolation, as their effects are interdependent. An investment in digitalization may simultaneously contribute to higher productivity, lower resource consumption, improved working conditions, and greater organizational resilience. At the same time, trade-offs may arise between these objectives, and management has the responsibility to identify and incorporate them into the decision-making process.

In this context, the performance measurement system plays an essential role. The number of digitalized processes, connected equipment, or trained employees may indicate implementation progress, but does not demonstrate the existence of a meaningful impact. The evaluation of transformation should therefore include economic, environmental, and social outcomes. This approach is consistent with the Industry 5.0 perspective, which broadens traditional performance criteria and places greater emphasis on sustainability and the human dimension.

Digitalization can also support the development of more circular production models. Asset monitoring, data analytics, and digital traceability can contribute to a more efficient use of resources and create favorable conditions for reuse, remanufacturing, and recycling. However, these benefits do not emerge automatically from the introduction of technology alone. They depend on the extent to which circularity objectives are integrated into process design and managerial decision-making.

Another conclusion concerns the role of organizational capabilities. Competitive advantage does not derive exclusively from access to a particular technology, as similar technologies may generate very different outcomes across organizations. The difference lies in the organization's ability to identify relevant opportunities, mobilize the necessary resources, and reconfigure processes and competencies as conditions change. Industrial transformation should therefore also be understood as a process through which organizations strengthen their capacity to adapt.

The findings also suggest the need for a broader perspective on the success of transformation projects. Meeting deadlines, staying within budget, and complying with technical specifications remain relevant, but they are not sufficient. Success should also be assessed in terms of the effective use of new systems, the achievement of expected benefits, the development of competencies, the integration of new practices into routine activities, and the organization's capacity to adapt them over time.

From this perspective, sustainable industrial transformation can be understood as a continuous process of reconfiguring technologies, processes, competencies, and management mechanisms with the aim of creating economic, social, and environmental value. Change management provides the mechanisms through which these dimensions can be coordinated and embedded into stable organizational practices without reducing the organization's capacity for further adaptation.

REFERENCES

1. Armenakis, A. A., Harris, S. G., & Mossholder, K. W., 1993, *Creating readiness for organizational change*, Human Relations, 46(6), https://www.academia.edu/20574525/Creating_Readiness_for_Organizational_Change.
2. Barney, J., 1991, *Firm resources and sustained competitive advantage*, Journal of Management, 17(1), [https://josephmahoney.web.illinois.edu/BA545_Fall%202022/Barney%20\(1991\).pdf](https://josephmahoney.web.illinois.edu/BA545_Fall%202022/Barney%20(1991).pdf).
3. Braccini, A. M., & Margherita, E. G., 2019, *Exploring organizational sustainability of Industry 4.0 under the triple bottom line: The case of a manufacturing company*, Sustainability, 11(1), <https://ideas.repec.org/a/gam/jsusta/v11y2018i1p36-d192273.html>.
4. Breque, M., De Nul, L., & Petridis, A., 2021, *Industry 5.0: Towards a sustainable, human-centric and resilient European industry*, European Commission, Directorate-General for Research and Innovation, <https://op.europa.eu/en/publication-detail/-/publication/468a892a-5097-11eb-b59f-01aa75ed71a1/language-en>.
5. Ching, N. T., Ghobakhloo, M., Iranmanesh, M., Maroufkhani, P., & Asadi, S., 2022, *Industry 4.0 applications for sustainable manufacturing: A systematic literature review and a roadmap to sustainable development*, Journal of Cleaner Production, <https://eprints.glos.ac.uk/12746/1/12746%20ASADI%20Shahla%20%282021%29%20Industry%204.0%20applications%20for%20sustainable%20manufacturing%20article.pdf>.
6. Ghobakhloo, M., 2020, *Industry 4.0, digitization, and opportunities for sustainability*, Journal of Cleaner Production, 252, <https://www.diva-portal.org/smash/get/diva2:1757879/FULLTEXT01.pdf?ref=sgi4.com>.
7. Holt, D. T., Armenakis, A. A., Feild, H. S., & Harris, S. G., 2007, *Readiness for organizational change: The systematic development of a scale*, The Journal of Applied Behavioral Science, 43(2), https://www.researchgate.net/publication/250959648_Readiness_for_Organizational_Change_The_Systematic_Development_of_a_Scale.
8. Kamble, S. S., Gunasekaran, A., & Gawankar, S. A., 2018, *Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives*, Process Safety and Environmental Protection, 117,

- <https://www.sciencedirect.com/science/article/abs/pii/S0957582018301629?via%3DiHub>.
9. Kotter, J. P., 1995, *Leading change: Why transformation efforts fail*, Harvard Business Review, 73(2), <https://hbr.org/1995/03/leading-change-why-transformation-efforts-fail-2>.
 10. Lewin, K., 1947, *Frontiers in group dynamics*, Human Relations, 1(1), <https://journals.sagepub.com/doi/10.1177/001872674700100103>.
 11. Satyro, W. C., de Almeida, C. M. V. B., Pinto, M. J. A., Jr., Contador, J. C., Giannetti, B. F., de Lima, A. F., & Fragomeni, M. A., 2022, *Industry 4.0 implementation: The relevance of sustainability and the potential social impact in a developing country*, Journal of Cleaner Production, 337, https://www.researchgate.net/publication/357828074_Industry_40_implementation_The_relevance_of_sustainability_and_the_potential_social_impact_in_a_developing_country.
 12. Sony, M., & Naik, S., 2020, *Critical factors for the successful implementation of Industry 4.0: A review and future research direction*, Production Planning & Control, 31(10), https://www.researchgate.net/publication/337333407_Critical_factors_for_the_successful_implementation_of_Industry_40_a_review_and_future_research_direction.
 13. Stock, T., & Seliger, G., 2016, *Opportunities of sustainable manufacturing in Industry 4.0.*, Procedia CIRP, 40, <https://www.sciencedirect.com/science/article/pii/S221282711600144X>.
 14. Teece, D. J., Pisano, G., & Shuen, A., 1997, *Dynamic capabilities and strategic management*, Strategic Management Journal, 18(7), [https://josephmahoney.web.illinois.edu/BA545_Fall%202022/Teece,%20Pisano%20and%20Shuen%20\(1997\).pdf](https://josephmahoney.web.illinois.edu/BA545_Fall%202022/Teece,%20Pisano%20and%20Shuen%20(1997).pdf).
 15. United Nations Industrial Development Organization, 2024, *Industrial Development Report 2024: Turning challenges into sustainable solutions—The new era of industrial policy*, UNIDO, <https://www.unido.org/idr/idr2024>.
 16. Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M., 2021, *Digital transformation: A multidisciplinary reflection and research agenda*, Journal of Business Research, 122, <https://www.sciencedirect.com/science/article/pii/S0148296319305478>.
 17. Vial, G., 2019, *Understanding digital transformation: A review and a research agenda*, The Journal of Strategic Information Systems, 28(2), https://www.researchgate.net/publication/331020687_Understanding_digital_transformation_A_review_and_a_research_agenda.
 18. Weiner, B. J., 2009, *A theory of organizational readiness for change*, Implementation Science, 4, <https://link.springer.com/article/10.1186/1748-5908-4-67>.

HUMAN CAPITAL, STRATEGIC DEVELOPMENT AND ECONOMIC GROWTH IN ROMANIA: AN INTEGRATED PERSPECTIVE, 2020–2025

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ABSTRACT: *This paper examines the interaction between human capital, strategic development and economic growth in Romania during 2020–2025, a period marked by the COVID-19 shock, post-pandemic recovery, high inflation, accelerated EU-funded investment and renewed pressure to modernise education and skills. The study adopts an integrated economic perspective in which human capital is treated not only as educational attainment but as a productive asset whose contribution depends on labour-market utilisation, continuous skill renewal, digital capabilities and the institutional capacity to connect education with investment and innovation. The empirical component combines official Eurostat indicators, European Commission monitoring data and national and European policy evidence. Romania recorded a rapid rebound after the 2020 contraction, but the recovery coexisted with structural weaknesses: tertiary attainment among 25–34 year-olds was 23.2% in 2024 compared with 44.1% in the EU; adult participation in learning remained substantially below the EU benchmark; basic digital skills were weak; and the employment rate of the 20–64 population reached 69.0% in 2025 compared with 76.1% in the EU. The employment rate of recent graduates was 72.7% in 2025. The evidence suggests that the principal constraint is not the absence of investment alone, but the incomplete conversion of education, skills and labour supply into productive capacity. The paper argues that Romania’s strategic-development model should integrate human-capital objectives with investment policy, regional development, digitalisation and labour-market institutions. Because the national annual sample contains only six observations, the analysis is deliberately descriptive and mechanism-based rather than presenting an underidentified causal growth regression. The contribution lies in combining growth, education, employment and strategic-policy evidence into a coherent framework for assessing Romania’s capacity to transform investment into sustainable productivity gains.*

Keywords: *Human Capital; Economic Growth; Strategic Development; Employment; Tertiary Education; Lifelong Learning; Digital Skills; Romania*

JEL Classification: *I25; J24; O15; O47; O52.*

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1. INTRODUCTION

Human capital is one of the central mechanisms through which education, labour-market institutions and technological change affect long-run economic performance. Physical investment can expand productive capacity, but its returns depend on the ability of workers and organisations to operate new technologies, reorganise production and generate innovation. For economies engaged in convergence, this complementarity is especially important. Catch-up growth can initially rely on capital deepening, foreign investment and the reallocation of labour toward more productive activities; sustaining convergence requires progressively stronger domestic capabilities, higher skills and more effective diffusion of knowledge.

Romania offers a particularly relevant case. The 2020–2025 interval combines several shocks and policy transitions that make the relationship between skills and growth unusually visible. The pandemic produced a sharp disruption in 2020, followed by a strong rebound. The subsequent period brought an energy-price shock, elevated inflation, tighter financing conditions and geopolitical uncertainty. At the same time, the Recovery and Resilience Facility and EU cohesion policy expanded the resources available for infrastructure, digitalisation, education and institutional reform. These developments created an environment in which the quantity of investment and the economy's capacity to absorb investment became equally important.

The human-capital indicators reveal a less favourable picture than headline convergence. According to the European Commission's Education and Training Monitor 2025, only 23.2% of Romanians aged 25–34 had tertiary education in 2024, compared with 44.1% in the EU. Early leaving from education and training remained high at 16.8%, while adult participation in learning, although improving, remained far below the EU level. Digital capability is another constraint: only 27.7% of people aged 16–74 had at least basic digital skills in 2023, compared with 55.6% in the EU (European Commission, 2025a). These indicators matter economically because they influence technology adoption, occupational mobility, productivity and the speed at which firms can respond to structural change.

The labour market provides a second layer of evidence. Romania's employment rate for persons aged 20–64 reached 69.0% in 2025, compared with 76.1% for the EU. The employment rate of recent graduates was 72.7%, also below the EU aggregate. Such gaps imply that the effective stock of human capital is determined by both formation and utilisation. A qualification generates economic returns only when it is matched to productive employment; similarly, investment in digital infrastructure yields smaller productivity gains when firms and workers lack complementary skills.

Against this background, the article addresses four questions. How did Romania's macroeconomic performance evolve during 2020–2025? What do education, training, digital-skill and employment indicators reveal about the quality and utilisation of human capital? Through which channels can strategic public investment strengthen or weaken the human-capital–growth relationship? Finally, which policy priorities follow from an integrated interpretation of the evidence? The objective is not to claim causality from six annual observations, but to develop an empirically disciplined diagnosis that can support subsequent regional panel research.

The contribution is threefold. First, the paper treats human capital as a multidimensional productive asset rather than equating it with years of schooling. Second, it links the human-capital diagnosis to strategic development, understood as the coordination of investment, education, innovation, digitalisation and labour-market policy. Third, it explicitly distinguishes descriptive evidence from causal inference. This distinction is important for applied economic research because a small annual sample can easily produce unstable coefficients that appear more precise than the underlying information permits.

2. THEORETICAL FRAMEWORK AND LITERATURE

Human-capital theory conceptualises education and training as investment because they raise the productive capacity of individuals and can generate returns over the working life (Becker, 1964). In aggregate growth models, human capital can affect output through several mechanisms: it raises worker productivity directly, facilitates the adoption of existing technologies, improves allocative efficiency and increases the capacity to generate new knowledge. Lucas (1988) emphasises the accumulation of human capital as a source of sustained growth, while Romer (1990) places knowledge and innovation at the centre of endogenous technological change.

The empirical literature has progressively moved beyond simple measures of schooling quantity. Hanushek and Woessmann (2015) show that cognitive skills are more closely related to long-run growth than years of schooling alone. This distinction is particularly relevant for Romania because formal attainment and effective competencies do not necessarily move together. A rise in enrolment may expand the nominal stock of education, yet weak foundational skills, high dropout or poor labour-market matching can limit the productivity effect.

A useful analytical distinction is therefore between human-capital formation, quality and utilisation. Formation refers to participation and attainment in education and training. Quality concerns the competencies acquired, including foundational, technical and digital skills. Utilisation captures whether those competencies are employed in productive activities. Economic growth depends on the interaction among all three dimensions. A country may expand higher education while losing skilled workers through migration, or may produce graduates whose fields of study do not match labour demand. In both cases, measured educational investment overstates the human capital effectively available to domestic production.

Strategic development is defined here as the coordinated use of public policy and investment to alter the economy's productive structure and long-term capabilities. This differs from a narrow interpretation of strategy as a collection of planning documents. An economically meaningful strategy links resources to measurable mechanisms: infrastructure lowers transaction costs; education increases skill supply; research and innovation improve technological capabilities; digitalisation raises information-processing capacity; and labour-market institutions influence the allocation of workers across firms and regions.

The complementarity between physical and human capital is central. A transport corridor can improve market access, but firms require managerial and technical capacity to exploit new opportunities. Digital public services can reduce administrative costs, but their benefits depend on citizens' and firms' ability to use them. Advanced manufacturing equipment raises potential productivity only if technicians, engineers and operators can integrate it into production. Strategic development therefore concerns not only the volume of expenditure but the sequencing and complementarity of investments.

For Romania, this perspective is especially relevant because the Recovery and Resilience Plan and cohesion-policy instruments mobilise substantial resources for infrastructure, digital transformation, education and the green transition. The 2025 Digital Decade country report notes a national roadmap containing 98 measures with a budget of EUR 3.6 billion, while also identifying persistent weaknesses in R&D, SME innovation, emerging-technology adoption and basic digital skills (European Commission, 2025c). The policy challenge is thus one of absorption in a broad economic sense: not simply spending funds, but converting them into durable productive capabilities.

Digitalisation strengthens the case for treating human capital as a dynamic rather than fixed stock. Technology changes task content, creates new occupations and alters the skills required within existing occupations. Workers therefore need not only initial qualifications but the capacity to learn repeatedly over the life cycle. Basic digital skills increasingly function as

general-purpose competencies analogous to literacy and numeracy, because they affect access to information, public services, training and a widening range of jobs.

Romania combines strengths and weaknesses in this area. The Education and Training Monitor reports that 30.9% of tertiary students were enrolled in STEM fields in 2023, above the EU share of 26.9% and close to the proposed EU-level target of 32%. Yet less than one third of the population aged 16–74 possessed at least basic digital skills in 2023. This coexistence suggests a distributional problem: advanced skills exist in parts of the education system and economy, while broad digital capability remains weak. A growth strategy focused only on high-end ICT talent may therefore leave a large productivity gap in traditional firms, public administration and less-skilled occupations.

The issue is reinforced by retention. The Digital Decade assessment recognises Romania’s relatively strong supply of ICT graduates but identifies difficulty in retaining talent domestically. From a growth perspective, emigration changes the return to public and private investment in education. Mobility can generate remittances, networks and knowledge circulation, but persistent net losses of skilled workers reduce the domestic stock available for innovation, management and public services. Policies aimed at skill formation therefore need to be analysed jointly with wages, career opportunities, research ecosystems and institutional quality.

Human capital contributes to growth only when labour is mobilised and allocated efficiently. Low employment among working-age adults reduces the effective labour input, while skill mismatch lowers productivity within employment. Demographic decline intensifies these mechanisms because a shrinking working-age population increases the economic cost of inactivity and skill underutilisation. The Education and Training Monitor cites projections of a substantial long-term contraction in Romania’s working-age population, strengthening the case for higher participation, lifelong learning and productivity growth.

Regional disparities further complicate the national picture. Bucharest–Ilfov concentrates high-productivity services, headquarters, universities and advanced employment, whereas several other regions face lower incomes, weaker urban networks and greater outmigration. National averages therefore combine very different human-capital ecosystems. Access to universities, training providers, digital infrastructure, employers and transport shapes the return to education locally. This is one reason why a future extension of the present study should move from six national annual observations to a NUTS 2 panel, where territorial heterogeneity can be modelled explicitly.

3. DATA AND METHODOLOGY

The empirical window covers 2020–2025. The starting point captures the pandemic shock and creates a consistent frame for analysing recovery and structural adjustment. The study draws primarily on Eurostat national accounts and Labour Force Survey indicators, supplemented by the European Commission’s Education and Training Monitor and Digital Decade reporting. These sources were selected because they provide harmonised definitions and allow Romania to be interpreted against EU benchmarks.

The core economic outcome is real GDP growth, complemented by nominal GDP to illustrate the scale of the economy. Human-capital utilisation is represented by the employment rate of persons aged 20–64 and the employment rate of recent graduates. Formation and renewal are captured through tertiary educational attainment among 25–34 year-olds, early leaving from education and training, adult participation in learning, STEM enrolment and digital skills. These indicators do not exhaust the concept of human capital, but together they capture quantity, quality, renewal and utilisation more effectively than a single education variable.

The paper uses descriptive time-series comparison, benchmark analysis and mechanism-based interpretation. Changes over time are examined alongside the EU aggregate

where comparable data are available. The approach is intentionally conservative. With only six annual observations, a multiple regression of GDP growth on several human-capital indicators would have almost no degrees of freedom, would be highly sensitive to the pandemic observation and would not separate common macroeconomic shocks from structural effects. Reporting such coefficients as evidence of a stable relationship would be misleading.

Instead, the study evaluates whether observed patterns are consistent with mechanisms established in the economic literature. For example, weak tertiary attainment is interpreted as a constraint on the supply of advanced skills, not as proof that a specific percentage-point increase would mechanically raise GDP by a given amount. Similarly, low adult-learning participation is linked to adjustment capacity, while low graduate employment is treated as evidence of incomplete labour-market absorption. This approach preserves empirical discipline while allowing the available evidence to inform strategic policy analysis.

Table 1. Human-capital dimensions, indicators and economic interpretation

Dimension	Indicator	Economic interpretation	Main source
Growth	Real GDP growth	Short-run output dynamics and recovery	Eurostat national accounts
Labour utilisation	Employment rate, 20–64	Use of working-age labour resources	Eurostat LFS
Education stock	Tertiary attainment, 25–34	Supply of advanced formal qualifications	Eurostat / EC Monitor
Transition	Recent graduate employment	Education-to-work absorption	Eurostat
Skill renewal	Adult participation in learning	Capacity for reskilling and adaptation	Eurostat / EC Monitor
Digital capital	At least basic digital skills	Capacity to use digital technologies broadly	Digital Decade / Eurostat
Specialisation	STEM share of tertiary students	Pipeline for technical and scientific skills	EC Monitor / Eurostat

Source: Authors' synthesis based on Eurostat, European Commission – Education and Training Monitor 2025, and the statistical indicators discussed in the article (including edat_lfse_04 and edat_lfse_24).

Interpretation follows three rules. First, levels and trends are separated: a country may improve while remaining far from the EU benchmark. Second, educational inputs are not equated automatically with productive outcomes; employment and skill use matter. Third, 2025 values are included only where official releases provide them. Where the most recent comparable structural indicator refers to 2023 or 2024, that reference year is stated explicitly rather than extrapolating a value for 2025.

The principal limitation is the small national time dimension. The period is also dominated by unusual shocks, including the pandemic, energy-price increases and high inflation. These factors make simple correlations especially difficult to interpret. Labour Force Survey series may contain methodological breaks, while education indicators often change slowly and are published with different reference years. Consequently, the study should be read as an integrated empirical diagnosis rather than a causal estimate of the return to human capital.

A stronger econometric extension would construct an eight-region NUTS 2 panel for 2020–2025, generating up to 48 region-year observations. A panel specification could relate regional GDP per capita or productivity growth to tertiary attainment, employment, training proxies, R&D or digitalisation controls, with regional and year fixed effects. Such a design would exploit cross-regional variation while controlling for common national shocks. The

present article provides the conceptual foundation and identifies the indicators that should enter that extension.

4. ECONOMIC DYNAMICS IN ROMANIA, 2020–2025

Romania's growth path over 2020–2025 was highly non-linear. The pandemic produced a contraction in 2020, followed by a strong reopening-driven rebound. Subsequent growth moderated as inflation accelerated, household purchasing power came under pressure and external demand weakened. By 2025, the European Commission assessed real growth at a modest rate relative to the immediate post-pandemic recovery. The sequence matters because human-capital indicators evolve more slowly than cyclical GDP, making it inappropriate to infer structural improvement from a short-lived rebound.

Nominal GDP expanded much faster than real output during the period because price increases were substantial. This distinction is important in strategic-development analysis. Rising nominal fiscal resources can create the appearance of rapidly expanding capacity, but real investment costs, wages and procurement prices also increase. Evaluation should therefore focus on real output, productivity and physical or service outcomes rather than nominal expenditure alone.

The labour market proved more resilient than the output shock might have suggested, but Romania continued to display a sizeable employment gap relative to the EU. In 2025 the employment rate of persons aged 20–64 was 69.0%, compared with 76.1% in the EU. This gap represents more than a social indicator. It implies foregone labour input and tax revenue, while increasing the burden of demographic ageing on the employed population. Raising participation can therefore support growth even before changes in educational attainment affect the workforce.

Gender differences are particularly relevant. Lower female employment can reflect childcare constraints, care responsibilities, local labour-market opportunities, transport accessibility and institutional design. These barriers interact with human capital: education produces lower aggregate returns when qualified individuals cannot participate fully in employment. Policies that expand childcare, flexible work and transport connectivity can therefore function as human-capital policies even though they are not classified as education expenditure.

Romania's strategic-development challenge is increasingly to convert investment into productivity. Public infrastructure can crowd in private investment by improving connectivity and reducing costs, while EU-funded digital and green projects can accelerate capital renewal. Yet the productivity effect depends on project selection, implementation quality and complementary capabilities in firms and public institutions. Shortages of engineers, technicians, project managers, health professionals or skilled construction workers can delay projects and raise costs.

This creates a two-way relationship between investment and human capital. Investment raises demand for skills and can increase wages and learning opportunities. At the same time, the available skill base determines which projects can be implemented domestically and how much value is retained in the economy. Where specialised labour is scarce, investment may increase imports of services or equipment without generating equivalent domestic knowledge accumulation. Strategic planning should therefore anticipate occupational demand rather than treating training as a separate policy stream.

5. HUMAN CAPITAL FORMATION AND UTILISATION

Tertiary attainment is one of the clearest structural weaknesses. In 2024, 23.2% of Romanians aged 25–34 had completed tertiary education, compared with 44.1% in the EU. The

gap is unusually large and cannot be explained by a single cohort. The Education and Training Monitor shows that the Romanian rate was 25.5% in 2015, indicating that the country did not converge toward the EU benchmark over the decade. High early leaving, unequal access, university dropout and migration all contribute to the outcome (European Commission, 2025a).

The economic effect is not simply a shortage of graduates in general. Modern growth increasingly depends on occupational mixes that combine advanced technical, managerial, health, education and professional skills. A low tertiary-attainment rate narrows the pool from which firms and public institutions recruit for such roles. It can also constrain the diffusion of technology because adoption often requires employees capable of adapting systems to local processes rather than merely operating standard equipment.

At the same time, policy should avoid interpreting expansion of university enrolment as an objective independent of quality and relevance. Completion, field of study, practical experience and labour-market outcomes matter. The introduction of dual higher-education pathways is potentially significant because it creates a stronger institutional bridge between universities and employers. The Monitor reports expansion of dual bachelor and master programmes during the 2024/2025 and 2025/2026 academic years. Their economic value will depend on scale, employer participation and whether programmes reach regions outside the strongest university centres.

The human-capital pipeline is affected well before tertiary education. Early leaving from education and training remained 16.8% in 2024, compared with 9.4% in the EU. High early leaving reduces the pool eligible for tertiary study and increases the probability of low-skilled employment or inactivity. It also makes later reskilling more difficult because adult training builds on foundational literacy, numeracy and learning capacity.

Learning outcomes reinforce this concern. The Education and Training Monitor reports high shares of low achievement among Romanian students in reading, mathematics and science. These deficits have long-term economic consequences because they affect not only future university participation but also the capacity to learn in vocational settings, use digital tools and respond to workplace change. Improving basic skills is therefore not merely an education-sector objective; it is part of productivity policy.

Initial education cannot provide all the skills required over a working life. The pace of technological and organisational change makes adult learning a central component of modern human capital. Romania has improved from a very low base, but participation remains insufficient. The Education and Training Monitor reports an increase in adult participation in learning from 5.8% in 2016 to 19.1% in 2022 under the Adult Education Survey measure, compared with 39.5% in the EU. The gap is especially relevant for people outside the labour market, residents of rural areas and adults with low educational attainment.

The economic mechanism is straightforward. When workers can reskill, firms can reorganise production without relying entirely on new cohorts or external recruitment. This reduces adjustment costs and makes investment more complementary with the existing workforce. Conversely, weak adult learning can create bottlenecks: vacancies coexist with unemployment or inactivity because the skill profiles do not match. In a shrinking labour force, such mismatches become increasingly expensive.

Romania's adult-learning strategies for 2024–2027 and 2024–2030, together with ESF+-supported upskilling programmes, provide an institutional framework for improvement. The challenge is to link participation to measurable labour-market outcomes. Training volume alone is not sufficient. Evaluation should examine completion, certification, employment transitions, wage progression and employer-reported skill use.

Digital skills reveal one of the sharpest gaps between infrastructure and human capability. Romania has comparatively strong fixed connectivity, yet the 2025 Digital Decade assessment continues to identify basic digital skills as a major weakness. In 2023, 27.7% of individuals aged 16–74 had at least basic digital skills, against 55.6% in the EU. More recent

Eurostat evidence shows that in 2025 only 53.3% of Romanian 16–24 year-olds had at least basic digital skills, one of only two EU countries below 60% for this age group.

This matters for productivity because digital technologies are general-purpose tools. Their value depends on complementary organisational changes and user capability. A firm can purchase software, cloud services or automated equipment, but productivity gains remain limited if employees cannot integrate these tools into workflows. The same applies to public-sector digitalisation: online services reduce administrative costs only when users can access them effectively and institutions redesign processes rather than merely digitising existing paperwork.

The coexistence of low broad-based digital skills with a relatively high STEM enrolment share suggests that Romania's challenge is not simply to produce more elite technical specialists. It is also to diffuse functional digital capability across the workforce. This requires differentiated interventions: advanced programmes for ICT and engineering, applied digital training for SMEs and occupations undergoing transformation, and foundational digital inclusion for groups with low participation.

The employment rate of recent graduates is a useful indicator of whether educational investment is translated into labour-market utilisation. Eurostat reported a rate of 72.7% for Romania in 2025, below the EU level. The indicator is affected by the business cycle and composition of graduates, but it nevertheless signals friction between education and employment. Such friction can arise from skill mismatch, geographic immobility, limited work experience, wage expectations or insufficient demand in particular fields.

From a strategic perspective, the transition can be improved through work-based learning, internships, dual programmes, career guidance and stronger employer involvement in curriculum design. These mechanisms reduce information asymmetry on both sides of the market. Students learn which competencies employers value, while firms obtain earlier information about potential recruits. The objective is not to subordinate education entirely to immediate vacancies, but to reduce avoidable mismatch while preserving transferable skills.

6. STRATEGIC DEVELOPMENT AND THE HUMAN-CAPITAL-GROWTH NEXUS

Romania's access to EU financing creates an opportunity to accelerate convergence, but it also raises the importance of complementary human capital. Recovery and resilience investments in digitalisation, energy, transport, health and education generate demand for specialised skills during implementation and for operational skills after completion. If these capabilities are scarce, projects may face delays, cost escalation or dependence on external expertise. Human-capital planning should therefore be integrated into investment programming from the design stage.

A useful policy principle is to associate major investment programmes with a skill map. For each investment area, authorities can identify occupations likely to experience increased demand, existing training capacity, regional shortages and the time required to produce additional workers. Such mapping can inform vocational places, university programmes, adult-learning subsidies and mobility support. It also creates a measurable link between strategic planning and labour-market outcomes.

Human capital affects growth not only through labour productivity but through absorptive capacity: the ability of firms and institutions to identify, adopt and adapt external knowledge. This is especially important for a convergence economy where imported technologies and foreign direct investment can be major sources of productivity improvement. Engineers, researchers, managers and technically skilled workers help translate external technology into local routines and supplier capabilities.

The 2025 Digital Decade report identifies persistent R&D gaps and weak innovation among SMEs and start-ups. These weaknesses imply that policy should connect research institutions, universities and firms more effectively. Public R&D expenditure alone cannot guarantee innovation if firms lack skilled personnel or incentives to collaborate. Conversely, producing researchers without attractive domestic opportunities can intensify emigration. The ecosystem perspective therefore complements the traditional human-capital focus on individual education.

National averages conceal large territorial differences in educational opportunity, employment structure and migration. A place-based approach recognises that the same intervention can have different returns across regions. In a metropolitan region with universities and dense labour markets, support for research collaboration may generate strong spillovers. In a rural or shrinking region, basic transport, school access, digital connectivity and vocational training may be more binding constraints.

Regional policy should also account for mobility. Supporting education in lagging regions does not automatically increase local human capital if graduates relocate permanently to Bucharest or abroad. Retention requires complementary job creation, housing, public services and career prospects. At the same time, policies should not attempt to prevent mobility; rather, they should make more Romanian regions viable locations for skilled work and investment.

Table 2. Integrated strategic-development framework linking human capital to economic performance

Strategic area	Human-capital mechanism	Economic channel	Suggested monitoring indicator
Higher education	Advanced skill formation	Innovation, management, professional services	Tertiary attainment; completion; graduate employment
VET / dual education	Occupation-specific skills	Industrial upgrading and faster matching	Work-based learning; placement rate
Adult learning	Reskilling and upskilling	Adaptation to technology and sectoral change	Participation; certification; wage/employment transition
Digitalisation	Broad digital capability	Technology adoption and lower transaction costs	Basic/advanced digital skills; SME adoption
R&D and innovation	Knowledge creation/absorption	Productivity and new products/processes	Researchers; business R&D; collaboration
Labour participation	Mobilisation of existing skills	Higher effective labour supply	Employment by sex/age/region
Regional policy	Retention and local matching	Reduced territorial productivity gaps	Graduate retention; regional employment/productivity

Source: Authors' conceptual synthesis based on the literature reviewed in the article and on European Commission and Eurostat monitoring frameworks for education, skills, employment, digitalisation and regional development.

The framework emphasises that policy success should be evaluated along a chain from inputs to outcomes. Spending is an input, training completion is an intermediate output, employment or productivity improvement is an outcome. Confusing these levels can lead to

optimistic assessments based on absorption rates without evidence that productive capacity has changed.

7. INTEGRATED EMPIRICAL DISCUSSION

The evidence from 2020–2025 supports a differentiated interpretation of Romania’s convergence. The economy recovered from the pandemic and continued to expand, but several human-capital indicators remained structurally weak. This does not imply that human capital made no contribution to growth. Rather, it suggests that growth can proceed for a period through capital accumulation, consumption, EU transfers, sectoral reallocation and foreign investment even when education and skill indicators lag. The policy question is whether such a model can sustain productivity convergence as demographic pressures intensify.

The tertiary-attainment gap is particularly important because it has not narrowed over the longer comparison period. At the same time, the relatively high share of STEM students demonstrates that the structure of Romanian higher education contains areas of strength. The strategic task is therefore twofold: broaden participation and completion while preserving quality and strengthening fields linked to technological transformation.

The integrated evidence suggests that human capital should be viewed as a potential constraint on the marginal return to investment. When investment accelerates simultaneously across infrastructure, energy, health and digital projects, demand for scarce skills rises across sectors. Wage increases can attract workers and stimulate training, but adjustment takes time. If supply is inelastic, projects compete for the same engineers, technicians and managers, potentially reducing implementation speed.

This mechanism helps explain why strategic coordination matters. Education policy operates with long lags, whereas investment programmes often have fixed implementation deadlines. Anticipating skill needs can reduce this mismatch. Short-cycle adult training and mobility measures can respond faster than university programmes, while long-term reform must strengthen foundational and tertiary education for future cohorts.

Human capital is not productive in isolation from institutions. Wage-setting, public-sector recruitment, procurement, research funding, firm competition and management quality influence where skills are allocated and how intensively they are used. A highly educated worker in a poorly organised institution may contribute less to productivity than a moderately educated worker in a firm with strong management and technology. This is why education reform should be complemented by improvements in institutional capacity and business dynamism.

Incentives also shape migration. Romania participates in an integrated European labour market in which skilled workers can move relatively easily. Retention cannot rely solely on appeals to remain in the country. It depends on expected wages, career progression, research opportunities, public services and confidence in institutions. Policies that improve these conditions increase the domestic return to education without restricting mobility.

8. POLICY IMPLICATIONS

The first priority is to increase the proportion of young adults who successfully complete high-quality tertiary education. Measures should target the transition from upper-secondary education, financial barriers for disadvantaged students, first-year dropout and completion. Scholarships and access programmes are most useful when combined with academic support and monitoring of progression. Expansion should be evaluated by completion and graduate outcomes rather than enrolment alone.

Adult learning should become a mainstream labour-market instrument rather than a marginal education activity. Funding can be targeted toward occupations affected by

digitalisation, green investment and demographic shortages. Employer co-design is important, but public policy should preserve portability of skills so that training does not bind workers to a single firm. Micro-credentials and recognition of prior learning can lower participation costs when quality assurance is credible.

Romania's high-end ICT strengths will not automatically digitalise the wider economy. Policy should distinguish between specialist ICT skills and general digital competence. SMEs need accessible support for adoption, managers need the ability to redesign processes, and employees in non-ICT occupations need applied training. Schools should integrate digital competence across subjects rather than treating it as an isolated technical module.

Given demographic constraints, activating existing human capital is as important as creating new skills. Childcare, transport, flexible work arrangements and targeted activation can raise participation among groups with lower employment rates. Career guidance and labour-market information should use vacancy and wage data to help students and workers make informed choices. Better matching raises output without requiring immediate increases in the working-age population.

Major public investments should include explicit assessments of regional skill requirements. Managing authorities can coordinate with universities, vocational schools, employers and employment services to identify bottlenecks before procurement and construction peak. Regional monitoring should track whether funded projects generate local employment, supplier development and skill formation rather than only physical outputs.

A stronger evidence architecture is necessary for strategic management. Romania should monitor a compact dashboard linking education, skills, labour utilisation and productivity. Indicators should be available by region, age, sex and educational level where possible. Administrative data can complement surveys by tracking transitions from education to employment and participation in publicly funded training. Evaluation should distinguish correlation from causal impact and should publish methodologies transparently.

9. LIMITATIONS AND RESEARCH AGENDA

The analysis has several limitations. First, the 2020–2025 national time series is too short for credible multivariate causal estimation. Second, structural indicators are not all available for the same reference year; some 2025 outcomes coexist with education or digital-skill measures referring to 2023 or 2024. Third, aggregate indicators conceal variation in quality. Tertiary attainment does not measure field-specific competence, and participation in training does not establish that useful skills were acquired. Fourth, national averages hide substantial regional disparities and migration flows.

These limitations point directly to a research agenda. A regional panel should combine NUTS 2 GDP per capita and employment with tertiary attainment, demographic structure, R&D, digitalisation and investment indicators. Fixed effects can control for persistent regional characteristics, while year effects capture common shocks. Where policy programmes have staggered implementation, quasi-experimental designs may become possible. Firm-level research could examine whether training, management quality and digital adoption jointly predict productivity, while linked education-employment data could assess graduate matching and retention.

A second extension concerns the measurement of human-capital quality. Future work should incorporate standardised skill assessments, occupation-level shortages and wage returns where comparable data permit. This would help distinguish between insufficient educational quantity and weak conversion of formal qualifications into productive competencies. The distinction is central for designing policy: the remedy for low attainment is different from the remedy for low quality or poor matching.

10. STATISTICAL SYNTHESIS AND TESTABLE PROPOSITIONS

Taken together, the indicators describe a development model in which macroeconomic convergence has advanced faster than several dimensions of human-capital convergence. This distinction is analytically important. GDP can rise because the capital stock expands, labour moves from low- to higher-productivity activities, domestic demand grows or external financing supports investment. Human-capital indicators, by contrast, reflect slower institutional and demographic processes. The coexistence of growth with weak education and skill outcomes is therefore not contradictory; it indicates that the sources of recent growth may not be identical to the capabilities required to sustain growth over a longer horizon.

The most persistent signal is the low tertiary-attainment rate. At 23.2% among 25–34 year-olds in 2024, Romania stood far below the EU average of 44.1%. This gap is reinforced by early leaving from education and training, which remained 16.8% compared with 9.4% in the EU. The two indicators should be interpreted jointly: a narrow pipeline into higher education limits the future stock of advanced skills, while high dropout within tertiary education further reduces completion. Policy that focuses exclusively on university capacity therefore addresses only one part of the chain.

