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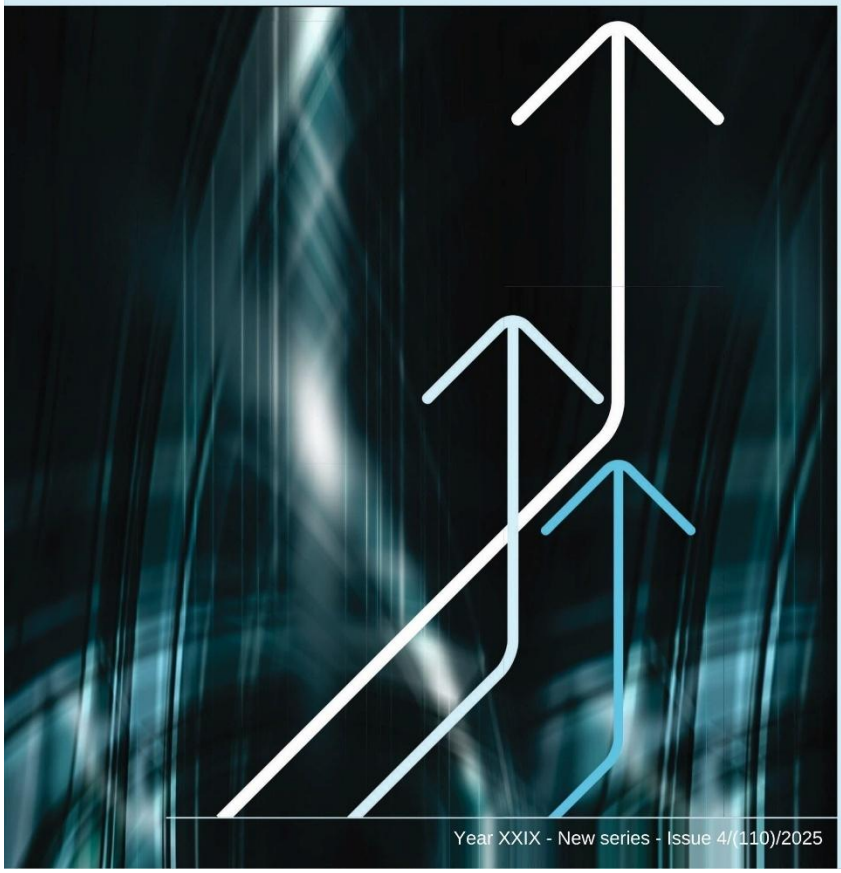

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"VICTOR SLĂVESCU" CENTRE FOR FINANCIAL
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FINANCIAL STUDIES

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CAPITAL STRUCTURE AND PROFITABILITY OF SMALL PHARMACEUTICAL FIRMS: EVIDENCE FROM THE ALTERNATIVE INVESTMENT MARKET

Nurudeen AKINOLA, MSc*
Rod APPS, PhD**

Abstract

The relationship between capital structure and profitability remains a critical issue for finance scholars and corporate decision-makers. While prior studies have examined this relationship in the pharmaceutical sector, limited attention has been given to small pharmaceutical firms. This study investigates the impact of capital structure on the profitability of small pharmaceutical companies listed on the Alternative Investment Market (AIM) of the London Stock Exchange (LSE). Using a five-year panel dataset (2018–2022), three regression models (Ordinary Least Squares, Fixed Effects, and Random Effects) were estimated with R statistical software. Profitability was measured by return on assets (ROA) and return on equity (ROE), while capital structure was captured through debt-to-equity ratio, short-term debt, and long-term debt, with firm size included as a control variable. The findings reveal a significant negative relationship between short-term debt and ROA, and between debt-to-equity and ROE, while firm size exhibits a positive relationship with both profitability measures. This study extends existing literature by focusing on small pharmaceutical firms, offering insights into their capital structure decisions and the implications for firm performance.

Keywords: debt-to-equity, return-on-equity, return-on-assets, short-term debt, London Stock Exchange

JEL Classification: G32, C23, D22

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* *Sheffield Hallam University, Sheffield, United Kingdom. ORCID: https://orcid.org/0009-0004-1434-125X. Corresponding author, e-mail: Nurudeen Akinola olaoluwa349@outlook.com*

** *Associate Lecturer, Sheffield Hallam University, Sheffield, United Kingdom. ORCID: http://orcid.org/0009-0009-8245-0454*

1. Introduction

The pharmaceutical industry, with origins tracing back to Merck in 1668, has long been dominated by major firms such as GlaxoSmithKline, Pfizer, Eli Lilly, Bristol-Myers Squibb, Bayer, and AstraZeneca. While large pharmaceutical companies have traditionally led the industry, a paradigm shift in the late 1970s through the early 2000s saw the rise of small and medium-sized pharmaceutical firms, driven by innovation and technology. Notably, small firms account for the discovery of a significant share of new medicines—81% of drugs launched by large pharmaceutical companies (Jung et al., 2019), with 76% of such discoveries co-owned by larger firms (Kennedy et al., 2023).

Within the United Kingdom, the Alternative Investment Market (AIM) of the London Stock Exchange provides a platform for small and medium-sized growth companies. As of 2022, AIM hosted 816 companies with a combined market capitalization of £93 billion, of which pharmaceutical and biotechnology firms represented 7.5% of listings and 10.1% of market capitalization (£9.4 billion). Of the 61 AIM-listed pharmaceutical firms, most operate within the UK, with a few maintaining global or regional presence. Market capitalisations vary widely, from over £1 billion to under £100 million. However, the majority remain unprofitable, reflecting their concentration in clinical trials and early-stage research and development.

2. Research Gap

Capital structure, defined as the mix of debt and equity financing (Yegon et al., 2014), is one of the most critical managerial decisions due to its implications for risk, return, and firm value (Ullah et al., 2020). While equity and debt financing provide essential resources, both entail costs and obligations that influence profitability, with investors responding to financing choices through stock price movements (Myers, 1984). Thus, determining an optimal capital structure is vital for maximising firm value (Tailab, 2014).

Although prior studies (e.g., Mohammadzadeh et al., 2013; Enekwe et al., 2014; Dinh & Pham, 2020; Rehan et al., 2020; Jacob & Ajina, 2020; Tretiakova et al., 2021; Nwafor et al., 2022) have examined the capital structure–profitability nexus in pharmaceutical companies, they predominantly focus on larger firms. Tretiakova et al. (2021) specifically recommended further research considering firm

size. Accordingly, this study addresses the gap by investigating the extent to which capital structure influences the profitability of small pharmaceutical companies.

3. Literature review

3.1. Theories

The six alternative theories regarding the capital structure choice can be identified as Net income (NI), Net operating income (NOI), Traditional, M&M, pecking order, and Trade-off.

Capital structure and profitability are topics in finance that have been around for a long time and have witnessed a lot of academic effort from different scholars who have propounded theories to explain or provide an ideal solution; however, scholars recognised the complexity of the topic. According to Myers (1984), we know little about capital structure; we do not know how firms choose the debt, equity, or hybrid securities they issue. Patrick et al. (2021) further state that capital structure remains a riddle among researchers in the finance literature.

Prior to Modigliani and Miller's seminal 1958 work, three main approaches shaped the capital structure debate: the Net Income (NI) approach, the Net Operating Income (NOI) approach, and the Traditional approach. The NI approach (Durand, 1952) argued that capital structure influences firm value, as higher leverage lowers the weighted average cost of capital (WACC), thereby increasing profitability. Conversely, the NOI approach posited that capital structure is irrelevant, asserting that financing choices have no effect on firm value or WACC (Lawal, 2014). The Traditional approach proposed a compromise, suggesting that moderate use of debt reduces WACC and enhances firm value, but beyond an optimal point, excessive leverage increases financial risk and reduces value (Ahmadinia et al., 2012). These early theories faced criticism for overlooking agency costs, environmental shifts, and behavioural factors. Nonetheless, they provide a foundation for understanding how leverage and financing decisions may influence profitability.

Modigliani and Miller (1958) revolutionised capital structure theory, proposing that firm value is independent of financing choices (Proposition I) and that the cost of equity rises with leverage to offset the benefits of cheaper debt (Proposition II). In their 1963 revision, they incorporated corporate taxes, showing that interest deductibility provides a tax shield that enhances firm value. However, critics (e.g.,

Stiglitz, 1969; Baxter, 1967) noted the model's unrealistic assumptions, including the neglect of bankruptcy costs and risk heterogeneity.

With respect to *trade-off theory,* Kraus and Litzenberger (1973) extended M&M by incorporating bankruptcy costs, framing the trade-off between the tax benefits of debt and potential financial distress. Myers (1984) emphasised adjustment costs, leading to a "dynamic trade-off theory" (Fischer et al., 1989). While debt offers tax advantages, its value depends on balancing benefits against the costs of financial distress, with empirical evidence yielding mixed results (Fama & French, 1998).

In relation to the pecking order theory, Donaldson (1961) and later Myers and Majluf (1984) argued that firms prioritise internal financing, followed by debt, and, lastly, equity, to minimise costs and avoid control dilution. The theory highlights practical financing preferences but may not apply in highly leveraged firms (Yıldırım & Çelik, 2020).

The six capital structure theories yield mixed predictions. The NI approach suggests a positive relationship between leverage and profitability, while the NOI approach indicates a negative one. The Traditional, M&M, Trade-Off, and Pecking Order theories provide inconclusive outcomes, emphasising conditional or context-specific relationships. Overall, while theoretical insights are valuable, their assumptions—particularly the neglect of debt heterogeneity—limit real-world applicability. This gap underscores the need for empirical investigation to address the research question: "To what extent does capital structure impact profitability?"

3.2. Empirical literature review

The relationship between capital structure and profitability remains a central theme in empirical finance research, particularly within industries where research and development (R&D) and regulatory costs are high, such as pharmaceuticals. Theoretically, the debate is shaped by Modigliani and Miller's (1958) irrelevance proposition, the Pecking Order Theory (Myers & Majluf, 1984), and the Trade-off Theory (Kraus & Litzenberger, 1973). However, empirical findings show little consensus, particularly for smaller firms that often face greater financing constraints, information asymmetries, and volatility in earnings. This section reviews empirical studies on capital structure and profitability, focusing on small and pharmaceutical firms, and highlights the gap this study addresses.

Evidence from Small and Medium Enterprises (SMEs)

Several studies have investigated the financing choices of SMEs, providing useful insights for understanding smaller pharmaceutical firms. Abeywardhana (2015) examined the capital structure and profitability of UK SMEs, employing regression analysis with return on assets (ROA) and return on capital employed (ROCE) as profitability measures, and short-term debt, long-term debt, and total debt as capital structure proxies. The results indicated a significant negative relationship between all forms of debt and profitability, but a positive relationship between firm size and profitability. The author argued that SMEs in the UK primarily rely on internally generated funds to avoid the risks associated with external debt, a finding consistent with the Pecking Order Theory.

In contrast, Ferati and Ejupi (2012) studied small firms in Macedonia using an ordinary least squares regression approach. They measured profitability with return on equity (ROE) and capital structure using short-term debt, long-term debt, and total debt. The findings showed that short-term debt and equity positively correlated with ROE, while long-term debt had a negative effect. This result is different from Abeywardhana (2015), suggesting that country context, institutional frameworks, and access to credit significantly influence how SMEs finance their operations. Together, these studies indicate that SMEs face unique financing challenges, but their reliance on debt and its effect on profitability varies across regions.

Evidence from Pharmaceutical Companies Globally

Research has also explored the relationship between capital structure and profitability within the pharmaceutical industry, where capital intensity and long R&D cycles complicate financing decisions. Mohammadzadeh et al. (2013) studied 26 Iranian pharmaceutical firms between 2001 and 2010. Using correlation and regression analysis, they measured profitability with ROA, ROE, and net profit margin, while short-term, long-term, and total debt were used to represent capital structure. The results revealed a significant negative relationship between all forms of debt and profitability, with firms predominantly financing operations internally, aligning with the Pecking Order Theory.

Similarly, Enekwe et al. (2014) analysed five Nigerian pharmaceutical companies using regression methods, finding that the debt ratio and debt-to-equity ratio negatively affected ROA, while interest coverage had a positive effect. Their findings were consistent

with Mohammadzadeh et al. (2013), reinforcing the negative impact of leverage on pharmaceutical profitability in emerging markets.

Rehan et al. (2020) extended this line of inquiry to Pakistan, studying seven listed pharmaceutical companies from 2007 to 2018 using regression and Pearson correlation methods. Their results showed that debt-to-equity ratios were negatively associated with profitability, measured by ROE, ROCE, net profit margin, and earnings per share. These findings aligned with the evidence from Iran and Nigeria.

Jacob and Ajina (2020) investigated the Indian pharmaceutical sector, analysing five listed firms between 2016 and 2020. Using regression analysis, they found a negative relationship between debt-to-equity ratios and ROE, in line with the Net Operating Income approach, and consistent with Mohammadzadeh et al. (2013), Enekwe et al. (2014), and Rehan et al. (2020).

However, Dinh and Pham (2020) reported divergent findings in Vietnam, where long-term assets, leverage-to-assets ratio, and debt-to-assets ratio positively influenced profitability, while equity-to-assets had a negative relationship. Using least squares regression on data from 30 firms (2015–2019), they attributed their findings to the growth strategies of Vietnamese pharmaceutical firms, which may rely more heavily on external debt for expansion.

Tretiakova et al. (2021) conducted one of the most comprehensive recent studies, analysing 185 pharmaceutical companies in the UK using panel data regression and Wald tests. The findings showed that short-term debt was negatively correlated with ROA, return on investment, and firm value. Long-term debt negatively affected market valuation and price-to-book ratio, while equity positively influenced market value but negatively impacted ROA and price-to-book ratio. Importantly, Tretiakova et al. (2021) recommended further investigation into smaller firms, given their distinct financing needs and vulnerabilities.

Nwafor et al. (2022) explored Nigerian pharmaceutical companies (2011–2020) using correlation and regression analysis. Their findings showed that both debt-to-equity and total debt ratios negatively influenced profitability measured by ROA. This evidence was consistent with the negative impact of debt found in the UK and other emerging markets, further strengthening the case for caution in the use of leverage.

Overall, while studies on SMEs and pharmaceutical companies provide valuable insights, the evidence does not converge to a clear consensus. Most studies (Mohammadzadeh et al., 2013; Enekwe et al., 2014; Rehan et al., 2020; Jacob & Ajina, 2020; Tretiakova et al., 2021; Nwafor et al., 2022) report a negative relationship between debt ratios and profitability, consistent with the Pecking Order Theory. However, exceptions (e.g., Dinh & Pham, 2020) suggest that context, economic environment, and firm strategy can alter this relationship. Firm size often shows a positive effect on profitability, reflecting economies of scale and greater market power.

Despite this growing body of work, there remains a significant gap: no empirical study has focused on **small pharmaceutical companies**. These firms are particularly distinct, as they are often listed on the Alternative Investment Market (AIM) of the London Stock Exchange (LSE), rely heavily on R&D, and face limited cash flows compared to larger pharmaceutical companies. This study responds to Tretiakova et al.'s (2021) recommendation by examining how capital structure affects profitability in small pharmaceutical firms.

The expected relationships, informed by the reviewed literature, are summarised in Table 1.

Table 1

Expected relationship between capital structure and profitability

Proxy variable	Measurement	Expected relationship with profitability
Short-term Debt (STD)	Short-term debt to total assets	Negative with ROA
Long-term Debt (LTD)	Long-term debt to total assets	Negative/Uncertain with ROA
Total Debt (TDR)	Total debt to total assets	Negative with ROA and ROE
Debt-to-Equity Ratio (DER)	Total debt / Equity	Negative with ROE
Firm Size (Control) (FS)	Market value as of 2022	Positive with ROA and ROE

Source: Authors' contribution

4. Methodology

This study adopts a positivist research philosophy, which assumes that financial phenomena can be objectively observed and measured using quantitative techniques. The focus is on testing the extent to which capital structure affects the profitability of AIM-listed

pharmaceutical companies, thereby seeking to validate or reject predictions derived from established theories. Following a deductive approach, the study builds on the Trade-off Theory (Modigliani & Miller, 1963), Pecking Order Theory (Myers & Majluf, 1984), and Agency Theory (Jensen & Meckling, 1976) to examine empirical evidence within the context of small pharmaceutical firms.

The analysis is based on a panel dataset comprising twenty-eight AIM-listed pharmaceutical companies over five years from 2018 to 2022. Firm-level financial data were obtained from publicly available annual reports and verified databases to ensure reliability. This sector was chosen because small pharmaceutical firms often differ significantly from both larger pharmaceutical and non-pharmaceutical firms; they are typically more research-intensive, face constrained cash flows, and are subject to unique financing challenges, making them particularly suitable for studying the relationship between capital structure and profitability (Tretiakova et al., 2021).

Profitability is measured using return on assets (ROA) and return on equity (ROE), in line with prior literature (Enekwe et al., 2014; Rehan et al., 2020). Capital structure is proxied by short-term debt to total assets, long-term debt to total assets, and the debt-to-equity ratio. Firm size, measured as the natural logarithm of total assets, is included as a control variable to account for the potential scale effects identified by Abeywardhana (2015).

To investigate the relationship between capital structure and profitability, the study employs a panel regression framework. Ordinary Least Squares (OLS) is used as a baseline estimator, while Fixed Effects (FEM) and Random Effects Models (REM) are applied to account for unobserved heterogeneity across firms. The Hausman test guides the selection between FEM and REM, ensuring that the chosen specification provides consistent estimates. Panel data are particularly appropriate for this research, as they exploit both cross-sectional and time-series variation.

The regression model is formally expressed as ROA Model (1) and ROE Model (2).

$$ROA_{i,t} = \beta_0 + \beta_1 STD + \beta_2 LTD + \beta_3 TDR + \beta_4 DER + \beta_5 FS + \varepsilon_{i,t} \quad (1)$$

$$ROE_{i,t} = \beta_0 + \beta_1 STD + \beta_2 LTD + \beta_3 TDR + \beta_4 DER + \beta_5 FS + \varepsilon_{i,t} \quad (2)$$

i = firm and t = period.

Standard diagnostic tests for heteroscedasticity and multicollinearity are conducted to ensure robustness of the estimates.

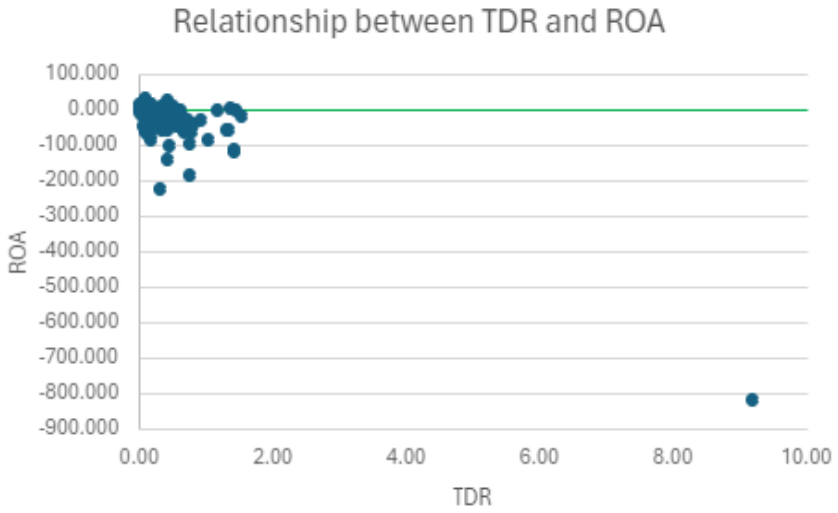
The adoption of OLS, FEM, and REM is consistent with studies in both pharmaceutical and broader SME contexts (Mohammadzadeh et al., 2013; Jacob & Ajina, 2020), allowing for comparability of results and enhancing the credibility of the findings. This methodology thus provides a rigorous framework for addressing the research question concerning the extent to which capital structure impacts the profitability of small pharmaceutical firms listed on the AIM.

5. Findings and discussion

The findings start with the visual relationship between capital structure and profitability.

Figure 1

Total debt ratio and return on assets

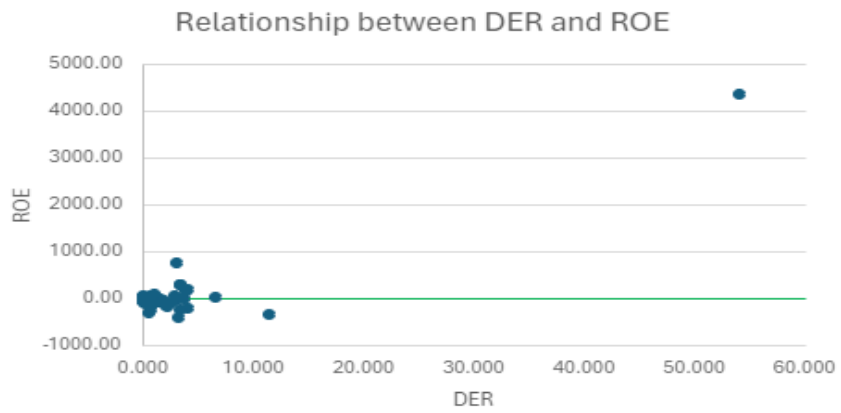


Source: Author's own illustration

As shown in Figure 1, the data points are clustered, indicating distinct characteristics except for an outlier. The outlier has a low asset in the year 2018, and it impacts the ROA calculation.

Figure 2

Debt-to-equity ratio and return on equity



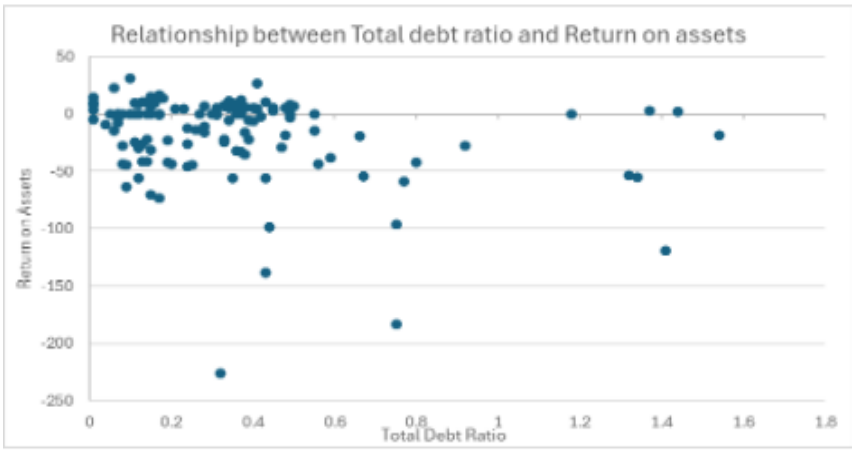
Source: Author's own illustration

The clustered points in Figure 2 suggest that the data points follow the same pattern; however, there is an outlier. The outlier was identified as having negative total equity and a loss in 2020.

The extreme outliers in Figures 1 and 2 might have a potential implication for the results of the regression models. The study will proceed without the extreme outliers.

Figure 3

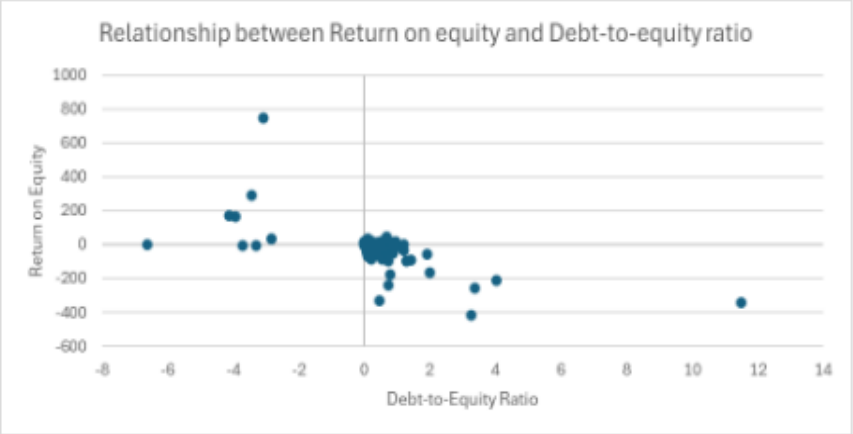
Total debt ratio and return on assets



Source: Author's own illustration

Figure 4

Debt-to-equity ratio and return on equity



Source: Author's own illustration

These scattered plots, without the extreme outliers in Figure 3, suggest no clear relationship between ROA and TDR (Long-term and Short-term), whereas the clustered data points in Figure 4 suggest a relationship. However, the direction of the relationship is not clear.

