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OFFICE: Poznań University of Economics and Business
Department of Business Activity and Economic Policy
al. Niepodległości 10, 61-875 Poznań, Poland
phone +48 61 856 95 56, https://ref.ue.poznan.pl, ref@ue.poznan.pl

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ul. Powstańców Wielkopolskich 16, 61-895 Poznań, Poland
phone +48 61 854 31 54, +48 61 854 31 55
https://wydawnictwo.ue.poznan.pl, wydawnictwo@ue.poznan.pl
Postal address: al. Niepodległości 10, 61-875 Poznań, Poland

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Preface

The editorial team is pleased to share the first issue of *Research Papers in Economics and Finance* (REF) for 2025. Comprising eight original studies, this volume captures the intellectual energy driving today's economic and financial discourse. The topics range broadly – from a very conceptual theoretical work focusing on economic surplus, action systems and their longevity, to innovative methods for uncovering non-obvious patterns in data using bibliographic networks, to machine learning techniques for fraud detection. The studies offer theoretical insights grounded in substantive empirical evidence.

The issue opens with a contribution by Fidiana Fidiana, Endang Dwi Retnani, and Dini Widyawati from Sekolah Tinggi Ilmu Ekonomi, who attempt to verify whether there are differences in investors' responses to political events in 2024 – the presidential and vice-presidential candidate debates in Indonesia. The results the authors present seem to call into question stereotypical views regarding the influence of policy on capital flows in developing economies.

Julita Żebrowska and Joanna Lizińska, both affiliated with the Poznań University of Economics and Business, contribute by mapping of existing studies and the identification of key topics in research on economic and financial socialisation by means of innovative methodology that builds upon quantified network-based bibliometric analysis of articles from the Scopus database using *Bibliometrix* R package, supplemented by an in-depth content analysis of selected scientific works. The proposed approach offers insights that may uncover overlooked domains worth exploring in subsequent studies.

Habib Zouaoui and Meryem-Nadjat Naas, both from University of Relizane, demonstrate how advanced machine learning tools can be leveraged to bolster fraud detection and reinforce risk management mechanisms within the European Union's financial sector. As the final prediction, they apply a hard voting, in which the majority decision among five deep learning algorithms determines the outcome. In their conclusions, the authors reflect on and identify possible reasons why the hard voting classifier did not consistently prove to be the optimal solution. They also outline directions for future research in this area.

Suggested citation: Klimanek, T. (2025). Preface. *Research Papers in Economics and Finance*, *9*(1), 4–5.

Hubert Witczak, affiliated with the Poznań University of Economics and Business, explores the law of economic surplus within the context of action systems. In his paper, two research problems are defined: 1) What is energy/economic surplus in relation to action systems and their longevity? and 2) What is the relationship between economic surplus and action system longevity?

Muntaser Hamdouna's contribution echoes some of the aspects explored in the second article of this issue. The author who is affiliated with Poznan University of Technology examines the evolution of research on critical success factors for enterprise competitiveness in crises based on a bibliometric analysis of Scopus-indexed literature from 1998 to 2024, with a special focus on the fields of business, economics and finance, emphasising their critical role in steering turbulent markets. The findings presented may act as a strategic roadmap for experts, managers and policymakers seeking to enhance organisational resilience and competitiveness.

Mourad Hamadi, Abdelfateh Tebani and Abdeslam Hetatache form Ferhat Abbas University Setif 1 delve into the impact of Shari'a-compliant microfinance on expanding financial access and fostering socio-economic development among rural, marginalised communities. The authors compare Shari'a-compliant microfinancing with conventional microfinance models and present the case study of Al-Amal Microfinance Bank in Yemen to show how Islamic microfinance contributes to financial inclusion of society in this country.

Daria Sarol, affiliated with Gdańsk University of Technology, analyses the modernisation of the Roucas Blanc facilities in Marseille in preparation for the nautical events of the 2024 Summer Olympics. Based on mixed data sources, including official documents and strategies, photographic documentation and expert interviews, her study highlights how the development of modern sailing infrastructure enhances the city's recognition, constituting a coherent element of the promotional policy.

Closing the issue, Brian E. Porter from Hope College compares retirement investment strategies which offer valuable opportunities for tax-advantaged retirement savings. While the conclusions are based on US data, they may offer useful insights for retirement planning systems globally.

Taken together, these eight contributions reflect a vibrant and interdisciplinary dialogue shaping contemporary economics and finance. We hope that readers will find both intellectual stimulation and practical relevance in the pages that follow.

We thank our dedicated reviewers, the editorial board and, above all, the contributing authors whose rigorous work makes this journal possible. We invite scholars, practitioners and students alike to engage critically with this issue – and, as always, we welcome future submissions that build foundations of our economic understanding.

Tomasz Klimanek
Editor

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Does presidential debate bring optimism? A study of Indonesia's 2024 pre-election year

Fidiana Fidiana[1] **Endang Dwi Retnani**[2]
Dini Widyawati[3]

Abstract

The political future is inherently unpredictable, particularly in the run-up to elections. This article analyses whether such uncertainty matters. In this paper, we raise an interesting issue of the impact of political debate on the stock market of a developing country. Specifically, we investigate whether people's economic expectations are conditional on their estimations of potential election outcomes. The subject of this study is the relationship between political events, including the 2024 presidential debate, and Indonesia's financial markets. The authors analyse stock price movements of the 30 most actively traded issuers, as ranked by the Indonesia Stock Exchange, acknowledging that not all issuers trade daily in this emerging market. Using the Wilcoxon rank-sum test, we assess whether significant differences in investor responses exist before and after the debate periods (debates 1 to 5). According to the findings, investors believe that this event has no impact on their economic decisions, because candidate electability is dominated by incumbent candidates, so it is assumed that there will be no significant changes in financial policy. Therefore, investors appear relatively indifferent to the election dynamics during this period. Overall, the results show that Indonesian people anticipate election outcomes; in other words, pre-election economic expectations reflect both current political realities and projections of the future.

Keywords

- electability
- presidential debate
- volatility
- stock markets

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[1] Sekolah Tinggi Ilmu Ekonomi Indonesia Surabaya, Jl. Menur Pumpungan No. 30, Surabaya, Jawa Timur 60118, Indonesia, corresponding author: fidiana@stiesia.ac.id

[2] Sekolah Tinggi Ilmu Ekonomi Indonesia Surabaya, Jl. Menur Pumpungan No. 30, Surabaya, Jawa Timur 60118, Indonesia, endangdwiretnani@stiesia.ac.id

[3] Sekolah Tinggi Ilmu Ekonomi Indonesia Surabaya, Jl. Menur Pumpungan No. 30, Surabaya, Jawa Timur 60118, Indonesia, diniwidyawati@stiesia.ac.id

Introduction

The capital market is often seen as a barometer of a country's economic health (Raza et al., 2023), with stock prices fluctuating in response to various factors, including economic conditions and political developments. Political uncertainty from various political events has a strong influence on stock performance (Nguyen et al., 2023; Pástor & Veronesi, 2013). This link often arises because investors respond to uncertainty during a political year, especially during election periods. Markets tend to respond to new information regarding political decisions that may have an impact on a country's fiscal and monetary policies (Pantzalis et al., 2000).

Reviewing the factors that impact capital markets is especially important in the context of developing countries, where stock markets are often more volatile and susceptible to sudden changes. Previous literature confirms that political risk is the main determining factor in stock returns in emerging markets compared to developed countries (Diamonte et al., 1996; Yiadom et al., 2023). Investors may not be able to fully anticipate the impact and benefits on their portfolios, particularly regarding potential future political changes (2016) also argues that political events and uncertainty influence investors' decisions regarding market timing and portfolio allocation in different markets.

The impact of political events on stock market performance has been widely explored in the literature, revealing the influence of various political events on stock prices and returns during elections. The market absorbs election-related news and trends into stock prices to anticipate election results as implied by information efficiency (Pantzalis et al., 2000).

The interaction between politics and finance is always interesting to study (Martínez & Santiso, 2003), especially the relationship between the polling analogy and financial behaviour (Fry & Burke, 2020). Previous literature has noted a significant increase in the CBOE Volatility Index (VIX) in the 2020 US presidential election (Białkowski et al., 2022; Nguyen et al., 2023). The polling results of the US presidential election in July 2020 pointed to Joe Biden's victory over Donald Trump, which was followed by an increase in the CBOE volatility index to a record high of 28%, soaring 41% from the historical average (Nguyen et al., 2023). Another event was the poll in England on April 21, 2015, which showed the potential for equal victory between the Labour Party and the Conservative Party (Whiteley, 2016) resulting in high volatility in the UK stock market (Fry & Burke, 2020).

Empirical evidence regarding the relationship between political events and stock prices raises the question of how election uncertainty affects the stock market ahead of the election. To answer this, the research examines the impact of presidential and vice-presidential candidate debates on changes in polling results that impact the stock market during the pre-election period in developing coun-

tries such as Indonesia. Capital markets in developing countries are very responsive to current political issues and events such as presidential candidate debates.

Previous literature has widely related polling to stock prices (Herold et al., 2021; Su et al., 2023). Polling, i.e. summarising current voter preferences that determine political support and the likelihood of winning future elections, provides a signalling effect over a certain period of time. Polling provides pre-election predictions that represent market expectations of election results. A large body of evidence shows that different preferences for various candidates proposed by parties have different economic expectations (Mian et al., 2023; Montone, 2022). For example, in America, differences in participants' political ideologies influence differences in stock market participation, investment decisions, risk preferences and financial analysis (Kaustia & Torstila, 2011; Kempf & Tsoutsoura, 2021).

Therefore, this research estimates that deviations between actual election results and voter expectations will contribute to the stock market. Higher accuracy of polling results means investors are less surprised, resulting in lower returns and stock volatility. This setting eliminates the possibility of reverse causality between changes in financial markets and changes in the probability of political party success, because uncertainty over the election outcome has been resolved and cannot be influenced by subsequent price changes.

This research contributes to the literature, namely contributing to previous research which focuses on the relationship between pre-election political uncertainty and stock market performance. Previous studies reveal how changes in the incumbent party's probability of re-election affect the variance of market returns using a sample of seven US elections (Goodell et al., 2020). This research is unique in that it focuses on the examination of the presidential and vice-presidential debate events, and, specifically, on the impact of the electability of certain presidential candidates on stock price volatility, thereby providing insight into political uncertainty that has not previously been explored in the literature. Research on the predictive power of frequent changes in political support on stock performance in developing countries is still limited. In addition, there is no consensus in determining whether election events affect stock market performance negatively or positively. Third, although some empirical research has revealed significant stock market reactions to election shocks (Białkowski et al., 2022; Pantzalis et al., 2000), no attention has been paid to the role of presidential and vice-presidential candidate debates and the accuracy of pre-election polls in anticipating movements in stock volatility and returns. This research is innovative compared to previous studies by exploring the influence of the presidential debate and the accuracy of market predictions before the election.

The aim of this research is to investigate the impact of various signals or events on stock market movements, with a special focus on the presidential and vice-presidential candidate debates and the polling results which influence the IHSG in the

context of changes in the political, financial and economic situation in Indonesia in the political year of 2024. Although previous research has examined the influence of political factors, especially elections, on stock market movements, there is still no research that focuses on the presidential and vice-presidential debate events. Thus, this research is expected to contribute to the current literature by examining the impact of the presidential debate on stock market returns in developing countries.

The relationship between finance and politics (especially opinion polls) is interesting to study both theoretically and empirically. Examining presidential debate events can provide insight into the influence of certain events on stock market speculation. The findings of this study can provide valuable input for future financial markets research and help understand the complex relationship between events and stock market movements. Predicting market volatility based on political events is a challenging task. This research provides a comprehensive examination of the role of political events as well as pre-election dynamics in determining stock market performance, thereby contributing to the existing body of knowledge in the field. Simply, the following study seeks to provide empirical evidence on the relationship between political events and stock prices, specifically addressing how pre-election uncertainty affects the stock market in the lead-up to an election.

1. Literature review

Political preferences and investment decisions. Personal values including political preferences influence investment decisions. Some literature states that reluctance to participate is associated with a mismatch in personal values, such as personal beliefs or sentiments (Conlin et al., 2015; Kaustia et al., 2023; Merkoulova & Veld, 2022). Nadeem et al. (2020) specifically found that certain psychological factors, such as investor beliefs, preferences and psychological biases, influence stock market participation.

The idea that personal values are fundamental and at least partly exogenous is supported by research results which prove that political preferences are genetically inherited (Alford et al., 2005; Dawes & Weinschenk, 2020). Elements of value expression can also appear in investment behaviour (Dawes & Weinschenk, 2020). Individuals with the same value considerations would choose not to participate in capital markets. Prejudice or negative perceptions of the capital market, such as speculation, injustice and gambling, may also have an impact on the decision not to invest in shares (Moueed & Hunjra, 2020), along with perceptions of risk (Almansour et al., 2023). However, there remains difficulty in explaining the de-

terminants of why individuals do not participate in the stock market, even though investment in the stock market is free (Guiso et al., 2003).

Previous research results show that party alignment or party affiliation has an impact on economic expectations, including participation in the stock market. There is empirical evidence that distrust of promises shifts investment decisions towards the stock market (Guiso et al., 2003). Bonaparte et al. (2017) show that individuals become more optimistic and perceive the market to be less risky when their preferred candidate is in power. Furthermore, supporters of incumbent political parties in America tend to be optimistic about obtaining stock returns (Bonaparte et al., 2022). Therefore, investors with political affiliation in their preferred candidates tend to increase their allocation to risky assets, demonstrating a stronger preference for high-beta, small-cap and high-value stocks, while showing a weaker preference for local stocks (Bonaparte et al., 2022).

In the context of the Australian election, research has shown that sentiment and preferences towards parties influenced future consumer behaviour, including vehicle purchases (Gillitzer & Prasad, 2018). Supporters of the winning party tend to be more optimistic than supporters of the losing party. Similarly, a positive relationship has been identified between voter preferences and aggregate demand as well as state-level GDP growth (Benhabib & Spiegel, 2019).

Discrepancies in personal values regarding the stock market tend to create cognitive dissonance (Akerlof & Dickens, 1982). Cognitive dissonance can be thought of as an additional participation cost on individuals who are reluctant and do not participate in the stock market. Kaustia and Torstila (2011) suggest that some people consider the stock market to be incompatible with their personal values, in the context of an imbalance between actions and values (cognitive dissonance). On the other hand, several studies are still inconsistent in concluding the relationship between party affiliation and economic expectations. There is evidence of a significant relationship between partisan affiliation and optimism about the future economy (Mian et al., 2023). Republican affiliated partisans have a more optimistic outlook as evidenced by increased spending. Other studies confirm the impact of shifts in the political climate (change in power) on stock prices in America. This research found systematic changes in the composition of investors' portfolios (Addoum & Kumar, 2016). Further research also supports the finding that investor portfolio allocation to risky assets is influenced by the conformity of expectations towards the authorities, whether the candidate being nominated is in power (Bonaparte et al., 2017). This means that partisan perceptions impact investment behaviour in real ways.

Polling results and share prices. The Efficient Market Hypothesis (efficient capital markets) states that important new information is immediately reflected in prices. A substantial body of literature explores the relationship between election outcomes and stock market performance (Fry & Burke, 2020; Goodell et al., 2020).

In this case, opinion polls reveal information regarding the likelihood of a candidate winning the election (Herold et al., 2021). A common concern in opinion polls is a socially desirable response bias (Fry & Burke, 2020). Why do party preferences matter? Private companies face political risks, and political stability is considered important for investment and economic growth. Party preferences, as reflected in election results, effectively determine government philosophy and resulting policies, including international trade policies that impact investment. The relationship between political parties and business or certain economic sectors has a long history (Faccio, 2006). Morgan and Stocken (2008) explain that opinion polls actually reflect ideological beliefs so that policymakers take signals from opinion polls.

A candidate's winning potential has been proven to have a positive (negative) relationship with share prices. Investors' disapproval of the potential victory of presidential candidates (based on polling) was followed by weakening stock returns in America in 2003 (Montone, 2022). This is especially true in countries with high political uncertainty and low market sentiment.

Herold et al. (2021) examined the market reaction to the 2016 presidential election. The study found that, intuitively, active investment strategies tend to outperform when stocks that react positively to Trump's polling score increase. Furthermore, Wagner et al. (2018) document that Trump's election was largely unexpected and significantly shifted market expectations – particularly regarding lower corporate taxes and stricter trade policies – leading to a swift response in stock prices. In short, polling analysis shows that expectations regarding tax rates greatly influence firm value. Considering that this election was a surprise, this also means that the probability of such an event occurring was considered low in advance. Therefore, elections also provide an opportunity to assess whether – and to what extent – low-probability political outcomes are reflected in share prices. Ejara et al. (2012) confirmed these results. They looked at the impact of polling during the 2008 US presidential election campaign on the stock market and found negative reactions to Democratic Party presidential candidates. Another study in Australia revealed strong evidence showing that stock returns react more to preferences for voting for the Australian Labor Party over the Liberal-National Party (Narayan & Narayan, 2021). The different candidate profiles of the two candidates are also expected to have different impacts on the stock market. Different findings that do not support the relationship between political events and stock performance come from several studies. Ioannidis and Thompson (1986), for example, find a positive but insignificant relationship between the Conservative Party polling in the UK and stock market performance. Likewise, Upadhyaya et al. (2023) found no significant impact of opinion polls supporting one candidate over another on stock returns. However, a simple statistical test shows that the market performed better when Trump was ahead in the polls compared to Clinton. Based on the following illustration, the following hypotheses may be formulated:

H_1 there is a difference in returns before and after the first presidential debate
H_2 there is a difference in returns before and after the second presidential debate
H_3 there is a difference in returns before and after the third presidential debate
H_4 there is a difference in returns before and after the fourth presidential debate
H_5 there is a difference in returns before and after the fifth presidential debate

We illustrate the conceptual framework of event window of this study as well as estimation in Figure 1.

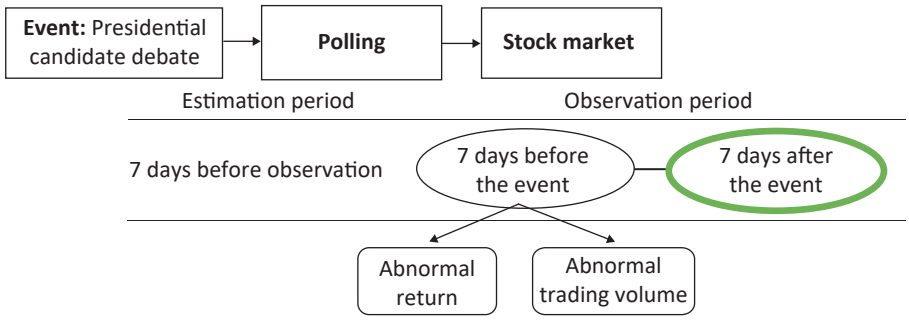

Figure 1. Framework of thought

Note: Estimation event window (estimation and observation period) to get abnormal return for the 7 days in a generic event study.

Source: authors' own elaboration.

2. Research methods

Event studies also serve an important purpose in capital market research as a way to test market efficiency. Abnormal returns that are systematically non-zero and persist after certain types of corporate events are inconsistent with market efficiency. Therefore, event studies that focus on the short run of an event can provide important evidence regarding market efficiency.

The basic data consists of daily returns and other company characteristics that are widely used in the return predictability literature, obtained from the Indonesia Stock Exchange. The testing procedure follows a general methodology, starting with a regression equation by looking at random price fluctuations if the market is efficient and past information is incorporated into current prices Investor

reaction can be measured by abnormal return during the event period. If investors react when the announcement is received, it means that the announcement contains information. Hypothesis testing begins by calculating the actual return, then calculating the market return, then calculating the abnormal return, after the abnormal return is obtained, the next step is to calculate the cumulative abnormal return (CAR) which is used to see the accumulation of abnormal returns 7 days before and after. In addition, this study also uses a paired t-test by comparing abnormal returns before and after. Considering that election polls after the presidential and vice-presidential debates 1 to 3 are assumed to influence asset prices, opinion poll information is included in the equation, as done by Chen et al. (2023), Forsythe et al. (1999) as well as Li and Born (2006). Forsythe et al. (1999) used a similar model, although using experimental (laboratory) stock markets to predict election outcomes. The coefficient of change in stock prices is expected to be negative because, ceteris paribus, rational investors will sell shares following a price increase on the previous day and buy an asset a price decline.

The coefficient of the poll variable is subject to the hypothesis that it will be positive if the market is bullish about the prospect of the candidate winning the election, and will be negative if the market is bearish about the prospect of the candidate winning the election. The daily return of this index is obtained from the IHSG database. For the polling variable, this research uses data from three top survey institutions, i.e. the Polling Institute (PI), the Indonesian Survey Circle (LSI) and the Center for Strategic and International Studies (CSIS). Polling results are preferred because they involve a large sample, more than 1,000 people in 34 provinces in Indonesia. The data series starts from the first debate (12 December 2023) to the fifth debate (4 February 2024):

The expected result is a sample of 165 observations, excluding weekends and holidays. To eliminate the influence of deviations (trends) in the estimates, we use daily returns on the indices described above. The current position (January 2024) shows that the electability of the Prabowo-Gibran (PG) candidate outperforms the other two candidates. The positive (negative) coefficient and significance of PG indicate a favourable (unfavourable) stock market response to the prospect of PG winning (losing). In short, the sample was determined using certain criteria, namely issuers with daily and monthly active trading. Issuers that are not active in daily trading cannot be selected as samples because they do not have daily or monthly return figures or do not have an *actual return value*. Data were analysed using a difference test with observations of 5 events (see Table 1), with the assumption of normality fulfilled using a probability plot.

Next, hypothesis testing is carried out based on data normality conditions: (1) a paired sample t test is used on observed data with a normal distribution; (2) a non-parametric Wilcoxon Signed Rank test is used on observed data that is not normally distributed.

Table 1. Operational definition of variables

Variables	Indicators
Actual returns	$R_{i,t} = (P_t - P_{t-1}) / P_{t-1}$
Expected return	ER = IHSG (Composite Stock Index) $R_{mt} = (IDX80_t - IDX80_{t-1}) / IDX80_{t-1}$
Abnormal returns	AR = difference ER over R_i
Window period	debate 1 to debate 5 (–7 to +7) days

Note: $R_{i,t}$ – the actual return share *i* on day *t*; P_t – share price on day *t*; P_{t-1} – stock price the previous day; R_{mt} – market return day *t*; $IDX80_t$ – an index of 80 stocks on day *t* that have high liquidity and large market capitalization and are supported by good company fundamentals.

Source: (Chen et al., 2023; Forsythe et al., 1999; Li & Born, 2006).

3. Research results and discussion

Based on the calculation results in Table 2, the average stock trading frequency table during the research shows a decreasing trend in activity and trading frequency during the debate event period. The frequency before the debate event is more active than the period during the debate. This illustrates people's pessimism that this political event affects the expected decline in economic expectations. Based on the results of calculating the average abnormal return during the research, it appears that investors received less profitable returns in the first and fifth debates. This shows that the market responded negatively to these particular debate events; this was a real action of investors' lack of partiality towards the pair of candidates who were declared dominant in winning the polling results (PG). Profitable returns began to be obtained from the second to fourth debates, which showed investor optimism towards the candidate pairs. Overall, the average abnormal return was negative both in the period before and after the debate event. These results show a decreasing trend in returns during the debate event. Meanwhile, transaction volume shows a decrease in the number from debate period 1 to debate period 5. This illustrates the anticipatory attitude of investors towards political uncertainty during the election process, which has an impact on the decision to sell the shares they own.

Table 2. Average return during the presidential candidate debate event

No.	Issuer	AAR_1		AAR_2		AAR_3		AAR_4		AAR_5	
		before	after	before	after	before	after	before	after	before	after
1.	ACES	0.0090	–0.0096	–0.00213	0.00026	0.0022	–0.0091	–0.0003	–0.0005	–0.0740	–0.0522
2.	ADRO	–0.0004	–0.0063	0.00324	0.01401	0.0159	0.0129	0.0070	0.0105	–0.0795	–0.0715
3.	AKRA	–0.0004	–0.0069	0.00260	–0.00490	–0.0030	–0.0045	–0.0001	0.0025	–0.0695	–0.0670
4.	AMRT	–0.0001	–0.0050	0.00451	0.01009	0.0120	0.0183	0.0110	0.0036	–0.0737	–0.0722
5.	ANTM	0.0033	–0.0043	0.00526	0.00515	0.0071	0.0133	0.0061	0.0082	–0.0738	–0.0658
6.	ARTO	–0.0016	0.0226	0.03213	–0.00187	0.0001	–0.0161	–0.0055	0.0097	–0.0555	–0.0563
7.	ASII	–0.0091	–0.0027	0.00685	0.00421	0.0061	0.0094	0.0099	0.0127	–0.0818	–0.0678
8.	BBCA	0.0000	–0.0133	–0.00381	0.00239	0.0043	0.0024	0.0042	0.0062	–0.0773	–0.0694
9.	BBNI	–0.0010	0.0000	0.00954	–0.00255	–0.0006	–0.0014	0.0079	0.0022	–0.0824	–0.0725
10.	BBRI	–0.0044	–0.0100	–0.00046	0.00425	0.0062	0.0043	0.0028	0.0084	–0.0798	–0.0754
11.	BMRI	–0.0019	–0.0076	0.00187	–0.00435	–0.0024	–0.0049	0.0031	0.0020	–0.0808	–0.0794
12.	BRPT	–0.0819	0.0202	0.02970	0.01206	0.0140	0.0446	0.0084	0.0093	–0.0709	–0.0598
13.	BUKA	0.0054	–0.0104	–0.00090	0.00881	0.0107	0.0143	0.0082	0.0128	–0.0717	–0.0491
14.	CPIN	–0.0003	–0.0041	0.00544	0.00762	0.0095	0.0159	0.0095	0.0109	–0.0761	–0.0773
15.	GOTO	0.0067	0.0053	0.01480	0.00614	0.0081	0.0014	0.0067	0.0037	–0.0857	–0.0545
16.	ICBP	0.0089	–0.0023	0.00723	0.00332	0.0053	0.0007	0.0027	0.0035	–0.0770	–0.0643
17.	INCO	0.0063	–0.0046	0.00495	0.00476	0.0067	0.0121	0.0080	0.0121	–0.0691	–0.0581

18.	INDF	–0.0025	0.0001	0.00961	0.00223	0.0042	0.0041	0.0031	0.0048	–0.0736	–0.0674
19.	INKP	0.0129	–0.0079	0.00159	0.00572	0.0077	0.0124	0.0053	0.0096	–0.0814	–0.0708
20.	ITMG	0.0008	–0.0093	0.00022	–0.00179	0.0001	–0.0034	0.0062	0.0091	–0.0773	–0.0679
21.	KLBF	–0.0051	–0.0025	0.00703	0.00660	0.0085	0.0081	0.0076	0.0112	–0.0698	–0.0635
22.	MDKA	0.0053	–0.0177	–0.00819	0.00142	0.0033	0.0249	–0.0078	–0.0070	–0.0665	–0.0588
23.	MEDC	0.0113	–0.0102	–0.00064	–0.00071	0.0012	–0.0077	–0.0015	0.0051	–0.0737	–0.0696
24.	PGAS	–0.0023	–0.0047	0.00486	–0.00146	0.0005	–0.0002	0.0034	0.0079	–0.0761	–0.0676
25.	PGEO	–0.0125	–0.0239	–0.01439	–0.00469	–0.0028	0.0013	0.0005	–0.0015	–0.0800	–0.0538
26.	PTBA	–0.0007	–0.0051	0.00438	–0.00877	–0.0068	–0.0094	0.0069	0.0085	–0.0764	–0.0723
27.	SMGR	0.0048	–0.0027	0.00680	0.00388	0.0058	0.0104	0.0116	0.0024	–0.0817	–0.0698
28.	TLKM	–0.0118	–0.0047	0.00479	0.00870	0.0106	0.0063	0.0075	0.0045	–0.0754	–0.0700
29.	UNTR	–0.0032	–0.0045	0.00505	–0.00167	0.0003	–0.0080	0.0005	0.0129	–0.0766	–0.0685
30.	UNVR	0.0023	–0.0051	0.00447	0.00412	0.0061	0.0105	0.0125	0.0129	–0.0734	–0.0540
Average		–0.0021	–0.0046	0.0049	0.0028	0.0047	0.0054	0.0048	0.0066	–0.0753	–0.0656
StDev		0.0163	0.0089	0.0090	0.0054	0.0054	0.0121	0.0048	0.0049	0.0059	0.0079
$Average_{before,\ after}$		–0.0126	–0.0111	–	–	–	–	–	–	–	–
$StDev_{before,\ after}$		0.0083	0.0078	–	–	–	–	–	–	–	–

Note: AAR – average abnormal return; StDev – standard deviation.