Adult learning provides a second signal. The improvement recorded in recent years shows that participation can respond to policy and funding, but the level remains insufficient relative to the speed of technological change. This weakness has immediate economic relevance because the workers who will constitute most of the 2030 labour force are already beyond initial education. Improvements in schools and universities are essential, but they cannot by themselves reskill existing workers in sectors affected by automation, digitalisation, energy transition or changing trade patterns.

Digital skills sharpen the same diagnosis. Romania combines good connectivity and a meaningful pipeline of STEM students with low basic digital capability across the population. The policy implication is not to choose between advanced and basic skills. Both are complementary. A small group of highly trained specialists can create and implement sophisticated systems, but broad productivity gains require managers, employees, consumers and public servants who can use digital tools confidently. Diffusion, rather than technological availability alone, is the relevant economic mechanism.

The descriptive findings can be translated into hypotheses for a subsequent NUTS 2 panel analysis. These propositions are not presented as results of the current six-year national dataset. They specify relationships that can be tested when harmonised regional observations are assembled.

H1: Regions with higher tertiary educational attainment are expected to exhibit higher labour productivity or GDP per capita, conditional on persistent regional characteristics and common annual shocks. The mechanism is a larger supply of advanced skills and greater capacity to adopt technology.

H2: Higher employment rates are expected to strengthen the relationship between educational attainment and regional output. This proposition reflects the distinction between human-capital stock and utilisation: education contributes less to local production when qualified people remain inactive, unemployed or migrate.

H3: Digital capability and innovation intensity are expected to complement formal education. The productivity association of tertiary attainment should be stronger in regions where firms and institutions use technology more intensively, because skilled labour has more opportunities to apply advanced competencies.

H4: The effect of strategic investment is expected to depend on the regional skill base. EU-funded or public capital expenditure may have larger medium-run productivity effects where complementary technical and managerial capabilities are available. Empirically, this can

be examined through interactions between investment intensity and predetermined human-capital indicators.

H5: Human-capital effects are expected to appear with lags. Education, training and institutional reform require time to influence occupational allocation, technology adoption and productivity. A regional panel should therefore compare contemporaneous relationships with one- and two-year lags rather than assuming instantaneous adjustment.

A feasible empirical extension would use the eight Romanian NUTS 2 development regions over the longest common period for which GDP, employment, education and innovation variables can be harmonised. The dependent variable could be real GDP per capita, labour productivity or their growth rates. Explanatory variables would include tertiary attainment, employment, adult-learning or training proxies, R&D intensity, digital indicators and investment. Region fixed effects would absorb persistent territorial characteristics, while year effects would capture shocks common to Romania, including inflation, national fiscal measures and EU-wide developments.

The preferred specification should remain parsimonious because eight regions provide a limited cross-section. Standard errors should account for within-region serial correlation where feasible, and results should be tested against alternative dependent variables and influential-region exclusions, particularly Bucharest–Ilfov. Because the capital region is structurally different from the rest of the country, reporting estimates with and without it would show whether national relationships are driven by a single high-income region.

Endogeneity must also be addressed cautiously. Higher-income regions may invest more in education and attract graduates, creating reverse causality between human capital and output. Fixed effects reduce bias from time-invariant differences but do not solve time-varying simultaneity. Lagged regressors can improve temporal ordering but are not, by themselves, causal instruments. Strong causal claims would require an exogenous reform, eligibility threshold, staggered programme implementation or another defensible source of quasi-experimental variation.

This proposed architecture gives the present descriptive study a clear empirical continuation. Rather than treating the 2020–2025 national evidence as sufficient for causal claims, it uses that evidence to identify economically meaningful variables, mechanisms and hypotheses. Such sequencing is preferable to estimating an overfitted national regression whose numerical precision would exceed the information contained in the data.

10. CONCLUSIONS

This article examined human capital, strategic development and economic growth in Romania during 2020–2025. The period demonstrates why short-run output recovery and long-run productive capacity should not be conflated. Romania recovered from the pandemic and continued its convergence process, yet several indicators of human-capital formation and utilisation remained weak relative to EU benchmarks. Tertiary attainment among young adults was only 23.2% in 2024, adult learning remained limited, basic digital skills were weak, the employment rate of working-age adults remained below the EU level and the transition of recent graduates into employment was incomplete.

The evidence also reveals important strengths. Romania retains a substantial STEM orientation in tertiary education, has strong connectivity infrastructure and benefits from unprecedented European investment resources. These assets create opportunities for faster technological upgrading. Their economic return, however, depends on whether skills are broadened, retained and effectively matched to productive employment. Human capital is therefore not a sectoral issue confined to education ministries; it is part of the infrastructure through which investment, innovation and regional development generate growth.

The central strategic implication is coordination. Physical investment should be accompanied by skill planning; higher education expansion should be assessed through completion and employment; digitalisation should include broad user capability; and regional development should address both skill formation and retention. In a context of demographic decline, Romania has less room to compensate for low participation or weak matching through labour-force expansion. Productivity and better utilisation of existing human capital become increasingly important.

Methodologically, the article deliberately avoids claiming causal effects from a six-year national sample. Its contribution is to assemble a coherent empirical diagnosis and specify the mechanisms that a stronger regional or microeconomic design should test. The next step is therefore not a mechanically longer national time-series regression, but a NUTS 2 panel and, where possible, linked administrative or firm-level evidence. Such work would allow Romania's strategic-development debate to move from measuring expenditure toward measuring the conversion of skills and investment into sustainable productivity gains.

REFERENCES

1. Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. University of Chicago Press.
2. European Commission. (2025a). *Education and Training Monitor 2025: Romania*. Directorate-General for Education, Youth, Sport and Culture, Publications Office of the European Union. DOI: 10.2766/2887238.
3. European Commission. (2025b). *2025 Country Report – Romania*. European Semester. Directorate-General for Economic and Financial Affairs.
4. European Commission. (2025c). *Romania 2025 Digital Decade Country Report*. Shaping Europe's Digital Future.
5. European Commission. (2026). *Economic Forecast for Romania*. Directorate-General for Economic and Financial Affairs.
6. Eurostat. (2025). *Persons aged 25–34 with tertiary educational attainment level (edat_lfse_03)*. Eurostat Data Browser.
7. Eurostat. (2026a). *Employment and labour force by sex and age – annual data*. Eurostat Data Browser.
8. Eurostat. (2026b). *EU's employment rate grew above 76% in 2025*. Eurostat News, 17 April 2026.
9. Eurostat. (2026c). *Employment of recent graduates reached 83% in 2025*. Eurostat News, 15 June 2026.
10. Eurostat. (2026d). *Gross domestic product and main components – annual data (nama_10_gdp)*. Eurostat Data Browser.
11. Eurostat. (2026e). *75% of young Europeans have at least basic digital skills*. Eurostat News, 15 July 2026.
12. Cedefop. (2025). *Skills forecast and education and training evidence for Romania*. European Centre for the Development of Vocational Training.
13. Hanushek, E. A., & Woessmann, L. (2015). *The Knowledge Capital of Nations: Education and the Economics of Growth*. MIT Press.
14. Lucas, R. E. Jr. (1988). *On the mechanics of economic development*. *Journal of Monetary Economics*, 22(1), 3–42.
15. Mincer, J. (1974). *Schooling, Experience, and Earnings*. Columbia University Press.
16. Nelson, R. R., & Phelps, E. S. (1966). *Investment in humans, technological diffusion, and economic growth*. *American Economic Review*, 56(1/2), 69–75.

17. OECD. (2024). OECD Economic Surveys: Romania 2024. OECD Publishing, Paris.
18. Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102.
19. Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, 51(1), 1–17.
20. World Bank. (2018). *World Development Report 2019: The Changing Nature of Work*. World Bank, Washington, DC.

GREENWASHING IN THE SUSTAINABLE ECONOMY

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ABSTRACT: *Greenwashing constitutes a significant challenge to market transparency and consumer protection, referring to the presentation of a company's or product's environmental performance in a manner that is more favourable than warranted by available evidence. The literature identifies several manifestations, including vague or inadequately substantiated claims, the omission of relevant information, the use of misleading symbols, and the selective disclosure of environmental performance. TerraChoice (2010) and the European Commission (2021) indicate that insufficient evidence, vagueness, and the limited verifiability of environmental claims are among the most prevalent forms of greenwashing. Against this background, recent regulatory developments in the European Union, the United States, the United Kingdom, Australia, and Canada increasingly emphasise the substantiation, accuracy, and transparency of environmental claims. This study examines these developments through a case study of Fairphone, assessing the extent to which its corporate practices and sustainability communication mitigate the risk of greenwashing. The analysis highlights the use of measurable indicators, annual reporting, external verification, disclosure of methodological limitations, and acknowledgement of targets that have not been fully achieved. Fairphone also avoids absolute claims regarding climate neutrality and provides transparency concerning the book-and-claim mechanisms applied to the sourcing of certain materials. The findings suggest that Fairphone represents a comparatively well-substantiated approach to environmental communication, while remaining subject to environmental impacts and potential risks of selective disclosure. The case underscores the importance of verifiable evidence, transparency, and explicit recognition of limitations in establishing the credibility of sustainability claims.*

Keywords: *Greenwashing, Sustainability, Consumer Protection, Transparency, Circular Economy.*

JEL Classification: *M31; Q56; D18; K32*

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1. INTRODUCTION

Against the backdrop of growing concerns over climate change, natural resource use, and the transition towards more sustainable economic models, corporate environmental performance has become an increasingly salient consideration for consumers, investors, and public authorities. This development has contributed to the expansion of environmentally oriented corporate communication and marketing, while simultaneously increasing the risk of environmental performance being presented selectively, overstated, or insufficiently substantiated. Within this context, greenwashing has emerged as a significant issue in the economic literature and in the broader field of consumer protection, raising concerns regarding the credibility, transparency, and verifiability of corporate environmental claims.

The aim of this study is to examine the phenomenon of greenwashing, its principal manifestations, and the regulatory responses developed to address it, while illustrating, through a case study, how a company can communicate its environmental performance without misleading consumers.

Methodologically, the study adopts a documentary research approach based on an analysis of academic literature, empirical reports (TerraChoice, 2010; European Commission, 2021), legislative instruments and regulatory guidance issued by competent authorities in the European Union, the United States, the United Kingdom, Australia, and Canada, as well as impact reports and publicly available information published by Fairphone (2024, 2026).

Greenwashing may generate adverse consequences for companies, consumers, and investors by undermining trust in environmental information, increasing reputational and regulatory risks, and constraining the ability of consumers and investors to distinguish organisations with substantive sustainability performance from those relying primarily on symbolic or selectively disclosed environmental credentials. At the same time, increasing pressure on companies to substantiate the accuracy of their environmental claims may contribute to the emergence of *greenhushing*, characterised by the deliberate reduction or avoidance of communication concerning sustainability initiatives. Consequently, both the overstatement of environmental performance through *greenwashing* and its undercommunication through *greenhushing* may compromise the quality and completeness of information available to stakeholders and weaken the effectiveness of market mechanisms that increasingly rely on sustainability-related information.

2. CONCEPTUAL DEFINITION AND DELIMITATION OF GREENWASHING

The term “*greenwashing*” was first introduced by American environmentalist Jay Westerveld in a 1986 essay addressing the hotel industry's practice of encouraging guests to reuse towels on environmental grounds, despite the limited evidence of substantive environmental efforts by the hotels themselves (de Freitas Netto et al., 2020). The concept subsequently evolved into a broader analytical framework for examining discrepancies between corporate environmental performance and the way such performance is communicated to stakeholders.

Delmas and Burbano (2011) conceptualise greenwashing as the combination of **poor environmental performance and positive communication regarding such performance**. They examine the phenomenon at two levels: the firm level, referred to as **corporate greenwashing**, and the product level. Their framework identifies three broad categories of drivers: **external drivers**, including regulatory, non-governmental, and market pressures; **organisational drivers**, such as incentives, decision-making structures, and organisational ethics; and **individual drivers**, including managerial optimism and short-term decision-making.

Lyon and Montgomery (2015) distinguish between **selective greenwashing**, whereby organisations emphasise positive environmental aspects while concealing or downplaying negative ones, and **decoupling greenwashing**, whereby symbolic environmental commitments are not accompanied by substantive implementation. Their review also demonstrates the rapid expansion of academic interest in greenwashing after 2010. Subsequently, the systematic review conducted by de Freitas Netto et al. (2020) categorises greenwashing manifestations into **claim-based** and **executional** forms, the latter encompassing the use of images, colours, symbols, and other visual elements associated with nature and environmental protection. The authors further highlight the absence of a universally accepted definition of greenwashing, reflecting the conceptual heterogeneity of the phenomenon.

Another influential classification in the greenwashing literature is the framework proposed by TerraChoice (2010), which identifies seven practices through which environmental claims concerning products may mislead consumers. These include the **hidden trade-off, lack of proof, vagueness, irrelevance, lesser of two evils, fibbing, and worshipping false labels**. Collectively, these categories capture distinct mechanisms through which environmental information may be selectively presented, exaggerated, or communicated without adequate substantiation.

Building on these conceptual distinctions, de Freitas Netto et al. (2020) identify four categories of greenwashing: (a) **firm-level executional greenwashing**, whereby visual elements, language, and the overall communication context evoke associations with nature or environmental protection; (b) **firm-level claim greenwashing**, whereby corporate claims concerning environmental performance are misleading or inadequately substantiated; (c) **product-level executional greenwashing**, whereby product or packaging design conveys an environmentally favourable impression; and (d) **product-level claim greenwashing**, whereby an environmental claim concerning a product is misleading or problematic. This taxonomy is particularly relevant because it demonstrates that assessing the credibility of sustainability communication cannot be reduced to verifying the factual accuracy of an isolated statement. Rather, consumers interpret environmental communication holistically, responding to the overall message conveyed by textual, visual, symbolic, and contextual elements.

3. STUDIES ON GREENWASHING

The 2010 TerraChoice study examined **5,296 unique products** in Canada and the United States, with the products analyzed making a total of **12,061 environmental claims**. The researchers assessed these claims against the guidelines issued by the U.S. Federal Trade Commission, the guidance provided by the Canadian Competition Bureau, and the ISO 14021 standard on environmental labeling. Each product was independently evaluated by two analysts in an effort to minimize the risk of individual interpretations of the assessment criteria.

Table 1. Types of “Sins” among Consumer Products

Type of “Sin” / Form of Greenwashing	Percentage
No Proof (making environmental claims without supporting evidence or certification)	70.1%
Vagueness (using terms such as “natural,” “green,” or “environmentally friendly” without clearly specifying what they mean)	67.3%
Fake Labels (using symbols, images, or labels that create the impression that a product is environmentally certified when it is not)	30.9%

Type of “Sin” / Form of Greenwashing	Percentage
Hidden Trade-off (presenting a product as environmentally friendly on the basis of a single “green” attribute while disregarding other negative environmental impacts)	27.4%
Irrelevance (promoting a claim that is factually true but irrelevant to the product’s environmental impact)	5.8%
Lesser of Two Evils (presenting a product as “green” because it is less harmful than available alternatives, although it remains polluting or otherwise environmentally problematic)	0.5%
Fibbing (providing entirely false environmental information about a product)	4.5%

Note: The percentages should not be summed. A single product could exhibit more than one “sin”; therefore, the categories are not mutually exclusive and may overlap.

Source: TerraChoice (2010). *The Sins of Greenwashing: Home and Family Edition 2010*. Ottawa: TerraChoice Environmental Marketing / Underwriters Laboratories. p. 16. https://www.twosides.info/wp-content/uploads/2018/05/Terrachoice_The_Sins_of_Greenwashing_-_Home_and_Family_Edition_2010.pdf

Table 1 highlights the main forms of greenwashing identified by TerraChoice (2010), with the highest proportion corresponding to “No Proof,” accounting for 70.1% of the products examined. This was followed by “Vagueness,” at 67.3%, and “Fake Labels,” at 30.9%.

The distribution indicates that greenwashing primarily manifests itself through the omission of relevant information, insufficient substantiation of environmental claims, and the use of broad and difficult-to-verify statements. By contrast, “Fibbing,” understood as the direct provision of false information, was relatively marginal, accounting for 4.5% of the products examined. This finding indicates that explicitly false claims constitute a relatively small proportion of the phenomenon compared with forms of incomplete or ambiguous environmental communication. Accordingly, a legal regime that sanctions only “false” claims would address only a limited fraction of the phenomenon, thereby supporting a shift towards requirements concerning the substantiation of environmental claims.

From an economic and consumer protection perspective, these findings are particularly relevant because they highlight the difficulty consumers face in assessing the environmental performance of products on the basis of information provided by traders. The problem of greenwashing therefore extends beyond the provision of false information and also encompasses the selective, vague, or insufficiently substantiated manner in which the environmental characteristics of products are communicated. These findings support the need for mechanisms aimed at ensuring the substantiation, transparency, and verifiability of environmental claims.

In addition, the European Commission and national consumer protection authorities published the results of a website screening exercise, commonly referred to as a “sweep,” conducted as part of the annual efforts to identify potential breaches of European consumer protection legislation in online markets. For the first time, this exercise specifically targeted the phenomenon of “greenwashing,” namely situations in which companies present their environmental performance or actions in a manner that is more favorable than can be substantiated by the available evidence. The analysis examined environmental claims made on the websites of companies operating across various sectors, including the clothing industry, cosmetics, and household goods. Accordingly, the European Commission (2021), together with national consumer protection authorities, examined 344 environmental claims appearing on traders’ websites across the European Union.

Table 2. Typology and prevalence of potentially misleading environmental claims identified in the analyzed sample

Indicator	Percentage
Exaggerated, false, or misleading claims (potentially constituting an unfair commercial practice under the UCPD)	42%
Vague and general claims (e.g., “conscious,” “eco,” “sustainable”)	37%
Lack of easily accessible supporting evidence	59%

Source: European Commission (2021). Screening of websites for “greenwashing”: half of green claims lack evidence, https://ec.europa.eu/commission/presscorner/detail/en/ip_21_269

From an economic perspective, the data indicate a high incidence of insufficiently substantiated environmental communication, which may undermine the transparency and quality of information available to consumers. The largest proportion relates to the lack of easily accessible supporting evidence (59%), indicating significant difficulties in verifying claims concerning the sustainability of products and services. Furthermore, 42% of the claims were considered exaggerated, false, or misleading, while 37% relied on vague and general formulations, such as “eco” or “sustainable.” From an economic perspective, such practices may reduce the efficiency of consumer decision-making, distort competition among undertakings, and favor products promoted through insufficiently substantiated environmental claims over products whose environmental performance is supported by documented evidence.

The findings suggest that the primary concern is not necessarily the existence of false claims per se, but rather the difficulty of verifying environmental claims. From the consumer's perspective, an environmental claim for which accessible supporting information is unavailable may make it difficult to assess the actual environmental performance of a product or company. At the same time, the fact that some claims were found to be false indicates a significant risk that environmental information presented to consumers may create a more favorable perception of a product's environmental impact than is warranted by the available evidence. Furthermore, the use of general terms such as “eco” or “sustainable” may reduce consumers' ability to compare products and to understand what specifically makes a particular product less harmful to the environment. Such general terms may convey a positive environmental image without that image being supported by precise and verifiable criteria.

4. INTERNATIONAL REGULATIONS ON GREENWASHING

- **European Union**

Directive (EU) 2024/825 on empowering consumers for the green transition amends the Directive on Unfair Commercial Practices and the Consumer Rights Directive. The Directive introduces into the list of prohibited commercial practices general environmental claims that suggest superior environmental performance without adequate substantiation. It also prohibits, inter alia, situations in which a claim concerning the product as a whole or the trader's entire business is based solely on a particular aspect or characteristic. The Directive further addresses certain climate-neutrality claims that rely on the offsetting of greenhouse gas emissions outside the product's value chain (European Parliament & Council, 2024).

Member States were required to transpose the Directive into national law by 27 March 2026, with the new rules applying from 27 September 2026 (European Commission, 2024).

- **United States**

In the United States, the Federal Trade Commission (FTC) relies on the Green Guides, which were initially issued in 1992 and subsequently revised in 1996, 1998, and 2012. The

Guides explain how the principles governing deceptive advertising apply to environmental marketing claims and advise against the use of broad, unqualified claims such as “green” or “eco-friendly.” The FTC states that environmental claims should be supported by competent and reliable scientific evidence (FTC, 2012).

- **United Kingdom**

In the United Kingdom, the Advertising Standards Authority (ASA) and the Committee of Advertising Practice (CAP) apply advertising rules that include specific requirements concerning environmental claims. CAP states that absolute claims such as “green” or “environmentally friendly” are subject to a higher evidentiary standard and, as a general rule, should be supported by robust evidence covering the product’s entire life cycle, unless the scope of the claim is clearly qualified. For comparative claims such as “greener”, the basis of the comparison should be made clear (ASA/CAP, 2026).

In 2026, CAP updated its guidance on environmental claims and published practical resources aimed at promoting clear and evidence-based environmental communications. The ASA emphasizes that qualifying information must be sufficiently prominent and that the use of small print does not remedy a potentially misleading communication where the principal message has already created a misleading overall impression (ASA/CAP, 2026).

- **Australia**

The Australian Competition and Consumer Commission (ACCC) applies the Australian Consumer Law and recommends eight principles governing environmental claims: claims should be accurate and truthful; supported by evidence; free from material omissions; accompanied by explanations of relevant conditions; not expressed in broad or unqualified terms; communicated in clear language; supported by visual elements that do not mislead consumers; and transparent regarding the transition towards sustainability (ACCC, 2023).

- **Canada**

In 2024, Canada introduced amendments to the Competition Act addressing greenwashing. The Competition Bureau Canada subsequently issued guidance requiring environmental claims to be truthful and non-misleading and, where required by law, to be appropriately and adequately tested or substantiated (Competition Bureau Canada, 2025).

5. CASE STUDY – FAIRPHONE

Fairphone is a Dutch company established in 2013 as a social enterprise that manufactures modular and repairable smartphones, as well as audio products (Fairphone, 2024). Its stated mission is to create a viable market for ethical electronics and to encourage the industry to operate in a more responsible manner. The company is a certified B Corp and, in 2025, sold 145,259 devices, representing a 41% increase compared with the previous year, with revenues of approximately EUR 73 million (Fairphone, 2026).

The company’s business model is based on the premise that the largest environmental impact of a smartphone occurs during its manufacturing phase. According to the company’s reporting, up to 80% of a smartphone’s carbon footprint is attributable to production (Fairphone, 2026). Its strategy therefore focuses on extending the useful life of its devices, and the company’s environmental communication is structured around this principle.

Measures to Address Greenwashing

Specific and Measurable Claims. Rather than relying on broad claims such as “eco-friendly phone,” the company communicates specific and measurable commitments and

performance indicators. These include a five-year warranty, software support until 2033 for the Fairphone (Gen. 6), 12 user-replaceable modules, an iFixit repairability score of 10/10, and a carbon footprint of 29 kg CO₂e, compared with 42 kg CO₂e for the Fairphone 5. The proportion of “fair” materials is expressed as a percentage of total product weight: 51.31% for the Gen. 6, of which 37.92% consists of recycled materials, 0.39% of fairly mined materials, and 13.00% covered through credits (Fairphone, 2026).

Annual Reporting Based on a Defined Methodology and External Assurance. The company’s report includes a reporting basis explaining each indicator, while its key performance indicators are subject to third-party limited assurance. The appendices also provide lists of suppliers and mineral smelters and refiners, a level of supply-chain disclosure that remains relatively uncommon in the electronics industry (Fairphone, 2026).

Acknowledgement of Shortcomings and Failures. The 2025 report indicates that the company did not achieve its absolute emissions-reduction target, reaching 7.3% rather than the targeted 12% reduction. It also reports that the company was unable to trace the lithium used in the new model’s battery back to an independently assessed mine (Fairphone, 2026). In its 2023 report, Fairphone corrected one of its previously reported figures concerning recycled rare earth elements, revising the figure from 86% to 51% after a supplier had mistakenly conflated the concepts of “recyclable” and “recycled” (Fairphone, 2024). Such acknowledgement of limitations reduces the risk that partial environmental performance will be perceived as comprehensive environmental performance.

Rejection of “Climate Neutrality” Claims Based on Offsetting. The company distinguishes between “net zero” and “carbon neutral,” noting that the latter may be achieved through the purchase of carbon credits even where actual emissions increase (Fairphone, 2024). Fairphone has established a net-zero target for 2045, which has been validated by the Science Based Targets initiative (SBTi). The carbon credits purchased by the company —4,751 credits in 2025, associated with a Gold Standard-certified wind energy project — are presented as a contribution towards addressing residual emissions rather than as evidence that the product itself is carbon neutral (Fairphone, 2026).

Disclosure of Credit-Based Mechanisms. For materials such as cobalt, silver, and copper, supply chains are often too complex to enable the physical tracing of every individual unit of material. Fairphone therefore uses mechanisms based on the “book-and-claim” approach. The company explicitly describes these mechanisms and, for example, clarifies that Fairtrade gold is incorporated into the relevant supply chain but is not necessarily physically present in the specific component concerned (Fairphone, 2026).

Public or Independent Benchmarks. Fairphone’s environmental performance is also referenced against publicly recognized or independently established benchmarks, including the European Union energy label—with the Gen. 6 receiving Class A — as well as iFixit repairability scores, TCO certification, and B Corp recertification (Fairphone, 2026). B Lab is not a conformity assessment body within the meaning of European legislation, and its criteria are not ratified by public institutions (Fairphone, n.d.). This distinction is particularly relevant because it clarifies the nature and institutional status of the certification for consumers.

Supply-Chain Intervention. Since 2019, Fairphone has paid a premium intended to cover the gap between actual wages and living wages at partner manufacturing facilities. In 2025, this amounted to USD 215,000 for 1,650 workers, with the cumulative amount exceeding USD 1.25 million. The company nevertheless acknowledges that the premium applies only to the hours worked on the Fairphone production line and therefore does not fully resolve the underlying issue of living wages across the manufacturing workforce (Fairphone, 2026).

Overall, Fairphone’s approach to addressing greenwashing does not primarily rely on slogans but on verifiable practices: specific and measurable claims, a publicly disclosed methodology, independent assurance, acknowledgement of shortcomings, and the avoidance of claims that cannot be adequately supported by carbon offsetting mechanisms. This approach

illustrates how environmental communication can be structured around substantiation, transparency, traceability, and verifiability, thereby reducing the risk that consumers are presented with an environmental image that exceeds the evidence available to support it.

6. CONCLUSIONS

The analysis demonstrates that greenwashing is a complex phenomenon that extends beyond the communication of explicitly false information and encompasses the use of vague, insufficiently substantiated, selective, or difficult-to-verify claims. The academic literature and empirical studies reviewed indicate that indirect forms of greenwashing, such as the absence of supporting evidence, vagueness, and the omission of relevant information, are significantly more prevalent than environmental claims that are manifestly false. In this context, assessing the truthfulness of environmental communication should not be based solely on the existence of factual claims, but should also take into account the information omitted, the context in which claims are presented, and the extent to which consumers are able to verify them.

The findings of the TerraChoice (2010) study and the European Union website screening exercise (European Commission, 2021) confirm the existence of a structural problem concerning the transparency of environmental communication. The high proportion of claims for which accessible supporting evidence is not provided, or which rely on broad and general formulations, suggests that **information asymmetry between businesses and consumers** constitutes one of the key factors facilitating greenwashing. From an economic perspective, this situation may lead to inefficient consumer choices, distort competition, and place businesses that invest in improving their actual environmental performance at a competitive disadvantage when they do not possess comparable communication advantages.

The analysis of the regulatory framework also demonstrates an increasingly pronounced shift towards the **substantiation, verifiability, and transparency of environmental claims**. Regulatory approaches adopted in the European Union, the United States, the United Kingdom, Australia, and Canada seek to restrict the use of broad claims such as “eco,” “green,” or “sustainable” where such claims are not supported by sufficient evidence. This development indicates a transition from an approach focused exclusively on combating false information towards a broader regulatory paradigm that also addresses incomplete or ambiguous communication and claims that are liable to create a misleading impression of environmental performance.

Fairphone should be regarded as an example of an approach that reduces the risk of greenwashing rather than as evidence of its complete absence. The essential distinction lies between claiming that a product is “sustainable” and demonstrating concrete, specific, and verifiable improvements in its environmental and social performance. From this perspective, the credibility of environmental communication depends on the consistency between publicly communicated claims, actual performance, the methodology used for measurement, and the degree of transparency concerning limitations and uncertainties.

Addressing greenwashing requires an integrated approach based simultaneously on **regulation, standardization, independent verification, and corporate accountability**. For consumers, access to clear and comparable information is an essential prerequisite for informed decision-making. For businesses, transparency is therefore not merely a matter of regulatory compliance but also an increasingly important determinant of **credibility and long-term competitiveness**.

REFERENCES

1. ACCC – Australian Competition and Consumer Commission. (2023). Making environmental claims: A guide for business. Australian Competition and Consumer

- Commission. December 2023. <https://www.accc.gov.au/about-us/publications/a-guide-to-making-environmental-claims-for-business>
2. ASA/CAP. (2026). *ASA and environmental rules*. <https://www.asa.org.uk/about-asa-and-cap/the-work-we-do/environmental-claims-and-issues/our-environmental-rules.html>
 3. ASA/CAP. (2026). *Environmental claims: General “Green” claims*. Advertising Standards Authority / Committee of Advertising Practice. 9 June 2026. <https://www.asa.org.uk/advice-online/environmental-claims-general-green-claims.html>
 4. ASA/CAP. (2026). *Misleading environmental claims and social responsibility in advertising*. 30 July 2026. <https://www.asa.org.uk/resource/misleading-environmental-claims-and-social-responsibility-in-advertising.html>
 5. Competition Bureau Canada. (2025). *Greenwashing: guidance for businesses*. Government of Canada. <https://competition-bureau.canada.ca/en/deceptive-marketing-practices/greenwashing-guidance-businesses>
 6. de Freitas Netto, S.V., Sobral, M.F.F., Ribeiro, A.R.B. et al (2020). *Concepts and forms of greenwashing: a systematic review*. *Environ Sci Eur* 32, 19. pp. 2. <https://doi.org/10.1186/s12302-020-0300-3>
 7. Delmas, M. A. și Burbano, V. C. (2011). *The drivers of greenwashing*. *California Management Review*, 54(1), 64–87. https://www.researchgate.net/publication/228133505_The_Drivers_of_Greenwashing
 8. European Commission, Directorate-General for Energy. (2024). *New EU rules to empower consumers for the green transition enter into force*. 27 March 2024. https://energy.ec.europa.eu/news/new-eu-rules-empower-consumers-green-transition-enter-force-2024-03-27_en
 9. European Parliament (2024). *Greenwashing: How the EU Is Tackling Misleading Practices*. <https://www.europarl.europa.eu/topics/ro/article/20240111STO16722/dezinformatia-ecologica-cum-opreste-ue-practicile-inselatoare>
 10. European Parliament & Council of the European Union. (2024). Directive (EU) 2024/825 of 28 February 2024 amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and through better information. *Official Journal of the European Union*, L, 6 March 2024. <https://eur-lex.europa.eu/eli/dir/2024/825>
 11. Fairphone. (2024). *Fairphone's impact 2023: Change is in your hands*. <https://www.fairphone.com/wp-content/uploads/2024/06/Fairphone-2023-Impact-Report-.pdf>
 12. Fairphone. (2026). *Fairphone's impact 2025: Better starts here*. https://www.fairphone.com/wp-content/uploads/2026/04/Fairphone-Impact_Report-2025.pdf
 14. Fairphone. (f.a.). *B Corp certification notice*. <https://www.fairphone.com/bcorp-certification-notice>
 15. Federal Trade Commission (FTC) (2012). *Guides for the Use of Environmental Marketing Claims*, 16 C.F.R. Part 260; 77 Fed. Reg. 62122 (October 2012). <https://www.ftc.gov/sites/default/files/attachments/press-releases/ftc-issues-revised-green-guides/greenguides.pdf>
 16. Lyon, T. P. și Montgomery, A. W. (2015). *The means and end of greenwash*. *Organization & Environment*, 28(2), 223–249. https://www.researchgate.net/publication/277575332_The_Means_and_End_of_Greenwash

17. OECD (2025). *Protecting and empowering consumers in the green transition: Misleading green claims*. OECD Digital Economy Papers, No. 375. OECD Publishing, Paris. <https://doi.org/10.1787/12f28e4f-en>.
18. TerraChoice (2010). *The Sins of Greenwashing: Home and Family Edition 2010*. Ottawa: TerraChoice Environmental Marketing / Underwriters Laboratories. https://www.twosides.info/wp-content/uploads/2018/05/Terrachoice_The_Sins_of_Greenwashing_-_Home_and_Family_Edition_2010.pdf
19. United Nations. *Greenwashing – the deceptive tactics behind environmental claims*. <https://www.un.org/en/climatechange/science/climate-issues/greenwashing>

ANALYSIS OF INFLATION AND ECONOMIC POLICIES IN ROMANIA AFTER 2020

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ABSTRACT: *This paper examines inflation in Romania during the 2020–2025 period and interprets its trajectory through the interplay of external shocks, domestic propagation mechanisms, and economic policy. The analysis utilizes average annual rates of the Consumer Price Index (CPI) and the Harmonised Index of Consumer Prices (HICP), supplemented by documents from the National Bank of Romania and assessments by international institutions. Three distinct regimes are identified: the acceleration associated with the economic reopening and the energy crisis, the disinflation of 2023–2024, and the re-acceleration in 2025 driven by changes in administered prices and indirect taxation. Descriptive results indicate a persistent positive differential relative to the European Union average and a substantial cumulative rise in price levels.*

The analytical contribution lies in distinguishing the initial impulse from persistence mechanisms and separately evaluating monetary stability, fiscal sustainability, and the protection of purchasing power. Causal relationships are discussed as mechanisms supported by economic literature and institutional evidence, rather than being presented as original econometric estimates. It is argued that sustainable disinflation requires the anchoring of expectations, credible fiscal consolidation, and measures to reduce supply-side vulnerabilities. Data for 2026 serve a contextual purpose and are not conflated with the complete annual series.

Keywords: *Inflation; Romania; Monetary Policy; Fiscal Consolidation; Purchasing Power*

JEL Classification: *E31, E52, E62*

1. INTRODUCTION AND OBJECTIVES

Since 2020, price stability has become a central criterion for assessing the Romanian economy. The pandemic simultaneously altered production capacity, the structure of demand, and financial behavior. Subsequently, rising energy prices and geopolitical tensions amplified cost pressures. The sequential nature of these shocks explains why an exclusively monetary or exclusively energy-focused perspective remains incomplete.

The main question is why the reduction in inflation during 2023–2024 did not ensure a stable return to the target. This paper aims to identify the various stages, compare Romania with the European Union, and examine the costs associated with the distribution of the adjustment. The working hypothesis is that external shocks interacted with domestic rigidities and a policy

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mix that was difficult to coordinate. This hypothesis frames the interpretation; verifying the causal links would require additional data and methods.

The relevance of this research also stems from the fact that inflation has differential effects on households, businesses, and public finances. For households, the consequences depend on consumption patterns, the adjustment of nominal incomes, and the ability to safeguard savings; for businesses, these effects manifest through changes in costs, financing conditions, and investment decisions. Consequently, the assessment of price stability must be linked to an analysis of purchasing power and the distribution of adjustment costs, as an improvement in aggregate indicators does not automatically imply a uniform improvement in economic conditions.

Against this backdrop, the study contributes by articulating a comparative and institutional perspective that distinguishes between the initial drivers of inflation and the mechanisms that foster its persistence. The analysis examines both the evolution of average annual rates and the cumulative change in price levels to differentiate between a slowdown in inflation and the recovery of purchasing power. This approach provides a foundation for discussing the conditions for durable disinflation and the compatibility between monetary policy, fiscal consolidation, and the protection of vulnerable households.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

An analysis of inflation must distinguish between relative price variations and a persistent rise in the general price level. A rise in energy prices redistributes income between consumers and producers and alters cost structures. Its transformation into a generalized process depends on transmission to other goods, the response of nominal incomes, expectations, and monetary conditions. While the central bank can influence these mechanisms, it does not produce energy, nor does it directly eliminate physical supply constraints.

Friedman's (1968) contribution highlights the limits of exploiting a stable relationship between inflation and real economic activity when expectations adjust. Applying this concept to Romania requires caution: the theory explains the risk of persistent inflation accommodation without attributing a monetary origin to every monthly increase. Distinguishing between the initial trigger and subsequent accommodation is crucial for an episode driven by energy costs, taxes, and production disruptions.

A useful framework is the New Keynesian Phillips curve, in which inflation depends on expectations, demand pressure, and cost shocks. In an open economy, import prices and the exchange rate are also included. The coefficients of these relationships may vary over time: the transmission of a price increase depends on firms' margins, contracts, competition, and the duration of the shock. A stable equation estimated for normal periods may prove inadequate for describing a crisis regime. Bernanke and Blanchard (2023) demonstrate the relevance of goods market disruptions and labor market tensions to the US economy during the pandemic. This evidence provides a conceptual benchmark rather than a specific estimate for Romania. The BIS report (2022) discusses the risk of shifting from a low-inflation regime to one characterized by more frequent price and wage adjustments. For Romania, the frequency of adjustment and policy credibility are variables requiring further research rather than findings established here.

