THE ROLE OF THE PRIVATELY ADMINISTERED PENSION SYSTEM IN ROMANIA IN FINANCING AND SUPPORTING THE DEVELOPMENT OF AGRIPHOTOVOLTAICS

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Abstract

In this article, the authors analyzed the strategic connection between the private pension system in Romania and the agriphotovoltaic potential, emphasizing the importance of these funds as a source of institutional capital for the energy transition and sustainable agriculture. Thus, the possibility of mobilizing financial resources from Pillar II towards agriphotovoltaic infrastructure was examined, simultaneously contributing to climate objectives, food security and long-term returns of the funds. Privately managed pension funds, as institutional investors with long-term horizons and responsibility for the financial security of participants and beneficiaries, are constantly identifying assets that combine sustainable returns, controlled risk and positive social impact. In this context, agriphotovoltaic systems represent an emerging opportunity for diversifying the investment portfolio towards green and multifunctional assets. In order to achieve the research goal, the authors conducted a study on the investment activity of privately managed pension funds in Romania, using data published by the Financial Supervisory Authority, for the period 2010-2024. At the same time, in order to evaluate agriphotovoltaic projects by private pension funds, the authors proposed an ESG matrix model, structured on the dimensions E (Environment), S (Social) and G (Governance), with scores from 1 (very poor) to 5 (excellent) and importance weights. The research results highlighted the fact that in Romania, although there are favorable legal premises, there is a lack of unified and explicit regulation for agriphotovoltaics. However, private pension funds can invest indirectly through infrastructure funds, public-private partnerships or green investment vehicles.

Keywords: *private pension funds, capital, investments, agriphotovoltaics, yield, sustainability.*

Clasificare JEL: *E22, J32, O16*

1. Introduction

The objective of this research is to explore the potential of privately managed pension funds in Romania to financially support the development of agriphotovoltaic systems, from the perspective of investment opportunities, existing regulations and compatibility with the long-term strategy of these funds. The working hypotheses are:

H1: Agriphotovoltaic systems offer investment characteristics compatible with the profile of private pension funds' portfolios.

H2: The lack of specific regulation and dedicated financial instruments in Romania limits the capacity of pension funds to invest directly in agriphotovoltaics.

H3: The integration of agriphotovoltaic projects into pension fund portfolios would contribute to diversifying investments and strengthening the sustainability of the pension system in the long term.

The research was based on a quantitative and qualitative approach, carried out in the following stages: documentary and legislative analysis, study of the regulatory framework in Romania regarding private pension funds, conducting a study on the evolution of the rate of return of funds during the period 2010-2024, as well as analysis of investment opportunities in agriphotovoltaics.

2. Literature review

In the modern economy, the concepts of sustainability, sustainable development and stability are the basis of economic actions and development strategies of many companies operating in key sectors. The concentration of energy supply sources not only exposes member states to geopolitical risks, but also limits the ability to react to crises or economic and diplomatic pressures (Anghelache and Anghel, 2024). In this context, the diversification of energy sources by promoting renewables becomes a priority, and sustainable financing mechanisms, including the involvement of private pension funds, acquire a strategic role in strengthening European energy autonomy. In addition to the best possible returns sought by private pension funds, stability and predictability are two other essential elements for their investments (Park and Song, 2024). Thus, a potential investment option is represented by renewable energy generating parks, which have specific characteristics that would fit the desirable profile. Agrivoltaic systems are a real potential for sustainable energy from a global perspective (Lakshmi and others, 2025). The level of use of renewable energy and the achievement of the energy transition are directly influenced by the financing modality in the ecological area (Iqbal and others, 2022). The integration of renewable sources into institutional portfolios, including those of private pension funds, must also be analyzed from the perspective of geopolitical instability (Cheikh and Zaied, 2024). It is necessary to implement adapted support policies that stimulate investments and the development of agriphotovoltaic infrastructure in regions with high agricultural potential (Kierdorf and others, 2025). At the same time, in Romania, it is necessary to create an institutional and financial framework that supports the expansion of agriphotovoltaic systems (Anghel and Strijek, 2024). Energy efficiency, although aimed at reducing energy consumption and carbon emissions, can have unintended effects, and current policies should be evaluated according to the types of consumption and the level of services they support (Shove, 2017).