Source: authors' own calculation.

3.1. Calculation results of average daily *abnormal return*

Based on the calculation results in Table 3, we may observe a negative direction, which means that investors did not get profitable returns during the debate periods 1 to 5. This illustrates people's pessimism that this political event has influenced the expected decline in economic expectations. In line with previous studies, a pessimistic view of political attitudes that influences ideological positions raises anxiety regarding the possibility of socio-economic decline (Galdi et al., 2020; Mitrea et al., 2021).

There is empirical evidence that individual-level economic expectations are shaped not only by retrospective perceptions but also by political preferences (Ladner & Wlezien, 2007). Individuals who favour the current government tend to view the country's past economic performance more positively. Moreover, those with favourable views of the economy's past are generally more optimistic about the future, particularly if they align politically with the ruling party. Naturally, both retrospective evaluations and forward-looking expectations are influenced by the availability of information. This highlights the significant role politics plays in shaping economic perceptions. Therefore, the ideological inclination towards the presidential candidates is a function of retrospective financial appraisals and other economic considerations, which can ultimately influence investment decisions (Guiso et al., 2003). Similarly, Bonaparte et al. (2017) demonstrate that when an investor's preferred candidate loses, they tend to become more pessimistic and perceive the market as riskier.

Debate 1. The statistical test results, summarised in Table 4, show that the average abnormal return (AAR) was negative both before (–0.002) and after (–0.004) the event, indicating sustained underperformance (realised return < expected return). This reflects a condition in which actual investment outcomes fell short of prior market predictions. This is supported by previous studies regarding the poor performance of stocks in election years compared to non-election years (Yennaco, 2020).

From the CAPM perspective, this indicates that the performance of securities during the event period deviates from what would be expected based on their risk levels and the overall market performance. Investors in this event failed to obtain positive compensation based on the level of risk they predicted. Sustained underperformance in the period following the debate was even worse. This means that, overall, the market responded negatively to the results of the first edition of the presidential and vice-presidential debate held by the General Election Commission on December 12, 2023. The debate addressed key themes including law, human rights, government, strengthening democracy, eradicating corruption, community harmony and improving public services. Survey results summarised by Katadata

Table 3. Average daily abnormal return during the presidential debate event

Debate	t_{-7}	t_{-6}	t_{-5}	t_{-4}	t_{-3}	t_{-2}	t_{-1}	t_{0}	t_{+1}	t_{+2}	t_{+3}	t_{+4}	t_{+5}	t_{+6}	t_{+7}
1	–0.004	0.006	–0.002	–0.008	–0.002	–0.018	0.015	–0.013	0.007	–0.017	–0.005	0.009	–0.015	–0.009	–0.002
2	–0.004	0.006	–0.002	–0.008	–0.002	–0.018	0.015	–0.013	0.007	–0.017	–0.005	0.009	–0.015	–0.009	–0.002
3	0.003	0.004	0.011	–0.004	0.012	–0.005	0.012	0.030	–0.006	0.017	0.005	0.007	0.001	0.008	0.007
4	0.006	0.002	0.005	0.003	0.010	0.002	0.006	0.006	0.011	0.008	0.006	0.000	0.006	0.009	0.006
5	–0.148	–0.151	–0.018	–0.009	–0.088	–0.074	–0.039	0.883	–0.124	–0.062	–0.067	–0.011	–0.142	–0.001	–0.053
Average	–0.030	–0.027	–0.001	–0.005	–0.014	–0.022	0.002	0.179	–0.021	–0.014	–0.013	0.003	–0.033	–0.001	–0.009

Source: authors' own calculation.

Table 4. Statistical test results during presidential candidate debate events 1–5

Statistic	Debate 1		Debate 2		Debate 3		Debate 4		Debate 5	
	AR_{before}	AR_{after}	AR_{before}	AR_{after}	AR_{before}	AR_{after}	AR_{before}	AR_{after}	AR_{before}	AR_{after}
Descriptive										
Mean	–0.0020	–0.0045	0.0048	0.0027	0.0046	0.0054	0.0048	0.0066	–0,0753	–0.0655
Dev	0.0162	0.0089	0.0089	0.0053	0.0053	0.0120	0.0048	0.0048	0.0058	0.0078
Normality										
K–S test	0.293	0.232	0.230	0.084	0.084	0.097	0.139	0.141	0.139	0.175
Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.020
Conclusion	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
Hypothesis										
Wilcox-Z	–2.746*		–1.018*		–0.510*		–2.088*		–4.720*	
Sig.	0.006		0.039		0.959		0.037		0.000	
Conclusion	significant		significant		not significant		significant		significant	

Note: * based on negative ranks; AR_{before} – abnormal return before; AR_{after} – abnormal return after; dev – standard deviation; K–S test – Kolmogorov–Smirnov test; sig. – significance level; Wilcox-Z – the Wilcoxon signed rank-test, which is $z = 1.96$ for a two-tailed test and directionality.

Source: authors' own calculation.

Insight Center (KIC) show that presidential candidate 2 received the best rating (37%) compared to other candidate pairs (Annur, 2023). It seems that the results of the survey were not well-received by investors and instead led to an increase in the investment risk map so that no investor was able to obtain positive performance for their investment portfolio. This finding aligns with Hull's study (2017), which also reported negative market performance during the period leading up to an election. Opposition supporters are constantly more inclined than the incumbent party to expect the opponents to win. People who oppose the current government tend to view the past more negatively and, as a result, are more pessimistic about the future. Naturally, both retrospective evaluations and future expectations evolve as new information becomes available. Kaustia and Torstila (2011) suggest that some people consider the stock market to be inconsistent with their personal values, in the context of an imbalance between actions and values (cognitive dissonance).

The results of the data normality test show that the data is normally distributed (sig. 0.000). The Wilcoxon signed rank (WSR) test states that there is a difference ($p = 0.006 < 0.05$) in AAR before and after, which means that Hypothesis 1 is accepted. This finding is in line with market efficiency theory, that Indonesia with the semi strong form (SSF) of efficiency has been represented by the investor response which is reflected in changes in AAR before and after debate 1 (negative direction). This negative response shows that the political event (debate 1) did not gain public empathy and had an impact on people's economic expectations so that securities performance showed a downward trend, which investors had not anticipated. This finding is in line with previous studies suggesting that a pessimistic view of political attitudes that influences ideological positions gives rise to anxiety regarding the possibility of socio-economic decline (Galdi et al., 2020; Mitrea et al., 2021).

Debate 2. The statistical test results, summarised in Table 5, show that the average abnormal return (AAR) was positive both before (0.048) and after (0.0027) the event, indicating that realised returns exceeded expected returns – a condition in which actual investment performance surpassed prior market predictions. The CAPM perspective provides this information as a signal that the performance of securities during this event period has succeeded in considering risk and market performance effectively so that investors have succeeded in obtaining positive compensation. Realised return performance is smaller after the debate, which means that investors' calculations regarding risk and return expectations are slightly off.

The second debate (22 December 2023) carried the themes of digital economy, people's economy, taxes, investment, infrastructure, APBN and APBD management and urban areas. According to survey results by Political Indicators, presidential candidate 1 received the highest rating (35%) compared to the other candidate

pairs (CNN, 2024). Presumably, the results of the survey are in line with the expectations of the public and investors so that investors are able to obtain positive performance for their investment portfolios. The WSR test states that there is a difference ($p = 0.039 < 0.05$) in average abnormal return (AAR) before and after, which means hypothesis 2 is accepted. This finding aligns with market efficiency theory, suggesting that Indonesia – with the semi strong form (SSF) of efficiency – has been represented by investor responses which are reflected in changes in AAR before and after debate 2. This response shows that the political events of debate 2 are in line with public expectations, and thus the performance of securities shows a positive trend. Although there was a slight decline, it appears to have been anticipated and absorbed by investors.

This finding is consistent with previous empirical evidence indicating a significant relationship between the congruence of expectations of the winning candidate and optimism about the future economy (Mian et al., 2023). Investors then have a more optimistic view as evidenced by an increase in AAR. Other studies confirm systematic changes in the composition of investor portfolios (Addoum & Kumar, 2016). Investor portfolio allocation to risky assets is influenced by the congruence of expectations that the candidate being nominated is likely to assume power (Bonaparte et al., 2017). This means that partisan perceptions have a real impact on investment behaviour. This can be explained by the fact that the congruence of expectations toward candidates reflects ideological investors' ideological beliefs, leading them to interpret positive signals.

Debate 3. The statistical test results, summarised in Table 5, show that the average abnormal return (AAR) was positive both before (0.0046) and after (0.0054) the event, indicating that realised returns exceeded expected returns – a condition in which actual investment performance surpassed prior market predictions. The CAPM perspective provides this information as a signal that the performance of securities during this event period has succeeded in considering risk and market performance effectively so that investors have succeeded in obtaining positive compensation. Realised return performance is greater after the debate. This means that investors have been able to learn from previous events related to risk, so they are able to determine return expectations better. The third debate (7 January 2024) focused on the issues of geopolitics, international relations and defence and security. Survey results from Indonesian Indicator Research show that presidential candidate 1 received the best rating from netizens (35%) compared to the other candidate pairs (Putra, 2024). The results of this survey appeared to be in line with the expectations of the public and investors so that investors are able to obtain positive performance and increase their investment portfolio. The WSR test states that there is no difference ($p = 0.959 > 0.05$) in AAR before and after, which means that Hypothesis 3 is rejected. This finding is in line with market efficiency theory, suggesting that Indonesia with the semi strong form (SSF) of effi-

ciency does not represent the investor response which is reflected in the average AAR before and after debate 3. This response shows that the political events of debate 3 are not in line with public expectations, and therefore securities performance showed no change. This result is in line with previous studies which showed that investor disapproval of the potential victory of candidates (based on the results of the debate) was followed by a weakening of stock returns in America in 2003 (Montone, 2022). This is especially true in countries with high political uncertainty and low market sentiment.

Debate 4. The statistical test results, summarised in Table 5, show that the average abnormal return (AAR) was positive both before (0.0048) and after (0.0066) the event, indicating that realised returns exceeded expected returns – a condition in which actual investment performance outperformed prior market predictions. The CAPM perspective provides this information as a signal that the performance of securities during this event period succeeded in considering risk and market performance effectively, indicating that investors have succeeded in obtaining positive compensation. Realised return performance is greater after the debate. This means that investors learn from previous events related to risk so they are able to determine return expectations better. The fourth debate (21 January 2024) focused on the issues of sustainable development, environment, natural resources, energy, agrarian affairs, food, indigenous communities and villages. The majority of survey institutions put the electability of presidential candidate 2 ahead in this fourth debate. The results of the survey appeared to have received positive support from the market and investors, suggesting that investors are able to obtain positive (increased) performance for their investment portfolios. The WSR test states that there is a difference ($p = 0.037 < 0.05$) in AAR before and after, which means that Hypothesis 4 is accepted. This finding is in line with market efficiency theory, suggesting that Indonesia with the semi strong form (SSF) of efficiency represents an investor response which is reflected in the average AAR before and after debate 4. This response indicates that the political issues discussed in debate 4 aligned with public and investor expectations, resulting in improved (positive) performance of securities. This is in line with previous empirical evidence suggesting that there is a significant relationship between the congruence of expectations of the winning candidate and optimism about the future economy (Mian et al., 2023). Investors then have a more optimistic view as evidenced by an increase in AAR. Other studies confirm systematic changes in the composition of investor portfolios (Addoum & Kumar, 2016). Investor allocation to risky assets is influenced by the alignment between their expectations and the likelihood of their preferred candidate gaining power (Bonaparte et al., 2017). This means that partisan perceptions have a real impact on investment behaviour. This can be explained by the fact that the alignment of expectations

with certain candidates reflects investors' ideological beliefs, prompting them to interpret these developments as positive signals.

Debate 5. The statistical test results, summarised in Table 5, show that the average abnormal return (AAR) was negative both before (–0.0753) and after (–0.0655) the event, indicating sustained underperformance, where realised returns were lower than expected, reflecting actual investment outcomes falling short of prior market predictions. From the CAPM perspective, this indicates that the performance of securities during the event period did not effectively account for risk and overall market performance, resulting in investors failing to receive adequate positive compensation. Realised return performance is smaller after the debate. This means that investors fail to assess risk, and therefore fail to determine their best return expectations. The fifth debate (4 February 2024) touched upon the issues of social welfare, education, culture, information technology, employment, health, inclusion and human resources. The majority of survey institutions put the electability of presidential candidate 2 ahead in this fifth debate. The results of the survey appear to have received negative support from the market, leading to a situation where investors were unable to achieve positive performance in their investment portfolios. The WSR test states that there is a difference ($p = 0.000 < 0.05$) in AAR before and after, which means that Hypothesis 5 is accepted. This finding is in line with market efficiency theory, showing that Indonesia with the semi strong form (SSF) of efficiency represents an investor response which is reflected in the average AAR before and after debate 5. This response suggests that during the political events of debate 5, investors were apathetic toward the electability outcomes, resulting in a decline (negative) in security performance.

This is consistent with Hull's study (2017), which found negative performance in the period leading up to the election. Opposition supporters are constantly more inclined than the incumbent party to expect the opponents to win. People who oppose the current government tend to view the past more negatively, which in turn leads to greater pessimism about the future. Certainly, both retrospection and anticipation are shaped by the acquisition of new information. Kaustia and Torstila (2011) suggest that some people consider the stock market to be inconsistent with their personal values, in the context of an imbalance between actions and values (cognitive dissonance). Similarly, Wagner et al. (2018) documented that Trump's election came as a surprise, altering expectations – such as lower corporate taxes and stricter trade policies – which led to a swift response in stock prices. In short, the debate analysis shows that expectations about tax rates greatly affect company value. Ejara et al. (2012) confirmed this finding, showing that the impact of polling during the 2008 US presidential election campaign led to a negative reaction in the stock market, particularly towards the Democratic presidential candidate.

Table 5. AAR holistic summary of debate 1 to debate 5

Debate 1–5	Descriptive		Normality			Wilcoxon Signed Rank Test		
	mean	dev	K–S test	sig.	conclusion	Z	sig.	conclusion
Before	–0.1260	0.0032	0.144	0.015	normal	–1.656*	0.098	not significant
After	–0.0110	0.0047	0.101	0.000	normal			

Note: see Table 4.

Source: authors' own calculation.

The statistical test results, summarised in Table 5, show that the average abnormal return (AAR) was negative both before (–0.1260) and after (–0.0110) the event, indicating sustained underperformance, where realised returns were lower than expected, signifying that actual investment performance was worse than predicted. The CAPM perspective indicates that this information is a signal that investors failed to predict risk and return during this event so they were unable to obtain positive compensation. In fact, the realised return performance was smaller after the debate. This means that investors' estimates have missed their proper expectations.

The results of the electability survey (debates 1 to 5) appear to have received negative support from the market and investors, leading to a situation where investors were unable to obtain positive performance for their investment portfolios. The results of the data normality test show that the data is normally distributed, with a significance value of 0.000 both before and after. The WSR (Wilcoxon signed rank) test states that there is no difference (p = 0.098 > 0.05) in AAR before and after, which means that Hypothesis 5 is rejected. This means that it is assumed that this debate event does not contain information that investors consider meaningful in influencing investment decisions. As is known, the presidential and vice-presidential debate is a campaign event that can increase the electability of candidates. The response to the debate results, as summarised in the polling data from five survey institutions in Indonesia, i.e. Indonesian Data Scale (SDI), Charta Politika, LSI, Political Indicators and Poltracking Indonesia (Monalisa, 2024), indicates that candidate number 2 was consistently ahead across all five debates when compared to the other candidates. However, the results of various electability surveys are widely doubted because it is suspected that these institutions are political consultants for presidential candidates (Maulana & Abdullah, 2023). This doubt leads to the assumption of neutrality as well as the expectation of honest and fair elections. Political power remains in the hands of the incumbent so it will not have a significant impact on economic policy. Therefore, investors are not very responsive to the political events of the 2024 election and its instruments such as the presidential candidate debate.

This finding aligns with market efficiency theory, suggesting that Indonesia, exhibiting semi-strong form of efficiency (SSF), experienced a stagnant investor response to pre-election events, such as the presidential candidate debates, as reflected in the average AAR before and after the debates. This response indicates that, during the political events of debates 1–5, investors were apathetic towards electability outcomes and, as a result, failed to predict the performance of their securities.

On the other hand, because these debate events were held more than once, with each debate agenda seemingly favoring the incumbent presidential candidate, the resulting opinions and information became predictable and unsurprising. Therefore, in line with the SSF market concept, investors will only reach AR around event announcements (Tandelilin, 2010), i.e. in this case, in the second to fourth debate positions.

We show that favourable economic expectations improve slightly between the second and fourth debates. Following De Boef and Kellstedt (2004) and Adam (2014), we refer to this impact as the "honeymoon in economic approval ratings". However, as we show, this honeymoon is fairly short lived; any favourable influence wears out rather quickly within the final debate. In line with De Boef and Kellstedt (2004), who find that the positive effects of such events are short-lived, lasting less than two months, indicating that agents in a very short period of time revise their expectations about the manipulated survey results.

Meanwhile, the first debate was a moment to study the situation, while the last debate showed investors' lack of optimism. The debate event did not cause a difference in returns. Meanwhile, negative returns indicate that investors failed to predict market performance and securities market risks as a result of public confusion over the performance of presidential candidates which was not in line with statistical figures from survey institutions.

The current research found negative abnormal return movements. This downward movement can also be interpreted as a bearish condition, namely a decline in share prices for a certain period which indicates investment pessimism. Differences in the sources of survey institutions' calculations with the results of exit polls and internal counting of candidates cause confusion, and as a result, investors find it difficult to predict their investment decisions and postpone investment decisions around that period.

Conclusions

This research aims to test empirically whether there are differences in investors' responses to political events in 2024, namely the presidential and vice-presidential candidate debates. Empirical evidence regarding the relationship between politi-

cal events and stock prices raises the question of how election uncertainty affects the stock market ahead of the election. To answer this, the research examines the impact of presidential and vice-presidential candidate debates on changes in polling results (electability) on the stock market during the pre-election period in Indonesia. Capital markets in developing countries are very responsive to current political issues and events such as presidential candidate debates. WR statistical analysis is used to assess whether or not there are differences in investors' responses. This research comprehensively proves that investors react no differently both before and after the 1–5 debate period. This indicates that investors perceive the debates as having no substantial impact on their economic decisions, largely because candidate electability is dominated by incumbents. As a result, investors assume there will be no significant shifts in financial policy, leading to minimal market response to the current election period.

The findings may also help to explain Suzuki's (1992) discovery of an election cycle in expectations. In short, as the election approaches and the likely outcome becomes clearer, the majority of people become more positive about the economy's prospects. In essence, voters may consider this uncertainty, which may be especially true when there is a non-trivial possibility of shifts in political control, such as through a vote of no confidence, scandal or even strategic election timing (Kayser, 2005; Smith, 2003). To the degree that expectations shape behaviour, pre-election changes in economic expectations may generate tangible effects on real economic activity (Matsusaka & Sbordone, 1995).

This study faced several limitations, particularly related to the timing of the event. Specifically, during the presidential debate events, the stock exchange was closed, so there were no transactions in period t. To overcome this, the research extended the event window to ensure that trading data surrounding the event was still captured. However, this limitation has consequences for the validity and accuracy of the information content of the event. Future studies may consider alternative methods to estimate abnormal returns even when trading activity is absent on the exact event date.

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Research on economic and financial socialisation in Poland and worldwide: A bibliometric analysis

Julita Żebrowska[1] **Joanna Lizińska**[2]

Abstract

Economic and financial socialisation is essential for building a person's confidence in managing finances independently and fostering financial self-sufficiency. The growing complexity of the financial environment, marked by market globalisation, digital transformation and accessibility of sophisticated financial products, creates unprecedented challenges for individual financial decision-making. This situation is further complicated by generational changes and challenges such as underperforming pension systems, making research on economic and financial socialisation particularly relevant and timely. The aim of this article is to review research on economic and financial socialisation, enabling a comprehensive mapping of existing studies and the identification of key topics and underexplored areas that may guide future studies. Conclusions are drawn from a quantified bibliometric analysis of articles from the Scopus database, supplemented by an in-depth content analysis of purposefully selected scientific works. The analysis was conducted using the R environment, specifically the Bibliometrix package and the Biblioshiny functionality. The findings map the status and developments of the research existing in the field, indicating also a need for further research into the impact of economic and financial socialisation on a broad spectrum of financial decision-making in adulthood.

Keywords

- finance
- personal finance
- economic socialisation
- financial socialisation
- financial behaviour
- financial knowledge
- bibliometric analysis

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[1] Poznań University of Economics and Business, al. Niepodległości 10, 61-875 Poznań, Poland, corresponding author: julitazebrowska@interia.eu

[2] Poznań University of Economics and Business, al. Niepodległości 10, 61-875 Poznań, Poland, joanna.lizinska@ue.poznan.pl

Introduction

Nowadays, the complexity and dynamics of the financial environment are increasing, which is manifested through international financial crises, the globalisation of financial markets and the digitalisation of financial services. Even sophisticated financial products are now accessible to average consumers. A significant challenge in contemporary times is the necessity of long-term planning oriented toward retirement and substantial personal investments. Contemporary societies are confronted with a multifaceted spectrum of challenges such as underperforming pension systems, increasing vulnerability of society to financial fraud, as well as financial decisions made on the basis of intuition. These changes are overlaid with generational shifts, including Generation Z's novel approach to financial matters and the growing influence of social media on financial decisions, resulting in evolving patterns of consumption and savings. Consequently, individual financial decision-making has undergone a significant transformation, marked by escalating levels of sophistication (LeBaron & Kelley, 2021).

Under these conditions, the importance of conscious personal budget management assumes paramount significance. The need for early financial education becomes particularly crucial. The earlier and more effectively individuals are introduced to economic concepts, the greater the likelihood that their financial decisions will be more responsible and beneficial, both for their individual well-being and for broader societal welfare. An individual's role within the economic system, after all, contributes to the stability of the entire economy, and their financial management skills can affect not only their personal wealth but also macroeconomic financial stability. Thus, economic and financial socialisation plays a crucial role in enabling individuals to make informed financial decisions. These processes create natural environments conducive to developing crucial competencies for responsible future budget management decisions in their future endeavours. The effective implementation and optimisation of initiatives in this domain necessitates in-depth research into these aspects.

The concept of socialisation is inherently multidisciplinary in nature, and this study focuses specifically on economic and financial socialisation. Researchers from various scientific disciplines, including economics and finance as well as pedagogy and psychology, have contributed to this field (Raszka, 2018). Generally, it may be assumed that socialisation is a process through which an individual acquires a system of values, norms and behaviour patterns. This process depends on individual characteristics and occurs as a result of interactions with the social environment. The intended outcome of socialisation processes should be the acquisition of competencies and capabilities for effective societal functioning, which undergo dynamic development throughout the individual's lifespan (Borowicz, 1997; Perez-Felkner, 2013).

Economic socialisation assumes paramount importance in the contemporary context of an increasingly dynamic economic landscape. It encompasses the processes through which a child assumes the role of a consumer (consumer socialisation) as well as that of a conscious holder and manager of financial resources (financial socialisation). Additionally, it involves the acquisition of general principles related to the functioning of the economy. In other words, economic socialisation is shaped by the mutual interaction between those undergoing the process and the individuals who influence the development of young people. Through socialisation, a child becomes a social being, and this process continues throughout one's life. Initially, the primary agents of socialisation are parents, while in later stages of life, other social groups and institutions play a more prominent role (Moreno et al., 2018; Roszkowska-Hołysz & Gąsiorek-Kowalewicz, 2019; Zaeri, 2016).

Closely related to economic socialisation is the process of financial socialisation. The latter represents a more focused and specialised component. Financial socialisation refers to the process of acquiring and developing values, knowledge and behaviours that promote financial stability and individual well-being. It encompasses five main areas: earning, spending, saving, borrowing and sharing. It is worth noting that the concept of financial socialisation is closely related to that of financial education; however, the distinguishing factor is the formality involved, as education tends to be more formalised and systematic in nature (Furrebøe et al., 2023; Kim & Torquati, 2019; Swacha-Lech & Solarz, 2019).

This article focuses on issues related to economic socialisation and financial socialisation, excluding consumer socialisation. The focus on economic socialisation and financial socialisation allows for a deeper and more detailed analysis. This approach is justified considering the growing importance of this issue in the context of contemporary economic challenges (household debt, complexity of financial products, retirement planning needs, etc.). The narrowing of the research scope also stems from methodological considerations – bibliometric analysis requires a precisely defined scope, as such narrowing ensures greater methodological coherence and accuracy of results. Despite the increasing interest from society, authorities, researchers and individuals in financial literacy, there remains a significant research gap in identifying crucial areas where empirical and theoretical research on economic and financial socialisation should evolve to provide more effective tools.

This would contribute to improving the understanding of financial decision-making processes and the development of evidence-based financial literacy interventions. The aim of this article is to review research on economic and financial socialisation, enabling a comprehensive mapping of existing studies and the identification of key topics and underexplored areas that may guide future studies.

This study places particular emphasis on the Polish context, although it also references findings from research conducted in other parts of the world. Poland

represents an interesting case for investigation due to the dynamic socio-economic changes that have occurred since the political transformation in 1989. The transition from a centrally planned economy to a market-oriented system has significantly influenced how individuals operate within the economic sphere, as well as the processes shaping financial attitudes. Moreover, the relatively limited number of empirical studies focusing on economic and financial socialisation in the Polish context highlights the need for further exploration and supplementation. An analysis of the local cultural context may contribute to a deeper understanding of socialisation mechanisms specific to post-transformation societies and, in turn, enrich the broader body of international literature (Kowalczyk & Chudzian, 2015).

Specifically, this paper aims to answer the following research questions:

(Q1) What are the temporal patterns and scholarly impact of research in economic and financial socialisation literature?
(Q2) What are the most impactful publications, prominent scholars and dominant countries in the field of economic and financial socialisation?
(Q3) What are the synthesised research streams in international literature regarding economic and financial socialisation?
(Q4) What are the interconnections in economic and financial socialisation studies?
(Q5) What are the established and emerging research directions in economic and financial socialisation studies?
(Q6) What are the key research topics and contributions in international literature regarding economic and financial socialisation?
(Q7) What are the specific research topics and contributions in literature concerning economic and financial socialisation in Poland?
(Q8) What research methods have been employed and what were the results in the existing literature on economic and financial socialisation?

This study employs a comprehensive mixed-method literature review, combining both quantitative and qualitative approaches. It is based on an extensive database of both international and Polish studies. Due to the multifaceted character of the investigation, the research methodology employs a three-stage analytical framework. The first two stages encompass quantitative bibliometric analysis, both initial and detailed. It is based on 245 literature items, conducted using the R environment, specifically the Bibliometrix package and the Biblioshiny functionality. It allows for an assessment of the achievements to date in this field. The third step employs a qualitative content analysis of purposefully selected scholarly studies and enables a detailed examination of research contributions. In this regard, conclusions were drawn from both international and Polish literature. This is important, as the phenomenon of economic and financial socialisation seems to be, to some extent, influenced by regional specificities.

The studied area, while undeniably significant and gaining scientific attention, remains insufficiently explored in the realm of academic research. This study allows us to provide an in-depth insight into economic and financial socialisation. It enables the discussion of recent research status and main research developments, while also identifying research gaps and future directions. This creates a starting point for new and compelling empirical research in this area. This research offers several contributions.

First, the initial quantitative bibliometric analysis provides important insights. We provide a comprehensive bibliometric analysis of both economic and financial socialisation literature, offering a quantitative assessment of publication trends and citation patterns over time. Another significant finding reveals the key contributors to the field by mapping the most influential authors, publications and countries through multiple bibliometric indicators, including Lotka's Law analysis, citation metrics and publication activity patterns.

Second, the detailed quantitative bibliometric analysis also yields significant findings. We synthesise and map the intellectual structure of the field by identifying distinct research streams through network analysis of keyword co-occurrences and country-author collaborations. Next, we provide a detailed mapping of the intellectual landscape through network analysis of keyword interconnections. Moreover, the study identifies both established and emerging research directions in the field by analysing temporal evolution of topic trends and keyword co-occurrence networks.

Finally, the qualitative content analysis complements the findings derived from the quantitative analysis. Here, the important contribution of this study is an in-depth review of the international literature to identify and systematise key research topics and scholarly contributions in economic and financial socialisation. Subsequently, we provide a pioneering systematic review of Polish literature on economic and financial socialisation, identifying distinctive research topics, followed by identification of scholarly contributions in the national context. Another significant finding reveals the methodological approaches used in economic and financial socialisation research, providing a comprehensive overview of research designs and empirical methods employed in the field.