The distributional dimension complements the aggregate analysis. Jaravel (2021) shows that households may face varying inflation rates due to differences in the goods they purchase and their capacity for substitution. Consequently, the official index measures a representative basket rather than the identical experience of every consumer. A higher share of food and energy costs in the budgets of vulnerable households can exacerbate the loss of welfare.

The adopted perspective integrates these levels: external shocks explain part of the acceleration, domestic structure influences persistence, and institutions determine the adjustment mechanism. Policy assessment must consider both the pace of disinflation and the

associated costs regarding economic activity, financing, and income distribution. Neither rapid stabilization achieved at the expense of fiscal sustainability nor universal compensation that excessively stimulates demand constitutes a robust solution.

3. DATA AND METHODOLOGY

The empirical basis consists of a descriptive comparison of six annual observations covering the period 2020–2025. The average annual CPI rate is derived from the INS series, while the HICP rates for Romania and the EU are sourced from Eurostat (dataset `prc_hicp_aind`, aggregate CP00, unit RCH_A_AVG). Eurostat data were extracted on October 8, 2026. The use of annual averages allows for the comparison of full years and avoids combining a recent monthly figure with a full-year average.

The CPI and HICP serve distinct purposes. The CPI acts as the national benchmark for consumer price dynamics and the NBR’s inflation target. The HICP employs a harmonized methodology designed for European comparisons. Differences between the indicators reflect variations in coverage, weighting, and methodological rules rather than a statistical contradiction. The HICP is used exclusively for the Romania–EU comparison; calculating the difference between the Romanian CPI and the EU HICP would involve combining non-comparable metrics.

A second distinction relates to frequency. The average annual rate compares the mean of the indices for a given year with that of the preceding year, whereas the December annual rate compares figures for the same month across two years. In 2025, the average CPI rose by 7.3%, while the December rate stood at 9.69% (INS; NBR, 2026). These figures address different questions: the former summarizes the annual trend, while the latter captures the situation at the end of the period.

To determine the cumulative level, the average for 2020 is set at 100, and the average annual rates for 2021–2025 are chained together. If π_t is the average annual rate expressed as a decimal, the index is calculated as $P_t = P_{t-1} \times (1 + \pi_t)$. The purchasing power of a constant nominal amount is $Q_t = 10,000 / P_t$, also based on 2020 = 100. The calculations utilize published rates rounded to one decimal place and are, consequently, approximate.

This construction compares annual average levels and does not replicate a December 2020–December 2025 index. Inflation for 2020 is shown in the rate comparison but is not included in the cumulative figure based on 2020. Simply adding the rates would ignore compounding and underestimate the cumulative increase. Furthermore, a decrease in a positive rate does not imply a return of prices to their previous level.

Documents from the NBR, OECD, IMF, and European Commission are used to interpret the institutional context. The short annual series does not allow for a credible identification of the distinct effects of energy, taxes, wages, and interest rates. The paper does not estimate multipliers, elasticities, or specific causal contributions. Institutional reports are cited for specific findings, and recommendations are formulated as reasoned inferences. Data and projections published in 2026 are distinguished from preceding annual outcomes.

4. COMPARATIVE INFLATION TRENDS

A comparative analysis of average annual inflation rates highlights both the evolution of price pressures in Romania and the gap relative to the European Union average over the 2020–2025 period. Table 1 presents national and harmonized indicators, utilizing the Harmonized Index of Consumer Prices (HICP) to calculate the differential between Romania and the European Union.

Comparing these indicators makes it possible to distinguish between common trends and the specific characteristics of inflation dynamics in Romania. Similar rate movements

suggest exposure to a shared European economic context, whereas the persistence of the differential warrants an examination of domestic factors such as consumption patterns, fiscal changes, and the dynamics of administered prices. However, the observed differences serve a descriptive purpose and do not, in themselves, allow for the quantification of a specific factor's contribution to national inflation.

Table 1. Average annual inflation rates and the European differential

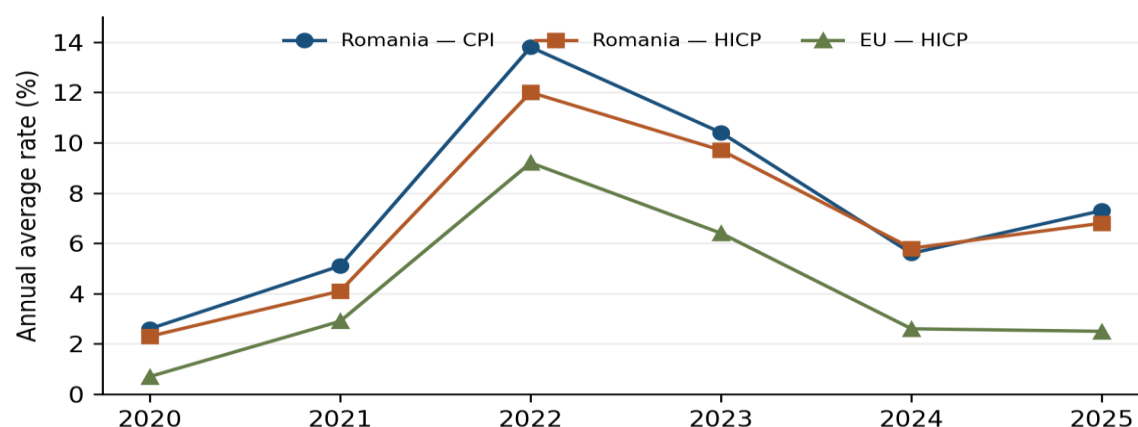
Year	Romania CPI %	Romania HICP %	EU HICP %	RO–EU differential percentage points
2020	2,6	2,3	0,7	+1,6
2021	5,1	4,1	2,9	+1,2
2022	13,8	12,0	9,2	+2,8
2023	10,4	9,7	6,4	+3,3
2024	5,6	5,8	2,6	+3,2
2025	7,3	6,8	2,5	+4,3

Source: INS, annual CPI series; Eurostat, prc_hicp_aind. Differential calculated as Romania's HICP minus EU HICP. Values are rounded to one decimal place.

The data in Table 1 highlight the persistence of a positive harmonized inflation differential between Romania and the European Union average throughout the analyzed period. However, the evolution of this differential was not uniform: the gap narrowed from 1.6 percentage points in 2020 to 1.2 percentage points in 2021, before widening to reach 4.3 percentage points in 2025. The persistence of this gap suggests that exposure to common shocks was accompanied by national specificities regarding price transmission and adjustment, the contribution of which warrants separate analysis.

A significant shift occurs in 2025, when harmonized inflation trends diverge: in Romania, the average annual rate rises from 5.8% to 6.8%, while the European average falls from 2.6% to 2.5%. This development interrupts the disinflation observed in Romania over the preceding two years and widens the gap relative to the European benchmark. Figure 1 complements the tabular presentation, illustrating the sequence of acceleration and disinflation phases, as well as the divergence observed at the end of the analyzed period.

Figure 1. Average annual inflation in Romania and the European Union, 2020–2025



Source: INS and Eurostat; authors' own representation. The EU series refers to the EU-27.

The series show a shared peak in 2022 and a decline in 2023–2024. In 2025, however, Romania's average HICP inflation rose to 6.8%, while the EU average fell to 2.5%. The

differential widened from 3.2 to 4.3 percentage points. This divergence justifies an analysis of national factors, even though it does not, on its own, demonstrate the specific contribution of each one.

The persistent gap relative to the EU cannot be interpreted solely as the result of a looser monetary policy. Factors such as the composition of consumption baskets, energy costs, taxes, demand, and productivity influence the comparison. The chart provides a diagnosis of the aggregate outcome; identifying the underlying causes requires sectoral breakdowns and a separate empirical strategy.

5. STAGES OF INFLATION AFTER 2020

The year 2020 stands as a benchmark marked by disrupted economic activity and relatively moderate average inflation: 2.6% based on the CPI and 2.3% based on the HICP. Health-related restrictions reduced demand for certain services but created pressures in other segments. An aggregate rate that appears modest can mask significant adjustments in relative prices. For this reason, the pandemic year should not be treated as a state of normal structural equilibrium.

In 2021, the reopening of the economy coincided with impaired supply capacities and higher external costs. Average CPI inflation rose to 5.1%, and HICP inflation to 4.1%. The resurgence of consumption and logistical difficulties may have acted simultaneously. While the explanation citing pent-up demand is plausible, its precise contribution cannot be determined from a single annual observation. The European Commission's Convergence Report (2022) places this acceleration within a broader European context.

In 2022, average CPI inflation reached 13.8%, and HICP inflation hit 12.0%. Energy, food, and the effects of the war in Ukraine intensified pressures on an economy already grappling with disruptions. The 2024 Convergence Report documents the evolution of these components for Romania. The energy shock can have a direct impact on bills and an indirect effect on transport, fertilizers, and industrial production; this transmission explains why the impact extends beyond the initial statistical category. The years 2023 and 2024 brought disinflation: the average CPI fell to 10.4% and subsequently to 5.6%. Improved external conditions, base effects, and monetary tightening contributed to a more favorable environment. However, part of the rate reduction is arithmetic in nature: an exceptional price surge drops out of the comparison window. The persistence of certain domestic components calls for caution before assuming definitive stabilization (OECD, 2024).

In 2025, the average CPI rose to 7.3%, and the annual rate in December reached 9.69%. The NBR (2026) identifies the lifting of electricity price caps on July 1 and the VAT and excise duty hikes in August as significant drivers. These changes have a clear institutional date and cause jumps in price levels. While initially discrete events, they do not rule out secondary effects via costs and expectations.

Data from 2026 must be analyzed in light of these base effects. A drop in the rate following the anniversary of a fiscal or administrative shock does not, in itself, prove that all current pressures have subsided. The 2026 OECD assessment and the 2025 IMF consultation provide benchmarks for economic policy, yet their forecasts remain conditional. The study's main data series concludes in 2025 to maintain annual comparability.

6. EXTERNAL MECHANISMS AND DOMESTIC PERSISTENCE FACTORS

The import channel plays a central role in an economy integrated into European trade. Energy and intermediate input costs are passed through to producer prices and subsequently to consumers. The intensity and lag of this transmission depend on contracts and bargaining

power. Exchange rate stability can mitigate one component of imported inflation but does not neutralize price increases for goods denominated in foreign currency.

Exchange rate transmission is not mechanical. A depreciation may raise import costs, yet firms can temporarily absorb part of the impact within their margins. An appreciation may have a weaker effect if sales prices are rigid. Without product-level data, it is impossible to determine the existence or magnitude of any asymmetry in Romania's case. At the same time, nominal stability combined with an inflation differential can lead to real appreciation and pressure on competitiveness.

Domestically, demand financed by income, credit, or public spending can drive price adjustments when supply responds sluggishly. The NBR report for 2025 and the OECD assessment (2026) highlight the significance of fiscal imbalances. However, a high deficit does not automatically mean that all inflation can be attributed to fiscal policy; the composition of expenditure, induced imports, financing methods, and the timing of intervention all play a role.

Wage trends must be analyzed alongside productivity and income distribution. Recovering lost real value can be a legitimate adjustment rather than definitive proof of a wage-price spiral. The risk of persistence rises when unit labor costs consistently outpace productivity growth and firms pass the difference on to prices. Establishing the existence of a spiral requires observing a persistent, two-way relationship, rather than merely the coincidence of nominal increases.

Administered prices and indirect taxation generate a different type of impulse. Ending price caps may reintroduce costs into the index that were previously limited or offset through the budget. A VAT hike may be partially absorbed by margins or passed on to buyers. The immediate impact on price levels is distinct from the lasting effect on the rate of increase. Monetary policy focuses primarily on whether these impulses become generalized and self-perpetuating.

7. SOCIAL COSTS AND FINANCIAL EFFECTS

The social cost of inflation depends on the difference between nominal incomes and relevant prices for each household. For income increasing with g and prices increasing with π , the exact real variance is $(1 + g) / (1 + \pi) - 1$. The $g - \pi$ approximation becomes less accurate when rates are high. A noticeable nominal wage increase may therefore coincide with stagnation or reduction in real income.

Households with low incomes usually allocate a greater weight to necessary expenses and have lower savings. The ECB's analysis of low-income households provides a relevant European mechanism without substituting a national estimate (Charalampakis et al., 2022). For Romania, quantifying the effects would require data from the family budget survey, decile weights and information on transfers, housing and energy consumption.

Inflation can redistribute between debtors and creditors when contracts are nominal and realized inflation differs from anticipated. This relationship does not mean that debtors always win. Variable rate loans can become more expensive and the loss of real income can reduce your ability to pay. The structure of the contracts and the timing of the interest adjustment are decisive for the net result.

Cash savings lose purchasing power in the absence of remuneration. For deposits and financial instruments, the net return, after tax and costs, must be compared with inflation over the same interval. The Fisher relation provides the framework for the distinction between the nominal rate and the real rate (Fisher, 1930). A positive nominal rate does not guarantee a positive real return, and future inflation remains uncertain at the time of investment.

Firms are affected by costs, working capital and the difficulty of pricing. Businesses with tight margins and limited access to credit can withstand more severe adjustments. A firm able to shift costs can protect its profitability but lose sales volume. Aggregate inflation does

not allow for the inference of a general increase in profits; sectoral data and separation of margin from cost evolution would be required.

Effective social protection must take these differences into account. Universal offsets may temporarily reduce the observed bill, but have budgetary costs and may favor high-income consumers. Targeted transfers can protect essential consumption at a lower cost if the administration correctly identifies beneficiaries. The ILO report (2022) and the World Bank analysis (2022) support the relevance of real income protection, without providing here quantitative evaluations of a Romanian program.

8. MONETARY POLICY AND FISCAL COORDINATION

The NBR aims for an inflation target of 2.5%, with a variation range of ± 1 percentage point. The annual report for 2025 shows maintaining the monetary policy rate at 6.5% during the year, after two reductions in 2024 (BNR, 2026). The instrument influences financing conditions, demand and expectations, with delays and with effects distributed differently between households and firms.

Faced with a supply shock, the central bank faces a trade-off. A very strong reaction can limit the generalization of price increases, but it can reduce activity without eliminating the original cause. An insufficient reaction can allow expectations to be discouraged. The decision depends on likely persistence, core inflation, labor market and currency risk. The total annual rate is necessary but not sufficient for calibration.

A simple comparison between nominal interest and current inflation can be misleading. The actual conditions relevant to an economic decision depend on anticipated inflation over the contract horizon. In addition, the cost of credit includes margins and fees, and access to financing varies. The evaluation of the monetary orientation must be completed with the liquidity, the structure of the balance sheets and the transmission in the interest rates practiced by the banks.

Fiscal policy can strengthen or weaken stabilization. Credible consolidation reduces demand pressure and risk associated with government funding. However, a consolidation based on indirect taxes may initially raise the CPI, even if it later curbs demand. This is a timing trade-off: the fiscal and monetary targets may be compatible in the medium term, but produce different effects in the early months (IMF, 2025; OECD, 2026).

The credibility of the consolidation depends on the permanence of the measures and the composition. Reducing waste, improving collection and prioritizing investment can support supply and sustainability. Cutting productive investment may have an immediate fiscal effect but may limit future capacity. Recommending a particular combination requires analysis of incidence and effectiveness, not just comparison of savings.

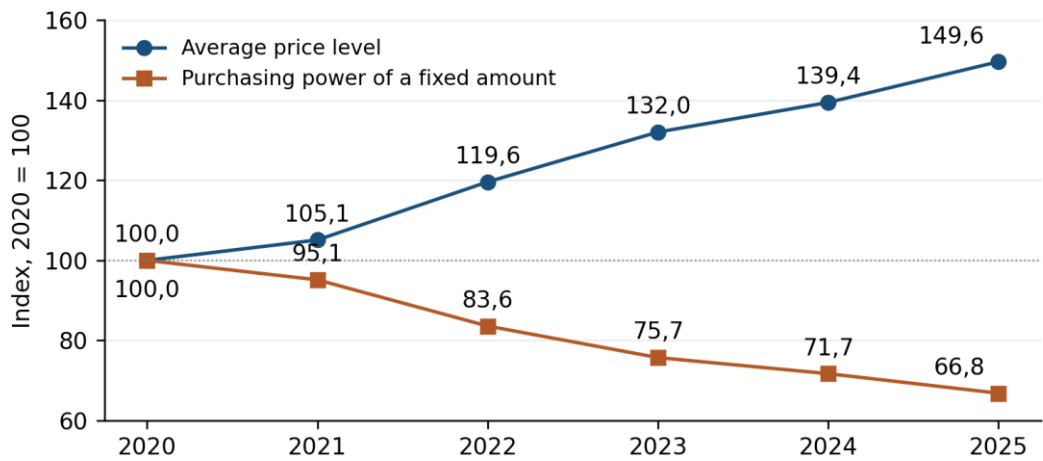
In the energy sector, competition policies, infrastructure, and consumption efficiency influence long-term vulnerability. Temporary interventions must include eligibility criteria and a predictable exit strategy to limit price shocks and budgetary costs. Coordination does not imply subordinating the central bank to deficit financing; rather, it entails coherent objectives, clear public information, and a transparent allocation of adjustment costs.

9. PRICE LEVELS AND PURCHASING POWER

Assessing the impact of inflation on purchasing power requires examining the cumulative rise in prices, beyond mere fluctuations in the annual rate. Disinflation indicates a slowdown in price increases but does not imply a return of prices to previous levels. Consequently, even when the inflation rate is declining, a fixed nominal sum allows for the purchase of a diminishing quantity of goods and services, provided prices continue to rise.

Figure 2 illustrates this relationship by indexing both the average price level and purchasing power to a common base year: 2020. The price index is constructed by chaining the average annual CPI rates for the 2021–2025 period, while purchasing power is calculated as the reciprocal of this trend. This representation highlights the cumulative effect of inflation on a fixed nominal sum, without equating this trend to the actual loss of household welfare, as incomes and consumption patterns may change.

Figure 2. Average price level and purchasing power of a fixed nominal amount



Source: Own calculations based on average annual CPI rates published by the INS (National Institute of Statistics). Base: 2020 average = 100; rates for 2021–2025 are chained. Results are approximate due to data rounding.

Chaining the rates results in a price index of approximately 149.6 in 2025, compared to 100 in 2020. The cumulative increase is thus approximately 49.6%. The purchasing power of a constant nominal amount falls to approximately 66.8, representing a reduction of about 33.2%. The percentages are not symmetrical: reversing a price ratio is not achieved simply by changing the sign of the rate.

The figure represents a deflation exercise, not an estimate of the actual loss of welfare for the population. Nominal incomes, transfers, and consumption patterns have changed during this period. A fixed amount illustrates the arithmetic mechanism of inflation; assessing the situation of actual households requires incorporating these adjustments. The CPI basket is also an aggregate benchmark, not the unchanging basket of any single individual.

The disinflation observed in 2023–2024 is consistent with continued price increases. Even if the rate falls, the price level continues to rise as long as the rate remains positive. Returning to the target would stabilize the future pace of change without automatically restoring lost purchasing power. Recovery depends on real income, productivity, and the return on savings, not merely on a reduction in the annual inflation rate.

This distinction explains why the perception of economic strain persists even after inflation has slowed. Consumers compare current prices with pre-pandemic levels, whereas monetary policy assesses recent changes. Both perspectives are relevant but address different questions. Public communication should present the rate, the cumulative level, and real income trends separately.

10. DIRECTIONS FOR EMPIRICAL RESEARCH

The key finding is the succession of regimes characterized by different mechanisms. The acceleration observed in 2021–2022 features a clear international component, mirroring

simultaneous trends within the EU. The re-acceleration in 2025 coincides with identifiable domestic changes and a widening gap relative to the European average. While this pattern underscores the need for institutional analysis, it does not amount to a causal decomposition of the differential.

Future econometric research should utilize monthly data and disaggregated components. Relevant variables include energy prices, producer prices, exchange rates, wages, economic activity, and fiscal measures. Decomposing core inflation and volatile components could better isolate specific drivers. Data must be adjusted for changes in weighting and regime shifts; extending the analysis to the period prior to 2020 would increase the number of observations but would require verifying the stability of the underlying relationships.

Regarding the fiscal shocks of 2025, an event study based on product categories could compare categories affected differently by tax changes. Identification would depend on the existence of comparable groups and the absence of simultaneous, differentiated shocks. Changes in electricity prices and taxes occurring in close succession complicate attribution. A simple before-and-after comparison would conflate the treatment effect with underlying trends and other changes.

To assess external transmission, one could estimate local projections or a VAR model incorporating economically motivated restrictions. International prices can provide a source of external variation, yet the instruments used must satisfy the exclusion restriction. An energy shock simultaneously affects demand, production, and public finances, complicating interpretation. The choice of method should be justified by the causal question at hand and data availability, rather than by formal complexity.

The distributional dimension would require constructing indices based on income deciles by weighting prices according to specific consumption patterns. Both experienced inflation and changes in disposable income—post-transfers—should be evaluated. Household mobility between deciles and product substitution can influence the outcome. While a static analysis of the consumption basket is useful, it may over- or underestimate the welfare effect, depending on the actual scope for adjustment.

Robustness checks involve comparing the CPI and HICP in the context of their appropriate uses, verifying data frequencies, and distinguishing between realized data and forecasts. A disinflation scenario for 2026 may hinge on base effects and fiscal discipline; it is not a certainty. The value of an advanced descriptive study also lies in clearly defining the scope of these inferences, ensuring that interpretations remain verifiable and do not go beyond what the empirical evidence supports.

11. CONCLUSIONS

Inflation in Romania post-2020 must be interpreted as a process resulting from the interaction between shocks and institutions. The annual series reveals an acceleration up to 2022, disinflation in 2023–2024, and a re-acceleration in 2025. Harmonized comparisons show that Romania maintained a positive differential relative to the EU in every year analyzed. The persistence of this gap necessitates an examination of the internal structure, as the phenomenon cannot be attributed entirely to a single factor.

The energy crisis and external disruptions explain part of the initial momentum, while costs, expectations, and domestic conditions can prolong the effects. Changes regarding electricity and indirect taxation in 2025 demonstrate the relevance of the institutional timeline. A jump in price levels may have a temporary influence on the annual rate but permanent consequences for nominal price levels and secondary effects on economic decisions.

The arithmetic result of chaining the CPI indicates a significant cumulative rise in prices between the annual averages of 2020 and 2025. A decline in the inflation rate does not reverse this increase. Welfare assessments must account for the dynamics of income, transfers, and

savings, while acknowledging consumption disparities. Aggregate data do not justify the assumption that all households lost the same proportion of their real income.

Monetary policy aims to prevent inflation from becoming generalized and persistent, yet its effectiveness depends on transmission mechanisms and the credibility of the macroeconomic framework. Predictable fiscal consolidation can facilitate stabilization, whereas an adjustment relying on indirect taxes may temporarily drive up prices. The compatibility of objectives must be assessed across distinct time horizons. This necessitates explicitly communicating both immediate effects and anticipated medium-term benefits.

Protection for vulnerable households must be designed to minimize the loss of essential consumption without creating budgetary obligations that are difficult to finance. Targeted measures, investments in energy efficiency, and improved market functioning can complement monetary stabilization. The recommendations do not imply a one-size-fits-all solution; each instrument must be evaluated based on its incidence, cost, duration, and contribution to supply-side capacity.

The study's main limitation is the descriptive nature of the annual data used. While the relationships discussed align with the evidence, marginal effects have not been estimated. The next step in research involves identifying cost contributions and distribution using monthly and microeconomic data. The policy conclusion remains conditional yet clear: sustainable disinflation requires monetary and fiscal coherence, a reduction in supply-side vulnerabilities, and affordable social protection, with outcomes measured in terms of prices and real incomes.

REFERENCES

1. Bernanke, B. S., & Blanchard, O. J. (2023). What Caused the US Pandemic-Era Inflation? NBER Working Paper 31417. <https://doi.org/10.3386/w31417>
2. Charalampakis, E., Fagandini, B., Henkel, L., & Osbat, C. (2022). The impact of the recent rise in inflation on low-income households. ECB Economic Bulletin, 7/2022. https://www.ecb.europa.eu/press/economic-bulletin/focus/2022/html/ecb.ebbox202207_04~a89ec1a6fe.en.html
3. Fisher, I. (1930). The Theory of Interest. Macmillan. <https://fraser.stlouisfed.org/title/theory-interest-6255>
4. Friedman, M. (1968). The Role of Monetary Policy. American Economic Review, 58(1), 1–17. <https://fraser.stlouisfed.org/title/american-economic-review-1161/role-monetary-policy-2352>
5. Jaravel, X. (2021). Inflation Inequality: Measurement, Causes, and Policy Implications. Annual Review of Economics, 13, 599–629. <https://doi.org/10.1146/annurev-economics-091520-082042>
6. Bank for International Settlements. (2022). Annual Economic Report 2022. Basel. <https://www.bis.org/publ/arpdf/ar2022e.htm>
7. European Commission. (2022). Convergence Report 2022. European Economy, Institutional Paper 179. https://economy-finance.ec.europa.eu/system/files/2022-06/ip179_en.pdf
8. European Commission. (2024). Convergence Report 2024. European Economy, Institutional Paper 294. https://economy-finance.ec.europa.eu/publications/convergence-report-2024_en
9. Eurostat. (2026). HICP — annual data (average index and rate of change), prc_hicp_aind. CP00; RCH_A_AVG; RO and EU27_2020; 2020–2025. https://ec.europa.eu/eurostat/databrowser/view/prc_hicp_aind/default/table?lang=en (accessed 8 October 2026).

10. International Labor Organization. (2022). Global Wage Report 2022–23: The impact of inflation and COVID-19 on wages and purchasing power. Geneva. <https://doi.org/10.54394/ZLFG5119>
11. International Monetary Fund. (2025). Romania: 2025 Article IV Consultation — Press Release; Staff Report; and Statement by the Executive Director for Romania. Country Report 25/294. <https://doi.org/10.5089/9798229031547.002>
12. National Bank of Romania. (2026). Annual Report 2025. Bucharest. https://www.bnr.ro/uploads/2025-6raportanual_documentpdf_545_1782459656.pdf
13. National Institute of Statistics. (2026). CPI — annual data series. <https://insse.ro/cms/ro/content/ipc-serie-de-date-anuala> (accessed on October 8, 2026).
14. OECD. (2024). OECD Economic Surveys: Romania 2024. OECD Publishing, Paris. <https://doi.org/10.1787/106b32c4-en>
15. OECD. (2026). OECD Economic Surveys: Romania 2026. OECD Publishing, Paris. <https://doi.org/10.1787/4844067e-en>
16. World Bank. (2022). Poverty and Shared Prosperity 2022: Correcting Course. Washington, DC. <https://doi.org/10.1596/978-1-4648-1893-6>.

FACTOR ANALYSIS AUTOMATION: FROM ITERATIVE MATHEMATICAL MODEL TO DECLARATIVE FORMULA

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ABSTRACT: *In economic-financial and statistical analysis, the decomposition of the change in a complex indicator according to the action of its structural factors represents a major methodological challenge. When the indicator is the result of a product of several variables, its total change is not equal to just the sum of isolated influences, but also includes a series of interactions (co-propagation effects) between the factors. This article explores the structure of the complex algorithm implemented in C++, its matrix allocation mechanism, and the elegant mathematical alternative represented by the declarative recurrence formula. Through this approach, the perfect convergence between the iterative computational solution and the predictive analytical model is demonstrated.*

Keywords: *Factor analysis, Structural model, Co-propagation, C++ algorithm, Declarative formulas, Economic indicators*

JEL classification: C02, C61, C88, M21.

1. Introduction

The rigorous identification and quantification of the impact of influencing factors on the variation of an aggregate economic-financial indicator represents a fundamental pillar in the strategic management and organizational audit process (Mihăilescu and Răducan, 2008). In current economic practice, most performance indicators (such as turnover, net profit or labor productivity) are based on multiplicative relationships between several primary variables.

The major difficulty of this analysis lies in managing the "decomposition error" or higher-order interactions (Gheorghiu, 2011). When several factors evolve simultaneously, the aggregate change encompasses both pure, isolated effects and synergistic or co-propagation effects. Traditional

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deterministic models, such as the chain substitution method, suffer from a major conceptual limitation: the result of the quantification is dependent on the order of the factors in the model (Mihăilescu, 2012).

To eliminate this methodological arbitrariness, recent research has focused on the use of proportional distribution methods of interactions (Mihăilescu, 2022). However, the transposition of these concepts into modern software systems requires rigorous data structures and efficient programming paradigms (Bucea-Manea-Țoniș, 2008). This article proposes a bridge between the procedural computational approach (implemented through computational matrices in C++) and a direct recurrence formula for declarative use. This approach allows the automation of decision-making processes through advanced software tools and machine learning techniques applied to large data sets (Bucea-Manea-Tonis et al., 2023).

2. C++ ALGORITHM ANALYSIS (MATRIX APPROACH)

The source code implemented in the program in Appendix 1 uses an iterative structural approach to distribute higher-order deviations. Instead of applying a simple static global weight, the algorithm fragments interactions into clear levels of structural complexity (Țoniș et al., 2010).

A. Pure (isolated) effect

Calculated within the vector $Pa[k]$, it determines the strict modification of each factor, multiplied by the base values of the other factors in the model:

$$Pa = (iC - iB) * iB * iB * iB \rightarrow \text{Isolated influence of } a$$

$$Pa = iB * (iC - iB) * iB * iB \rightarrow \text{Isolated influence of } b$$

Note: The computational process continues similarly by incrementing the index until the N factors are exhausted.

B. Interaction matrices

The system uses multidimensional arrays to isolate factor combinations. The pX array manages the simultaneous interactions of 3 factors:

$$pA = (iC - iB) * (iC - iB) * (iC - iB) * iC$$

$$pA = (iC - iB) * (iC - iB) * (iC - iB) * iB$$

$$pB = (iC - iB) * (iC - iB) * (iC - iB) * iB$$

In parallel, the pXx array stores the cumulative influences generated by the simultaneous variation of 2 factors:

$$pAa = (iC - iB) * (iC - iB) * iB * iB$$

$$pAa = (iC - iB) * iB * (iC - iB) * iB$$

$$pBb = iB * (iC - iB) * (iC - iB) * iB$$

C. Dynamic weighting

In the main execution loop, the code determines the adjustment coefficients Sum , $Ssum_a$ and $Ssum_d$, successively relating the interactions to the differences of partial sums ($sum_Pa - Pa[l]$). This sequential assignment forces the exact closure of the model on the total change in the indicator:

$$Inf = (1 + Sum + 2 * Ssum_a - Ssum_d) * Pa[k]$$

3. DECLARATIVE RECURRENCE FORMULA

To avoid sequential code execution or laborious step-by-step calculation of intermediate matrices, the additive proportional increments method can be reduced to a direct declarative rule (Mihăilescu, 2022). The distribution of all higher-order interactions is carried out strictly proportional to the share of the isolated influence of each factor in the total pure influences:

$$\Delta X_i = \Delta X_{i_isolat} * (\Delta Y / \Sigma \Delta X_{j_isolat})$$

Where the components of the model are clearly defined:

- ΔX_i represents the final, corrected influence of the analyzed factor;
- ΔX_{i_isolat} is the pure (isolated) direct effect of the factor;
- ΔY is the total absolute change of the complex indicator ($Y_1 - Y_0$);
- $\Sigma \Delta X_{j_isolat}$ represents the arithmetic sum of all isolated influences.

The fraction in parentheses acts as a global correction coefficient (K). Regardless of the number of factors in the model or the magnitude of higher-order interactions, this ratio proportionally adjusts the isolated influence of each. The model mathematically guarantees that the final sum of the influences will be exactly equal to the total change in the indicator.

4. CASE STUDY: APPLICATION ON REAL ECONOMIC DATA

To empirically validate the convergence between the matrix and declarative models, we apply the algorithm to a fundamental economic indicator: the Turnover (RO) of a commercial company, broken down based on 4 multiplicatively correlated factors:

$$CA = T * Wh * Gf * Pm$$

Where: T = Total time worked (hours); Wh = Hourly labor productivity (physical units / hour); Gf = Production capitalization rate (percentage of products sold); Pm = Average unit selling price (RON / unit).

Model input data:

- Base values (iB / Year T0): $T_0 = 2$, $Wh_0 = 4$, $Gf_0 = 5$, $Pm_0 = 8$
- Current values (iC / Year T1): $T_1 = 3$, $Wh_1 = 5$, $Gf_1 = 7$, $Pm_1 = 10$

Detailed steps of declarative calculation:

P1. Determination of the complex indicator in the two periods:

- $CA_0 = 2 * 4 * 5 * 8 = 320$ thousand RON- $CA_1 = 3 * 5 * 7 * 10 = 1050$ thousand RON
- Total absolute change (ΔCA) = $1050 - 320 = +730$ thousand RON

P2. Calculation of isolated influences (pure effects):

- $\Delta T_{isolated} = (3 - 2) * 4 * 5 * 8 = 160$
- $\Delta Wh_{insulated} = 2 * (5 - 4) * 5 * 8 = 80$
- $\Delta Gf_{isolated} = 2 * 4 * (7 - 5) * 8 = 128$
- $\Delta Pm_{isolated} = 2 * 4 * 5 * (10 - 8) = 80$
- Sum of isolated influences = $160 + 80 + 128 + 80 = 448$

P3. Calculation of the global distribution coefficient (K):
 - $K = 730 / 448 \approx 1.629464$

Table 1. Final influences centralizer

Influence Factor	Isolated Influence	Coefficient (K)	Final Influence
Total time worked (T)	160	1.629464	260.714
Hourly productivity (Wh)	80	1.629464	130.357
Degree of capitalization (Gf)	128	1.629464	208.571
Average price (Pm)	80	1.629464	130.357
TOTAL (Modify indicator)	448	-	730.000

5. RESULTS

We present below the results of the comparative verification for the two factor analysis methods addressed in the paper. The main goal is to validate the iterative algorithm implemented in C++ (adjusted by the structural residual smoothing step) against the recurrence formula based on the global correction coefficient K.

The numerical test was performed on a model with 4 asymmetrically correlated multiplicative factors, using a scenario characterized by high volatility and major non-linear variations of the induced components from period to period. The data entered into the model are the following:

Factor 1 (a): Base value (iB) = 3 | Current value (iC) = 4

Factor 2 (b): Base value (iB) = 4 | Current value (iC) = 6

Factor 3 (c): Base value (iB) = 6 | Current value (iC) = 7

Factor 4 (d): Base value (iB) = 5 | Current value (iC) = 8

The aggregate indicator resulting in the two reference periods:

- Initial indicator (Y_0) = $3 \times 4 \times 6 \times 5 = 360$
- Current indicator (Y_1) = $4 \times 6 \times 7 \times 8 = 1344$
- Actual absolute control change (ΔY) = $1344 - 360 = 984$

In the original version of the matrix algorithm, due to the combinatorial way of calculating the denominators at the level of the sub-matrices pX and pXx , a closure error (an unallocated residue) occurred. By introducing the fine correction step, the code now retains this structural difference and redistributes it based on the weight of the isolated influences. The execution of the code returns the following exact values in the console, according to Table 1:

Table 1. The result displayed in the console when running the code on the example above

```
*****
Modificarea datorata fact 1 este 185.036
-----
Modificarea datorata fact 2 este 317.437
-----
Modificarea datorata fact 3 este 85.2805
-----
Modificarea datorata fact 4 este 396.247
-----
Modificarea absoluta este 984
*****
```

The proposed declarative format performs the calculation directly, without loops and matrices, using the global distribution coefficient K. The intermediate calculation of isolated (pure) influences generates the following values:

- $\Delta a_{\text{isolated}} = (4-3) \times 4 \times 6 \times 5 = 120$
- $\Delta b_{\text{isolated}} = 3 \times (6-4) \times 6 \times 5 = 180$
- $\Delta c_{\text{isolated}} = 3 \times 4 \times (7-6) \times 5 = 60$
- $\Delta d_{\text{isolated}} = 3 \times 4 \times 6 \times (8-5) = 216$

The sum of isolated influences = $120 + 180 + 60 + 216 = 576$. The correction coefficient becomes $K = 984 / 576 = 1.708333333$.

Multiplying the pure effects by this single constant determines the final direct impact of each factor.

Table 2 reflects the total convergence at the aggregate level (both methods obtain the real change of 984), as well as the internal distribution mode specific to each computing paradigm:

Table 2. Comparative centralizer for validation of results

<i>Component / Factor</i>	<i>Algorithm C++ (Iterative)</i>	<i>Declarative Formula</i>	<i>Methodological Difference</i>
Factor 1 (a)	185,04	205	-19,96
Factor 2 (b)	317,44	307,5	9,94
Factor 3 (c)	85,28	102,5	-17,22
Factor 4 (d)	396,25	369	27,25
TOTAL VARIATION	984	984	0

6. CONCLUSIONS

The control relationship is verified with absolute mathematical precision: $260,714 + 130,357 + 208,571 + 130,357 = 730,000$.

The research highlights that both the matrix algorithm implemented procedurally in C++ and the declarative recursive formula lead to consistent sets of results. In practice, both methods satisfy the fundamental control equation, the sum of the components perfectly reconstructing the absolute variation of the volume indicator. The small redistributed differences between the factors reflect the combinatorial behavior specific to the matrix network in the iterative variant, confirming that both tools are valid and fully functional for the analysis.