The private pension funds have significant potential to promote the green transition and sustainable development, by allocating assets to sustainable projects, such as renewable energy infrastructure (Bulut, 2023). The architecture of the pension system directly influences the degree of poverty among the elderly population (Been, 2017). Investment decisions on the capital market are influenced not only by classic financial indicators (expected return, risk, liquidity), but also by behavioral factors, macroeconomic policies and geopolitical developments (Manaenko and Okhrimenko, 2014). The design of pension systems plays a key role in ensuring economic sustainability and social protection in an ageing world (Amaglobeli et al, 2019). The loss of confidence in financial markets, caused by the 2008/2009 financial crisis, negatively influenced participation in private pension schemes, highlighting the essential role of trust for saving and investment decisions (Brandt et al, 2024). De La Peña et al (2022) proposed an actuarial model for private pensions that adjusts payments according to the life expectancy and health status of beneficiaries, integrating support for long-term care without increasing the total cost of the plan.

Reforms of public pension systems can increase long-term financial sustainability if they are designed to adapt to demographic trends, minimizing immediate losses and reducing the risk of political backlash (Díaz-Giménez et al, 2025). The mandatory contributions to occupational pensions influence the level of private household savings, with different effects depending on occupational status and income level (Dillingh et al, 2023). The expansion of private pensions in Europe has varied across countries and may influence the income distribution among retirees, but the effects on total inequality depend on the combination with public pensions and the evolution of other sources of income (Doctrinal, 2023).

Comparative analysis of European pension systems highlights significant differences in the level of poverty and inequality among the elderly, influenced both by the structure of public pensions and by contributions to private schemes, ensuring an adequate minimum income is essential to reduce poverty risks (Ebbinghaus, 2021). Contributions to private pension funds

transform savings into investments in financial markets, complementing public systems, and regulation and collective schemes support the stability of retirement income (Hassel et al, 2019).

3. Data, results and discussion

At the end of 2024, 96.45% of the total assets of the private pension system in Romania belonged to privately managed pension funds (Pillar II), which means 150.88 billion lei and a share of 8.74% in the Gross Domestic Product. Thus, the research will be focused on the analysis of the investment activity of Pillar II.

In order to ensure the balance between protecting the interests and rights of participants and beneficiaries of privately managed pension funds and maximizing the return on investments, the administrators of these funds in Romania practice a prudent investment policy of the funds' assets. Figure 1 highlights the structure of the portfolio of financial instruments in which the assets of privately managed pension funds in Romania were invested in 2024. Thus, as can be seen, the largest share was allocated to government securities (67.06%), i.e. very close to the maximum limit imposed by the primary legislation in force (Law no. 411/2004 on privately managed pension funds, with subsequent amendments and supplements), which provides that the administrator may invest a maximum of 70% of the total value of the pension fund's assets in government securities issued by the Ministry of Finance of Romania, by member states of the European Union or belonging to the European Economic Area.

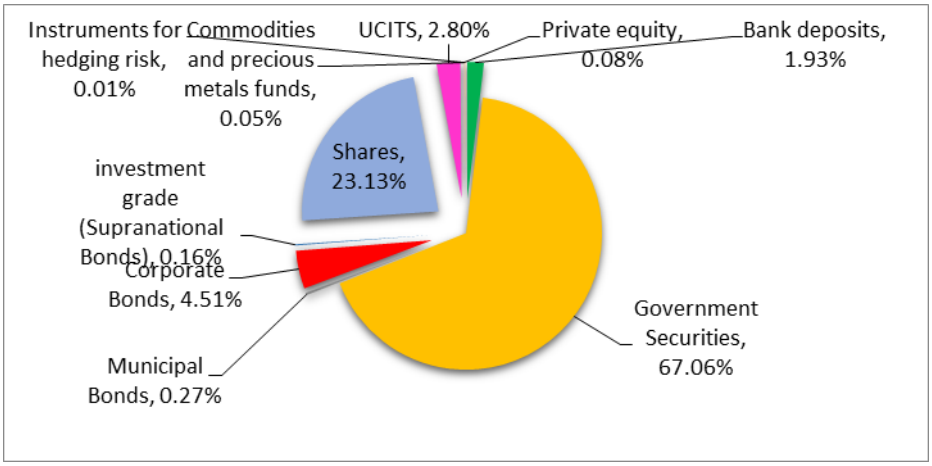

Figure no. 1. Investment structure of all privately managed pension funds in Romania as of December 31, 2024