Empirical Analysis and Discussion

This study examined the relationship between capital structure and profitability in AIM-listed pharmaceutical companies, using a fixed effects model (FEM) for return on assets (ROA) and a random effects model (REM) for return on equity (ROE). After excluding two outliers, the analysis was conducted on 26 firms. Robustness checks confirmed FEM and REM as the most appropriate models.

Table 2

The Hausman test - ROA

Hausman Test
data: ROA ~ STD + LTD + DER + FS
chisq = 2.3159, df = 4, p-value = 0.6779
alternative hypothesis: one model is inconsistent

Source: Authors'

The p-value of 0.6779 in the Hausman test result, which is greater than conventional significance level of 0.05 chosen by the study suggests that either of the models is appropriate to predict ROA. However, the study also ran Breusch-Pagan multiplier test on REM before a decision was made. The Breusch-Pagan multiplier test is used to determine whether random effects are significant in a panel data model (Rehal, 2022). The result is shown in table 5.3.6 below.

Table 3

Lagrange Multiplier test result

```
    Lagrange Multiplier Test - (Breusch-Pagan)

data:  ROA ~ STD + LTD + DER + FS
chisq = 64.824, df = 1, p-value = 8.19e-16
alternative hypothesis: significant effects
```

Source: Authors'

The significantly high Chi-square (64.824) and low p-value (8.19e-16) in the result suggest that the random effects model may not be appropriate. This result shows evidence against the null hypothesis and suggests that heteroscedasticity is present in the REM, therefore the study chose the fixed effect model.

Table 4

ROA Model

```
          Balanced Panel: n = 26, T = 5, N = 130

Coefficients:
       Estimate   Std.Error  t-value   Pr(>|t|)
STD -89.9107349   3.4241240 -26.2580   <2e-16 ***
LTD  -9.2601650  15.7151137  -0.5893   0.5570
DER   0.2647648   0.5542052   0.4777   0.6339
FS    0.0053002   0.0071517   0.7411   0.4604

Total Sum of Squares:    586870
Residual Sum of Squares: 73671
R-Squared:      0.87447
Adj. R-Squared: 0.83806
F-statistic: 174.153 on 4 and 100 DF, p-value: < 2.22e-16
```

Source: Authors'

The results indicate that short-term debt has a statistically significant and negative relationship with ROA (t-value = –26.258, 95%

confidence). Specifically, an additional unit of short-term debt reduces ROA by approximately 0.89 units. Case analysis of firms with high short-term debt (Redx Pharma and Hvivo PLC) revealed persistent net losses despite increased borrowings, suggesting reliance on debt to remain operational. Conversely, firms with little or no short-term debt (Ixico PLC and Anpario PLC) reported positive ROA and ROE throughout the study period.

Table 5

ROE Model

```
Balanced Panel: n = 26, T = 5, N = 130

Coefficients:
               Estimate  Std. Error  z-value  Pr(>|z|)
(Intercept)   7.4618319  14.4288284   0.5171    0.6051
STD          -7.3902664  11.5632759  -0.6391    0.5227
LTD          30.6455082  48.1574290   0.6364    0.5245
DER         -76.0548740   1.9235449 -39.5389    <2e-16 ***
FS            0.0049942   0.0180484   0.2767    0.7820

Total Sum of Squares:    18730000
Residual Sum of Squares: 1285200
R-Squared:      0.93138
Adj. R-Squared: 0.92919
Chisq: 1696.66 on 4 DF, p-value: < 2.22e-16
```

Source: Authors'

The ROE model identified the debt-to-equity ratio as the only significant predictor. A one-unit increase in debt-to-equity is associated with a 0.76 fall in ROE (95% confidence). Other variables, including long-term debt and firm size, were statistically insignificant.

Table 9

Correlation coefficient matrix

	ROA	ROE	STD	LTD	TDR	DER	FS
ROA	1	-0.0727	-0.8711	-0.0557	-0.8647	0.0938	0.0529
ROE		1	0.028	0.2733	0.0966	-0.9641	-0.0295
STD			1	-0.036	0.9673	-0.0455	-0.0485
LTD				1	0.2184	-0.2711	0.0244
TDR					1	-0.1132	-0.0411
DER						1	0.0384
FS							1

Source: Authors'

The magnitude of the statistically significant variables (short-term debt and debt-to-equity ratio) in Tables 4 and 5 is consistent with the coefficients in Table 9.

Comparison with Theory and Literature

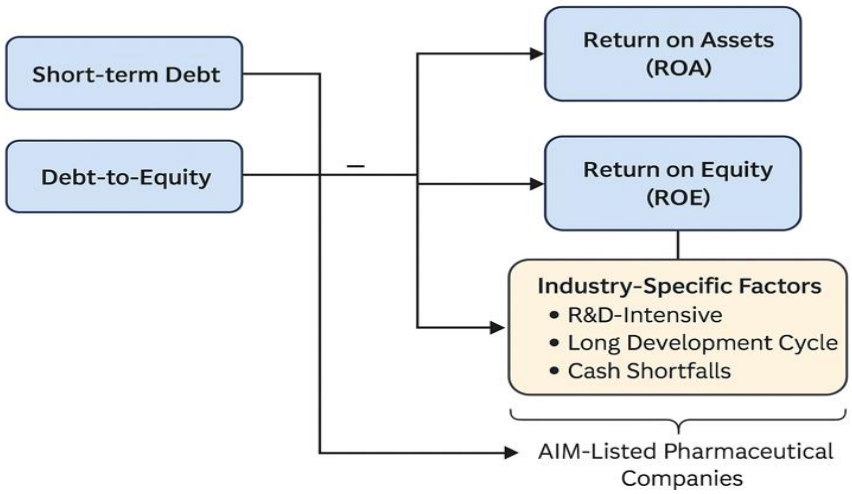
The findings align with the net operating income (NOI) approach, which posits that capital structure is largely irrelevant to firm valuation. The negative association between short-term debt and ROA, and between debt-to-equity and ROE, corroborates prior studies on pharmaceutical firms (e.g., Mohammadzadeh et al., 2013; Tretiakova et al., 2021; Mathur et al., 2021; Afroze & Khan, 2022). However, unlike Dinh and Pham (2020), this study did not observe a positive relationship between debt and profitability.

Implications

The results suggest that profitability challenges in AIM-listed pharmaceutical firms stem less from capital structure and more from their operational realities: long R&D cycles (10 –15 years), high upfront costs, and dependence on acquisitions by larger firms (Gelijns & Halm, 1991; Kennedy et al., 2023; Schuhmacher et al., 2023). The reliance on short-term debt appears to be a survival strategy in the face of sustained negative returns, rather than a driver of profitability.

Figure 5

Conceptual Framework



Source: Author's own illustration

The framework in Figure 5 illustrates how short-term debt and debt-to-equity, as significant components of capital structure, negatively influence return on assets (ROA) and return on equity (ROE), respectively. It also highlights the moderating role of industry-specific factors, such as high R&D costs, long drug development cycles, and limited revenue streams, which amplify the reliance on short-term financing and shape the profitability outcomes of AIM-listed pharmaceutical firms.

6. Conclusion

This study examines the relationship between capital structure and the profitability of small pharmaceutical firms with 26 AIM-listed companies, totalling 130 observations. This study concludes that while capital structure variables such as short-term debt and debt-to-equity significantly influence profitability, their negative impacts are indicative of broader sectoral challenges. Thus, capital structure alone does not determine profitability; instead, the financial fragility of AIM-listed pharmaceutical firms is deeply linked to their R&D-intensive business models and delayed revenue generation.

This study investigated the relationship between capital structure and profitability among AIM-listed small pharmaceutical companies, but several limitations constrain the findings. The limited literature on small pharmaceutical firms restricted the theoretical foundation, while profitability was measured solely by ROA and ROE, with firm size as the only control variable. The focus on Alternative Investment Market (AIM)-listed firms (a developed market managed by the London Stock Exchange) limits generalisability to other sectors or emerging economies. Industry-specific factors, such as the lengthy payback period and high costs of drug development, were excluded. Several firms reported net losses between 2018 and 2022, which may have influenced the results. Moreover, the study examined only the impact of capital structure on profitability, without testing reverse causality. Future research should therefore explore the bi-directional relationship between capital structure and profitability, extend analysis to small firms in other industries, and incorporate broader profitability measures and controls to enhance generalisability.

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DEVELOPMENT OF THE GOVERNMENT SECURITIES MARKET OF THE REPUBLIC OF MOLDOVA THROUGH INCREASING THE INVESTMENT ATTRACTIVENESS OF THESE INSTRUMENTS

Rodica HINCU, PhD*
Ana LITOCENCO, PhD**

Abstract

In the current period, when countries, including the Republic of Moldova, need to identify financial resources, the need is constantly growing, and investors are increasingly interested in diversifying their investment portfolios into safe and profitable financial instruments. The development of the government securities market and increasing the attractiveness of these financial instruments are becoming primary considerations and objectives. The purpose and objective of this article is to provide an analysis of the particularities of the Moldovan government securities market, international experiences and best practices on this topic (Romania, Hungary, Türkiye, Brazil, Canada) with a view to identifying opportunities for development of the Moldovan government securities market. The development opportunities identified by the authors as a result of the research focus on aspects aimed at increasing the attractiveness of Moldovan government securities and diversifying the investor base, such as market accessibility, the diversity of instruments, financial benefits, and opportunities to manage related investment risks. The methodology includes analytical, descriptive, synthesis, quantitative, qualitative, comparison, and graphical methods.

Keywords: government debt instruments, sovereign bond market, investors, investment appeal, development

JEL Classification: G15, G18, G23, G24, H63

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* *Professor, Technical University of Moldova, Chișinău, Republic of Moldova. ORCID: https://orcid.org/0000-0002-6939-2861*
** *Ministry of Finance, Chișinău, Republic of Moldova. ORCID: https://orcid.org/0000-0001-7649-8894. Corresponding author, e-mail: ana.litocenco@mf.gov.md*

1. Introduction

Emerging as a source of funding for state needs, currently, government securities (GS) are widely used by most countries in the world to cover the budget deficit and provide the state with the resources needed to finance the economy. The recession of 2020 caused by the Covid-19 pandemic, the severe drought of 2021 that took place in the Republic of Moldova and the energy crisis of the years 2021-2022, led to a series of price increases in both regional and domestic energy resources and food products, have created new global and national challenges, emphasising the need for all the countries, including the Republic of Moldova, for guidance on domestic GS markets in order to obtain financing needs. At the same time, as GS are fully guaranteed by the State and accompanied by certain financial advantages (interest, tax exemptions), they are an important financial instrument for investors. As a result of developments over time in the sector and in the financial markets, investments in GS have become a viable alternative to savings and investing for the population and economic agents, providing: investment risk management and protection opportunities; possibilities to use, as a reference instrument, for pricing other debt instruments and as a financial guarantee for the purpose of securing financial transactions (OECD, 2019). Given the importance of the resources obtained through the GS market, its development is a firm objective for the Moldovan authorities (Darovanaia, 2005).

2. Literature review

In essence, GS are financial instruments which attest public debt, which are State loans for a certain period, carried out with the aim of developing the country's economy, supporting investment activity, creating new jobs, etc. (Hîncu & Litocenco, 2020). Irrespective of the type of financial instrument, investors' decisions to place the investment are determined by a number of issues, including: market aspects, the potential of expected gains, the economic, political and legal environment of each economy, etc. At the same time, investment activity is successful when a number of factors are cumulated, such as will, energy, information, time and financial resources (Litocenco, 2015). Therefore, an effective investment policy serves as a sound assurance that investors can operate, activate and invest in a properly manner, in a sufficiently regulated business environment, which is why attracting investment must be one of the main objectives of a State

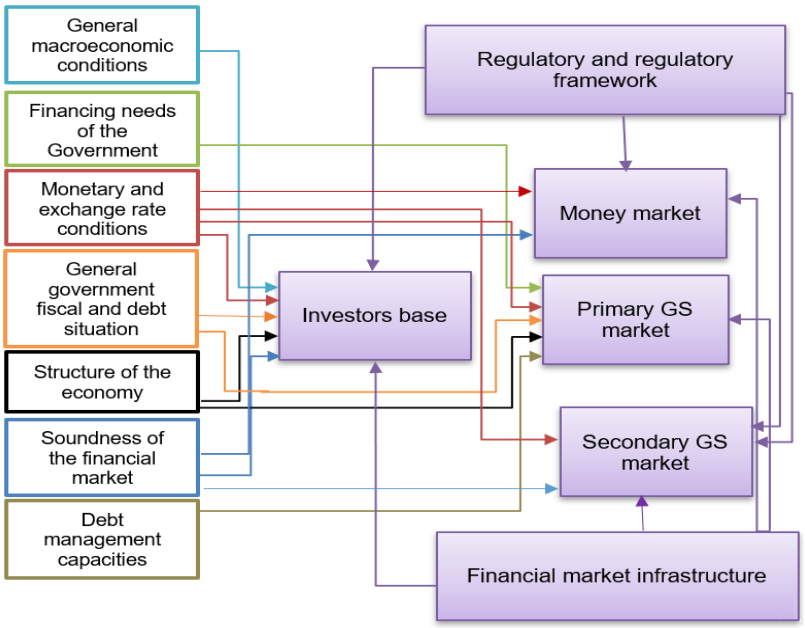
(Litocenco, 2016). This action may lead to diversifying the investor base, including attracting foreign investors to the market.

Given the importance of GS as a source of funding for the state and an investment instrument, greater attention has been paid, particularly in the last two decades, to the development of the GS market through various research and analysis (International Monetary Fund & World Bank (2021), Muharam H., Ghozali I. (2018), Ebeke C., Lu Y. (2015), Pradhan Z., Maradana R.P. (2015), Matei I. (2013). According to these researches, a developed internal GS market can contribute to: diversification of sources of state funding; safeguarding issuance portfolios against certain currency mismatches and maturities; preventing financial crises in emerging markets. The smooth functioning of the GS markets largely supports governments in carrying out and implementing their policy initiatives; helps to better connect investors with existing investment opportunities, based on profitability and risk management preferences; facilitates the financing of infrastructure projects; reduces reliance on foreign currency loans and bank financing. The development of efficient GS markets is vital, especially for developing countries, as they ensure an efficient use of capital for productive investments, promote job creation and prosperity.

According to the Methodological Guide for the development of the GS internal market, developed jointly by the World Bank, the International Monetary Fund, the European Bank for Reconstruction and Development and the Organisation for Economic Co-operation and Development, the development of the GS market is driven by certain mandatory conditions and components (Figure 1).

Figure 1

Conditions for GS market development and its basic components



Source: International Monetary Fund & World Bank (2021)

The conditions reflected in Figure 1 influence the direction of development of the GS market, in particular, the evolution of four components (money market, primary market, secondary market, and investor base) out of the six components of the GS market. The other two components (regulatory framework and financial market infrastructure) are adapting to market developments.

A well-developed GS market is more attractive to investors, offering various investment opportunities (types of instruments and maturities) and the possibility to effectively minimise and manage the related investment risks. In turn, increasing the attractiveness of GS investment contributes to the development of the GS market by attracting new investors.

The concept of „attractiveness and investment activity" has been researched by many foreign (Iasimraroi S., Ulubasoglu M.A. (2015), Fîrțescu B. (2005) and local researchers (Hîncu R., Litocenco A. (2020), Hîncu R., Gumovschi A., Suhovici A. (2010). The analysis

of the investment attractiveness concept allowed us to observe that it has a wide range of interpretations (Table 1).

Table 1

Approaches to the investment attractiveness concept

Researcher	Interpretations
Kiofficva A., Semina A.	*The level of favourable economic conditions in a country or region for investment.* *All the organisational, economic, financial, and legal conditions that facilitate the investor's selection of the investment object to obtain certain benefits.* *Subjective assessment by the investor of the investment object in terms of the appropriateness of allocating financial resources.*
Mișkin F.I.	*The existence of investment conditions, which influence investors' preferences in the process of selecting the investment object.*
Burman G., Schmidt C.	*All indicators that characterise an entity's financial situation.*
Bociarov V.	*Safety of securities issued by an entity*.
Stanecova M.	*The existence of the economic effect (profit) of placing cash in corporate securities while minimising risks.*
Blanc I.A.	*Key elements of investment attractiveness - characteristics of the investment qualities of a specific investment object, which are assessed by the investor. The investment attractiveness reflects the direction of an entity's investment policy and is directly interconnected with the entity's life cycle stages.*
Hîncu R., Gumovschi A., Suhovici A	*Totality of benefits generated by certain economic conditions, which increase the profitability of the investment, by minimising the risks associated with the investment process.*

Source: Litocenco, A. (2024a)

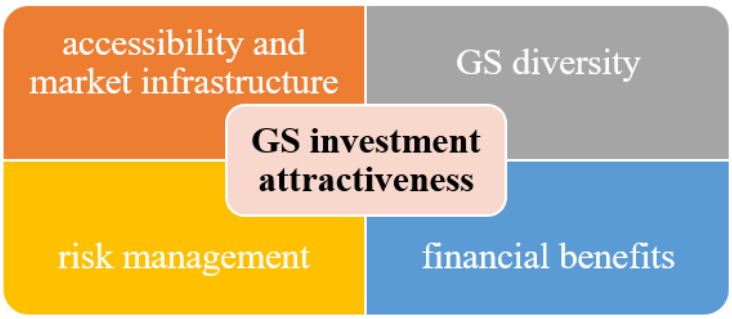
From the abovementioned interpretations of the investment attractiveness concept, we note that it has been studied, predominantly in relation to a geographical area, to an entity interested in attracting investments or in relation to corporate securities, from the perspective of attracting investors by the issuer (company) of those securities.

Thus, given that, to date, GS have been studied and researched to a large extent in the light of the development of the GS market, and the investment attractiveness has predominantly been studied from the perspective of a country, region, industry or company (as an investment object), in our view, the investment attractiveness of GS represents all the organisational, financial, legislative factors and conditions which determine the investor, on the basis of certain reasoning, to place its financial availabilities and savings in the GS.

These factors, conditions and reasoning may, in our view, be grouped into the following determinants of GS investment attractiveness (Figure 2).

Figure 2

Determinants of GS investment attractiveness



Source: prepared by authors

Market accessibility consists of providing wide access to financial instruments, fair treatment and conditions for all investors in the GS market, which requires the State to provide conditions that encourage the active participation of various categories of investors in the process of issuing and trading GS. At the same time, a developed GS market *infrastructure* enhances market access for investors as well as guarantees the safety and security of transactions. The *diversity of the GS* ensures greater satisfaction of investors' preferences, thus attracting more investors but also new categories of investors, which contributes to increased demand for GS, the development of the GS market and the reduction of State refinancing risks and lower costs for issuing GS. The *financial benefits* associated with GS are financial income in the form of interest and returns that can be obtained by investors as a result of their investments, and the tax regime applicable (whether exempt from income tax or not). Although guaranteed by the State, investments in GS, like any investment, are accompanied by certain risks (inflation, liquidity, interest rate, etc.). *Risk management* and opportunities are very important for investors to protect their investments.

3. Data sources and used methods

For the purpose of collecting the research data, the following research methods have been used: analytical method, descriptive method, synthesis method, quantitative and qualitative analysis methods, comparison method, and graphical method. The information support is the legal framework, publications and statistical data of the central public administration authorities of the Republic of Moldova (Ministry of Finance, National Bank of Moldova, National Commission of the Financial Market) and the Ministry of Finance, central banks and state debt management authorities of the following states (Brazil, Canada, Romania, Türkiye and Hungary), as well as scientific research carried out on the subject of the study, presented in specialist journals, at national and international conferences, etc.

4. The results of research and discussions

According to the statistical data (Table 2), the volume of GS issuances on the GS primary market of the Republic of Moldova in 2024 reached a record 40,3 billion MDL, exceeding by about four times the volume of issuances in 2017.

Table 2

Evolution of issuances, redemptions and related costs GS issued on the primary market of R. Moldova in 2017-2024

Indicators	2017	2018	2019	2020	2021	2022	2023	2024
GS issued, billion MDL	9,9	9,8	9,3	18,1	25,3	26,3	34,7	40,3
GS redemptions, billion MDL	8,8	9,1	9,0	12,1	21,0	27,0	29,2	34,5
Net financing of the SB deficit through GS, billion MDL	0,6	0,6	0,7	6,1	4,0	0,1	6,5	4,9
GS service, billion MDL	0,8	0,4	0,4	0,6	0,8	1,4	3,0	1,7
GS service (share of budget revenue), %	2,4	1,2	1,1	1,5	1,7	2,5	5,0	2,6
Domestic state debt service ratio in budget revenues, %	4,6	3,1	3,0	3,4	3,2	4,8	6,5	3,9
Sovereign debt sustainability, %	≤15%	≤15%	≤10%	≤10%	≤10%	≤8%	≤10%	≤10%

Source: provided by authors, based on data from the Ministry of Finance of the Republic of Moldova

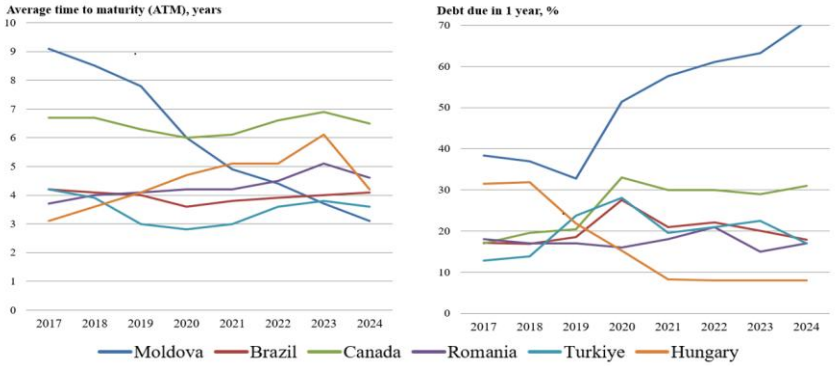
A significant value is also shown in the case of GS redemptions in 2024 – 34,5 billion MDL, which is 5,3 billion MDL more than in 2023. In 2024, the net financing of the State budget deficit through GS amounted to 4,9 billion MDL. This volume was considerable compared to the other years of the analysed period, especially since in 2022 no financial resources were channelled from the GS market to finance the budget deficit, and 0,1 billion MDL were allocated from the State budget to honour commitments to investors. However, this amount is 1,6 billion MDL less than in 2023, a situation which is explained by the increase in GS redemptions in 2024.

At the same time, in this research, attention was paid to the state debt sustainability. Therefore, it is worth mentioning that though there was an increase in the volume of GS issued in 2024, the GS service decreased at 1,7 billion MDL (which is 1,3 billion MDL less compared to 2023), or 2,6% of the total budget revenue (excluding grants) This decrease is due to the fact that in 2024 the interest rate of GS issued on local market decreased from around 16% in January 2023 to about 6% at the end of 2024.

In the context of events affecting the world in the period under review, increasing demand for state funding and increasing levels of public sector debt have led to higher *refinancing* needs, not only for the Republic of Moldova. Therefore, for a broader, individualised and complex analysis, including on the basis of statistical data, in addition to the domestic market of GS, the characteristics of the GS markets of the following countries have been analysed: Brazil, Canada, Romania, Türkiye and Hungary. International practices were used to identify the best experiences and opportunities for taking over and implementing them in the Republic of Moldova.

According to statistical data related to the *refinancing risk indicators* of Republic of Moldova's domestic debt (Figure 3), it appears that between 2017 and 2024 there was a reduction in the *average time to maturity* (ATM) of domestic government debt (from 9.1 years in 2017 to 3.1 years in 2024) and an increase in the debt ratio maturing over 1 year (from around 38% in 2017 to 71.0% in 2024). This shows an increase in the refinancing risks of domestic debt of the Republic of Moldova.

Figure 3
Dynamics of refinancing risk indicators of domestic debt of the R. Moldova and the analysed countries in 2017-2024



Source: prepared by authors based on data from the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

In the case of Brazil, Hungary and Türkiye, a similar situation to R. Moldova's increased refinancing risks, where the coverage of the funding needs from the short-term GS issuance led to the reduction, between 2018 and 2020, *of the average time to maturity* of the domestic debt stock and the increase *in the debt ratio maturing over 1 year* in total domestic debt towards the end of 2020, the latter reaching around 30%. Towards the end of 2024, with the recovery of the economy and the return to moderate GS issuance in *the short term, the refinancing risk* of their domestic debt declined compared to 2020.