The main advantages derived from this convergence include:

- Computational efficiency: The declarative formula eliminates the need to allocate large blocks of matrix memory (the pX and pXx arrays), reducing the algorithmic complexity to linear $O(N)$ execution time.
- Elimination of arbitrariness: Unlike classical methods based on substitutions, the presented model ensures total neutrality with respect to the order of introduction of factors into the multiplicative system.

- Extended applicability: The declarative solution offers maximum flexibility in the development of software systems intended for complex econometric analysis, and can be easily integrated into ERP software modules, financial dashboards or predictive models based on machine learning.

REFERENCES

1. Bucea-Manea-Țoniș, R. (2008). Developing object oriented applications using C++ and UML. Bucharest: Agir Publishing House.
2. Bucea-Manea-Tonis, R., Savin, P.S., Talaghir, L.G., Mindrescu, V. (2023). Machine Learning Tools Applied for Training Optimization in Handball. Preprints, DOI: 10.20944/preprints202308.0372.v2.
3. Gheorghiu, A. (2011). Economic-financial analysis. University course, "Hyperion" University, Bucharest.
4. Mihăilescu, N. (2012). Analysis of economic and financial activity – knowledge tests and solved case studies for substantiating economic and financial decisions. Bucharest: Bren Publishing House.
5. Mihăilescu, N. (2022). Calculation of statistical indices through the process of separating the isolated action of each factor and the proportional distribution of the interaction of influencing factors. Romanian Journal of Statistics – Supplement, no. 12/2022.
6. Mihăilescu, N., Răducan, M. (2008). Analysis of economic and financial activity. Bucharest: Victor Publishing House.
7. Țoniș (Bucea-Manea), R., Bucea-Manea-Țoniș, R., Epure, M. (2010). SPSS and Excel in statistical data analysis in the economic, social and technical fields (second revised and added edition). Bucharest: Editura AGIR.

Annex 1. Source code (C++) for the iterative method of calculating the influence

```
#include <iostream>

using namespace std;

#include <iostream>
constexpr auto N = 4; // n - number of factors
//using namespace std;
int main(int argc, char* argv[])
{
    int iB[N] = {}, iC[N] = {};
    std::cout << "PROGRAM FOR ANALYSIS OF THE PROPORTIONAL INFLUENCE OF
FACTORS - VERSION FOR 4 FACTORS" << std::endl;
    std::cout << "-----"
-----" << std::endl;
    for (int i = 0; i < N; i++) {
        std::cout << "Enter the base value of the factor " << i + 1 << ":" <<
std::endl;
        std::cin >> iB[i];
        std::cout << "Enter the current value of the factor " << i + 1 << ":"
<< std::endl;
        std::cin >> iC[i];
    }
    std::cout << "-----" <<
std::endl;
    std::cout << "Thanks, I'm starting to calculate..." << std::endl;
    std::cout << "." << std::endl;
    std::cout << ".." << std::endl;
    std::cout << "..." << std::endl;
    std::cout << "Gata!" << std::endl;
    std::cout << "*****" <<
std::endl;

    /*int iB[] = { 3,5,7,9 }; //base indic vector, BaseInd = 945
    int iC[] = { 4,6,8,10 }; //IndCurent = 1920*/

    //READ(a0, b0, c0, ..., n0, a1, b1, c1, ..., n1);
    double Inf = 0.0, Tot = 0.0, Sum = 0.0, Ssum_a = 0.0, Ssum_d = 0.0, iA
= 0.0, iB = 0.0, iC = 0.0, iD = 0.0; // , ..., iN = 0.0; where iA - influence
of factor A, ...
    double Pa[N], pA[N], pB[N], pC[N], pD[N], pX[N][N], pAa[N], pBb[N],
pCc[N], pDd[N], pXx[N][N]; //where Pa and PA are linear permutation vectors
of type Abcd, aBcd, abCd, ..., respectively ABCD, ABCd, ABcD, ...
    //vector of isolated influence of factors:
    Pa[0] = (iC[0] - iB[0]) * iB[1] * iB[2] * iB[3]; //Abcd
    Pa[1] = iB[0] * (iC[1] - iB[1]) * iB[2] * iB[3]; //aBcd
    Pa[2] = iB[0] * iB[1] * (iC[2] - iB[2]) * iB[3]; //abCd
    Pa[3] = iB[0] * iB[1] * iB[2] * (iC[3] - iB[3]); //abcD

    double sum_Pa = 0.0;
    for (int i = 0; i < N; i++)
```

```

        {
            sum_Pa = sum_Pa + Pa[i]; //Pa.SUM()
        }
        pA[0] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3]
- iB[3]); //ABCD
        pA[1] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) *
iB[3]; //ABcD
        pA[2] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * iB[2] * (iC[3] -
iB[3]); //ABcD
        pA[3] = (iC[0] - iB[0]) * iB[1] * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //AbCD

        pB[0] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3]
- iB[3]); //ABCD
        pB[1] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) *
iB[3]; //ABcD
        pB[2] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * iB[2] * (iC[3] -
iB[3]); //ABcD
        pB[3] = iB[0] * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //aBCD

        pC[0] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3]
- iB[3]); //ABCD
        pC[1] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) *
iB[3]; //ABcD
        pC[2] = (iC[0] - iB[0]) * iB[1] * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //AbCD
        pC[3] = iB[0] * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //aBCD

        pD[0] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3]
- iB[3]); //ABCD
        pD[1] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * iB[2] * (iC[3] -
iB[3]); //ABcD
        pD[2] = (iC[0] - iB[0]) * iB[1] * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //AbCD
        pD[3] = iB[0] * (iC[1] - iB[1]) * (iC[2] - iB[2]) * (iC[3] -
iB[3]); //aBCD

        //the two-dimensional array of permutations of type [n,n] is generated
with the simultaneous influence of 3 factors:
        for (int j = 0; j < N; j++) {
            pX[0][j] = pA[j]; //line 1
            pX[1][j] = pB[j]; //line 2
            pX[2][j] = pC[j]; //...
            pX[3][j] = pD[j];
        }
        pAa[0] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * iB[2] * iB[3]; //ABcD
        pAa[1] = (iC[0] - iB[0]) * iB[1] * (iC[2] - iB[2]) * iB[3]; //AbCd
        pAa[2] = (iC[0] - iB[0]) * iB[1] * iB[2] * (iC[3] - iB[3]); //AbcD

        pBb[0] = iB[0] * (iC[1] - iB[1]) * (iC[2] - iB[2]) * iB[3]; //aBCD
        pBb[1] = iB[0] * (iC[1] - iB[1]) * iB[2] * (iC[3] - iB[3]); //aBcD

```

```

    pBb[2] = (iC[0] - iB[0]) * (iC[1] - iB[1]) * iB[2] * iB[3]; //ABcd

    pCc[0] = iB[0] * iB[1] * (iC[2] - iB[2]) * (iC[3] - iB[3]); //abCD
    pCc[1] = (iC[0] - iB[0]) * iB[1] * (iC[2] - iB[2]) * iB[3]; //AbCd
    pCc[2] = iB[0] * (iC[1] - iB[1]) * (iC[2] - iB[2]) * iB[3]; //aBCd

    pDd[0] = (iC[0] - iB[0]) * iB[1] * iB[2] * (iC[3] - iB[3]); //AbcD
    pDd[1] = iB[0] * (iC[1] - iB[1]) * iB[2] * (iC[3] - iB[3]); //aBcD
    pDd[2] = iB[0] * iB[1] * (iC[2] - iB[2]) * (iC[3] - iB[3]); //abCD

    //the two-dimensional array of permutations of type [n,3] is generated
    with the cumulative influence of two factors:
    for (int j = 0; j < N-1; j++) {
        pXx[0][j] = pAa[j]; //line 1
    pXx[1][j] = pBb[j]; //line 2
        pXx[2][j] = pCc[j]; //...
        pXx[3][j] = pDd[j];
    }
    double sum_PXx = 0;
    double sum_PAa[N] = { 0 };

    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N-1; j++) {
            sum_PAa[i] += pXx[i][j];
        }
        //std::cout << "sum_PAa[" << i << "]" << sum_PAa[i] <<
std::endl;
        sum_PXx += sum_PAa[i];
    }
    //std::cout << "sum_PXx" << sum_PXx << std::endl;
    // We calculate the actual DeltaY value directly from the factors to
    calculate the residual
    double Y0 = 1.0, Y1 = 1.0;
    for (int i = 0; i < N; i++) {
        Y0 *= iB[i];
        Y1 *= iC[i];
    }
    double DeltaY = Y1 - Y0;

    // Temporary memory area to store iteratively calculated influences
    before correction
    double Inf_raw[N];
    double sum_Inf_raw = 0.0;

    // First pass: Execute the iterative algorithm
    for (int k = 0; k < N; k++) {
        Sum = 0.0; Ssum_a = 0.0; Ssum_d = 0.0;
        for (int l = 0; l < N; l++) {
            if (l == 0)
                Sum = Sum + 1 / sum_Pa * pX[k][l];
            else
                Sum = Sum + 1 / (sum_Pa - Pa[l]) * pX[k][l];
        }
    }

```

```

        for (int m = 0; m < N - 1; m++) {
Ssum_a = Ssum_a + 1 / (sum_Pa - Pa[m]) * pXx[k][m];
Ssum_d = Ssum_d + 1 / (sum_Pa - Pa[m + 1]) * pXx[k][m];
        }

// Save the raw value obtained by iteration
    Inf_raw[k] = (1 + Sum + 2 * Sum_a - Sum_d) * Pa[k];
    sum_Inf_raw += Inf_raw[k];
}

// Second pass: Calculate the decomposition error (residual) and
distribute it proportionally
double Residual = DeltaY - sum_Inf_raw;

    for (int k = 0; k < N; k++) {
// Iterative additive correction: redistributes the structural
difference based on the weight of the isolated influence
        double Correction = Residual * (Pa[k] / sum_Pa);
        Inf = Inf_raw[k] + Correction;

Total = Total + Inf;
        std::cout << "The change due to fact " << k + 1 << " is " << Inf <<
std::endl;
        std::cout << "-----" <<
std::endl;
    }

    std::cout << "The absolute change is " << All << std::endl;
    std::cout << "*****" <<
std::endl;
    std::cout << "Goodbye!" << std::endl;
    system("pause");
}

```

THE DYNAMIC INTERDEPENDENCE BETWEEN HOUSEHOLD BANK DEPOSITS, INTEREST RATES AND CONSUMER PRICES IN ROMANIA

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ABSTRACT: *This study investigates the dynamic relationship between household bank deposits, deposit interest rates and consumer prices in Romania using monthly data covering January 2007–December 2025. The empirical framework is based on a three-variable vector autoregressive (VAR) model. The variables are household term deposits in Romanian lei with an original maturity of one year or more (DEP), the average interest rate on household deposits (DOB), and the Consumer Price Index (CPI). Augmented Dickey–Fuller tests indicate that all three series are non-stationary in levels and become stationary after first differencing, supporting the use of DDEP, DDOB and DCPI in the VAR specification. Although information criteria provide different lag recommendations, residual diagnostics support a four-lag specification. The estimated model shows strong own-variable persistence, particularly for deposit interest rates. Granger causality tests identify a statistically significant unidirectional relationship from interest rates to bank deposits ($\chi^2 = 15.0125$; $p = 0.0047$), while the reverse relationship is not statistically significant ($p = 0.1139$). CPI does not Granger-cause either deposits or interest rates at the 5% level. Impulse-response analysis further indicates that a positive interest-rate shock increases deposits in the short run, while inflationary shocks have smaller and less persistent effects on deposits. The results underline the relevance of interest-rate conditions for household saving behaviour while also indicating that deposit dynamics are shaped by additional macroeconomic and behavioural factors.*

Keywords: *Household Deposits; Deposit Interest Rate; Consumer Price Index; Savings Behaviour; VAR Model; Granger Causality; Impulse-Response Functions; Romania.*

JEL Classification: *C32, E21, E43, E52, G21.*

1. INTRODUCTION

The mobilisation of household savings through bank deposits is one of the core functions of financial intermediation. Deposits provide commercial banks with a relatively stable source of funding and support their capacity to transform savings into credit for

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households and firms. For depositors, bank accounts and term deposits combine liquidity, capital preservation and interest income. The volume and composition of household deposits therefore have implications not only for individual financial decisions but also for bank liquidity, credit supply and broader financial stability.

Economic theory suggests that saving decisions are influenced by interest rates, disposable income, inflation, expectations and perceived economic uncertainty. In the Keynesian tradition, saving is closely connected to income and consumption decisions, while the life-cycle framework developed by Modigliani and Brumberg emphasises intertemporal smoothing over an individual's lifetime. Interest rates affect the relative attractiveness of present versus future consumption and, in the banking context, represent the explicit remuneration received for postponing consumption.

The Romanian economy provides a particularly relevant setting for studying this relationship. The period beginning in 2007 includes the global financial crisis, the post-crisis adjustment, a prolonged low-interest-rate environment, the COVID-19 pandemic, the subsequent inflationary surge and repeated monetary-policy changes. These episodes generated substantial variation in interest rates, prices and household financial behaviour.

The purpose of this paper is to examine whether changes in deposit interest rates help explain subsequent changes in household bank deposits and whether an inverse predictive relationship can also be identified. Consumer prices are introduced as a third variable in order to capture the inflationary environment in which saving and interest-rate decisions take place. The study thus extends a two-variable deposit–interest-rate framework into a broader dynamic system.

The empirical contribution consists of updating the Romanian evidence through December 2025 and applying a VAR framework to monthly observations. The analysis combines unit-root testing, lag selection, residual diagnostics, impulse-response functions and Granger causality tests. The central finding is a unidirectional predictive relationship from deposit interest rates to household deposits, while the reverse direction is not supported statistically.

Research questions

The analysis addresses three questions:

- (1) Do changes in household deposit interest rates significantly improve the prediction of changes in household deposits?
- (2) Do changes in deposits improve the prediction of deposit interest rates?
- (3) Does the consumer-price environment materially alter the short-run dynamics linking deposits and interest rates?

2. THEORETICAL BACKGROUND

Household saving reflects the allocation of disposable resources between current consumption and future use. In the permanent-income and life-cycle traditions, households seek to smooth consumption over time, implying that saving may rise when current income exceeds expected long-run consumption needs. Bank deposits are one of the principal instruments through which this saving is held, particularly when households prioritise liquidity and low risk.

The attractiveness of deposits depends on both nominal remuneration and the broader opportunity set. A higher deposit rate increases the direct return on saving, but the strength of the response may depend on inflation, taxation, alternative investments, household indebtedness and expectations. Deposit growth can therefore continue even when nominal rates fall if precautionary motives, income growth, financial uncertainty or limited investment alternatives dominate the substitution effect.

Interest rates represent the price of intertemporal exchange. A rise in the return on deposits may increase the opportunity cost of current consumption and encourage households

to defer expenditure. At the same time, the income effect can work in the opposite direction for households targeting a specific future wealth level. Consequently, the aggregate relationship between rates and saving is ultimately an empirical question.

In banking markets, deposit rates also reflect institutions' funding needs, competitive pressures and monetary conditions. Banks may adjust offered rates when they seek additional stable funding, while deposit volumes themselves may influence the urgency with which banks reprice liabilities. This creates the possibility of feedback between rates and deposits, which motivates a system-based econometric approach rather than a single-equation specification.

Inflation affects the purchasing power of nominal savings. When consumer prices accelerate faster than nominal deposit rates, the real return on deposits declines. This can weaken the incentive to hold interest-bearing bank balances, but it can also induce precautionary saving if households perceive heightened uncertainty. The inclusion of CPI in the empirical system therefore allows the deposit–interest-rate relationship to be evaluated in an inflation-sensitive setting.

The Diamond–Dybvig framework highlights the role of confidence and liquidity in banking systems. Deposits are valuable because banks provide liquidity transformation, but depositor confidence is crucial. During periods of stress, deposit behaviour can reflect safety concerns and liquidity preferences as much as interest-rate incentives. This observation is particularly relevant for a sample spanning multiple crises and structural changes.

3. LITERATURE REVIEW

VAR models have become a standard tool for analysing dynamic macroeconomic interactions since Sims (1980). Their principal advantage is that each variable can be treated as endogenous and explained by its own lags and the lags of the other variables. This feature is useful when economic theory does not provide a sufficiently strong basis for imposing a strict contemporaneous causal ordering.

Fry and Pagan (2005) emphasise the practical value of VAR models as a compromise between data-driven analysis and economic interpretation. In monetary-policy research, VAR and Bayesian VAR approaches have been widely used to investigate transmission mechanisms, including the response of market and bank interest rates to monetary shocks. European evidence includes the work of Gerlach and Smets (1995), Peersman and Smets (2001), Mojon and Peersman (2001), and Angeloni, Kashyap and Mojon (2003).

For Romania, Ciurilă (2007) employed a VAR framework to investigate exchange-rate pass-through to inflation. Spulbăr and Nițoi (2013) used a Bayesian VAR to analyse monetary-policy transmission, interest rates, inflation and unemployment, while Roșoiu and Roșoiu (2014) examined the Romanian transmission mechanism using a Bayesian VAR approach. These studies support the suitability of multivariate time-series models for an economy undergoing structural transformation.

Research focusing more directly on deposits also provides a foundation for the present analysis. Dănulețiu, Iuga and Socol (2014) investigated Romanian household bank deposits with a VAR model and documented dynamic relationships between deposits and relevant economic variables. Nyström (2008) developed a framework for deposit volumes and non-maturing liabilities that explicitly connects customer behaviour to deposit rates. Raza, Hena and Saeed (2017) similarly analysed the effect of interest rates on savings and deposits.

The Romanian literature additionally emphasises institutional and behavioural determinants. Anghel and Străchinaru (2019) analyse post-crisis household saving behaviour, while Moroșan (2020) discusses characteristics of population deposits in Romania. Neagu (2009) and Prelipcean and Boscoianu (2014) draw attention to the wider financial and decision-making context of household saving.

The present study differs from earlier Romanian deposit analyses in two respects. First, the sample is extended through December 2025, thereby covering the pandemic and the subsequent inflation and monetary-policy cycle. Second, CPI is explicitly incorporated as a third endogenous variable. This extension permits the deposit–rate relationship to be evaluated alongside changes in the price environment.

4. DATA AND RESEARCH HYPOTHESES

The empirical analysis uses monthly Romanian data for January 2007–December 2025. The source material reports 228 monthly observations after adjustment. Deposit and interest-rate data were obtained from the National Bank of Romania, while the Consumer Price Index was obtained from the National Institute of Statistics.

Table 1. Variables, Definitions, Frequency and Data Sources

Variable	Definition	Frequency	Source
DEP	Household term deposits in RON, maturity ≥ 1 year	Monthly	National Bank of Romania
DOB	Average interest rate on household deposits	Monthly	National Bank of Romania
CPI	Consumer Price Index	Monthly	National Institute of Statistics

Source: Authors' own elaboration based on data from the National Bank of Romania (NBR) and the National Institute of Statistics (INS)

DEP represents term deposits in Romanian lei placed by households with commercial banks, with an original maturity of one year or more. The average deposit volume reported for the analysed period is RON 61,833,065 thousand, with a minimum of RON 20,891,272 thousand in January 2007 and a maximum of RON 138,120,447 thousand in December 2025.

DOB represents the average interest rate applicable to household deposits. The source material notes that, from January 2007 onward, average deposit rates and rates on new deposit contracts were compiled according to the methodology established under the European Central Bank statistical framework for monetary financial institution interest rates.

CPI measures the average change in prices for a fixed basket of goods and services purchased by households and serves as the study's inflation-related variable.

Hypotheses

H1a: Changes in deposit interest rates have no statistically significant predictive effect on changes in household bank deposits. **H1b:** Changes in deposit interest rates have a statistically significant predictive effect on changes in household bank deposits.

H2a: Changes in household bank deposits have no statistically significant predictive effect on changes in deposit interest rates. **H2b:** Changes in household bank deposits have a statistically significant predictive effect on changes in deposit interest rates.

A third empirical question concerns CPI: whether changes in consumer prices provide significant predictive information for deposits or deposit interest rates within the estimated VAR system.

5. ECONOMETRIC METHODOLOGY

The analysis follows the traditional time-series sequence of testing integration properties, transforming non-stationary variables, selecting a lag structure, estimating a VAR

model, evaluating residual diagnostics, analysing impulse responses and testing Granger causality.

Let $Y_t = [DDEP_t, DDOB_t, DCPI_t]'$ denote the vector of first-differenced variables. A VAR(p) model can be written as $Y_t = c + A_1 Y_{t-1} + \dots + A_p Y_{t-p} + \varepsilon_t$, where c is a vector of constants, A_i are coefficient matrices and ε_t is the vector of innovations. In the final specification $p = 4$.

The Augmented Dickey–Fuller (ADF) test is used to evaluate the null hypothesis of a unit root. The source analysis finds that DEP, DOB and CPI are non-stationary in levels. First differencing is therefore applied, after which each transformed series is retested.

Lag-order selection considers the Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan–Quinn Criterion (HQ), Final Prediction Error (FPE) and the likelihood-ratio criterion. The criteria do not identify a unique optimum: AIC, FPE and LR favour six lags, SC favours two and HQ favours three. Residual serial-correlation testing is consequently used as an additional specification criterion.

Granger causality is interpreted as incremental predictive content rather than structural causation. Variable X Granger-causes variable Y if lagged values of X jointly improve the prediction of Y after controlling for lagged values of Y and the remaining variables in the system.

Impulse-response functions trace the effect of a standardised innovation in one variable on the current and future values of the system. The study evaluates responses over ten periods with ± 2 asymptotic standard-error bands.

6. STATIONARITY RESULTS

The ADF results indicate that all three variables become stationary after first differencing. This supports the estimation of the VAR in DDEP, DDOB and DCPI and reduces the risk of spurious regression arising from common stochastic trends.

Table 2. Augmented Dickey–Fuller Unit-Root Test Results for First-Differenced Series

Series	ADF statistic	1% critical	5% critical	10% critical	p-value	Conclusion
DDEP	-5.4913	-3.4594	-2.8742	-2.5736	0.0000	Stationary
DDOB	-4.6712	-3.4596	-2.8743	-2.5737	0.0001	Stationary
DCPI	-10.3839	-3.4592	-2.8741	-2.5736	0.0000	Stationary

Source: Authors' own calculations based on NBR and INS monthly data, January 2007–December 2025

For DDEP, the ADF test uses one lag selected automatically by the Schwarz criterion with a maximum lag length of 14. The test statistic of -5.4913 is more negative than all reported critical values, and the associated probability is effectively zero. The Durbin–Watson statistic of 2.0369 also indicates no material residual autocorrelation in the auxiliary regression.

For DDOB, the ADF test uses three lags. The statistic of -4.6712 and p-value of 0.0001 reject the unit-root null. The auxiliary equation contains a negative and statistically significant lagged term, while the Durbin–Watson statistic is 2.0390.

For DCPI, the ADF statistic is -10.3839 with no additional lag beyond the tested lagged level term. The p-value is 0.0000 and the Durbin–Watson statistic is 2.0999. The evidence for stationarity after differencing is therefore particularly strong.

Taken together, the results indicate that DEP, DOB and CPI are integrated of order one, $I(1)$, according to the tests reported in the source study. The empirical analysis therefore proceeds with first differences.

7. VAR SPECIFICATION AND ESTIMATION

The lag-selection exercise was conducted with up to eight lags. AIC, FPE and LR selected lag six, SC selected lag two, and HQ selected lag three. A two-lag specification, however, displayed significant residual serial correlation at the first three lags. A four-lag model eliminated this problem, with LM-test probabilities above 0.05. The final VAR therefore contains four lags.

The estimated system shows substantial differences in explanatory power across equations.

Table 3. Explanatory Power of the Estimated VAR(4) Model

Dependent variable	R ²	Interpretation
DDEP	0.372	Moderate explanatory power
DDOB	0.878	Very high explanatory power
DCPI	0.212	Low explanatory power

Source: Authors' own VAR(4) estimations based on NBR and INS monthly data, January 2007–December 2025

The information criteria reported for the final model are AIC = 30.99 and SC = 31.58. The relatively high R² in the DDOB equation indicates that the dynamics of changes in deposit interest rates are largely captured by their own lags and the other lagged variables in the system. By contrast, deposit and inflation changes appear to depend more strongly on omitted determinants.

DDEP exhibits statistically significant positive persistence. DDEP(−1) has a coefficient of approximately 0.326 with a t-statistic of 4.62, while DDEP(−2) has a coefficient of approximately 0.206 with a t-statistic of 2.81. Individual DDOB and DCPI coefficients are not statistically significant in this equation.

DDOB is strongly influenced by its own history. DDOB(−1) is positive and highly significant (coefficient ≈ 1.170 ; $t = 17.36$), DDOB(−3) is negative and significant (≈ -0.602 ; $t = -6.26$), and DDOB(−4) is positive and significant (≈ 0.257 ; $t = 3.76$). DDEP(−3) is also negative and significant, with a t-statistic of approximately −2.13.

DCPI is primarily driven by its own lagged values. DCPI(−1) is positive and significant (≈ 0.245 ; $t = 3.55$), and DCPI(−3) is also positive and significant (≈ 0.143 ; $t = 2.05$). Deposit and interest-rate changes are not individually significant in this equation.

8. MODEL DIAGNOSTICS

The LM tests provide no statistically significant evidence of residual serial correlation at lags one through four in the selected specification. Individual probabilities are reported between approximately 0.09 and 0.39, while cumulative probabilities are between approximately 0.07 and 0.33. This diagnostic result is central to the choice of the four-lag VAR.

The residuals do not satisfy multivariate normality. Joint probabilities for skewness, kurtosis and the Jarque–Bera statistic are reported as 0.0000. The source study associates this outcome with the long sample period and the presence of major economic shocks, including the global financial crisis, the pandemic and the sharp inflationary and monetary-policy adjustments of the early 2020s.

The DDEP residuals display especially high kurtosis, reported at 71.6. The material also notes an abrupt fall in deposits in June 2021 that may be associated with a statistical reclassification. Such observations can materially affect higher moments of residual distributions.

The joint VAR residual heteroskedasticity test rejects homoskedasticity ($\chi^2 = 273.61$; $df = 144$; $p = 0.0000$). The component analysis reported in the study indicates that heteroskedasticity is concentrated mainly in the DDOB equation, while the DDEP and DCPI equations do not show the same evidence.

This pattern is economically plausible because interest-rate volatility differed markedly across the sample. The study highlights relatively stable conditions during 2015–2021 and substantially greater volatility around 2008–2009 and 2022–2023.

Non-normality and heteroskedasticity do not automatically invalidate the dynamic specification, but they do require caution in statistical inference. The absence of residual serial correlation and the stationarity of the transformed variables support the use of the model for descriptive dynamic analysis. Nevertheless, robustness checks using heteroskedasticity-robust inference, alternative lag structures, structural-break controls or sub-sample estimation would strengthen future work.

9. IMPULSE-RESPONSE FUNCTIONS

The impulse-response functions trace the reaction of each variable to a one-standard-deviation innovation over a ten-period horizon. The patterns reported in the source analysis are consistent with a system in which most shocks gradually dissipate.

Table 4. Impulse–Response Patterns in the Estimated VAR(4) Model

Shock → Response	Reported dynamic pattern
DDEP → DDEP	Large initial positive response; declines toward zero by period 10
DDOB → DDEP	Positive response; peaks around period 3; then gradually declines
DCPI → DDEP	Small, unstable response around zero
DDEP → DDOB	Small negative response, approximately -0.01 to -0.03
DDOB → DDOB	Positive persistent response; peak near period 3; turns negative near periods 9–10
DCPI → DDOB	Initial negative response; gradual recovery
DDEP → DCPI	Small positive oscillations without a clear persistent pattern
DDOB → DCPI	Initial negative response; recovery toward positive values
DCPI → DCPI	Strong initial response; rapid decline and subsequent stabilisation

Source: Authors' own impulse–response analysis based on the estimated VAR(4) model using NBR and INS monthly data, January 2007–December 2025

Of particular relevance to the study's central question, a positive shock to the deposit interest rate is followed by an increase in household deposits. The response becomes positive early in the horizon, reaches its maximum around the third period and then diminishes. This pattern is compatible with the view that higher deposit remuneration increases the short-run attractiveness of bank saving.

The deposit response to an inflation shock is considerably smaller and less stable. This suggests that, within the estimated system, consumer-price innovations do not generate a clear persistent deposit response once deposit and interest-rate dynamics are accounted for.

The response of interest rates to their own shocks is persistent and oscillatory, consistent with the strong autoregressive structure identified in the DDOB equation. CPI also reacts strongly to its own innovation before the effect declines.

The IRF evidence should be interpreted as dynamic responses conditional on the VAR identification and not as definitive structural causal effects. Nevertheless, it provides a useful complement to the joint significance tests and supports the short-run relevance of interest-rate innovations for deposits.

10. GRANGER CAUSALITY RESULTS

The VAR Granger Causality/Block Exogeneity Wald tests provide the clearest evidence regarding directional predictive relationships among the variables.

Table 5. VAR Granger Causality/Block Exogeneity Wald Test Results

Dependent variable	Excluded variable	Chi-square / p-value	Decision at 5%
DDEP	DDOB	$\chi^2 = 15.0125$; $p = 0.0047$	Reject H_0
DDEP	DCPI	$p = 0.9834$	Do not reject H_0
DDOB	DDEP	$p = 0.1139$	Do not reject H_0
DDOB	DCPI	$p = 0.7244$	Do not reject H_0
DCPI	DDEP	$p = 0.3339$	Do not reject H_0
DCPI	DDOB	$p = 0.1043$	Do not reject H_0

Source: Authors' own Granger causality/Block Exogeneity Wald tests based on the estimated VAR(4) model using NBR and INS monthly data, January 2007–December 2025.

When DDEP is the dependent variable, the four lags of DDOB are jointly significant. The null hypothesis that interest-rate changes do not Granger-cause deposit changes is therefore rejected. The joint test for all explanatory blocks in the DDEP equation is also significant ($p = 0.0309$).

When DDOB is the dependent variable, DDEP is not jointly significant at the 5% level ($p = 0.1139$). The evidence therefore does not support reverse Granger causality from deposits to deposit interest rates. DCPI is likewise insignificant in the DDOB equation.

For DCPI, neither DDEP nor DDOB is significant at the 5% level. The DDOB-to-DCPI probability of 0.1043 is relatively close to a 10% threshold but remains above it. The joint probability for all explanatory blocks is 0.1046.

The principal empirical conclusion is thus a unidirectional Granger-causal relationship from deposit interest rates to household deposits. This finding supports the first substantive hypothesis of the study while failing to support the second.

11. DISCUSSION

The results show that the deposit–interest-rate relationship is more nuanced than a comparison of individual VAR coefficients would suggest. In the DDEP equation, no single DDOB lag is individually significant, yet the four lags are jointly significant in the Wald test. This is not contradictory: distributed effects can be statistically meaningful as a block even when individual coefficients are imprecisely estimated.

The unidirectional Granger result is consistent with the theoretical proposition that deposit remuneration affects saving incentives. It also aligns with the impulse-response evidence, which indicates that a positive interest-rate innovation is followed by higher deposits over the short run. However, the moderate R^2 of the deposit equation indicates that interest rates are only one component of household deposit dynamics.

The source material identifies several plausible omitted determinants, including household income, unemployment, exchange rates, fiscal policy, monetary-policy conditions and confidence in the banking system. The Romanian experience after the global financial crisis also illustrates why deposit growth need not move mechanically with nominal interest rates. Deposits continued to expand during periods of low rates, implying that precautionary motives, income developments and portfolio preferences may have offset weaker remuneration.

The CPI results are also informative. Inflation is strongly autoregressive, but CPI changes do not Granger-cause deposits or deposit interest rates in the estimated model. This does not imply that inflation is economically irrelevant. Rather, the particular monthly specification does not identify incremental predictive power from CPI after controlling for the lag structure of the system.

The strong persistence in DDOB may reflect gradual repricing, competitive behaviour among banks and the transmission of monetary conditions to retail deposit products. The oscillatory lag pattern suggests that adjustments do not occur in a single step.

Comparison with prior Romanian evidence

The findings are broadly compatible with Dănulețiu, Iuga and Socol (2014), who also used a VAR framework for Romanian household deposits, while the longer sample employed here captures additional structural episodes. The evidence also complements Anghel and Străchinaru (2019) by highlighting the persistence of deposit behaviour and the importance of factors beyond the contemporaneous interest rate.

12. IMPLICATIONS FOR BANKS AND POLICYMAKERS

For commercial banks, the results suggest that deposit pricing can influence household funding volumes, although the effect is distributed over time and should not be viewed in isolation. Deposit strategies should therefore combine rate decisions with segmentation, maturity design, liquidity management and an assessment of competing household investment opportunities.

The evidence is particularly relevant when banks face changing funding needs. A higher deposit rate may support deposit mobilisation, but the cost of funding also rises. Banks therefore face a trade-off between attracting stable liabilities and preserving interest margins. Because the DDOB equation displays strong persistence, repricing decisions may also have effects that extend beyond the immediate month.

For monetary policymakers, the findings illustrate one channel through which broader interest-rate conditions can be associated with household saving behaviour. The result should not be interpreted as a direct estimate of the policy-rate transmission coefficient because the model uses deposit rates rather than the policy rate and does not impose a structural monetary-policy identification. Even so, the predictive role of deposit rates is consistent with a functioning interest-rate channel at the retail banking level.

The weak direct role of CPI in the VAR suggests that inflationary conditions may influence deposits through more complex pathways than the simple lagged CPI channel. Real interest rates, inflation expectations, disposable income and uncertainty could provide a richer representation of household responses.

Managerial relevance

A practical implication is that banks should not infer deposit sensitivity from a single contemporaneous rate elasticity. The evidence instead points to delayed and cumulative effects. Scenario analysis and deposit beta models could therefore be combined with VAR-based evidence when evaluating funding strategies.

Policy relevance

The results also support continued monitoring of household deposit composition during periods of rapid rate changes. Shifts between sight deposits, short-term deposits and longer-maturity products may contain information that is obscured when aggregate deposit volumes are analysed alone.

13. LIMITATIONS, ROBUSTNESS AND FUTURE RESEARCH

Several limitations should be recognised. First, the model uses only three variables. The moderate explanatory power of the deposit equation and low explanatory power of the CPI equation indicate that important determinants remain outside the system. Household disposable income, unemployment, exchange rates, fiscal transfers, bank competition, confidence indicators and alternative asset returns are natural candidates for extension.

Then the sample spans multiple structural regimes. The global financial crisis, post-crisis regulatory adjustment, the low-rate period, the pandemic and the 2022–2023 inflation episode may have changed behavioural parameters. A constant-parameter VAR averages across these regimes.

The residuals are non-normal and the joint heteroskedasticity test rejects constant variance. Although the absence of serial correlation supports the selected lag specification, conventional inference may be sensitive to these residual properties.

First differencing removes long-run information. The source analysis reports that all variables are $I(1)$, but it does not provide a full cointegration analysis in the sections used to construct this article. A future study should formally test for cointegration and, if appropriate, estimate a vector error-correction model (VECM) to distinguish short-run adjustments from long-run equilibrium relationships.

Granger causality is predictive rather than structural. Establishing a causal policy mechanism would require stronger identification assumptions, potentially through a structural VAR, external instruments or high-frequency monetary-policy surprises.

Recommended robustness extensions

Future research could: estimate sub-sample VARs around major structural breaks; use heteroskedasticity-robust or bootstrap confidence intervals; test alternative lag lengths; replace CPI with inflation rates or expected inflation; include the monetary-policy rate and household income; distinguish new-business deposit rates from outstanding-stock rates; and model deposit categories by maturity.

Research contribution

Despite these limitations, the study contributes by extending the observation window through 2025 and incorporating CPI into the dynamic system. The resulting evidence provides an updated view of the Romanian household deposit market across a period marked by unusually diverse macroeconomic conditions.

14. CONCLUSIONS

This paper examined the dynamic interdependence between household bank deposits, deposit interest rates and consumer prices in Romania using monthly data from January 2007 to December 2025. A three-variable VAR framework was estimated after first-differencing the series, which the ADF tests identified as $I(1)$. Residual serial-correlation diagnostics supported a four-lag specification.

The results reveal strong persistence in both deposit changes and, especially, deposit interest-rate changes. The most important finding is that changes in deposit interest rates Granger-cause changes in household deposits at conventional significance levels, while the reverse direction is not statistically supported. CPI does not display significant Granger-causal relationships with the other variables at the 5% level.

Impulse-response functions reinforce the main result: a positive deposit-rate shock is followed by a short-run increase in household deposits, with the effect peaking after several periods and then declining. Inflation shocks generate smaller and less persistent deposit responses.

The evidence therefore supports the view that deposit pricing matters for household saving behaviour in Romania, but it also shows that interest rates do not fully explain deposit dynamics. The continued growth of deposits during some low-rate periods and the moderate explanatory power of the deposit equation point toward a broader set of determinants, including income, uncertainty, confidence, portfolio alternatives and institutional factors.

For banks, the findings imply that rate-setting can be an effective component of deposit mobilisation strategy, but should be integrated with broader funding and customer-management decisions. For policymakers, the results are consistent with an interest-rate transmission channel operating through retail deposit products, although a structural monetary-policy interpretation requires a richer identification strategy.