Source: authors' representation based on Financial Supervisory Authority data, Pension Fund Statistical Data Section, accessed on April 22, 2025.

An important indicator that must be analyzed in assessing the performance of privately managed pension funds is the profitability obtained by these pension funds as a result of the investments made. Fig. no. 2 graphically represents the evolution of the weighted average rate of return of all privately managed pension funds, recorded at the end of December during the period 2010-2024.

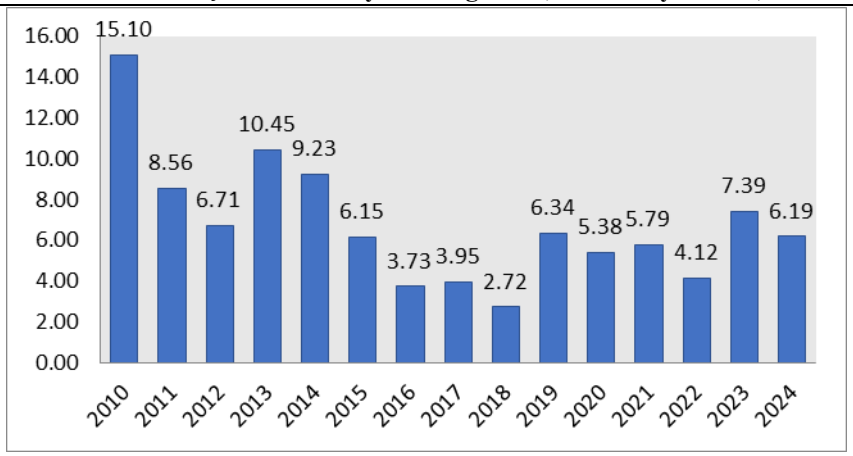

Figure no. 2. Evolution of the weighted average rate of return of all privately managed pension funds in Romania, during the period 2010-2024 (%)

Source: authors' representation based on Financial Supervisory Authority data, Pension Fund Statistical Data Section, accessed on April 22, 2025.

The analysis of the evolution of total Pillar II assets in Romania, for the period 2010-2024, reveals a significantly upward trend, illustrating both the maturation of the private pension system and its capacity to mobilize long-term financial resources (fig. no. 3).