From numerous research studies (Hîncu et al,, 2010, Matei, 2013, Kapingura & Markheta-Kosi, 2014, Pradhan et. al, 2015, 2016, Muharam et al., 2018, OECD, 2019, 2021, Litocenco A., 2024), the authors of the article have concluded that, in order to mitigate the refinancing risks of domestic State debt, the State may take the following measures:

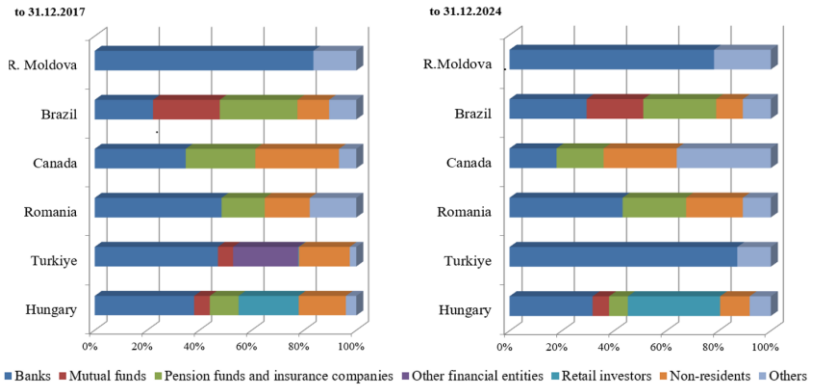
- *planning the debt redemption profile through the issuance and construction of benchmark GS* – the debt redemption profile determines the level of indicators to measure refinancing risk. The objective of this measure is to maintain the same redemption profile each year by issuing a concrete volume of GS at the same maturity conditions, so that the redemption profile remains at the same level in terms of maturity and values.

- *application of State debt management operations*, such as: early repurchase and switching operations, in order to obtain a certain structure of the sovereign debt portfolio.
- *diversification of sources of State funding on the GS market by diversifying the range of investors*, through increasing the GS investment attractiveness, based on the 4 determinant elements identified by the authors which is further analysed and developed in this article.

Thus, in the Republic of Moldova, there is a very poorly diversified investors base on the GS market, which is heavily concentrated on banks, which held around 78.3 % of the volume of GS in circulation at the end of 2024 (Figure 4), a slight decline (5,3 p.p. less) compared to 2017. A similar situation, for the same period of analysis, of the concentration of the range of investors in the domestic GS market is evidenced in the case of Türkiye, with 87,2.0 % of the outstanding GS in the banking sector.

Figure 4

The structure of the investors based on the GS market of the Republic of Moldova and the selected countries, 2017 and 2024



Source: prepared by authors based on data of the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

The remaining analysed countries have a *wider and more diverse investor base*. Thus, significant shares in the internal GS market in Brazil, Canada and Romania accrue to pension funds and insurance companies (21,7 %, 18.0 % and 24.3 % respectively). Significant GS holdings are also registered as retail investors in the Hungarian GS domestic market

(35.3 %). Looking at the dynamic structure of the investor mix of the analysed countries shown in Figure 4, most of them show that the banks' GS holdings have increased, which is due to the high financing needs of the economies of the 5 countries analysed, which increased between 2020 and 2024, as banks are the main category of investors that meets the offer of GS in the short term. Also, against the backdrop of international uncertainties and the consequences of the Covid-19 pandemic, it is noted that, for all analysed states, the share of foreign investors declined towards the end of 2024.

In order to better understand the behaviour of investors in the domestic GS markets, the authors of the article investigated national and international practices regarding the GS investment attractiveness reflecting them on the basis of the four key determinants of the GS investment attractiveness identified by the authors, namely: 1) *accessibility and market infrastructure; 2) VMS diversity; 3) financial benefits and benefits; 4) risk management.*

4.1. Accessibility and market infrastructure

The placement and distribution of GS in the primary market of the Republic of Moldova and in the analysed States are conducted through tenders, with primary dealers represented by commercial banks (Table 2).

Table 2

Methods of placing GS on the domestic GS market of the Republic of Moldova and the analysed countries

States	Retail sales of VMS	Primary dealers
R. Moldova	E-VMS programme	commercial banks
Brazil	Tesouro Direto programme	commercial and investment banks; investment companies; foreign entities
Canada	Canada Savings Bonds programme Canada Premium Bonds programme	commercial and investment banks; investment companies
Romania	The "Thesaurus" programme The 'Fidelis' programme	credit institutions (banks); resident and non-resident investment companies (authorised in EU States)
Türkiye	GS denominated in gold.	commercial banks.
Hungary	7 VMS lines/ programmes for population	commercial and investment banks; investment companies.

Source: prepared by authors based on data of the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

In order to diversify sources of funding by attracting retail investors, most States, analysed in this research, have implemented *GS retail sales programmes,* increasing the accessibility and attractiveness of GS (Table 2). In the case of the Republic of Moldova, with a view to diversifying investors, facilitating the accessibility and developing the infrastructure of the domestic GS market, and increasing financial education, the authorities initiated in 2022 the conceptualisation of a programme for direct trading of GS to the population. Thus, on 31 July 2024, the e-VMS retail platform was launched, the first subscription by means of the e-VMS platform taking place in December 2024, during which the State made available to individuals a volume of 500 000 government bonds, with a 2-year maturity, at a fixed interest rate of 6 % (which is more attractive than the interest on bank deposits), and the coupon payment made on a semi-annual basis. As a result of the subscription, the individuals acquired GS in the amount of 78.7 million MDL, which is 28.7 million MDL more than the state's offer. This over-demand in comparison to supply shows the success of the launch of the platform, the interest of citizens in safe financial instruments, the increasing accessibility of the population to the GS market and thus the increased attractiveness of GS investment. From the second quarter of 2025, subscriptions to the e-VMS platform are made on a monthly basis.

Another method of attracting investors, especially foreign investors, to the domestic GS markets and facilitating their access, implemented by most of the countries analysed, was to *establish an interconnection between the domestic depository and an international depositary*, such as Euroclear (Türkiye and Romania) and Clearstream (Canada, Hungary and Romania). In the Republic of Moldova, the establishment of such interconnection is under discussion between the relevant authorities and institutions and external partners.

4.2. GS diversity

GS offered for placement on the internal market, it appears that, compared to the other countries analysed, the Republic of Moldova offers a relatively modest range of GS to investors, which are limited to traditional GS – fixed rate, floating interest rate and zero-coupon type (Table 3). In addition, between 2017 and 2023, the authorities of the Republic of Moldova introduced three new GS lines with maturities of 5 years (in 2018), 7 years (in 2021) and 10 years (in 2023), but they were not issued regularly.

Looking at international practice, in the analysed countries, the proposed GS is more varied in both type and maturity (Table 3). Thus, the GS maturities proposed by the other states start from the short term (up to 1 year) to the ultra-long ones (30-50 years).

Table 3

GS traded on the domestic market of the Republic of Moldova and the analysed states

States	VMS types	Types of maturities
R. Moldova	- fixed rate and floating interest rate; - with zero coupon.	short term – 3, 6, 12 months; medium to long term – 2, 3, 5, 7, 10 years.
Brazil	- fixed rate and floating interest rate; - zero coupon; - indexed to the inflation rate; - retail/savings bonds.	short term – 6, 12, 24 and 36 months; medium, long and ultra-long term – 3, 5, 10, 20, 30 and 40 years.
Canada	- fixed rate and floating interest rate; - indexed to the inflation rate; - retail/savings bonds; - green bonds.	short term – 6, 12, 24 and 36 months; medium, long and ultra-long term – 3, 5, 10, 20, 30 and 50 years.
Romania	- fixed rate and floating interest rate; - savings bonds.	short term – 6, 12 months; medium and long term – 2, 3, 4, 5, 7, 8, 10 and 15 years.
Türkiye	- fixed rate and floating interest rate; - zero coupon; - indexed (inflation rate and income of State-owned entities); sukuk type, - retail/savings bonds, including GS denominated in gold.	short term – 6, 12 months; medium and long term – 2, 3, 4, 5, 7, 8, 10 and 15 years.
Hungary	- fixed rate and floating interest rate; - indexed to the inflation rate; - issued in foreign currency (euro) in the internal market; - retail/savings bonds (including baby bonds); - green bonds.	short term – 3, 6, 12 months; medium and long term – 2, 3, 4, 5, 7, 10, 15, 19, 20 and 30 years.

Source: prepared by authors based on data of the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

As shown in Table 3, it is noted that, in addition to traditional GS (fixed rate and floating interest rate), in most of the countries analysed, savings and inflation-linked GS are issued in most countries analysed as a perfect means of protecting investment against the risk of inflation. It should be noted that the launch of these types of GS in various states (beyond those analysed) took place in various circumstances of inflation: in some countries, at times when inflation was high (Great Britain and Israel), and in others, inflation was low

(Germany and Japan). According to the European Central Bank, regardless of the circumstances in which indexed GS were launched on domestic markets, the significant increase in their issued volume over the last decade is due to the existence of a low inflation environment, which has been observed in many countries in the period up to the Covid-19 crisis. A logical explanation of the increase in volumes of these types of GS was the credibility vis-à-vis central banks in the process of ensuring price stability during that period.

In addition, we note that the increase in budget deficits has created space for additional GS issuances, with considerable funding needs resulting in the configuration of new types of GS in a relatively short period without reducing the volume of existing ones. Among the new types of GS, the issuance of which has been initiated/accelerated due to the significant financing needs of the economies of the States, is green bonds. Countries such as Hungary launched this type of GS in 2020, Canada in 2021 and Türkiye initiated, in mid-2021, procedures to amend national legislation in order to create the necessary legal prerequisites for initiating issuances of this type of GS. It should be noted that the launch of this product, in the case of Canada and Hungary, was preceded by the decision on the introduction of this type of GS as a new financing instrument before the Covid-19 crisis. Rising financing needs at the government level have prompted the issuing states either to kick-start such issuances faster or to increase the volume of such issuances. Green bonds have greater benefits for the general economy and the financial market by supporting governments' efforts to finance low-carbon activities and promoting the development of an internal market for such GS. Despite rapid growth, the size of the green bond market is rather small compared to traditional ones (OECD, 2016).

At the same time, it is noted that the analysed states, with the exception of the Republic of Moldova, have built and issued various benchmark GS lines with varying maturities in order to manage the refinancing risk effectively. Typically, benchmark GS are fixed-rate bonds issued with certain key maturities, which are the most suitable tools to build a yield curve as they tend to attract a wide range of investors with different investment preferences.

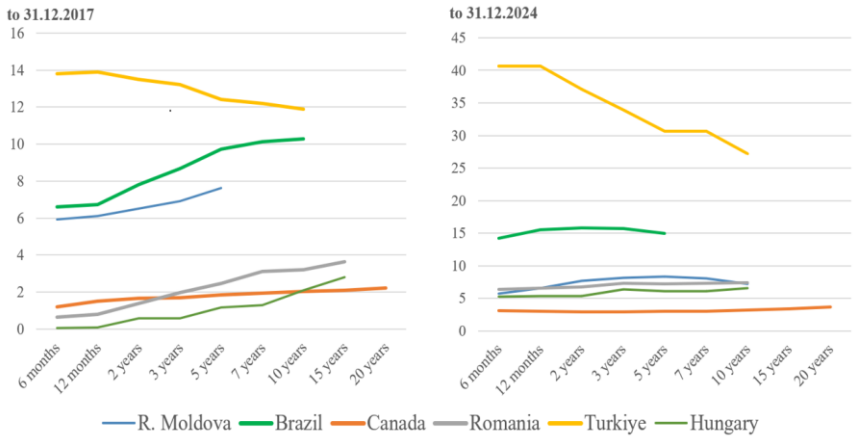
4.3. Financial benefits

Looking at the financial yields of GS issued on the domestic market of the Republic of Moldova, it is noted that while in 2017 the yield

curve was on an upward trend, in 2024 it is marked by a downward trend (Figure 5), which indicates that short-term yields are higher than long-term ones. As of 31 December 2020, investors' preferences were oriented towards lower maturities of GS, and for GS with longer maturities, a decrease in the interest rate was expected. This is due to the fact that 2020 was marked by the Covid-19 crisis, which affected the whole economy of the Republic of Moldova and countries around the world, and 2022 was marked by high inflation.

Figure 5

GS yield curve of the domestic market of the Republic of Moldova and the analysed countries for 2017 and 2024, %



Source: prepared by authors based on data of the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

With reference to the evolution of the GS yield curve issued on the domestic market of the analysed countries, it is noted that Romania, at the end of 2017 and 2024, has an upward trend, indicating that the returns to be obtained by long-term investors are higher than in the short term. On the other hand, in both periods considered, Türkiye has a downward trend in yields, which confirms the abovementioned aspects - that short-term yields are higher compared to long-term returns. This is due to the fact that Türkiye experienced a significant depreciation of the national currency over the analysed period, resulting in higher returns demanded by short-term investors.

Relatively constant yields, with a slight downward trend in both, 2017 and 2024, are shown in the case of Brazil, which means that for GS

in the short term, yields are higher and, in the long run, they are expected to be slightly depressed while maintaining a steady trend in yield levels. Also, as of December 2024, the GS yield curve of the Republic of Moldova is close to the GS yield curve of Romania and Hungary.

In addition to the above, it is noted that in the Republic of Moldova, since 2021, an income tax has been introduced on interest received by investors on GS holdings. At the same time, in 2024, in the context of the launch of the e-VMS platform for citizens, the GS interest income received by individuals was exempt from income tax, which was intended to make the GS more attractive, to stimulate investment by individuals in these financial instruments, and to help diversify the range of market investors (Table 4).

Table 4

Tax regime for GS issued on the market of the Republic of Moldova and of the analysed countries

States	Tax regime
R. Moldova	- income from interest on GS holdings in the case of legal persons (tax rate – 6 %) is subject; - in the case of GS interest income obtained by individuals, from September 2024 onwards, they are not subject to taxation; - revenues obtained after GS trading on the secondary market shall be taxed in the event of a capital increase.
Brazil	- GS interest income (between 0 and 27.5 % for revenues between approximately USD 3 900 and more than USD 9 900); - revenues from GS trading on the secondary market (15-30 % at values between 185 thousand USD and 3.7 million USD). Starting with 2023, foreign investors benefit of income tax exemptions.
Canada	- income from interest on GS holdings. - revenues from GS trading. Only GS holdings of Canadian residents are subject to taxation; non-residents are exempt from income tax.
Romania	- exempt from income tax.
Türkiye	- GS interest income shall be taxed at the rate of 10%, except GS denominated in gold, which shall not be taxed; - revenues obtained as a result of GS trading on the secondary (stock exchange) market shall not be taxed; - all GS revenue was exempt from income tax for the period of December 2021 to December 2022.
Hungary	- income from interest on GS (15%) is subject to taxation. As of June 2019, exemptions from income taxes generated by interest on GS holdings for retail investors

Source: prepared by authors based on data of the Ministries of Finance of the Republic of Moldova, Brazil, Canada, Hungary, Romania and Türkiye

At the same time, tax exemptions have been applied in Hungary – for retail investors, Türkiye – for all types of GS, for the period from December 2021 to December 2022, and in Brazil - for foreign investors - since January 2023.

The application of these selective income tax exemptions has had a significant impact in Hungary, where GS holdings by retail investors have increased significantly. It is also noteworthy that Romania is the only country, out of those studied, where the financial means obtained from GS holdings are exempt from taxes, for all categories of investors.

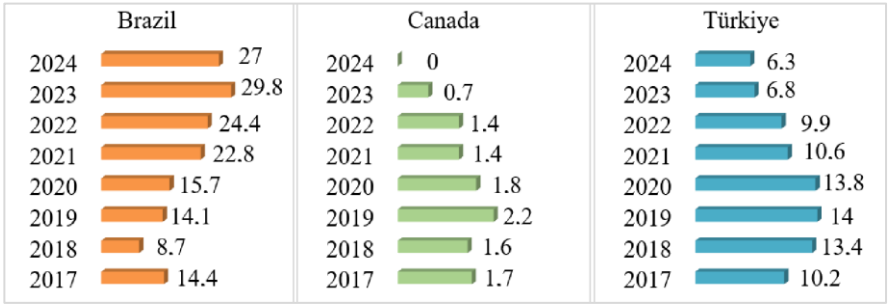
4.4. Risk management

Opportunities for effective risk management of GS investments (credit risk, inflation risk, interest rate risk, liquidity risk, operational risk, etc.) are an important element in attracting investors to the GS market. Thus, with regard to *credit risk*, it should be noted that, since the establishment of the GS market in the Republic of Moldova, the Government has always honoured its commitments. According to national law, expenditure on state debt service is prioritised and honoured irrespective of the amount approved in the State budget for that purpose.

An effective measure to manage the *risks of investors related to inflation* is the availability and accessibility of indexed GS products on the domestic market. However, as noted in Table 3, the Republic of Moldova does not offer such financial instruments to investors, unlike most of the other analysed countries (Brazil, Canada, Türkiye and Hungary), which issue such GS. Moreover, looking at the statistical data of Brazil (Figure 6), a relatively steady increase in the share of these types of GS in the domestic market issuance portfolio can be noticed during the analysed period. However, in Canada and Türkiye, a different situation can be noted, where the issuance of such instruments is decreasing. Therefore, in 2024, Canada stopped issuing indexed GS due to low demand, and Türkiye experienced a decrease in issued volumes due to high inflation.

Figure 6

Share of indexed GS in total GS issuances on the domestic market of the analysed countries, 2017-2024, %

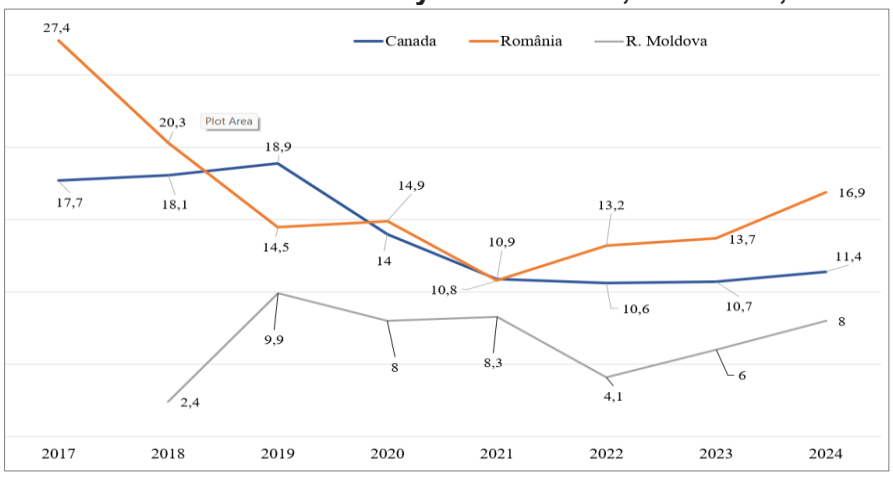


Source: produced by authors based on data of the Ministries of Finance of Brazil, Canada and Türkiye

The liquidity risk of the GS secondary market[1] in the Republic of Moldova and the analysed countries for the same period are depicted in Figure 7.

Figure 7

Evolution of the liquidity of GS secondary market in the Republic of Moldova and the analysed countries, 2017-2024,%



Source: produced by authors based on data of the Ministries of Finance of the Republic of Moldova, Canada and Romania

[1] *Calculated as the ratio between the GS volume traded on the GS secondary market and the volume of GS in circulation.*

According to Figure 7, the liquidity of the GS secondary market in the Republic of Moldova is significantly lower than in Canada and Romania. At the same time, the indicator is in a downward trend during 2018 - 2022, implying an increase in investors' liquidity risks. This decrease for 2022 compared to 2021 is explained by the reduction (by 2 times) in the volume of GS traded on the domestic secondary market. Such a decrease is appropriate for Canada and Romania as well, for the same period.

Starting with 2023, all three countries have experienced an increase in the liquidity level of the GS secondary market. In our opinion, on one hand, a well-developed GS market is more attractive to investors, offering them various investment opportunities in a timely manner, a higher level of investment certainty and opportunities to minimise and manage the related investment risks effectively. On the other hand, a high investment attractiveness of GS issued on the internal market, based on the key elements identified by the authors in this research, contributes, respectively, to a diversification of the range of investors in the market and to the development of the GS market.

5. Conclusions

As a result of this research and the comparative analysis with other countries (Brazil, Canada, Hungary, Romania, Turkiye), we conclude that the investment attractiveness of GS is of a particular importance, providing the State with access to the necessary financial resources and providing investors with safe and profitable investment opportunities. Moreover, as mentioned above, a high investment attractiveness of GS can help boosting the development of the domestic GS market. In these circumstances, given the role of the GS in providing the State with the necessary financial resources, the low development level of the internal GS market of Republic of Moldova and of the GS investment attractiveness, as well as the problems that Republic of Moldova is currently facing on the domestic GS market (increased refinancing risks, the predominance of short-term GS in the issuance portfolio, the massive concentration of market investors in one category of participants - banks), implies the undeniable need to increase the GS investment attractiveness issued on the internal market of R. Moldova.

In the light of the research carried out and set by the authors in this article, as well as taking into account the analysed international

practices, the authors have identified and set 4 determinant elements of the GS investment attractiveness: accessibility and market infrastructure; GS diversity; financial benefits of the GS; and GS investment risk management. Therefore, the authors have identified opportunities to increase the investment attractiveness of GS issued on the domestic market of the Republic of Moldova, which are corelated with the respective four determinants of GS investment attractiveness mentioned above (Figure 2), namely:

- On the "Accessibility and market infrastructure" dimension – expanding the category of primary dealers on the GS market in Moldova, creating the conditions for a connection between a domestic depository and an international one, and initiating trading the GS on the regulated market, similar to the experience of Romania. The implementation of such a measure will increase the accessibility of foreign investors in the domestic GS market and contribute to greater expansion and diversification of the investor base in the Republic of Moldova's GS market, including by attracting foreign investors.
- On the "GS diversity" dimension – examining the appropriateness of issuing indexed GS, green bonds and benchmark GS, similar to the experience of Hungary, Turkiye, Brazil and Canada. These initiatives will increase the attractiveness of domestic GS and attract new categories of investors (retail, foreign), given that these types of GS can ensure an efficient management of the investor's liquidity risk, being in line with current, globally adopted policies to ensure the sustainability of the economy, society and climate.
- Under the "Financial benefits" dimension – full exemption or reduction of income tax on GS holdings, similar to the Romanian practice, which will make GS issued on the Republic of Moldova's market more financially attractive.
- On the dimension of "Investment risk management" – issuance of indexed GS according to the practices applicable in Turkiye, Hungary and Brazil. Focusing on these tools would give investors the opportunity to restructure investment portfolios and manage liquidity risk effectively in the GS secondary market.

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DIGITAL TRANSFORMATION OF THE INSURANCE MARKET: CHALLENGES AND OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT

Victoria POSTOLACHE, PhD*

Abstract

Under current conditions, the implementation of automation and artificial intelligence in insurance services marks a significant change in the way customers access the services of this industry. This transformation is driven by the need to increase operational efficiency, improve service accuracy, and enhance the value offered to customers. The main objective of this research is to analyse how digital transformation influences competition and market development in the insurance sector. The study uses a qualitative approach, examining the most relevant technological and innovative factors – such as the automation of claims processing, underwriting, and risk assessment, as well as the implementation of omni-channel digital platforms. The research results indicate that digitalisation contributes to faster service delivery, increased customer satisfaction, and improved operational sustainability. In conclusion, a balanced approach between innovation and risk management is essential to ensuring long-term competitiveness in the insurance sector.

Keywords: insurance sector, robotic process automation, digital platforms, innovative solutions

JEL Classification: G22, O33, M15

DOI: https://doi.org/10.65672/fs.2025.4.3

1. Introduction

Throughout its history, the insurance industry has experienced a series of fundamental technological innovations, including the implementation of actuarial calculations, which became the foundation of modern insurance; the use of insurance agents, which laid the

* *Associate Professor, Balti State University "Alecu Russo", Faculty for Exact, Economic and Natural Science, Bălţi, Republic of Moldova. ORCID: https://orcid.org/0000-0003-4023-9705. Corresponding author, e-mail: vic.postolache@yahoo.com*

groundwork for mass insurance; and the application of computers, which simplified many business processes in the insurance sector, among others. In the modern world, digitalisation has become a key driver of development across various industries, and insurance is no exception.

One of the main factors driving digitalisation in insurance is the use of artificial intelligence (AI) and machine learning. These technologies automate risk assessment, claims management, and fraud detection. AI analyses large volumes of data, facilitating faster and more accurate processing of insurance cases, reducing customer wait times, and enhancing overall satisfaction with the service.

2. Literature review

To date, insurance companies have been developing their official websites and mobile applications much more slowly than commercial banks, and their applications do not fully meet the rapidly growing user demands. In the insurance sector, the insufficient penetration of digital technologies is due to the following reasons:

- the high cost of implementing new digital technologies that insurers can use in their operations;
- the insufficient adaptation of digital technologies to insurance programs;
- the high risks associated with information and financial security;
- changing customer expectations, as they demand real-time service rather than delayed responses;
- the generally low level of trust in the insurance company and the insurance culture.