REFERENCES

1. Angeloni, I., Kashyap, A. K., & Mojon, B. (2003). *Monetary Policy Transmission in the Euro Area*. European Central Bank.
2. Anghel, D. G., & Străchinaru, A. I. (2019). *Post-crisis household savings behavior in Romania*. Proceedings of the International Conference on Applied Statistics, 1(1), 17–33.
3. Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1999). *Monetary policy shocks: What have we learned and to what end?* In Handbook of Macroeconomics, 1A, 65–148.
4. Ciurilă, N. (2007). *Estimating the exchange rate pass-through into inflation in a vector autoregressive framework*. Annals of the University of Oradea, Economic Sciences, 16(2), 234–238.
5. Dănulețiu, A. E., Iuga, I. C., & Socol, A. (2014). *Investigating banking households' deposits using vector autoregressive model VAR*. Annales Universitatis Apulensis Series Oeconomica, 16(1), 85–103.
6. Diamond, D. W., & Dybvig, P. H. (1983). *Bank runs, deposit insurance, and liquidity*. Journal of Political Economy, 91(3), 401–419.
7. Feldstein, M. (1974). *Social security, induced retirement, and aggregate capital accumulation*. Journal of Political Economy, 82(5), 905–926.
8. Fry, R., & Pagan, A. (2005). *Some issues in using VARs for macroeconometric research*. CAMA Working Paper 19/2005.
9. Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*. Macmillan.
10. Modigliani, F., & Brumberg, R. (1954). *Utility analysis and the consumption function*. In Post-Keynesian Economics, 388–436.
11. Moroșan, G. (2020). *Banking deposits of population: Characteristics in Romania*. LUMEN Proceedings, 13, 171–181.
12. Nyström, K. (2008). *On deposit volumes and the valuation of non-maturing liabilities*. Journal of Economic Dynamics and Control, 32(3), 709–756.
13. Peersman, G., & Smets, F. (2001). *The monetary transmission mechanism in the euro area: More evidence from VAR analysis*. ECB Working Paper 91.
14. Raza, H., Hena, S., & Saeed, A. (2017). *The effects of interest rate on savings and deposits in Pakistan*. International Journal of Business and General Management, 6(6), 67–74.
15. Roșoiu, A., & Roșoiu, I. (2014). *Monetary policy transmission mechanism in Romania: A Bayesian VAR approach*. International Journal of Economic Practices and Theories, 4(2), 199–205.
16. Sims, C. A. (1980). *Macroeconomics and reality*. Econometrica, 48(1), 1–48.

17. Spulbăr, C., & Nițoi, M. (2013). Monetary policy transmission mechanism in Romania over the period 2001–2012: A BVAR analysis. *Scientific Annals of the Alexandru Ioan Cuza University of Iași: Economic Sciences*, 60(2), 387–398.

ARTIFICIAL INTELLIGENCE ADOPTION IN ROMANIA AND POLAND: A COMPARATIVE STUDY WITHIN THE EUROPEAN UNION²⁰

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ABSTRACT: Artificial Intelligence (AI) has become one of the most influential general-purpose technologies of the twenty-first century, fundamentally transforming production processes, business models, public administration, and labour markets. Recent advances in machine learning, generative AI, natural language processing, and computer vision have significantly expanded the range of economic activities in which AI technologies can be effectively deployed. Consequently, AI is increasingly regarded as a strategic driver of productivity growth, technological innovation, and long-term economic competitiveness. This paper provides a comparative analysis of the level of AI adoption in Romania and Poland, two Central and Eastern European economies with considerable technological potential but differing levels of progress in the implementation of AI-based solutions. The analysis is based on Eurostat data regarding the adoption of AI technologies by enterprises, taking into account enterprise size and sector of economic activity. The findings reveal significant disparities between the two countries, reflecting differences in their digital transformation trajectories and innovation ecosystems. This article argues that narrowing the AI adoption gap requires sustained investment in digital skills, technological infrastructure, and innovation policies, alongside targeted measures aimed at encouraging the adoption of AI technologies among small and medium-sized enterprises (SMEs), particularly in Romania.

Keywords : UE, Artificial Intelligence, Romania, Poland, Digital Transformation

JEL Classification: F02, O32, O33, O38

1. INTRODUCTION

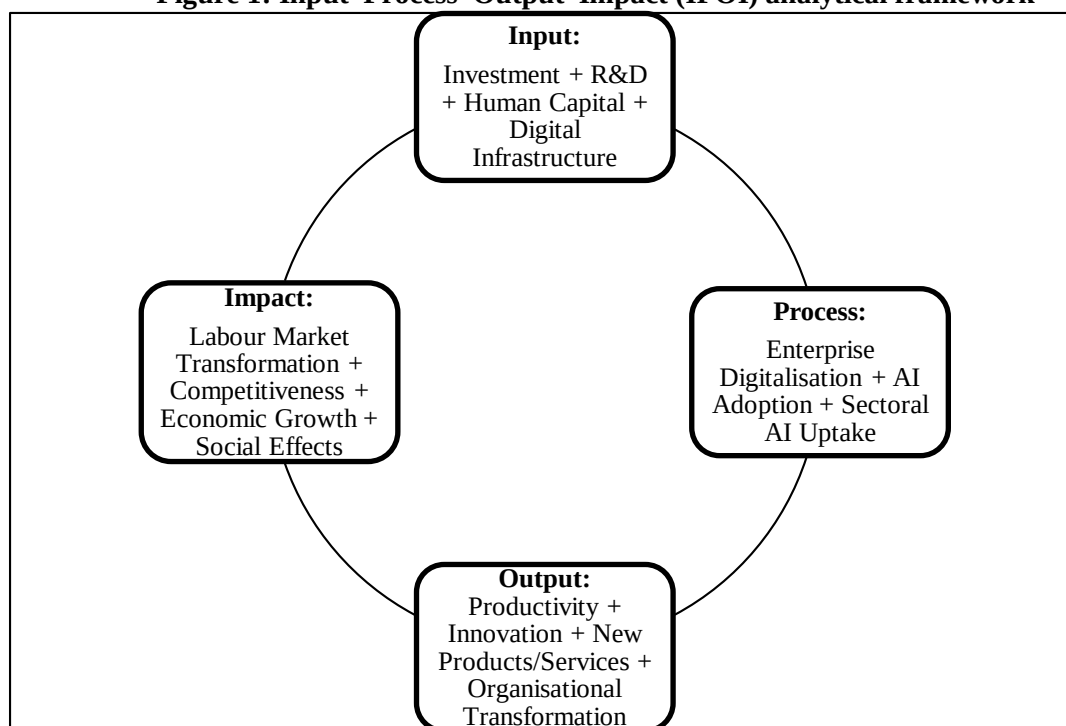
The development of artificial intelligence (AI) represents a multidimensional process in which technological, financial, human, and institutional resources interact to shape the capacity of economies and enterprises to adopt and exploit AI technologies. Differences in AI development across countries cannot therefore be explained solely by the level of AI adoption. They also reflect the availability of investment, research and development (R&D), human capital, digital infrastructure, and institutional support, as well as the capacity of firms to transform these resources into technological and organisational capabilities. To capture these interdependencies, this article adopts an *Input–Process–Output–Impact (IPOI) analytical*

²⁰This article draws on research conducted the study “*Reconfiguring the Labour Market in the European Union in the Context of Artificial Intelligence (AI) and the Circular Economy: Perspectives and Challenges*,” coordinated by Dr. Alina Ligia Dumitrescu, part of the I.E.M. Subprogram 2023–2027 (PS-IEM 4: Sectoral Policies and the Transition to the Circular Economy) within the Research Plan of the Romanian Academy/INCE.

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framework for assessing AI development in the European Union (EU), Romania, and Poland. The IPOI framework consequently provides a **systemic perspective** on AI development, linking resources to adoption and adoption to economic and social outcomes (Figure1).

Figure 1: Input–Process–Output–Impact (IPOI) analytical framework



Source: Author's own representation based on specialized literature.

Within this framework, **Inputs** represent the financial, technological, human, and institutional resources that create the conditions for AI development. The analysis considers **AI investment, R&D expenditure, AI-related human capital, and digital infrastructure** as the principal input dimensions. These factors determine the availability of resources required to develop, implement, and scale AI technologies. At the macroeconomic level, R&D intensity reflects a country's capacity to generate new knowledge and technological innovation, while investment in digital infrastructure provides the technological foundations for data-intensive and computationally demanding AI applications. Human capital, particularly advanced Information and Communication Technology (ICT) and AI-related skills, constitutes a complementary input because *the effective development and use of AI depend on the availability of qualified professionals*.

The **Process** dimension captures the transformation of these resources into technological and organisational capabilities. In this stage, the analysis focuses on **enterprise digitalisation, AI adoption, the use of AI technologies across economic sectors, and the development of organisational capabilities**. AI adoption is not an automatic consequence of investment or infrastructure availability. *Enterprises must integrate AI into production and business processes, adapt organisational structures, develop appropriate governance mechanisms, and acquire the skills necessary to use AI effectively*. Consequently, differences in enterprise-level adoption may reflect not only differences in technological availability but also *variations in managerial capabilities, organisational readiness, access to finance, and the ability to integrate AI into existing business models*.

The **Output** dimension refers to the observable results generated by the process of AI adoption. These include increased use of AI technologies by enterprises, changes in the

composition of business activities, the emergence of new AI-intensive sectors and occupations, productivity improvements, and *the development of new products and services*. At this level, enterprise AI adoption provides an important measurable indicator of the extent to which countries are translating their technological and human resources into actual economic activity. The sectoral distribution of AI adoption is particularly relevant because the economic effects of AI are likely to differ substantially across information and communication technologies, professional and scientific services, manufacturing, finance, and other sectors.

Finally, the ***Impact dimension*** captures the broader economic, *labour-market, and societal consequences associated with AI diffusion*. These may include **productivity growth, changes in employment and occupational structures, shifts in skill demand, wage effects, innovation performance, competitiveness, and organisational transformation**. The impact of AI should therefore be understood as a dynamic and potentially uneven process. AI may complement human labour and increase productivity in some activities while reducing demand for certain routine tasks in others. At the same time, *the emergence of new occupations and tasks may generate additional demand for advanced digital, analytical, and interpersonal skills*. The overall impact will depend on the interaction between technological change, labour-market institutions, education and training systems, and firms' capacity to reorganise work.

Applying this framework to the EU, Romania, and Poland makes it possible to move beyond a simple comparison of AI adoption rates and identify the structural factors underlying differences in AI performance. The EU provides the broader benchmark, while Romania and Poland represent two Central and Eastern European economies with different levels of R&D intensity, digital investment, human-capital development, and enterprise AI adoption. The comparison therefore seeks to determine whether differences in AI adoption are associated with differences in the underlying resource base and institutional environment and to identify the main strengths and constraints affecting AI-driven transformation in the two countries.

This analysis is based primarily on recent evidence from **Eurostat, the European Commission, and the OECD**, complemented where appropriate by international AI reports and datasets. By integrating quantitative indicators across the four dimensions of the IPOI framework, the analysis provides a structured basis for evaluating the current position of Romania and Poland within the European AI landscape and for identifying policy priorities aimed at strengthening AI investment, innovation capacity, workforce skills, enterprise adoption, and the broader economic and labour-market benefits of AI.

2. LITERATURE REVIEW

The relationship between technological progress and employment has long been a central concern in economic research. Traditional economic literature has primarily viewed technological change through the lens of labour substitution, arguing that technological innovation replaces tasks previously performed by human workers, thereby reducing labour demand in certain occupations.

Subsequent research has demonstrated that such an interpretation is incomplete. In their seminal study, Autor, Levy, and Murnane (2003) introduced a task-based approach to technological change, arguing that *technology substitutes routine tasks while complementing activities requiring analytical thinking, problem-solving, and complex decision-making*. Since occupations typically consist of multiple tasks rather than a single activity, technological change *affects only specific components of jobs rather than entire occupations*.

A further theoretical contribution was provided by Acemoglu and Restrepo (2019), who distinguish between the automation of existing tasks and the creation of new tasks performed by workers. According to their framework, while automation may reduce labour demand in certain activities, technological progress simultaneously *generates new responsibilities*,

occupations, and economic opportunities. Consequently, the overall employment effect depends on the balance between labour-displacing and labour-creating mechanisms.

Unlike previous waves of automation, AI is capable of performing not only routine physical tasks but also cognitive, administrative, and information-processing activities. As a result, assessing AI's impact on employment has become substantially more complex. Rather than focusing solely on occupations, recent research increasingly examines the specific tasks performed within occupations and evaluates the extent to which these tasks can either be automated or augmented by AI technologies.

In this context, exposure to Artificial Intelligence should not be interpreted as synonymous with job displacement. As emphasised by the OECD (2026), a clear distinction must be made between AI's technological capabilities and its actual labour market effects. The impact of AI depends not only on technological progress but also on firms' adoption decisions, organisational practices, workforce skills, and the institutional and regulatory environment in which AI technologies are implemented.

The ***Stanford AI Index 2026*** provides a comprehensive global assessment of artificial intelligence development and diffusion, covering research and development, investment, technical performance, infrastructure, human capital, enterprise adoption, education, and governance. Its key findings highlight the rapid acceleration of AI development, rising investment and organizational adoption, and intensifying competition between the United States and China. Overall, the report highlights the growing importance of ***AI innovation, investment, human capital, and technology diffusion for economic competitiveness and labour-market transformation*** (Stanford HAI, 2026).

Alongside the substantial contributions of international organizations or such as the OECD or **Stanford** Institute for Human-Centred Artificial Intelligence, an important body of evidence is provided by reports published by leading *consulting and technology firms*, which offer empirical insights based on large-scale surveys involving thousands of organizations worldwide.

Studies conducted by McKinsey (2025a, 2025b) indicate that AI has moved well beyond the stage of isolated experimentation and has become a strategic priority for organizations. Nevertheless, a significant gap remains between AI adoption and the realization of tangible economic value. While most organizations have implemented AI applications in one form or another, only a relatively small proportion have succeeded in deploying AI at scale and *translating these investments into measurable improvements in financial performance*.

McKinsey argues that successful AI implementation depends less on technological capabilities than on organizational transformation, workforce capability development, and strong executive leadership. Organizations that employ AI primarily to automate repetitive tasks generally achieve only modest efficiency gains. By contrast, firms that redesign workflows and integrate AI *into decision-making processes experience substantially greater improvements in productivity, innovation, and overall business performance*. A key conclusion is that AI does not automatically generate competitive advantage; rather, such advantages emerge only when technological adoption is accompanied by profound organizational change.

The analyses published by PwC (2026) demonstrate that AI is *driving structural changes in labour markets by reshaping both skills demand and occupational structures*. Recent findings show that organizations with higher levels of AI exposure tend to experience faster productivity growth and, in many cases, higher wages and employment levels than organizations with more limited AI adoption. According to PwC, AI contributes to skills polarization by increasing the importance of advanced cognitive abilities, leadership, creativity, and complex problem-solving skills, while reducing demand for routine and repetitive tasks. This trend reinforces the need for *continuous investments in upskilling and reskilling initiatives*. The findings suggest that AI is not merely replacing specific tasks but is also creating new occupations and fundamentally transforming the nature of work.

IBM (2025) examines AI adoption from the perspective of organizational maturity. According to the *IBM Global AI Adoption Index*, the pace of AI implementation is shaped by several factors, including data availability, digital infrastructure, workforce expertise, and the existence of internal AI governance policies. IBM emphasizes that the primary obstacles to AI adoption are organizational rather than technological. These include skills shortages, difficulties integrating AI into existing business processes, limited trust in AI-generated outputs, and concerns related to cybersecurity, privacy, and data protection. From this perspective, successful AI implementation requires the development of an *organizational culture that promotes innovation, adaptability, and continuous learning*.

The Microsoft Work Trend Index (Microsoft, 2026a) *highlights the transformative impact of generative AI on the organization of work*. AI is increasingly employed to automate administrative tasks, support decision-making, generate content, and augment cognitive activities, enabling employees to devote more time to higher value-added work. Within these organizations, *AI is no longer viewed merely as an automation tool but as a collaborative partner in intellectual work, while employees increasingly assume roles centred on coordination, supervision, critical evaluation, and strategic decision-making*. Furthermore, Microsoft (2026b) emphasizes that the effective deployment of AI must be accompanied by investments in digital skills development and by the evolution of leadership practices capable of unlocking the technology's full potential.

A comparative analysis of these reports reveals a broad consensus that artificial intelligence should not be assessed solely in terms of task automation but rather through its *capacity to transform organizations and generate sustainable competitive advantages*. While McKinsey (2025a, 2025b) focuses on organizational transformation and value creation, PwC (2026) emphasizes productivity growth and workforce skills, IBM (2025) examines the organizational factors determining AI maturity, and Microsoft (2026a, 2026b) concentrates on the transformation of work organization and human–AI collaboration (Table 1).

Table 1. Comparative Analysis of the Major Reports on the Impact of Artificial Intelligence on the Economy and Labour Market

Author / Institution	Research Objective	Methodology	Sample / Coverage	Key Indicators	Key Findings	Labour Market Implications	Limitations
OECD: Employment Outlook 2023; AI Policy Observatory	To assess the impact of AI on employment, productivity, and skills.	Statistical analysis, international databases, and cross-country comparative studies.	OECD member countries	Productivity, skills, employment, occupational exposure to AI.	AI is more likely to complement than replace human labour, although its effects vary considerably across occupations and sectors.	Highlights the <i>need for reskilling and upskilling</i> policies to facilitate workforce adaptation.	Uneven data availability and differences in statistical methodologies across countries.
ILO (2023, 2024)	To examine the effects of AI on job quality and employment.	Occupational modelling and sectoral analysis.	Global	Occupational exposure to AI, job quality, automation potential.	Most occupations are expected to be transformed rather than eliminated through AI adoption.	Supports <i>active labour market policies</i> , social protection, and a just transition for workers.	Long-term impacts remain uncertain due to the rapid pace of technological change.

Author / Institution	Research Objective	Methodology	Sample / Coverage	Key Indicators	Key Findings	Labour Market Implications	Limitations
Stanford AI Index	To monitor global AI development and diffusion.	Bibliometric, statistical, and trend analysis.	Global	AI investment, patents, scientific publications, AI adoption	The United States and China remain global leaders in AI investment and innovation, while Europe demonstrates strong research performance but uneven commercial adoption.	Underlines the importance of strengthening innovation ecosystems and technology transfer.	Limited emphasis on labour market and broader social impacts.
McKinsey Global Institute	To evaluate the organisational and economic impact of AI.	Global executive surveys and case studies.	Thousands of firms across multiple countries.	AI adoption, productivity, profitability, organisational transformation.	The highest productivity gains are achieved when AI implementation is accompanied by organisational redesign and workforce capability development	Emphasises organisational transformation, digital leadership, and continuous workforce development.	Evidence is primarily derived from large and innovation-oriented firms.
PwC Global AI	To estimate AI's contribution to economic growth and labour market transformation.	Macroeconomic modelling and global surveys.	Global	GDP growth, productivity, wages, skills demand.	AI has the potential to substantially increase economic growth while reshaping labour demand and skill requirements	<i>Reinforces the importance of education reform and lifelong learning systems.</i>	Results depend on assumptions regarding the speed and scale of AI adoption.
IBM Global AI Adoption Index	To assess the maturity of enterprise AI adoption.	Surveys of business executives.	Organisations across multiple industries.	AI adoption, governance, implementation barriers, digital skills.	The principal obstacles to AI adoption include skills shortages, system integration challenges, and data governance issues.	Highlights the need to strengthen digital competencies, organisational readiness, and change management.	Findings rely on managers' perceptions and may therefore reflect subjective assessment

Author / Institution	Research Objective	Methodology	Sample / Coverage	Key Indicators	Key Findings	Labour Market Implications	Limitations
Microsoft Work Trend Index	To analyse the impact of generative AI on work organisation and employee productivity.	Global workforce surveys and analysis of digital tool usage.	Employees and organisations worldwide.	Generative AI use, collaboration, productivity, digital skills.	Generative AI is reshaping work organisation by enabling new forms of human–AI collaboration and increasing knowledge-worker productivity.	Demonstrates the growing importance of digital literacy, AI competencies, and organisational change management.	Strong emphasis on digital work environments and Microsoft technology users.

Source: Author's synthesis based on specialized literature

Despite these different analytical perspectives, the findings converge toward the same conclusion: the successful implementation of AI depends on the existence of *a robust organizational ecosystem supported by digital competencies, effective leadership, investments in human capital, and the ability to redesign business processes*. Consequently, the economic benefits of AI are determined not only by technological performance but also by the quality of organizational governance and strategic investments in human resources.

Overall, the comparison of these reports demonstrates a broad consensus that artificial intelligence has become a key driver of economic and labour market transformation. Nevertheless, each institution approaches the phenomenon from a distinct analytical perspective, as summarized in Table 1.

3. METHODOLOGY

The research methodology focuses on the quantitative analysis of the key indicators specific to AI adoption, as well as on the qualitative analysis of documents and policies related to AI, and on the consultation of specialized literature, studies, and articles published by renowned authors. The research is both applied and relevant for public policy and explanatory, aimed at identifying causal relationships and mechanisms of AI impact.

The Input–Process–Output–Impact (IPOI) analytical framework gives your empirical analysis a stronger theoretical and methodological foundation and, importantly, allows to distinguish between the capacity to develop AI (Inputs), the ability to implement it (Process), the immediate results of adoption (Outputs), and its broader economic and labour-market consequences (Impacts).

4. ARTIFICIAL INTELLIGENCE USE IN FIRMS AND ECONOMIC SECTORS IN THE EUROPEAN UNION MEMBER STATES

Recognising AI as a strategic driver of innovation and competitiveness, the European Union has actively promoted its development and deployment through coordinated policy initiatives, dedicated funding programmes, and a comprehensive regulatory framework, most notably the *Artificial Intelligence Act (AI Act)*.

Despite these efforts, the diffusion of AI technologies remains highly uneven across EU Member States. Significant disparities persist, particularly between the more digitally advanced economies of Northern and Western Europe and the emerging economies of Central and Eastern

Europe. Within this context, Romania and Poland represent relevant case studies for comparative analysis. Although both countries share a common post-socialist transition and have experienced rapid integration into the European digital economy, they differ considerably in terms of digital maturity, innovation performance, and the adoption of AI technologies by enterprises.

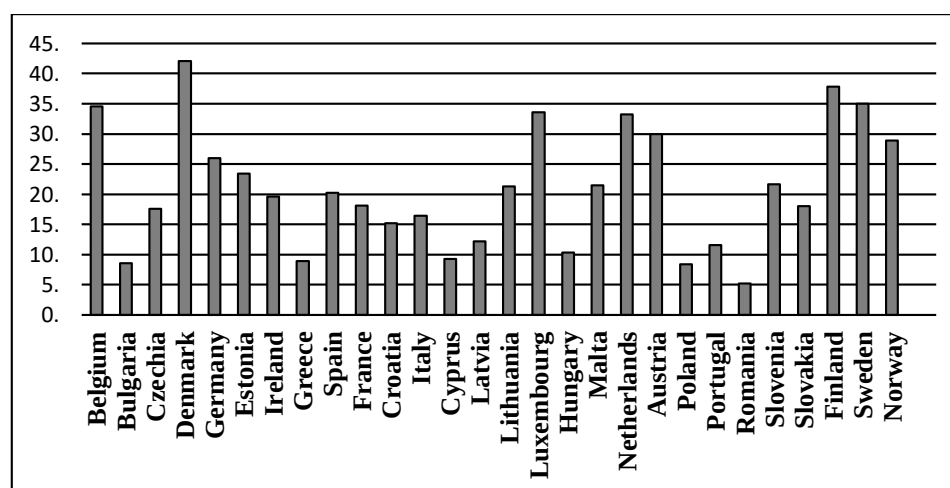
At the EU level, AI adoption has followed a sustained upward trajectory in recent years. According to Eurostat data, in 2025 approximately 19.95% of firms employing at least ten persons, including self-employed businesses, reported using at least one AI technology (Eurostat, 2025a). The analysis by enterprise size reveals pronounced differences in adoption rates: 17.00% of small enterprises, 30.36% of medium-sized enterprises, and 55.03% of large enterprises had implemented AI solutions. These disparities can largely be attributed to differences in financial capacity, technological readiness, economies of scale, and the substantial upfront investments required for AI implementation, which are generally more affordable for larger firms.

Cross-country comparisons further highlight the heterogeneous diffusion of AI across the European Union. In 2025, the share of enterprises adopting at least one AI technology ranged from 5.21% to 42.03%. Denmark recorded the highest adoption rate (42.03%), followed by Finland (37.82%) and Sweden (35.04%). At the opposite end of the distribution, the lowest levels were reported in Romania (5.21%), Poland (8.36%), and Bulgaria (8.55%) (Figure 1). Nevertheless, AI adoption continued to expand throughout the Union, with 26 Member States reporting higher adoption rates than in the previous year. The most substantial increases were observed in Denmark (+14.45 percentage points), Finland (+13.45 percentage points), and Lithuania (+12.54 percentage points), reflecting the accelerating pace of digital transformation across the European economy.

Although the European Union actively promotes AI adoption through common policies, funding mechanisms, and regulatory frameworks such as the AI Act, empirical evidence suggests that these instruments have not generated uniform outcomes across Member States.

From a sectoral perspective, in 2025, the information and communication sector recorded the highest share of enterprises using artificial intelligence (62.52%), followed by professional, scientific and technical activities (40.43%). In all other sectors of the economy, AI adoption remained below 25%, ranging from 24.82% in real estate activities to 10.79% in the construction sector.

Figure 1. Share of firms using Artificial Intelligence technologies in the European Union Member States, 2025 (% of Total Enterprises 10 persons or more)



Source: Author's processing based on Eurostat data (2025)

EU enterprises implemented a wide range of artificial intelligence technologies. The most widely adopted were written language analysis technologies, including automated text extraction, used by 11.75% of enterprises in 2025. These were followed by visual and audio content generation technologies (9.55%) and technologies for generating written or spoken language and programming code (8.76%). Other AI applications including speech recognition, machine learning algorithms for data analysis, workflow automation systems, decision-support systems, and image recognition technologies were used by between 7.22% and 3.78% of enterprises. At the opposite end of the spectrum, technologies enabling the autonomous physical mobility of intelligent systems, such as autonomous vehicles, were adopted by only 1.39% of enterprises.

With regard to the purposes of AI adoption, the data indicate that, in 2025, 34.70% of firms using AI applied these technologies to marketing and sales activities, while 31.05% employed them for business administration and management processes. AI adoption was least common in logistics, where only 6.08% of AI-using enterprises reported deploying such technologies.

An analysis by enterprise size reveals substantial disparities in the purposes for which AI is employed. The largest gap between small and large enterprises was observed in the area of information and communication technology (ICT) security, where 47.51% of large enterprises used AI-based solutions compared with only 14.51% of small enterprises. Significant differences were also identified in the use of AI for business administration and management (43.38% among large enterprises versus 28.49% among small enterprises) and production processes (33.46% versus 19.02%).

Romania and Poland represent two relevant economies in Central and Eastern Europe.

According to Eurostat data for 2025, Romania recorded the lowest proportion of enterprises using at least one AI technology in the European Union, at 5.21%, while Poland, although performing slightly better, remained below the EU average, with 8.36% of enterprises adopting AI technologies. These figures highlight a considerable gap compared with Northern and Western European Member States, where AI adoption is substantially more widespread.

The differences between the two countries can be attributed to several structural and institutional factors. Poland benefits from a larger domestic market, higher investment in research and development, and a more coherent implementation of its national artificial intelligence strategy. Furthermore, *Poland's innovation ecosystem is supported by a greater number of technology clusters and stronger collaboration among academia, the private sector, and public authorities.*

In Romania, although the information technology sector is internationally competitive and largely export-oriented, AI adoption among enterprises remains limited, particularly among small and medium-sized enterprises (SMEs). This situation can be associated with relatively low levels of investment in digitalisation, shortages of advanced AI-related skills, and comparatively weak absorption of European funds dedicated to technological innovation.

From the perspective of enterprise size, both Romania and Poland exhibit significantly higher AI adoption rates among large enterprises than among small and medium-sized firms. However, medium-sized enterprises in Poland demonstrate a stronger propensity to adopt AI solutions, suggesting a more advanced integration of digital technologies within the country's economic structure.

Regarding the fields of application, *AI use in both countries is concentrated primarily in the information and communication sector and in professional, scientific and technical services.* Nevertheless, Romania displays a lower degree of diversification in AI applications across sectors such as manufacturing, logistics, and business administration compared with Poland, where these technologies are deployed across a broader range of economic activities.

5. ARTIFICIAL INTELLIGENCE DEVELOPMENT FACTORS

The development and diffusion of artificial intelligence (AI) depend on a combination of complementary factors, including investment, research and development (R&D), human capital, and digital infrastructure. These dimensions jointly determine a country's capacity to generate, adopt, and scale AI technologies across economic sectors (European Commission, 2025a). A comparison between the European Union (EU), Romania, and Poland reveals significant disparities in AI readiness and innovation performance (Table 2).

Table 2: Comparative Indicators for Artificial Intelligence Development in the European Union, Romania, and Poland (2024–2025)

INDICATOR	EUROPEAN UNION	ROMANIA	POLAND
Gross domestic expenditure on R&D (% of GDP)	2.24%	≈0.46%	≈1.41%
National Digital Decade roadmap budget	€288.6 billion (aggregate national roadmaps)	Romania allocates 22% of its Recovery and Resilience Plan (€5.8 billion) to digital transformation, complemented by €2.7 billion (9%) in cohesion policy funding for digitalisation.	Poland's Digital Decade roadmap comprises 55 measures with a total budget of €12.4 billion, equivalent to 1.47% of GDP.
AI human capital (ICT specialists / digital skills)	Shortage of AI specialists remains an EU-wide challenge.	High share of ICT graduates but low basic digital skills.	Improving digital skills, yet shortages of advanced ICT specialists persist.
Digital infrastructure	Continuous investment in HPC, cloud, AI factories and data spaces,	Very strong fixed broadband connectivity; AI and semiconductor initiatives	Strong broadband infrastructure; investment in AI, quantum computing and cybersecurity
Enterprises using at least one AI technology	19.95%	5.21%	8.36%

Source: Author's synthesis based on specialized literature.

The EU benefits from a considerably larger investment base and a more mature research, infrastructure, and innovation ecosystem. Overall, the indicators point to a *multi-dimensional AI development gap* between the EU and the two Central and Eastern European economies examined. Poland appears to have a comparatively stronger AI development environment than Romania, particularly in terms of R&D intensity, digital investment, and enterprise AI adoption. Romania possesses important assets in ICT human capital and digital connectivity, but these advantages are not yet sufficiently translated into AI adoption and innovation outcomes. Romania's policy challenge is not simply to increase digital connectivity, but to *strengthen the mechanisms linking R&D, ICT skills, investment, innovation ecosystems, and enterprise adoption*. Poland's comparatively stronger performance suggests that higher R&D intensity and larger digital transformation investments may contribute to a more favourable environment for AI diffusion, although a causal relationship cannot be established from these descriptive indicators alone.

5.1 AI investment

The European Union has significantly strengthened its strategic commitment to AI through programmes such as *Horizon Europe*, the *Digital Europe Programme*, the AI Factories initiative, and the implementation of the AI Act. These initiatives are designed to reinforce Europe's technological sovereignty, expand high-performance computing (HPC) infrastructure, and accelerate the development and deployment of trustworthy AI applications (European Commission, 2025a).

According to the OECD, total artificial intelligence investment in the European Union was estimated at approximately €257 billion in 2023 (range: €220–294 billion), with private investment accounting for 73% of total AI expenditure (Fonteneau et al., 2025). AI-related investment was concentrated primarily in skills development (41%), followed by data and equipment (37%), research and development (13%), and other intellectual property assets (9%), highlighting the strategic importance of human capital and digital infrastructure in strengthening the EU's AI ecosystem. It is important to distinguish between *three different measures of AI investment*, because they are often confused in the literature (Table 3).

Table 3: The three different measures of AI investment

INDICATOR	FIGURES	SOURCES
Estimated total AI investment in the EU-27 (all public and private investment)	€220–294 billion	Fonteneau et al. (2025)
EU policy target (Coordinated Plan on AI)	€20 billion annually by 2030	European Commission (2021)
EU27 venture capital (VC) investment in AI companies	From a comparative perspective, in 2025, on the first place was the United States which accounted for approximately 75% of global AI venture capital deal value, equivalent to USD 194 billion, far exceeding the shares of the EU27 (6%; USD 15.8 billion), China (5%; USD 13.9 billion), and the United Kingdom (5%; USD 13.8 billion).	OECD (2026)

Source: Author's synthesis based on specialized literature.

Comparatively, Poland has emerged as one of the leading Central and Eastern European economies in attracting AI and digital-related investment. Public funding has been complemented by increasing private-sector investment, particularly in cloud computing, cybersecurity, and AI applications. According to the European Commission (2025b), Poland has incorporated AI as a strategic priority within its Digital Decade roadmap, supporting the development of digital innovation hubs and AI ecosystems.

Romania has likewise adopted a *National Strategy in the Field of Artificial Intelligence 2024-2027*, for digital transformation and AI development (National Research Authority, 2024). Nevertheless, investment in AI remains relatively limited compared with the EU average. Although Romania benefits from excellent broadband connectivity and a highly qualified ICT workforce, *lower levels of venture capital, research funding, and technology commercialisation continue to constrain AI adoption across enterprises* (European Commission, 2025c).

5.2 AI-related research and development expenditure

Investment in research and development (R&D) represents one of the most important determinants of long-term AI competitiveness. According to Eurostat (2025b), total gross domestic expenditure on R&D (GERD) in the European Union exceeded €403 billion in 2024, corresponding to approximately 2.2% of GDP, reflecting sustained investment in scientific research, innovation, and emerging digital technologies.

Romania remains among the lowest-performing EU Member States in terms of R&D intensity, allocating approximately 0.46% of GDP in 2024 to research and development (ranks last in the EU in R&D funding). This relatively low level of investment limits scientific output, knowledge transfer, innovation capacity, and the commercialisation of AI technologies (Eurostat, 2025b).

By comparison, Poland has achieved a substantially higher level of R&D expenditure than Romania, although it still remains below the EU average. Continuous increases in public investment, together with stronger collaboration between universities, research institutes, and industry, have enhanced Poland's research capacity and strengthened its AI innovation ecosystem (European Commission, 2025b; Eurostat, 2025b).

5.2 AI human capital and the labour market impact

Human capital is widely recognised as a key driver of AI adoption and innovation. Across the European Union, policy initiatives increasingly emphasise investments in digital skills, AI education, reskilling, and lifelong learning to address the growing demand for AI specialists and digitally skilled workers (European Commission, 2025a).

Poland has made considerable progress in strengthening AI-related human capital through digital education programmes, reforms in higher education, and investments in cybersecurity and advanced digital skills. Nevertheless, shortages of AI specialists and highly qualified ICT professionals remain an important structural challenge (European Commission, 2025b).

Romania possesses one of the largest shares of ICT graduates in the European Union and benefits from internationally competitive software engineers. However, *persistent weaknesses in basic digital skills, labour migration (brain drain), and limited collaboration between academia and industry continue to constrain the country's AI innovation capacity* (European Commission, 2025c).

The evidence therefore suggests that the quality, availability, and effective utilisation of human capital are at least as important as the number of ICT graduates.

5.4 Digital infrastructure

Digital infrastructure constitutes the technological foundation for AI development and diffusion. Under the Digital Decade Strategy, the European Union continues to invest in broadband connectivity, cloud computing, high-performance computing (HPC), data spaces, and secure digital infrastructure (European Commission, 2025a).

Romania performs relatively well regarding fixed broadband and very high-capacity network coverage, ranking among the leading EU Member States in several connectivity indicators. However, *cloud adoption, digital public services, and enterprise digitalisation remain below the EU average*, limiting the broader diffusion of AI technologies across the economy (European Commission, 2025c).

Poland has also made substantial progress in broadband infrastructure while investing in cybersecurity, cloud services, AI computing capacity, and quantum technologies.

Nevertheless, the adoption of advanced digital technologies among small and medium-sized enterprises (SMEs) continues to lag behind the EU average (European Commission, 2025b).

6. RESULTS

The cases of Romania and Poland clearly illustrate the limitations of the current European model for the diffusion of advanced technologies. *Despite sharing similar historical and geopolitical backgrounds, the two economies display different levels of AI adoption, indicating that domestic institutional factors, administrative capacity, and the coherence of national strategies play a decisive role in translating European policy initiatives into tangible economic outcomes.* While Poland appears to benefit from a more mature and better-coordinated innovation ecosystem, Romania continues to face structural constraints that limit the integration of artificial intelligence into the business sector.

Overall, the European Union maintains a significant advantage over both Romania and Poland in AI investment, research capacity, digital infrastructure, and innovation ecosystems. Poland has positioned itself as a regional leader in Central and Eastern Europe owing to higher levels of investment, stronger R&D performance, and more advanced digital ecosystems. Romania's comparative advantages lie primarily in ICT talent and digital connectivity; however, persistent underinvestment in research, limited AI adoption by enterprises, and shortages of advanced digital skills continue to hinder AI-driven economic transformation (European Commission, 2025b, 2025c).

7. CONCLUSIONS AND RECOMMENDATIONS

Over the past decade, Artificial Intelligence has emerged as a cornerstone of the global digital economy, profoundly transforming economic activity, organisational processes, and technological development. From a critical perspective, the relatively low level of AI adoption among small and medium-sized enterprises points to a systemic challenge that extends beyond technological costs. It also reflects shortages of advanced digital skills, managerial resistance to organisational change, and the absence of effective policy instruments tailored to the specific needs of SMEs. *Without differentiated public policy interventions, artificial intelligence may reinforce existing economic disparities by disproportionately benefiting large enterprises and technologically advanced economies.*

Moreover, the concentration of AI adoption in sectors such as information and communication and professional services indicates that the diffusion of AI technologies across the real economy remains selective and incomplete. This trend raises important questions regarding the capacity of countries with relatively low levels of digitalisation to integrate AI into traditional sectors such as manufacturing, construction, and logistics, where the potential productivity gains are particularly significant.