This paper is structured as follows: the next section discusses the methodological approach and the sample of our study. Section 2 concerns the results based on initial bibliometric findings. Section 3 provides an advanced bibliometric analysis. Section 4 presents the results of the content analysis of both international and Polish literature, along with identified research gaps. Finally, the article concludes with a summary and discussion of results.

1. Methodology

The study drew upon two distinct types of sources. The first part involved the identification and analysis of literature selected from the Scopus database. The second part consisted of identifying and analysing scientific works available in Google Scholar authored by Polish researchers, focusing on topics related to economic and financial socialisation within the Polish context.

The initial stage commenced by selecting a group of publications from the Scopus database, which was analysed as of August 12, 2024, based on phrases present in titles, abstracts and keywords. The search expression was as follows: ((“financ* sociali*”) OR (“econom* sociali*”) OR (“financ* parent*”) OR (“financ* sociali* agent*”) OR (“econom* sociali* agent*”)). A total of 477 publications meeting the specified criteria were identified. The results were then narrowed down to articles, reducing the count to 403 publications. Subsequently, the dataset was refined to include only finalised publications, excluding 17 items. The final filtering focused on the language of publication, resulting in a dataset of 328 English-language articles. The next step involved an initial content analysis of titles and abstracts, allowing for the inclusion of articles specifically and directly related to financial or economic socialisation. Ultimately, a sample of 245 articles was selected for further research. From this selection, 37 articles were subjected to content analysis to identify research gaps. To refine the obtained database, synonymous phrases were grouped, with the most frequently used phrase displayed as the representative term. Sixteen primary phrases were identified. The stages of the literature review obtained from the Scopus database are illustrated in Table 1. A bibliometric analysis was then conducted on the selected sample using R-Studio, the Bibliometrix package and Biblioshiny functionality.

In the analysed sample received from the Scopus database, 245 articles published between 1971 and 2024 were found across 117 journals. The ratio of articles to journals was 2.1, indicating that, on average, slightly more than two articles were published per journal. The total number of authors amounted to 514, resulting in an author-to-article ratio of 2.1, which means that each publication had, on average, just over two authors. Only 37 articles were authored by a single individual, suggesting that the majority of research on financial and economic socialisation is conducted collaboratively. This reflects the labour-intensive nature of research in this field. The total number of keywords was 550, indicating the wide scope of the topic and the diversity of issues addressed.

The second part began with entering the Polish translation of the phrase “economic socialisation, financial socialisation” into Google Scholar on September 12, 2024. All search results were reviewed and additional sources were identified based on the bibliographies of these works. The final database consisted of 38 scientific

Table 1. Literature review stages based on the Scopus database

Stage	Description	Number of publications
1. Literature search – initial sample	a. General filtering b. Filtering – articles c. Filtering – final publications d. Filtering – English language	a. 477 publications b. 403 publications c. 386 publications d. 328 publications
2. Database "cleaning"	a. Title and abstract review b. Identification of the research sample	a. 328 publications b. 245 publications
3. Initial bibliometric analysis	a. Annual number of scientific publications b. Authors' publication activity c. Leading countries	a–c. 245 publications
4. Detailed bibliometric analysis	a. Network analysis b. Co-occurence analysis of terms c. Keywords analysis	a–c. 245 publications
5. Content analysis	a. Key contributions b. Specific topics c. Leading research methods d. Identification of research gaps	a–d. 37 publications

Source: own study.

works, including doctoral dissertations and articles authored by economists, psychologists, sociologists and educators. Titles, abstracts and keywords were then reviewed, resulting in the selection of 26 scholarly articles that were particularly relevant for the content analysis. To identify research gaps, articles written or co-authored by economists were chosen, forming a subset of 16 works. The stages of the literature review obtained from the Google Scholar database are illustrated in Table 2.

Table 2. The stages of the literature review conducted on the Google Scholar database

Stage	Description	Number of publications
1. Literature search – initial sample	a. Research literature general filtering by keywords	a. 38 publications
2. Database cleaning	a. Title and abstract review b. Identification of the final research sample	a. 38 publications b. 26 publications
3. Content analysis	a. Key contributions b. Specific topics c. Leading research methods d. Identification of research gaps	a. 26 publications b–d. 16 publications

Source: own study.

The text analysis of the research sample, sourced from the Scopus database, included 37 scientific articles, with studies conducted across four continents. The collected sources were expanded with a text analysis of 26 additional academic works drawn from the Google Scholar database. Consequently, the final sample of academic works subjected to text analysis comprised 63 publications, as presented in Table 3.

Table 3. The number of scientific works subjected to text analysis, categorised by data source and origin of the research sample by region

Region	The number of scientific works	
	Scopus database	Scholar database
Africa	3	–
North America	15	–
Asia	13	–
Europe	6	26
including: Poland	1	26
Total	37	26

Source: own study.

2. Initial quantitative bibliometric analysis: results and discussion

This section addresses research questions Q1 and Q2. It provides insights into the chronological development and academic impact of research on the economic and financial socialisation. The investigation yields a multi-dimensional assessment of scholarly contributions, encompassing author productivity patterns, publication dynamics, citation impact, and geographical distribution of research influence in the field.

Looking at the annual trend of the number and citations of published research articles (Figure 1), we can observe a remarkable change in the scientific activities and their impact. The first article was published in 1971, with the next appearing only in 1978. Until 2010, interest in the topic was minimal, with only 30 sporadic articles produced over a span of nearly four decades. However, after 2010, a steady increase in publications and a noticeable rise in interest in the subject can be observed. Between 2010 and 2024, 215 articles were published, accounting for 88% of the analysed sample. The peak years were 2023, with 36 articles (representing 15% of the sample), and 2020, with 31 articles (13% of the sample). The most substantial growth in research studies is evident in the last several years,

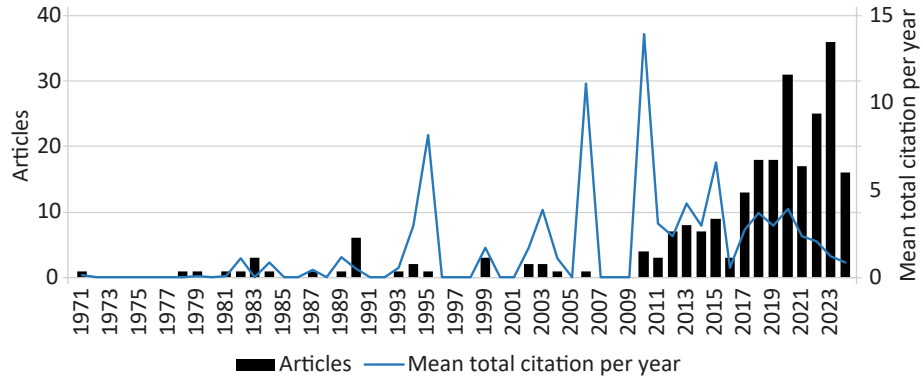

Figure 1. Annual trend of citations and number of published articles

Source: own study based on data from the Scopus database.

reflecting the field's expanding significance within academic research. The citation analysis shows a notable concentration of impact among early publications, with several foundational works from previous decades accumulating exceptional citation counts. Contemporary publications are actively building their citation impact.

The analysis of author activity over the years aligns well with Lotka's Law, also known as the inverse square law of productivity. This implies that a relatively small number of researchers are responsible for producing the majority of works, garnering a dominant share of citations and playing a critical role in shaping the identity of academic disciplines (Kwiek, 2019), as shown in Figure 2.

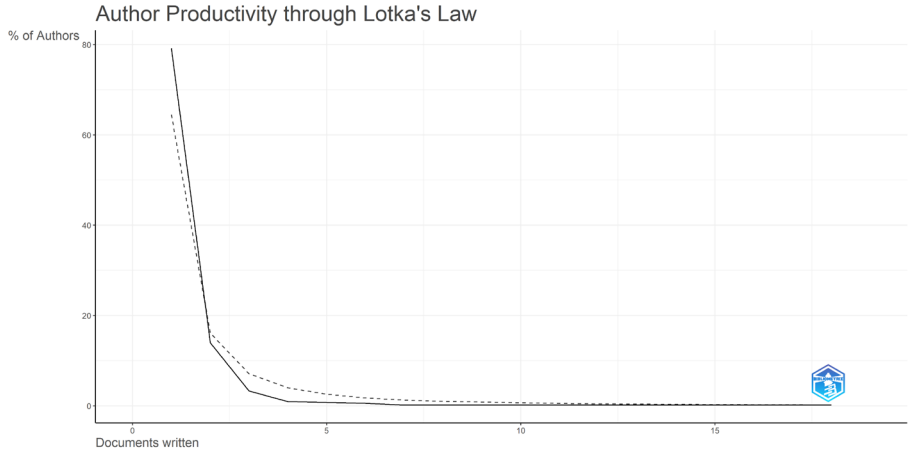

Figure 2. Author productivity according to Lotka's Law

Source: own study in the R environment, using the Bibliometrix package.

A total of 35 key authors publishing on the topics of economic and financial socialisation were identified. Each of the researchers listed in Figure 3 has at least three publications in this area. Four leading authors stand out, each with more than ten publications. Consequently, these four most active authors account for 55 works, representing 22% of the sample, while the 35 authors collectively contributed to 179 documents, comprising 73% of the analysed sample.

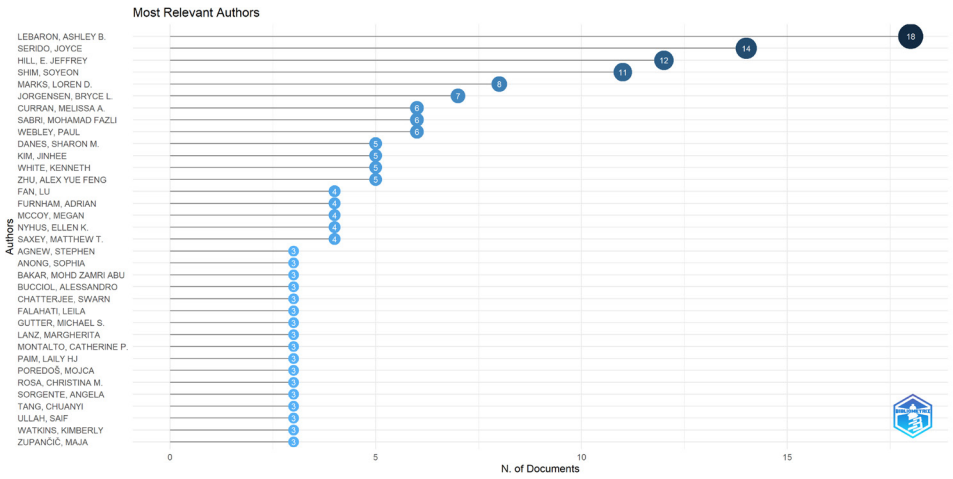

Figure 3. Key authors

Source: own study in the R environment, using the Bibliometrix package.

The analysis of publication intensity among the most active authors reveals interesting research patterns. The chart (Figure 4) illustrates the number of articles published by individual researchers over a given period and the number of citations received. The size of the dots represents the number of published works (the larger the dot, the more articles), while colour indicates the citation amount (the darker the colour, the higher the citation number). It can be observed that, as of the study date, there are nine key authors who have already published in 2024. Additionally, ten researchers have been active in this area for over a decade. Overall, increased publication activity among authors has been observed in recent years. Several authors including LeBaron, Schug, Hill and Jorgensen demonstrate consistent productivity in recent years, with multiple publications and substantial citation impact. The publication timeline demonstrates some long-standing contributors to the field, with their research activity spanning over many years. However, the majority of contributors in the field are concentrated in the more recent period. Detailed information is presented in Figure 4.

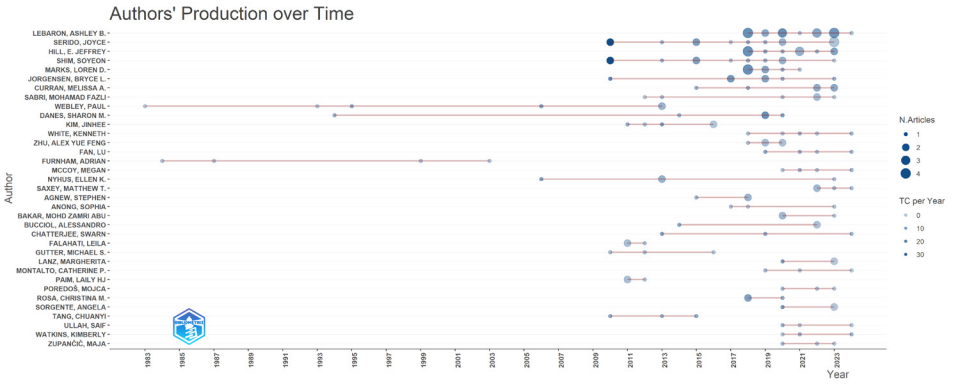

Figure 4. Authors' publication activity

Source: own study in the R environment, using the Bibliometrix package.

The analysis of the most frequently cited authors in the field of economic and financial socialisation is also of significant importance (Figure 5). Each of these authors has been cited over 200 times. Notably, two standout researchers have been cited over 860 times. These authors occupy the highest positions in the ranking, which reflects their significant impact on the advancement of research in this field. Their work can be regarded as a cornerstone for further research in this field. Other authors, despite having fewer citations, also play a significant role, suggesting that this area of study is advancing through the efforts of a broad community of scholars and the diversity of topics they address.

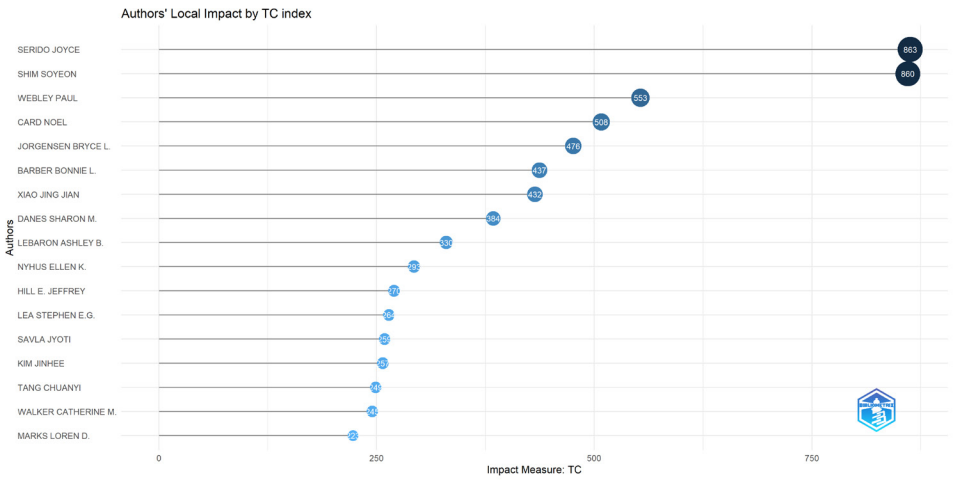

Figure 5. Authors' impact by total citation count

Source: own study in the R environment, using the Bibliometrix package.

The analysis of citation counts for published works also plays an important role. It can be observed that one particular study stands out among the others, i.e. Shim et al. (2010), which has been cited 431 times. Figure 6 presents publications with citation counts exceeding 50. It is worth emphasising that journals related to youth, family and economic psychology appear to generate the highest citation impacts, indicating that economic and financial socialisation, though primarily rooted in finance and economics, necessitates a multidisciplinary approach.

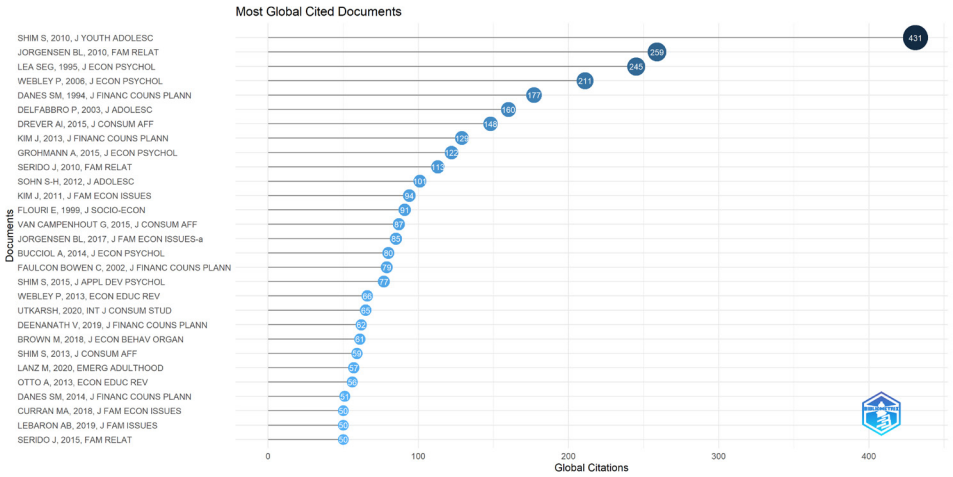

Figure 6. Most cited articles

Source: own study in the R environment, using the Bibliometrix package.

The study also focused on the most frequently cited works by countries of their publication. The United States of America ranks first, with just over 2,300 citations in the field under investigation. The United Kingdom follows in second place with 317 citations. Additionally, Figure 7 displays countries that received over 20 citations. Polish researchers in economic and financial socialisation are also among the recognised researchers, with their work receiving 22 citations. This underscores the need to explore the studied topic in cultural contexts beyond the United States of America, for example, in European or Asian countries.

The initial bibliometric analysis of economic and financial socialisation suggests that the field is growing in terms of research output. Recent years show unprecedented levels of publication activity. The results indicate that the field has matured and broadened. The increased academic attention mirrors the importance of financial literacy and economic education in contemporary societies that face many challenges and rapid changes.

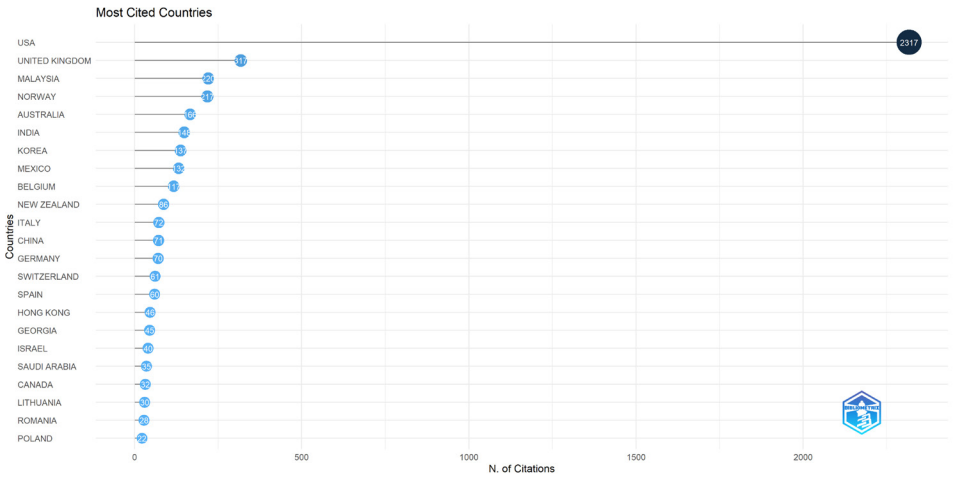

Figure 7. Most cited countries

Source: own study in the R environment, using the Bibliometrix package.

3. Detailed quantitative bibliometric analysis: results and discussion

This section addresses research questions Q3, Q4 and Q5. The investigation maps the key research directions and intellectual connections within the economic and financial socialisation. The examination also enables visualisation of relationships between keywords, allowing us to analyse the structure of thematic clusters and their interconnectivity. We also aim to recognise the chronological development in research themes, distinguishing between mature and emerging areas of scholarly interest. Figure 8 provides a cohesive summary of the research landscape in the field, illustrating (from left to right) the connections among corresponding authors' countries (AU_CO), the frequency distribution of authors' keywords (DE) and individual contributors (AU) in the area of economic and financial socialisation. The analysis shows the dominance of the United States of America. Research activity from Asian countries, particularly Malaysia and Indonesia, is also noticeable. It should be noted that American researchers have contributed to all key topics indicated below, highlighting a substantial and broad-ranging impact. Among European countries, only Italy and the United Kingdom appear in this figure, suggesting a need for further research on economic and financial socialisation within Europe.

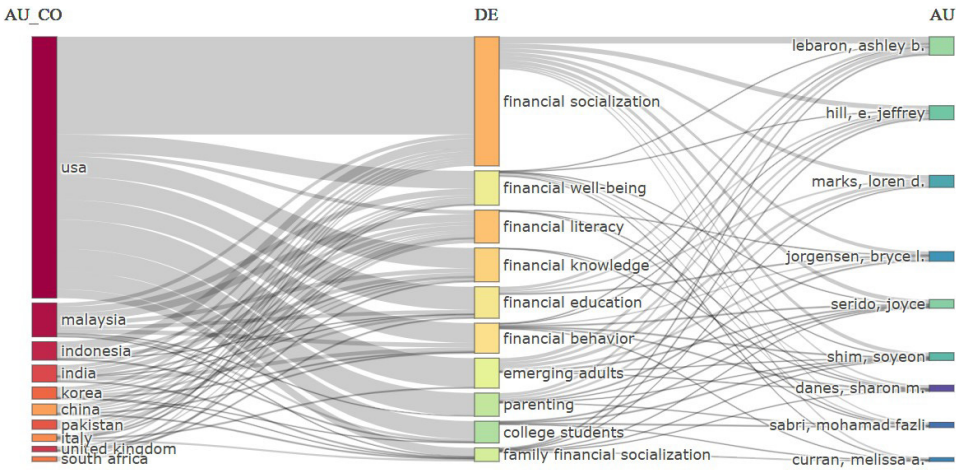

Figure 8. Connections among countries, keywords and authors

Source: own study in the R environment, using the Bibliometrix package.

An essential aspect of the research is the analysis of keywords. Figure 9 presents terms designated as keywords by authors at least 10 times in the analysed publications. Beyond the core term of "financial socialisation", the diagram highlights the prevalence of concepts related to financial behaviours and financial literacy. The supporting role of terms related to the age ("college students", "young adults"), family ("parenting", "family financial socialisation") or "gender" suggests that these demographic and contextual factors provide important background in understanding the mechanisms of financial and economic socialisation processes.

In the network map, the central concept is financial socialisation, which is connected to numerous issues, highlighting its critical importance in this field. Financial socialisation is directly associated with concepts of financial behaviours, financial skills and financial education, emphasising its role in the formation and acquisition of these competencies. Additionally, terms such as parental influence, adolescents, young adults, family and millennials indicate that financial socialisation is examined in the context of various age groups and social influences, suggesting a diversity of socialisation agents. References to Malaysia and Saudi Arabia illustrate that studies also address specific social and economic regional conditions that may impact the financial socialisation process. The emergence of new concepts, such as financial inclusion and financial autonomy, which have gained popularity, is also noteworthy, potentially marking directions for new research. Based on the aforementioned topics, one can observe the interdisciplinary nature and complexity of the studied field, as depicted in Figure 10.

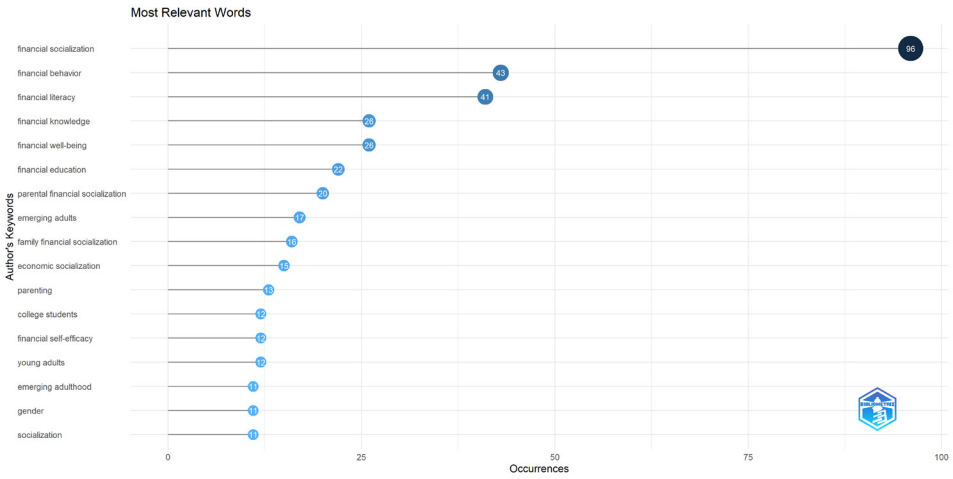

Figure 9. Most relevant words

Source: own study in the R environment, using the Bibliometrix package.

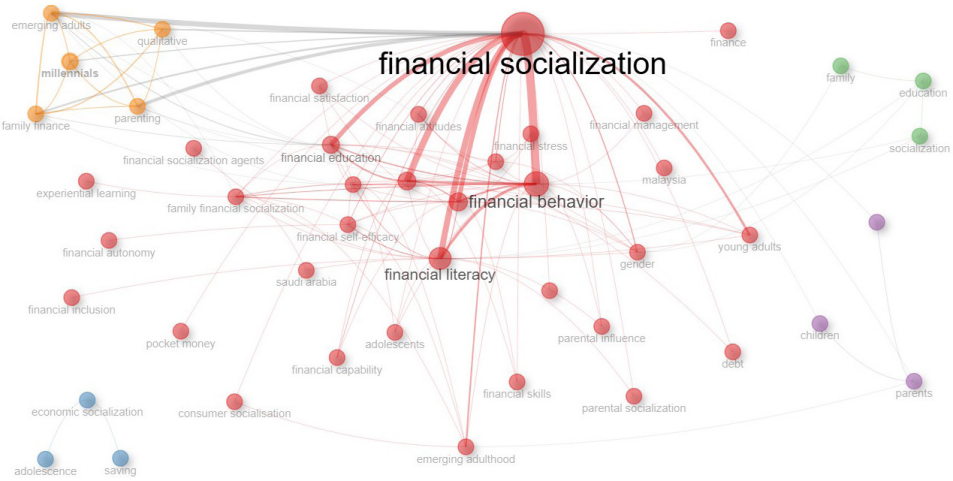

Figure 10. The network map of connections between keywords

Source: own study in the R environment, using the Bibliometrix package.

We categorised the keywords indicated by the authors. Four main groups can be identified: education and the process of financial socialisation, financial competencies and behaviours, financial well-being and the specificity and characteristics of the studied sample (demographic group). Figure 11 presents thematic trends in publications, where the size of the dots indicates the frequency with which a given phrase appears. It can be observed that the term "gender" appeared consistent-

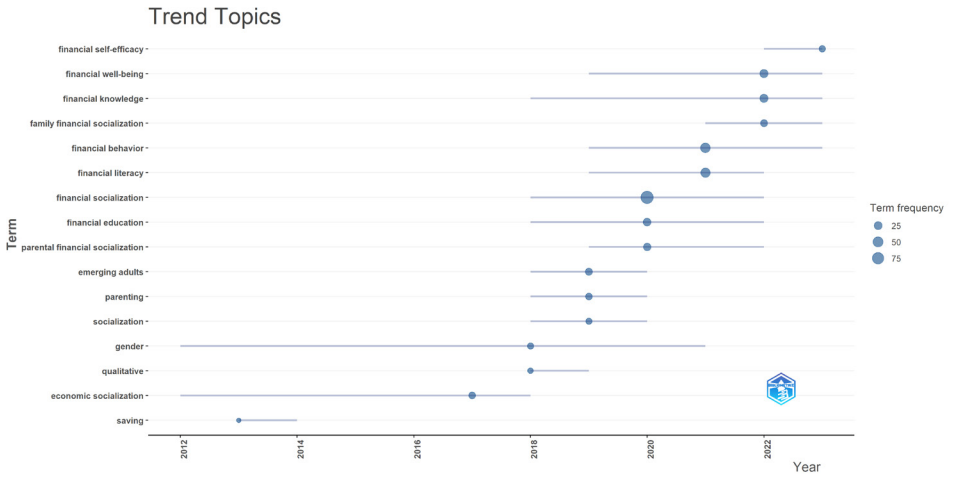

Figure 11. Trend topics

Source: own study in the R environment, using the Bibliometrix package.

ly over a longer period, while the phrase "financial socialization" showed a higher intensity of occurrence within a shorter timeframe. In general, researchers in earlier years focused on economic socialisation and later narrowed the scope to financial socialisation, which subsequently led to a focus on financial education and knowledge, ultimately concentrating on individuals' sense of financial efficacy and well-being.