To determine the place and role of insurance in the digital economy, a theoretical grounding of the concept of "digital insurance" is necessary, which can be viewed from two perspectives. On the one hand, digital insurance can be understood as a part of economic relations determined by the existence of the insurance interests of companies and citizens and their satisfaction through digital technologies. In other words, digital insurance represents the realisation of insurance services through digital technologies.

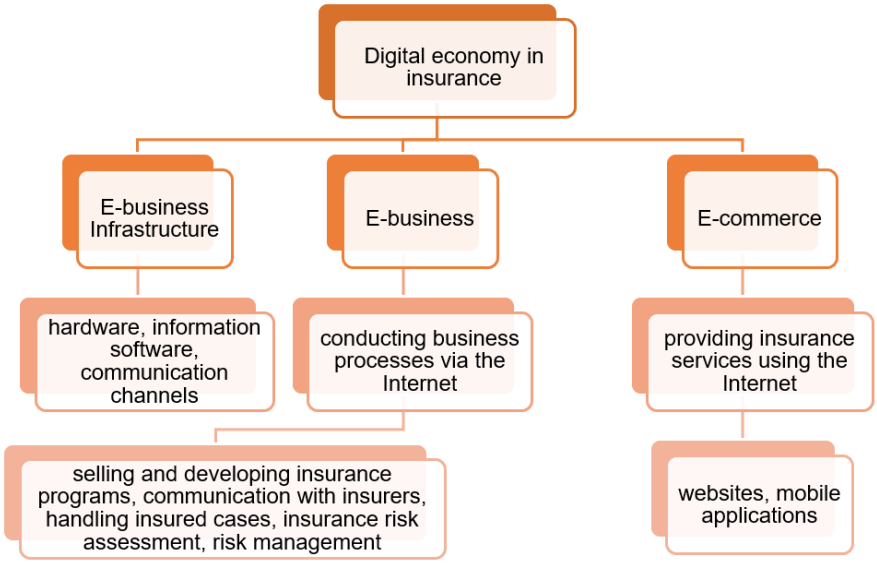
Secondly, the active development of technologies in the context of the emerging digital economy is creating new risks, including a new interpretation of cyber risks that have been known since the 1990s (Grebenchshikov, Zlobin & Sarycheva, 2018), as well as other risks

that may arise in scientific research. Some risks in the digital economy are minimised through the use of insurance mechanisms. Therefore, digital insurance is understood as an insurance that can unify these risks. Similar processes have already taken place in the insurance market. For example, insurance for telephones was the basis for the further development of insurance for electronic equipment, which is nowadays no longer seen as a stand-alone insurance product but as a complement to electronic property insurance.

Thus, the problem of determining digital insurance lies in its duality, as shown in Figure 1.

Figure 1

The building blocks of the digital economy in insurance



Source: adapted by author from Grebenchshikov et al. (2018), p. 47.

On the one hand, digital insurance is driven by the digital economy, while on the other hand, it is part of it through the implementation of digital technologies that are organically integrated within insurance companies.

Therefore, digital insurance represents a way of meeting both traditional and digitalisation-driven protection needs through the use of digital technologies. In this regard, the insurance activities carried out

by insurance companies using digital technologies are defined by us as the digitalization of the insurance market.

It meets the needs of policyholders for specific protection against adverse events occurring mainly in the environment of the digital economy and related to the use of technological equipment, which is the material basis for the realisation of economic relations. In the past, these insurance services were referred to as e-commerce insurance (Shepelin, 2017, pp. 21-22), cyber-risk insurance, insurance against electronic and cyber-crime, etc., but the term "digital insurance" has become more relevant.

At present, the main directions of the digitalisation of the insurance market are represented by several phenomena, which, within the already established terminology of the digital economy, can be defined as the internationalisation, digitalisation, and individualisation of insurance business, the characteristics of which are presented in Table 1.

Table 1

Characteristics of the main directions of digitalisation of the insurance market

Direction	Definition	Applied digital technologies	Main audience of the insurer
Internetization	The use of the Internet in the business processes of the insurance company	New production technologies, wireless communication technologies, and cloud technologies	External policyholders, internal employees, and insurance agents
Individualization	The development of a personalised insurance offer (based on tariff, risks, and other conditions) by obtaining a broad set of data about the policyholder and the insured object	Big data, new production technologies, and wireless communication technologies	External policyholders (including potential ones)
Digitalization	The use of digital technologies (digitalisation) in the insurer's business processes	New production technologies, wireless communication technologies	Internal employees; external policyholders

Source: Tsyganov & Bryzgalov (2018), p. 114

Published studies prepared by leading audit firms present the issues and prospects of the digitisation of insurance business in developed countries worldwide. These studies highlight the main trends, risks and threats to traditional insurance as well as changes in the insurance labour market (Table 2).

Table 2

Issues and prospects of insurance digitalisation

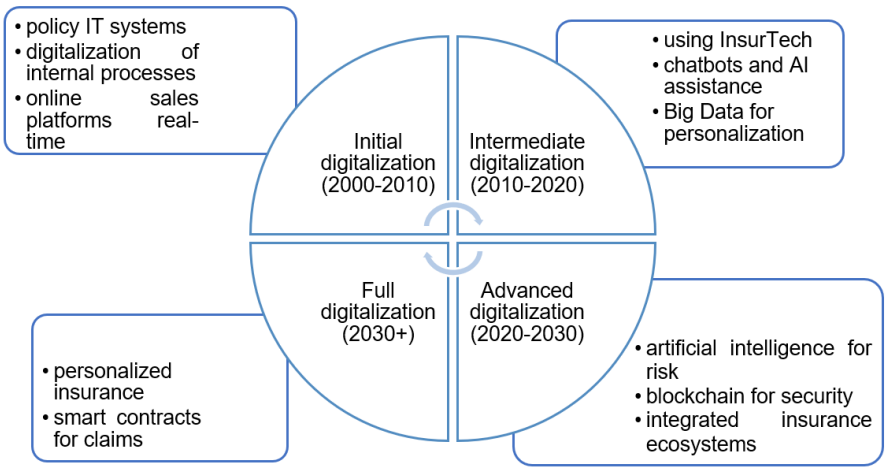
Author	Challenges	Prospects
Sukma & Yamnill (2025), Braun & Jia (2025)	- resistance to change from traditional insurance companies; - need for significant investments in digital infrastructure and skilled human resources.	- digitalisation improves operational efficiency and service personalisation; - innovative models such as usage-based insurance.
Malhotra R. (2015)	- data fragmentation and difficulties in integrating legacy systems; - cybersecurity and data protection risks.	- use of big data and predictive analytics for more precise services; - increased transparency and trust through blockchain.
Gai, K., Qiu, M. Sun, X. (2018), Delloitte (2018)	- competitive pressure from Fintech companies; - regulatory complexity and compliance with standards.	- digitalisation enables faster and more flexible products and services; - adoption of AI and IoT for optimisation and cost reduction.
PwC (2019) Braun, A., & Schreiber, F. (2017)	- challenges in managing cultural and organisational changes; - risks associated with excessive reliance on technology.	- development of new products, such as micro-insurance; - Collaboration with startups and technology partners for innovation.

Source: compiled based on the sources mentioned in the table.

As demonstrated in Table 2, although digitalisation presents substantial challenges, it also offers significant opportunities for transforming the insurance industry. The adoption of advanced technologies and the adaptation to new market demands are imperative for long-term success in this evolving field.

The digital transformation of the insurance market can be divided into several key stages, each significantly impacting the industry. According to the specialised literature and global trends, these stages are illustrated in Figure 2.

Figure 2
The phases of the digital transformation of the insurance market



Source: prepared by the author

Thus, the digital transformation of the insurance market is not just a trend but a necessity for adapting to new consumer behaviours and emerging risks. Technologies such as InsurTech, AI, IoT, and blockchain will reshape the industry, providing more efficient, faster, and safer solutions for customers. The future trajectory of the insurance sector is anticipated to be defined by comprehensive digitalisation, underpinned by intelligent ecosystems and individualised service models.

3. Data and methodology

The main objective of this research is to analyse how digital transformation influences the competitiveness of the insurance market and contributes to its sustainable development, with a particular focus on the case of the Republic of Moldova. The study aims to identify both the determinants and the main barriers affecting the digital transition process of insurance companies.

To achieve this objective, a qualitative and comparative methodological approach was applied. The research combines a documentary analysis of recent academic literature, policy documents and reports published by international organisations (OECD, World

Bank, EIOPA, National Commission for the Financial Market of the Republic of Moldova) with case studies of insurance companies from the Republic of Moldova that are actively implementing digital solutions.

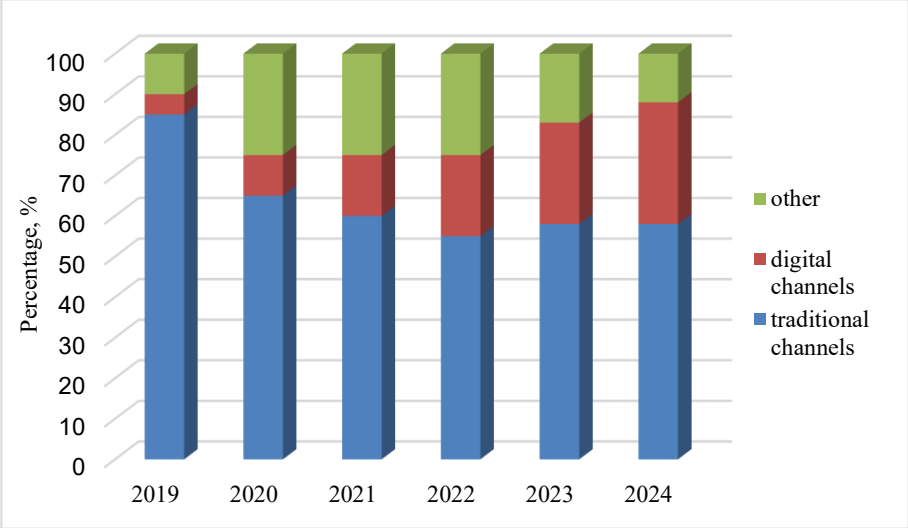
For the purpose of the comparative analysis, the insurance market of the Republic of Moldova will be assessed based on indicators such as the level of digital readiness, customer experience and the degree of adoption of technological innovations, using public statistical data from the National Bank of Moldova.

The qualitative analysis enabled the identification of key results and trends driving the digital transformation of the insurance sector and facilitated an assessment of their impact on operational efficiency, sustainability, and customer satisfaction.

For a comprehensive understanding of the structure of insurance product sales channels, it is essential to evaluate their composition based on the information presented in Figure 3.

Figure 3

The structure of insurance product sales channels in the Republic of Moldova



Source: prepared by the author based on the data from www.bnm.md

The results shown in Figure 3 indicate an increase in transactions through digital channels, brokers, and online platforms, alongside a decrease in product sales through traditional channels.

The share of sales via traditional channels (agencies) has gradually declined, while digital channels (online, apps) have registered steady growth during this period.

Traditional channels (brokers, agents, bancassurance) continue to account for approximately 58% of the total premiums underwritten in 2023–2024. Insurance brokers dominate intermediation (between 67–77% of this category). Digital channels/online platforms have rapidly developed between 2022 and 2024, gaining a significant share of sales, even though official data is not reported separately. Digitalisation is actively supported by the National Bank of Moldova reforms, which have improved transparency, offered comparability, and reduced costs for consumers.

In the Republic of Moldova, the MakeIT solution was created: full automation of the insurance process by the MakeIT – Digital Agency team. They developed and launched e-Asigurari.md – a 100% digital platform that allows users to obtain insurance in less than one minute, without bureaucracy and unnecessary travel, simply by accessing e-asigurari.md.

The platform's key results include:

1) UX/UI design optimised for conversions:
   - an intuitive interface that allows users to obtain a policy in just three steps;
   - responsive design, optimised for both desktop and mobile, enabling users to purchase policies from anywhere;
   - a simplified ordering process, eliminating any elements that could lead to cart abandonment.
2) Automation through API integration with official partners:
   - connection with the National Bank of Moldova for real-time verification of RCA policies;
   - API integration with Donaris for instant policy generation, without manual intervention;
   - secure online payment via MAIB, eliminating the need for cash payments.
3) SEO optimisation and digital marketing campaigns:
   - implementation of meta descriptions and content optimisation for better Google indexing;
   - Google Ads and Facebook Ads campaigns to attract new users and increase conversion rates;

- remarketing for users who abandoned the purchase process.

4) Automated policy renewal notification system:
   - clients receive email and SMS notifications 7 days before their policy expires;
   - one-click renewal option, without the need to re-enter personal data.
5) Technical support and operational automation:
   - integrated live chat to quickly respond to customer inquiries;
   - centralised database, with the history of all policies and customers (MakeIT Digital Agency, 2025)

In just one month since its launch, e-Asigurari.md has demonstrated the potential of digitalisation in the insurance industry, offering users a fast, secure, and efficient solution:

A. Significant reduction in time and costs for customers;

B. Increase in the number of policies issued thanks to the intuitive online experience;

C. Full automation, eliminating bureaucracy (MakeIT Digital Agency, 2025)

In addition to the points mentioned, it is necessary to highlight the effect of digitalisation achieved through the collaboration between Donaris VIG and BC “Moldova-Agroindbank” SA.

Donaris VIG, part of Vienna Insurance Group (VIG), continues to strengthen its strategic partnership with the largest bank in the Republic of Moldova, expanding the range of insurance services.

Clients of the bank will benefit from quick and efficient access to tailored financial protection solutions, integrated into the bank's digital ecosystem.

Performance and digitalisation in insurance services.

Throughout the collaboration, Donaris VIG has implemented a series of progressive improvements aimed at simplifying and facilitating bank clients' access to insurance products. These measures provide users with greater financial security and comfort. The first step was the automation of insurance processes for policies, ensuring efficient cooperation without interruptions. This stage has significantly reduced administrative burdens and made insurance policies more accessible and user-friendly.

Building on this foundation, Donaris VIG will further integrate insurance solutions into the bank's digital ecosystem, allowing clients to purchase RCA, Green Card, and travel insurance directly through the mobile banking app – offering greater convenience and accessibility.

The latest result of this collaboration is the development of the Credit Protection Insurance (CPI) product.

CPI provides clients with support in unforeseen situations and offers protection against financial difficulties. This coverage reimburses loan instalments in cases of incapacity to pay due to unexpected events, such as illness or loss of job, thereby reducing financial stress and allowing clients and their families to focus on the truly important matters (Mold-Street, 2025).

For Vienna Insurance Group, the innovation of products and digital services represents a priority for positioning oriented towards building relationships with clients. Donaris VIG responds to these challenges with innovative solutions and takes an important step in consolidating the bancassurance market in the Republic of Moldova. VIG ensures that its partnership with the bank continues successfully and actively continues to further it. We are proud to felicitate the bank for the recognition obtained in the prestigious program "The Innovators 2025" by the Global Finance magazine, as one of the most innovative financial institutions in Central and Eastern Europe. The award granted to our joint project underscores the success of the partnership and the added value it brings to clients in the Republic of Moldova," declared Peter Höfinger, Vice President of the Vienna Insurance Group Management Board and President of the Donaris VIG Supervisory Board.

For the development of innovative insurance products, Donaris VIG leverages the extensive expertise of the VIG Group in the field of digitalisation. Plans are in place to continue developing financial products and integrating them into the local banking system. The expansion of collaboration between Donaris VIG and the bank further highlights the importance of strategic partnerships in building a unified financial ecosystem. Integrating the CPI product into banking services represents a significant step forward in consolidating a more resilient financial market, where clients benefit from integrated solutions for their economic security (Mold-Street, 2025).

Electronic platforms launched in recent years e-Asigurări.md, TotalAsig.md, Omnis.md, Asiguratori.md, AsigurariOnline.md,

PRIMASIG and others offer fully online purchase (RCA, CASCO, Green Card, travel insurance, health, goods).

4. Main results

On the global insurance market, three main groups of innovative technologies are currently spreading:

- Technologies aimed at optimising insurance payments and business processes;
- Technologies that create new insurance products for customers or improve existing ones;
- Technologies that contribute to the development of the insurance market infrastructure.

In insurance companies in the Republic of Moldova, it is currently possible to insure a wide range of cybersecurity-related risks. Such insurance covers the following:

- bank payment cards – for various risks, including unauthorised fund withdrawals from accounts through different methods (including online fraud);
- electronic devices and information storage media, with the possibility of covering costs related to data recovery (from damaged or lost storage media due to an insured event);
- professional liability of software developers.

Achieving the objective of increasing digitalisation in insurance companies, in the context of InsurTech implementation, requires government support to stimulate the technological modernisation of insurers and to establish the legal framework for the formation of a digital insurance system. Additionally, it is important to motivate insurance companies to maximise transparency and openness of information, collaborating with engineering firms and research centres for the development and implementation of the internal security system of the digital platform.

By digital insurance, we understand the concept of the digitalization of the insurance market, which is characterized by a dual approach to digital transformation in the insurance sector: on the one hand, as a technical-economic process of digitizing insurers' activities – transferring all business processes into a digital format, implementing and developing a suite of digital technologies, and creating service platforms for the design and delivery of insurance products and services based on InsurTech; on the other hand, as an organizational-

economic process of insurance – the creation of specialized insurance covering specific risks. This allows for a discussion on the need to develop a new concept for the advancement of insurance in the context of the digital transformation of the economy.

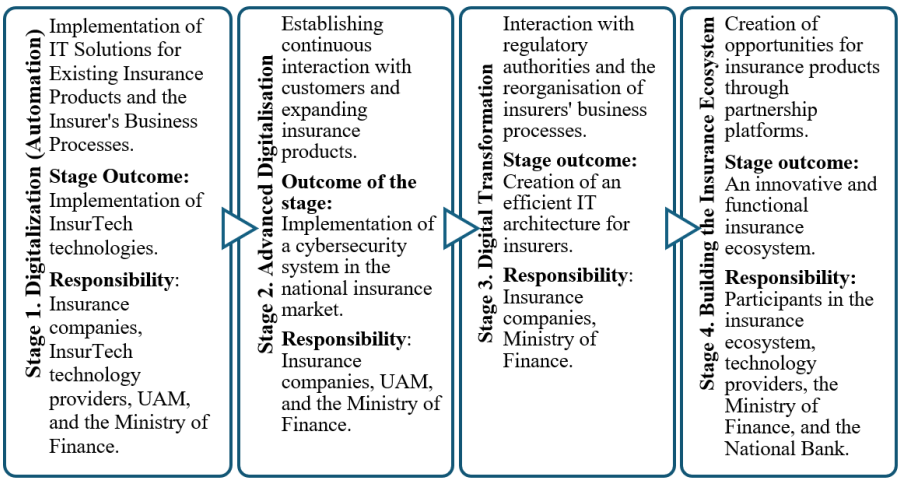
To shape the concept of the digital transformation of the insurance market, it is necessary to develop both the internal digital environment of insurers and the external digital environment, which not only defines the outward digital presence of the insurance industry but also influences the overall process of digitalisation of the economy (Tsyganov & Bryzgalov, 2018, pp. 118-119). In this regard, it is important to rely on the concept of "Industry 4.0," which involves the use of resources, business processes, and big data analytics for information exchange and communication (Tarasov, 2018, p. 44).

In the developed concept of the digital transformation of the insurance market, trust is a key factor. In an informational space, the criterion of trust ensures the security of both users and insurance service providers, forming a robust protection system.

The formation of a digital insurance system in the country does not happen instantly. However, it involves going through several development stages that create the necessary conditions for digital insurance (see Figure 4).

Figure 4

The stages in the formation of the digital insurance system in the Republic of Moldova



Source: prepared by the author

Stage 1. Digitalisation (Automation) is characterised by the transfer of information from analogue to digital formats. It involves developing a digital insurance product by implementing IT solutions for insurers' products and existing business processes. This transformation is necessary to meet customers' needs and expectations, which will expand the customer base and increase the number of insurance products per client.

In this stage, the structure of the information does not change, but it takes an electronic form. The initial launch of cyber insurance products is also foreseen. To achieve this objective, it is necessary first to analyse existing international regulatory and legal acts in the field of cyber insurance and adapt them to the Republic of Moldova market.

Additionally, it is essential to create a working group composed of representatives from insurance companies, the Insurance Union of Moldova (UAM), regulatory authorities, and consultants. The purpose of this group is to develop a unique model for evaluating the cybersecurity system of the insured before concluding a cyber-insurance contract.

Creating a mechanism for cooperation between insurance companies and organisations specialising in evaluating the insured's cybersecurity before signing a cyber-insurance contract will simplify the process of policy issuance and risk underwriting. In European practice, such organisations are international and create a unique protection mechanism for all market participants.

We believe that for the national insurance market, international companies should be involved in the initial phase of developing general recommendations, while applicable mechanisms should be developed with the participation of national companies. This synergy is optimal because local developers understand the specifics of the business environment in the Republic of Moldova, and investments in implementation will return to the national economy. The final result of the first stage will be the implementation of a system based on InsurTech technologies.

Stage 2. Digitalisation (Digital interaction with the client) involves the integration of InsurTech technologies into the physical environment of the insurer and the implementation of electronic information exchange both within the company and in relation to customers, ensuring omnichannel communication. Active use of remote insurance services is promoted, including offering real-time personalised insurance products and services.

As a result, a digital environment is created by the launch and wide-scale implementation of smart services in the activities of insurance organisations. This stage also involves the full implementation and expansion of cyber insurance products, based on previous methodological research.

The proposed approach is based on the principle of informational transparency, which is of major importance in the development of the digital transformation of the insurance market and in the introduction of cyber insurance. Access to public, professional, industrial, and other types of data (governmental, private) is an essential tool for the emergence of new cyber insurance products and services, directly impacting the efficiency of the insurance market development. In the modern world, data is the foundation of many digital services and products, and processing large volumes of data, combined with InsurTech technologies and predictive analytics, contributes to more efficient and productive operations. To benefit from the advantages of data analysis, access to large volumes of information (Big Data) is necessary.

Changes will include the introduction of reporting by insured companies regarding their current cybersecurity system for evaluation and inclusion in insurance rates. In this regard, the development of services such as "insured's electronic cabinet" and "insured's history" will be necessary. These measures will contribute to activating the customer base and increasing their retention rate.

One of the most important objectives of this stage is the creation of a unique platform for reporting cyber incidents by the insured, allowing for specialised evaluation and the subsequent selection of cyber insurance conditions. This platform will allow data analysis for decision-making using Big Data technologies, and will function as an informational space for developing recommendations to minimise risks for insured parties, based on their cybersecurity evaluation.

Information systems should form the basis for creating digital insurance. Therefore, developing a digital platform, in the form of an informational-analytical system that supports decision-making at all levels, is an essential prerequisite for building the digital insurance system in the Republic of Moldova.

The result of this stage will be the implementation of a cyber insurance system in the national insurance market.

Stage 3. Digital transformation involves improving existing business processes within insurance companies by using InsurTech tools and creating a unique informational space. It involves the development of a remote interaction system with the regulatory authority, which will allow for automation and optimization of internal processes, reducing transaction costs, time, and operational risks.

It is considered necessary to create an "electronic cabinet for insurers," an integrated electronic identification system that will allow both insurers and the insured to evaluate the level of cybersecurity and decide on the conclusion of a cyber insurance contract.

The role of the unique state regulator is to develop rules for managing personal data within a unique digital insurance platform, based on blockchain technology, which will allow users to establish rules for the use of their data.

A critical issue when working with data is their level of protection. The state should focus on this aspect when creating a unique digital insurance platform and providing access to the personal data of the insured.

This stage will result in a well-structured and efficient IT architecture for insurers.

Stage 4. Building an integrated insurance ecosystem involves a complete integration of InsurTech capabilities with traditional insurance, leading to the emergence of new products and processes with fundamentally new features. A unique information system in the insurance sector should integrate the databases of all market participants. Thus, insurers and the insured will be able to access all necessary information through a single interface system.

The development of a partner ecosystem involves creating opportunities to sell insurance products through partner platforms, which will lead to the expansion of the customer base and an increase in the number of products per customer.

The result of this process will be an innovative insurance ecosystem that will fully leverage the potential of the insurance market in the Republic of Moldova. This system will contribute to speeding up decision-making and solution implementation, reducing operational costs, and increasing customer satisfaction. Additionally, it will expand the range of insurance services and strengthen trust in the national insurance sector.

For insurance companies to improve their level of digitalisation by adopting InsurTech, state support is welcome. This support should include:

A. Stimulating the technological modernisation of local insurance companies.

B. Ensuring an appropriate legal and regulatory framework for the development of a digital ecosystem in the insurance sector.

In this context, it is important for insurance companies to be encouraged to adopt informational transparency and collaborate with engineering companies and research centres to develop and implement effective internal security systems for digital platforms.