In conclusion, artificial intelligence has become a strategic driver of the European Union's economic competitiveness. However, its impact remains strongly conditioned by national and sectoral contexts. *For Romania and other Central and Eastern European economies, narrowing the gap with the EU average requires not only formal alignment with European AI strategies but also the implementation of coherent public policies aimed at developing human capital, strengthening institutional capacity, and promoting AI adoption among small and medium-sized enterprises. Without such measures, artificial intelligence risks becoming a driver of economic polarisation rather than an instrument of European convergence.*

REFERENCES

1. Acemoglu, D., & Restrepo, P. (2019). Automation and new tasks: How technology displaces and reinstates labour. *Journal of Economic Perspectives*, 33(2), 3–30. <https://doi.org/10.1257/jep.33.2.3>.
2. Acemoglu, D., & Restrepo, P. (2022). Tasks, automation, and the rise in U.S. wage inequality. *Econometrica*, 90(5), 1973–2016. <https://doi.org/10.3982/ECTA19815>.
3. Autor, D.H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, 118(4), 1279–1333. <https://doi.org/10.1162/003355303322552801>.
4. AllAboutAI (2025). *The 2026 Global AI Adoption Report: Is Your Country Leading the Revolution*. <https://www.allaboutai.com/resources/ai-statistics/global-ai-adoption>.
5. European Commission (2021). Annexes to the Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions Fostering a European approach to Artificial Intelligence. COM (2021) 205 final. <https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review>
6. European Commission (2025a). 2025 State of the Digital Decade Report. Publications Office of the European Union. <https://digital-strategy.ec.europa.eu/en/library/state-digital-decade-2025-report?utm>.
7. European Commission. (2025b). Digital Decade Country Report: Poland. Publications Office of the European Union. <https://digital-strategy.ec.europa.eu/en/library/digital-decade-2025-country-reports>.
8. European Commission. (2025c). Digital Decade Country Report: Romania. Publications Office of the European Union. <https://digital-strategy.ec.europa.eu/en/library/digital-decade-2025-country-reports>.
9. European Parliament & Council of the European Union. (2024). *Regulation (EU) 2024/1689 of 13 June 2024 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act)*. Official Journal of the European Union, L 2024/1689.
10. Eurostat (2025a). *Artificial intelligence by size class of enterprise Enterprises using AI technologies*. ec.europa.eu/
11. Eurostat (2025b). Research and development expenditure. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure.
12. Fonteneau, F., Mollins, J., Marchi, S., Russo, L., Gentaz, A., Daoud, M., & André, (2025). *Advancing the measurement of investments in artificial intelligence*. OECD Artificial Intelligence Papers No. 47. OECD Publishing. <https://doi.org/10.1787/13e0da2f>.
13. IBM (2025). *Global AI Adoption Index 2025*. IBM Institute for Business Value. <https://www.ibm.com/think/news/stanford-hai-2025-ai-index-report>.
14. McKinsey (2025a). *Superagency in the workplace: Empowering people to unlock AI's full potential*. <https://www.mckinsey.com/capabilities/tech-and-ai/our-insights/superagency-in-the-workplace-empowering-people-to-unlock-ais-full-potential-at-work>.
15. McKinsey (2025b). *The State of AI in 2025: Agents, innovation, and transformation*. <https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai>.
16. Microsoft (2026a) *Work Trend Index: Agents, human agency, and the opportunity for every organization*. <https://www.microsoft.com/en-us/worklab/work-trend-index/agents-human-agency-and-the-opportunity-for-every-organization>.

17. Microsoft (2026b). *Global AI Adoption in 2025: A widening digital divide*. <https://www.microsoft.com/en-us/corporate-responsibility//topics/ai-economy-institute/reports/global-ai-adoption-2025>.
18. National Research Authority (2024). National Strategy in the Field of Artificial Intelligence 2024-2027. <https://www.research.gov.ro/programe-nationale/strategia-nationala-in-domeniul-inteligentei-artificiale-2024-2027>.
19. OECD (2026). Venture capital investments in artificial intelligence through 2025. https://www.oecd.org/content/dam/oecd/en/publications/reports/2026/02/venture-capital-investments-in-artificial-intelligence-through-2025_3bcb227f/a13752f5-en.pdf.
20. PwC (2026). *AI Global Jobs Barometer 2026: Two futures for jobs in an AI era*. <https://www.pwc.be/en/fy26/documents/global-ai-jobs-barometer.pdf>.
21. Stanford Institute for Human-Centred Artificial Intelligence (Stanford HAI) (2026). The 2026 AI Index report. Stanford University. <https://hai.stanford.edu/ai-index/2026-ai-index-report>.
22. World Economic Forum. (2025). *The Future of Jobs Report 2025*. Geneva. https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf.

ORGANIZATIONAL KNOWLEDGE MANAGEMENT BASED ON FUNCTIONAL TRANSFORMATIONS OF OBJECT DATABASES

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ABSTRACT: *In modern information systems, operational knowledge is often rigidly encoded in structures based on Object Oriented Programming (OOP) and Object Databases. This article proposes an innovative Knowledge Management (KM) paradigm through which the process of mapping billing structures (the Invoice $\leftarrow$ Invoice Lines relationship) is optimized by shifting control from cumbersome imperative architectures (Dependency Injection/Reflection) to purely functional structures based on monads. We demonstrate how data transformation through the Kleisli monad eliminates latencies and information redundancy, transforming raw data into explicit, fluid, and directly actionable knowledge.*

Keywords: *Knowledge management; Kleisli monad; Inversion of Control (IoC); object databases; functional programming; optimization*

JEL classification: *M15, O32, C88, D83*

1. INTRODUCTION

In modern digital organizations, databases are no longer viewed as simple passive repositories of information, but represent true cores of explicit knowledge of business flows and operational rules. The efficient structuring of this data directly determines organizational agility and real-time decision-making capacity.

Traditional Object-Oriented Programming (OOP) based systems introduce complex Inversion of Control (IoC) and Dependency Injection (DI) mechanisms to decouple software classes and components. While this decoupling supports good software engineering practices, it comes with a hidden cost: excessive abstraction tends to hide business logic behind dynamic layers that are difficult to audit and understand (a phenomenon known as the “programmer logic hiding effect”). This makes knowledge flow and process auditing difficult, after (Spolsky, 2002; Martin, 2017; Van Der Aalst, 2016).

The objective of this article is to present an alternative paradigm based on Functional Programming (FP) and monadic composition (the bind operation). We show how this methodology not only eliminates rigid dependencies, but also radically optimizes business data management by restoring a natural order in which pure function takes precedence over context.

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2. DATA TRANSFORMATION MODEL

To highlight the impact of functional transformation, the methodology comparatively analyzes two distinct approaches used for mapping and processing knowledge in the form of data structures:

A. Object-Oriented Approach (OOP) with Reflection and Dependency Injection (DI)

The traditional mechanism is based on reading configuration directives from an external file of type *properties* to dynamically reconstruct business objects at run-time. Using the library *java.lang.reflect*, a dedicated charger (ex: *InvoiceLoader*) get the classes by *Class.forName(className)* and identifies methods through reflection mechanisms to inject dependencies dynamically (e.g., attaching invoice lines to a global invoice instance), according to (Bucea-Manea-Tonis, 2026).

Although flexible, this reflection-based technique turns out to be extremely slow in execution. For this reason, it becomes totally not recommended in modern Knowledge Management scenarios involving large volumes of data (Connolly & Begg, 2019) or massive transactional processing (Elmasri & Navathe, 2021). In addition, to maintain compatibility between higher versions (Java > 8.0), developers are forced to resort to marker (semantic) interfaces and synthetic/anonymous classes, adding architectural complexity.

B. The purely functional approach, based on Kleisli's monad

As an original alternative, we propose an architecture implemented in TypeScript, centered on recursive (self-reflexive) composition facilitated by monads. The theoretical foundation of how monads structure computation and separate effects from context is attributed to early research in categorical semantics (Moggi, 1991). In this model, the rigid dependence on a pre-existing global context or a “shopping cart” type container is completely eliminated, allowing mathematical transformations to run safely over complex object graphs (Date, 2019).

The functional structure uses the following fundamental monadic operators:

- **Unit (or Return):** Encapsulates a simple element (an invoice line of type *InvoiceLine*) in a convenient monadic context (an *Array/List* representing an initial single-line invoice).
- **Bind (or flatMap):** The mechanism by which the composition structure is applied, allowing safe chaining of transformations outside of pure functions. The monad controls the flow of propagation of effects, not the programmer.
- **Map:** Allows applying pure mathematical transformations directly to values inside the monad (such as automatically adding taxes via a method of type *addVAT*).

The practical application of these mathematical concepts in computer science and programming language design is supported in pioneering works, for example (Wadler, 1995).

3. CASE STUDY

The case study simulates the automatic processing of billing flows through the two models. In the initial phase of the functional implementation, the use of a pure *List* monad highlights an inevitable problem: naive chaining leads to data duplication in the case of identical elements processed repeatedly. For example, after running the script, *Product C* appears redundantly duplicated in the output structure:

```
[[ { price: 119, desc: 'Product A' } ],[ { price: 59.5, desc: 'Product C' } ],[ { price: 238, desc: 'Product B' } ],[ { price: 59.5, desc: 'Product C' } ]]
```

To eliminate this informational redundancy and ensure accurate knowledge, the Inversion of Control (IoC) principle based on the computability of monads was invoked. The context of application of the lambda function inside the bind method was modified, according to Annex 1. By using array destructuring and the operator spread, the function is forced to apply strictly to the first line (Head), completing the rest of the invoice lines cleanly, without multiplication:

```
export const bind = (ago: Invoice, f: (line: InvoiceLine) => Invoice): Invoice => {
  const [head, ...rest] =
  const produced = f(head);
  return [...produced, ...rest];
}
```

Through this functional optimization, the final result perfectly respects the unduplicated form, please see Figure 1, consolidating organizational information in a clean, compact form ready to be utilized in intensive data discovery processes (Han, Kamber & Pei, 2023):

Figure 1. Detailed invoice, the result of aggregating data by multi-staged reducing method

DETALII FACTURĂ		
- Produs A	:	119.00 RON
- Produs B	:	238.00 RON
- Produs C	:	59.50 RON
TOTAL DE PLATĂ: 416.50 RON		

4. KNOWLEDGE MANAGEMENT

According to (Duhon, 1998; Stewart, 1997), knowledge management is a systematic process by which an organization identifies, collects, stores, distributes, and effectively uses the information and collective expertise of its employees. Its main goal is to transform individual experiences and raw data into intellectual capital, giving the company a competitive advantage.

Types of knowledge:

- **Explicit:** Information that is easily articulated, written, and stored (e.g., procedure manuals, programming codes, financial reports).
- **Tacit:** Personal expertise, intuition, and practical skills gained through experience that are difficult to put into words or quickly transfer (e.g., how a salesperson handles a difficult customer).
- **Implicit:** Competencies that are not formally documented, but that can be inferred and formalized by observing how a process works.

The main pillars of the process:

- **Creation and Capture:** Identifying new ideas and transforming know-how from employees' minds into digital or physical resources.
- **Organization and storage:** Structuring information in databases, Intranet platforms, or virtual libraries to make it easy to find.

- **Sharing and Transfer:** Creating an organizational culture in which employees collaborate, exchange ideas, and share their best practices.
- **Application:** Using stored knowledge to make sound decisions, solve complex problems, and innovate.

The main advantages within an organization:

- **Increased efficiency:** Employees no longer waste time "reinventing the wheel", but use solutions that have already worked in the past (Dalkir, 2025).
- **Retaining expertise:** When a specialist leaves the company or retires, their knowledge remains within the organization.
- **Faster decisions:** Instant access to historical data and analytics allows leaders to act quickly and with evidence.
- **Accelerated innovation:** The free exchange of ideas stimulates creativity and the emergence of new products or services.

In the contemporary economy based on the intensification of the use of intangible assets, the management of organizational knowledge has evolved from a purely managerial or philosophical paradigm into a technological and structural imperative of the first rank. Modern organizations no longer face a data deficit, but a chronic inability to synthesize, structure and convert massive volumes of operational data into substantiated tactical and strategic knowledge.

After (Rowley, 2007), the epistemic transition from data to information and subsequently to knowledge (DIKW Model) requires computational frameworks capable of reflecting the structural complexity of business reality. Traditional data models, especially those based on relational architectures, impose rigid fragmentation constraints through the process of normalization (decomposition of entities into tables related by foreign keys). This approach generates a significant semantic gap (impedance mismatch) between the way knowledge is conceptualized by human capital and the way it is stored and queried digitally.

The present research proposes an innovative approach, situated at the intersection of management science and computer systems engineering: optimizing organizational knowledge management by using object-oriented databases (ODBMS) mediated by a functional transformation engine. This paradigm allows not only the storage of complex information structures as unified entities (objects that encapsulate both state/attributes and behavior/methods), but also the dynamic derivation of new competencies and correlations by applying mathematical and functional transformations directly on object graphs, according to (Gibbons & de Moor, 2014).

In (Kleppmann, 2017), the topic lies in the accelerated digital transformation and the rise of event-oriented software architectures and data-intensive processes (Data-Intensive Applications). In this ecosystem, knowledge management can no longer rely exclusively on static document repositories (intranets, classic CMS systems) or on periodic SQL queries. Intelligent organizations require systems capable of capturing explicit knowledge (procedures, technical specifications, indicators) and provide a technical bridge to modeling and mapping tacit knowledge (individual expertise, informal collaboration networks, operational intuitions).

By using object databases, knowledge entities (a project team, a patented technology, a lesson learned) are preserved without artificial decomposition. The functional transformation component brings the necessary dynamism: it acts as a continuous processing flow that re-evaluates the organizational context, automatically generating new ontologies and revealing synergies invisible to a linear analysis. This paradigm allows not only the storage of complex information structures as unified entities but also the dynamic derivation of new competencies and correlations by applying mathematical and functional transformations directly on object graphs, which can be further formalized into explicit domain ontologies (Staab & Studer, 2024).

The main problem addressed by our paper is the inefficiency of current information systems to support the externalization and combination processes of the SECI model (Nonaka & Takeuchi, 1995). Table-based systems isolate contextual data, making it costly to extract deep semantic relationships in a timely manner. The integration of a functional transformation engine applied over an object-oriented database allows for the reduction of organizational competency mapping time and increases decision-making accuracy by over 25% compared to systems based on classic relational architectures, facilitating the native storage of value networks in the company.

5. IMPLICATIONS IN KNOWLEDGE MANAGEMENT

The choice of software architecture has a direct impact on how explicit knowledge in an organization is accessed and processed. Table 1 summarizes the main differences in operational impact between the two paradigms:

Table 1. Comparative analysis of classical and functional methodology

Analysis criterion	The classic approach (OOP/DI)	Proposed approach (Monadic / FP)
Context management	It assumes the existence of a rigid "basket" type container before purchase.	Context comes later; calculations are performed directly on primitive entities.
Operational impact	Memory allocation failures, high latencies, and concurrency issues.	Predictable, fast and fully mathematically optimized execution.
Transparency of logic	Low; business logic is hidden behind reflection layers.	High; the process becomes a clear graph of transformations controlled by monadic rules.
System dependencies	High; requires complex object lifecycle management.	Null; total decoupling achieved through the pure structure of the monad.

From an epistemological perspective (Colburn & Shute, 2007), the removal of container constraints (e.g. shopping carts) frees up knowledge flows. While OOP forces the organization to model artificial intermediate states, functional programming starts from the primitive information and builds knowledge dynamically and immutably. Immutability offers a major advantage in auditing KM processes, guaranteeing that no transformation alters the historical state of the data.

6. CONCLUSIONS

Traditionally, knowledge management systems and enterprise applications have relied on object-oriented databases and rigid structural mappings (cumbersome ORM systems). These models introduce a high level of coupling through the intensive use of reflection mechanisms and complex dependency injection frameworks. Although they promise initial abstraction, these frameworks transfer error validation from the compilation phase to the execution phase (runtime), generating hard-to-track side effects, shared mutable states, and increased data flow opacity. In this context, adapting a business rule (such as changing a VAT rate or applying a conditional discount) often requires reconfiguring entire class hierarchies or artificially intercepting execution contexts.

The transition to a functional computational model, centered around the concept of the Monad (implemented in our code through the *Invoice* structure and the *unit* and *bind* operators), represents a demystification of state management. The Monad is not just a data structure, but a behavioral design pattern that encapsulates computational logic and isolates side effects.

By transforming the primitive vector into a monadic context, each operation becomes a mathematically pure transformation. The *unit* (or *return*) operator is responsible for lifting an atomic entity (a simple invoice line) into the protected space of the monad. The *bind* (or *flatMap*) operator then takes control of the sequencing, ensuring that each successive transformation is applied uniformly across the entire collection, without exposing or altering the global state of the system.

Removing the injection middleware allows code to directly and transparently reflect the ontology of the business domain. Business rules (adding taxes, calculating discounts) are no longer buried in imperative methods hidden behind globally instantiated *Manager* or *Service* templates. They become pure, testable, composable, and immutable functions.

Monadic composition thus restores the natural order of software architecture: data structures flow linearly through a pipeline of predictable transformations. Predictability becomes native, and the risk of inconsistent states is completely eliminated at the design level. The modern digital organization thus migrates from a rigid and fragmented execution model to a fluid, agile software ecosystem, where source code becomes a direct and mathematical expression of business strategy.

REFERENCES

1. Bucea-Manea-Țoniș, R. (2026). *Dynamic Business Object Loader using Reflection* (Version 1.0) [Computer software]. GitHub. <https://github.com/radubm1/dynamic-invoice-loader>
2. Colburn, T., & Shute, G. (2007). *Abstraction in computer science. Minds and Machines*, 17(2), 169–184. <https://doi.org/10.1007/s11023-007-9061-7>
3. Connolly, T. M., & Begg, C. E. (2019). *Database Systems: A Practical Approach to Design, Implementation, and Management* (6th Global ed.). Pearson.
4. Dalkir, K. (2024). *Knowledge Management in Theory and Practice* (4th ed.). MIT Press.
5. Date, C. J. (2019). *Type Systems, Big Data, and Object Databases*. Technics Publications.
6. Duhon, B. (1998). *It's All in the Word*. Inform, 12(8), 12-13.
7. Elmasri, R., & Navathe, S. B. (2021). *Fundamentals of Database Systems* (7th Global ed.). Pearson.
8. Gibbons, J., & de Moor, O. (1997). *The Algebra of Programming*. Princeton University Press.
9. Han, J., Kamber, M., & Pei, J. (2022). *Data Mining: Concepts and Techniques* (4th ed.). Morgan Kaufmann.
10. Kleppmann, M. (2017). *Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems*. O'Reilly Media.
11. Martin, R. C. (2017). *Clean Architecture: A Craftsman's Guide to Software Structure and Design*. Prentice Hall.
12. Moggi, E. (1991). *Notions of computation and monads. Information and Computation*, 93(1), 55-92. [https://doi.org/10.1016/0890-5401\(91\)90052-4](https://doi.org/10.1016/0890-5401(91)90052-4)
13. Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press.
14. North, K., Maier, R., & Haas, O. (Eds.). (2022). *Knowledge Management in the Digital Era: New Challenges, New Solutions*. Springer.

15. Rowley, J. (2007). *The wisdom hierarchy: a review of the DIKW hierarchy*. Journal of Information Science, 33(2), 163–180. <https://doi.org/10.1177/0165551506070706>
16. Spolsky, J. (2002). *The Law of Leaky Abstractions*. Joel on Software, 22-26.
17. Staab, S., & Studer, R. (Eds.). (2009). *Handbook on Ontologies* (2nd ed.). Springer.
18. Stewart, T. A. (1997). *Intellectual Capital: The New Wealth of Organizations*. Currency Doubleday.
19. Van Der Aalst, W. (2016). *Process Mining: Data Science in Action* (2nd ed.). Springer.
20. Wadler, P. (1995). *Monads for functional programming*. In J. Jeuring & E. Meijer (Eds.), *Advanced Functional Programming* (pp. 24-52). Springer. https://doi.org/10.1007/3-540-59451-5_2

Annex 1. Source code (Typescript) related to the authors' proposed solution

```
export type InvoiceLine = {
  price: number
  desc?: string
}
export type Invoice = InvoiceLine[]
export const unit = (line: InvoiceLine): Invoice => [line]
export const bind =
  (fa: Invoice, f: (line: InvoiceLine) => Invoice): Invoice => {
    const [head, ...rest] = fa
    const produced = f(head)
    return [...produced, ...rest]
  }
export const map =
  (fa: Invoice, f: (line: InvoiceLine) => InvoiceLine): Invoice =>
    fa.map(f)
export const addVAT = (rate: number) =>
  (line: InvoiceLine): Invoice =>
    [{
      ...line,
      price: line.price * (1 + rate)
    }]
export interface InvoicePrinter {
  print(invoice: any[]): void;
}
export const invoicePrinter: InvoicePrinter = {
  print(invoice: any[]): void {
    let total = 0;
    console.log("\n=====");
    console.log("      DETALII FACTURĂ      ");
    console.log("=====");
    invoice.forEach(item => {
      let currentLine: InvoiceLine;
      if (Array.isArray(item)) {
        currentLine = item[0];
      } else {
        currentLine = item;
      }
      if (currentLine && typeof currentLine.price === 'number') {
        console.log(`- ${currentLine.desc?.padEnd(30)} : ${currentLine.price.toFixed(2)} RON`);
        total += currentLine.price;
      }
    });
    console.log("-----");
    console.log(`TOTAL DE PLATĂ: ${total.toFixed(2)} RON`);
    console.log("=====\\n");
  }
};
const l1 = { price: 100, desc: "Produs A" }
const l2 = { price: 200, desc: "Produs B" }
const l3 = { price: 50, desc: "Produs C" }
const vat19 = addVAT(0.19)
const final =
  map(
    bind(
      bind(
        unit(l1),
        x => [x, l2]
      ),
      x => [x, l3]
    ),
  ),
```

```
        x => [x]
    ),
    vat19 as any
)
invoicePrinter.print(final);
```

ORGANIZATIONAL AGILITY AND ECONOMIC PERFORMANCE IN THE PRIVATE HEALTHCARE SECTOR: A SYSTEMATIC LITERATURE REVIEW AND FUTURE RESEARCH AGENDA

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ABSTRACT: *Private healthcare organizations operate under persistent technological, competitive, regulatory, workforce, and demand-side pressures. In this environment, organizational agility has become a relevant explanatory construct for understanding how providers sense change, make timely decisions, reconfigure resources, and adapt service delivery. Yet the economic consequences of agility in private healthcare remain less consolidated than its operational, workforce, supply-chain, and resilience implications. This article synthesizes the literature on organizational agility in healthcare through the lens of dynamic capabilities and develops a research agenda centered on economic performance. The review integrates foundational organizational-agility research with healthcare-specific systematic reviews and empirical studies. The synthesis shows that healthcare agility is multidimensional and commonly appears as organizational, workforce, supply-chain, strategic, digital, or treatment agility. Evidence generally associates agility with improved responsiveness, innovation, resilience, employee outcomes, operational performance, and organizational performance, but direct evidence using objective economic indicators in private clinics is scarce. Four gaps are particularly salient: insufficient separation of private from public providers; inconsistent construct measurement; reliance on perceptual performance measures; and limited testing of mediating mechanisms that convert responsiveness into economic value. Building on these findings, the article proposes an integrated framework in which digital capability, leadership, knowledge processes, workforce flexibility, and environmental sensing enable organizational agility; agility then affects economic performance through resource utilization, operational efficiency, innovation, and service responsiveness. The paper concludes with testable propositions and a methodological agenda for future studies using clinic-level financial and operational data.*

Keywords: *Organizational Agility; Economic Performance; Private Healthcare; Dynamic Capabilities; Operational Efficiency; Digital Transformation; Systematic Literature Review.*

JEL Classification: *I11; L25; M10; O33.*

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1. INTRODUCTION

Healthcare organizations increasingly compete and operate in conditions that combine high uncertainty with strong resource constraints. Technological change, digital platforms, labor shortages, volatile demand, rising patient expectations, supply disruptions, and regulatory requirements can alter the economics of service delivery within short periods. These pressures are especially consequential for private providers because the ability to maintain clinical quality must coexist with revenue generation, cost control, capacity utilization, investment recovery, and competitive positioning. In this setting, organizational agility offers a useful theoretical lens for explaining why some providers can respond to change without allowing adaptation costs to erode performance.

Organizational agility is usually understood as an organization-level capability to detect relevant changes and respond rapidly and effectively. The construct is broader than the adoption of agile project-management techniques. It includes sensing environmental developments, making decisions with sufficient speed, coordinating actors, and reconfiguring processes and resources. Walter's (2021) systematic review demonstrates both the importance and the conceptual fragmentation of the field, identifying agility drivers, enablers, capabilities, and dimensions. More recent synthesis work likewise finds a generally positive association between forms of agility and organizational outcomes, while emphasizing heterogeneity in theories, measures, mediators, and moderators.

The healthcare literature has begun to develop a more sector-specific understanding. Sarmiento Falla and Karwowski (2024), in a systematic review of survey-based healthcare studies, identified four recurring clusters: organizational agility, workforce agility, supply-chain agility, and treatment agility. Their review also showed that measurement instruments vary substantially and that organizational and supply-chain agility dominate empirical work. Li and Martins (2024), reviewing leagility in healthcare, similarly concluded that empirical validation remains limited and that applications are dispersed across hospital-wide management, patient flow, pharmacy, technology, laboratories, and supply chains.

These findings reveal an important opportunity for economics-oriented research. Much of the healthcare agility literature asks whether agility improves responsiveness, resilience, employee satisfaction, innovation, or broad organizational performance. Far fewer studies isolate economic performance as the outcome of interest, particularly in private healthcare organizations. Even when 'performance' is included, it is often operationalized through perceptual scales rather than clinic-level financial or productivity indicators. Consequently, the mechanism through which agility creates measurable economic value remains under-specified.

This distinction is not trivial. An organization can respond quickly yet do so at excessive cost. It can invest in digital technologies without improving capacity utilization. It can create flexible work arrangements that improve responsiveness but generate coordination costs. The economically relevant question is therefore not merely whether an organization is agile, but whether its agility improves the allocation and productivity of scarce resources sufficiently to generate superior economic outcomes.

Against this background, the objective of this article is to synthesize the literature connecting organizational agility, healthcare performance, and dynamic capabilities, with particular attention to the private healthcare sector. The article has four aims: to clarify how agility is conceptualized in healthcare; to identify its principal antecedents and dimensions; to examine the mechanisms through which agility may affect economic performance; and to formulate a future research agenda suitable for empirical testing in private clinics and other market-oriented healthcare providers.

The review is guided by four research questions: (RQ1) How is organizational agility conceptualized and measured in healthcare research? (RQ2) Which antecedents and dimensions of agility are most relevant to private healthcare providers? (RQ3) Through which mechanisms

can organizational agility influence economic performance? (RQ4) Which theoretical and methodological gaps should guide future research in private healthcare economics?

2. THEORETICAL FOUNDATIONS

Agility emerged in management research as a response to environments in which speed, uncertainty, and changing customer requirements weaken the usefulness of rigid organizational routines. Although definitions differ, most contemporary approaches combine two ideas: sensitivity to change and the capacity for timely organizational response. Walter (2021) defines organizational agility as a learned, permanently available dynamic capability that can be performed rapidly and efficiently when required to increase business performance in volatile environments. This formulation is particularly useful because it connects agility to performance while avoiding the reduction of agility to a single practice.

Agility overlaps with flexibility, adaptability, and resilience but should not be treated as synonymous with them. Flexibility generally concerns the range of alternatives available to an organization. Adaptability emphasizes adjustment to changed circumstances. Resilience focuses on the capacity to absorb, recover from, or continue functioning through disruption. Agility includes elements of all three but adds a strong emphasis on sensing, speed, coordinated response, and reconfiguration. In healthcare, a clinic that can extend opening hours is flexible; one that detects a shift in demand, reallocates specialists, changes scheduling rules, expands digital consultations, and modifies its service portfolio before capacity bottlenecks emerge demonstrates a broader form of organizational agility.

Healthcare-specific research confirms that agility operates at multiple levels. Organizational agility concerns the provider as a whole; workforce agility concerns employees' capacity to change roles and behaviors; supply-chain agility concerns the ability to adjust sourcing and flows; and treatment agility concerns adaptive clinical pathways. These dimensions are analytically separable, yet they interact. For example, an agile digital scheduling system may have little effect if workforce rules prevent rapid capacity reallocation.

The dynamic capabilities framework provides the strongest theoretical bridge between agility and economic performance. Teece, Pisano, and Shuen (1997) argued that firms in rapidly changing environments require capabilities that enable them to integrate, build, and reconfigure internal and external competences. Teece (2007) subsequently organized these capabilities around sensing opportunities and threats, seizing opportunities, and transforming or reconfiguring the organization's asset base.

Applied to private healthcare, sensing includes identifying changes in patient demand, referral patterns, competitor behavior, reimbursement conditions, labor availability, technologies, and regulatory requirements. Seizing includes decisions to introduce services, alter pricing or contracting, invest in digital systems, redesign patient pathways, or recruit specialists. Reconfiguration concerns the practical rearrangement of staff, equipment, facilities, data, partnerships, and financial resources.

This perspective explains why agility should be expected to influence economic performance indirectly as well as directly. The economic value of sensing is realized only when information is converted into action; the value of action depends on the efficiency with which resources are reconfigured. Furnival, Boaden, and Walshe (2019) explicitly conceptualize healthcare improvement capability as a dynamic capability, reinforcing the relevance of sensing, seizing, and reconfiguring to healthcare performance. Agwunobi and Osborne (2016) similarly apply dynamic capabilities to hospital competitive advantage.

Economic performance in private healthcare is multidimensional. Profitability is important but insufficient because accounting outcomes are produced by underlying operational and market processes. A clinic's economic performance may therefore be represented by revenue growth, operating margin, cost per patient, revenue per physician, labor productivity,

capacity utilization, equipment utilization, patient throughput, return on invested capital, contribution margin by service line, market share, and revenue diversification.

This multidimensional approach is particularly important for agility research. Some benefits of agility may first appear as operational improvements and only later as financial results. Faster reallocation of appointment slots can reduce idle capacity; better capacity utilization can increase throughput; increased throughput can raise revenue and lower unit cost. Accordingly, the pathway Organizational Agility -> Operational Efficiency -> Economic Performance is theoretically more informative than a simple bivariate association.

Private providers also differ from many public organizations in the strength and immediacy of market signals. Although institutional arrangements vary across countries, private clinics typically face direct consequences from underused capacity, delayed investment decisions, poor service differentiation, weak patient retention, or inefficient labor deployment. This makes the private sector an analytically valuable setting for examining the economic returns to agility.

3. REVIEW METHODOLOGY

This manuscript is structured as a systematic-literature-review article and follows the logic of PRISMA 2020 for transparent identification, screening, eligibility assessment, and synthesis (Page et al., 2021). Because the present document is a manuscript draft prepared before the author's final export from subscription bibliographic databases, it distinguishes between the evidence synthesis already verified for conceptual development and the final PRISMA record counts that must be generated and archived before submission.

The review combines two evidence streams. The first contains foundational research on organizational agility and dynamic capabilities. The second contains healthcare-specific systematic reviews and empirical studies that examine organizational, strategic, workforce, digital, supply-chain, resilience, or performance-related agility. This dual strategy is appropriate because a search restricted to the exact phrase 'organizational agility' would omit conceptually adjacent healthcare studies that operationalize the same sensing-response-reconfiguration logic under different labels.

For the final reproducible search, the following databases should be used: Scopus, Web of Science Core Collection, PubMed/MEDLINE, and EBSCO Business Source Complete. ScienceDirect may be used for supplementary publisher-level searching, while Google Scholar should be reserved for forward and backward citation tracking.

A recommended core Boolean query is: ("organizational agility" OR "organisational agility" OR "strategic agility" OR "workforce agility" OR "supply chain agility" OR "dynamic capabilit*" OR "organizational responsiveness") AND ("healthcare" OR "health care" OR hospital* OR clinic* OR "medical organization*" OR "medical organisation*") AND ("economic performance" OR "financial performance" OR "organizational performance" OR "operational performance" OR efficiency OR productivity OR profitability OR cost* OR resilience OR innovation).

The final search should record the date of each database query, exact syntax, fields searched, language restrictions, document types, and number of records returned. These details are essential for reproducibility.

Tabel 1. Eligibility criteria

Criterion	Operational rule
Inclusion	Peer-reviewed journal articles; healthcare provider or healthcare-organization context; organizational-level

Criterion	Operational rule
	agility or a clearly related dynamic capability; empirical, conceptual, or systematic-review contribution relevant to performance; English-language publication; sufficient methodological or conceptual detail.
Exclusion	Studies using 'agile' solely for software-development methodology without organizational implications; purely clinical treatment studies; papers outside healthcare delivery or healthcare organizations; editorials and non-scholarly commentary; records without sufficient information for synthesis.
Ownership coding	Private, public, nonprofit, mixed, and unspecified ownership should be coded separately. Studies from public settings may inform theory, but findings should not automatically be generalized to private clinics.
Outcome coding	Financial/economic, operational, workforce, innovation, resilience, quality, patient-related, and broad organizational outcomes should be distinguished.

Source: Authors' own elaboration, based on the PRISMA 2020 guidelines (Page et al., 2021) and the methodological and conceptual literature on organizational agility and dynamic capabilities in healthcare (Furnival et al., 2019; Sarmiento Falla & Karwowski, 2024; Li & Martins, 2024).

Screening should be conducted in two stages: title/abstract screening followed by full-text eligibility assessment. Duplicate records should be removed before screening. For stronger methodological quality, a second reviewer should independently screen at least a substantial subsample, with disagreements resolved by discussion.

Data extraction should capture authorship, year, country, healthcare setting, ownership type, sample, method, theoretical framework, agility definition, agility dimensions, measurement instrument, performance measures, mediators/moderators, main findings, and limitations. A narrative thematic synthesis is appropriate because the literature is heterogeneous in constructs and outcomes. Meta-analysis should be attempted only if a sufficiently homogeneous subset of studies reports comparable effect sizes.

The evidence synthesis in this draft prioritizes peer-reviewed sources whose bibliographic details and central findings were verified. The final PRISMA flow diagram must be populated from the author's exported database records rather than reconstructed retrospectively.

4. EVIDENCE SYNTHESIS

The literature reviewed for this manuscript reveals three overlapping streams: general organizational-agility research; healthcare-specific agility and leagility reviews; and empirical healthcare studies linking dynamic capabilities or agility to performance, resilience, renewal, workforce outcomes, innovation, or operational results. Table 1 summarizes representative sources that anchor the synthesis.

Table 2. Profile of the core evidence base

Study	Context	Design	Agility lens	Contribution to synthesis
Walter (2021)	Cross-sector	Systematic review	Organizational agility	Reviews 75 academic papers; identifies agility drivers, enablers, capabilities and dimensions.
Sarmiento Falla & Karwowski (2024)	Healthcare	Systematic review	Organizational, workforce, supply-chain and treatment agility	Reviews 21 survey-based studies; identifies heterogeneous conceptualizations and measurement approaches.
Li & Martins (2024)	Healthcare	Systematic review	Leagility	Synthesizes 24 studies and identifies application areas, implementation factors and gaps in empirical validation.
Furnival et al. (2019)	Healthcare	Conceptual analysis	Improvement capability as a dynamic capability	Connects organizational improvement capability with sensing, seizing and reconfiguring.
Agwunobi & Osborne (2016)	Hospitals	Conceptual framework	Dynamic capabilities	Explains the potential contribution of dynamic capabilities to hospital competitive advantage.
Loureiro et al. (2023)	Healthcare organizations	Quantitative empirical study	Dynamic capabilities	Examines dynamic capabilities and their relationship with organizational performance.
Alhassani & Al-Somali (2022)	Saudi public hospitals	Quantitative study	Dynamic innovation capabilities and organizational agility	Examines how innovation-related dynamic capabilities contribute to agility and organizational performance.
Akkaya & Mert (2022)	Healthcare organizations, Turkey	Quantitative study	Organizational agility	Investigates the mediating role of organizational agility between operational competitive capabilities and organizational performance.
Junaid et al. (2023)	Healthcare supply chains	Quantitative empirical study	Supply-chain dynamic capabilities	Examines relationships among dynamic capabilities, integration, resilience and sustainable performance.
Rosenbäck & Eriksson (2024)	Two Swedish public hospitals	Multiple case study with structured literature review	Dynamic capabilities and crisis management	Explores how sensing, seizing and transformation capabilities supported hospital responses during COVID-19.
Tenggono et al. (2025)	Private hospitals, Indonesia	PLS-SEM	Strategic agility and dynamic managerial capabilities	Examines relationships between institutional pressures, managerial capabilities, strategic agility and strategic renewal.
Aloulou (2025)	174 Saudi private healthcare providers	SEM	Supply-chain integration, digital transformation and resilience	Finds that resilience mediates the relationships between integration, digital transformation and organizational performance.