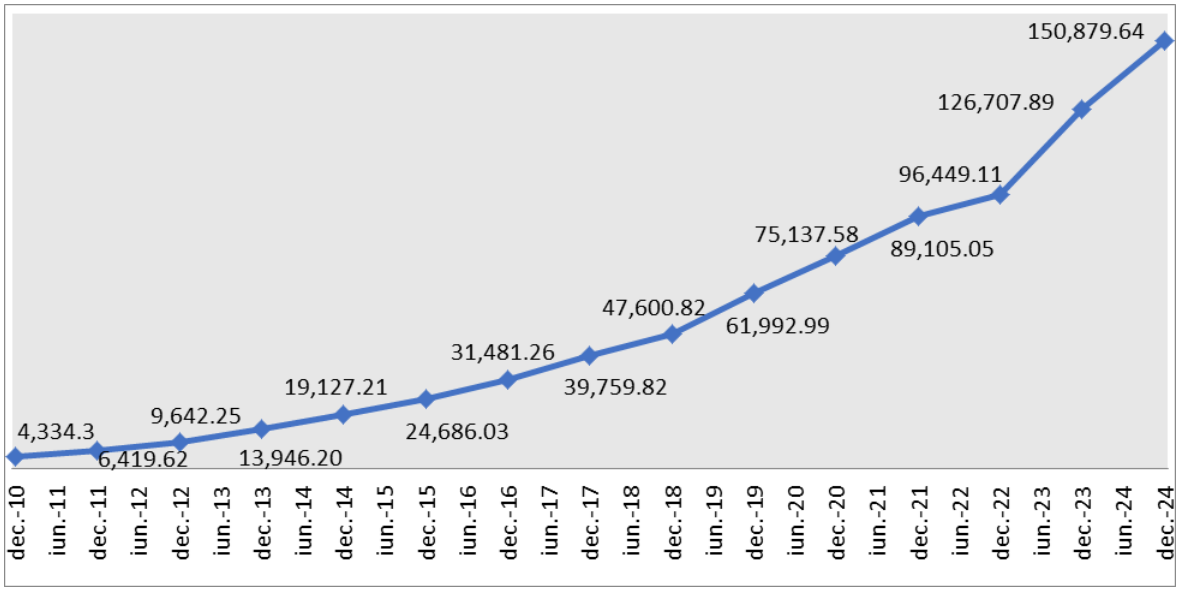

Figure no. 3. Evolution of total assets related to privately managed pension funds in Romania (Pillar 2), during the period 2010-2024 (%)

Source: authors' representation based on Financial Supervisory Authority data, Pension Fund Statistical Data Section, accessed on October, 06, 2025.

At the end of 2010, total assets amounted to 4.33 billion lei, a relatively modest value, corresponding to the early stage of private fund management and the initial level of confidence of participants. In this first phase, the annual growth of assets was moderate but constant, reflecting the accumulation of mandatory contributions and the reinvestment of the first returns, which suggests a gradual consolidation of the financial infrastructure and the associated administrative mechanisms.

The period 2011-2014 marks a stage of accelerated growth of assets, reaching 19.13 billion lei at the end of 2014. This evolution can be interpreted through the lens of a series of converging factors: the gradual increase in the number of participants in the system, the relative

macroeconomic stability of Romania in those years, as well as the beginning of the process of diversification of fund portfolios, which allowed for more stable and consistent returns. During this period, the funds began to adopt more prudent investment policies, with an emphasis on government bonds and low-risk instruments, in accordance with the existing legal framework, thus ensuring asset protection and fund stability for participants. This stage can be described as an "early maturation phase", in which private pension funds began to gain visibility and credibility among the general public.

Between 2015 and 2019, Pillar II assets recorded accelerated growth, reaching 61.99 billion lei in 2019, which represents almost a tripling of the level in 2014. This significant expansion was supported both by consistent contribution flows and by the investment performance of the portfolios. During this period, the funds benefited from a broader diversification of allocations, including, in addition to government bonds, corporate bonds and balanced financial instruments, which allowed for the optimization of the risk-return ratio. The accelerated growth rate also reflects the strengthening of the population's confidence in the private pension system, as well as the relative stability of the Romanian and European financial market. This stage can be considered one of "active expansion and diversification of investments", essential for preparing funds to support long-term projects.

The recent period, 2020-2024, is characterized by continuous and more pronounced growth, with Pillar II assets reaching 150.88 billion lei at the end of 2024, which represents approximately 8.74% of Romania's Gross Domestic Product. This sharp growth can be associated both with the post-pandemic macroeconomic stability and with favorable legislative developments, which allowed for more flexible portfolio management and the adoption of more efficient investment strategies. During this period, private pension funds managed to record positive returns even in a context marked by geopolitical uncertainties and global volatility, which indicates a particular resilience and the capacity of the system to protect participants' savings in the long term.

A more detailed analysis of the annual growth rate highlights that the accumulation rates were slower in the first two to three periods (2010-2012), reaching substantial values in the period 2015–2019 and accelerating significantly after 2021. This suggests that the funds not only accumulated capital through mandatory contributions, but also benefited from the compound effect of reinvesting returns, optimizing the portfolio structure and diversifying investments. Also, the growth of assets coincides with a gradual expansion of the financial instruments accepted by the legislation, including the possibility of participating in infrastructure funds or green investment vehicles, which is directly relevant for the integration of agriphotovoltaic projects.