Insurance trends for 2025

A. Advanced personalisation of insurance products

In 2025, insurance companies will continue to develop the personalisation of their products, using more sophisticated analytical tools and diverse data sources. This will allow for the creation of offers that are much more tailored, taking into account not only the current needs of customers but also their future requirements. Personalised insurance products will become a key competitive factor in the market.

B. Automation and robotisation of processes

The trend toward complete automation of insurance processes will continue. Robots and virtual assistants will increasingly be used for customer interaction, offering advice and resolving simple claims. This will reduce the burden on employees and improve service quality, ensuring 24/7 access to insurance services.

C. Development of on-demand insurance

On-demand insurance will become more widespread in 2025. Customers will be able to take out temporary or short-term policies through mobile applications, offering flexibility and convenience in using insurance services based on specific needs and situations.

D. Integration with financial technologies

Insurance companies will adopt more Fintech solutions, offering customers integrated financial products. Joint offerings, which include insurance, investments, and loans, will help attract and retain customers with a broad portfolio of services available in one place;

E. Strengthening cybersecurity

As the volume of digital data grows, the need to strengthen cybersecurity measures will also increase. Insurance companies will invest in advanced technologies to protect data and prevent

cyberattacks, ensuring the security of customer information and maintaining trust in their services.

The mentioned development directions will ensure an increase in the volume of insurance products traded through digital channels, in the context of ensuring the protection not only of the client's personal data but also of enhancing the population's financial literacy.

The findings of these studies highlight the fact that the digital transformation of the insurance industry is a complex process that redefines how this industry operates and is structured. Numerous effect directions and pertinent contributions were identified by a qualitative analysis of digital trends and practices, along with examples from the Republic of Moldova's insurance market.

First and foremost, digitising processes — especially through the use of artificial intelligence and automation — improves operational efficiency, shortens processing times for requests, and improves risk assessment accuracy. In the second place, the use of digital omnichannel platforms has enabled customers and providers to communicate more openly and directly. This has increased long-term customer satisfaction and loyalty.

On the other hand, studies have shown a number of persistent provocations, such as cybersecurity vulnerabilities, the need to modify regulatory frameworks, and the need to retrain employees in their technical skills.

The scientific contribution to the field consists in elucidating the connections between the digital transformation and the long-term development of insurance components, providing an interdisciplinary perspective that integrates economic, technological, and managerial dimensions. The results obtained could be used as the foundation for the development of public policies and corporate strategies aimed at long-term sustainability, innovation, and competitiveness.

5. Conclusions

With the latest advancements in InsurTech, the following considerations must be addressed to ensure the efficient growth of digitisation in the insurance industry.

- Monitoring the insurance industry players utilising advanced InsurTech frameworks for compliance with the law must be conducted on a statutory level

- Participants in the insurance markets must be provided with unimpeded access to the internet in the performance of their functions.
- Telecommunication systems should provide for the active exchange of information between the participants in the insurance market.
- Provision of services through the internet to enable omnichannel access.

Embracing digital technology enables the insurance industry to compete more effectively internationally, thereby fostering global information security. Additionally, the use of digital technology in the insurance sector reflects a country's financial system's efficiency, facilitates sector growth, and enhances service delivery, making it a vital provider of advanced services and information technology.

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THE REVENUES FROM TAXATION OF HOUSEHOLD CAPITAL IN EU MEMBER STATES. EVOLUTIONS AND EFFECTS AT THE MACROECONOMIC LEVEL

Nicoleta MIHĂILĂ, PhD*

Abstract

In this paper, we consider the analysis of tax revenues from household capital at the level of EU states, in the period 2015-2023, respectively, those regarding property taxation, capital gains from the population/ individuals, as well as the effects of tax benefits granted by the authorities regarding households on distribution/inequality. In this regard, we carry out a case study, through regression, for a panel data set for EU countries, through which we want to demonstrate that the fiscal pressure on households impacts the population's gross investment and saving rate, tax revenues, as well as inequality; the main statistical data come from the Eurostat and OECD-Global Revenue Statistics - Comparative tax revenues databases, expressed as a share of GDP, for the period 2015-2023. The analysis shows that income tax systems reduce inequality, but excessively high tax burdens can harm saving and increase social polarisation. This highlights the importance of balancing tax efficiency with distributive fairness within the European Union.

Keywords: population, taxation of capital, saving, inequality

JEL Classification: D31, H24, H26, G51

DOI: https://doi.org/10.65672/fs.2025.4.4

1. Introduction

Capital taxation, namely taxation of capital income and stocks, could play an important role in increasing revenue efficiency and making the tax system fairer. Recent international tax developments in terms of automatic exchange of information and administrative

* *Scientific Researcher III, "Victor Slăvescu" Centre for Financial and Monetary Research, Romanian Academy, Bucharest. ORCID: https://orcid.org/0009-0009-4791-8656. Corresponding author, e-mail: nicoleta.mihaila@icfm.ro*

cooperation have increased the ability of Member States to collect taxes on mobile tax bases such as capital income.

Capital taxes include taxes on capital income from corporations, households and the self-employed, as well as taxes on capital stocks (recurrent property taxes, inheritance taxes) or on their transactions. Specifically, household capital means the capital stock and capital income. Capital stock refers to property taxation and property transfer taxation, and capital income refers to the taxation of income from capital holdings (rentals, financial assets, or private pension funds) and the taxation of income from the transfer of capital property (capital gains).

If we briefly approach the literature on household capital, some studies suggest that taxation has an important effect on household investment choices and portfolio composition (Domar & Musgrave, 1944; Mirrlees, 1971; Feldstein, 1976), an effect that can be achieved through different effective (marginal) tax rates across households and across assets, which can lead to portfolio specialisation.

There are also studies that consider tax reforms affecting different types of assets (real estate, financial assets, or private pensions). For real estate, the papers show that transaction taxes can lead to a shift from housing investments to higher-yielding commercial investments (Best, 2017). However, they can discourage the process of housing commercialisation and implicitly the reallocation of housing to its most productive use.

In the case of investments in financial assets, Alan and Leth-Petersen (2006) examined the effects of a substantial tax reform in Denmark on the composition of households' portfolios. The reform reduced the marginal tax rate on capital (bonds and shares), while increasing the cost of debt. The study finds that the tax reform significantly incentivises households to restructure their balance sheets in favour of capital. Zoutman (2014) studied the effects of a capital income tax reform in the Netherlands, which increased taxes on financial assets and owner-occupied housing. The study shows that the tax reform had a significant impact on the share of the portfolio invested in financial assets.

A study of OECD found that effective marginal tax rates are often higher than the statutory marginal tax rates applicable to households' capital income (OECD, 2018). This is mainly due to heterogeneous tax treatment, the presence of multiple taxes on capital income (income taxes, capital gains taxes, transaction taxes, etc.), tax

deferral effects and specific tax treatment of specific assets that reduce the tax base (e.g. tax expenses).

Taxation of household capital income has an impact on household disposable income, on household investment decisions, namely households' decisions on how much, when to invest and in which assets to invest. In addition, there is a "push" to reconsider taxation of household capital as a source of income. Given the mobility of international capital flows, taxes on capital have long been considered to be relatively more distortive sources of income, as they would lead to major behavioural changes (and could be easily avoided). As a result, many Member States rely little on taxation of household capital as a revenue-raising tool; also, there are countries that tax dividends, interest and capital gains at a flat and lower rate than labour income, as keeping final taxes withheld at source prevents tax avoidance behaviour. However, this argument may become less relevant given recent developments in the area of automatic exchange of information and anti-abuse measures, which have increased the ability of Member States to collect taxes from mobile tax bases. This makes capital taxation more attractive as a source of revenue and offers the opportunity to design it in a way that fosters inclusive growth (EC, 2020).

Given the lower tax rate on capital income, a dual income tax system gives preferential tax treatment to capital income compared to labour income, which can affect equity, as high-income households tend to earn higher capital income than low-income households.

The tax treatment of households' capital income differs considerably across countries. Sweden and Finland apply *a dual income tax system* (an income tax system that uses two different tax rates for labour and capital, for example, a proportional rate for capital and a progressive rate for labour); most other Member States apply a mixed tax approach, combining the features of a comprehensive and dual income tax system by taxing some assets inside and others outside the personal income tax system.

In this paper, we present the analysis of tax revenues from household capital at the level of EU states, during the period 2015-2023, the effects of tax benefits granted by the authorities regarding households on distribution/inequality and we develop a case study, through regression, for a panel data set for EU countries, through which we want to demonstrate that the tax pressure on households impacts the population's gross investment and saving rate and inequality (Gini

coefficient); the main statistical data come from the Eurostat and OECD-Global Revenue Statistics - Comparative tax revenues databases, expressed as a share of GDP, for the period 2015-2023.

2. Assessment of tax revenues from household capital taxation in the EU, 2015-2023

According to the latest data on tax trends in the EU (EC, 2025a), tax revenues as a share of GDP fell to 39.0% in 2023, from 39.7% in 2022, the lowest level since 2011. By economic function in the EU-27, revenues from taxes on labour (including social contributions) increased in nominal terms in 2023 by 5.9% (mainly due to wage increases), revenues from capital taxes increased by 4.5%, supported by rising corporate profits, while revenues from consumption taxes had the lowest growth rate (2.5%), due to sluggish domestic demand. As a result, the share of taxes on labour (including social contributions) in total tax revenue increased from 50.6% to 51.2%, consumption taxes as a share of GDP decreased from 27.6% to 26.9%, and the share of capital tax revenue remained unchanged at 21.9%.

In 2023, taxes on labour income, including social contributions, were the main source of tax revenue for 25 Member States, and in 13 of them, they accounted for more than half of total tax revenue. Sweden (57.0%), Germany (56.6%) and Austria (54.7%) occupied the top positions, while Croatia (34.8%), Bulgaria (36.2%) and Poland (38.5%) were on the opposite side. Consumption taxes were the largest source of tax revenue in two Member States (Croatia, 49.6% and Bulgaria, 42.5%) and accounted for over 35% of total tax revenue in five other Member States (Latvia, Greece, Estonia, Hungary and Romania). In contrast, they did not reach 25% of total tax revenue in four Member States (Luxembourg, Belgium, France and Spain). While capital bases were not the main source of tax revenue in any Member State, they accounted for 32.1% of total tax revenue in Ireland and over 25% in five other Member States (Poland, Luxembourg, Malta, Italy and Belgium). In contrast, Estonia, Latvia, Slovenia and Slovakia derived less than 15% of total tax revenue from capital bases.

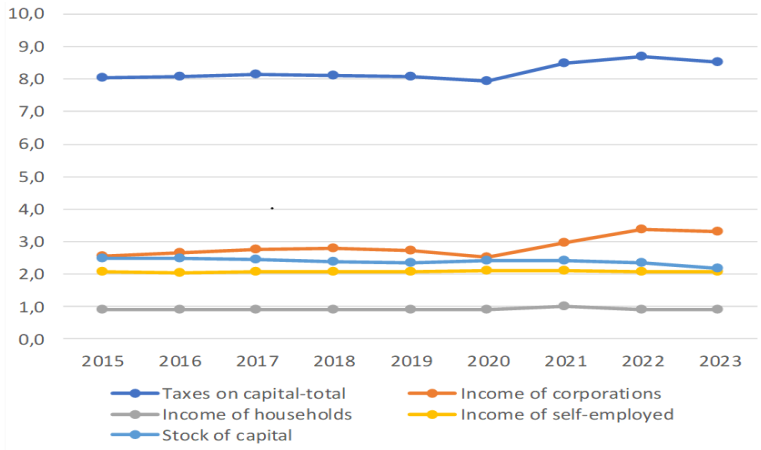
Capital tax revenues remain substantial, driven by corporate profits and more effective mechanisms to combat aggressive tax planning. In 2023, tax revenues from capital tax bases reached 8.5% of GDP, slightly down from the previous year (8.7%); the sustained growth of corporate profits in the years following the COVID-19

pandemic has significantly broadened capital tax bases, in a context where CIT rates (corporate income tax rates) appear to have stabilized in recent years, and ongoing reforms contribute to combating base erosion and profit shifting practices, as well as improving the efficiency of tax administrations. All this has led to significant changes in the composition of capital tax sources.

Corporate income taxes accounted for almost 39% of total capital tax revenues in 2022 and 2023, around 5.5 percentage points more than in 2015 and 2019. In contrast, self-employed income and, in particular, capital stock "lost weight" in the composition of capital tax bases, while revenues from taxation of household capital income remained largely stable. Capital stock taxes, in particular, accounted for over 30% of capital tax revenues until 2020, but fell to 25.7% in 2023. They also lost importance in GDP terms (2.19% in 2023, the lowest since 2011). This type of capital taxes includes, among others, property and wealth taxes, as well as others related to business activities.

Figure 1 illustrates the development of revenues from taxation of capital components for the EU-27 between 2015 and 2023.

Figure 1
Revenues from taxation of capital components for the EU 27, % of GDP, 2015-2023



Source: EC (2025b)

According to data that between 2015 and 2023, tax revenues had an oscillating trend, the exception being 2020 (pandemic year),

when revenues from profit taxation decreased by 0.2 pp, and subsequently "recovered" (+ 0.5 pp in 2021); the situation was similar for the level of revenues from capital taxation as a whole, the other components recording approximately the same level throughout the period.

2.1. Analysis of revenues from property taxation in EU member states in the period 2015-2023

Property taxes include a wide variety of taxes. The European Commission groups property taxes into two main categories. Firstly, recurrent taxes on real estate, which can be on residential property (usually paid by households) or non-residential property (usually paid by businesses). Secondly, in the category of other property taxes we can find, among others, taxes on net wealth, inheritance and gift taxes, taxes on financial or real estate transactions and stamp duties (EC, 2025).

Property tax revenues (in terms of GDP) have decreased significantly since 2020. After stabilizing at around 2.25% of GDP between 2014 and 2020, property tax revenues followed a downward trajectory and decreased to 1.85% of GDP in 2023, the lowest value since 2009. The decrease in recurrent property taxes was more pronounced (from 1.22% of GDP in 2020 to 0.94% in 2023) than other property taxes (from 1.04% in 2020 to 0.92%), leading to a leveling off of both categories. Such a trend suggests that recurring property taxes were more affected than other property taxes by the high price inflation of 2022-2023, indicating an incomplete update of property values, which would erode the tax base.

The share of property taxes in the tax mix varies significantly across Member States, falling in 21 of them over the past decade. In 2023, property taxes accounted for 4.7% of total tax revenues in the EU-27, 1.1 percentage points less than in 2015. Despite recent decreases, France is at the top of the list (8.4% of total revenues in 2023), followed by Belgium (7.4%).

Property taxes show limited development in many eastern EU countries, with Czechia and Estonia at the bottom (0.8% of total revenues). Compared to 2015, the share increased in only six Member States (the largest increase in Luxembourg) and decreased in the other 21 (the largest decrease in Greece). In terms of the composition of property taxes, Greece (5.1% of total revenues), France (4.6%) and Denmark (3.9%) rely more on recurrent taxes on real estate, while

other property taxes are particularly important in Luxembourg (5.5% of total), followed by Belgium (4.5%) and Portugal (4.2%). As for Romania, in 2023, recurrent taxes and other property taxes have the same level of GDP, at 0.9%, 0.4 pp and 0.1 pp respectively, less compared to 2015.

Recurrent taxes on residential properties usually have a limited impact on economic activity and the behaviour of economic agents. They are usually based on cadastral values and managed by local entities, and the updating process is sometimes not transparent. In this context, outdated cadastral values have likely led to a decrease in revenues in the period 2022-2023. Some improvements have been proposed in the design of recurrent taxes on housing, with the aim of strengthening their fairness and serving the objective of the green transition, such as a progressive rate schedule and a periodically updated tax base that takes into account the energy performance of the building.

Figure 2
Property tax revenues as a percentage of GDP, EU-27, 2015-2023

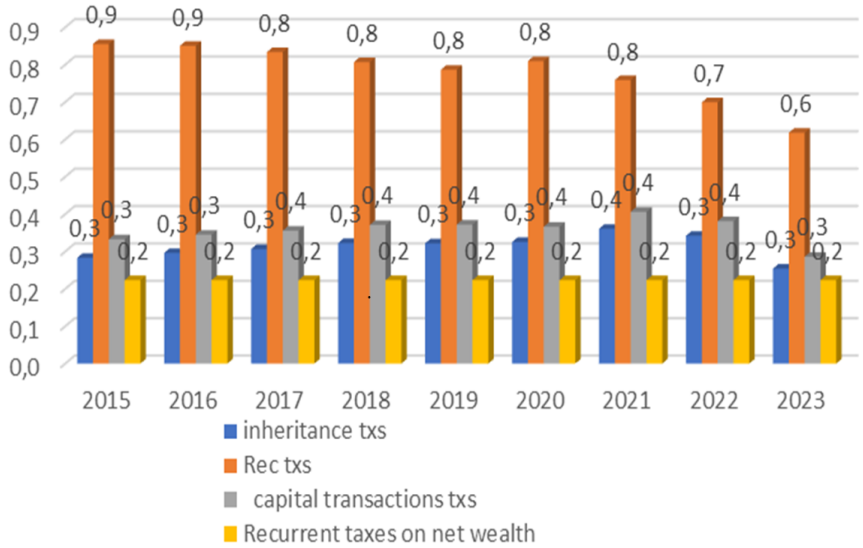
Source: EC (2025b)

2.2. Analysis of revenues from taxes on the transfer of wealth - inheritances/successions and gifts in the period 2015-2023 in EU Member States

Inheritance and donation taxes are, according to the OECD classification (the European Commission includes them in "other property taxes"), included in property taxes, along with recurrent

property taxes, taxes on net wealth, other taxes, including those on financial transactions. Therefore, if we consider inheritance taxes as a share of GDP, within property taxes, the situation is revealed in the figure below.

Figure 3
Evolution of revenues from property taxation, by components, in EU countries, in 2015-2023, % GDP



Source: OECD data explorer, Global tax revenues. https://data-explorer.oecd.org/

Inheritance and gift tax revenues have fluctuated slightly over time. Figure 3 analyses the evolution of the revenues generated by inheritance and gift taxes compared to those generated by wealth/property taxes in general over the last 8 years. It shows that, while the share of total wealth taxes (as % of GDP) has increased steadily over time, the share of inheritance taxes is only slightly increasing, an aspect explained by the fact that several countries have abolished inheritance taxes, despite the increase in the wealth/income ratio and the concentration of wealth over the same period.

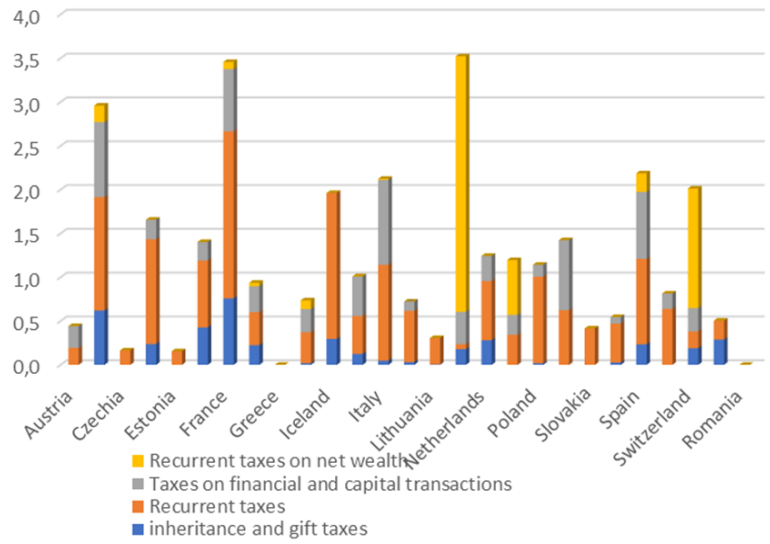
In the period 2015-2023, inheritance taxes have remained relatively constant, with the EU average being approximately 0.3%. It is worth noting that Belgium and France stand out for their contribution, with shares that have remained relatively constant over this period, at 0.7 and 0.6 % of GDP, respectively. We note that within property

taxation, recurrent property taxes predominate, with values ranging from 0.8% of GDP in 2015 to 0.6% of GDP in 2023. Also important are revenues related to the taxation of financial transactions, their level remaining somewhat constant in the analysed period, at approximately 0.4% of GDP.

In 2023, we note that recurrent property taxes (France, Denmark, Belgium, Poland) and financial transaction taxation (Italy, Belgium, France, Portugal) predominate, inheritance taxation is reduced in the EU (France, Finland, Belgium), and the net wealth tax is present only in Luxembourg, France, Belgium, Hungary (0.1% of GDP).

Figure 4

Property taxation by components, 2023, % of GDP, in the EU



Source: OECD data explorer, Global tax revenues. https://data-explorer.oecd.org/

2.3. Assessing the revenues from capital gains taxation in the EU countries

We discuss capital gains, these revenues that are "culpable", among other factors, for the increase in wealth concentration and tax avoidance strategies available exclusively to high and ultra-high net worth individuals at European and global levels (by increasing the value of assets held, their price leading to an increase in the shares of the richest) (Oxfam, 2025).

Taxes on capital income (dividends and capital gains) should play a key role in current tax systems, as they apply predominantly to the richest individuals. According to the Oxfam report (2025), in Europe, the richest 1% own 47% of total financial wealth, this being the main source of capital income. However, in most EU countries, capital income is taxed at rates that are generally lower than the top income tax rate, making tax systems more regressive, increasing inequalities by not taxing the rich adequately or by taxing people with similar incomes differently depending on the source of that income (e.g. labour or capital).

In recent years, realised capital gains have increased in many EU countries; however, their level as a percentage of GDP is zero or very low, the states where they are present being, according to OECD statistics (OECD, 2024), Greece (in the period 2015-2023, the level remained the same, at 0.1% GDP), Ireland (the level varied between 0.2-0.3% GDP), Sweden (the highest level in the EU 27, in 2016, 1.6% GDP, 2018, 1.8% GDP, 2023, 1.1% GDP), Malta (0.8-0.5% GDP in 2023), Croatia or Romania (0.2-0.3% GDP in 2022).

Here are some states that draw attention to the taxation of capital gains: in Luxembourg, a person pays 44 percentage points (pp) less tax on income from capital gains from shares than on income from labour. The country also exempts capital gains from small holdings of securities held for more than six months, making it an attractive destination for anyone looking to sell assets tax-free (Finér, Pankka, 2025).

In France, long-term capital gains taxation for high-income earners is 21 pp lower than that for labour; similarly, in Italy, the difference is 20 pp in Italy, 15 pp in Spain and 9 pp in Denmark.

Belgium has been notable for not taxing capital gains. However, the government has proposed introducing a 10% tax on gains exceeding 10,000 euros from 2025. That said, majority shareholders (holding more than 20%) would benefit from a full exemption for capital gains below 1 million euros, with reduced rates applicable to gains up to 10 million euros. Similarly, Cyprus exempts capital gains not related to the ownership of real estate, while Malta exempts many capital gains or taxes them at very low rates, particularly for wealthy non-residents.

As mentioned above, most EU countries tax capital gains more favourably than other forms of income, separately from income from employment, most commonly at fixed rates (possibly together with other capital income) or at progressive rates, which tend to be lower

than the rates charged on employment income. Some countries tax capital gains together with other personal income, but offer tax reliefs, such as partial exemptions (Hourani & Perret, 2025).

In general, capital gains tax revenues fluctuate considerably, with the most important tax bases being housing and financial assets, which may follow a different cycle compared to aggregate economic activity (Mengden, 2025). Tax treatment and tax rates also differ considerably between Member States and are subject to regular changes.

In most tax systems, capital gains income is taxed only upon realisation, that is, when assets are sold, and increases in value are realised. The profit realised from the sale of capital assets constitutes a realised capital gain. OECD research shows that realised capital gains have been increasing in many OECD countries (Hourani & Perret, 2025). Among countries with available data, realised capital gains have represented between 1% and 6% of GDP over the past two decades and have increased as a share of GDP since the global financial crisis.

Unrealised capital gains are largely untaxed due to difficulties in monitoring and valuation. As a result, the share of economic resources controlled by the wealthy increases without generating significant taxable income. The realisation tax base can incentivise tax-minimising behaviours, such as income shifting and deferring capital gains. Alternatively, several options for specific tax reforms are possible. However, an important negative consequence of increasing taxes on personal capital income is the potential for capital flight or behavioural changes. High and very high net worth individuals and investors may relocate their capital to lower tax jurisdictions to avoid high taxes, thereby reducing the overall tax base and potentially reducing tax revenues. This effect is particularly common in small, open economies with lower tax rates where capital is highly mobile (Chirinko, Wilson, 2017).

3. Macroeconomic effects of taxation of household capital income

Capital taxation has multiple effects, both macro and microeconomic. In this case, we consider the taxation of household capital income, which can impact savings, investments and the economic/fiscal behaviour of individuals.