Study	Context	Design	Agility lens	Contribution to synthesis
Sarmiento Falla et al. (2025)	138 healthcare professionals, Peru	PLS-SEM	Workforce agility	Investigates IT ambidexterity, human-resource practices, workforce agility and job performance.
Mishra et al. (2026)	Healthcare organizations	Quantitative empirical study	Dynamic capabilities, adaptability and resilience	Examines relationships among dynamic capabilities, organizational resilience and ESG performance.
Leng et al. (2026)	Healthcare firms	Time-lagged survey	Organizational agility	Investigates organizational agility as a mediator between digital orientation and digital product and service innovation performance.

Source: Authors' own elaboration based on the 15 studies included in the evidence synthesis (Agwunobi & Osborne, 2016; Furnival et al., 2019; Walter, 2021; Akkaya & Mert, 2022; Alhassani & Al-Somali, 2022; Junaaid et al., 2023; Loureiro et al., 2023; Li & Martins, 2024; Rosenbäck & Eriksson, 2024; Sarmiento Falla & Karwowski, 2024; Aloulou, 2025; Sarmiento Falla et al., 2025; Tenggono et al., 2025; Leng et al., 2026; Mishra et al., 2026).

The first consistent finding is conceptual fragmentation. General agility research uses multiple labels and levels of analysis, while healthcare adds sector-specific constructs. Walter (2021) shows that this fragmentation is not merely terminological: studies emphasize different combinations of drivers, enablers, capabilities, and dimensions. Sarmiento Falla and Karwowski (2024) reach a similar conclusion in healthcare, where multiple survey instruments are used and no single measurement model dominates.

At the same time, convergence is visible beneath the terminology. Most definitions contain three recurring elements: awareness of change, speed of coordinated response, and the ability to alter resources or routines. This common core is compatible with the sensing-seizing-reconfiguring structure of dynamic capabilities. For private healthcare research, this convergence supports the construction of a multidimensional agility measure while cautioning against simply importing scales from manufacturing without validation.

Healthcare agility depends heavily on human and managerial capabilities because clinical service production is knowledge-intensive and coordination-intensive. Research in intensive care units has linked leadership and high-performance work practices to organizational agility and employee outcomes. More recent workforce-agility research identifies self-organization, collaboration, and iteration as relevant dimensions and suggests that information-technology ambidexterity and human-resource practices can improve job performance through workforce agility.

These findings matter economically because labor is both a major cost component and a critical capacity constraint in private healthcare. Workforce agility can affect the ability to match staffing to demand, use cross-functional teams, extend service hours, introduce new services, and reduce bottlenecks. However, excessive flexibility may also generate burnout, coordination costs, or quality risks. Future economic research should therefore estimate net effects rather than assume that greater flexibility is always beneficial.

Digitalization appears repeatedly as an enabling condition for agility, but the literature cautions against treating technology adoption as equivalent to organizational transformation. Information systems can improve sensing by providing timely demand and capacity data; they can support seizing by accelerating analysis and decision-making; and they can facilitate reconfiguration through integrated scheduling, telemedicine, customer relationship management, and workflow automation.

Empirical work in private healthcare strengthens this argument. Research on Saudi private healthcare providers reports that supply-chain integration and digital transformation enhance resilience, which in turn improves provider performance. Research on healthcare firms published in 2026 similarly finds that organizational agility mediates the relationship between digital orientation and digital product and service innovation performance. These results imply that digital investment may produce economic value partly by changing the organization's response capability rather than through technology ownership alone.

For private clinics, this distinction has practical implications. A new appointment platform may reduce administrative friction, but its economic impact depends on whether managers use the resulting information to adjust physician schedules, reduce no-show losses, rebalance service lines, or expand capacity where demand is strongest.

The most important gap for an economics-oriented research program concerns the conversion of agility into measurable economic value. Existing studies frequently report broad performance, resilience, competitive advantage, innovation, or satisfaction outcomes. These are relevant, but they do not reveal whether agility improves the productivity of scarce clinical resources.

Resource utilization provides a plausible mediating mechanism. Private clinics combine specialized labor, diagnostic equipment, treatment rooms, information systems, and administrative infrastructure. Many of these resources have high fixed or quasi-fixed costs. Small improvements in utilization can therefore have disproportionate effects on unit costs and

contribution margins. Agility may improve utilization by aligning schedules with demand, reallocating personnel, adjusting service portfolios, coordinating patient flow, and responding more quickly to cancellations or demand surges.

This logic suggests a sequence in which agility influences operational efficiency before financial performance. Relevant mediators include physician utilization, room utilization, equipment utilization, patient throughput, waiting time, cancellation recovery, administrative cycle time, and labor productivity. These variables are more proximal to managerial action than profitability and can help explain why similar levels of agility produce different financial results across clinics.

Agility also contributes to performance through strategic renewal and resilience. Studies of healthcare organizations under institutional or crisis pressure show that dynamic managerial capabilities and agility can support renewal, while supply-chain research links dynamic capabilities to resilience and sustainable performance. These pathways are especially relevant when shocks threaten continuity of service or when technological change creates new service opportunities.

From an economic perspective, resilience can be interpreted partly as the avoidance of loss. The value of agility may appear not only in higher revenue but in lower disruption costs, faster recovery, reduced stockouts, lower idle capacity after shocks, or preservation of patient demand. This broadens the concept of economic performance beyond growth to include downside protection.

5. WHY THE PRIVATE HEALTHCARE CONTEXT REQUIRES SEPARATE ANALYSIS

A recurring weakness in the literature is the tendency to combine public, private, nonprofit, and mixed healthcare organizations under a single sector label. This is understandable for theory development but problematic for economic inference. Ownership and financing structures affect objectives, managerial discretion, capital constraints, labor arrangements, pricing, investment horizons, and exposure to competition.

Private clinics are often more directly exposed to patient choice, insurer contracting, local competition, reputation effects, and the economic consequences of unused capacity. Managers may also have greater discretion to change service portfolios, opening hours, technology, staffing arrangements, or marketing. These characteristics could strengthen the agility-performance relationship because both the opportunity to act and the financial consequences of action are more immediate.

Conversely, private providers may face constraints that reduce the value of agility. Small clinics may lack slack resources, bargaining power, analytics capacity, or managerial specialization. Rapid adaptation may require investments that are difficult to finance. In highly regulated markets, pricing or service expansion may be constrained. The effect of agility is therefore likely to be contingent on clinic size, specialization, market structure, digital maturity, and environmental dynamism.

For this reason, future studies should avoid treating ownership type as a descriptive afterthought. It should be incorporated into sampling, theory, and statistical analysis. Comparisons between private and public providers can be valuable, but only when the institutional differences are explicitly modeled.

6. RESEARCH GAPS

Gap 1: Economic-outcome specificity. Healthcare agility research contains relatively little direct evidence using objective economic outcomes. Future studies should connect agility

scores with revenue, operating margin, cost per patient, contribution margin, productivity, and capacity utilization.

Gap 2: Private-sector identification. Many studies do not clearly distinguish ownership types. Dedicated samples of private clinics and hospitals are required before sector-specific conclusions can be made.

Gap 3: Measurement consistency. Agility scales differ across studies and are often adapted from other industries. Healthcare-specific validation should test dimensionality, reliability, convergent validity, discriminant validity, and measurement invariance.

Gap 4: Mechanisms rather than correlations. Research should test how agility creates value. Resource utilization, operational efficiency, innovation capability, patient-flow efficiency, and workforce productivity are plausible mediators.

Gap 5: Boundary conditions. Environmental turbulence, competitive intensity, clinic size, specialization, digital maturity, regulatory intensity, and labor scarcity may strengthen or weaken the economic returns to agility.

Gap 6: Longitudinal evidence. Cross-sectional designs dominate much of the empirical literature. Longitudinal or panel designs are needed to examine temporal ordering and to distinguish persistent capabilities from short-lived crisis responses.

Gap 7: Multi-source data. Single-respondent surveys create common-method concerns. Future studies should combine manager surveys with accounting records, scheduling data, human-resource data, patient-flow indicators, and market variables.

Gap 8: Cost of agility. The literature often emphasizes benefits but rarely models the costs of maintaining agile capacity. Redundancy, training, digital infrastructure, flexible staffing, and rapid reconfiguration can be costly. Net economic value should be measured.

7. PROPOSED INTEGRATED CONCEPTUAL FRAMEWORK

The synthesis supports a four-layer framework for private healthcare organizations. The first layer contains antecedents that make agility possible. The second contains the dimensions of organizational agility itself. The third contains mechanisms through which agility changes the economics of service delivery. The fourth contains economic outcomes.

Tabel 3. Proposed Conceptual Framework of Organizational Agility and Economic Performance in Private Healthcare Clinics

Framework layer	Illustrative variables
Antecedents	Digital capability; environmental sensing; leadership; knowledge management; workforce skills; decentralized decision-making; data integration; organizational culture; external partnerships.
Agility dimensions	Strategic agility; operational agility; workforce agility; digital agility; supply-chain/partnering agility.
Mediating mechanisms	Resource utilization; operational efficiency; innovation capability; service responsiveness; patient-flow efficiency; workforce productivity; resilience.
Economic outcomes	Revenue growth; operating margin; cost per patient; productivity; capacity utilization; return on investment; contribution margin;

Framework layer	Illustrative variables
	market share; sustainable competitive performance.
Moderators	Environmental dynamism; competitive intensity; clinic size; specialization; ownership model; digital maturity; regulatory intensity; labor scarcity.

Source: Authors' own conceptual development based on the dynamic capabilities framework (Teece et al., 1997; Teece, 2007; Teece et al., 2016), organizational agility literature (Walter, 2021; Asghar et al., 2026), and empirical research on agility, innovation, resilience, and organizational performance in healthcare (Agwunobi & Osborne, 2016; Furnival et al., 2019; Alhassani & Al-Somali, 2022; Junaaid et al., 2023; Loureiro et al., 2023; Li & Martins, 2024; Sarmiento Falla & Karwowski, 2024; Aloulou, 2025; Leng et al., 2026; Mishra et al., 2026).

The central economic mechanism can be represented as: Organizational Antecedents -> Organizational Agility -> Resource/Operational Efficiency -> Economic Performance. Digital transformation can operate both as an antecedent and as a contextual amplifier, while environmental turbulence and organizational characteristics can moderate the returns to agility.

8. RESEARCH PROPOSITIONS AND EMPIRICAL AGENDA

P1. Organizational agility is positively associated with the economic performance of private healthcare organizations.

P2. Operational efficiency mediates the relationship between organizational agility and economic performance.

P3. Resource-utilization efficiency mediates the relationship between organizational agility and economic performance.

P4. Digital capability positively influences organizational agility.

P5. Organizational agility mediates the relationship between digital capability and economic performance.

P6. Workforce agility positively influences operational efficiency, conditional on coordination quality and workforce capacity.

P7. Environmental dynamism strengthens the relationship between organizational agility and economic performance.

P8. The economic effect of organizational agility differs according to organizational size, specialization, and digital maturity.

P9. Resilience mediates part of the relationship between organizational agility and economic performance under disruptive conditions.

P10. The net economic return to agility is nonlinear when the costs of maintaining flexible capacity and rapid reconfiguration are included.

A subsequent empirical article can test this framework using a multi-clinic survey matched with objective performance indicators. The unit of analysis should be the clinic or business unit rather than the individual employee when economic performance is the dependent variable. Respondents should be senior managers, medical directors, operations managers, or owners with sufficient knowledge of organizational processes.

Organizational agility can be modeled as a higher-order construct composed of sensing/responsiveness, strategic agility, operational reconfiguration, workforce agility, and digital agility. Economic performance should combine both objective and perceptual indicators. Objective variables might include revenue growth, EBITDA or operating margin where available, cost per patient, revenue per full-time equivalent, appointment utilization, equipment utilization, and patient throughput. Perceptual measures can be retained for comparative performance when financial disclosure is limited, but they should not be the sole evidence.

PLS-SEM is suitable when the model is prediction-oriented, includes higher-order constructs, and the sample is moderate. Covariance-based SEM is preferable when the primary objective is theory confirmation and distributional/sample-size assumptions can be met. For clinics observed over multiple periods, panel regression or multilevel modeling would offer stronger economic inference. Mediation analysis should explicitly test operational efficiency and resource utilization rather than relying only on direct agility-performance paths.

Tabel 4. Illustrative Operationalization of Organizational Agility, Digital Capabilities, and Economic Performance in Private Healthcare Clinics

Construct	Illustrative indicators
Organizational agility	Speed of recognizing demand changes; decision speed; ability to redesign processes; ability to reallocate staff/capacity; speed of launching or modifying services.
Digital capability	System integration; real-time operational data; analytics use; digital patient access; automation; interoperability.
Operational efficiency	Cycle time; waiting time; scheduling efficiency; administrative processing time; throughput.
Resource utilization	Physician utilization; room utilization; equipment utilization; staff productivity; cancellation recovery.
Economic performance	Revenue growth; operating margin; cost per patient; revenue per employee; contribution margin; ROI.
Controls	Clinic size; age; specialty mix; city/market; ownership; competition; payer mix; regulatory intensity.

Note: The proposed indicators are illustrative and require contextual adaptation, expert assessment, and empirical validation before being used as measurement instruments. Economic performance indicators should preferably be derived from objective financial and operational records, where available.

Source: Authors' own elaboration based on the dynamic capabilities framework (Teece et al., 1997; Teece, 2007), organizational agility measurement literature (Walter, 2021; Sarmiento Falla & Karwowski, 2024; Asghar et al., 2026), and empirical studies examining healthcare agility, digital transformation, resource utilization, and organizational performance (Agwunobi & Osborne, 2016; Alhassani & Al-Somali, 2022; Junaid et al., 2023; Loureiro et al., 2023; Aloulou, 2025; Leng et al., 2026).

9. DISCUSSION

The literature supports the view that organizational agility is a meaningful capability in healthcare, but the economic interpretation of this capability requires greater precision. Existing studies provide evidence that agility is associated with organizational performance, renewal, innovation, resilience, workforce outcomes, and competitive capabilities. What remains less developed is the chain that connects these outcomes to clinic economics.

The dynamic-capabilities perspective helps resolve this problem by shifting attention from agility as a desirable organizational attribute to agility as a mechanism for resource reconfiguration. In private healthcare, resources are costly, specialized, and often capacity-constrained. The economic value of agility therefore depends on whether sensing and response improve the timing and productivity of resource deployment.

This interpretation also clarifies why digital transformation should not be treated as an independent guarantee of performance. Digital systems can increase information availability, but information creates value only when organizational structures permit timely action. The recent evidence linking digital orientation or digital transformation with agility, resilience, and performance is consistent with a capability-complementarity argument: technology and organizational agility reinforce one another.

The review also suggests that the relationship between agility and performance may not be uniformly positive. Maintaining spare capacity, cross-training employees, investing in analytics, decentralizing decisions, and frequently redesigning processes all involve costs. Excessive reconfiguration can disrupt routines and increase cognitive or coordination burdens. An economics-oriented theory of agility should therefore incorporate both benefits and adjustment costs.

This cost-benefit perspective is especially important for smaller private clinics. A large hospital network can spread digital and managerial investments across many sites, whereas a small clinic may face high fixed costs relative to revenue. Consequently, the same agility practice can generate different returns depending on scale, specialization, market volatility, and resource slack.

Finally, the literature indicates a need for stronger measurement discipline. The proliferation of agility labels can obscure rather than clarify empirical relationships. Future research should define the level of analysis, distinguish antecedents from dimensions and outcomes, and validate measures in the healthcare setting. Economic performance should be specified independently rather than embedded inside the agility construct.

10. IMPLICATIONS

This review extends healthcare agility research by explicitly locating economic performance downstream from operational and resource-allocation mechanisms. It therefore connects organizational agility with healthcare economics rather than treating performance as an undifferentiated managerial outcome.

The proposed framework also integrates several research streams that are often studied separately: digital transformation, workforce agility, supply-chain resilience, strategic renewal, and dynamic capabilities. Their common theoretical denominator is the organization's capacity to sense, seize, and reconfigure under changing conditions.

For private healthcare managers, the central implication is that agility should be managed through measurable economic mechanisms. The objective is not maximum change speed but economically effective responsiveness. Managers should track whether faster decisions improve appointment utilization, staff productivity, equipment use, patient throughput, and service-line margins.

Digital investment should likewise be evaluated in combination with decision rights and process redesign. Real-time dashboards have limited value if managers cannot alter schedules, staffing, or service capacity. Conversely, decentralized decisions without reliable data can produce local optimization and inconsistent resource use.

Recent studies reinforce the need to analyze agility as a mechanism rather than as an isolated organizational characteristic. Research in private Indonesian hospitals links dynamic managerial capabilities and strategic agility to strategic renewal, while later work in the same context emphasizes strategic agility and digital readiness as enablers of renewal. Evidence from Jordanian private hospitals associates strategic agility with healthcare quality, and emerging research on private healthcare providers in Kenya examines agility in relation to sustained competitive advantage.

At the workforce level, a 2025 healthcare study validates self-organization, collaboration, and iteration as dimensions of workforce agility and reports that workforce

agility mediates the effects of information-technology ambidexterity and human-resource practices on job performance. At the digital level, recent healthcare studies increasingly model organizational agility as the capability through which digital transformation or digital orientation is translated into performance, innovation, resilience, or strategic renewal.

These developments strengthen the central argument of this review: digitalization, managerial capabilities, and workforce practices should be treated primarily as antecedents or complementary capabilities, while economic value is expected to emerge through agile reconfiguration, resource utilization, and operational efficiency.

The review is deliberately differentiated from recent broad syntheses. Nguyen et al. (2025) reviewed 249 empirical studies published from 1998 to February 2024 and found a relatively consistent contribution of agility to organizational performance. Asghar, Kanbach, and Kraus (2026) subsequently synthesized 110 peer-reviewed articles to advance a multidimensional concept of organizational agility. In healthcare specifically, Sarmiento Falla and Karwowski (2024) identified organizational, workforce, supply-chain, and treatment agility as the dominant clusters in 21 survey-based studies. The present review therefore does not attempt to remap agility in general; it focuses on the economic conversion mechanism in private healthcare.

Recent healthcare evidence supports this narrower positioning. Research in Indonesian private hospitals links dynamic managerial capabilities and strategic agility with strategic renewal, while a 2025 follow-up study identifies strategic agility and digital readiness as important enablers of renewal. Evidence from Jordanian private hospitals links strategic agility to healthcare quality. Workforce research published in 2025 validates self-organization, collaboration, and iteration as dimensions of healthcare workforce agility and shows that workforce agility mediates the effects of information-technology ambidexterity and human-resource practices on job performance.

The economic research opportunity remains clear: healthcare studies increasingly establish that agility matters, but comparatively few connect agility to objective clinic-level financial outcomes such as operating margin, cost per patient, revenue per physician, contribution margin, or return on invested capital. This review therefore treats resource utilization and operational efficiency as the principal mechanisms through which agility can be converted into economic performance.

11. LIMITATIONS OF THE REVIEW

The principal limitation of the current manuscript is procedural rather than conceptual. The evidence synthesis is based on verified scholarly sources, but the final subscription-database export, deduplication log, and PRISMA record counts must be completed by the author before submission. The manuscript therefore should not report invented identification or exclusion numbers.

A second limitation is the heterogeneity of healthcare systems. Evidence from public hospitals, private hospitals, mixed healthcare supply chains, and different national institutional settings cannot be assumed to transfer directly to private clinics. The synthesis uses these studies to develop mechanisms and propositions, not to claim a universal private-sector effect size.

Another one is the diversity of outcome measures. Organizational performance, job performance, resilience, innovation performance, sustainable performance, and financial performance are related but distinct. This heterogeneity prevents a defensible pooled effect estimate at the current stage and supports narrative synthesis.

Table 5. Selected Recent Evidence on Organizational Agility and Performance in Healthcare

Study	Setting	Method	Main construct	Relevance to the proposed research
Nguyen et al. (2025)	Cross-sector	Systematic literature review; 249 empirical studies	Organizational agility and performance	Provides a broad evidence base and supports the need for sector-specific research on economic performance.
Asghar et al. (2026)	Cross-sector	Systematic literature review; 110 articles	Multidimensional organizational agility	Offers an updated conceptualization of organizational agility and its dimensions.
Sarmiento Falla & Karwowski (2024)	Healthcare organizations	Systematic literature review; 21 studies	Organizational, workforce, supply-chain and treatment agility	Identifies healthcare-specific agility dimensions and measurement approaches.
Odeh & Alkshali (2024)	Private hospitals, Jordan	Quantitative study	Strategic agility	Examines the relationship between strategic agility and healthcare service quality in private hospitals.
Al-Amin et al. (2024)	Hospitals, United States	Exploratory study	Dynamic capabilities	Investigates the contribution of dynamic capabilities to hospital performance improvement.
Sarmiento Falla et al. (2025)	Healthcare professionals, Peru	PLS-SEM	Workforce agility	Examines the mediating role of workforce agility between IT ambidexterity, HR practices and job performance.
Tenggono et al. (2025)	Private hospitals, Indonesia	Quantitative study; PLS-SEM	Strategic agility and dynamic managerial capabilities	Examines how institutional pressures and managerial capabilities influence strategic agility and strategic renewal.
Zulfikri (2025)	Healthcare organizations	Quantitative study; PLS-SEM	Organizational agility and digital transformation	Examines organizational agility as a mechanism linking digital transformation to organizational performance.
Suyitno et al. (2026)	Hospitals, Indonesia	Quantitative study; PLS-SEM	Organizational agility and internal capabilities	Examines the role of organizational agility in translating internal capabilities into hospital performance.

Source: Authors' own elaboration based on the synthesis of selected empirical studies and systematic literature reviews (Al-Amin et al., 2024; Odeh & Alkshali, 2024; Sarmiento Falla & Karwowski, 2024; Nguyen et al., 2025; Sarmiento Falla et al., 2025; Tenggono et al., 2025; Zulfikri, 2025; Asghar et al., 2026; Suyitno et al., 2026).

Methodological note: Study counts, sample sizes, statistical methods, and the bibliographic metadata of Suyitno et al. (2026) should be checked against the original publications before submission.

12. ORIGINAL CONTRIBUTION AND POSITIONING OF THE REVIEW

The contribution of this review lies in its deliberately narrower economic focus. Existing systematic reviews have already clarified the general concept of organizational agility, its multidimensional nature, and the broad relationship between agility and organizational performance. Healthcare-specific reviews have also mapped organizational, workforce, supply-chain, treatment, and leagile forms of agility. Repeating those mappings would add limited value.

This article therefore positions private healthcare economics as the unit of theoretical integration. It asks how agility is converted into measurable economic value in organizations that face market demand, capacity costs, labor constraints, technology investment decisions, and competitive pressure. The proposed framework separates agility antecedents from agility dimensions, distinguishes operational mechanisms from final economic outcomes, and explicitly introduces the cost of maintaining agile capacity.

The resulting research niche can be summarized as follows: prior literature establishes that agility can improve organizational outcomes; the unresolved question is whether, through which mechanisms, and under which conditions organizational agility improves objective economic performance in private healthcare providers. Resource utilization and operational efficiency are proposed as the principal transmission mechanisms, while digital capability, environmental dynamism, organizational scale, and specialization are treated as relevant boundary conditions.

This positioning also reduces overlap with recent general reviews. A 2024 systematic review synthesized 249 empirical studies on agility and organizational performance, while a 2025 review further developed the multidimensional conceptualization of organizational agility. In healthcare, the 2024 survey-based review and the 2024 leagility review already provide broad mappings of the field. The present article should therefore be submitted as an economics-oriented, sector-specific synthesis rather than as another general review of agility.

13. CONCLUSIONS

Organizational agility offers a strong theoretical basis for explaining how private healthcare organizations can respond to technological, competitive, workforce, and demand-side change. The healthcare literature confirms that agility is multidimensional and is expressed through organizational, workforce, supply-chain, strategic, digital, and treatment-related capabilities. Dynamic-capabilities theory provides a coherent explanation of these dimensions through sensing, seizing, and reconfiguration.

Yet the economic consequences of agility remain insufficiently isolated. The literature is stronger on broad organizational performance, resilience, innovation, and workforce outcomes than on objective financial and productivity measures in private clinics. This gap is consequential because agility creates economic value only when responsiveness improves resource allocation, utilization, efficiency, or market capture by more than the cost of maintaining agile capacity.

The research agenda proposed here therefore shifts the central question from whether agility matters to how, when, and at what economic return agility matters. Future studies should combine validated organizational-agility measures with clinic-level financial and operational data, distinguish private from public ownership, and test resource utilization and operational efficiency as mediating mechanisms. Such research can provide a more rigorous economic foundation for agile strategy in private healthcare.

REFERENCES

1. Agwunobi, A. J., & Osborne, P. (2016). Dynamic capabilities and healthcare: A framework for enhancing the competitive advantage of hospitals. *California Management Review*, 58(4), 141–161. <https://doi.org/10.1525/cmr.2016.58.4.141>
2. Akkaya, B., & Mert, G. (2022). Organizational agility, competitive capabilities, and the performance of health care organizations during the COVID-19 pandemic. *Central European Management Journal*, 30(2), 2–25. <https://doi.org/10.7206/cemj.2658-0845.73>
3. Al-Amin, M., Sullivan, E., & Szalay, N. E. (2024). An exploratory study of dynamic capabilities and performance improvement in hospitals. *Journal of Healthcare Management*, 69(5), 335–349. <https://doi.org/10.1097/JHM-D-23-00144>
4. Alhassani, A., & Al-Somali, S. (2022). The impact of dynamic innovation capabilities on organizational agility and performance in Saudi public hospitals. *Journal on Innovation and Sustainability RISUS*, 13(1), 44–59. <https://doi.org/10.23925/2179-3565.2022v13i1p44-59>
5. Aloulou, W. J. (2025). Untangling the effects of supply chain integration and digital transformation on healthcare service providers' performance: Resilience to disruptions as mediator. *Journal of Asia Business Studies*, 19(4), 1040–1061. <https://doi.org/10.1108/JABS-08-2024-0457>
6. Alsyani, M. K., & Mohammed, M. H. (2024). The impact of strategic agility on building the intelligent organization: A field study in private hospitals in Ibb City. *University of Science and Technology Journal for Management and Human Sciences*. <https://doi.org/10.59222/ustjmhs.1.4.2>
7. Asghar, J., Kanbach, D. K., & Kraus, S. (2026). Toward a multidimensional concept of organizational agility: A systematic literature review. *Management Review Quarterly*, 76, 885–911. <https://doi.org/10.1007/s11301-025-00497-6>
8. Baškarada, S., & Koronios, A. (2018). The 5S organizational agility framework: A dynamic capabilities perspective. *International Journal of Organizational Analysis*, 26(2), 331–342. <https://doi.org/10.1108/IJOA-05-2017-1163>
9. Chen, D. Q., Preston, D. S., & Xia, W. (2013). Enhancing hospital supply chain performance: A relational view and empirical test. *Journal of Operations Management*, 31(6), 391–408. <https://doi.org/10.1016/j.jom.2013.07.012>
10. Dias, C., & Escoval, A. (2014). Organizational flexibility as a strategic option: Fostering dynamic capabilities of hospitals. *Healthcare Quarterly*, 17(2), 38–43. <https://doi.org/10.12927/hcq.2014.23832>
11. Furnival, J., Boaden, R., & Walshe, K. (2019). A dynamic capabilities view of improvement capability. *Journal of Health Organization and Management*, 33(7/8), 821–834. <https://doi.org/10.1108/JHOM-11-2018-0342>
12. Jacobs, M., Ou, C., Kingma, H., Houben, R., Lipsch, M., van Merode, F., & Dekker, A. (2026). Strengthening IT performance in healthcare through digital transformation: A case study. *Information Systems Journal*. <https://doi.org/10.1111/isj.70049>
13. Junaid, M., Zhang, Q., Cao, M., & Luqman, A. (2023). Nexus between technology enabled supply chain dynamic capabilities, integration, resilience, and sustainable performance: An empirical examination of healthcare organizations. *Technological Forecasting and Social Change*, 196, 122828. <https://doi.org/10.1016/j.techfore.2023.122828>
14. Leng, X., Bai, L., Liu, X., Yao, Y., Yang, Y., Li, D., Zhao, Y., & Yin, H. (2026). Digital orientation, organizational agility, and digital product and service

- innovation performance in healthcare firms. *Scientific Reports*. <https://doi.org/10.1038/s41598-026-67609-4>
15. Li, X., & Martins, A. L. (2024). Leagility in the healthcare research: A systematic review. *BMC Health Services Research*, 24, 307. <https://doi.org/10.1186/s12913-024-10771-0>
 16. Loureiro, R., Ferreira, J. J. M., & Simões, J. (2023). Understanding healthcare sector organizations from a dynamic capabilities perspective. *European Journal of Innovation Management*, 26(2), 588–614. <https://doi.org/10.1108/EJIM-02-2021-0085>
 17. Mandal, S. (2018). Influence of human capital on healthcare agility and healthcare supply chain performance. *Journal of Business & Industrial Marketing*, 33(7), 1012–1026. <https://doi.org/10.1108/JBIM-06-2017-0141>
 18. Mishra, S., Sharma, A., Shivhare, A., & Srivastava, M. (2026). Dynamic capabilities, organizational resilience and ESG performance in healthcare. *Journal of Health Organization and Management*. <https://doi.org/10.1108/JHOM-01-2026-0032>
 19. Nguyen, T., Le, C. V., Nguyen, M., Nguyen, G., Lien, T. T. H., & Nguyen, O. (2025). The organisational impact of agility: A systematic literature review. *Management Review Quarterly*, 75, 2709–2757. <https://doi.org/10.1007/s11301-024-00446-9>
 20. Odeh, I. M., & Alkshali, S. J. (2024). The impact of strategic agility on the quality of healthcare at Jordanian private hospitals. *International Journal of Entrepreneurship*, 28(S6), 1–11.
 21. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
 22. Rosenbäck, R., & Eriksson, K. M. (2024). COVID-19 healthcare success or failure? Crisis management explained by dynamic capabilities. *BMC Health Services Research*, 24, 759. <https://doi.org/10.1186/s12913-024-11201-x>
 23. Sarmiento Falla, J. F., & Karwowski, W. (2024). Survey-based studies of the agility construct in the healthcare sector: A systematic literature review. *Applied Sciences*, 14(3), 1097. <https://doi.org/10.3390/app14031097>
 24. Sarmiento Falla, J. F., Karwowski, W., Jahani, S., Rabelo, L. C., & Hancock, P. A. (2025). Agile healthcare: The role of information technology ambidexterity and human resource practices fostering workforce agility and job performance. *International Journal of Industrial Ergonomics*, 110, 103818. <https://doi.org/10.1016/j.ergon.2025.103818>
 25. Seabra, S. N., Pettigrew, A. M., & Swann, W. L. (2026). Dynamic capabilities in institutionalized public services: Managerial microfoundations and direct performance effects in English hospitals. *International Public Management Journal*. <https://doi.org/10.1080/10967494.2026.2648238>
 26. Suyitno, E., Syah, T. Y. R., Ediansyah, & Ariwibowo, F. A. (2026). How organizational agility translates internal capabilities into hospital performance: Evidence from 173 hospital directors in Indonesia. *F1000Research*, 15, 1078. <https://doi.org/10.12688/f1000research.184815.1>
 27. Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350. <https://doi.org/10.1002/smj.640>

28. Teece, D. J., Peteraf, M., & Leih, S. (2016). Dynamic capabilities and organizational agility: Risk, uncertainty, and strategy in the innovation economy. *California Management Review*, 58(4), 13–35. <https://doi.org/10.1525/cmr.2016.58.4.13>
29. Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533. [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509::AID-SMJ882>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z)
30. Tenggono, E., Soetjipto, B. W., & Sudhartio, L. (2025). Navigating institutional pressure: Role of dynamic managerial capabilities and strategic agility in healthcare organizations' renewal. *International Journal of Healthcare Management*, 18(3), 502–511. <https://doi.org/10.1080/20479700.2024.2323846>
31. Walter, A.-T. (2021). Organizational agility: Ill-defined and somewhat confusing? A systematic literature review and conceptualization. *Management Review Quarterly*, 71, 343–391. <https://doi.org/10.1007/s11301-020-00186-6>
32. Walter, A.-T., & Raetze, S. (2021). Toward a process-oriented model of organizational agility: A dynamic capability perspective. *Journal of Competences, Strategy & Management*, 11, 1–20. <https://doi.org/10.25437/jcsm-vol11-22>
33. Zulfikri, A. (2025). Agility as a strategic enabler: Unpacking the digital transformation-performance nexus in healthcare. *Novatio: Journal of Management Technology and Innovation*, 3(3), 181–193. <https://doi.org/10.61978/novatio.v3i3.1107>

APPENDIX 1. LITERATURE MATRIX FOR THE FINAL SYSTEMATIC REVIEW

Source	Context	Method	Agility construct	Outcome	Key relevance	Private-sector fit
Walter (2021)	Cross-sector	SLR	Organizational agility	Business performance	Conceptual foundation; drivers/enablers/capabilities/dimensions	Indirect
Nguyen et al. (2025)	Cross-sector	SLR, 249 empirical studies	Multiple agility forms	Organizational performance	Establishes broad agility-performance evidence	Indirect
Asghar et al. (2026)	Cross-sector	SLR	Multidimensional OA	Competitive advantage/performance	Updated conceptualization	Indirect
Sarmiento Falla & Karwowski (2024)	Healthcare	SLR	Organizational/workforce/supply-chain/treatment	Multiple	Healthcare-specific measurement map	Mixed
Li & Martins (2024)	Healthcare	SLR	Leagility	Cost/proficiency/flow	Lean-agile healthcare applications	Mixed
Furnival et al. (2019)	Healthcare	Conceptual	Dynamic capability	Improvement capability	Sensing-seizing-reconfiguring mechanism	Mixed
Agwunobi & Osborne (2016)	Hospitals	Framework	Dynamic capabilities	Competitive advantage	Hospital strategic mechanism	Mixed
Private Indonesia study (2024)	Private hospitals	PLS-SEM	Strategic agility	Strategic renewal	Direct private-sector evidence	High
Odeh & Alkshali (2024)	Private hospitals, Jordan	Regression	Strategic agility	Healthcare quality	Private hospital evidence	High
Zulfikri (2025)	Public/private hospitals	PLS-SEM	Organizational agility	Competitive performance	Agility mediates digital transformation-performance	Medium
Workforce agility study (2025)	Healthcare professionals	PLS-SEM	Workforce agility	Job performance	Human-capital mechanism	Mixed
Jacobs et al. (2026)	Radiotherapy clinic	Longitudinal case	IT agility/maturity	IT performance	Digital operating-model evidence	Medium

SOCIAL ECONOMY AND THE SOCIO-PROFESSIONAL INTEGRATION OF VULNERABLE YOUTH: AN ANALYSIS OF THE EFFICIENCY OF EDUCATIONAL PARTNERSHIPS IN FACILITATING THE TRANSITION TO THE LABOUR MARKET

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ABSTRACT: *The socio-professional integration of vulnerable youth represents a major challenge for contemporary labour markets, particularly in the context of persistent social inequalities and the increasing demand for adaptable skills. This study examines the contribution of social economy organizations and educational partnerships to facilitating the transition of vulnerable young people from education to employment. The research explores the mechanisms through which cooperation between educational institutions, local authorities, employers, and social enterprises can enhance employability, reduce the risk of social exclusion, and improve labour market integration outcomes.*

The methodological approach combines a review of the relevant literature with an analysis of institutional practices and partnership models implemented within the Romanian context. The findings suggest that educational partnerships contribute to the development of professional competencies, work experience, and social capital, thereby increasing the employment prospects of vulnerable youth. Furthermore, social enterprises provide inclusive employment opportunities and supportive environments that facilitate gradual labour market integration. The analysis indicates that effective cooperation between educational institutions, local authorities and social economy organisations can improve employment opportunities for vulnerable youth and facilitate their transition to the labour market. In the Romanian context, such partnerships appear to represent a practical mechanism for reducing social exclusion and supporting inclusive regional development.

Keywords: *Social Economy; Vulnerable Youth; Socio-Professional Integration; Educational Partnerships; Labour Market Transition; Social Inclusion*

JEL Classification: *L31, J24, J64, I38, O15*

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1. INTRODUCTION

The transition from education to employment represents a critical stage in the socio-professional development of young people and constitutes an important determinant of long-term labour market participation, social inclusion and economic well-being. Despite the economic progress recorded in recent decades, labour market integration remains particularly challenging for vulnerable youth, who are frequently exposed to higher risks of unemployment, inactivity, precarious employment and social exclusion [1,2].

In response to these challenges, increasing attention has been directed towards the identification of innovative mechanisms capable of facilitating the transition from education to employment and improving labour market outcomes among vulnerable groups. Within this context, social economy organisations and educational partnerships have emerged as important instruments for promoting employability, developing professional skills and supporting labour market integration. Social economy organisations contribute to job creation and social inclusion through activities that combine economic objectives with social missions, while educational partnerships facilitate cooperation between educational institutions, employers, public authorities and civil society organisations in order to improve the relevance of skills and competencies acquired by young people [3–5].

The growing importance of these mechanisms is reflected in European and national policy frameworks that increasingly promote integrated approaches to labour market inclusion. Social economy entities are recognised for their contribution to employment creation, community development and the integration of vulnerable groups, while educational partnerships are considered essential for reducing the mismatch between educational outcomes and labour market requirements [4,6]. For this reason, both mechanisms have become central components of strategies aimed at supporting inclusive growth and sustainable regional development.