The evolution of research on economic and financial socialisation over the studied years was also analysed, revealing shifts in topic popularity (Figure 12). During 1971–2012, thematic concentration was observed as authors focused on introducing the fundamental concepts of economic and financial socialisation. In the years 2013–2016, interest grew in more specific areas, such as parental financial socialisation, students and financial behaviours. From 2017 to 2020, dominant themes included financial well-being, financial literacy and financial capabilities with continued research on financial behaviours. In the latest publications, researchers emphasise the importance of family and parents in the financial socialisation process and continue to explore financial well-being, financial literacy and behaviours.

The analysis explores the key research directions and makes it possible to distinguish intellectual connections in the field of economic and financial socialisation. This mapping highlights the interconnectivity of topics and allows differentiation between mature research themes and emerging areas of interest. Additionally, the findings highlight significant contributions from countries such as the United States of America and reveal a focus on specific demographic groups like adolescents reaching the age of maturity and families. These insights provide a comprehensive overview of the field's development and underline its evolving and multidimensional nature.

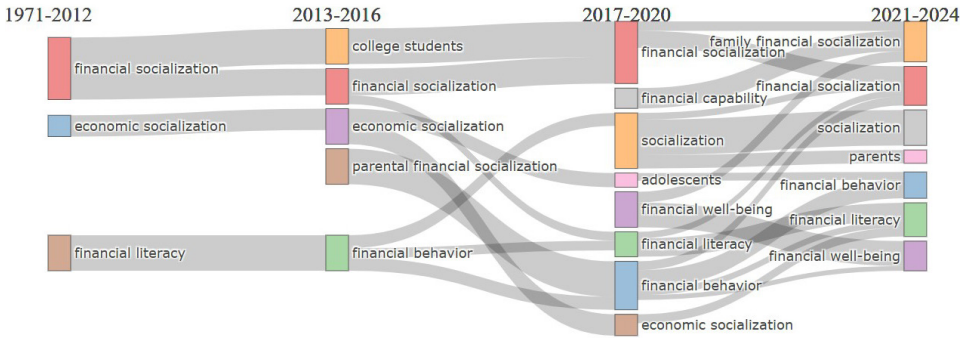

Figure 12. Thematic evolution

Source: own study in the R environment, using the Bibliometrix package.

4. Qualitative content analysis: results and discussion

This section addresses research questions Q6, Q7 and Q8. First, a comprehensive synthesis of international literature presents the field's theoretical and empirical advancements. Second, an analysis of Polish academic discourse enables comparison with international research trends and highlights unique characteristics of Polish academic discussion in this field. Finally, the review of research methodologies employed in the existing literature sheds light on dominant methodological approaches, regional particularities and potential gaps, thereby paving the way for future inquiries into this dynamic and evolving field of study.

It should be emphasised that due to the interdisciplinary nature of the concept of economic and financial socialisation, the scientific works identified in Google Scholar encompassed various research disciplines, including economics and finance, psychology and pedagogy. Researchers from different fields apply distinct approaches to the analysed topic (Raszka, 2018). The research contribution in the existing literature outlined below is drawn solely from works conducted by economists, comprising a total of 16 studies. The contribution of Polish authors are detailed in Table 4. Additionally, Table 5 lists selected research studies by international authors from the Scopus database.

The conducted content analysis encompassed 63 scientific publications selected from the Scopus and Google Scholar databases. The primary aim of the study was to identify the specific characteristics of academic discourse on economic and financial socialisation across various regions of the world, with particular emphasis on research conducted in Poland. The findings highlight the significant influence

Table 4. Overview of Polish studies on financial socialisation: methods and key findings

Source	Research method and sample	Research contribution
Roszkowska-Hołysz (2018)	A retrospective survey study involved 72 adults from three voivodeships.	Active parental involvement in economic socialisation not only facilitates easier control of expenditures later in life but also increases children's propensity to save.
Swacha-Lech & Solarz (2019)	A CAWI survey among 800 individuals aged 15–50 years, using the CART algorithm; review and analysis of the literature, as well as a descriptive method.	Key parental actions include the transfer of knowledge and skills regarding expenditure planning and money management by parents/guardians; encouraging saving and offering pocket money for performing household chores; analysis of the property financial behaviour in the context of managing household budget.
Swacha-Lech (2019)	A CAWI survey among 1,100 individuals, using the CART algorithm; review and critical analysis of the literature, as well as a descriptive method.	Pocket money is an instrument commonly used by parents in Poland in the process of financial socialisation.
Roszkowska-Hołysz & Gąsiorek-Kowalewicz (2020)	A direct interview using a questionnaire survey among 115 students of the University of Zielona Góra, aged 18–25; analysis of correlation, chi-square independence test and Cramér's V.	Active economic socialisation within the family fosters saving behaviours among adolescents. Place of residence does not influence the tendency to save.
Krzeszowska (2017)	Direct interview using a questionnaire survey among 185 individuals aged 16 from the Podkarpackie Voivodeship.	Girls learn to manage money faster than boys. High school students often handle their finances intuitively, motivated primarily by financial security.
Kowalczyk & Chudzian (2015)	A diagnostic survey using a questionnaire among 100 students from Warsaw.	The issue of established attitudes toward money often serves as a source of both social and economic problems. The two dominant (and opposing) attitudes are rational and wasteful. Men are more likely to exhibit the rational attitude, while women more often display the wasteful one.

Source: own study.

of regional determinants, underscoring the necessity of deepening analyses in the context of cultural differences, and improving the representativeness of research samples. The reviewed studies reveal notable research gaps, which may serve as a foundation for further investigations into the phenomenon of financial socialisation in a globalised context.

Table 5. Overview of international studies on financial socialisation: methods and key findings

Source	Area	Research method and sample	Research contribution
Xolile (2023)	Eastern Cape, Africa	A survey study among 360 students; regression analysis, t-tests, exploratory factor analysis (EFA) and Cronbach's alpha tests were utilised in the study.	Family structure has a significant influence on financial socialisation techniques and financial behaviour. Financial socialisation techniques mediate the influence of family structure and behaviour.
Damian et al. (2019)	Romania, Europe	A cross-sectional study was conducted involving 143 parent-child pairs (young adults); correlation analysis and hierarchical regression analysis.	Healthy financial behaviours in young adults were linked to earlier financial socialisation patterns by parents, including parents' own healthy financial behaviours and their monitoring of spending habits during adolescence. Current parental financial socialisation had less impact on young adults' financial behaviours. Parental financial socialisation influenced both financial behaviours and financial satisfaction in young adults.
Lep et al. (2022)	Slovenia, Europe	A mixed-methods study through an online survey among 515 students and one of their parents; chi-square tests, Kendall's tau correlation coefficient and logistic regression analysis.	Parents are more likely to save for retirement, while students save for financial independence. Students are more inclined to save when their parents also save. Female students save more frequently than male students. Among parents, those with higher financial status save more often. Direct financial education and parental monitoring were significant predictors of saving among students.
Robertson-Rose (2020)	UK, Europe	A mixed-methods approach, incorporating an exploratory method based on 25 qualitative interviews and Mill's Method of Difference (MMD).	Parents influence their children's retirement decisions primarily through general behavioural modelling and financial examples passed down to them. Many respondents recognised a link between their parents' behavioural patterns and their own decisions regarding saving. Men most frequently seek financial advice from their fathers, while women tend to turn to their mothers, particularly in cases where their mothers had limited retirement savings.

cont. Table 5

Source	Area	Research method and sample	Research contribution
Salumintao & Cinches (2019)	Philippines, Asia	An exploratory design using in-depth interviews, observations and three questionnaires. The research sample consisted of 641 students; Likert scale, multiple regression analysis and Structural Equation Modeling (SEM).	Financial knowledge and financial socialisation agents demonstrated a significant impact on students' financial practices. Regression analysis revealed that these variables accounted for 33% of the variance in students' personal financial practices, with financial knowledge having a greater influence than socialisation agents.
Anthony et al. (2022)	Malaysia, Asia	A questionnaire survey among 400 individuals aged 18–29; mediation testing using the bootstrap method with 1,000 samples, as well as multi-group Structural Equation Modeling (SEM) analysis.	Financial socialisation has a significant and direct impact on financial behaviour. Financial behaviour has a significant and direct impact on financial well-being. It was partially confirmed that financial behaviour mediates the relationship between financial socialisation and financial well-being. The gender of the respondents moderates the relationship between financial behaviour and financial well-being. The effect was significant for women but not significant for men.
Riaz et al. (2022)	Pakistan, Asia	A survey among 466 university students; convenience sampling method and Partial Least Square Structural Equation Modeling (PLS-SEM).	There is a significant relationship between: the attitude toward money and financial literacy; financial socialisation agents and financial literacy; financial self-efficacy and financial literacy; mindfulness and financial literacy; financial socialisation agents and financial self-efficacy; attitude toward money and financial self-efficacy. Self-efficacy plays a role in mediating the relationship between: attitude toward money and financial literacy; financial socialisation agent and financial literacy. Financial self-efficacy and attitude toward money are positively related to financial literacy, and mindfulness influences the strength of that positive relationship in students. The moderating role of mindfulness in the relationship between financial socialisation agents and financial literacy is not supported.

LeBaron (2019)	US, North America	A multi-generational semi-structured interview, involving 90 students, 17 parents and 8 grandparents.	Children learn about financial giving from their parents through three main forms: charitable donations, acts of kindness and investments in the family. These practices aim to transmit the values and significance of intergenerational giving, reflecting the participants' intentions to sustain and cultivate this value in future generations.
LeBaron et al. (2018)	US, North America	A semi-structured interview with 126 students; Nvivo 11 software.	Four main themes were identified regarding Millennials' plans for teaching their future children about finances: the process of saving, open communication about family finances, opportunities for responsibility, including experiential learning, and the value of hard work, including work ethic.
Jorgensen & Savla (2010)	US, North America	The Financial Knowledge of Students Questionnaire (CSFLS) along with Structural Equation Modeling (SEM).	The perceived influence of parents did not have a significant impact on students' financial knowledge but had a moderate and direct impact on students' financial attitudes. The effect of perceived parental influence and financial knowledge on financial behaviours was mediated by financial attitudes. Higher financial knowledge was significantly associated with more positive financial attitudes.
Kim & Torquati (2019)	US, North America	An online survey among 585 students aged 19–32. Descriptive analysis, correlation, factor analysis and path analysis using SPSS and Mplus.	Students' perceptions of parental financial behaviours influence their own financial behaviours, mediated by their financial attitudes. Parental avoidance of financial discussions weakens the relationship between parental financial behaviours and students' financial attitudes, while openness strengthens it. A conversation-oriented communication pattern enhances financial attitudes and strengthens the link between parental and student financial behaviours, whereas a conformity-oriented pattern has the opposite effect.

Source: own study.

The primary direction for future research in the field of economic and financial socialisation should involve studies conducted on a representative sample and within a longitudinal approach. It would also be valuable to extend the research to include other agents of socialisation, such as peers, schools and social media, as well as to thoroughly analyse the causes of differences observed between genders, age groups and places of residence. Future research should focus on several key aspects. First, it is important to assess how pocket money affects both the propensity to save and the total amount of savings. Second, we need to identify which combination of pocket money-related instruments is most effective in increasing savings behaviour when used alongside pocket money. Third, research should evaluate how modern technologies influence the financial socialisation of young adults. Conducting these studies while accounting for cross-cultural differences would also be valuable. Furthermore, comparing the perspectives of parents and their children in financially stable and unstable societies is recommended. Finally, the concept of economic and financial socialisation is subject to several definitional and conceptual limitations. The terms are often used inconsistently, leading to ambiguity in theoretical framing and empirical application. Moreover, the scope of socialisation – whether it includes only childhood learning or extends across the life course – varies across studies. In conclusion, economic and financial socialisation is undoubtedly a field that, due to its high social relevance, merits further exploration.

Conclusions

This research focuses on identifying the current status of research and latest developments in the area of economic and financial socialisation through quantitative and qualitative bibliometric analysis. The field has gained particular importance in contemporary society, where individuals are required to make complex financial decisions in an environment offering essentially costless and easy entry to advanced financial tools and sophisticated financial products. Additional challenges include facing the rapid development of technology and high volatility, uncertainty and ambiguity. This is associated with challenges that require a high level of financial competence. Effective financial socialisation is therefore crucial not only for the well-being of individuals but also for the stability of the entire economy.

The quantitative and qualitative literature review has allowed us to contribute to the knowledge of research on economic and financial socialisation:

1. The analysis helped to understand the temporal evolution and scholarly influence of this research field. The temporal evolution of research on economic

and financial socialisation was slow until 2010, with only 30 articles published over nearly four decades. A sharp increase followed, with 215 articles appearing between 2010 and 2024. The peak years were 2023 and 2020, reflecting growing academic interest. This rise reveals the field's expanding relevance and dynamic development. Foundational works from earlier periods still receive high citation counts. Meanwhile, recent publications are steadily building their scholarly impact (refers to Q1).

2. The study provided a detailed picture of intellectual leadership in the field. It is primarily concentrated among a few key researchers: Ashley B. LeBaron who stands out as the most prolific author with 18 publications, while Joyce Serido and Soyeon Shim emerge as the most frequently cited scholars, indicating their central influence in shaping the discourse. Importantly, the United States of America is the most frequently cited country, underscoring its dominant role in advancing the field's knowledge base (refers to Q2).
3. The research revealed the core thematic areas and knowledge flows within the literature on economic and financial socialisation, identifying three main research streams: core concepts like financial socialisation, literacy and education; outcomes such as financial behaviour and well-being; as well as contextual factors including age, family and gender. These clusters show how demographic and educational influences shape financial attitudes and behaviours (refers to Q3).
4. The analysis showed the relationships between research topics and identified distinct thematic clusters, including strong interconnections around financial socialisation, which is closely linked to financial behaviour, literacy and education. These core concepts are further connected to factors such as age, family and parental influence, as well as regional contexts and emerging themes like financial inclusion and autonomy. The network highlights the field's interdisciplinary and interconnected nature, providing a systematic understanding of how various concepts and research areas in economic and financial socialisation are related (refers to Q4).
5. The analysis of thematic trends in economic and financial socialisation research reveals a clear evolution from foundational concepts to more specialised and nuanced areas. Early studies (1971–2012) predominantly focused on introducing the basic frameworks of financial and economic socialisation. From 2013 to 2016, the research landscape expanded to include themes such as parental financial socialisation, financial behaviour and specific populations like college students. In recent years (2017–2024), emerging directions emphasise the role of family and parents, financial capability and financial well-being, reflecting a growing interest in individual experiences and contextual influences. This thematic shift underscores the dynamic nature of the field and its progression toward a more comprehensive understanding of financial development across different life stages (refers to Q5).

6. International literature on economic and financial socialisation presents a comprehensive synthesis of theoretical frameworks and empirical findings, highlighting the critical role of parental influence, family structure and financial socialisation agents in shaping financial knowledge and behaviour (refers to Q6).
7. Polish literature on economic and financial socialisation focuses on the role of family, particularly parental influence, in shaping children's and adolescents' financial behaviours and attitudes. Key research topics include the transfer of financial knowledge through practical actions such as offering pocket money, encouraging saving and involving children in household budgeting. Studies also explore gender differences, with findings indicating that girls may develop financial management skills earlier than boys. Additionally, Polish research highlights distinct attitudes toward money – rational versus wasteful – often influenced by gender. These contributions align with international trends while emphasising the practical and value-based aspects of financial education in the Polish context, reflecting a unique focus on family-driven financial socialisation processes (refers to Q7).
8. The existing literature on economic and financial socialisation employs a diverse range of research methods, including surveys, diagnostic questionnaires, interviews, mixed-methods approaches and advanced statistical techniques such as Structural Equation Modeling (SEM) and regression analysis. These methods have been applied across various regional contexts, revealing both shared patterns and unique socio-cultural dynamics (refers to Q8).

This research on financial and economic socialisation contributes to the development of tools and strategies that support the development of financial competencies from an early age, making individuals' decisions more responsible, thoughtful and beneficial both to themselves and to society as a whole. Such research also provides a foundation for identifying ways of acquiring skills for effective financial decision-making and enhancing self-efficacy.

Despite the systematic approach adopted in this study, multiple challenges emerged during this investigation that deserve critical consideration. One significant limitation stems from an incomplete access to scientific works on economic and financial socialisation due to paid resources or publishing restrictions. Additionally, relying solely on academic papers available in the Scopus and Google Scholar databases constitutes another methodological constraint. Exploring other databases, such as Web of Science, could provide a more comprehensive understanding of the available literature. Furthermore, future research should consider conducting a bibliometric analysis focused on the concept of consumer socialisation, which was not examined in the present study. This is an intriguing area that warrants further exploration and has the potential to provide valuable insights.

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Credit card fraud detection and risk management strategies: A deep learning-based approach for EU banks

Habib Zouaoui[1] **Meryem-Nadjat Naas**[2]

Abstract

This study explores supervised ML-DL based approaches for enhancing credit card fraud detection and improving financial risk management systems for EU banks. This research proposes an ensemble method based on majority voting (Hard Voting Classifier) of deep learning models to detect fraud transaction. Artificial Neural Network (ANN), Convolution Neural Network (CNN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU) have been used as deep learning models. First, the most significant features that affect the type of transaction (fraud or not fraud) have been selected. After that, the ML-DL models were applied. The performance of the proposed approach is tested using a confusion matrix, recall, precision, F-measure and accuracy. The proposed method is tested using accurate data that consists of 540,099 transactions recorded in Kaggle repository dataset of two days based on European card holder for September, 2023. The result shows that the Random Forest (RF) model detected anomalies with 99.99% accuracy, F1-score with 1.00, and excellent recall with 99.99%. As a result, the machine learning model based on RF approach shows promise as a real-time anomaly detection method with high performance and low computational cost.

Keywords

- credit card
- fraud detection
- deep learning
- risk management
- EU banks

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[1] University of Relizane, Cité Bourmadia, W. Relizane BP 48000, Algeria, corresponding author: habib.zouaoui@univ-relizane.dz

[2] University of Relizane, Cité Bourmadia, W. Relizane BP 48000, Algeria, meryemnadjat.naas@univ-relizane.dz

Introduction

Artificial Intelligence and Machine Learning are revolutionising fraud detection in banking and financial institutions. Leveraging sophisticated algorithms, these technologies analyse vast datasets to identify patterns indicative of fraudulent activities. Machine learning models continuously learn and adapt, enhancing their accuracy over time. By automating the detection process, AI minimises false positives and accelerates the identification of suspicious transactions. This proactive approach not only safeguards financial assets but also ensures a more efficient and secure environment for both institutions and customers, bolstering the resilience of the financial sector (Kolli et al., 2023). Whereas, the identification of fraudulent transactions has become a major factor affecting the greater utilisation of electronic payment. As a result, efficient and effective methods for detecting fraud in credit card transactions are demanded. Realistically, Credit card fraud has become a significant challenge for banks in the European Union. The projected credit card fraud losses between 2020 and 2025 reflect the ongoing challenges that the banking sector faces in dealing with financial fraud risks. However, in the period between 2020–2021, the EU witnessed a notable surge in card-not-present (CNP) fraud, exacerbated by the COVID-19 pandemic, which drove more consumers to online shopping. In 2020, card fraud losses amounted to approximately €1.5 billion across the EU, and it has increased to around €1.7 billion due to a continued rise in online fraud and e-commerce activities (*Nilson Report*, 2020). In 2022–2023, the growth of digital wallets, mobile payments and cross-border fraud continued to fuel fraud risks. It was estimated at €1.8 billion in 2022 (ECB, 2023), with CNP fraud accounting for 80% of total losses (Buzzard, 2022). In 2023, it was projected to exceed €2 billion, driven by the increasing adoption of instant payments, mobile wallet vulnerabilities and AI-powered fraud techniques (Detura et al., 2022). Furthermore, between 2024 and 2025, despite increasing security measures, fraud risks are expected to rise even further as new technologies like cryptocurrencies and real-time payments gain traction. Moreover, they were expected to reach €2.2 billion in 2024 due to higher transaction volumes in instant payments, AI-driven fraud and cross-border fraud. In 2025, these losses are forecast to exceed €2.5 billion, fuelled by the rise in synthetic identity fraud, cryptocurrency fraud and SIM swapping (ECB, 2025).

In order to minimise fraud losses, the development of advanced techniques and technologies has become essential for detecting and preventing fraudulent activity while effectively managing associated risks. Moreover, financial fraud detection and risk management are evolving rapidly with advancements in AI and ML. By leveraging deep learning and advanced techniques, organisations can significantly reduce fraud losses and improve operational efficiency. Financial fraud

detection and risk management are critical areas in the financial industry, aimed at identifying fraudulent activities and mitigating associated risks. Over the years, advancements in technology, particularly in Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL), have revolutionised these fields (Chaudhari & Kaur, 2025).

Therefore, the key challenges in this domain include handling imbalanced datasets, ensuring real-time detection and maintaining data privacy. To address these challenges, we discuss emerging trends such as federated learning, reinforcement learning and self-supervised learning, which enable secure, low-latency and scalable fraud detection systems. Furthermore, this literature review explores the evolution of fraud detection techniques, the challenges faced and the advancements made in recent years. The review is structured around such key themes as traditional methods, machine learning approaches, deep learning techniques and emerging trends.

In this study, we aim to test the following hypothesis (H1): Deep Learning (DL) models provide more accurate fraud risk management for credit card transactions than traditional Machine Learning (ML) models. The central research question is: which of the two approaches, i.e. Machine Learning models (Logistic Regression, Support Vector Classifier (SVC), Decision Tree Classifier, Random Forest Classifier, K-neighbor Classifier (KNN)) or Deep Learning models (LSTM, GRU, ANN, RNN, CNN), offers superior performance in managing credit card fraud risk?

1. Credit card fraud and risk management

Credit card fraud and risk management in EU banks involves a combination of advanced technologies, regulatory compliance and customer-centric strategies to detect, prevent and mitigate fraudulent activities. The European Union (EU) has a robust regulatory framework that governs data protection, payment security and consumer rights, which significantly influences the ways in which banks manage fraud risks. Below is a detailed overview of credit card fraud risk management in EU banks (BIS, 2024):

1. Regulatory Compliance: EU banks must adhere to strict regulations designed to protect consumers and ensure secure payment systems such as:

- Payment Services Directive 2 (PSD2): requires strong customer authentication (SCA) for online transactions, reducing the risk of fraud,
- General Data Protection Regulation (GDPR): ensures the secure handling of personal data and imposes heavy penalties for data breaches,

- Anti-Money Laundering (AML) Directives: mandate monitoring and reporting of suspicious transactions to prevent money laundering and terrorist financing.

2. Strong Customer Authentication (SCA): PSD2 mandates SCA for most electronic payments, which involves:

- Two-Factor Authentication (2FA): requires at least two of the following: something the customer knows (e.g. password or PIN), something the customer has (e.g. mobile device or card reader), something the customer is (e.g. fingerprint or facial recognition),
- Dynamic Linking: ensures that the authentication code is uniquely linked to the transaction amount and recipient.

3. Advanced Fraud Detection Technologies; EU banks leverage cutting-edge technologies to detect and prevent fraud:

- Real-Time Transaction Monitoring: uses AI and machine learning to analyse transactions in real time and flag suspicious activities,
- Behavioural Analytics: monitors customer behaviour to identify deviations from normal spending patterns,
- Geolocation Tracking: verifies the location of the cardholder and compares it to the transaction location,
- Risk Scoring Models: assigns risk scores to transactions based on factors such as transaction amount, location and merchant category.

4. Data Security and Encryption; EU banks prioritise the protection of sensitive cardholder data:

- End-to-End Encryption (E2EE): encrypts data during transmission and storage to prevent unauthorised access,
- Tokenisation: replaces sensitive card data with unique tokens to reduce the risk of data breaches,
- PCI DSS Compliance: adheres to the Payment Card Industry Data Security Standard (PCI DSS) to ensure secure handling of cardholder information.

5. Collaboration and Information Sharing; EU banks collaborate with other financial institutions, card networks and law enforcement agencies to combat fraud:

- Fraud Data Sharing: shares fraud-related data and trends to identify emerging threats,
- European Banking Federation (EBF): participates in industry initiatives to develop best practices for fraud prevention.

6. Customer Education and Awareness; EU banks educate customers on how to protect themselves from fraud:

- Fraud Prevention Tips: provide guidance on safeguarding card information and recognising phishing attempts,
- Real-Time Alerts: send notifications for suspicious transactions to keep customers informed.

7. Incident Response and Recovery; EU banks have robust incident response plans to address fraud incidents:

- Fraud Investigation Teams: dedicated teams investigate flagged transactions and confirm fraud cases,
- Customer Notification: notifies affected customers and provides guidance on securing their accounts,
- Chargeback Management: handles chargebacks efficiently to minimise financial losses.

8. Key Metrics for Fraud Risk Management; EU banks monitor key metrics to assess the effectiveness of their fraud risk management strategies:

- Fraud Detection Rate: percentage of fraudulent transactions detected,
- False Positive Rate: percentage of legitimate transactions flagged as fraudulent,
- Chargeback Rate: number of chargebacks as a percentage of total transactions,
- Average Time to Detect Fraud: time taken to identify and respond to fraud incidents.

Finally, the BIS Innovation Hub explores the use of artificial intelligence (AI) to support central banks and supervisors in their missions. So far, eight projects have employed AI methods, including: Ellipse, Aurora, Gaia, Symbiosis, Raven, Neo, Spectrum and Insight. They cover a wide range of use cases from information collection and statistical compilation, payments oversight and supervision, as well as macroeconomic and financial analysis to monetary policy analysis These projects draw on both in-house expertise and that of external providers.

We will analyse the effectiveness of traditional rule-based systems versus modern AI-driven approaches, highlighting the growing adoption of hybrid models, federated learning and behavioural biometrics to enhance detection accuracy while ensuring compliance. Key findings reveal that Card-Not-Present (CNP) fraud accounts for the majority of cases (73%), while synthetic identity fraud and authorised push payment (APP) scams are emerging as significant and growing threats. The study also identifies critical gaps, such as fragmented fraud data across EU member states and the trade-off between model explainability and performance. However, in order to address these challenges, we will propose a regulatory-aligned AI framework combining lightweight ML models, real-time anomaly detection and cross-border data collaboration. Our recommendations emphasise the need for standardised fraud datasets, privacy-preserving techniques and scalable risk man-

agement strategies tailored to EU banking ecosystems. This research contributes to the ongoing discourse on securing digital payments while fostering innovation in financial risk mitigation (Vadisena et al., 2024).

2. Literature review

Table 1 presents a structured analysis of recent studies (2020–2025) using Deep Learning (DL) models for credit card fraud detection, including a quantitative breakdown of model popularity and performance metrics.

Table 1. Reviewed previous studies

Author(s) and year	Study title	Methodology	Reported accuracy	Key findings
Moturi et al. (2024)	Optimizing credit card fraud detection using deep learning by smote-enn technique	Robust deep-learning approach using LSTM-GRU models with the SMOTE-ENN method versus ML classifiers.	99.7% (recall)	The experimental results showed that combining the proposed deep learning ensemble with the SMOTE-ENN method is superior to other widely used ML classifiers.
Chidananda (2025)	Deep learning for fraud detection in financial transactions using CNN-LSTM hybrid and GRU Model	Hybrid deep learning model combining CNN-LSTM and CNN-GRU.	88.85% (accuracy), 85.39% (recall), 88.30% (F1-Score)	Hybrid deep learning model with CNN-LSTM better than alternative CNN-GRU models.
Chaudhari et al. (2025)	Enhancing global banking security: A novel approach integrating federated learning and CNN-GRU for effective anti-money laundering measures	Anti-Money Laundering (AML), Federated Learning, Privacy-Preserving, Intrusion Detection, Hybrid CNN-GRU Model.	98.7% (accuracy)	The proposed method offers a scalable and effective solution for the global banking sector. It also surpasses traditional techniques in terms of security and efficiency in the battle against money laundering in the emerging financial scenario.

cont. Table 1

Author(s) and year	Study title	Methodology	Reported accuracy	Key findings
Tayebi & El Kafhali (2025)	A novel approach based on XGBoost classifier and Bayesian optimisation for credit card fraud detection	This study proposes an enhanced XGBoost algorithm for detecting fraudulent transactions using an intelligent technique that tunes the hyperparameters of the algorithm through Bayesian optimisation.	99.96% (accuracy), 87.40% (recall) 98.79% (F1-AUC)	For Data 1, the best performance was obtained using SMOTE. For Data 2, the random under-sampling technique yielded the highest performance.
Mienye & Swart (2024)	A hybrid deep learning approach with generative adversarial network for credit card fraud detection	Hybrid deep learning framework that integrates Generative Adversarial Networks (GANs) with Recurrent Neural Networks (RNNs) versus LSTM-GRU.	99.2% (recall)	This work highlights the potential of GANs combined with deep learning architectures to provide a more effective and adaptable solution for credit card fraud detection.
Sulaiman et al. (2024)	Credit card fraud detection using improved deep learning models	Three deep learning models, i.e. AutoEncoder (AE), Convolution Neural Network (CNN), and Long Short-Term Memory (LSTM), are proposed to investigate how hyperparameter adjustment impacts the efficacy of deep learning models used to identify credit card fraud.	Accuracy (99.2%), detection rate (93.3%), and area under the curve (96.3%)	The results demonstrate that LSTM significantly outperformed AE and CNN.
Wahab et al. (2024)	Credit card default prediction using ML and DL techniques	Evaluates the efficacy of a DL model (ANN) and compares it to other ML models, such as Decision Tree (DT) and AdaBoost.	Accuracy (82%)	The evaluation indicates that the AdaBoost and DT exhibit the highest accuracy rate of 82% in predicting credit card default, surpassing the accuracy of the ANN model, which is 78%.