3.1. Effects of tax expenditures on personal income taxation in the EU countries

According to the Annual Report on Taxation in the EU (EC, 2025), the assessment of tax expenditures, namely the benefits granted by the state related to various components of capital, involves heterogeneous distributional implications. Within the framework of personal income taxation, tax expenditures are typically related to employment, family and housing policies. For example, employment-related spending is often aimed at supporting low-income earners, while housing-related spending, such as mortgage tax relief, is aimed at increasing home ownership and can also affect inequality, benefiting households in higher-income deciles, depending on how it is designed. Tax expenses on family support tend to reduce income inequality, according to the EU Tax Expenditure Report (EC, 2024), with households with the lowest income levels benefiting less from such tax support, even in Member States where tax expenses are generally progressive.

The fiscal and distributional impact of tax expenditures on personal income taxation in the EU is analysed in the above-mentioned study, based on the EU EUROMOD tax and benefit microsimulation model[1]. It uses survey data on gross income, labour market status, and other characteristics of individuals and households, and applies them to the tax and benefit rules in force in each of the 27 EU Member States to simulate taxes, social security contributions, and cash benefits. In this context, tax expenditures related to employment, housing, education, health and family are used, the baseline scenario (the real situation) being compared with a hypothetical scenario in which the simulated tax expenditures related to employment, housing, education, health, and family are set to zero.

The conclusions reached by the authors of the study showed that there are EU countries where tax benefits represent a considerable part of the income tax revenues (over 25% in Slovakia (25%), Greece (27%), Portugal (30%), Romania (32%), but less than 5% in Cyprus (1%), Malta (3%), Estonia (4%) Denmark (5%)), or, if the cost associated with tax expenditures can also be expressed as a percentage of GDP, simulated tax expenditures represent on average

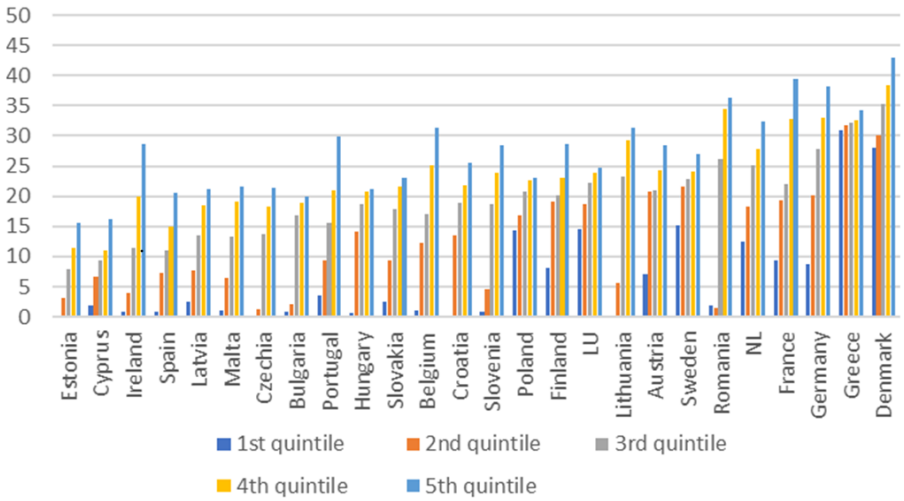
[1] *EU EUROMOD (The tax benefit microsimulation model for the European Union) is updated by the European Commission's Joint Research Centre. Details are available at: https://euromod-web.jrc.ec.europa.eu/*

1.2% of EU GDP, ranging from 0.03% in Cyprus to 2.8% in Belgium. Regarding the impact of tax expenditures on household disposable income in different Member States, they have a small impact on household disposable income (in Cyprus, Croatia, Malta), but a considerable impact in the Netherlands, for example, where simulated tax expenditures lead to a 14% increase in average household disposable income.

In the current context, using the latest available Eurostat data (2020), we analyse the percentage of direct taxes paid by households as a share of their gross income (Figure 5).

Figure 5

Median amount of direct taxes paid by households as a percentage of their gross income, in the EU countries, in 2020



Source: Eurostat data on Distribution of direct taxes paid by households as a percentage of their gross income by income quintile - experimental statistics. https://doi.org/10.2908/ICW_TAX_06

Households with higher incomes contribute relatively more to direct taxes in all EU Member States; if all direct taxes are taken into account, the median of the 20% of households with the highest incomes (5th income quintile) pays the largest share of their gross income for direct taxes. The difference in tax payments as a share of gross income between the first and 5th quintiles is highlighted in Romania (34.5 pp), Lithuania (31.4 pp), Belgium (30.2 pp), France

(30.1 pp), and Germany (29.5 pp). The 20% of the poorest households pay a relatively large share of their gross income in Greece and Denmark.

We believe that the current political context and global trends (ageing population, globalisation, and digitalisation) call for a rethink of income tax. In addition, increasing social security and income tax rates to compensate for a smaller tax base can discourage labour market participation, and a growing focus on inequality has led to the need for more substantial redistribution. Revenue losses could be compensated by shifting part of the tax burden to other tax bases (consumption, personal capital income), increasing overall tax compliance (i.e., reducing tax fraud, evasion, and avoidance), and considering a reallocation of taxing rights (as foreseen for Pillar 1).

3.2. Case study on the effects of taxation of household capital through taxation of personal income, including capital gains, recurrent property taxation on investment rates, saving and inequality

We analyse how the tax structure and the level of tax pressure influence the financial behaviour of households and income inequality in the European Union Member States, over the period 2011–2024. The study uses a panel data set for EU countries, which includes indicators on the gross household saving rate (REBG), the gross household investment rate (RIBG) and the Gini coefficient (GINI), along with the main components of the tax system such as income taxes (IVG), recurrent property taxes (IRP), inheritance and gift taxes (TMC) and total tax revenue (VF).

Using panel estimations with fixed effects by country and year, the analysis aims to capture the impact of structural differences across European tax systems on households' saving and investment decisions, as well as on income distribution. The main aim is to assess the extent to which different forms of taxation contribute to stimulating prudent economic behavior or reducing social inequalities. Overall, the research provides a comparative perspective on the relationship between fiscal policy, private saving and distributive equity in the context of the post-crisis European Union, highlighting the role of fiscal reforms in balancing economic growth and social cohesion. The results of the three regressions are reported in Table 1.

Table 1

Estimation results

Explanatory variable	(1) REBG – Gross saving rate	(2) RIBG – Gross investment rate	(3) GINI –Gini coefficient
IVG (household income tax)	−0.544 (p = 0.260)	0.353 (p = 0.027)	−0.309 * (p = 0.051)
IRP (recurrent property tax)	−1.249 (p = 0.410)	−0.213 (p = 0.786)	+1.157 (p = 0.342)
TMC (inheritance/ gift tax)	+3.191 (p = 0.446)	−3.643 (p = 0.207)	+6.514 (p = 0.040)
VF (total tax revenues)	−0.684 *** (p = 0.001)**	−0.111 (p = 0.311)	+0.228 (p = 0.044)
GINI	+0.348 (p = 0.153)	+0.092 (p = 0.570)	—
REBG	—	—	+0.095 (p = 0.131)
RIBG	—	—	+0.108 (p = 0.496)
Constant	26.76 *** (p = 0.004)	6.39 (p = 0.154)	20.88 *** (p < 0.001)
Fixed Effects	Country & Year	Country & Year	Country & Year
No of observations	158	158	158
No of clusters (countries)	16	16	16
F-statistic (robust)	7.49	1.78	6.38
Prob > F	0.0011	0.1772	0.0017
R^2 total	0.9176	0.9073	0.9166
R^2	0.2529	0.0477	0.1270

source: Author's

*Note: p-value (p) is reported in parentheses. Statistically significant results are marked with *,**,*** representing statistical significance at the 10%, 5%, and 1% level, respectively.*

The results of the three regressions highlight notable differences in how tax policy affects saving, investment, and income inequality across European Union member states over the period 2011–2024.

First, the estimated model for the gross household saving rate (REBG) shows that total tax revenues (VF) have a negative and statistically significant effect on saving, suggesting that a high overall tax burden limits households' ability to accumulate financial resources. The other tax components – income taxes (IVG), property taxes (IRP) and inheritance taxes (TMC) – do not show significant effects, although the signs of the coefficients are in the theoretically expected direction (taxation of income and property reduces saving, and inheritance taxes can stimulate it). This model has an overall R^2 of 0.9176 and an R^2 of 0.25, indicating a good explanation of the total variation, but a

moderate effect of tax variables on the variation in saving over time within countries.

In the second model, with the household gross investment rate (RIBG) as the dependent variable, only income taxes (IVG) are significant, having a positive effect. This suggests that in countries where the income tax system is more consolidated and collection is more efficient, households tend to make more formal investments, possibly as a result of a more predictable and transparent economic environment. Neither total tax revenues nor other types of taxes significantly influence investments, and the R^2 of only 0.05 shows that variations in investments over time are explained to a small extent by the tax structure, suggesting that other factors (e.g. interest rates, economic expectations, credit policies) play a more important role in households' investment decisions.

In contrast, the best performing regression in terms of explanatory power is the one for the Gini coefficient (GINI), which has an overall R^2 of 0.9166 and a high overall significance (Prob > F = 0.0017). The results show that income taxes (IVG) significantly reduce inequality, confirming the redistributive role of direct taxation, while inheritance and gift taxes (TMC) and total tax revenues (VF) are positively associated with inequality, signalling that, in some cases, the general tax burden and taxes on wealth fail to compensate for social differences, but can actually increase them.

Overall, the models indicate that income-based tax systems help reduce inequalities. However, a high total tax burden reduces saving and can increase social polarisation, highlighting the need for a balance between tax efficiency and distributive equity within the EU.

4. Conclusions

In the paper, we presented the analysis of tax revenues from household capital at the level of EU states, in the period 2015-2023, respectively those regarding property taxation (recurrent taxes and those related to the transmission of assets - inheritances, gifts), capital gains from the population/individuals, as well as the effects of tax benefits granted by the authorities regarding households on distribution/inequality.

According to European Commission data, at the EU 27 level, for the year 2023, tax revenues from capital taxation as a share of GDP represent 8.5% of GDP, and of total taxes, 21.9%. In structure,

corporate income tax generates the largest revenues from capital tax, followed by property taxes. Other capital taxes, such as inheritance and wealth taxes, generate only a small part of total capital tax revenues.

A contribution of the paper consists in conducting a case study, through regression, for a panel data set for EU countries, the aim being to demonstrate how the fiscal pressure on households (in our case, recurrent property taxation and taxation of population income, including capital gains) impacts the population's gross investment and saving rate, tax revenues (excluding social contributions), as well as inequality (Gini coefficient). The conclusion is that tax systems based on income taxation contribute to reducing inequalities, but a high total tax burden reduces saving and can amplify social polarisation, highlighting the need for a balance between fiscal efficiency and distributive equity within the EU.

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PUBLIC FINANCES, BANK CREDIT, AND FOREIGN DIRECT INVESTMENT: EVIDENCE FROM EUROPEAN UNION COUNTRIES

Ioan CHIRILĂ, PhD Student*

Abstract

This study explores the macroeconomic and financial determinants of Foreign Direct Investment (FDI) inflows in the 27 European Union member states over the period 2005–2023. Using a dynamic panel specification, we assess the influence of domestic demand, fiscal stance, political stability, and credit conditions on FDI dynamics. The results indicate that lagged FDI, GDP growth, household consumption, and political stability significantly enhance FDI inflows, while inflation is not a significant driver. Public debt and fiscal deficits are associated with reduced FDI, pointing to the importance of macro-financial stability. Of particular interest is the role of bank credit, which shows a positive and marginally statistically significant effect on FDI. This finding suggests that improved access to domestic credit may lower entry costs, increase investor confidence, and facilitate integration into local value chains. The analysis underscores the complementary relationship between financial intermediation and foreign investment, providing empirical support for policies aimed at strengthening banking sector depth as part of FDI attraction strategies.

Keywords: foreign investment inflows, credit to private sector, fiscal policy, panel data econometrics, GMM estimation

JEL Classification: G21, H62, H63, C23, F21

DOI: https://doi.org/10.65672/fs.2025.4.5

1. Introduction

Foreign direct investment (FDI) continues to be a key driver of economic growth, providing not only capital but also knowledge transfer, access to global markets, and productivity gains. For many countries, particularly within the European Union, attracting stable and long-term FDI is an essential part of development strategy. While

* *Doctoral School of Finance, Bucharest University of Economic Studies, Romania. ORCID: https://orcid.org/0009-0001-1600-102X. Corresponding author, e-mail: chirilaioan20@stud.ase.ro*

classic factors such as tax rates, labor costs, and infrastructure still matter, there is a growing understanding that deeper institutional and financial variables shape investor decisions in more complex ways.

Among these, the strength and accessibility of the domestic banking sector is gaining attention. When local firms and foreign investors have access to credit, it becomes easier to finance operations, build partnerships, and expand activity. A stable and supportive financial system also sends important signals about the country's economic health and resilience. In this sense, credit conditions do more than just support the local economy; they may influence whether or not foreign capital decides to enter in the first place.

At the same time, public finance indicators remain crucial in shaping investor confidence. High fiscal deficits and growing public debt can raise concerns about macroeconomic risks, future tax burdens, and exchange rate stability. Even when other fundamentals are strong, weak fiscal positions can undermine credibility in the eyes of investors. The relationship between fiscal policy and FDI is therefore not simply a matter of numbers, but a reflection of how broader economic governance is perceived internationally.

Based on the existing literature and the theoretical foundations outlined earlier, this paper puts forward several working hypotheses. It is expected that greater availability of credit to the private sector contributes positively to foreign direct investment inflows across European Union countries. Conversely, higher fiscal deficits and elevated levels of public debt are anticipated to have a discouraging effect on FDI, as they may signal macroeconomic instability and reduced fiscal discipline. Political stability is assumed to enhance investor confidence, thereby exerting a positive influence on FDI dynamics. Furthermore, it is hypothesized that the effect of domestic credit on FDI may not be uniform across countries, but rather more pronounced in economies that already attract moderate to high levels of foreign investment, suggesting a heterogeneous relationship along the FDI distribution.

Based on an empirical analysis covering all 27 EU countries from 2005 to 2023, we find that larger fiscal deficits and higher levels of public debt are associated with lower FDI inflows. In contrast, the availability of bank credit to the private sector is positively related to FDI and reaches statistical significance at the ten percent level. These results suggest that even in the presence of fiscal challenges, strong

domestic credit markets may help mitigate risk perceptions and sustain investor interest. By improving access to finance, countries may enhance their attractiveness and capacity to absorb foreign capital more effectively.

This study contributes to the literature by exploring how financial sector development, particularly through bank credit, interacts with macro-fiscal conditions to shape FDI flows within the European Union. Unlike previous research that focused mainly on tax incentives or labor market reforms, this paper highlights the complementary role of financial intermediation in building a credible and investment-friendly environment. It offers new evidence on the importance of credit markets in supporting foreign investment and suggests a more integrated policy approach that considers both fiscal responsibility and financial sector depth as part of a broader strategy for attracting sustainable FDI.

What sets this paper apart from previous studies is its integrated approach to analysing both fiscal sustainability and financial sector development as joint determinants of FDI inflows within the European Union. While prior research has largely focused on the effects of tax incentives, labour costs, or institutional quality in isolation, this study explicitly examines how the availability of domestic credit interacts with macro-fiscal imbalances—such as public debt and deficits—to shape investor behaviour. In doing so, it contributes to the growing body of literature that emphasises financial intermediation as a key enabler of investment and provides new empirical evidence based on dynamic panel techniques and quantile regression analysis. By identifying the conditions under which bank credit may offset negative fiscal signals, this paper offers a more nuanced understanding of FDI drivers in post-crisis and post-pandemic Europe, with clear implications for integrated policy design.

2. Literature review

Foreign Direct Investment (FDI) is widely recognized for its potential to enhance economic growth by contributing to capital formation, technology diffusion, and productivity gains (Borensztein et al., 1998; De Mello, 1997; Alfaro et al., 2010). However, empirical findings on the causality between FDI and growth remain inconclusive. A comprehensive meta-analysis by Iamsiraroj and Ulubaşoğlu (2015) found that only 43% of studies report a statistically significant positive

relationship. More recent panel analyses (Nupehewa et al., 2022) show regionally divergent results: bi-directional causality in Asia, uni-directional causality from growth to FDI in the Americas, and no clear direction in Europe and Africa.

The sustainability of public debt plays a critical role in shaping investor sentiment. Large and persistent budget deficits are often interpreted as signals of macroeconomic vulnerability, potentially deterring FDI. Onafowora and Owoye (2019) found that in Caribbean economies, high public debt had a significant negative impact on growth, while FDI had a generally positive impact. Their findings suggest that fiscal imbalances may crowd out private investment or undermine the credibility of macroeconomic policy, especially in small or open economies.

While fiscal deficits may discourage FDI through higher risk premiums, certain deficit-financed expenditures—such as infrastructure, education or tax incentives—can actually improve a country's investment climate (Egert, 2015; Banday & Murugan, 2021). Governments may strategically run deficits to attract FDI, particularly in sectors with strong externalities. Nonetheless, the success of such strategies hinges on institutional quality and policy coherence. Studies confirm that the FDI-growth link is stronger in countries with sound institutions and transparent governance (Fabro & Aixalá, 2012; Li & Liu, 2005).

Recent studies highlight the relevance of sovereign solvency and financial cycles for FDI and bank credit interactions. Korzeb et al. (2023) show that host-country creditworthiness enhances foreign bank presence, while Rancan et al. (2023) reveals that elevated public debt constrains banks' domestic funding. Zhou et al. (2024) underscore that credit booms significantly shape debt cycles, suggesting complex feedback effects. Palmén (2020) further finds that sovereign risk dampens private lending, a mechanism highly relevant for FDI financing in EU member states.

The COVID-19 pandemic, the war in Ukraine, and the rise of nationalist policies have reshaped global capital flows. UNCTAD (2021) reports that while global FDI rebounded after COVID, flows became more concentrated and risk-sensitive. According to Nupehewa et al. (2022), FDI volatility increased notably in regions affected by political instability or external shocks. This suggests that fiscal stability and predictable governance are now more critical than ever in retaining

and attracting investment. Countries with high debt and weak institutions face compounded risks of FDI flight.

Together, these studies underscore the importance of integrating fiscal policy dynamics into the analysis of FDI inflows. There is a growing need for research that explores threshold effects—identifying the point beyond which fiscal deficits cease to be simulative and begin to deter FDI. Moreover, the role of FDI in supporting fiscal consolidation (via increased tax revenues or GDP growth) remains under-explored. Future studies should build on the methodologies of Onafowora & Owoye (2019) and Nupehewa et al. (2022) to examine how different compositions of public expenditure and external shocks alter the FDI-deficit-growth triangle across various country groups.

Building on this body of research, the present study proposes that the relationship between fiscal conditions and FDI inflows is strongly influenced by the depth and functioning of the domestic financial system. More precisely, we argue that high levels of public debt and persistent budget deficits tend to discourage foreign investors by increasing perceptions of macroeconomic risk and reducing confidence in the long-term stability of the host economy. At the same time, a well-developed banking sector, reflected in the availability of credit to the private sector, can improve the overall investment climate by facilitating access to finance, supporting business expansion, and signalling institutional maturity. This paper investigates whether the presence of robust credit markets can mitigate the negative effects of fiscal imbalances on FDI inflows, and whether there are thresholds beyond which fiscal deterioration becomes a dominant deterrent to foreign investment, particularly in the European Union.

3. Data description

This study is based on a balanced panel dataset comprising all 27 European Union member states over the period 2005 to 2023. The dependent variable is the level of foreign direct investment (FDI), measured as a percentage of GDP. This indicator captures the relative intensity of foreign capital inflows into each country and is widely used to assess international investment dynamics.

The model follows a dynamic specification by including the lagged value of FDI, which reflects persistence in investor behaviour and the cumulative nature of investment decisions. A range of macroeconomic and institutional control variables is included to

account for country-specific conditions that may influence FDI inflows. These include real GDP growth, which reflects overall economic performance; household consumption, as a proxy for domestic demand; inflation, capturing macroeconomic stability; the public debt, representing fiscal discipline and sustainability; and political stability, used to approximate institutional quality and predictability.

A central variable of interest is bank credit to the private sector, which serves as a proxy for the depth of financial intermediation in each country. This indicator is used to assess whether greater access to domestic credit facilitates the attraction and absorption of foreign investment. All variables are collected from TheGlobalEconomy.com, which provides harmonized and comparable economic indicators across countries and time. The dataset is balanced and spans nineteen years, ensuring consistency and robustness in the panel estimations.

Before proceeding with the estimation, it is essential to examine the stationarity properties of the panel data series used in the analysis. Non-stationary variables can lead to spurious regression results, compromising the validity of statistical inferences and potentially overstating relationships between variables. To ensure robustness, we apply the Levin, Lin, and Chu (LLC) panel unit root test, which assumes a common unit root process across cross-sections and is appropriate for balanced panel data such as ours. The results of the stationarity tests for all variables included in the model are summarised in Table 1.

Table 1

Unit Root Tests

Variable	Statistic	p-value
FDI	-6.4305	0.0000
Growth	-11.9085	0.0000
Household	-2.3679	0.0000
Inflation	-3.0761	0.0010
Balance	-5.0148	0.0000
Stability	-2.9118	0.0018
Bank	-1.8442	0.0326

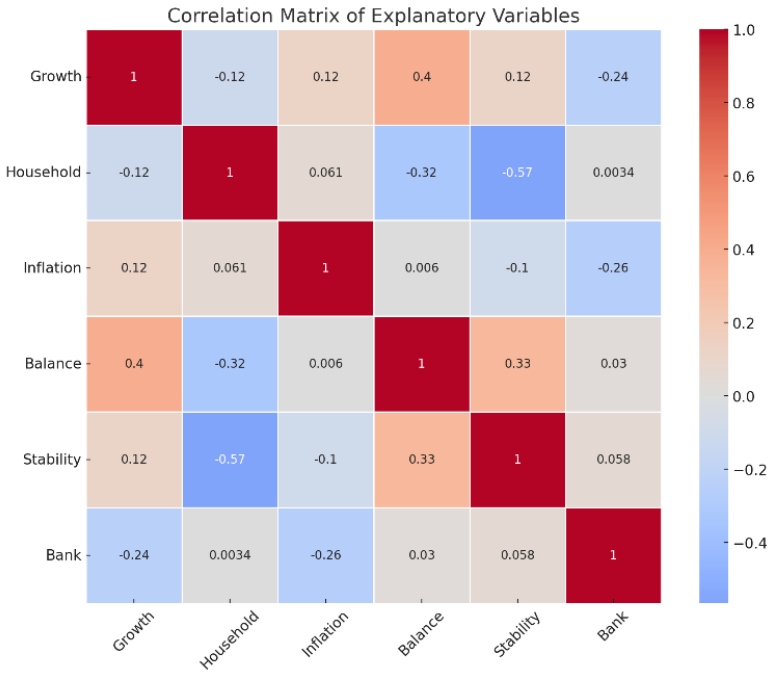
Source: Author's

The results of the Levin, Lin, and Chu panel unit root tests indicate that all variables are stationary at conventional significance

levels, thereby mitigating concerns about spurious regression and supporting the validity of the econometric estimates.

Figure 1

The correlation matrix



Source: Author's

Examining the correlation matrix among explanatory variables is a key diagnostic step to ensure the robustness of the regression model and to detect potential multicollinearity. As shown in Figure 1, the correlations between variables are generally low to moderate, indicating that the explanatory variables capture distinct economic dimensions and are not excessively overlapping. The relationship between household consumption and political stability appears to be inversely associated, suggesting potential structural differences in consumption patterns across countries with varying institutional environments. Economic growth tends to be positively related to fiscal balance, which is consistent with the notion that stronger economies often exhibit healthier public finances. Bank credit shows weak associations with most macroeconomic variables, reflecting its

independent contribution as a measure of financial depth. Overall, the correlation structure supports the inclusion of all selected variables in the model and reduces concerns about multicollinearity affecting the accuracy of the estimated coefficients.

4. Results

To investigate the determinants of foreign direct investment (FDI), we applied the System GMM estimator, which is particularly suitable for panel datasets with a moderate time dimension and a relatively small number of cross-sectional units. This approach addresses key econometric challenges such as unobserved heterogeneity, potential endogeneity of explanatory variables, and autocorrelation within country panels. Including the lagged value of FDI as a regressor captures the persistence of investment behaviour over time, which is in line with the literature on path-dependence in capital flows. Moreover, the use of internal instruments ensures more consistent estimates in the presence of potentially endogenous regressors like domestic credit, institutional stability, and macroeconomic indicators. Compared to traditional fixed-effects or pooled OLS approaches, System GMM offers a more robust framework for identifying causal patterns in dynamic investment processes. The estimation results are presented in Table 2.