This consolidated evolution highlights two essential aspects for the analysis of investments in agriphotovoltaics: firstly, the Pillar II of privately managed pensions has significant and stable resources, which can be mobilized for investments with a long horizon and strategic impact; secondly, the trend of accelerated growth and diversification of portfolios reflects the flexibility of the funds to adapt to new investment opportunities, including in innovative sectors such as agriphotovoltaics. From an academic perspective, the data underlines the fact that private pension funds in Romania are not only mechanisms for saving and social protection, but also institutional financial actors with the potential to influence sustainable development and the energy transition, through the strategic allocation of assets in green projects, with stable returns and controlled risk.

Therefore, the detailed analysis of the evolution of Pillar II assets over the period 2010–2024 provides a solid basis for arguing that these funds can financially support agriphotovoltaic infrastructure projects. The constant upward trend, the significant acceleration after 2021 and the stability recorded during periods of economic volatility demonstrate that private pension funds constitute a reliable source of capital, suitable for long-term investments, with a positive impact on both the energy and agricultural sectors, thus contributing to the sustainable development of Romania.

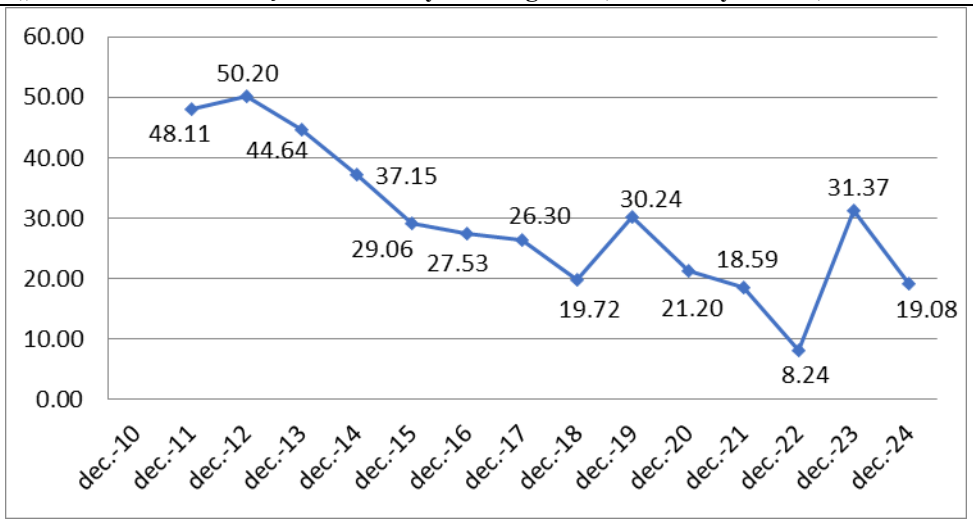

Figure no. 4 Evolution of the annual growth rate of privately managed pension funds in Romania (Pillar 2), during the period 2010-2024 (%)

Source: authors' representation based on their own calculations.

The analysis of the annual growth rate of Pillar II assets in the period 2011-2024 reveals a strongly positive, but not uniform, dynamics, which provides additional information on the evolution of the private pension system and its investment potential (fig. no. 4).

During the period 2011-2013, assets recorded spectacular annual increases, of 48.11% in 2011, 50.20% in 2012 and 44.64% in 2013, values that reflect both the rapid accumulation of contributions from participants and the favorable initial returns of the funds. This stage can be considered the "rapid expansion phase", characterized by an exponential growth of assets, the strengthening of participants' confidence and the consolidation of the funds' administrative mechanisms.

During the period 2014-2017, the annual growth rate begins to moderate, registering values of 37.15% in 2014, 29.06% in 2015, 27.53% in 2016 and 26.30% in 2017. This gradual decrease in the percentage rate does not indicate stagnation, but a maturation of the funds, as the accumulated asset base becomes larger and the percentage effect of the absolute growth is diluted. At this stage, portfolio diversification and a more prudent allocation to safe financial instruments, such as government bonds, explain the moderation of the annual growth rate.