Source: authors' analysis based on literature review (2025).

Several research works have proposed different methods in tackling credit card fraud. From Regression, Random Forest and KNN to Neural networks. Ghosh and Reilly (1994) were the first to apply neural networks for fraud detection. They used a large sample of labelled credit card transactions to train half a dozen neural networks, which was then validated on validation data consisting of account activities over a two-month period. Lost or stolen cards, application fraud, counterfeit fraud, mail-order fraud and NRI (non-received issue) fraud were all utilised to train the neural network (Misra et al., 2020). Brause et al. (1999) used association rule mining and neural networks to reduce the false positive rate in their study. Several supervised and unsupervised machine learning and optimisation algorithms have been used to detect credit card fraud in recent years. Therefore, the above table is a summarised comparison of the results from recent studies (2022–2025) on credit card fraud detection using deep learning models versus machine learning algorithms. These results highlight the key findings and performance metrics from the studies. Effectively, the choice between ML and DL depends on the dataset size, data complexity and real-time requirements of the fraud detection system. ML works well for traditional fraud detection in smaller datasets, while DL is suited for large, complex datasets, where deep pattern recognition and higher accuracy are needed.

3. Materials and methods

3.1. Definitions

Table 2 below presents a summary of the definitions, **mathematical formulation**, key components and descriptions of deep learning algorithms used in our research, including LSTM, CNN, GRU, RNN, ANN and the KNN model.

Table 2. Definitions, mathematical formulation, key components and descriptions of deep learning algorithms

Model	Definition	Mathematical formulation	Key components & descriptions
LSTM (Long Short-Term Memory)	LSTM is a type of RNN that addresses the vanishing gradient problem, enabling the learning of long-term dependencies. It uses gates (input, forget,	$r_t = \sigma(W_f.[h_{t-1}, x_t]) + b_f$ $d_t = \tanh(W_d.[h_{t-1}, x_t]) + b_d$ $f_t = \sigma(W_i.[h_{t-1}, x_t]) + b_i$ $C_t = f_t.C_{t-1} + r_t.d_t$ $o_t = \sigma(W_0.[h_{t-1}, x_t]) + b_0$ $h_t = o_t \tanh C_t$	Input Gate (x_t): controls the amount of incoming information written to the cell state. Forget Gate (f_t): decides how much of the previous memory is kept.

cont. Table 2

Model	Definition	Mathematical formulation	Key components & descriptions
	and output) to control the flow of information in the network.		Output Gate (o_t): determines the next hidden state. Cell State (C_t): the long-term memory that carries information across time steps.
GRU (Gated Recurrent Unit Model)	GRU is a simplified version of LSTM, combining the input and forget gates into a single update gate. It is more efficient and works well for learning long-term dependencies with fewer parameters.	$z_t = \sigma(W_z.[h_{t-1}, x_t]) + b_z$ $r_t = \sigma(W_r.[h_{t-1}, x_t]) + b_r$ $\hat{h}_t = \tanh(W_h.[r_t.h_{t-1}, x_t] + b_h)$ $h_h = (1 - z_t).h_{t-1} + z_t.\hat{h}_t$	Update Gate (z_t): controls the amount of previous memory retained. Reset Gate (r_t): decides how much of the past hidden state is discarded. Candidate Hidden State (h_t): a potential new hidden state.
RNN (Recurrent Neural Network)	RNNs process sequential data by maintaining a hidden state that is updated with each time step based on the current input and the previous hidden state. They suffer from vanishing gradients with long sequences.	$h_t = \sigma(W_{hh}.h_{t-1} + W_{xh}x_t + b)$	Hidden State (h_t): the memory of the previous time steps. Weight Matrices (W_{hh}, W_{xh}): used to transform the input and hidden state to compute the next hidden state.
CNN (Convolutional Neural Network)	A Convolutional Neural Network (CNN) is a deep learning model specifically designed for processing structured grid data, such as images. It uses convolutional layers to automatically and adaptively learn spatial hierarchies of features from input data.	1. Convolution Operation: $(I \cdot K)(i \cdot j) = \sum_m \sum_n I(i - m, j - n).K(m, n)$ 2. Activation Function: $A = f(Z)$, where $Z = W \cdot X + b$ 3. Pooling Operation: $P(i, j) = \max_{m,n}(X(i.s + m, j.s + n))$ 4. Fully Connected Layer: $y = f(W.X + b)$ 5. Output Layer: $\text{Softmax}(z_i) = \frac{e^{z_i}}{\sum_j e^{z_j}}$ 6. Loss Function: $\text{Loss} = -\sum_i y_i \log(\hat{y}_i)$ 7. Backpropagation: $W = W - \eta \frac{\partial \text{Loss}}{\partial W}$	Convolutional Layers: apply filters to detect local features (edges, textures). Pooling Layers: reduce dimensionality to retain important features while improving efficiency. Fully Connected Layers: use output from convolutional layers for classification or regression.

cont. Table 2

Model	Definition	Mathematical formulation	Key components & descriptions
ANN (Artificial Neural Network)	ANN is a network of interconnected neurons used for supervised learning tasks. It consists of layers of nodes (neurons), where each node represents a mathematical function.	1. Neuron Computation: $z = \sum_{i=1}^{n} w_i x_i + b$, $a = f(z)$ 2. Forward Propagation: – compute activations layer by layer. 3. Loss Function: – measure prediction error (e.g. MSE, cross-entropy). 4. Backpropagation: – compute gradients and update weights and biases.	Input Layer: takes the input features. Hidden Layers: layers that apply non-linear transformations to the input data. Output Layer: produces the final predictions (classification or regression).

Source: Bolton & Hand (2002); Naas & Zouaoui (2024); Zareapoor & Shamsolmoali (2015); Zouaoui & Naas (2023).

3.2. Data description

The study was conducted using real-world time series data from a credit card fraud dataset, obtained through a research collaboration focused on big data mining and fraud detection. The dataset was downloaded from Credit Card Fraud Detection repository on Kaggle. It contains 540,099 credit card transactions recorded over a two-day period in September 2023, involving European card holders. Among these, 270,049 transactions were labelled as fraudulent, indicating a highly imbalanced dataset. Notably, the fraud class represents approximately 50% of the total transactions, which is atypical compared to real-world distributions. The dataset includes 31 attributes, each representing different features relevant to transaction behaviour and fraud detection (Table 3).

Table 3. Description of the attributes in the credit card fraud detection dataset

N°	Columns	Data type	Description
1	Time	Numeric	Time represents the seconds elapsed between each transaction and the first transaction in the dataset.
2–29	V1–V28	Numeric	V1 to V28 are transformed using Principal Component Analysis. For security reasons, original attribute names are not disclosed.
30	Amount	Numeric	Transaction amount.
31	Class	Numeric	Binary classification: ‘1’ indicates fraud; ‘0’ indicates a legitimate transaction.

Source: own study.

3.3. Initial analysis

The attributes' properties and characteristics were carefully examined during the initial stages of the analysis. Key focuses at this stage included the distribution of variables, correlation dependencies, and uncovering data-driven insights. The data analysis was structured around three main focal criteria, which are detailed in the following subsections.

3.3.1. Univariate analysis

After inspecting the dataset for null values and verifying data types, it was found that 0% duplicate observations were present and subsequently removed. An analysis of the target variable "Class" through a count plot revealed a significant class imbalance. The number of non-fraudulent transactions was 270,050, while 270,049 were fraudulent – each comprising nearly 50% of the dataset (Figure 1). This unusual balance is atypical compared to real-world fraud detection scenarios, where fraudulent cases are usually rare. To address this, oversampling techniques will be applied in subsequent stages of the analysis to ensure the robustness of model training and evaluation (Figure 2).

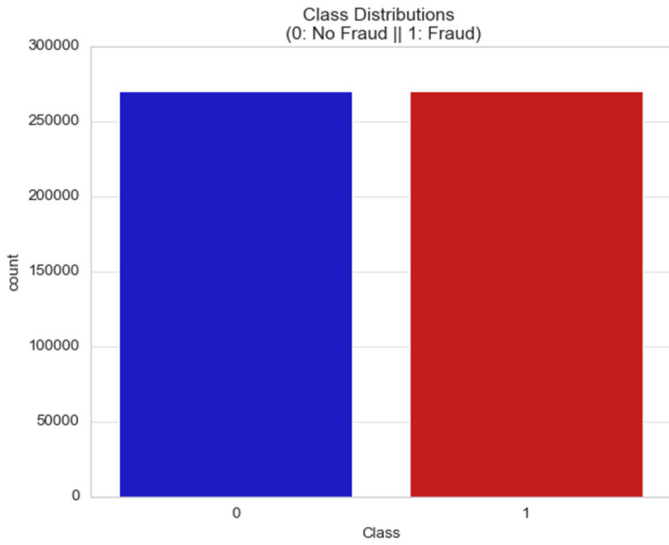

Figure 1. Distribution of Class variable

Source: based on python code GitHub.

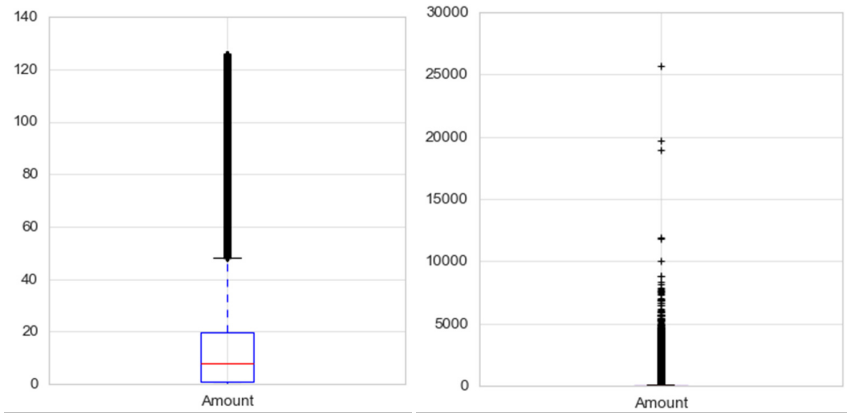

Figure 2. Anomaly detection and transformation using the Interquartile Range (IQR) method

Source: based on python code GitHub.

The Amount variable was plotted vertically, revealing that most transaction values are concentrated in the lower range, with only a few instances involving large amounts. If left unaddressed, these outliers could significantly bias the prediction performance of the fraud detection model. To mitigate this, we applied Median Imputation following the detection of anomalies. In this approach, extreme values are replaced with the median, ensuring the integrity of the distribution without the influence of outliers. The Interquartile Range (IQR), calculated using the formula IQR = Q3 − Q1, was used to identify the outliers. For the Amount feature, the IQR was computed using Python, and extreme values were adjusted accordingly. Upon re-plotting the Amount variable after this transformation, the values predominantly fall within the range of approximately $100 to $200, indicating a successful reduction of anomalies (Figure 3).

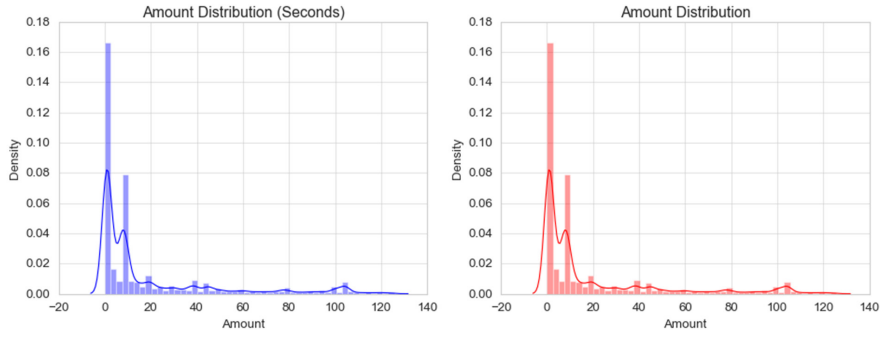

Figure 3. Time and Amount distribution plot

Source: based on python code GitHub.

From the distribution analysis of the Time and Amount features, no significant patterns were immediately evident. However, it was observed that transaction amounts close to zero exhibited the highest concentration, indicating that most transactions involve relatively small sums. In contrast, the Time variable – plotted in seconds over two consecutive days – showed a higher transaction density during daytime hours. To interpret the time feature in a more intuitive format, it can be converted to hourly intervals by dividing the values by 3600, as one hour equals 3600 seconds.

3.3.2. Bivariate analysis

A correlation heatmap was plotted to visualise the two-dimensional correlation matrix (Figure 4), assessing the pairwise relationships between all 31 attributes in the dataset. The heatmap illustrates correlation coefficients ranging from +1 (perfect positive correlation) to approximately –0.5 (moderate negative correlation), represented using a two-colour scale: red for positive correlations and blue for negative correlations. The intensity of the colour indicates the strength of the correlation, with values also displayed within each cell for reference. The analysis revealed that features V1 to V28 show little to no correlation with each other. Due to data anonymisation for security purposes, the original names and meanings of these features are not disclosed. As a result, traditional descriptive statistical analysis for these components offers limited interpretive value.

Although the correlation heatmap appears visually cluttered due to its size (it is readable in the notebook file), several key relationships can be highlighted. Notable correlations include:

- Time / V3 = –0.42
- Amount / V2 = –0.53
- Amount / V5 = –0.39
- Amount / V7 = 0.40
- Amount / V20 = 0.34

These correlations represent moderate linear relationships. Other minor correlations were observed in the range of –0.3 to 0.3, but they are not considered statistically significant for this analysis. We can conclude that Time and Amount are the most important variables.

Next, we plotted the distributions of features V1 to V28, grouped by the two target classes: Genuine and Fraud. The density is represented on the vertical axis, while the feature values are shown on the horizontal axis. The visualisation is organized into a grid layout, with four features per row and a total of seven rows,

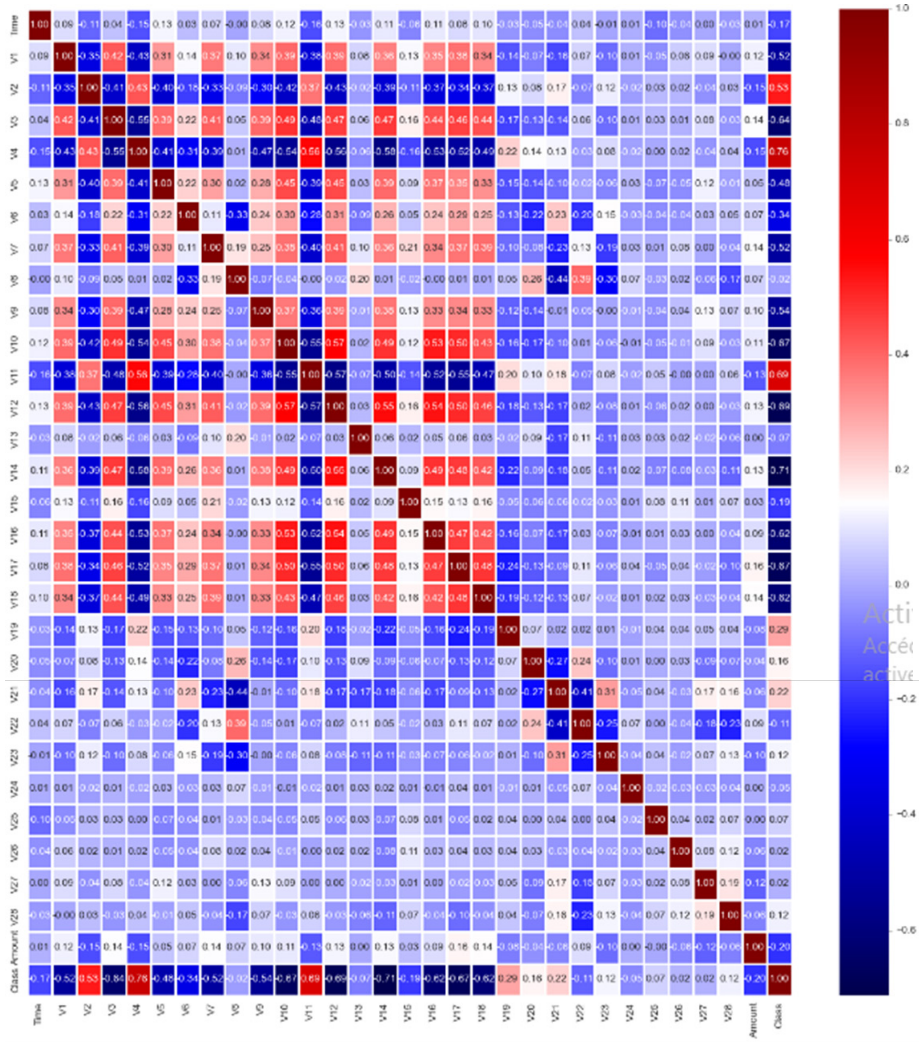

Figure 4. Correlation heatmap of the credit card fraud detection dataset

Source: based on python code GitHub.

covering all 28 principal components. The purpose of this analysis is to explore how the distributions of these features differ between the two classes, and to identify any patterns or feature behaviours that could aid in distinguishing fraudulent transactions from genuine ones.

The distributions for both classes generally resemble Gaussian bell curves, indicating normal-like behaviour across most features. However, certain features exhibit clear differences between the Genuine and Fraud classes. Specifically, features

V3, V9, V10, V12, V14, V16, V17 and V18 show a higher probability of negative or lower values for fraudulent transactions compared to genuine ones. In contrast, features V4 and V11 display the opposite trend, where fraudulent transactions tend to have higher values. The remaining features appear to have similar distributions across both classes, offering limited discriminatory power.

It is worth noting that due to anonymisation for privacy and security reasons, the original names and meanings of these features are unavailable. Had the features been properly labelled, these distributional differences could have provided even more valuable insights for fraud detection.

Next, we analysed the distribution of the Amount feature across the two classes – Genuine and Fraud – to investigate patterns in transaction values (Figure 5). The plot clearly indicates that fraudulent transactions are predominantly associated with very small amounts. One plausible explanation is that fraudsters intentionally use low-value transactions in an attempt to remain undetected by the account holder or financial institution. In many cases, individuals may overlook minor debits, assuming they are routine charges such as bank fees, interest adjustments or service costs. This tactic reflects a subtle and strategic form of deception, often referred to as the "art of forgery" in fraud detection literature (Chidananda, 2025).

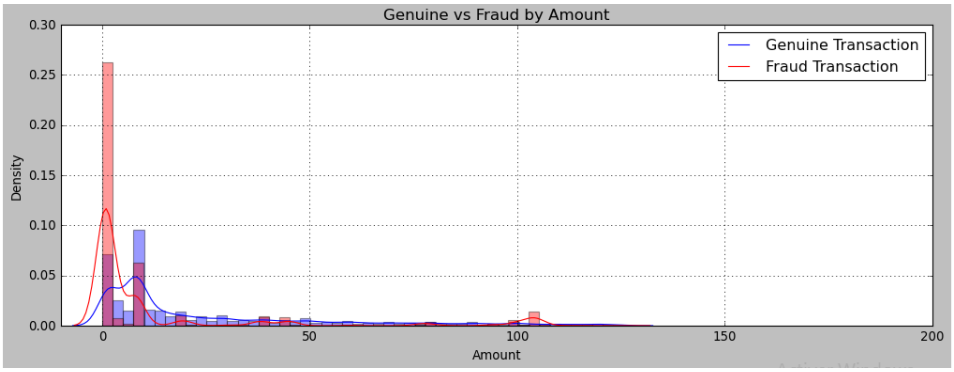

Figure 5. Distribution of Amount by Class label

Source: based on python code GitHub.

Furthermore, we observed that the Amount distributions for genuine and fraudulent transactions are quite similar after anomaly reduction. This suggests that transaction amount alone is not a reliable predictor of fraud, as both classes exhibit overlapping value ranges. In addition, we plotted the two classes against the Time variable to examine temporal patterns. The resulting graph shows that both classes are similarly distributed across the time axis. The Time feature represents the number of seconds elapsed since the first transaction, and the dataset cov-

ers a two-day period. Each day consists of 86,400 seconds, allowing for the conversion of time values into hourly intervals using the formula: (86400/(60 · 60)). For instance, a time value of 50,000 seconds corresponds to approximately 13:00 (1:00 PM). From this analysis, we can infer that transaction frequency tends to peak around midday, particularly near 12:00 PM, for both genuine and fraudulent activities.

3.3.3. Multivariate analysis

To better visualise the class imbalance, a scatter plot was generated to display the distribution of class instances (Figure 6). Genuine transactions were plotted as the majority class, while fraudulent (minority) instances were displayed with five times more visual weight to enhance their visibility on the graph. This scaling was applied solely for visualization purposes and does not affect the data distribution.

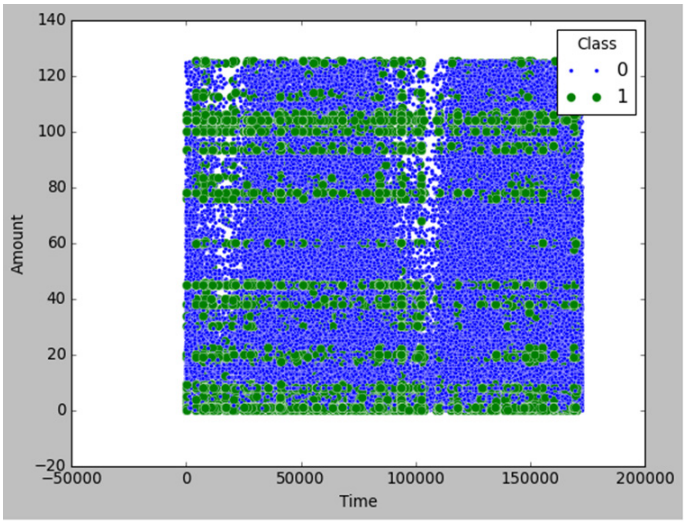

Figure 6. Scatter plot of Class in terms of Amount and Time

Source: based on python code GitHub.

In the scatter plot, the Amount variable is plotted on the vertical axis, while Time is represented on the horizontal axis. Blue dots indicate genuine transactions, whereas green dots represent fraudulent ones. The plot reveals that most fraudulent transactions involve small amounts, often close to $0. Additionally, a noticeable concentration of fraudulent activity appears around the $20 range.

Another key observation is that fraudulent transactions tend to cluster within specific time intervals. Interestingly, the density of fraud appears to increase during periods of high overall transaction activity.

4. Results

In the first step, the data set was randomly divided into a training set (80%) and a test set (20%). Then, in order to balance the data, the following methods were used: SMOTE, random oversampling and random undersampling. Initially, there were 540,099 observations in the source set, of which only 270,049 observations were fraud transactions (Class variable equal to 1), which accounted for 50% of all observations. The training set consisted of 216,040 fraud transactions, and the test set of 54,009. The overall proposed model framework is illustrated in the diagram below, which provides a visual representation of the sequential stages involved in the fraud detection process (Figure 7).

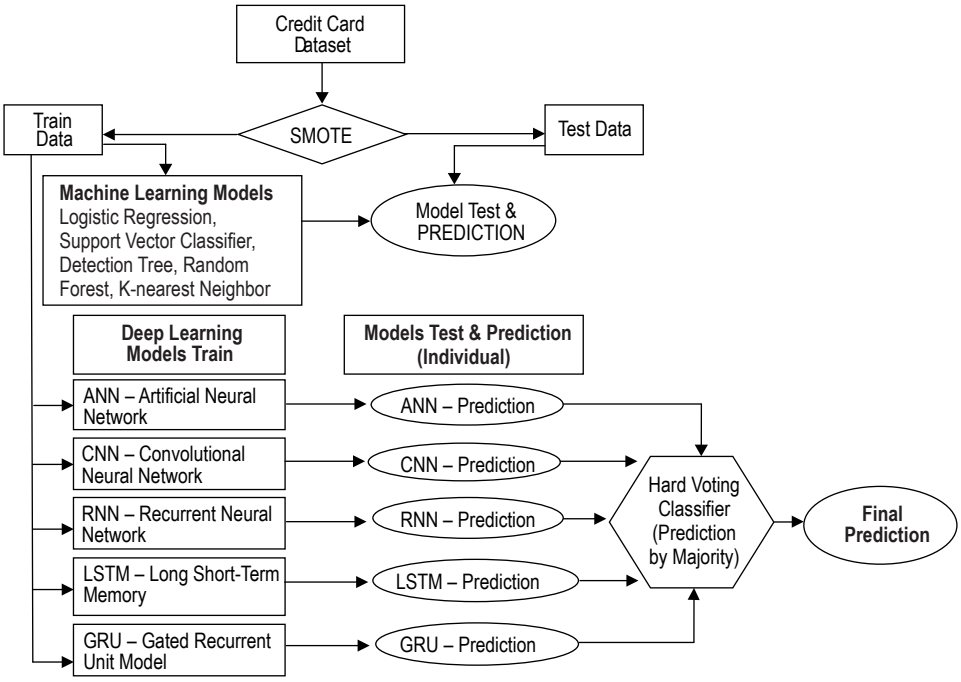

Figure 7. Proposed ensemble hard voting classifier architecture

Source: own study.

Given the high class imbalance in the dataset, balancing techniques are necessary to improve model performance and fairness. This can typically be achieved through either undersampling the majority class or oversampling the minority class. For this project, we opted to perform oversampling of the minority class to retain all valuable information in the dataset.

To address this, we applied the SMOTE (Synthetic Minority Oversampling Technique) method. SMOTE creates synthetic samples of the minority class, rather than duplicating existing ones, thereby enhancing the diversity of the training data. It operates based on the k-nearest neighbors algorithm and constructs new synthetic instances as follows (Chhabra et al., 2024):

- determine the feature vector's closest neighbour,
- calculate the distance between the two sample points,
- multiply the distance by a random number between 0 and 1,
- find a new point on the line segment at the computed distance,
- repeat the process for identified feature vectors.

After scaling the Time and Amount features to ensure uniformity in feature range, we applied SMOTE to oversample the minority class and address the dataset's imbalance. Following this preprocessing step, we evaluated the performance of five different machine learning models for classification purposes during the initial testing phase. These models were selected based on their widespread use and proven effectiveness in fraud detection tasks (Ren, 2023).

The machine learning algorithms used for initial prediction are:

- Logistic Regression,
- Support Vector Classifier (SVC),
- Decision Tree Classifier,
- Random Forest Classifier (maximum depth = 6),
- K-neighbor Classifier (KNN) (k = 5).

We created five neural networks which will be used for prediction individually. Moreover, the hyperparameters and their respective options for this paper are illustrated in Table 4.

In addition, we developed a 4-layer Artificial Neural Network (ANN) for binary classification. The network architecture includes:

- input layer: a 1D array of 30 features (i.e., one observation per transaction),
- three hidden layers: with 6, 20, and 10 units respectively, each using the ReLU activation function,
- output layer: a single neuron with a sigmoid activation function, appropriate for binary output (fraud or genuine).

Table 4. Variations of DL models involved in hyper-parameter tuning

Parameter	Options
Activation function	ReLU, Tanh, Sigmoid
Loss function	RMSE, RMSPE
Neurons	[100, 100, 100, 100, 100, 1]
Learning rate	0.001
Optimiser	Adam
Layers	2, 3, 4
Batch Size	32, 64

Note: Here, [100, 100, 100, 100, 100, 1] represents the number of neurons from the first to the last network layer.

Source: own study.

The model was compiled using binary cross-entropy as the loss function and Adam as the optimizer. For sequential data processing, we also implemented a Recurrent Neural Network (RNN) consisting of three layers: two hidden layers and one output layer. The hidden layers used 32 and 8 units respectively, again with the ReLU activation function. While the loss function remained binary cross-entropy, the RMSprop optimizer was used, which is better suited for handling temporal dependencies in sequential data.