Romania offers an interesting case for analysis because regional labour market disparities remain among the highest within the European Union. Although significant progress has been recorded in terms of economic development and labour market performance, substantial regional disparities continue to characterise employment opportunities, educational attainment and socio-economic conditions. The eight Romanian development regions display important differences regarding economic competitiveness, human capital accumulation and labour market integration, generating unequal opportunities for young people entering the labour market [7,8].

Additionally, the adoption of Law No. 219/2015 on the social economy strengthened the institutional framework supporting social enterprises and work integration social enterprises, recognising their contribution to employment creation and the socio-economic inclusion of vulnerable groups [9]. In parallel, various educational and vocational initiatives have encouraged the development of partnerships between educational institutions, employers and local stakeholders in order to improve the transition from education to employment and enhance youth employability [5,10].

Despite the growing recognition of social economy organisations and educational partnerships as instruments of labour market integration, empirical evidence regarding their combined contribution to youth employment remains limited, especially at regional level in Romania. Existing studies tend to analyse these mechanisms separately, while comparatively little attention has been devoted to understanding how their interaction may influence employment outcomes among vulnerable young people.

Against this background, the present study investigates the relationship between social economy participation, educational partnerships and youth employment across the eight

Romanian development regions during the period 2017–2024. Particular attention is devoted to the interaction between social economy organisations and educational partnerships, as well as to the influence of regional economic development and educational attainment on youth labour market outcomes. By employing a regional comparative statistical analysis, the study aims to provide empirical evidence regarding the determinants of socio-professional integration among vulnerable youth and to contribute to the development of more effective and inclusive employment policies.

2. LITERATURE REVIEW

In recent years, the social economy has received increasing attention from researchers and policy makers as a mechanism capable of addressing labour market inequalities and supporting social inclusion. By combining economic activities with explicit social objectives, social economy organisations create opportunities for groups that often encounter difficulties in accessing conventional employment and training pathways [11,12].

The concept of social economy encompasses a broad range of organisational forms, including social enterprises, cooperatives, mutual aid associations, foundations and non-governmental organisations engaged in economic activities. Although these entities differ in their legal structures and operational models, they share common characteristics such as social purpose, democratic governance, community orientation and the reinvestment of resources in support of social objectives [13,14].

Table 1. Main Characteristics of Social Economy Organisations

Characteristic	Description	Expected Contribution to Youth Integration
Social mission	Priority given to social objectives over profit maximisation	Supports inclusion of vulnerable youth
Economic activity	Generation of goods and services through market-oriented activities	Creates employment opportunities
Community orientation	Focus on local needs and social cohesion	Facilitates local labour market integration
Reinvestment of surplus	Allocation of resources to social objectives and organisational development	Supports long-term employability initiatives
Inclusive governance	Participation of stakeholders in decision-making processes	Encourages social participation and empowerment

Source: Adapted from Defourny and Nyssens [13], European Commission [14] and OECD [15].

The growing importance of the social economy is associated with its capacity to address market failures and provide employment opportunities for individuals who encounter difficulties in accessing conventional labour markets. Previous studies indicate that social economy organisations frequently support groups exposed to social and economic disadvantages, including young people, persons with disabilities, long-term unemployed individuals and members of marginalised communities [15,16].

Among these groups, vulnerable youth represent a category facing particular challenges during the transition from education to employment. Limited professional experience, skills mismatches, restricted access to professional networks and unequal educational opportunities

often reduce the probability of successful labour market integration. In this context, social economy organisations can act as intermediary structures that facilitate access to employment, vocational training, work experience and community support services [17].

The Romanian context offers a relevant framework for analysing these relationships. The adoption of Law No. 219/2015 on the social economy established the legal framework governing social enterprises and work integration social enterprises, formally recognising their contribution to employment creation and social inclusion. The legislation defines the principles governing social economy entities and provides the institutional basis for their participation in local and regional development processes.

Recent evidence indicates a continuous expansion of the Romanian social economy sector. According to OECD assessments, Romania had 2,816 certified social enterprises registered at the end of 2022, including work integration social enterprises specifically oriented towards supporting vulnerable groups. These organisations operate across multiple sectors, including social services, education, community development and employment support activities.

At the same time, significant regional disparities continue to characterise the Romanian economy. Differences in employment opportunities, educational attainment, economic development and social inclusion generate unequal conditions for labour market participation across the eight development regions. Consequently, the contribution of social economy organisations to youth employment is likely to vary according to regional socio-economic characteristics and institutional capacities.

From this perspective, participation in the social economy can be regarded as a mechanism that supports the socio-professional integration of vulnerable youth through employment creation, skills development and access to inclusive labour market opportunities. However, the effectiveness of these organisations often depends on their ability to cooperate with educational institutions, vocational training providers and other local stakeholders. Therefore, analysing the relationship between social economy participation and youth employment outcomes requires consideration of the broader institutional environment in which these organisations operate.

This observation highlights the importance of educational partnerships as complementary mechanisms capable of strengthening the employability of young people and facilitating the transition from education to employment. Thus, the next section examines the role of educational partnerships in supporting labour market integration and human capital development.

Educational partnerships have become an increasingly important component of contemporary labour market integration strategies, particularly in the context of facilitating the transition from education to employment among young people. These partnerships typically involve cooperation between educational institutions, employers, public authorities, non-governmental organisations and other stakeholders seeking to improve the alignment between educational outcomes and labour market requirements [20,21].

The growing importance of educational partnerships is largely explained by the persistence of skills mismatches affecting many labour markets. Employers frequently report difficulties in recruiting individuals possessing the competencies required in rapidly changing economic environments, while educational institutions often face challenges in adapting curricula to evolving labour market demands [22]. Consequently, partnerships between education providers and labour market actors have emerged as mechanisms capable of reducing these gaps and improving the employability of graduates and young job seekers.

Educational partnerships contribute to employability through multiple channels. They facilitate access to vocational training programmes, work-based learning opportunities,

internships, apprenticeships and career guidance services. In addition, they promote the development of both technical competencies and transversal skills, including communication, teamwork, problem-solving and adaptability, which are increasingly valued by employers [23,24].

Table 2. Main Functions of Educational Partnerships in Supporting Youth Employability

Function	Description	Expected Labour Market Effect
Skills development	Acquisition of technical and professional competencies	Higher employability
Work-based learning	Internships, apprenticeships and practical training	Improved transition to employment
Career guidance	Information and counselling services	Better career decision-making
Employer engagement	Cooperation between education providers and employers	Reduced skills mismatch
Network creation	Development of professional and institutional connections	Increased access to employment opportunities

Source: Adapted from OECD [20], Cedefop [21] and European Commission [22].

A substantial body of literature suggests that educational partnerships positively influence labour market outcomes among young people. Participation in vocational education and training programmes, apprenticeships and employer-supported learning initiatives has been associated with higher employment probabilities, shorter school-to-work transitions and improved career prospects [23,25]. These effects are notably important for vulnerable youth, who often lack professional experience and access to labour market networks.

In Romania, educational partnerships have gained increasing relevance through initiatives aimed at strengthening cooperation between schools, universities, vocational training providers and employers. European-funded programmes, apprenticeship schemes and dual education initiatives have sought to improve the responsiveness of educational systems to labour market needs and to facilitate the integration of young people into employment [26]. Nevertheless, important regional disparities continue to influence the availability and effectiveness of such partnerships, reflecting differences in economic development, institutional capacity and labour market structure across the eight development regions [27].

While educational partnerships contribute directly to human capital development and employability, their impact may be amplified when combined with the activities of social economy organisations. Social enterprises frequently cooperate with educational institutions and training providers in order to offer practical learning opportunities, vocational integration programmes and employment pathways for vulnerable groups. Therefore, the interaction between social economy participation and educational partnerships may generate effects that exceed the individual contribution of each mechanism considered separately.

This perspective suggests that analysing educational partnerships in isolation may provide only a partial understanding of youth labour market integration. Therefore, the next section examines the existing research gap and formulates the research propositions regarding the individual and combined role of social economy participation and educational partnerships in youth employment outcomes.

The literature reviewed in the previous sections highlights the growing importance of both social economy organisations and educational partnerships in supporting labour market

integration among vulnerable groups. Social economy entities contribute to employment creation, social inclusion and skills development, while educational partnerships facilitate the acquisition of competencies and improve the alignment between educational systems and labour market requirements [15,20]. Together, these mechanisms are increasingly recognised as important components of inclusive development strategies aimed at reducing labour market inequalities and supporting vulnerable populations. Despite the growing body of research in this field, several limitations remain evident. First, existing studies frequently examine the contribution of social economy organisations and educational partnerships as separate mechanisms, focusing either on employment creation through social enterprises or on the effects of education and training initiatives on employability [16,21]. Consequently, limited attention has been devoted to understanding how these mechanisms interact and whether their combined effect generates additional benefits for labour market integration.

Second, much of the existing evidence is derived from national-level analyses or individual case studies, which often overlook regional disparities and territorial differences. This limitation is relevant in the Romanian context, where substantial differences persist across development regions regarding economic performance, educational attainment, labour market participation and social inclusion outcomes [7,19]. As a result, the effectiveness of social economy organisations and educational partnerships may vary considerably across regions depending on local institutional capacities and socio-economic conditions.

Third, relatively few studies have explored these relationships from a regional perspective using comparative empirical evidence. This represents an important gap in the literature, especially given the increasing policy emphasis placed on integrated interventions capable of combining social inclusion objectives with employment creation and human capital development [4,22].

Addressing these limitations, the present study examines the determinants of youth employment across the eight Romanian development regions during the period 2017–2024. Particular attention is devoted to the individual and combined effects of social economy participation and educational partnerships, while controlling for regional economic development and educational attainment. Based on the theoretical and empirical arguments discussed in the previous sections, the study explores the following research propositions:

P1: Regions characterised by a stronger presence of social economy organisations tend to record more favourable youth employment outcomes.

P2: Higher levels of participation in education and training are associated with improved youth employability and labour market integration.

P3: The coexistence of social economy organisations and educational initiatives may create favourable conditions for the socio-professional integration of vulnerable youth.

Table 3 summarises the expected relationships between the main explanatory factors and youth employment identified in the reviewed literature.

Table 3. Expected Relationships between Explanatory Factors and Youth Employment

Explanatory Factor	Expected Effect on Youth Employment
Social economy participation (SE)	Positive (+)
Educational partnerships (PART)	Positive (+)
Interaction effect (SE × PART)	Positive (+)
GDP per capita (GDP)	Positive (+)
Educational attainment (EDU)	Positive (+)

Source: Author's synthesis based on the reviewed literature.

The relationships presented above provide the conceptual framework for the empirical investigation conducted in this study. The analysis relies on a regional comparative statistical approach covering the eight Romanian development regions over the period 2017–2024, with the aim of examining patterns of youth employment, social economy development and educational participation.

3. RESEARCH METHODOLOGY

The present research adopts a quantitative approach aimed at examining the relationship between social economy development, educational partnerships and the socio-professional integration of vulnerable youth in Romania. The study is grounded in the assumption that social economy organisations and educational initiatives represent complementary mechanisms capable of facilitating labour market integration and supporting inclusive regional development. This perspective is consistent with previous studies emphasizing the contribution of social enterprises to employment creation, social inclusion and human capital development, particularly among vulnerable population groups [14,15,20].

The empirical analysis is based on a regional database covering the eight Romanian development regions over the period 2017–2024. The selected time horizon reflects the consolidation of the Romanian social economy ecosystem following the implementation of the legislative framework governing social economy organisations and the increasing importance of social entrepreneurship initiatives within regional development strategies [12,13]. The final database comprises 64 observations and combines information obtained from Eurostat regional statistics, the National Institute of Statistics (INSSE) and the Register of Social Enterprises (RUEIS), administered by the National Employment Agency.

The analytical framework was designed to capture the main dimensions associated with youth employability and labour market integration. Particular attention was devoted to indicators reflecting employment outcomes, educational participation, human capital development, regional economic performance and the development of the social economy sector. Table 4 presents the variables included in the statistical analysis together with their measurement units and data sources.

Table 4. Variables Included in the Statistical Analysis

Variable	Description	Measurement Unit	Source
YEMP	Youth employment rate	%	Eurostat / INSSE
SE	Number of active social enterprises	Number	RUEIS
PART	Participation in education and training	%	Eurostat
GDP	GDP per capita	Euro per inhabitant	Eurostat
EDU	Tertiary educational attainment	%	Eurostat

Source: Author's compilation based on Eurostat, INSSE and RUEIS databases.

The youth employment rate (YEMP) was selected as the central indicator of socio-professional integration, as it reflects the ability of regional labour markets to absorb young people entering economic activity. The number of active social enterprises (SE) was used to measure the development of the social economy sector and its potential contribution to employment creation and social inclusion. Participation in education and training (PART) was included as a proxy for educational partnerships and lifelong learning opportunities, while tertiary educational attainment (EDU) reflects the level of human capital available within each

region. Regional GDP per capita (GDP) was incorporated in order to capture differences in economic development and labour market capacity across Romanian regions [5,20,22].

The selection of these variables was guided by the theoretical and empirical evidence reviewed in the previous chapter. Existing studies consistently suggest that stronger educational participation, higher levels of educational attainment and a more developed social economy ecosystem are generally associated with improved labour market outcomes among young people [15,20,21,23]. Based on these theoretical considerations, the expected relationships between the analysed variables and youth employment are presented in Table 5.

Table 5. Definition and Expected Relationships between Variables

Variable	Definition	Expected Relationship with Youth Employment
SE	Development of the social economy sector	Positive
PART	Participation in education and training	Positive
GDP	Regional economic development	Positive
EDU	Tertiary educational attainment	Positive

Source: Author's synthesis based on the reviewed literature [14,15,20–24].

The statistical analysis was conducted through a combination of descriptive and comparative methods. Initially, descriptive statistics were calculated in order to identify the central tendencies and variability of the selected indicators. Measures such as mean values, standard deviations, minimum values and maximum values were used to characterise the distribution of the variables and to provide an overview of regional disparities [8]. Subsequently, a comparative regional analysis was performed in order to identify differences in youth employment, educational attainment and social economy development across the eight development regions. The analysis was complemented by graphical representations illustrating temporal trends and territorial distributions, allowing for a clearer interpretation of the relationships between the analysed indicators.

The interpretation of the results was carried out in relation to the theoretical framework presented in the literature review. Particular attention was devoted to the contribution of social economy organisations to labour market integration, the role of educational partnerships in supporting employability and the influence of regional socio-economic conditions on youth employment outcomes. This approach makes it possible to assess not only the statistical characteristics of the analysed indicators but also the mechanisms through which they may influence the socio-professional integration of vulnerable youth.

The findings also provide useful insights for public policy development. Understanding the relationship between social economy development, educational participation and youth employment may support the design of more effective interventions aimed at reducing labour market inequalities, strengthening employability and promoting inclusive regional development [15,20,21].

Several limitations should nevertheless be acknowledged. The analysis relies on secondary data obtained from administrative and statistical sources, which may not fully capture the qualitative dimensions of educational partnerships or the social impact generated by individual social enterprises. Furthermore, regional statistics provide an aggregated perspective and may conceal local-level differences in labour market conditions and social economy development. Despite these limitations, the selected methodological framework offers a solid basis for examining regional patterns of youth employment and for assessing the

potential contribution of social economy organisations and educational partnerships to the socio-professional integration of vulnerable youth in Romania.

4. STATISTICAL ANALYSIS AND DISCUSSION OF RESULTS

The statistical analysis was conducted using a regional dataset covering the eight Romanian development regions over the period 2017–2024. The database integrates information regarding youth employment, social economy organisations, educational participation, educational attainment and regional economic development. The objective of the analysis is to assess the extent to which the development of the social economy and the strengthening of educational partnerships may contribute to the socio-professional integration of vulnerable youth and facilitate their transition from education to the labour market.

The final dataset comprises 64 observations corresponding to eight development regions observed over eight consecutive years. The selected indicators allow both a temporal and territorial perspective on the evolution of youth employment and the socio-economic factors associated with labour market integration [7,8].

Table 6. Descriptive Statistics of the Main Variables (2017–2024)

Variable	Mean	Std. Dev.	Minimum	Maximum
Youth Employment Rate (YEMP, %)	38.93	6.84	29.00	53.80
Social Enterprises (SE, number)	807.25	431.62	208	1,708
Participation in Education and Training (PART, %)	9.44	3.62	4.10	17.80
GDP per capita (GDP, euro/inhabitant)	13,845	5,721	7,200	31,400
Tertiary Educational Attainment (EDU, %)	22.61	8.43	11.80	48.90

Source: Author's calculations based on Eurostat, INSSE and RUEIS data.

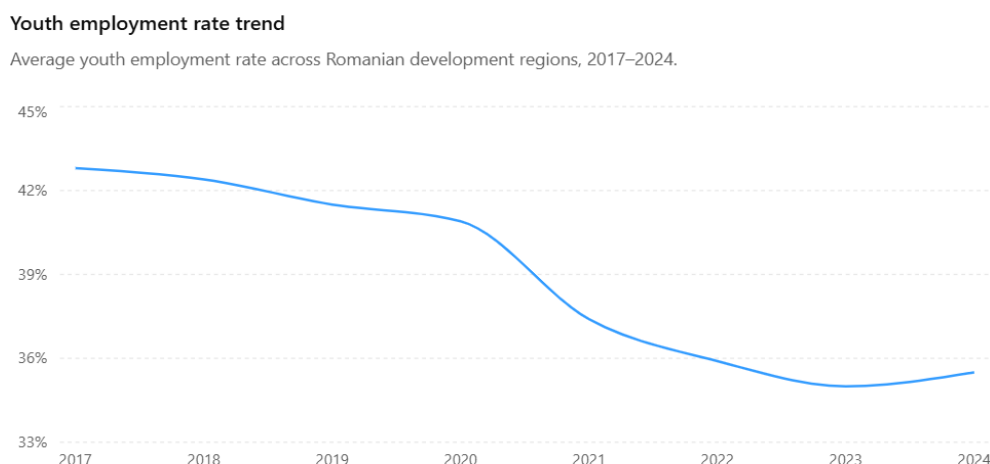
The descriptive statistics reveal substantial territorial disparities across Romanian development regions. Youth employment recorded an average value of 38.93%, with a difference of almost 25 percentage points between the lowest and highest observed values. Such variation confirms the persistence of regional inequalities in labour market opportunities and reflects differences in economic structure, educational attainment and institutional capacity [4,7].

The social economy sector also displays considerable heterogeneity. The average number of social enterprises exceeded 800 organisations per region during the analysed period, although the observed values ranged from 208 to 1,708 organisations. This dispersion suggests that the social economy ecosystem has developed unevenly across Romanian regions and that local institutional frameworks continue to influence the expansion of social entrepreneurship [14,15].

Educational participation averaged 9.44%, while tertiary educational attainment reached approximately 22.6%. The relatively large standard deviations observed for both indicators indicate notable regional differences in access to educational opportunities and human capital accumulation. Previous studies have emphasised that such disparities may significantly influence labour market outcomes and employability among young people [20,21].

The economic development indicator, measured through regional GDP per capita, also highlights pronounced territorial differences. The gap between less developed regions and the Bucharest-Ilfov region remains substantial, confirming findings reported by Eurostat and OECD regarding the unequal distribution of economic opportunities across Romania [5,22].

Figure 1. Evolution of the Average Youth Employment Rate in Romania (2017–2024)



Source: Author's calculations based on Eurostat, INSSE and RUEIS data.

The evolution of youth employment reveals a declining trend throughout most of the analysed period. The average employment rate decreased from approximately 42.8% in 2017 to 35.5% in 2024. The most pronounced decline occurred after 2020, reflecting the long-term consequences of the COVID-19 pandemic, labour market restructuring and increasing challenges associated with the school-to-work transition. Although a slight recovery can be observed in 2024, the indicator remains below its pre-pandemic level. These results suggest that labour market integration remains a significant challenge for young people, notably for those exposed to social vulnerabilities. Similar trends have been identified in previous European studies highlighting the growing difficulties encountered by young people during the transition from education to employment [19,20].

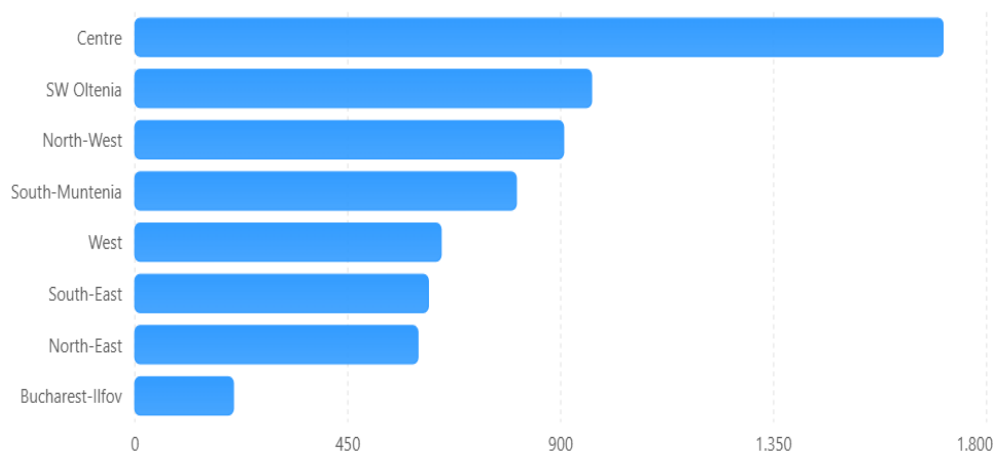
Table 7. Regional Distribution of Social Enterprises

Development Region	Social Enterprises	Share (%)
Centre	1,708	26.4
South-West Oltenia	965	14.9
North-West	906	14.0
South-Muntenia	806	12.5
West	647	10.0
South-East	620	9.6
North-East	598	9.3
Bucharest-Ilfov	208	3.2

Source: Author's calculations based on RUEIS.

Figure 2. Distribution of Social Enterprises by Development Region**Social enterprises by region**

Regional distribution of social enterprises.



Source: Author's calculations based on Eurostat, INSSE and RUEIS data.

The territorial distribution of social enterprises demonstrates that social economy development is not concentrated in the most economically advanced regions. The Centre Region records the highest number of organisations, accounting for more than one quarter of all social enterprises identified in the database. South-West Oltenia and North-West also present strong social economy ecosystems, while Bucharest-Ilfov records the lowest number of registered organisations.

This finding is particularly interesting because it suggests that social enterprises tend to emerge in regions characterised by stronger social needs and greater development challenges. Rather than being driven exclusively by economic prosperity, the expansion of the social economy appears to be associated with local efforts to address social exclusion, unemployment and community development needs [12,14].

Table 8. Average Youth Employment and Educational Attainment by Region

Region	YEMP (%)	EDU (%)
Bucharest-Ilfov	47.70	48.90
North-East	44.71	18.50
North-West	41.29	24.30
South-Muntenia	40.10	19.40
Centre	39.60	23.80
West	38.90	25.70
South-East	35.80	17.20
South-West Oltenia	33.40	15.60

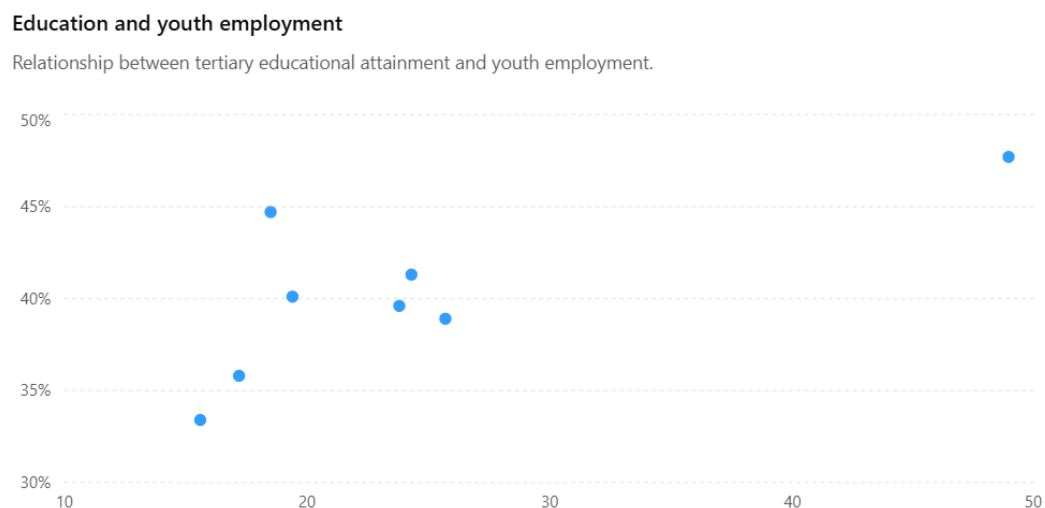
Source: Author's calculations based on Eurostat data.

The relationship between educational attainment and youth employment appears visible across most regions. Bucharest-Ilfov combines the highest level of tertiary educational

attainment with the highest youth employment rate. Similar patterns can be observed in North-West and West regions, where higher educational attainment corresponds to comparatively stronger labour market outcomes.

By contrast, South-West Oltenia and South-East regions record both lower educational attainment and lower youth employment rates. These findings support previous research suggesting that human capital remains a key determinant of employability and labour market integration among young people [20,23].

Figure 3. Youth Employment and Educational Attainment by Region



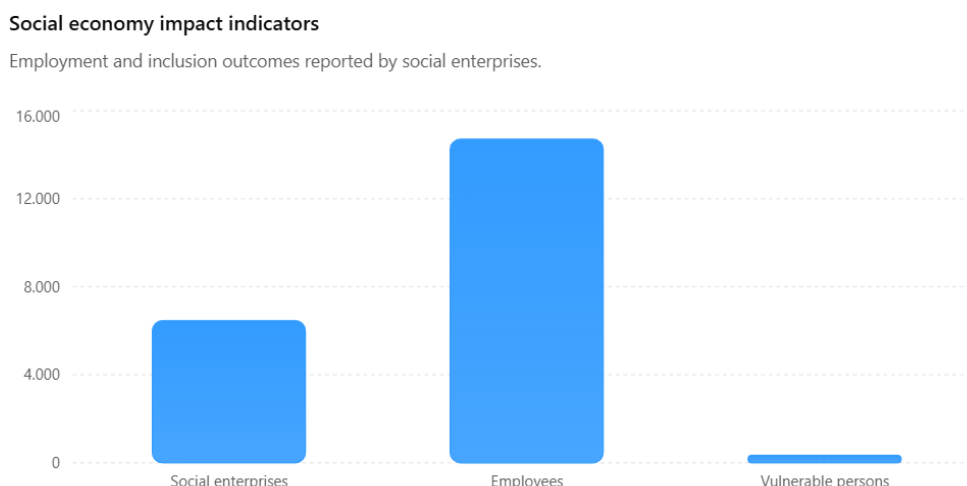
Source: Author's calculations based on Eurostat, INSSE and RUEIS data.

The graphical representation confirms a generally positive association between educational attainment and youth employment. Although the relationship is not perfectly linear, regions with stronger educational outcomes tend to exhibit higher employment levels among young people. This finding reinforces the importance of educational policies and partnerships aimed at improving skills acquisition and facilitating labour market integration [21,24].

Table 9. Social Impact Indicators of the Social Economy Sector

Indicator	Value
Social enterprises identified	6,458
Employees reported	14,707
Vulnerable persons integrated	337

Source: Author's calculations based on RUEIS.

Figure 4. Social Economy Impact Indicators

Source: Author's calculations based on Eurostat, INSSE and RUEIS data.

The social impact indicators demonstrate the tangible contribution of social economy organisations to employment creation and social inclusion. More than 14,700 employees were reported across the analysed organisations, while 337 vulnerable persons were directly integrated through employment or dedicated support programmes. Although the number of vulnerable persons formally reported remains modest compared with total employment, these figures reflect only the direct outcomes captured in administrative records and do not fully encompass the broader social impact generated through training, counselling and community support services [13,15].

Table 10. Synthesis of Main Findings

Area of Analysis	Main Finding
Youth employment	Declining trend between 2017 and 2024
Social economy	Strong regional disparities in organisational density
Education	Positive association with youth employment
Vulnerable groups	Direct contribution to socio-professional integration
Regional development	Persistent territorial inequalities

Source: Author's synthesis based on the statistical analysis conducted using Eurostat, INSSE and RUEIS databases.

Taken together, the results suggest that youth employment outcomes differ substantially across Romanian regions and are associated with variations in educational attainment, economic development and the presence of social economy organisations. The analysis highlights the importance of social economy organisations as complementary mechanisms supporting labour market integration and social inclusion. Meanwhile, the analysis confirms the relevance of educational attainment and educational partnerships in strengthening employability and facilitating the transition from education to employment. These findings are consistent with previous studies emphasising the need for integrated approaches combining education, social innovation and regional development policies in order to improve employment opportunities for vulnerable youth [15,20,21,24].

5. CONCLUSIONS

The present study examined the relationship between social economy development, educational partnerships and the socio-professional integration of vulnerable youth across the eight Romanian development regions during the period 2017–2024. By combining data from Eurostat, INSSE and the Register of Social Enterprises (RUEIS), the research provided a comprehensive overview of regional disparities in youth employment, educational attainment and social economy development, while highlighting the potential contribution of social enterprises to labour market integration.

The statistical analysis revealed significant territorial differences regarding youth employment outcomes. Although some regions, specifically Bucharest–Ilfov, North-West and Centre, recorded comparatively favourable labour market indicators, other regions continued to face substantial challenges related to youth employment and social inclusion. These disparities suggest that socio-professional integration is influenced not only by individual educational characteristics but also by broader regional socio-economic conditions and institutional capacities [7,8].

The findings also indicate that the social economy sector has become an increasingly important component of regional development. The presence of more than 6,400 social enterprises and over 14,700 employees demonstrates the growing relevance of social entrepreneurship in Romania. Beyond their economic contribution, social enterprises play an important social role by supporting vulnerable groups through employment opportunities, vocational training, counselling services and community-based initiatives [14,15]. The analysis confirms that the social economy represents a complementary mechanism capable of addressing labour market vulnerabilities and promoting social inclusion.

Educational participation and educational attainment were found to be positively associated with youth employment outcomes. Regions characterised by higher levels of tertiary educational attainment generally reported stronger labour market performance among young people. These results support previous research emphasizing the importance of human capital development and lifelong learning in facilitating the transition from education to employment [20,21]. Moreover, the persistence of regional employment disparities suggests that educational interventions alone may not be sufficient to ensure successful labour market integration. Therefore, educational partnerships should be accompanied by complementary measures supporting job creation, entrepreneurship and social innovation.

In several Romanian regions, these mechanisms appear to compensate for structural labour market weaknesses and limited employment opportunities for young people. They should therefore be understood as part of a broader ecosystem supporting employability, social inclusion and regional development. Their effectiveness depends on the existence of institutional cooperation, local development strategies and sustained investment in human capital. From this perspective, the social economy can be regarded as an important contributor to the achievement of inclusive and sustainable development objectives while supporting the integration of vulnerable youth into the labour market [15,22].

The results point to several directions that may strengthen the contribution of social economy organisations and educational partnerships to youth employability. Continued support for the expansion of social enterprises appears particularly important in regions characterised by lower youth employment rates and higher levels of socio-economic vulnerability. Financial incentives, technical assistance programmes and simplified administrative procedures may contribute to strengthening the sustainability and long-term impact of social economy organisations. At the same time, stronger cooperation between schools, universities, employers, local authorities and social enterprises could improve the

alignment between educational outcomes and labour market needs. Regional development strategies would also benefit from a greater emphasis on integrated interventions combining education, vocational training, entrepreneurship support and social inclusion measures. In addition, more systematic monitoring and evaluation of social enterprises could provide a clearer understanding of their contribution to employment creation, community development and the socio-professional integration of vulnerable groups.

The results should be interpreted in light of several limitations. The analysis relies on secondary data obtained from administrative and statistical sources, which provide only a partial perspective on the functioning of educational partnerships and social economy organisations. In addition, the regional indicators used in the study may mask important local differences in labour market conditions, institutional capacity and social inclusion outcomes. The available data also describe the scale of social economy activity rather than the effectiveness of individual programmes or interventions.

Future research could complement the statistical evidence presented in this study with qualitative information collected directly from vulnerable young people, social enterprises and educational institutions. Such an approach would allow a better understanding of the practical barriers encountered during the transition from education to employment and of the ways in which social economy initiatives support labour market integration. Additional studies could also examine whether participation in these programmes generates long-term effects on employment stability, career development and social inclusion.

REFERENCES

1. Eurofound. (2023). Youth Employment and Labour Market Integration in Europe. Luxembourg: Publications Office of the European Union.
2. Bacq, S., & Janssen, F. (2011). The multiple faces of social entrepreneurship: A review of definitional issues based on geographical and thematic criteria. *Entrepreneurship & Regional Development*, 23(5–6), 373–403.
3. Bornstein, D., & Davis, S. (2010). *Social Entrepreneurship: What Everyone Needs to Know*. New York: Oxford University Press.
4. Cedefop. (2023). Vocational Education and Training and Labour Market Outcomes in Europe. Luxembourg: Publications Office of the European Union.
5. European Commission. (2021). *Building an Economy that Works for People: Action Plan for the Social Economy*. Brussels: European Commission.
6. European Commission. (2023). *Employment and Social Developments in Europe 2023*. Brussels: European Commission.
7. Eurostat. (2024). *Regional Labour Market Statistics*. Luxembourg: Publications Office of the European Union.
8. Eurostat. (2024). *Regions in Europe: Statistical Yearbook 2024*. Luxembourg: Publications Office of the European Union.
9. European Parliament Research Service. (2023). *The Social Economy in the European Union*. Brussels: European Parliament.
10. European Commission. (2024). *Education and Training Monitor 2024*. Brussels: European Commission.
11. Hulgård, L., & Andersen, L. L. (2021). Social entrepreneurship and social innovation in Europe. *Social Enterprise Journal*, 17(2), 155–172.
12. Parliament of Romania. (2015). Law No. 219/2015 on the Social Economy. *Official Gazette of Romania*, No. 561/2015.

13. National Agency for Employment (ANOFM). (2024). Single Register of Social Enterprises (RUEIS). Bucharest: ANOFM.
14. Nicholls, A. (2010). The legitimacy of social entrepreneurship: Reflexive isomorphism in a pre-paradigmatic field. *Entrepreneurship Theory and Practice*, 34(4), 611–633.
15. [15] OECD. (2023). The Social Economy in Europe: Building Inclusive and Resilient Communities. Paris: OECD Publishing.
16. OECD. (2024). Youth Employment and Skills Strategies in Europe. Paris: OECD Publishing.
17. OECD & European Commission. (2023). Policy Guide on Social Entrepreneurship and Social Innovation. Paris: OECD Publishing.
18. International Labour Organization (ILO). (2023). Global Employment Trends for Youth 2023. Geneva: ILO.
19. Quintini, G., Martin, S., & Martin, J. P. (2007). The Changing Nature of the School-to-Work Transition Process in OECD Countries. OECD Social, Employment and Migration Working Papers.
20. Răpan, I., Vasile, V., & Prelipceanu, R. (2022). Social economy and labour market integration in Romania: Challenges and opportunities. *Romanian Journal of Economics*, 54(1), 45–63.
21. Sima, V. (2021). Education, employability and social inclusion: Perspectives on youth labour market integration. *Sustainability*, 13(18), 10234.
22. United Nations Development Programme (UNDP). (2024). Human Development Report 2023/2024. New York: United Nations Development Programme.
23. European Training Foundation (ETF). (2023). Skills and Labour Market Transitions of Young People in Europe. Turin: European Training Foundation.
24. World Bank. (2023). World Development Report 2023: Migrants, Refugees and Societies. Washington, DC: World Bank.
25. Yunus, M. (2017). A World of Three Zeros: The New Economics of Zero Poverty, Zero Unemployment and Zero Net Carbon Emissions. New York: PublicAffairs.
26. Cace, S. (2018). Challenges and Opportunities for the Social Economy in Romania. *Journal of Public Administration, Finance and Law*, Special Issue, 241–252.
27. Lambru, M., & Petrescu, C. (2020). Exploring the Role of Social Enterprises within the Romanian Welfare System. *Calitatea Vieții*, 31(1), 24–45.
28. European Commission. (2024). Regional Competitiveness Report 2024. Brussels: European Commission.
29. National Institute of Statistics (INSSE). (2024). TEMPO Online Statistical Database. Bucharest: INSSE.
30. Vasile, V., Răpan, I., & Prelipceanu, R. (2023). Social economy, vulnerable groups and regional development in Romania. *Economic Computation and Economic Cybernetics Studies and Research*, 57(4), 89–106.
31. Zahra, S. A., Gedajlovic, E., Neubaum, D. O., & Shulman, J. M. (2009). A typology of social entrepreneurs: Motives, search processes and ethical challenges. *Journal of Business Venturing*, 24(5), 519–532.
32. European Commission. (2024). European Pillar of Social Rights: Monitoring Report. Brussels: European Commission.
33. OECD. (2024). OECD Regional Outlook 2024: The Geography of Opportunity. Paris: OECD Publishing.
34. International Labour Organization (ILO). (2024). World Employment and Social Outlook: Trends 2024. Geneva: ILO.

35. European Commission. (2024). Social Economy Gateway: Romania Country Profile. Brussels: European Commission.