A particularly novel contribution of this study lies in emphasizing the role of the domestic banking sector—measured through the availability of credit to the private sector—as a significant and robust driver of FDI inflows. While existing studies have largely focused on growth, trade openness, or fiscal variables as FDI determinants, relatively few have explicitly examined how financial intermediation conditions shape investor confidence. Our results show that credit to the private sector is strongly and positively associated with FDI inflows (coefficient = 0.6051; $p < 0.01$), suggesting that domestic financial systems are not merely supporting players but central pillars of the investment climate. This finding introduces a new dimension to the FDI-growth-deficit framework and positions financial depth as a potential buffer against macroeconomic risk perceptions.

Beyond facilitating access to capital, a well-functioning credit market may also act as a proxy for broader institutional maturity. In economies where banks operate transparently and allocate credit efficiently, foreign investors are more likely to perceive reduced

operational risks and stronger enforcement of contracts. This interpretation is especially relevant in emerging markets or transitional economies where fiscal imbalances and political uncertainty can deter long-term investments. Our results support the view that a sound financial system can offset some of the negative signals sent by fiscal deficits or inflationary pressures. This mechanism helps explain why credit availability remains a statistically significant predictor of FDI, even when other macro-fiscal variables such as inflation or the current account balance are not.

Table 2

System GMM results

Variable	Coefficient	Std. Error	z	p-value
Lagged FDI	0.1352	0.0360	3.76	0.000
Growth	1.3901	0.5668	2.45	0.014
Household	1.9997	0.6031	3.32	0.001
Inflation	-0.2768	0.6624	-0.42	0.676
Balance	-0.3348	0.8749	-0.38	0.702
Stability	0.7031	0.1563	4.50	0.000
Bank	0.6051	0.0966	6.27	0.000

Source: Author's

Aside from banking credit, several other variables exhibit important effects. Both economic growth and household consumption have strong and significant positive impacts on FDI, consistent with the market-seeking motive of many investors. These results align with classical studies (e.g., Borensztein et al., 1998; Alfaro et al., 2004) that emphasise the role of host market size and demand potential in attracting foreign capital. Interestingly, inflation and fiscal balance were not found to be statistically significant, suggesting that short-term macroeconomic instability may carry less weight for investors than structural conditions or institutional quality. The significance of the "Stability" variable reinforces this interpretation—predictable legal and political environments remain critical for long-term investment decisions. Finally, the positive and significant coefficient on the lagged FDI variable confirms the presence of inertia and continuity in

investment flows, supporting the idea that once a country becomes an investment destination, it tends to remain attractive over time.

While average effects derived from linear or GMM estimations offer valuable insights, they may obscure significant heterogeneity across the distribution of FDI. Quantile regression allows us to examine whether the determinants of FDI—particularly access to domestic credit—vary between countries that attract low, median, or high levels of investment. This is especially relevant in the context of European economies, where structural and institutional differences produce widely dispersed FDI levels. By modelling conditional quantiles, we can uncover whether banking credit plays a more prominent role at higher levels of FDI, or whether its effect is only observable in low or moderate FDI environments.

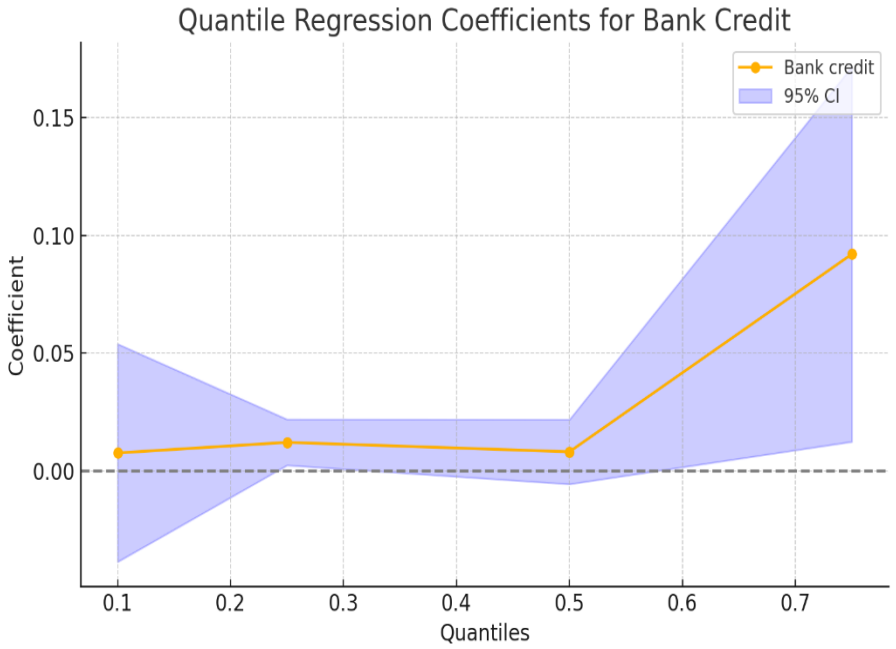
The results presented in Figure 1, confirm the previous finding reported by the SYS GMM. The results from the quantile regression analysis provide important insights into the heterogeneous effect of bank credit across the FDI distribution. While traditional mean-based estimators assume a uniform relationship, our findings indicate that the influence of domestic credit availability varies depending on a country's position within the FDI distribution. Specifically, bank credit does not appear to significantly affect FDI in countries with very low investment levels, where structural weaknesses or institutional instability may override financial considerations. However, the effect becomes positive and statistically significant in the middle and upper parts of the distribution, implying that in economies with moderate to high FDI inflows, the depth and accessibility of credit markets play a more substantial role. This pattern suggests that banking sector development serves as a key enabler in converting macroeconomic potential into actual investment, particularly in settings where other investment fundamentals are already in place. The growing importance of bank credit at higher quantiles may also reflect investor confidence in the long-term financing environment, reinforcing the notion that financial infrastructure complements broader investment strategies.

These findings are broadly consistent with the existing literature, particularly the work of Alfaro et al. (2010), who emphasize that well-developed financial systems amplify the positive effects of foreign direct investment by improving resource allocation and enhancing investor confidence. Similarly, Borensztein et al. (1998) argue that the absorptive capacity of the host country—especially through financial market development—is a critical determinant of the

effectiveness of FDI. The positive and statistically significant impact of credit on the private sector in our model aligns with this perspective. In contrast, our finding that inflation and fiscal balance are not statistically significant stands in partial contradiction with Onafowora and Owoye (2019), who report a negative impact of inflation on FDI in the Caribbean region. This divergence may reflect structural differences between European and developing economies, particularly in terms of monetary credibility and investor expectations. Moreover, the importance of political stability in our model confirms the role of institutional quality highlighted by Fabro and Aixalá (2012), reinforcing the notion that FDI flows are sensitive to governance and legal predictability. Overall, our results support the view that financial intermediation and institutional conditions jointly shape the FDI environment, extending previous research by integrating both fiscal and credit-based determinants in a unified empirical framework.

Figure 1

Impact on Foreign Direct Investments



Source: Author's

5. Conclusions

The results of this study suggest that improving access to credit is not only a financial reform objective but also a strategic tool for attracting foreign direct investment (FDI) and supporting inclusive economic development. Given that the impact of bank credit on FDI becomes more pronounced in economies with moderate and high levels of investment, central banks could consider revisiting certain regulatory constraints that limit credit expansion—particularly those affecting sectors with strong externalities or investment spillovers. Targeted relaxation of credit-related policies, such as easing collateral requirements for productive investments or creating countercyclical lending schemes, could enhance the depth of the financial system and improve investor perceptions of long-term financial stability. In contexts where macroeconomic fundamentals are sound, such measures may amplify FDI inflows and reinforce a virtuous cycle of capital accumulation, productivity, and growth.

At the same time, governments have a key role to play in broadening the credit base by supporting small, and medium-sized enterprises (SMEs), particularly in structurally disadvantaged or underbanked regions. Many of these firms are excluded from traditional finance due to size, risk profile, or lack of formal records, yet they represent a critical foundation for local economic resilience and supply chain integration. Public credit guarantees, subsidized loan programs, or hybrid financing mechanisms—especially when tied to performance or formalization efforts—can reduce perceived risks and catalyze private lending. By embedding such strategies within a broader policy framework that emphasizes territorial cohesion, institutional trust, and sustainable development, governments can not only enhance the country's attractiveness to FDI, but also ensure that its benefits are more evenly distributed across regions and social groups.

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GREEN ENERGY STOCKS & MARKET TRENDS: AN OVERVIEW OF CONTEMPORARY LITERATURE

Răzvan TOPA, PhD Student*

Abstract

The energy sector has gained increasing importance in recent years, playing a vital role in economic development at both national and global levels, especially in the shift towards a zero-carbon economy. This study provides a comprehensive overview, analysing green energy stocks and their trends from various perspectives and scenarios. The analysis is based on a thorough selection of academic sources sourced from scholarly databases, filtered using keywords related to climate change modelling and analysis. Key topics explored include the influence of green investments on oil prices, the effect of online environmental news on green industry stocks, the relationship between green energy indices and financial markets, the impact of spillovers between dirty and clean energy markets and global stock indices, and their effect on volatility transmission between green and conventional stocks. Additionally, the paper examines climate policy and the connection between green bonds and the green stock market. The central research question addressed is whether green energy stocks have a tangible impact on market trends. The future trajectory of the economy in the context of climate change is a critical issue with implications for both local and global economies. As such, this literature review covers various themes that, directly or indirectly, investigate the relationship between climate change and economic dynamics.

Keywords: investments, oil prices, energy indices, financial markets, clean energy, volatility, climate policy, stock exchange

JEL Classification: G10, G12, Q40, Q42, Q50

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* *Doctoral School of International Business and Economics, Bucharest University of Economic Studies, Romania. ORCID: https://orcid.org/0009-0000-5908-0787. Correspondent author e-mail: razvan.topa@gmail.com*

1. Introduction

With the increasing recognition of sustainability's importance (Zhou et al, 2025), investors are progressively reallocating capital toward green investments (Wang et al, 2022a; Liu et al., 2024). In particular, there is a growing tendency to construct portfolios that incorporate environmentally responsible firms. These companies are gaining prominence for their production of, and support for, sustainable goods and services. Schaeffer et al. (2012), for example, contend that eco-friendly firms have garnered significant attention from investors, policymakers, and society at large due to their provision of environmentally sustainable services. Overall, green investments—also referred to as environmental assets—have become a focal point of interest among market participants.

Among other factors, this study also explores whether green investments exhibit a significant response to oil price shocks. This analysis could be crucial for policymakers in understanding the broader impact of oil price fluctuations on environmental investments and crafting suitable strategies to encourage the growth of eco-friendly businesses. For instance, during a downturn in the oil market, the incentives for environmentally conscious investors may diminish, potentially leading to a decline in the prices of environmental assets. Conversely, when oil prices rise, incentives for green investments tend to increase, which could drive up the equity prices of eco-friendly firms.

Several studies (Bondia et al., 2016; Dutta, 2017; Xia et al., 2019) suggest that an increase in oil prices fosters green investments. For example, Bondia et al. (2016) demonstrate that rising energy prices incentivise investors to shift towards green energy companies, as the potential rewards for such investments grow. Similarly, Dutta (2017) argues that oil price volatility (OVX) exerts an inverse effect on clean energy stocks, indicating that they tend to move in the same direction.

Undoubtedly, global economic growth generates a sustained demand for energy. As a result, countries strive to secure a reliable energy supply while maintaining reasonable energy prices. Both objectives must be pursued concurrently through the development of an integrated energy market. At the same time, there is a growing recognition that fossil fuel resources are becoming increasingly scarce, and renewable energy has emerged as both an alternative source and a sustainable solution for many nations.

The unforeseen Russian invasion of Ukraine on February 24, 2022, introduced increased uncertainty regarding access to fossil fuel commodities. However, it may have also opened new opportunities for alternative energy sources and investment in the green energy market. As a result, investors may be motivated to rebalance their portfolios by shifting towards alternative assets, thereby diversifying their exposure to risks in financial markets. However, the overall effect of the war on the global economy, as seen in the rising energy prices and the reactions of international financial markets, is still challenging to evaluate (Adekoya et al., 2022; Lo et al., 2022).

Considering the significant reliance on non-renewable energy resources from Russia by many countries, the Russia-Ukraine conflict could serve as a turning point for energy policy in Europe. Amid the global transition to renewable energy and the ongoing uncertainty surrounding the war, investments in green energy could pose challenges for market participants. The diverse impacts of energy commodity price shocks on other asset prices shape the decisions of various economic agents, such as companies, investors, and policymakers. However, it remains unclear how to mitigate portfolio risk with clean energy stocks and how the risk of the renewable energy market compares to that of traditional assets. In order to bridge this gap, one of the objectives of this study is to explore how the Russian-Ukrainian war affects financial interconnectedness, focusing on the volatility spillovers between energy markets and stock indices.

The global recognition of the pressing issue of climate change has led to an increased emphasis on environmental sustainability and carbon reduction (Ding et al 2020; Khurshid et al. (2022)). As a result, investors are showing greater interest in companies that specialize in green technologies or renewable energy. The 2022 report from the International Development Finance Club (IDFC) highlights a record-breaking total of USD 288 billion in green financing commitments, marking a 29% increase compared to 2021. Since the adoption of the Paris Agreement in 2015, cumulative green finance commitments from IDFC members have surpassed USD 1.5 trillion.

To reduce the carbon footprint of energy within the overall energy mix, it is essential to increase the share of clean energy by promoting green investments and discouraging investments in non-renewable energy sources (Khan, Razzaq, Yu, & Miller, 2021; Sohag, Hassan, Bakhteyev, & Mariev, 2023). Moreover, supporters argue that green investment plays a vital and irreplaceable role in driving a

market-based shift toward sustainable energy alternatives. To improve the cost competitiveness of renewables over fossil fuels, numerous governments have introduced carbon pricing policies and extended subsidies to promote the production of green energy (Intergovernmental Panel on Climate Change [IPCC], 2023; Reboredo & Ugolini, 2020).

Consequently, there has been a surge in investor interest in the renewable energy sector. Simultaneously, greater attention is being directed toward the role of the financial system as a catalyst for broader sectoral transformation. Nevertheless, there remains a noticeable gap in the literature regarding the relationship between green and conventional asset markets during periods of geopolitical and economic instability, particularly in the context of developing countries.

The green transformation presents significant opportunities for advancing global sustainable development. At present, there is broad international consensus on the importance of this transition, accompanied by tangible policy actions. As of 2022, over 120 countries had established or were in the process of establishing carbon neutrality targets, collectively representing 88% of global carbon emissions. Green bonds play a dual role by supporting the low-carbon transition and fostering economic growth (Reboredo et al., 2020).

The issuance of green bonds can facilitate the mobilization of greater social capital toward achieving carbon neutrality objectives. However, as an emerging asset class, green bonds embody both financial and environmental characteristics. Given the common exposure to macroeconomic conditions across green financial markets, there is potential for risk contagion among these assets—particularly during periods of crisis (Dai et al., 2022; Wei et al., 2023). Consequently, in the pursuit of carbon neutrality, examining the complex relationship between green bonds and green equity markets has emerged as a pressing concern.

Building on the preceding discussion, this article undertakes a comprehensive review of the literature examining the relationship between green energy stocks and evolving market dynamics. The primary focus is on how green investments respond to oil price shocks. The analysis then considers the influence of online environmental news on green industry stock performance. Further, the study explores the interplay between green energy indices and broader financial markets. It also addresses the effects of the Russia–Ukraine conflict on both dirty and clean energy markets, in comparison with global

indices. Finally, the review investigates the role of volatility transmission, hedging strategies across green and conventional stocks, and the uncertainty surrounding the correlation between green bonds and green stocks—particularly from the perspective of climate policy.

The remainder of this paper is organised as follows: Section Two outlines the data and methodology, detailing the primary approaches used in conducting the study. Section Three presents the key findings and discussions, while Section Four offers the conclusion.

2. Data and methodology

In order to evaluate the influence of green energy stocks on market trends, we carried out an extensive literature review, utilising academic research published from the early 2000s to the present. Pertinent studies were gathered from reputable scholarly databases, including Elsevier Ebooks, SpringerLink Journals, Wiley Ebooks, SciVal, ProQuest Central and Sage Journal Collection, through targeted searches using terms associated with green energy dynamics and current market movements.

The central research question addressed in this paper is whether green energy stocks have a tangible impact on market trends. The future trajectory of the economy in the context of climate change is a critical issue with implications for both local and global economies. As such, the analysis is based on six scholarly references that address the subject from various perspectives within the specialised literature. Those six dimensions are investigated further in the paper.

3. Results and discussion

3.1. Green investments and oil price shocks

This study distinguishes itself from previous research in two key ways. First, it investigates the relationship between crude oil and green investments across various economic regimes using the Markov Regime Switching (MRS) approach. In contrast, most existing studies on the relationship between ethical investments and other financial assets typically rely on ordinary least squares (OLS) regression. However, these studies often overlook the fact that the connections between financial markets are subject to frequent shifts due to events such as recessions, terrorist attacks, and natural disasters (Dutta et. al., 2020).

Consequently, the fixed parameter assumption inherent in the least squares method is overly restrictive, potentially leading to model misspecification. In this context, employing the MRS regression proves advantageous, as it enables the coefficients to vary across different economic states (Uddin et al., 2018). For example, by using this approach, it can be examined how green assets respond to oil price shocks in both high and low volatility states.

Secondly, this study incorporates newly introduced environmental indices that comprise companies engaged in eco-friendly production and green infrastructure development. Notably, it includes the MSCI Global Environment Index and the MSCI Global Green Building Index. According to MSCI.com, these indices are designed to enhance exposure to clean technologies, featuring companies that derive the majority of their revenue from products and services contributing to environmental sustainability. The index construction employs MSCI ESG Sustainable Impact Metrics. To the best of the authors' knowledge, this is the first study to analyze these specific green assets, whereas prior research has primarily focused on the relationship between oil prices and broader clean energy stock indices (Dutta et. al., 2020).

Henriques and Sadorsky (2008) utilize a vector autoregression (VAR) model to explore the relationship between oil prices, alternative energy, and other macroeconomic variables, finding that movements in clean energy stock prices are partially influenced by these factors. Sadorsky (2012a) argues that rising oil prices increase the risk associated with clean energy equities, while Sadorsky (2012b) further demonstrates that oil price volatility spills over into clean energy stock markets. Focusing on firm-level dynamics, Kumar et al. (2012) examine the sensitivity of renewable energy stock prices to oil price shocks. Wen et al. (2014) analyze the mean and volatility transmission between Chinese renewable energy and fossil fuel firms. Additionally, Reboredo (2015), using a copula approach, provides empirical evidence of a time-varying dynamic dependence between oil prices and clean energy stocks.

Bondia et al. (2016) identify a significant relationship between energy equities and oil markets, further establishing that movements in the commodity market Granger-cause those in the stock market, but not the reverse. Using wavelet analysis, Reboredo et al. (2017) observe weak short-term comovements between clean energy and conventional energy stock prices; however, this relationship becomes

more pronounced over the long term. Similarly, Ahmad (2017) confirms a co-movement between renewable energy stock returns and oil prices.

These findings suggest that rising energy prices may serve as a catalyst for increases in green energy stock prices. Dutta et al. (2018a, 2018b) demonstrate that clean energy stocks can be effectively hedged using information derived from carbon emission prices. Bouri et al. (2019) identify crude oil and gold as safe-haven assets for clean energy stocks during periods of heightened market volatility. Additionally, Xia et al. (2019) highlight that fluctuations in electricity, oil, and coal prices are key determinants of clean energy stock returns.

Recent research by Kocaarslan and Soytas (2019) reveals that the appreciation of the US dollar is a significant factor influencing the time-varying relationship between clean energy stock prices and oil prices. Another strand of the literature focuses on the Oil Volatility Index (OVX) to assess its impact on clean energy stock indices. In this context, Dutta (2017) identifies a positive relationship between the OVX and the realized volatility of renewable energy stocks. Conversely, Ahmad et al. (2018) find a negative correlation between clean energy equities and the OVX, suggesting that incorporating OVX into investment portfolios may help mitigate risks associated with clean energy stocks.

Dutta (2019) examines the influence of implied volatility indices for oil, gold, and silver on the equity prices of solar energy firms. The results indicate that oil market volatility, measured by the OVX, transmits greater risk to alternative energy stocks compared to the volatility indices of silver and gold. Additionally, Dutta et al. (2018a) suggest that the OVX serves as an effective instrument for hedging downside risk associated with clean energy stock prices.

The literature review indicates that many of the referenced studies address time-series data characterised by structural breaks. However, the majority rely on conventional OLS regression models to examine the relationship between oil prices and clean energy stock prices. As noted by Kim et al. (2008), the results derived from such models may be misleading in the presence of structural shifts. In contrast, regime-switching models—such as those proposed by Hamilton (1990), Fong and See (2002), and Lee and Chen (2006)—are better suited for capturing regime-dependent dynamics and may offer more accurate insights.

3.2. Online environmental news on green industry stock

Growing awareness of the detrimental effects of environmental pollution has led to increased public concern and policy attention in China. Both the government and the public have come to recognise the critical importance of environmental protection. In 2017, China committed to advancing green development, addressing major environmental challenges, and enhancing ecosystem conservation. In line with this commitment, the government introduced a green economic strategy aimed at simultaneously fostering economic growth and mitigating environmental degradation. To support this transition, a range of legal and economic policy instruments have been implemented to stimulate investment in emerging green industries, including renewable and clean energy, electric vehicles, clean production technologies, and environmental management technologies (Wang et al., 2021).

Also, many companies have begun to increase investments in renewable and clean energy and environmental protection technologies. Due to the importance of green industries in future developments, these green companies, as well as their environmental strategies, will receive increased attention from the public, and from media agencies, individual investors, and institutional investors. Evidence has been mounting recently to suggest that this greater attention should affect asset pricing and lead to a violation of market efficiency (Chen, 2017).

The news media serve as a primary source of public information for investors (Aman et al., 2018), and empirical evidence suggests that heightened media coverage can significantly influence investor attention, subsequently impacting trading volumes, stock prices, and returns (Yang et al., 2017; Seng & Yang, 2017). Prior research indicates that news impacts stock market movements not only through information dissemination but also by shaping investor sentiment. Various forms of news—such as macroeconomic updates, business events, corporate disclosures, and announcements related to technological innovation—can alter investor sentiment, which in turn influences stock returns and trading volumes (Gan et al., 2020).

While the relationship between news media, investor attention, sentiment, and stock returns has been extensively examined, the findings remain inconclusive—particularly regarding the extent to which environmental news influences investor sentiment and the stock performance of companies within the green industry. In the digital age,

nearly all mainstream news organizations publish reports via their official websites and social media platforms. Furthermore, specialised web portals such as Eastmoney (www.eastmoney.com) continuously monitor, aggregate, and disseminate a wide array of commercial, technological, economic, and financial news, providing investors with streamlined and immediate access to relevant market information (Wang et al., 2021).

The literature relevant to this analysis encompasses two key areas: the impact of news media coverage on stock returns and the influence of investor sentiment on stock market performance. Regarding the first area, an increasing body of research highlights the significant role that news media reporting plays in financial markets, with particular emphasis on online and social media platforms, which have become primary sources of information for investors (Zhang et al., 2018). Prior research on the influence of news media on stock returns can be understood through two theoretical frameworks. The first is the Efficient Market Hypothesis (EMH), which posits that stock prices fully reflect all available information—past, present, and anticipated future events—thus adjusting as new information emerges through news media. The second is the Attention Hypothesis (AH), which contends that investors are cognitively constrained and often react only to information that captures their attention. Within this framework, mainstream news coverage can significantly shape investor sentiment and, consequently, affect trading behavior (Aman et al., 2018; Yang et al., 2017).

Extensive empirical research has demonstrated that news reports can have both direct and indirect effects on stock returns. (Tetlock, 2007) showed that the content of news media could predict movements in broad stock market indicators. (Seng & Yang, 2017) provided evidence that financial news influenced stock returns in the Taiwanese market. (Vanstone et al., 2019) found that incorporating predictors such as the number of news articles and “X” posts could significantly enhance the accuracy of stock price predictions. (Su et al., 2019) examined the impact of news reporting in the United States on Chinese stock market returns, revealing that news-induced volatility (NVIX) had a negative effect on Chinese stock returns over the long term.