Binary cross entropy distinguishes each of the predicted probabilities to the actual class output, which can be either 0 or 1. The score is then calculated, penalising the probabilities depending on their deviation from the predicted value. This refers to how close or far the value is to the actual value. The negative value of log of corrected predicted probabilities is binary cross entropy. Lastly, we made a hard voting classifier for final prediction. In hard voting (also known as majority voting), every individual classifier votes for a class, and the majority wins. In statistical terms, the predicted target label of the ensemble is the mode of the distribution of individually predicted labels.

Credit card fraud detection is a binary classification. To evaluate the performance of classification models, the confusion matrix is one of the most widely used and effective tools. It provides a structured layout to visualize and assess the predictive outcomes of the model. In binary classification, there are four possible outcomes during prediction:

1. True Positive (TP): the model predicts the correct true label. In our case, this refers to the number of instances where non-fraudulent transactions are correctly identified.
2. True Negative (TN): the model predicts the correct false label. That means, in our problem, the number of fraudulent transactions correctly predicted as fraud.

3. False Positive (FP): the model incorrectly predicts the true label. In the fraud detection context, this occurs when the model predicts a transaction as genuine, but it is actually fraudulent. This is the most critical area where our attention needs to be focused.
4. False Negative (FN): the model predicts a false negative label. In our problem, this means the model predicts a fraudulent transaction, but it is actually genuine. This is our next concern to address.

Mathematically, several terms were computed to summarise the overall model performance based on model prediction, including:

- Sensitivity/Recall/True positive rate, which shows the probability of true positive prediction:

$$\text{Sensitivity/Recall/TPR} = TP/(TP + FN)$$

- Specificity/True negative rate, which shows the probability of true negative prediction:

$$\text{Specificity/TNR} = TN/(TP + FP)$$

- Precision/Positive predicted value, i.e. the probability to predict a positive class among all positive classes:

$$\text{Precision/PPV} = TP/(TP + FP)$$

- Negative predicted value (NPV), which is the opposite of precision; it measures the proportion of correctly predicted negatives among all predicted negatives:

$$TN/(TN + FN)$$

- F1 score: to compute the F1 score we need to take into account both precision and recall. The F1 score can be thought of as a weighted average of the precision and recall values:

$$\text{F1 score} = 2TP/(2TP + FP + FN)$$

- Accuracy: the accuracy of a model is determined by how well it perceives correlations and patterns between variables in a dataset using the input (training) data:

$$\text{Accuracy} = (TP + TN)/(TP + FP + TN + FN)$$

- AUC: a measurement of the complete two-dimensional area beneath the entire ROC curve. ROC curve plotted by TP vertically by TN horizontally.

As we initially applied five machine learning algorithms – Logistic Regression, Support Vector Machine, Decision Tree, Random Forest, and K-Nearest Neighbors – we obtained a confusion matrix for each model. Based on these, we computed the following summary performance metrics (Table 5).

Table 5. Five Machine Learning algorithms

Model	Model Precision	Recall/Sensitivity	F1-Score	Accuracy
LR	1.00	0.9987	1.00	0.9991
SVC	1.00	0.9993	1.00	0.9995
DT	1.00	0.9979	1.00	0.9979
RF	1.00	0.9999	1.00	0.9999
KNN	1.00	0.9997	1.00	0.9998

Source: own study based on python code GitHub.

We observed that the Random Forest algorithm achieved the highest accuracy among the traditional machine learning models, reaching 0.9999. Additionally, the K-Nearest Neighbors (KNN) model also delivered strong performance. Notably, both Random Forest and KNN produced zero false positives, which is a highly desirable outcome in classification tasks – especially in fraud detection. Furthermore, the false negatives for Random Forest were relatively low, with only 15 instances, indicating the model's effectiveness in correctly identifying fraudulent transactions.

We applied five deep learning algorithms – ANN, CNN, RNN, LSTM, and GRU – for classification, followed by the implementation of a hard vote classifier, which outputs the majority prediction among these models. All neural networks were trained and evaluated simultaneously using 50 epochs to ensure consistency in training. To assess the stability and reliability of the models, we ran the classifiers four times and compared the results across runs. To visualise the performance, we generated a heatmap of the confusion matrix based on the computed values. This augmented confusion matrix provides a comprehensive view of the classification performance of each deep learning model, as well as the ensemble classifier we proposed.

The confusion matrix values were machine-scaled and color-coded for visual clarity. Among the individual deep learning models, the Convolutional Neural Network (CNN) achieved the highest accuracy, with a false positive (FP) count of 0 and a false negative (FN) value of 628. Interestingly, our ensemble hard voting classifier demonstrated a significant improvement: it misclassified only 205 transactions as false negatives – meaning the model incorrectly labelled genuine transactions as fraudulent (Table 6).

To more effectively evaluate the performance of the hard voting classifier over multiple runs, we compiled a summary table of misclassifications, including False Negatives (FN), False Positives (FP), and Total Misclassifications (TM), where:

$$TM = FN + FP$$

This approach offers a clearer comparison across models and time, supporting the effectiveness of ensemble learning in minimizing classification errors (Ahmed et al., 2025).

Table 6. Misclassification summary table of all neural networks

Model	ANN			CNN			RNN			LSTM			GRU		
Epochs	FN	FP	TM	FN	FP	TM	FN	FP	TM	FN	FP	TM	FN	FP	TM
50	0	628	3760	2021	5781	87	211	298	87	211	298	298	0	205	205

Source: own study based on python code GitHub.

One intriguing finding was that our proposed classifier consistently outperformed other networks in terms of misclassification. The intended TM value for 50 epochs has been highlighted. CNN has the best overall effectiveness in detecting false negatives. LSTM and GRU performance are very similar. In this model, the RNN performances are the most inconsistent. For example, at epoch 50, there were more than 20,000 incorrect classifications on FN. Due to limited time and resources, we conducted our experiments using a relatively small number of epochs. However, it was discovered that the performance of each model is not dependent on the difference in epochs over a short period of time. As a result, when we combine the model accuracy for machine learning, deep learning (based on 50 epochs) and the proposed classifier, we get Figure 8.

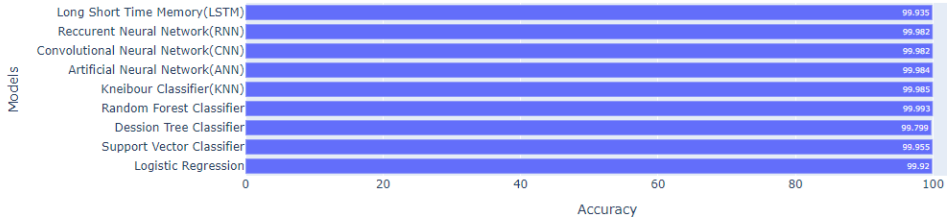

Figure 8. All neural network models and proposed ensemble model accuracy plot

Source: own study based on python code GitHub.

Although the Random Forest classifier with a maximum depth of 6 yielded the highest accuracy among traditional models, performance should not be evaluated solely on accuracy or other numerical metrics. Time complexity is also a critical factor. In our case, training Random Forest and KNN models took over 4 hours, which is comparable to the training time required for the five deep learning models.

When comparing accuracy across epochs, our proposed ensemble classifier achieved the highest overall accuracy, outperforming the individual neural net-

works. However, when isolating performance by epoch-based accuracy, we observed that the GRU model slightly outperformed the ensemble in specific cases.

To better understand these nuances, we proceeded with a deeper evaluation of each model's performance metrics.

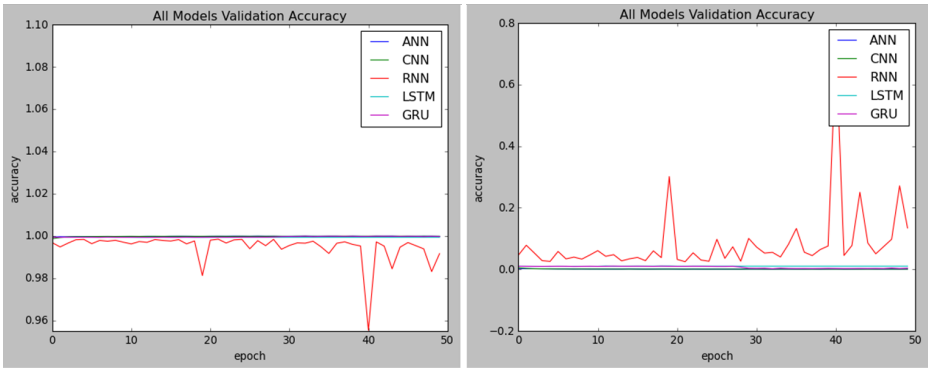

Figure 9. Accuracy and loss curve for all models together

Source: based on python code GitHub.

It was evident from the start of the epochs that RNN performance was substandard, although the other four networks produced a similar curve pattern for accuracy and loss. Furthermore, because the LSTM and GRU architectures are similar by nature, and we selected similar hyper parameters in our model, the accuracy and loss for both networks are extremely similar (Figure 9). When we increase epochs the pattern is still identical for these five networks.

Conclusions

This research highlights the evolving challenges and opportunities in combating credit card fraud within the EU banking sector. The study underscores the critical role of machine learning (ML) and deep learning (DL) in enhancing fraud detection while navigating the constraints imposed by PSD2, GDPR and strong customer authentication (SCA). Key findings reveal that Card-Not-Present (CNP) fraud remains the dominant threat, accounting for 50% of cases, while emerging risks such as synthetic identity fraud and AI-driven scams demand innovative countermeasures.

Credit card fraud detection remains a challenging problem due to the complexity of accurately identifying fraudulent transactions. In this case, the dataset lacked

detailed descriptions, which limited our ability to perform optimal feature selection. Even a single irrelevant feature can significantly impact model performance.

Interestingly, the proposed ensemble hard voting neural network classifier sometimes exhibited lower accuracy than individual neural networks. This outcome likely stems from certain difficult-to-classify observations where the true label was ambiguous or challenging to predict. Since the hard voting classifier relies on the majority decision of all models, it struggled when most individual networks failed to correctly classify these ambiguous cases, resulting in misclassification of some fraudulent transactions.

There is significant potential for further research in applying ensemble techniques to neural networks to address this challenge. Due to limited time and resources, we were unable to perform extensive hyperparameter optimization. Future work could explore different parameter settings and build neural network ensembles based on the highest accuracy scores. For example, assembling more than ten neural networks – such as multiple GRU, LSTM or CNN models – and combining their predictions could improve performance. Additionally, we did not employ k-fold cross-validation during training, as the training accuracy scores were already within an acceptable range. However, incorporating k-fold validation could enhance model robustness by providing a better assessment of generalisation performance.

Hyperparameter tuning remains a critical step to develop a more robust model architecture. On the data balancing front, we applied SMOTE to oversample the minority class, but there are at least six other oversampling techniques available in the research community, alongside various undersampling methods. Exploring these could yield better balance and performance. Moreover, ensemble methods such as AdaBoost show promise as powerful alternatives. In an optimised multi-neural network design, AdaBoost could be combined with GRU as the base learner. Finally, integrating both machine learning algorithms and neural networks within ensemble frameworks might further enhance classification effectiveness.

Based on the results presented above, we cannot confirm our hypothesis (H1) because our proposed solution outperforms other deep learning models, as demonstrated by these experimental results.

In future work, we will evaluate the model's scalability by testing it on larger and more diverse real-world datasets of EU banks. We aim to assess the model's potential deployment within real-world financial infrastructures, analysing its adaptability to live transactional data and integration with existing fraud detection pipelines. Ensuring robustness across various financial environments will be a key focus.

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The law of economic surplus in action systems

Hubert Witczak[1]

Abstract

This paper is an attempt to define the law of economic surplus (ES) in action systems (AS). Categories similar to ES are studied in particular by economics, praxeology (forms of efficiency) and management sciences. These sciences attribute the long-term success or failure of AS to various sources, but not directly/mainly to ES. Profit/loss, as forms of positive or negative ES respectively, can be a source of success/failure of AS. These, in turn, have their own sources and conditions.

So far, it has been assumed that profit need not be the guiding principle for the management of any (all) AS. None of the scientific theoretical concepts make claims that recognise and solve the broader problem of the sources of longevity of any (all) AS. I try to offer a solution using a praxeological and systemic approach, prognostic-diagnostic methodology and hypothetical-deductive reasoning.

I argue that the most important source of longevity is ES. The efficiency of the AS must always be greater than that required to repeat the cycle of action at the initial level and to make the necessary changes. Over the long term, a surplus must be achieved by any (all) AS. Civilisational success/failure depends on solving the problem of determining how to manage action systems and supersystems. This concerns particularly the proportions, parities and priorities in the mutual relations of the following: the activity portfolio, ES, non-economic values and goals, and security.

Keywords

- action system
- energy surplus
- economic surplus
- longevity

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[1] Professor Emeritus, Poznań University of Economics and Business, al. Niepodległości 10, 61-875 Poznań, Poland, studenci@witczak.pl

Introduction

The theoretical foundation of this paper is particularly complex, hence the precise determination of its domain.

First, it touches on the relationship between the laws of natural sciences, including the laws of thermodynamics, and the laws of AS in social sciences. Second, every action is an integrated structure of activities, focused around fundamental activities. The others are the activities of managerial and executive causing, auxiliary activities, economic activities, communications, as well as meta-action (Witczak, 2008). Third, the background is the formation (creation, existence, decline and changes) and running (structure, functional mechanisms, behaviours, actions) of any AS and reference to the foundations of its longevity. A special role is played by changes, including self-referential changes (meta-changes). Management is the combination and mutual interactions of creation, evolution and self-organisation of AS, their supersystems and the civilisation system (CS). Every AS in existence deals with the problem of addressing its longevity. This paper is not about AS that have a single cycle of activity with a predefined horizon (e.g. projects).

It is not the problem or aim of this paper to delve into categories such as profit and its relations with other categories related to human action. Profit is an economic category, a form of ES. I argue that ES is a necessary category for determining how any AS is run (material scope). Its functions are not limited to aspirations. Its necessary function is to fund the longevity of the AS. This requires the role of ES to be shaped in relation to the activity portfolio, non-economic values and security.

The aim and expected outcome of this paper is only to formulate the law of EC for any (all) AS in relation to longevity.

The paper also includes a review of the current state of knowledge in the relevant field, identification of the rationale for the scientific argument, formulation of the law of ES, and it ends with conclusions and recommendations. The paper is based on a theoretical examination of the state of the science, trying to find the key factor in the longevity of AS. My answer here is that this variable, this factor is ES.

The law of ES represents a step forward in understanding that economic surplus is not an optional source of longevity for selected AS. It is an absolute requirement for the longevity of all AS.

1. Overview of the state of sciences relevant to the research domain

A reference to the review is my preliminary definition of economic surplus.

'Economic surplus is a form of energy surplus. The energy surplus of any AS is tentatively defined by me as the positive balance of total energy gained and lost from all sources throughout the cycle of given activities (activity portfolio), including energy inputs from the environment, the transformation of these inputs within the AS and the emission/exchange of energy to and/or with the environment'.

Questions of energy are relevant in many sciences. Below I provide references for AS ES in selected sciences. Economics and management science are discussed more extensively because of the distinctive links with the research domain.

Physics. The category of "energy surplus" is not discussed directly in physics (thermodynamics). The first and second law of thermodynamics play a crucial role here. The first law says that in an isolated system, energy cannot be created or destroyed, it can only be transferred or changed from one form to another. According to the second law, the ultimate destination of the isolated system is entropy. The problem of the potential for shaping energy and economic surplus and their relationship to longevity is an indirect consequence of the laws of thermodynamics in relation to AS.

Praxeology deals with actions and work, and therefore with energy. At the universal level, these actions are regarded as categories, and this is the first connection to the general systems theory. Another stems from the interpenetration of systems theory, praxeology, management sciences and economics. Nevertheless, none of these sciences directly address the objective role of ES in longevity. Here, I analyse key papers dedicated to systems, including action systems, trying to find theorems of relevance to the domain of this paper[2].

Social systems science. Luhmann (2007) deals with social systems and tries to link sociological theory up to general systems theory. He does not address the question of ES, and his analysis of self-reference and rationality (Luhmann, 2007, pp. 407–444) has nothing to do with it. Parsons (2009) does not address economic surplus directly, either, though he recognises the economic aspects of roles in social systems (Parsons, 2009, pp. 91–199). His analysis of the place occupied by sociological theory among analytical theories of action does not refer to the problem, either, even though the author explores the relationships between social systems and problems of rationality (Parsons, 2009, pp. 403–405).

[2] Research work in praxeology and systems theory has moved towards a drill-down approach (specialisation) rather than universalisation, hence as of the end of the 20th century there has been a standstill in the development of general theories.

Economics. The writings of von Mises (2011) has been given special attention. The author explicitly accentuates in the very title that his work is a *Treatise on Economics*, that is an economic treatment of action as a category (a praxeological approach). His is practically the only work containing a comprehensive elaboration on action at the categorical level from the economic point of view. In part, von Mises directly addresses the problem of the nature of economic surplus. His take on value points to its relational and psychosocial nature: "Value is not intrinsic, it is not in things. It is within us; it is the way in which man reacts to the conditions of his environment. Neither is value in words and doctrines, it is reflected in human conduct" (Mises, 2011, p. 81). And further: "The difference between the value of the price paid (the costs incurred) and that of the goal attained is called gain or profit or net yield. Profit in this primary sense is purely subjective, it is an increase in the acting man's happiness, it is a psychical phenomenon that can be neither measured nor weighed" (Mises, 2011, p. 82). Von Mises then goes on to note that "Economics deals with action as such, and not with the psychical facts that result in definite actions". The negative "difference between the valuation of the result and the costs incurred is called loss" (Mises, 2011, p. 83). On page 336, von Mises claims that "There is in nature no such thing as a stream of income. Income is a category of action; it is the outcome of careful economizing of scarce factors. […] Changes in the market data can frustrate every endeavor to perpetuate a source of income". The latter claim is true, though not exhaustive for the law of economic surplus. On pages 552–553, von Mises refers to war and conquest, not seeing them clearly as sources of energy, or even resources. His thoughts on social collaboration without a market and about the hampered market economy are fully convincing. Von Mises presents a consistent theory of economic action, which, however, does not venture beyond market dominance, liberalism and the principle of rational economisation as a source of success. Aware of income inequality in a capitalist economy, he concludes that it is mainly a consequence of uncontrolled population growth, which is difficult to accept unconditionally. Von Mises disagrees with the statement (by Montaigne) that "the gain of one man is the damage of another; no man profits but by the loss of others," except with respect to certain situations in the financial market, "robbery, war, and booty" (Mises, 2011, p. 564). I can only agree with this opinion *ceteris paribus*. He goes on to assert that "the ultimate source of profits is always the foresight of future conditions". This assertion also applies to losses, however it does not exhaust the list of "ultimate" sources. Von Mises criticises socialism, especially planned economy, because of the absence of economic calculation (Mises, 2011, pp. 591 *et seq.*) and I agree with him. Throughout the volume, he raises the problems of the possibility, difficulty and impossibility of economic calculation – and does so aptly. He also refers to the relations between the market and common good, arguing that a welfare state based on the normative approach has no advantage over

market mechanisms in this area. I would agree with this statement, up to a point: provided that we can find a solution that preserves the benefits of the market and keeps the risks of over-regulation at bay.

For von Mises, income, which is a form of economic surplus, is the outcome of economising under conditions of limited resources, alignment of market conditions and – to use contemporary language – enterprise, with its ability to predict the alignment of future conditions. This theorem fits into the framework of this paper, while not exhausting the problem of the essence of economic surplus.

There are hardly any papers dealing strictly with energy surplus and economic surplus, while the question of the "law of economic surplus" is not raised at all. Apart from my own writings (Witczak, 2008, 2017, 2018, 2023), the problems of energy surplus have been the subject of scarce studies (e.g. Chakrabarti & Ramasvamy 2014; Włodarczyk 2008), though not according to the terms undertaken in this paper. In my previous papers, I have discussed, among others, the transition from the category of "energy surplus" to that of "economic surplus". In the field of economics, studies on economic surplus are largely confined to the financial domain and profit-oriented action systems. Such categories as financial accumulation, profit (separate, average, marginal, economic, operational – EBIT, EBITDA), added value (in various forms, cf. Mazzucato, 2018), return on investment, diminishing marginal productivity of factors of production, diminishing marginal cost, scale of production, break-even point, etc., feature significantly in economic theory and practice. There are certain papers on the edge of the present domain (in Poland: Machaj, 2013; Szkutnik, 2014).

Management sciences touch upon economic surplus in praxeological management studies, especially into the category of "efficiency", involving two out of three "forms of efficiency" – benefit and economy, as well as their combination – effectiveness (Kotarbiński, 1973; Zieleniewski, 1972).

Population theory and the *contingency approach.* The above assume that the success/failure of the organisation depends mainly on situational variables and adaptability to the environment. These theories, derived from the concepts of Malthus (late 18th century), linked to needs and resources as well as the pace of population development, place particular emphasis on the role of the environment and context for the success/failure of the AS.

Life-cycle theory is built on two categories: the broadly defined "life" and "cycle". Basically, it assumes that the life of an object (subject) has a beginning and an end, raising questions such as where it comes from and what purpose it serves. One of the classic answers to the latter question is "survival" (cf. Gościński, 1989). However, this theory does not clearly explain the sources of survival (including longevity).

Strategic management is a level of management, below political management but above tactical and operational management. These levels are inextricably linked and form the management system. Management systems theory is under-

developed, with no consensus even on the term "management system" itself. Neither management systems theory nor its component, strategic management (cf. Meyer & de Wit, 2007), provide a clear explanation of the sources of longevity.

Change management is one area of management where one would expect the issue of longevity to be addressed. However, it focuses on internal, operational and contextual systems, the success/failure of change. It does not specifically explore the relationship between change, energy and longevity (cf. Kotter, 1995).

The overview of the body of knowledge in the research domain lends itself to the following conclusions. The law of ES is not formulated or discussed directly, including in the categories of scientific, praxeological and systematic synthesis. As a consequence, it is not known whether ES refers (and if so, how) to any AS, and why. In science, there is no category of the "law of ES", except for the author's own writings. Vertical value chains are primarily associated with trophisms [*nutritional relationships*] between action systems and supersystems, and the CS. Systems of such trophisms may, but do not have to, indicate that economic surplus is achieved at the same time. The role of ES viewed as limited almost exclusively to an optional cognitive and normative function as an indicator in the business context. Critical economic sciences analyse the question of determining how any AS are run on the grounds of behavioural sciences, neurosciences, postmodernism, advancing ever new ideas and concepts. Their criticisms include the *homo oeconomicus* concept, neoliberalism, they study the relations between the classical surplus theory and heterodox economics (Martins 2013), present new ideas, such as sustainable development, gift economy, sharing economy, papers in the area of green economy (for instance by J. Rifkin, 2002, 2014) and circular economy. Such approaches, limited to efficient energy transformation, mainly in business, do not provide a clear view of the sources of longevity of any AS. The measurement, calculation and accounting for energy are not complete. As a matter of principle, concepts such as external benefits, added value or goodwill make sense from the axiological point of view rather than cognitive-objective. They do not exhaust the energy potential of the given system, e.g. the additional potential of unacceptable practices vis-a-vis competitors and customers. The human capital and outlay, cost and expense of nature is not fully accounted for, either.

The sources of ES and their relationship to longevity are not directly addressed by Coase (1937). His transaction cost or external cost theory (Coase, 1960) is intended to justify the reasons for the creation of firms and the market-based solution to external costs. This is a lower level analysis than the one proposed in this paper, with no links to ES and its relationship to AS longevity. The absence of transactions does not in any way contradict the law of ES, there are other rules that govern the management of AS energy.

With regard to non-business management, including "public governance", they assume *a priori* that public bodies operate on the assumption that needs take precedence over ES, in line with the principle: provide the necessary public

services, but according to the requirements of rational economy. It is argued that it is more advantageous for public management to apply and use business management principles, without further justification ("business tends to be more efficient"; it is difficult to measure public governance). Efforts to manage its energy run counter to efforts to meet public needs.

In conclusion, it should be emphasised that the problem of the key factor(s) determining the long-term success of AS has still not been resolved within economics or management. I would argue that there is a problem of the nature and law of ES in relation to AS longevity. More broadly, and beyond the scope of this paper, the problem relates to the role (status, situation and significance) of ES in the structure of the activity portfolio, AS values and aims (proportions, parities, priorities) and its role in their development.

2. Methodology

Although I have briefly outlined the problem and its rationale (Witczak, 2008, pp. 170–173, 2017, pp. 75–79), there is a need to define the problem more precisely, to advance research and to identify selected consequences. In this paper, I focus closely and exclusively on two research questions:

- What is energy/economic surplus in relation to any AS and their longevity?
- What is the relationship of ES to AS longevity?

The domain of this paper spans four scopes. The material scope of the paper comprises AS and supersystems, including CS, which are a complex sum of AS and "nature systems" (NS). The objective scope is the theorem on the essence of the law of ES in relation to running any (all) AS. The scope of space and time (space-time) is universal. As a result of all the above, the domain of the paper is categorical and synthetic. The paper will not investigate any determinants of ES, or any other consequences beyond AS longevity.

I use a praxeological and systematic approach, which is necessary when attempting a scientific synthesis with the aim of universalising the given theorems. Action is the fundamental category of the praxeological approach. I approach the research problem from the point of view of management sciences, trying to formulate theorems at the level of management science[3]. I use the prognostic-diagnostic

[3] Management sciences should not be confused with teaching management skills, that is an educational function aimed at enhancing the potential for managing people. Moreover, the term "management sciences" reflects specialised diversity, while "management science" is an attempt at synthesis and universalisation of that diversity.

method, where "prognostic" means that the research is based primarily on logic, heuristics and deductive reasoning. The object of the "diagnosis", which plays a secondary role in this arrangement, is exclusively an overview of the state of science in the field (desk research). It involves the exploration of the body of knowledge, value assignment and identification of basic research obstacles. Reasoning is hypothetical-deductive (cf. Witczak, 2023, pp. 335–385).

A diagnosis of the state of science in the field of research cannot, by its very nature, be developed further. I am adopting the principle that the overview will only include those disciplines, trends and concepts that I recognise as being related to the nature of the ES.

The problem-solving model begins by pre-defining the problem, determining the state of science in the relevant field and identifying the resulting research gap in the problem. I then construct a problem-solving model consisting of two components. First, based on certain premises (subsection 3), I establish that the essence of AS ES is a set of certain variables and relationships between them. Secondly, based on these premises and the essence of ES, I deduce its relationship to the longevity of all AS.

3. Premises for the theorem on the law of economic surplus

Premises determine the underlying foundations (assumptions) that are relevant to the given model of theorems, as well as reasons. On their basis, the given theory has a specific scientific value.

3.1. Identity of action systems

A system is a set of components that, as a whole, have system characteristics. I divide them into two groups.

Categorical system characteristics (applicable to any system): 1) generic identity of the set; 2) probabilism; 3) relationality; orderliness; structure, integrity, coherence; 4) interaction with the environment (openness; relative isolation); 5) functionality;

Generic system characteristics (specific to AS): 1) a complex set including the human being; 2) fuzziness (indeterminate boundaries); 3) particular complexity,

including hybridity; 4) mutability; 5) autopoieticity; 6) *in statu nascendi*; 7) evolutionary and teleological; 8) autonomous self-control (Witczak, 2023, p. 25).

Action is conscious and purposeful behaviour of a given entity towards itself or the environment. *Action system* is a framework of action of at least one human being, consisting of six interrelated subsystems: 1) AS aspiration subsystem; 2) AS doctrine subsystem; 3) AS core subsystem; 4) AS situation subsystem; 5) AS constraints subsystem; 6) AS meta subsystem (cf. Witczak, 2023, pp. 34 *et seq*.). Under the systemic-praxeological approach to AS, action is viewed as the main object of study, shaped and managed using the category of the "system" and systemic approach.

The *longevity* of a given AS is defined by me as the potential to arbitrarily and efficiently shape how it conducts its own multi-cycle activity (its material, objective and spacetime scope), including its ES, over an unlimited space-time horizon. The opposite is *ephemerality* (low potential for shaping). Longevity is a purely cognitive category, as opposed to survival. Survival is a form of longevity, but with a clear axiological recognition: the difficulty of existing, at whatever level, what matters is that one exists.