In the years 2018-2021, the growth rate evolution shows significant fluctuations, with 19.72% in 2018, followed by an increase of 30.24% in 2019, 21.20% in 2020 and 18.59% in 2021. This variability can be correlated with macroeconomic factors, such as financial market volatility and external events (e.g. pandemic, geopolitical developments), but also with adjustments in the investment strategies adopted by the funds. The sharp growth in 2019 can be interpreted as an effect of efficient reinvestment and the favorable performance of the selected financial instruments.

The period 2022-2024 marks a remarkable acceleration, with 8.24% in 2022, followed by 31.37% in 2023 and 19.08% in 2024. The 31.37% increase in 2023 is particularly significant, indicating a potential for rapid growth even in complex economic conditions, suggesting the adaptation of funds to new investment opportunities and possible diversification towards higher-yielding assets. These values support the argument that Pillar II can mobilize considerable financial resources for strategic projects, such as investments in agriphotovoltaics, which require a long time horizon and stability in asset management.

The academic interpretation of these data highlights the fact that although the percentage growth rate varies from one year to another, the overall trend is clearly upward. This confirms the role of private pension funds as institutional actors capable of providing stable and significant capital for long-term investments. Furthermore, the analysis of the annual growth rate allows the identification of periods in which the funds were more efficient in accumulating and managing

assets, which can be directly correlated with their capacity to support emerging sectors, including agriphotovoltaic infrastructure, thus contributing to sustainable development and Romania's energy transition.

Agriphotovoltaics represent an emerging concept of sustainable infrastructure, which combines renewable energy production with agricultural activity, offering multiple benefits for the environment, economy and society. In Romania, where agriculture occupies a significant area and renewable energy is becoming increasingly important in the context of the European energy transition, these systems offer concrete long-term investment opportunities. Photovoltaic panels installed on agricultural land allow the generation of clean electricity, without completely compromising agricultural productivity, thanks to the implementation of modular and adjustable structures. This optimized integration transforms traditional lands into multifunctional assets, where agricultural and energy yields can be maximized simultaneously.

From an economic performance perspective, agriphotovoltaic systems offer predictable revenue streams, generated both from the sale of electricity to the national grid and from agricultural production. The stability of these streams is particularly relevant for privately managed pension funds, whose investment policy is based on protecting participants' savings and maximizing returns within a controlled risk framework. Therefore, agriphotovoltaics represent not only a source of investment with a positive environmental impact, but also a tool for effectively diversifying fund portfolios, reducing exclusive dependence on government securities, corporate bonds or other traditional instruments. On the other hand, these systems significantly contribute to compliance with ESG criteria. The environmental dimension (E) is satisfied by reducing carbon emissions and by using energy and agricultural resources efficiently. The social dimension (S) is addressed by creating jobs in rural areas and stimulating the development of local communities. The governance dimension (G) can be strengthened by implementing projects in public-private partnerships, with transparency in capital management and clear reporting of financial and environmental performance. This integrated approach makes agriphotovoltaics compatible not only with the objectives of pension funds, but also with their long-term strategy of sustainability and social responsibility.

The reason why private pension funds would invest in such projects is directly linked to their institutional characteristics. The second pillar of privately managed pensions is based on constant contributions, which generate stable financial resources, available for long-term commitments. This predictability allows funds to adopt an investment strategy oriented towards assets with medium and long-term maturity, such as agrivoltaic infrastructure, renewable energy parks or other green projects. The stability and consistency of contribution flows match the structure of agrivoltaic projects, which involve significant initial costs, but offer constant and sustainable returns over 20–30 years.

Investments in agriphotovoltaics also bring portfolio diversification. Private funds in Romania are still predominantly focused on government bonds and low-risk instruments. The integration of green infrastructure and multifunctional assets, such as agriphotovoltaics, allows for the reduction of systemic risk and the improvement of the risk-return ratio. In addition, the income streams generated by these systems are less sensitive to the volatility of global financial markets, providing a natural protection against economic or geopolitical shocks. This characteristic is crucial for funds that must ensure the security of participants' savings and the long-term stability of returns.