(Mo et al., 2019) explored the relationship between news-induced volatility (NVIX) and stock market volatility in the United States from a multiscale perspective. They found that the correlation between

NVIX and market volatility was weak in the short term but significantly stronger in the long term. (Huang, 2018) demonstrated that macroeconomic news had a notable effect on the expected future stock returns of energy companies. (Robinson et al., 2018) examined the impact of news media on the stock market performance of green companies, revealing that the stock returns of green companies in emerging markets were less influenced by daily news and were instead more driven by long-term factors.

Regarding the second area, the influence of investor sentiment on market returns has long been acknowledged in financial literature. However, measuring investor sentiment remains challenging due to factors such as differences in sampling methods, time horizons, and other variables, leading to inconsistent conclusions regarding its relationship with stock returns. A review of the existing literature reveals that investor sentiment has been measured through various approaches, including direct indicators, indirect indicators, and online-based metrics.

Direct indicators measure investor sentiment based on their expectations about current and future market trends, typically gathered through survey data. Common examples include bullish and bearish sentiment indexes (Waggle et al., 2015; Renault, 2017), investor confidence indexes (Fisher et al., 2000; Wu et al., 2018), and consumer confidence indexes (Shen et al., 2017; Meier, 2018). For instance, Frugier et al. (2016) used the State Street Investor Confidence Index to proxy for investor sentiment and found that it significantly influenced stock returns under certain market conditions. Indirect indicators refer to financial market-based measures such as trading volume, turnover rate, the number of newly opened accounts, and the discount on closed-end funds. Building on the approach by Baker and Wurgler (2006), Aboody et al. (2018) utilised overnight returns as a proxy for gauging investor sentiment.

3.3. The relationship between green energy indices and financial markets

Green financial assets are part of the broader category of green investments—investments directed toward sectors that enhance the environmental sustainability of the economic system (Campiglio, 2016). As such, understanding the features of green stocks requires examining the broader trends in green energy investment. For instance, how are green energy investments progressing? Are green

financial assets becoming central to funding sustainable projects? And who are the major players driving this shift? This section provides a descriptive analysis to address these questions.

Historically, investments in fossil fuels have consistently outpaced those in green energy. However, since 2014, oil and gas investments have declined—largely due to falling oil prices—while global investments in green energy have steadily increased. This upward trend in green investment is encouraging, yet more substantial efforts are needed to advance toward low-carbon economies. During the COVID-19 pandemic, investments in both sectors saw significant declines. Between 2019 and 2020, fossil energy investments dropped by 32.09%, while green energy investments fell even more sharply by 51%. The dramatic decrease in oil demand during the Great Lockdown, coupled with storage capacity issues, played a major role in this downturn. This situation triggered panic in the West Texas Intermediate (WTI) crude oil futures market, driving prices into negative territory for the first time—plummeting from $18 to –$37 per barrel (Mignon, 2020).

In summary, green investments have shown a steady upward trend over time. Companies typically finance green projects through internal funding mechanisms, such as loans or equity issuance. To further promote green lending, various macroprudential policies can be implemented—for instance, introducing a brown-penalizing factor that compels banks to hold additional capital against carbon-intensive assets, or applying differentiated reserve requirements that adapt to green lending needs based on whether a country is developed or developing (D'Orazio and Popoyan, 2019). Although this topic is gaining attention in the literature, green stocks remain underexplored. As highlighted earlier, fostering investor participation in green firms via mutual funds or exchange-traded funds (ETFs) that track green indices demands greater transparency. This section underscores the importance of aligning green indices with green investment trends, given their strong interconnection. The next section outlines the criteria for selecting an appropriate green benchmark.

Choosing an appropriate green financial index is a complex task due to the varied definitions of green assets and the diversity of Sustainable and Responsible Investment (SRI) strategies. To begin, we examine the various SRI strategies and justify our preference for the exclusionary approach. Next, we present the specific criteria that informed our selection of the WilderHill New Energy Global Innovation

Index (NEX) as our green benchmark. Finally, we conduct a descriptive analysis of this green energy stock index to provide further context and support for its selection (Nobletz, 2022).

Green financial products vary widely in their Sustainable and Responsible Investment (SRI) strategies. The primary and contrasting approaches for company selection in portfolios include positive and negative screening, represented by the best-in-class and exclusion methods, respectively. The best-in-class strategy selects companies with the highest ESG (Environmental, Social, and Governance) scores within each industry, promoting leaders across sectors. On the other hand, the exclusion strategy—one of the oldest SRI approaches—removes companies that fail to meet specific ethical, social, or environmental standards, such as those involved in tobacco, alcohol, or nuclear energy.

Additionally, thematic investing focuses on specific environmental issues or sectors. Engagement and voting strategies use shareholder influence to encourage better ESG integration within firms. Lastly, impact investing targets primarily private companies aiming to generate measurable social and environmental benefits, often prioritising purpose over profit (Eurosif, 2018).

We select green indices based on several key criteria. First, the index should offer broad coverage of the environmental sector and adopt the exclusion strategy to ensure it aligns with sustainable investment principles. Second, it must use an equal-weighting approach to prevent a few large companies from dominating the index and skewing its representation. Lastly, it is essential that the index provides a complete and accessible list of its constituent companies for each year to ensure transparency and support long-term analysis. Two green energy indices satisfy the established criteria: the WilderHill Green Energy Index (ECO) and the WilderHill New Energy Global Innovation Index (NEX).

The ECO index concentrates on the U.S. market, while the NEX index has a broader global focus. Both indices emphasize environmental sectors, apply exclusion-based screening, use equal weighting to prevent overrepresentation by large firms, and provide publicly available constituent lists annually—making them suitable benchmarks for tracking green financial performance. We select the WilderHill New Energy Global Innovation Index (NEX) as our benchmark green index due to its comprehensive global coverage. This broader perspective allows for an international analysis of green

financial trends before narrowing the focus to more localised or sector-specific dynamics.

The NEX index comprises companies specialising in innovative clean energy solutions, energy conservation, efficiency, and advanced renewable technologies. It is calculated by Solactive using a modified equal-weighting methodology, is rebalanced quarterly, and ensures that no individual stock holds more than 5% of the total index weight (Nobletz, 2022).

For the selected green index, we choose a financial benchmark that offers both global and sectoral coverage of the world stock market. This allows for a meaningful comparison between the components of the green energy index and those of the benchmark index, helping to better understand the unique characteristics of green markets.

We adopt the market-oriented classification approach, as it offers a more accurate depiction of sectoral concentration (Hrazdil & Zhang, 2012) and is effective in capturing comovements in stock returns (Bhojraj et al., 2003). Within this framework, we choose the Global Industry Classification Standard (GICS) due to its suitability for global analysis. Developed by Standard & Poor's (S&P) and MSCI, the GICS is the first market-oriented classification system, updated annually, and structured into four hierarchical levels—11 sectors, 24 industry groups, 69 industries, and 158 sub-industries. For our analysis, we focus on the sector level to avoid losing critical insights that might be diluted at more granular levels.

3.4. Volatility spillovers between the dirty and clean energy markets and global stock indices during periods of escalating geopolitical risk

There is a growing global interest in renewable energy, driven by the increasing economic and societal impacts of climate change. International bodies and various stakeholders are actively working to establish targets and develop frameworks for managing environmental and climate-related risks, aiming to promote environmentally responsible practices in the coming decades. Fahmy (2022) emphasizes the rising awareness among investors about climate risks and the importance of green investments, particularly following the Paris Agreement. This heightened awareness has influenced the dynamics between clean energy prices and traditional sectors like oil and technology. Zhang et al. (2020), employing wavelet quantile-on-quantile analysis, revealed that oil price shocks affect clean energy

stocks differently depending on investment horizons and quantiles, with long-term asymmetry. Similarly, Yahya et al. (2021) found non-linear and long-term interconnections between oil prices and clean energy stocks, highlighting that clean energy has emerged as a leading factor influencing oil prices in the post-financial crisis period.

However, the impact of the Russian invasion on the global shift toward renewable energy remains uncertain. Amid the COVID-19 pandemic, the real options theory suggests that heightened uncertainty led many investors to delay investment decisions, which in turn negatively impacted stock returns. As the world continued grappling with the pandemic's economic fallout, a new shock arose with the onset of the Russia–Ukraine war on February 24, 2022. This conflict has had significant repercussions, especially for European nations heavily dependent on Russian oil and gas. The disruption in supply chains caused a sharp increase in global oil prices, reaching their highest point in eight years. This geopolitical development carries substantial weight for the global economy. Lo et al. (2022) assessed the war's effects on financial markets across a panel of 73 countries, finding that the impact varies depending on each country’s reliance on Russian commodity exports.

The authors identified heightened volatility and reduced asset returns in financial markets as a consequence of the war. Their findings indicate that the Ukraine conflict exerts a negative influence on stock markets and elevates volatility levels, irrespective of a country's reliance on Russian commodities. In a related study, Adekoya et al. (2022) explored whether oil behaves differently in relation to key financial assets during wartime. Their analysis revealed significant variation in asset connectedness prior to the conflict and a pronounced spillover effect from oil to all assets during the war. Further, Adekoya et al. (2023) examined cross-correlations between oil prices and major European and non-European stock markets before and during the Russia–Ukraine war. Their results demonstrate that the conflict has intensified the persistence of relationships between oil prices and European stock markets more than with non-European ones.

Steffen and Patt (2022) offer early insights showing that the Russia–Ukraine war has influenced public policy preferences, notably increasing public backing for phasing out fossil fuels and promoting clean energy alternatives. Their study found strong support among the Swiss public for clean energy initiatives, though they emphasize that such support must be matched by concrete political action. While past

research has explored the relationship between energy markets and financial markets during turbulent times, there is still a gap in comparative studies assessing the differing impacts of the Russia–Ukraine war and the COVID-19 pandemic on the interconnectedness between dirty and green energy sectors and financial markets.

Understanding these linkages is critical not only for shaping effective investment strategies but also for guiding governmental and regulatory responses to market instability. This issue becomes even more pertinent when viewed in the context of emerging policy instruments like the Market Stability Reserve, which seeks to regulate the volume of CO_2 allowances auctioned annually.

In light of rising concerns over energy security and climate change, renewable energy presents promising investment opportunities for market participants. Analyzing the interconnectedness between energy sectors and financial markets can provide valuable insights for risk diversification and optimal asset allocation. However, there is limited research examining the dynamic relationships between price movements in clean and fossil energy and equity market volatility across U.S., Asian, and European markets. Existing empirical studies mainly serve to guide investors in developing effective hedging strategies when navigating both stock and international energy markets (Karkowsca & Urjasz, 2023).

An increasing number of investors are incorporating energy assets into their portfolios, leading to stronger linkages between energy and equity markets (Jiang & Yoon, 2020; Kilian & Murphy, 2014; Kilian & Park, 2009; Managi & Okimoto, 2013; Nandha & Faff, 2008). For instance, Managi and Okimoto (2013) identify a positive correlation between non-renewable and clean energy prices, and highlight how clean energy and technology stock prices respond similarly to market changes. He (2020) further explores the implications for risk management, demonstrating the diversification and hedging benefits of including non-renewable energy assets in investment portfolios.

The findings provide strong evidence of a time-varying and asymmetric relationship between oil prices and East Asian equity markets. Ahmad (2017) highlights that dynamic hedging strategies suggest clean energy indices may offer more effective and profitable hedging opportunities when paired with oil futures, compared to technology indices. Similarly, Papathanasiou et al. (2022) examine the interactions between hedge arbitrage funds and traditional asset classes such as equities, bonds, gold, oil, currencies, commodities,

and real estate. They estimate hedging ratios and optimal portfolio weights to evaluate the hedging effectiveness of these funds, concluding that such funds exhibit the lowest sensitivity to shocks from stocks, oil, gold, and currency markets.

The existing literature review does not adequately address critical questions regarding the significance of the relationship between dirty and clean energy markets and global financial indices during the Russian invasion of Ukraine. Overall, the body of research exploring the link between energy and financial markets under the influence of geopolitical risk—as an external and destabilising factor—remains limited. Therefore, this study aims to bridge that gap, offering valuable insights for both investors and market regulators (Karkowsca & Urjasz, 2023).

3.5. Volatility transmission between green and conventional stocks

Understanding the interconnections and dynamics between various markets is crucial for asset managers aiming to manage portfolio risk effectively, as well as for policymakers who need to identify strategic sectors for targeted financial regulation. Extensive academic research has examined the significance of incorporating both green and traditional assets—such as crude oil, commodities, gold, and fossil fuels—into diversified investment portfolios. This strategy supports objectives related to asset allocation, risk mitigation, and hedging (Huang, Zhu, Hau, & Deng, 2023; Mensi, Naeem, Vo, & Kang, 2022; Nguyen, Naeem, Balli, Balli, & Vo, 2021; Reboredo et al., 2022; Umar et al., 2023; Vogl, Kojić, & Mitić, 2024; Yadav, Pandey, Taghizadeh-Hesary, Arya, & Mishra, 2023a). However, most of these studies are conducted within specific markets and concentrate on particular analytical aspects—such as examining volatility dynamics and persistence, spillover effects, or the influence of policy and regulatory shifts on the volatility of green assets. The findings on volatility behaviour, especially its dynamics and persistence, remain mixed and inconclusive.

The green equity market seeks to promote environmental sustainability, yet its financial viability is closely tied to market efficiency. The effectiveness of low-carbon equity in financing green initiatives hinges on understanding the mechanisms of risk transmission—particularly among oil prices, indices of high carbon-emitting sectors, and green equity indices aligned with "dual carbon" goals (Dai, Zhang, & Yin, 2023). Findings related to volatility dynamics

and persistence vary widely. For instance, Chakrabarti and Sen (2021) analysed time-varying market risks in green equity investments across the Asia-Pacific, U.S., and European markets, revealing significant volatility contagion from local markets to green equities in the U.S. and Europe.

Analysing the spillover effects between conventional and green assets provides critical insight into the transition risks financial markets may encounter as economies shift aggressively toward low-carbon models. According to Li, Li, and Zhang (2023), comprehending these spillover dynamics is essential for developing effective risk management strategies in energy markets. This understanding can help investors, policymakers, and regulators anticipate and mitigate volatility and instability during the transition to sustainable energy systems.

Liu, Lu, and Shi (2023) analyse the interaction between oil shocks and both conventional and green assets, uncovering heterogeneous spillover effects. They find that instruments like WTI crude oil futures and heating oil futures are particularly sensitive to both demand- and supply-side oil shocks. Their findings underscore the importance of shielding conventional and green assets from such risks. However, the study falls short in addressing the broader implications for a wider range of green and traditional financial instruments, limiting its applicability for comprehensive portfolio or policy-level decisions.

Naeem, Ashraf, Karim, and Moussa (2024) conducted a comprehensive investigation into the risk mitigation potential of green assets across various financial instruments, including green stocks, bonds, cryptocurrencies, and carbon markets. Their findings revealed strong intra-class connectedness—indicating that assets within the same class are tightly linked—while cross-market interconnectedness remained limited. Furthermore, by examining dynamic NET spillovers, they identified which markets served as key transmitters and recipients of risk before and after the COVID-19 pandemic. The study highlighted persistent and significant risk spillovers throughout the observation period, underscoring the complexity of managing environmental financial risks in turbulent times.

Dai et al. (2023) analysed extreme spillover effects among high carbon emission stocks, green bonds, and WTI crude oil over the period from 2010 to 2022. Their study reported a static total spillover index of 49%, highlighting substantial interconnectedness across these asset classes. Using a quantile-based approach, they effectively

captured risk contagion under extreme market conditions. However, a key limitation of their work is the absence of a dynamic analysis, which would reveal how these relationships shift over time, particularly in response to varying market regimes. Additionally, the study found that green bonds and WTI crude oil generally acted as net receivers of systemic shocks, exhibiting asymmetric behaviours in bullish versus bearish markets.

Arif, Naeem, Farid, Nepal, and Jamasb (2022) explored the potential of green bonds as a hedging tool and safe haven for conventional investments across commodities, foreign exchange, fixed income, and equities. Their findings suggest that the green bond index can serve as a diversified asset for long-term and medium-term equity investors, providing stability in diversified portfolios. However, these results slightly contrast with those of Tiwari et al. (2022), who, based on hedging effectiveness, found that two-dimensional and multi-dimensional portfolios significantly reduce the risk associated with investing in individual assets.

However, this remains unclear with regard to green bond strategies, suggesting that further research into the return transmission process is needed. Such an investigation is crucial, considering its potential for enhancing portfolio construction and optimising risk management.

Climate policy and the link between green bond and green stock market

In recent years, extreme climate events have been occurring more frequently around the world. However, the combined impacts of the COVID-19 pandemic and geopolitical conflicts seem to have weakened global commitments to climate action. For instance, some G7 nations have decided to reopen previously decommissioned coal-fired power plants in response to the Russia-Ukraine conflict. The ongoing changes and implementations of policies have increased climate policy uncertainty, which could potentially slow down the progress of the green low-carbon transition in financial markets (Gong et al., 2022; Huang, 2023; Sun et al., 2024).

Recent studies have revealed significant differences in how traditional and green energy sectors respond to climate risks (Kong, 2024; Ren et al., 2023; Siddique et al., 2023). Therefore, when examining the green financial market, it is essential to take climate policy uncertainty (CPU) shocks into account. On one hand, existing research on climate policy uncertainty (CPU) has primarily

concentrated on its effects on individual markets, with limited studies exploring its influence on asset correlations (Syed et al., 2023; Xi et al., 2023). In the context of carbon neutrality, financial integration, and the rising levels of CPU, there should be increased focus on addressing systemic risks in the green financial market.

On the other hand, much of the existing literature on the impact of climate risks on financial markets relies on a linear framework (Gong, Song, Fu, & Li, 2023; Gong & Liao, 2024). In reality, many economic variables interact in a multi-channel manner (Cui et al., 2024; Shahbaz et al., 2017). The effect of climate policy uncertainty (CPU) on the relationship between the green bond and green stock markets may involve multiple interconnected channels. For instance, the asset substitution channel posits that as CPU rises, investors might shift their investments by buying green bonds and selling green stocks to hedge against risks, which could result in a negative impact. On the other hand, the financial contagion channel suggests that an increase in CPU could strengthen the interconnections between markets, leading to a positive impact. These factors could cause the impact of CPU on asset correlations to be non-linear and asymmetric.

In conclusion, the interrelationship between financial asset correlations, portfolio construction, and risk management is fundamental. Analysing the dynamic evolution of green financial markets provides insight into the mechanisms behind their price interlinkages, enabling investors to develop effective hedging strategies for mitigating market risks. Furthermore, investigating the nonlinear effects of climate policy uncertainty (CPU) on long-term correlations enhances our understanding of the alignment between different segments of the green financial market and supports regulators in refining risk control strategies (Chen et al., 2025).

The rapid growth of the green bond market has sparked interest in its risk-return profile. Compared to conventional bonds, green bonds often yield higher returns but also demonstrate greater price volatility (Flaherty et al., 2017). Amid rising financial integration and growing uncertainty, researchers have begun to explore the price linkages and risk spillover dynamics between green bonds and other financial markets. For instance, Dai et al. (2023) found that within the broader system involving green bonds and carbon-intensive (“brown”) stocks, green bonds predominantly act as recipients of systemic risk.

Asl et al. (2023) utilized quantile cross-spectral analysis and non-linear Granger causality techniques to reveal that the interactions

between green bonds and Islamic bonds are inherently nonlinear. Similarly, Wei et al. (2023) applied a time-varying parameter vector autoregression (TVP-VAR) model to examine the transmission of risk between green bonds and conventional financial markets. While this body of research has substantially advanced our understanding of green bonds' connections with traditional asset classes—such as equities, fixed income instruments, and commodities—the internal dynamics among green financial sub-markets, particularly among green instruments like green bonds and green equities, remain notably underexplored.

The green bond not only mobilises capital for environmentally sustainable initiatives but also functions as a hedge against financial market disruptions (Zhong et al., 2023). For instance, Jin et al. (2020) demonstrated that green bonds offer a cost-efficient means of hedging against risks in the carbon market. Similarly, Guo and Zhou (2021) explored the protective roles of both Chinese and U.S. green bonds during the COVID-19 crisis. Xia et al. (2023) further showed that green financial instruments, including green bonds, can effectively hedge against economic policy uncertainty (EPU). Importantly, recent findings by Xiao and Liu (2023) highlight that the impact of climate policy uncertainty (CPU) on market volatility is distinct from that of other uncertainty types.

On one hand, geopolitical tensions have caused some countries to scale back their climate commitments. On the other hand, the rising frequency of extreme climate events has reinforced global efforts to combat climate change. These opposing forces have collectively heightened climate policy uncertainty (CPU). As a result, when analysing optimal hedge ratios and portfolio allocations, it is crucial to assess whether green bonds can function as a safe haven for green stock markets during periods of elevated CPU.

There is a noticeable degree of co-movement among green financial markets, including green bonds. From a corporate resource allocation perspective, one of the primary objectives behind the development of the green bond market is to channel financial resources into the green sector, thereby easing the financing constraints faced by environmentally focused industries (Wang et al., 2022b).

This underlying purpose establishes an intrinsic link between green financial instruments. From a policy standpoint, both green bonds and green stocks fall within the broader green finance

ecosystem and are influenced by similar macroeconomic conditions. As such, their co-movements may signal channels for risk transmission across markets (Wang et al., 2023). Consequently, it is essential to investigate the underlying drivers of these cross-market co-movements to better understand and mitigate potential systemic risks within the green financial landscape.

Recent research on cross-asset correlations has increasingly considered factors like economic policy uncertainty (Guo et al., 2023), market volatility (Nakagawa & Sakemoto, 2022), geopolitical risks (Babaei et al., 2023), and investor attention allocation (Hu et al., 2023). However, with the recent and significant rise in climate policy uncertainty (CPU), it becomes crucial to investigate how CPU influences correlations within green financial markets. This examination can offer deeper insights into risk transmission and portfolio management under environmental policy volatility.

4. Conclusions

This paper aims to examine and analyse the evolving relationship between green energy stocks and market tendencies and dynamics within the context of the transition to a zero-carbon economy. The analysis is based on six scholarly references that address the subject from various perspectives within the specialised literature.

The first topic of the study explores whether green investments are connected to oil price shocks. One key finding from the empirical analysis is that green assets exhibit greater sensitivity to oil market volatility than to changes in oil prices themselves. This has important implications for portfolio managers. Since investors primarily aim to secure strong returns, even environmentally conscious investors are likely to include assets in their portfolios that not only align with sustainability goals but also offer competitive financial performance.

The transition was then to the impact of online environmental news on the stock returns of green industry companies in China. The empirical findings indicated that environmental news significantly impacted the stock returns of green companies in China, with investor sentiment partially mediating this effect. These results are likely to be of considerable interest to both policymakers and investors.

Next on the list was the duo of green energy indices and financial markets. Focusing on the global green energy index, the NEX monitors trends in the green energy market, with its composition

highlighting the dynamic and volatile nature of environmental markets, particularly in terms of inflows and outflows of index companies. To deepen the analysis, we selected a financial benchmark, traced its constituents over time, and compared them with the green index components. Our findings reveal limited overlap between the green and financial indices. This outcome is twofold, as it underscores that the index selection methodology excluded many companies that could potentially be involved in pollution.

The fourth topic of the analysis focused on the relationship between renewable and non-renewable energy markets and stock markets. The analysis could be extended to examine the long-term effects of the Russian invasion of Ukraine on investment and policy decisions. Encouraging a shift towards a more renewable and sustainable energy system may spur innovation within individual energy sectors, potentially increasing the stock market's dependence on fluctuations in renewable energy prices.

Moreover, the study aimed to rigorously analyze the volatility transmission between green and conventional equities across major financial markets in the United States, Europe, and China, covering the period from June 1, 2016, to December 31, 2023. To the best knowledge, no prior study has undertaken this specific analysis.

Last but not least, the latest topic that was tackled was the link between climate policy and green bond / stock market. The correlations between the green bond and green stock markets are relatively weak and display time-varying characteristics across different time scales, the cost of using green bonds to hedge green stock markets is relatively high, we observe that, in the event of extreme shocks to the CPU, green bonds do not appear to serve as a strong safe-haven asset for green stocks and ultimately, CPU shows an asymmetric, nonlinear positive effect on long-term relationships. On average, the long-term correlation between green bonds and the clean energy market is the most responsive to CPU, while the correlation with the green transportation market is the least affected by CPU.

The limitations of this study arise from the broad scope of the research topic. Each area explored in this literature review represents a separate field of study, and therefore, the goal was not to provide an exhaustive analysis or conduct a citation count or document frequency analysis. Future research could focus on these topics individually, providing a more detailed analysis with a greater emphasis on their implications for policy development.

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"Victor Slăvescu" Centre for Financial and Monetary Research
Casa Academiei 13, Calea 13 Septembrie, Building B, 5th floor
Bucharest, 050711, Romania
Phone: +40 21.318.24.19
E-mail: s.vraciu@icfm.ro