I derive the definition of energy from that of a "random event", that is any change of the state of any particular thing. The *energy of a given object* (here: AS) is its potential to make conscious and purposeful changes internally and in its relations with the environment. The direction, the magnitude, the quality, the structure and the dynamics of the way in which the potential is utilised are determined teleologically. The energy of the AS is the sum of *inherent potential* and its *readiness and ability to be applied and used* (quality of individuals and communities). The source of energy springs from the diversity of any AS, their heterogeneity, resulting in movement and change. *Initial energy* is the total starting potential of the given AS, necessary and sufficient to engage in operational activity in the given domain and under the given conditions, for further functioning, behaviour and activity.

Praxeology (Kotarbiński, 1973; Zieleniewski, 1972) distinguishes three forms of *efficient action*: *effect, benefit and economy*. "Effect" results from the ability to achieve goals. A positive difference between the value of a useful outcome (positive) and the value of costs (negative) represents "benefit", while a negative difference – represents a *"loss"* in action. "Economy" is the product of division of the value of a useful outcome by the value of costs, equal or greater than one. *"Effectiveness"* is the product of division of benefit (numerator) and value of the cost/potential (denominator). Benefit is in fact a form of ES.

I shall not delve into a detailed analysis of such processes exclusive or crucial to the development of AS as primary economy, including the Aristotelian natural chrematistics (*ways of acquiring wealth: gathering, hunting, agriculture, barter*) (cf. Arystoteles, 2001; Cendejas, 2018).

3.2. Significant systemic premises

Significant systemic premises, objective and volitional, can be found/may be adopted in all subsystems of the AS. There are interactions between the premises, e.g. doctrinally high sensitivity to constraints and risks can result in orthodox conservative AS formation. This, of course, translates into results in the AS ES domain. Below, I discuss a selection of systemic premises below.

1. Selected laws of natural sciences and formal sciences can be analogously applied to AS science, including in this study (cf. Witczak, 2018). The distinctiveness of the subject matter does not preclude such an approach, despite the difficulties, e.g. with measurement, or the incomplete ability of social sciences to provide scientific syntheses at the level of natural sciences. In particular, I refer to the laws of: thermodynamics (physics), K. Gödel's incompleteness theorems (logic), W. Heisenberg's uncertainty principle (physics), law of ignorance (M. Planck; H. A. Simon; I. H. Ansoff – physics, cybernetics, systems theory), the law of requisite variety (R. W. Ashby – cybernetics, systems theory).
2. Each AS exists in and through its environment. In practice, the only existing AS are relatively isolated and interact with the environment through AS inputs (X) and AS outputs (Y). The output sphere (Y) refers to the trophic relationships of the AS with the downstream environment. It emits energy, including meeting the needs and expectations of the environment. The environment endorses it, transmitting its energy to the AS, or not. The same applies to the input sphere (X), but in reverse: here the AS endorses the *raison d'être* of the AS that is upstream in relation to it.
3. Energy relationships between the AS and its environment. The arrangement of (transactional and non-transactional) conditions between the AS and the environment can induce self-supply, active supply and passive supply. For example, there may be no transactions, only active supply. Energy transformations occur throughout the XTY cycle of activity. With *self-supply*, the energy harvested in Y is the only source of energy transformation throughout the cycle. *Active supply*, in its pure form, is active and self-reliant sourcing of energy, under any principles, including non-transactional (for instance, appropriation). *Passive supply*, in its pure form, is energy flow from the environment with the AS remaining completely passive. The most important and ultimate source of the energy flow structure is NS. Energy effects in the environment also include the dissipation of energy into the environment; purposeful discharges of energy into the environment, etc. AS always have to contend with limited resources (rational economy), in which they can be more or less successful. For instance, self-supply may lead to the objectivisation of energy exchange under certain conditions (see below: foundations of energy transformations). Active and pas-

sive supply do not provide for it at the same level, because of the inability to fulfil certain conditions, referred to as market conditions.

4. The principles for measurement, calculation and accounting, including references to: 1) balance and equivalence of energy flows; 2) non-transactional, non-rational and non-normative attributes of the flows; 3) dialectic nature of the energy exchange at the inputs and outputs. The AS must be clearly distinguished from the environment so that diagnostic operations, normative operations (development of models) and their implementation can be carried out. The relevant measurements, calculations and accounting also apply to active supply (e.g. we appropriate the energy from the environment at X and Y, calculating that we will ultimately achieve a positive energy balance) and passive supply (the environment calculates a positive energy balance and consequently supplies the given AS). Such non-transactional (non-reciprocal) operations are less precise, more voluntary and risky, but they do take place.

4. The basis of energy transformations of any action systems

4.1. Energy of action

ES is an objective concept, referring to the AS separated from its environment. It is determined by performing cognitive operations, i.e. defining concepts; here: energy, the principles of its detection, exploration, classification and explanation. Specific categories are then subject to measurement, calculation and accounting, e.g. performing the relevant cognitive operations on the content, size, structure, quality, dynamics of energy and its transformations.

Other operations that we can undertake with respect to energy surplus involve its psychosocial aspect. They are: value assignment, determination of further action following value assignment, determination of the normative magnitude, and lastly, implementation of the energy norm of choice.

Energy of action is applicable to any AS. It is dependent both on the relationships of all internal subsystems and on the relationship of the AS as a whole with its environment. For instance, the aims subsystem produces part of the aspirational motivation of any AS, which may be higher or lower, depending on the interdependent conditions. The energy of action is also a non-simple sum of three components: energy of nature, energy of artefacts and psychosocial energy. Psychosocial energy (some of its constituents being the energy of aims, energy of doctrines,

energy of meta-management of the AS) is the key determinant shaping the AS, their supersystems and the CS, using creation, evolution and self-organisation. The energy of NS is rudimentary, physical, real and natural, and – apart from certain instances (like dark energy) – it has been thoroughly studied. The energy of artefacts is real (material and virtual), secondary to the energy of NS, saturated with psychosocial elements. Psychosocial energy, in turn, is derived from the connection of the energy of the brain and consciousness with the physical energy of the human being. Its essence is the virtual mental energy and that of social relations, e.g. authority, social tensions and the relations of exchange of money and goods, including transactions. Potentialisation (a form of authority limited to the manifestation of a certain potential) is pure psychosocial energy (without a physical core). It must be manifested by "someone" (a subject), using specific methods and tools, like e.g. body language, that is elements of the energy of NS and/or artefacts. The parties, when transforming energy, shape their objective (physical), artefact-oriented and subjective (psychosocial) potential for change. Energy potential is a relative measure (internal potential in relation to the potential of the environment with axiological and normative attributes). The magnitude of axiological-normative energy potential may fluctuate around the objective potential of the energy of NS and artefacts. It can also deviate, for various reasons, from the requirements of equivalence and balance. These deviations may have a significant impact on the dynamic and static energy balance of the AS. The energy expected by an AS, whether in the form of goods or money, is measured against the energy lost, which is necessary to acquire the energy expected. Other comparisons relate to references to self-organisation, competition and testing of alternative efficiencies. Another reference is testing of efficiency in the given situation and spacetime context, including the future. Only when the energy balance has been achieved, a flow of energy between the sides is possible.

Throughout the XTY cycle, each AS keeps account (by deduction and/or division) of energy efficiency in terms of its ability to satisfy needs and achieve objectives in the context of probability. The given AS aspires to achieve the expected energy, having had to lose some energy to acquire it. For the system, energy acquisition makes sense only when the difference between the energy expected and the energy lost is equal or higher than zero and/or the ratio of the two types of energy is equal or higher than 1. Similar accounts are kept by the counterparties of the given AS, but in reverse. The energy expected by the given AS (for instance, the price in exchange for the products and services offered to the environment – the expected amount of money) should be as high as possible (fair price, etc. – the minuend/numerator), while the products and services represent the sum of energy lost by the given AS – the subtrahend/denominator. In turn, for the counterparties, the price of products and services from the given AS is regarded as the subtrahend/denominator (energy lost: the amount payable), while the energy of the products

and services (their potential for satisfying needs and interests) – as the minuend/numerator. The given AS and its counterparties aim to maximise and minimise the opposite sides of the equation. In this context, energy surplus becomes economic surplus (ES): measured, calculated and accounted for in relation to external conditions. In its essence and accounting, it is necessary to consider the value in use, benefit (the difference between energy gained and lost), economy (the ratio of energy gained to energy lost and to total potential) and effectiveness (the ratio of the difference between energy gained and lost to energy lost/potential).

Energy flows and external conditions form the foundation for repeating the cycle of action by way of self-supply, active supply or passive supply. Exchange, including transactions, may generate insufficient demand to achieve the desired balance of exchange. For certain reasons, e.g. social policy, communities decide to satisfy needs despite the inability to achieve transactional equivalence (supply, transfers). Some transfers are not socially accepted (for instance, energy in the form of waste), but AS "discharge" such energy into the environment (pollution). Exchange, including altruism, is the only form of energy transformation (under specific conditions) where the environment authorises and endorses the AS. Incomplete or no exchange at the system output results in the AS emitting energy in the form of unapproved discharges (e.g. "forced" or covert energy emissions to the environment) or in such energy not being expended. A similar, but reversed, mechanism operates at the input of the given AS. Here, too, the system may resort to force or covert activities to obtain the necessary energy. Lastly, sources of energy also include transformation efficiency and the environment.

4.2. Systems of energy transformation conditions

The relations of any AS with the environment take place within specific *systems of internal and external conditions*, including expectations, fulfilments and meeting needs and objectives of the parties. Characteristically, the variables of the conditions are interrelated, while the levels of their properties fluctuate and may discretely span the opposite extremes. I include the following categorical variables (with each category consisting of sub-variables):

1. Identity, singularity (e.g. level of development, variation, culture; location, stability, etc.) and ultimately potential, including energy bargaining power of the parties. The internal potential confronted with that of the other parties determines the relational potential of the interaction. The balance of the parties and the equivalence of the energy transformations mark a level from which the energy potentials and the bargaining power of the parties can diverge.

2. Freedom of organisational behaviour. Fluctuates between zero (absolute lack of freedom) and one (absolute freedom – authoritative decision-making energy unconstrained from the outside). Freedom is *primus inter pares*, the fundamental concept among all the variables co-determining the potential authority of AS. Without freedom, no other variables can develop fully.
3. Congruence of activities, that is the suitability of all the components of a given activity, focused around the acting subject (e.g. values and goals, resources, obligations, authority and responsibility). Higher/lower congruence refers to a broader/narrower span of coherence, organisation, integration of these components and activity as a whole. This makes for more/less focused direction of psychosocial energy and its remaining properties and parameters (content, magnitude, quality, structure, form, dynamics), and thus, ultimately, its potential of influence.
4. Freedom of access to energy, including matter and information. A complete lack of access to energy is self-cannibalism and collapse of the system. A transition of the parties towards equal access, and further on towards monopolisation, might trigger negative phenomena (e.g. dependence, conflict).
5. Arrangement of energy relations between inputs and outputs (self-supply, active and passive supply). Complete freedom of these arrangements creates the risk of illegitimate, non-ethical, non-normative behaviours, including those incompatible with the laws of science. Complete lack of freedom entrenches the given solution, even in forms that are unacceptable to the parties and the public.
6. Relations between creation, evolution and self-organisation. AS management is formed not only through creation. Management of the CS is, essentially, using and applying specific proportions, parities and priorities between creation, evolution and self-organisation. Their extreme forms (completeness or absence) are out of the question. Pure evolution signifies completely free selection and propagation of development, with no regulators or regulations. Pure creation, in turn, is the complete elimination of evolution, the pursuit of an acting machine. Pure self-organisation of AS supersystems excludes regulation. As a result, systems integrate at different levels, ranging from addition to the social machine (Witczak, 2008, 2017, 2023).
7. Interdependencies between AS subsystems and supersystems, such as dominant doctrines, technical levels, legal and cultural norms, etc. Extreme dominance of the aims subsystem can lead to a management style that can be summarised as “achieving values and goals at all costs”, or doctrines that focus on activity (e.g. communism), constraints and risks (e.g. defensive-orthodox orientation), situations (e.g. monopoly strategy), or compliance with operational requirements (e.g. technocratic dominance). Unfocused combination is also a possibility (without dominance: interstage crossing and its forms, e.g. drift).

8. Conformity of shaping the conduct of the AS with the laws of science. It is necessary – otherwise, we would not be able to progress as a human civilisation. While the natural and formal sciences define the laws of science, the social sciences and humanities mostly produce regularities, principles, rules, indications, guidelines, recommendations. This leaves room for manoeuvre in various areas of shaping the conduct of the AS, including justifying certain activities with opposing arguments, creating stalemates and decision-making dilemmas.

It is important to balance the status of the parties, the level of variables and their interdependence. The parties, with the exception of NS, negotiate, argue and compromise in an attempt – not always successful – to reach satisfactory (e.g. balanced) positions. The above conditions are crucial for the context of objectification, measurement, calculation and accounting of energy. Only then can the exchange/transfer and flow take place (or not) on an equal footing, close to or far from the objective measurement, calculation and accounting of energy. There is, of course, a crucial and very difficult problem of the interactions of AS and their supersystems in the absence of the ability to exchange and transact (non-transactional interactions), i.e. active and passive supply.

5. Energy transformation models

5.1. Model of permanently invariable energy transformations

There is a problem of the relationship of any AS with longevity, and then a problem of the necessary and sufficient energy for longevity. This problem must be resolved, as it is broader than the volitional decision of the AS to self-eliminate.

The energy transformation in a given XTY cycle requires that the given AS in the spacetime of the transformation should remain, as a matter of principle, in a permanently invariable condition, i.e. it should be a kind of machine. Let us assume that this period is marked by invariability and a balance in the status and the above-mentioned systems of conditions underlying the parties' activities in XTY spheres.

Moreover, operational energy transformations in this cycle are also permanently invariable and occur automatically – the parties approve and accept permanently invariable transformation rules, reaching an equilibrium point without discussion or delay. In fact, the permanent invariability of the approach to the management of the AS (cycle repetition) means that the freedom of organisational behaviours at a given level is solidified, and deviations from it are equal to zero.

Excellence, that is perfectly efficient transformation of any potential and form of energy into any other potential and energy without losses, is incompatible with the laws of science. In the first (initial) cycle understood in this way, and in subsequent cycles, the lost energy cannot be fully recovered. AS energy can be lost through the following mechanisms: 1) ageing of the potential; 2) wear of the potential; 3) incomplete efficiency of the energy transformation. In order to fully restore the initial energy; 4) additional energy is required for restoration, while some forms of transformation also produce; 5) irrecoverable energy (e.g. some heat losses). The AS reduces its initial energy potential by the sum of recoverable energy lost (items from 1 to 3 above) and the additional and irrecoverable energy (items 4 and 5 above).

The initial *energy of action* minus the *energy of restoration* leaves the *energy available*. The depletion of the energy potential available to the AS is gradual, initially imperceptible, and it affects all types and forms of energy. The energy of nature is only renewable in a certain sphere and up to a certain level. So is the energy of artefacts, such as infrastructure. The same is true of psychosocial energy: the permanent invariability leads to an inevitable decline in the energy of aims, erosion of doctrines, potential for reception, perception, commitment, lack of prospects. The well-known phenomena of frustration and fatigue increase, while innovation decreases, etc. The aggregate decline is equally complex, but, unlike the energy of NS and the energy of artefacts, it can still fluctuate. As a consequence of the permanently invariable energy, the AS must gradually fade away until it finally loses its static (amount of energy) and dynamic (process and outcomes of transformations) ability to exist.

5.2. Model of variable energy transformations

The situation changes when, upon repeating the cycle, we do away with the permanence and invariability of energy transformations (including the conditions for action), as well as the invariability, balance and status of the parties in the XTY spheres.

The sum of energy materialises in the form of products/services offered to the environment, in order to satisfy the needs and interests of the environment. The AS will try to exchange these products/services with the environment, thereby gaining energy to repeat the cycle and possibly serve other non-operational activities (e.g. capital acquisition). The sum of energy is formed partly through exploiting relationships with the environment, e.g. strategic positioning. The parties attribute a certain meaning to the actual and/or expected energy exchange in which they are (will be) involved, subject to certain conditions and contexts.

Psychosocial energy features importantly in this attribution, notably in terms of accounting for expectations, the fulfilment of expectations, and their balance – the satisfaction of subjects. The sum total also includes energy gains and losses from non-transactional, non-normative sources and outside the laws of science.

The operational horizontal activity of the system must refer to objective energy transformations, independent of the attribution of any meaning and importance (value) to them. They are founded on the laws of science. No energy is created by itself or from nothing, it can only be transformed from one form to another. During spontaneous and/or active transformation, energy losses occur throughout the XTY cycle, and the characteristics of objective and necessary energy losses are codependent on the systems of conditions and energy transformation efficiency (management). The shift from permanent invariability to total dynamism, however, changes the potential of psychosocial energy. It couples and self-couples, forming a positive feed-back and feed-forward loop, "awakening from its slumber", starts to look around, swell and grow, fluctuating powerfully. Due to changes in the systems of conditions, the conduct of other sources, types and forms of energy and the efficiency of energy transformations can be much better shaped. In particular, the increase in freedom (freedom of organisational behaviour) promotes the growth of the aggregate potential for action in the AS, though only up to a certain level. Too much freedom, on the other hand, can lead to an exponential increase in the spread of diversity, the distance between the extreme opposite sides of the remaining elements, properties, and relationships of the systems of conditions. The bargaining power of monopolies and monopsonies, deficiencies in congruence and other changes can trigger negative events and negative energy of change in terms of direction and other properties. As a result, negative synergies arise, lowering the potential for community, bringing about an overexploitation of the energy of nature, artefacts, as well as psychosocial energy itself (e.g. excessive and unreciprocated exploitation of people). At the same time and in parallel, the energy potentials of nature and artefacts are declining, at significant levels, albeit gradually, unevenly, and progress may not completely offset this decline.

For these reasons, throughout the cycle we may in principle be dealing with reversed processes in terms of the directions and rates of shaping the management of natural and artefactual energy on the one hand, and psychosocial energy on the other. Regardless of how an AS measures, calculates and accounts for the final energy presented to the environment for exchange at the output, the value of its properties (content, size, quality, structure, etc.) is assigned by the environment. The environment evaluates these properties in terms of its own accounting of expectations, fulfilment and satisfaction. The outcome of the account may be threefold: satisfaction on a par, below par (deficiency of energy fulfilments), above par (excess of energy fulfilments). As a result, inside these three nominal levels of action energy we will find a necessary and objective decrease in the en-

ergy of nature and artefacts and a fluctuating potential of psychosocial energy. These levels are nominal in nature because the actual potential depends on the input-output relationships of the potentials of the AS and their environment, the efficiency of transformation (management) throughout the cycle, and the forms and sustainability of energy transformations (transactional, non-transactional, non-normative). For instance, the bargaining power of a monopoly/monopsony enables it to effectively impose unequal terms of exchange and achieve energy surplus in excess of par. I assume that in the spacetime of the starting activity, the initial level of energy of nature, artefacts and psychosocial energy is equal. If we have not exchanged anything (by way of a transaction, barter) and did not gain anything under non-transactional terms (appropriation, transfer, etc.), there are no grounds to differentiate, or at most – nominal grounds. The distinguishing quality of psychosocial energy and the energy of artefacts is their purpose-orientation, unlike the energy of nature. The energy of nature and that of artefacts, on the other hand, have one objective and distinguishing quality: their predominant direction of change is the decline of the energy potential.

6. Synthesis of the essence of the law of economic surplus

The question of ES is one of the reference points: what level (potential) of energy must we achieve and surpass in order to have the energy necessary and sufficient for longevity? The possible reference points can be: the unattainable, perfect (complete) energy conversion; the energy lost by a given AS, necessary to successfully complete the intended operating cycle. Neither loss nor gain occur automatically or without energy input. Other possible reference points include: comparison of the energy with the level of realisability (possibility, desirability, feasibility), comparison of follow-up energy with the initial energy of the AS.

The first prerequisite for ES is the difficulty or impossibility of fully reproducing an activity cycle with the given parameters. Furthermore, the optimal conversion efficiency of the AS under given conditions is always imperfect. An energy surplus must be obtained that makes up for the irrecoverable losses at least to the level of "complete reproduction". The only source of this surplus, with the optimal transformation referred to above, is ultimately the environment.

The second prerequisite for ES is the indispensability of new changes – beyond the routine and permanently invariable operational and reproductive changes in the cycle and XTY spheres. Carrying them out requires additional energy, ultimately also originating from the environment. It serves to adapt/transform the

AS itself and its relationships with the environment. Shaping the change process also entails analogous energy losses – due to the incomplete efficiency of transformation, wear of the potential for change, and ageing of potential in the course of change. On aggregate: 1) the impossibility of complete reproduction of a cycle of activity with specific parameters; 2) the necessity of implementing new changes in the system; 3) the limitation of the available energy; 4) the diversification of the systems of conditions; 5) and the incompleteness and varied operational efficiency are the fundamental, *necessary and sufficient reasons for defining the essence of the problem of economic surplus*. In the case of a random AS, these necessary and sufficient conditions may differ in size, structure, other characteristics and relations to longevity.

ES primarily refers to the balance of energy gained and lost in the XTY cycle, expressed in the form of subtraction (benefit) and/or division (economy, effectiveness). Over the long term, the AS can acquire energy exclusively from the environment, through transactional and non-transactional means, it cannot supply itself.

In reality, a permanently invariable status and balance of the parties and the system of conditions do not exist or exist ephemerally, they are constantly being sought and transformed. This calls for additional energy to enable change. It must apply to the entire cycle of activity, encompassing a complete reproduction of the initial potential as well as new, innovative changes. Ultimately, the energy of change must exceed the energy of reproduction by a certain unique, categorically and generically different quantity. Add to that random, abrupt, revolutionary changes. In this situation, the role (status, situation, significance) of ES is not revealed immediately upon the completion of the initial cycle, but in the long term. Every AS may be subject to unique and separate conditions of fluctuation around the point of energy equilibrium. The energy balance (arrived at through subtraction and/or division) emerges over the long term, revealing zones of ES (energy surplus), loss (energy deficit) and interstage crossing. The law of ES is a necessary and sufficient condition for longevity. An AS may find itself in the ES zone, but the system of conditions may prevent the use of the surplus (e.g. constraints), and in such a case the system may decline despite the ES. The economic calculation of ES, provided we are fully able to measure, calculate and account for activity, is a necessary basis for shaping the conduct of any AS in the long term. Risk and uncertainty are constants in this process, but it is not clear and certain that the system will operate in the ES zone in perpetuity. The inability to measure, calculate, and account for the activity of any AS and to satisfy the conditions of exchange does not invalidate the law of ES, serving merely as a stimulus for research. The efficiency of transformation and positive/negative energy balance are unique, derived from a complex system of interactions, including energy transformations occurring according to non-objective, non-transactional, non-economic, non-legal requirements and constraints, and/or under conditions of ignorance.

The law of ES applies to all AS, and ES is a derivative and a constituent of the complex energy of action – natural, artefactual, and psychosocial energy. The differentiation and variability of the internal and external systems of conditions and levels of efficiency of energy transformations impact accordingly on the rate of changes in the energy structure and total relational energy potential.

Conclusions and recommendations

As a product of *subtraction*, energy surplus is the sum of the energy gained over the energy lost (energy held minus energy lost) by the AS in action. As a product of *division*, it has two forms: economy (total energy held divided by energy lost >1) and efficiency (total energy surplus divided by energy lost). Economic surplus (ES) is the form and measure of energy surplus, a conscious, professional and scientifically compliant shaping of the energy of the AS in relation to its longevity.

ES and its relationship to longevity have the status of a law, regardless of the AS energy transformation model. The important difference is the attainability of ES. According to the model of permanently invariable energy transformations of the AS, ES attainability does not exist (relationship certainty). Under conditions of change, the attainability of ES has the status of regularity (relationship probability), with dialectical, paradoxical and chaotic characteristics. This is due to the alignment of ES and the mutually interacting conditions, management efficiency and environment. ES can only be achieved if the alignment of conditions, management efficiency and environment is conducive to it.

The alignment of conditions, management efficiency, environment and ES forms a network system of feed-back and feed-forward interactions. ES as a derivative and function of purpose is only a probability, and is not given in advance or prescribed.

In practice, without ES, neither AS nor CS can exist in the long term if the alignment of conditions, management efficiency and environment is unfavourable and uneconomical. There is a problem of resolving this alignment. The problem of achieving ES is not optional – it is an absolute prerequisite for longevity.

Ultimately, the environment is the only source of energy for the longevity of the AS and the CS and their ES, especially the NS. In fact, AS and CS, forced to seek perpetual growth and ES, are parasitic on the NS, gradually devouring it. From this point of view, concern for the NS cannot be optional. In the light of the law of ES, the role of the NS becomes an essential priority factor for the longevity of AS and CS.

In axiological terms, the complete set of consequences of any action is a success (a positive evaluation) or a failure (a negative evaluation). Longevity can be an overriding value, but also a condition (e.g. we need to exist for as long as possible

to fulfil our mission). ES and loss have positive and negative axiological connotations, respectively. AS also succeed by achieving favourable conditions, in terms of the sources of ES. This creates a feedback loop: ES conditions – achieving/not achieving NE – feed-forward shaping of ES conditions. ES can be situated, in terms of its axiological role for the AS, as a superior value, constraint and a subordinate value (we need to achieve ES to be able to achieve higher-order values).

This paper essentially opens up a scientific problem and has numerous limitations typical of pioneering scientific activity. It does not venture beyond deductive reasoning, with categorical considerations of a universal scope, combining the research fields of systems theory, praxeology, management sciences and economics. All this creates further problems of methodological and substantive corroboration, particularly scientific synthesis and universalisation. The fundamental issues in the verification and falsification of the formulated law include the synthesis of various forms of energy into a universal conceptual and empirical category, as well the measurement, calculation and accounting of ES. By itself, the conceptualisation of the law of ES does not provide a sufficient explanation of its causes, conditions and consequences.

The law of ES is reflected in the practice of shaping the conduct of profit-oriented systems. Here, I refer more broadly to any AS, their supersystems and CS. An AS may not be profit-oriented because of the obstacles to measurement, calculation and accounting, possibility (not every AS can generate ES under the given system of conditions) and desirability (not every system is supposed to generate it). This does not change the need for developing solutions to ensure general and absolute compliance with this law in practice.

The current body of knowledge in the domain of this paper, research constraints and practical implications also determine other directions for studies, e.g. 1) the problem of measuring, calculating and accounting of potentially all AS and their supersystems; 2) the problem of shaping the relationships between the activity portfolio, economic and non- economic values, security, rational and non-rational values; 3) the growth of civilisation in the context of the inexorable devouring and freeloading of the environment by the AS; 4) the (non-)achievement of ES for "(un-)justified" reasons due to the interrelation of the efficiency of transformation and the system of conditions; 5) shaping of proportions, parities and priorities in the zones of surplus, loss and interstage crossing; 6) the relations of the law of ES to other laws of science, legal and cultural norms, ecology and ethics; 7) the relations of ES to the management of countries, states and regulatory systems, as well as to competition.

In line with the assumptions, this paper does not aim for positive corroboration. Its claims must therefore be empirically verified and falsified in further research.

ES is neither a cause nor a result of everything. Its mutual interactions with other variables require additional scientific elaboration and corroboration. Only then will we be able to determine its role among scientific theorems and in the practice of shaping the conduct of the AS.

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Exploring the critical success factors (CSFs) for enterprise competitiveness in crises: A bibliometric review

Muntaser Hamdouna[1]

Abstract

This paper examines the evolution of research on critical success factors (CSFs) that enhance competitiveness during enterprise crises. Crises include economic recessions, financial shocks, pandemics and global disruptions. A bibliometric analysis of Scopus-indexed literature from 1998 to 2024 was conducted to address influential authors, key journals, themes and countries. Excel was used to perform statistical analysis, while VOSviewer was used to visualise the authors' keywords in a network. The study focuses on the fields of business, economics and finance, emphasising their critical role in steering turbulent markets. The findings indicate a significant increase in research related to the CSF of enterprise competitiveness during major disruptive events, particularly during economic and financial crises. Countries such as the UK, China, Malaysia and India rank among the top publisher countries. Major themes focus on business resilience, supply chain continuity and organisational agility as core pillars for enterprises to maintain their competitiveness. Although this article relied on the Scopus database, its findings remain valuable, providing a solid foundation for future research. This study serves as a guide for experts, managers and policymakers on evidence-based strategies – such as risk management, dynamic capabilities and leadership agility – that enhance competitiveness in the face of both economic and non-economic crises.