Another strong argument in favor of these investments is the positive social and ecological impact. Private pension funds have a responsibility to society, not only by ensuring future pensions, but also by the way they allocate resources. Investments in agriphotovoltaics allow for the achievement of sustainable development objectives, supporting rural communities and reducing the carbon footprint, contributing to a balance between profitability and social impact. This type of investment directly reflects ESG criteria, strengthening the image of the funds in front of participants, authorities and international markets.

Furthermore, pension funds can explore innovative financial models, such as green investment vehicles, infrastructure funds or public-private partnerships, to facilitate allocation to agrivoltaic projects. These approaches allow for the reduction of individual risk and the increase of the attractiveness of the investment by sharing responsibilities between different economic and institutional actors. In Romania, where specific regulation for such projects is still in its infancy, private funds can play an active role in developing the institutional and financial framework necessary for the expansion of agriphotovoltaic infrastructure.

Privately managed pension funds in Romania have significant and stable resources, are institutions with a long-term horizon and have a strategic interest in diversifying portfolios, protecting capital and generating sustainable returns. Agriphotovoltaics align perfectly with these objectives, offering constant financial flows, risk reduction, positive social and ecological impact, and the opportunity to actively participate in Romania's energy transition.

To analyze the investment opportunity of privately managed pension funds' assets in an agriphotovoltaic projects, we propose that, in the preliminary evaluation phase of the project, an ESG matrix model be used. The evaluation matrix is structured on the dimensions Environment - E, Social - S and Governance - G and can be applied on a scale from 1 (very poor) to 5 (excellent) for each dimension (E, S, G), then aggregated.

$$\text{Aggregate ESG score} = (\text{Score E}\times 0.4) + (\text{Scoe S}\times 0.3) + (\text{Score G}\times 0.3) \quad (1)$$

Table no. 1. Interpreting the aggregate ESG score

Aggregate score	Grade	Remarks
4.5 – 5.0	Excellent	Top Sustainable Project
3.5 – 4.4	Good	Eligible for Investment
2.5 – 3.4	Average	Needs Improvement
<2.5	Poor	High ESG Risk

Source: authors' proposal.

The weights used in calculating the ESG score (E – 0.4; S – 0.3; G – 0.3) represent a proposal by the authors and can be adjusted depending on the strategic objectives of the pension fund or the specifics of each agriphotovoltaic project.

Investments in agriphotovoltaics can protect privately managed pension funds against financial market volatility and provide stable long-term income streams from energy production and the sale of agricultural products. These investments, being less volatile than stocks or bonds, can help stabilize portfolios and increase their sustainability. Thus, the integration of agrivoltaic projects into the portfolios of private pension funds represents not only a financial opportunity, but also a sustainable development strategy, coherent with the prudent investment policy, social responsibility and the long-term objectives of Pillar II.

4. Conclusions

The study highlights the role of privately managed pension funds in Romania as institutional financial actors with the capacity to mobilize long-term resources and with strategic potential to support the energy transition and sustainable development. The analysis of the evolution of Pillar II assets for the period 2010-2024 confirms that these funds have stable resources, with predictable returns, compatible with long-term investments, such as agriphotovoltaic projects, thus supporting hypothesis H1.

The results suggest that, although the specific legislative framework for agriphotovoltaics is still insufficiently developed in Romania, pension funds can invest indirectly through infrastructure vehicles or public-private partnerships, supporting hypothesis H2. This approach allows the integration of agrivoltaic systems into diversified portfolios, contributing to their stability and sustainability.

Regarding hypothesis H3, the analysis shows that the integration of agriphotovoltaic projects can bring multiple benefits: portfolio diversification, systemic risk reduction and generation of stable financial flows, but also a positive impact on the environment and rural communities, according to ESG criteria.

These results emphasize that private pension funds can play an active role in the development of green infrastructure in Romania, contributing not only to the financial security of participants, but also to the objectives of sustainability and energy transition at the national level. In conclusion, investments in agriphotovoltaics align with the long-term strategy of private pension funds, offering a balance between financial return, controlled risk and positive social and ecological impact. These findings recommend the further development of a legislative and financial framework that facilitates the participation of pension funds in green infrastructure projects, thus strengthening their role in promoting a sustainable and resilient economy.

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