Keywords

- enterprise competitiveness
- critical success factors (CSFs)
- crisis management
- economic disruption
- bibliometric analysis

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[1] Poznan University of Technology, pl. M. Skłodowskiej-Curie 5, 60-965 Poznań, Poland, muntaser.hamdouna@doctorate.put.poznan.pl

Introduction

Crises have become a more common problem for contemporary enterprises, endangering both operational continuity and market positioning, regardless of whether they are caused by supply chain disruptions, natural disasters, global pandemics or financial downturns (Ciekanowski et al., 2024). In addition to stressing strategic planning procedures and increasing uncertainty, these unanticipated events frequently expose enterprises' weaknesses. Consequently, scholars and business professionals worldwide alike underscore the significance of identifying critical success factors (CSFs) that allow enterprises to not only survive but also maintain or improve their capacity to compete in challenging environments (Rockart, 1979; Teece et al., 1997).

From a strategic management perspective, enterprises that can innovate, reconfigure and adapt during times of crisis can achieve superior performance and long-term benefits, according to resource-based theory (Barney, 1991) and dynamic capabilities (Teece et al., 1997). Moreover, these concepts align with current research on enterprise resilience, which emphasises the ability to recover and even thrive in the face of adversity (Lengnick-Hall et al., 2011). Combined, the key functions of elements such as strategic flexibility, risk management and leadership agility are highlighted by these theories. Moreover, different research on the resilience of supply chains and viability during significant disruptions indicates that crises often demand innovative strategies for supply chain structures, as highlighted by (Ivanov & Dolgui, 2021).

However, current publications on critical success factors for the competitiveness of an enterprise in times of crisis are still widely scattered across a variety of academic fields. For example, operations management, business, economics and sociology (Coombs, 2007). For researchers seeking a thorough comprehension of the conception, validation and application of critical success factors (CSFs), the fragmented nature of this literature presents difficulties. Assessing existing research, systematising and mapping, as well as a bibliometric review provide a systematic and quantitative approach to addressing this gap (Aria & Cuccurullo, 2017; Zupic & Čater, 2015). To guide future theoretical development and managerial practice, bibliometric methods, employing techniques such as citation analysis, co-occurrence networks and thematic analysis, help identify intellectual structures and emerging trends.

To address this gap, this paper presents a bibliometric analysis of 1,792 publications indexed by the Scopus database and published between 1998 and 2024. These publications were selected based on filters and keywords that were set to achieve the paper's objective, which is to examine in detail papers with heavily referenced critical success factors for enterprise competitiveness. In addition to the basic concepts of "critical success factors" and "key success factors", additional

criteria were added to focus on different crises using a wide range of terms existing in the field of articles, such as "crisis", "pandemic" and "economic crisis". The search also included the following terms: "businesses", "firms", "organizations", "competitiveness", "competitive advantage" and "business performance". After excluding irrelevant studies and non-English articles, as well as applying other filters to the original dataset of 8,034 documents, a core collection of important research in business, social sciences and economics was retained. This study addresses the following research questions:

- RQ1: What is the distribution of critical success factors (CSFs) for enterprise competitiveness during crises, as reflected in publications from 1998 to 2024?
- RQ2: Which journals and authors have been most influential in publishing research on the critical success factors for enterprise competitiveness during crises, as identified through bibliometric analysis from 1998 to 2024?
- RQ3: Which countries and institutions have contributed the highest number of publications on critical success factors for enterprise competitiveness during crises from 1998 to 2024?
- RQ4: What are the primary research keywords and thematic trends from 1998 to 2024 related to the critical success factors for enterprise competitiveness during crises?

Overall, addressing significant authors, topic clusters and emerging scholarly trends is the main aim of this review article. This will be achieved by answering the four research questions proposed in this introduction. This will provide insights into how enterprises can acquire and maintain a competitive edge during times of change. The following sections present the bibliometric analysis, outline the methodology and discuss the key findings, culminating in conclusions and recommendations for additional research and use.

1. Materials and methods

Bibliometric analysis offers an organised, data-driven approach to charting the evolution of scientific understanding. It reveals trends in research output, collaboration and thematic evolution; it is especially helpful for figuring out how a field has changed over time. In line with this approach, this review paper aims to reveal the profile of the studies conducted on the critical success factors for enterprise competitiveness during crises. In recent years, bibliometric analysis has become extremely popular in business research (Khan et al., 2021). Moreover, bibliometric analysis involves tracking studies on a particular topic and uncovering insights

by examining these studies based on different attributes. Therefore, visualisation and bibliometric methods were used together in the study to achieve the main aim of this paper. Furthermore, VOSviewer version 1.6.20 was used to analyse keywords and identify clusters within the authors' keywords.

The PRISMA framework was applied to structure the article selection process in 2 stages: identification (initial query using broad CSF-related keywords) and eligibility (applying year range, subject area, document type, publication stage and language filters). This process is visualised in Figure 1. Scopus was chosen as the sole data source due to its wide indexing of peer-reviewed journals across the fields

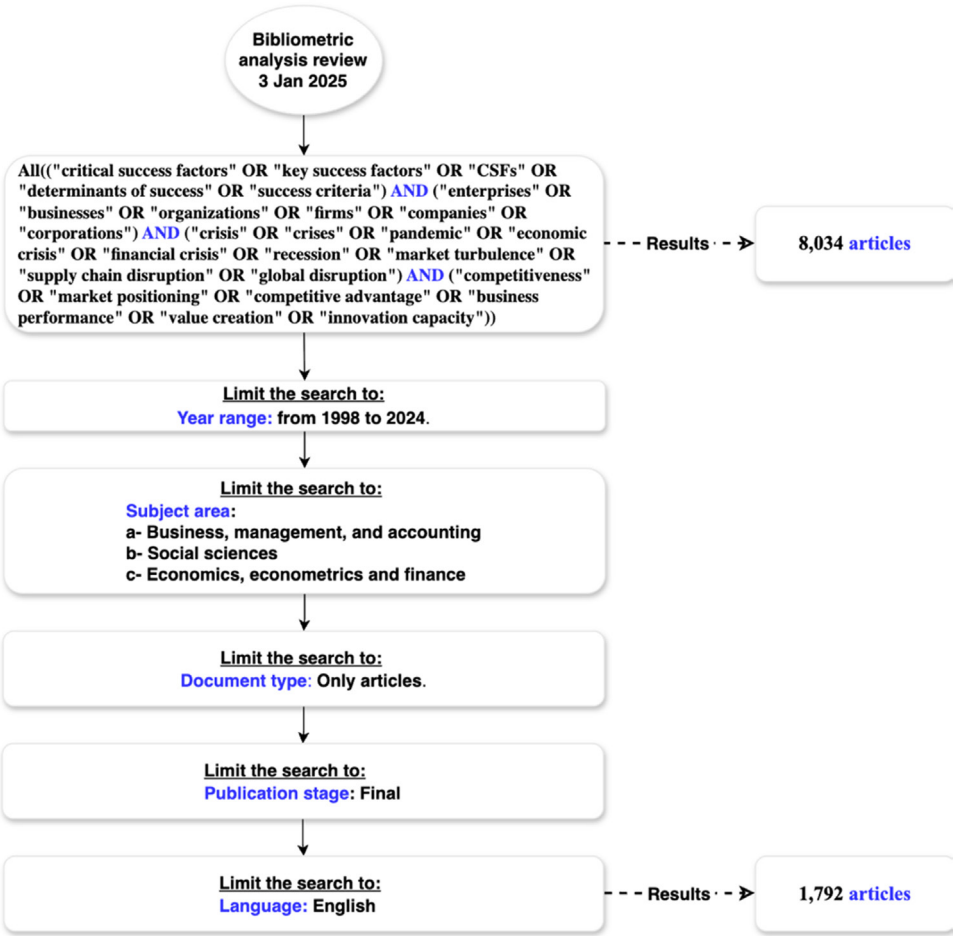

Figure 1. PRISMA flow diagram showing data screening and selection process

Source: author's adaptation based on PRISMA framework and Scopus data.

of business, economics and social sciences. It also offers full export of metadata necessary for keyword co-occurrence analysis and integration with bibliometric software such as VOSviewer. Although this creates some limitation by excluding sources like Web of Science, Scopus provided sufficient depth and breadth for the research scope and objectives.

This research was conducted on 3 January 2025. The Scopus database was used in this research. The initial search was done using the general query, which revealed that there are 8,034 articles in the context of Critical Success Factors (CSFs) for the international competitiveness of enterprises during crises. This does not mean the main focus of the paper; rather, it means any paper that meets the conditions in the query and contains the keywords of the query in any part of it. The "All fields" option was used to search for keywords in all fields during the first scan. The keywords that were used are ("critical success factors" OR "key success factors" OR "CSFs" OR "determinants of success" OR "success criteria") **AND** ("enterprises" OR "businesses" OR "organizations" OR "firms" OR "companies" OR "corporations") **AND** ("crisis" OR "crises" OR "pandemic" OR "economic crisis" OR "financial crisis" OR "recession" OR "market turbulence" OR "supply chain disruption" OR "global disruption") **AND** ("competitiveness" OR "market positioning" OR "competitive advantage" OR "business performance" OR "value creation" OR "innovation capacity"). This research covered the period between 1998 and 2024 articles and included the following subject areas (SUBJAREA, "BUSI") OR (SUBJAREA, "SOCI") OR (SUBJAREA, "ECON").

This research focuses on the already published articles and excludes preprints or drafts. In addition, only English-language journal articles were included in this study; publications in other languages were excluded. Moreover, the final articles used in this review were 1,792 in CSF of international competitiveness of enterprises during crisis. Exclusion and inclusion criteria are presented in Table 1.

In conclusion, this review article utilises bibliometric analysis using VOSviewer version 1.6.20, which is considered as one of the most commonly used software in the area of bibliometric analysis. The main reason for carrying out this research is that the international competitiveness of enterprises has evolved into a compelling research area with growing research numbers. Thus, it is required to investigate the thematic structure of research in this field with a focus on times of crisis. The study relies on tools capable of analysing extensive and documented literature data. This research aims to provide meaningful insights into the key discussions and emerging trends related to the international competitiveness of enterprises in the context of crisis management.

Table 1. Inclusion and exclusion criteria for data screening in review paper

Inclusion criteria	**Searches for all variations of CSFs, ensuring inclusiveness**: "critical success factors" OR "key success factors" OR "CSFs" OR "determinants of success" OR "success criteria"
	Target documents relevant to different types of organisations: "enterprises" OR "businesses" OR "organizations" OR "firms" OR "companies" OR "corporations"
	Captures a wide range of crisis-related scenarios: "crisis" OR "crises" OR "pandemic" OR "economic crisis" OR "financial crisis" OR "recession" OR "market turbulence" OR "supply chain disruption" OR "global disruption"
	Focuses on dimensions of competitiveness: "competitiveness" OR "market positioning" OR "competitive advantage" OR "business performance" OR "value creation" OR "innovation capacity"
Exclusion criteria	**Limit publication years**: PUBYEAR > 1998 AND PUBYEAR < 2025: limits the search to publications from 1998 to 2024, covering recent and relevant decades
	Limit to areas of business, social sciences and economics to ensure contextual relevance: LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ECON")
	Limit document type to journal articles, excluding reviews, conference papers or other formats: LIMIT-TO (DOCTYPE, "ar")
	Limit language to ensure the results are in English for ease of analysis: LIMIT-TO (LANGUAGE, "English")
	Limit publication stage to exclude preprints or drafts, focusing on finalised publications: LIMIT-TO (PUBSTAGE, "final")

Source: author's criteria based on Scopus search parameters and PRISMA guidelines.

2. Findings

This bibliometric review article investigates enterprise competitiveness under crisis conditions. The primary aim is to uncover the research landscape surrounding critical success factors (CSFs) that contribute to enterprise readiness and sustained competitiveness during crises. Based on the research questions, the findings of the review are presented below.

RQ1: What is the distribution of critical success factors (CSFs) for enterprises competitiveness during crises, as reflected in publications from 1998 to 2024?

This section addresses the distribution of critical success factors (CSFs) for enterprise competitiveness during crises, in response to Research Question 1 (RQ1). Figure 2 depicts the significantly increasing number of papers in Scopus databases between 2018 and 2024, with 2024 contributing the most with 428 articles, followed by 425 articles in 2023. It is clear that there was little discussion of this sub-

ject prior to 2018, with fewer than 50 articles, but a significant increase occurred between 2020 and 2024, which corresponds to the COVID-19 period.

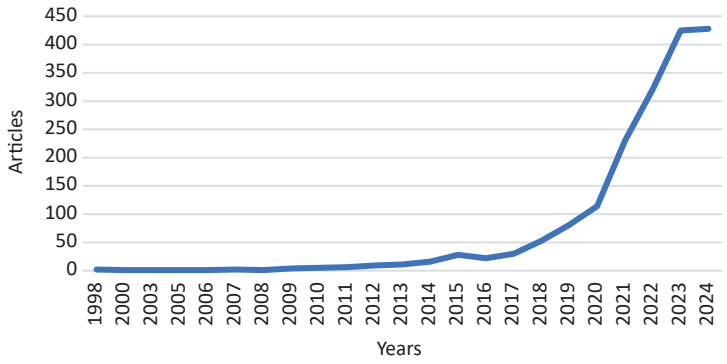

Figure 2. Annual number of publications related to critical success factors (CSFs) for enterprise competitiveness during crises

Source: Scopus, accessed 3 January 2025.

Concurrently, Figure 3, based on the Scopus database, shows the distribution of the retrieved articles by research field from 1998 to 2024. It shows that the fields of business, management, accounting and social sciences dominate, accounting for approximately 46% of the total 1,792 articles. This is followed by environmen-

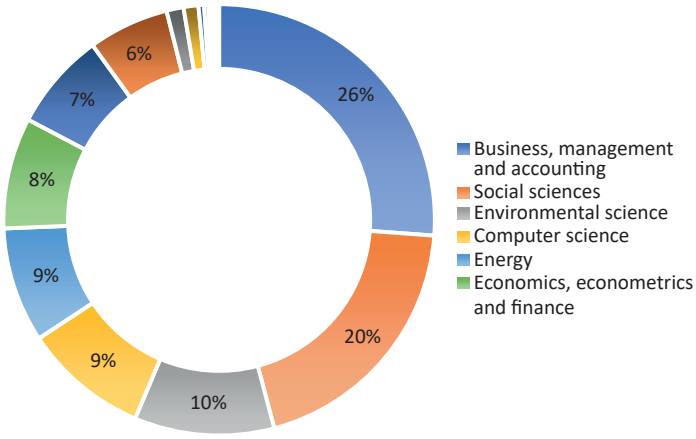

Figure 3. Subject area distribution of selected publications on CSFs and enterprise competitiveness in crisis contexts

Source: Scopus database, accessed 3 January 2025.

tal science (10%), economics, econometrics and finance (8%), decision sciences (7%) and engineering (6%).

RQ2: Which journals and authors have been most influential in publishing research on critical success factors for enterprise competitiveness during crises, as identified through the bibliometric analysis from 1998 to 2024?

Table 2 presents the top ten journals and includes the following data: "Total Publication (TP)", "Total Citation (TC)", "Cite Score of the journal", "The most cited article", "Times cited" and "Publisher of the journal". Sustainability (Switzerland) is the top journal, with 57,100 articles, 413,020 citations and a cite score of 7.2 in 2024. The table below lists the top ten journals.

Table 2. Top 10 journals in the international competitiveness of enterprises during crisis conditions according to the Scopus database

Journal	Number of articles using the query	TP	TC	Cite score	The most cited article	Times cited	Publisher
Sustainability (Switzerland)	319	57,100	413,020	7.2	Recent Advances in the Remediation of Textile-Dye-Containing Wastewater: Prioritizing Human Health and Sustainable Wastewater Treatment	64	Multidisciplinary Digital Publishing Institute (MDPI)
Cogent Business and Management	44	2,043	9,136	4.5	Exploring the evolution of creative accounting and external auditors: Bibliometric analysis	18	Cogent OA
Journal of Open Innovation: Technology, Market, and Complexity	37	883	11,178	12.7	Reducing transport sector CO2 emissions patterns: Environmental technologies and renewable energy	33	Elsevier
Journal of Cleaner Production	28	18,876	375,170	19.9	Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions	114	Elsevier

cont. Table 2

Journal	Number of articles using the query	TP	TC	Cite score	The most cited article	Times cited	Publisher
Uncertain Supply Chain Management	27	534	2,984	5.6	Utilizing blockchain technology in enhancing supply chain efficiency and export performance, and its implications on the financial performance of SMEs	36	Growing Science
Business Strategy and the Environment	26	1,215	28,456	23.4	Digitalization transformation and ESG performance: Evidence from China	88	John Wiley & Sons
SAGE Open	24	4,022	13,464	3.3	Modeling the Consumers' Flow Experience in E-commerce: The Integration of ECM and TAM with the Antecedents of Flow Experience	59	SAGE
Technological Forecasting and Social Change	23	2,928	72,165	24.6	Pathways towards carbon neutrality in low carbon cities: The role of green patents, R&D and energy use for carbon emissions	51	Elsevier
Journal of Business Research	17	3,243	76,633	23.6	The authentic virtual influencer: Authenticity manifestations in the metaverse	55	Elsevier
Administrative Sciences	15	896	4,680	5.2	Enhancing the Competitiveness of AI Technology-Based Startups in the Digital Era	13	Multidisciplinary Digital Publishing Institute (MDPI)

Note: TP – total publications, TC – total citations.

Source: Scopus, last updated for 2024 on 5 December 2024.

Figure 4 displays the ranking of the most influential authors based on analytics from the Scopus database, using the search query outlined in the methodology section. According to the data, A. F. Kineber holds the top position with ten published articles. He is followed by S. Luthra, A. Lutfi, and J. Antony, each with eight publications. Y. K. Dwivedi, J. A. Garza-Reyes, and A. Gunasekaran follow closely, with seven articles each. Rounding out the top ten are M. Alrawad, A. Kumar and A. E. Oke, each contributing six articles.

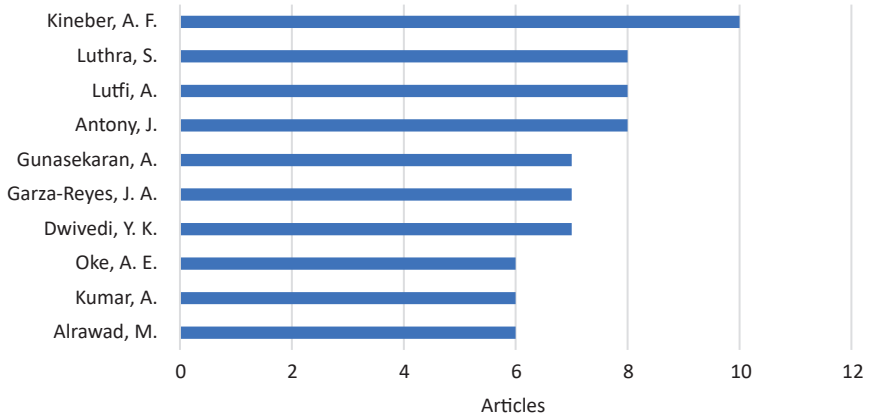

Figure 4. Most prolific authors contributing to research on CSFs and enterprise competitiveness during crises, based on publication count in Scopus (1998–2024)

Source: Scopus, accessed 3 January 2025.

RQ3: Which countries and institutions have been most productive in publishing research on critical success factors for enterprise competitiveness during crises between 1998 and 2024?

Table 3 shows the country and number of published articles based on the Scopus database and the keywords used in the query. According to the final list of articles, the United Kingdom has published the most, with 295 articles, followed by China with 158. This data suggests a significant academic interest in those two countries,

Table 3. Top 10 countries and educational institutions

Country	TP of the country using the final query	Educational institution of the highest cited article in the country
United Kingdom	295	Swansea University
China	158	Soochow University
Malaysia	138	Universiti Malaysia Perlis
India	135	Amity University
Spain	128	University of Alicante
United States	119	California State University
Italy	105	University of Padova
Indonesia	94	Universitas Islam Sultan Agung
Saudi Arabia	91	Mansoura University
South Africa	91	North-West University

Note: TP – total publications.

Source: Scopus database, accessed 3 January 2025.

which might be due to their well-developed research infrastructure and interest in the field of competitiveness of enterprises during a crisis. Malaysia and India follow with 138 and 135 articles, respectively. South Africa and Saudi Arabia have the fewest articles in the top ten (91 articles), but their appearance in the top ten shows emerging research activity and growing interest in this area. Other notable contributors in the top ten include Spain, Italy and the United States.

Figure 5 shows the distribution of affiliations, with the most prominent organisations being the University of Johannesburg, Applied Science Private University, King Faisal University, Al-Balqa Applied University, Silesian University of Technology and Universiti Utara Malaysia. These findings suggest that the critical success factors for enterprise competitiveness during crises align with overarching trends, thereby enriching our understanding of overall enterprise development.

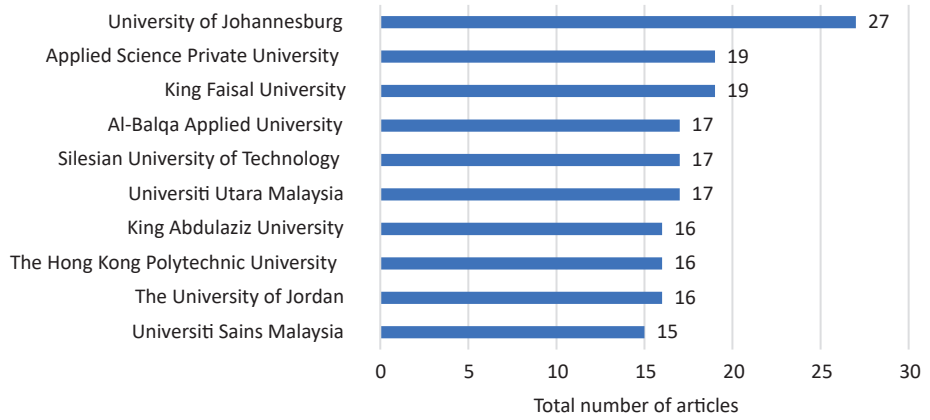

Figure 5. Distribution of publications by institutional affiliation, showing the top contributing organizations in CSF-related research during crisis contexts

Source: Scopus database, accessed 3 January 2025.

RQ4: What are the primary research keywords and thematic trends from 1998 to 2024 related to critical success factors for enterprise competitiveness during crises?

This section examines the keywords most commonly linked to enterprise competitiveness and critical success factors (CSFs) in crisis contexts. Using VOSviewer and based on the co-occurrence analysis of the 1,792 articles extracted from the Scopus database, Table 4 (below) presents the top 20 most frequent keywords, their occurrence counts and total link strengths.

Table 4. Top 20 keywords occurrences in the final dataset (1998–2024)

Rank	Keyword	Occurrences	Total link strength
1	sustainability	251	527
2	COVID-19	143	212
3	innovation	131	215
4	sustainable development	127	267
5	supply chain management	109	225
6	decision making	80	153
7	industry 4.0	66	137
8	SMEs	65	69
9	business	64	148
10	performance	60	52
11	digital transformation	56	122
12	strategic approach	55	158
13	manufacturing	51	133
14	small and medium-sized enterprise	47	150
15	competitiveness	45	77
16	project management	45	65
17	supply chains	44	83
18	critical success factors	42	57
19	stakeholder	39	101
20	artificial intelligence	39	60

Source: author's analysis using VOSviewer (based on Scopus data).

Additionally, Figure 6 presents the distribution of authors' keywords generated using VOSviewer, with a minimum occurrence threshold of 30. This led to five different clusters of keywords, each category reflecting a particular thematic focus within the literature on enterprise competitiveness in times of crisis.

The following list presents a full analysis regarding these five clusters marked by the VOSviewer:

1. **First cluster (red)**: it includes keywords with high occurrence values: sustainability (251), COVID-19 (143), sustainable development (127), supply chain (127), decision-making (80), business (64), stakeholder (39), strategic approach (55), competitiveness (45) and entrepreneurship (32). The first cluster draws attention to the importance of technical innovation and digital transformation as key drivers of resilience and success in the modern environment.
2. **Second cluster (green)**: this cluster has the following keywords with their occurrence value regardless of their order: Industry 4.0 (66), technology adoption (34), digitization (36) and critical success criteria (42). The second cluster

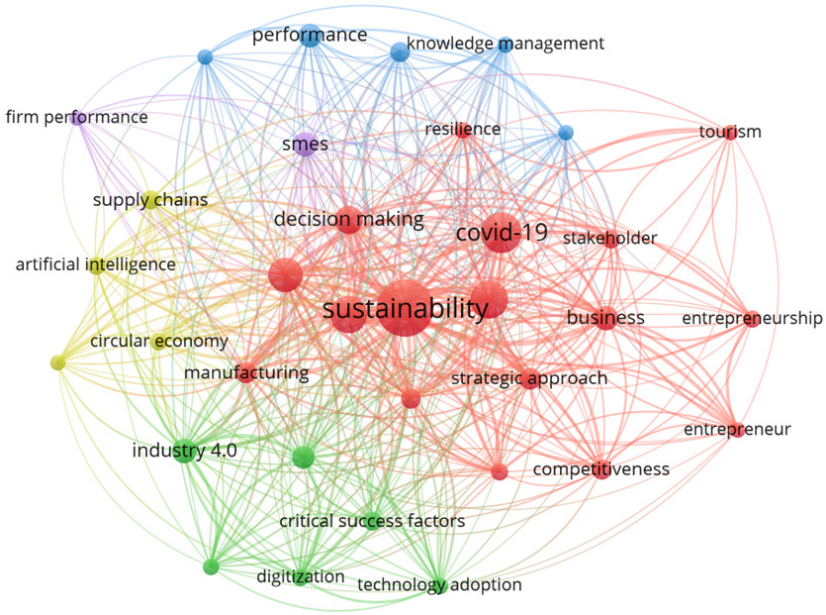

Figure 6. Network visualisation of keyword co-occurrence on critical success factors for enterprise competitiveness in crises

Source: author's analysis using VOSviewer (based on Scopus data).

spotlights the drivers of resilience and success in today's dynamic landscape, such as digital transformation and technical innovation.

3. **Third cluster (blue)**: it covers many keywords such as performance (60), competitive advantage (32), knowledge management (35), performance assessment (30) and project management (45). This cluster concentrates on the importance of studying the strategies that businesses follow to handle crises by means of resilience and performance.
4. **Fourth cluster (purple)**: it covers SMEs (65) and firm performance (32) keywords. It raises awareness of small and medium-sized businesses, and it investigates how they can improve their performance, especially in times of crisis.
5. **Fifth cluster (yellow)**: this cluster focuses on the following keywords along with their occurrence values: circular economy (36), artificial intelligence (39), supply chain (31) and supply chains (44). This cluster focuses on modern technologies – such as artificial intelligence (AI) – that improve competitiveness and resource economy as well as on sustainable production methods.

The five clusters reveal interconnected dimensions of business competitiveness during crises: sustainability and crisis management (red) is enabled by technological capabilities (green), which in turn drives firm performance and resilience

(blue/purple), while being shaped by emerging paradigms like circular economy and AI (yellow). The dense network of interconnections visible in Figure 6 demonstrates how contemporary research on firm competitiveness in challenging contexts requires an interdisciplinary approach, integrating aspects from all five identified clusters.

Moreover, clicking on the "competitiveness" keyword will highlight its links with other important keywords, which are shown clustered around it, as illustrated in Figure 7.

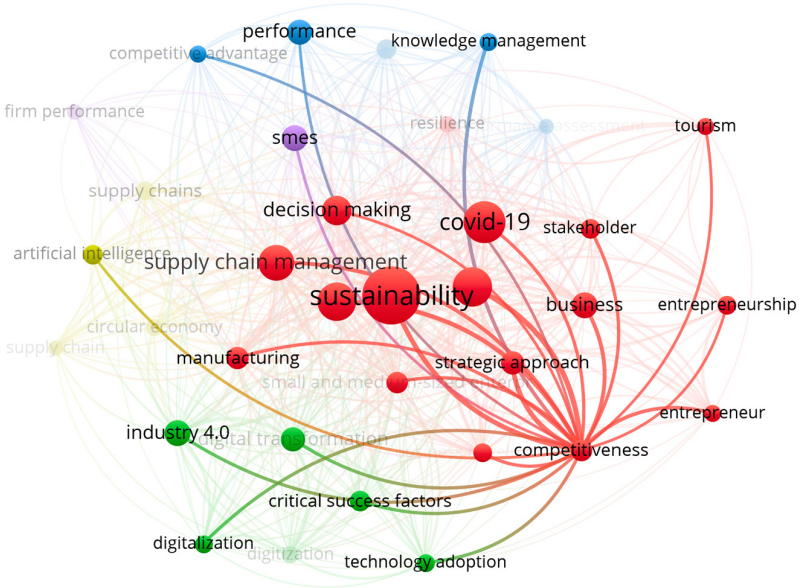

Figure 7. Network visualisation of keyword co-occurrence on critical success factors for enterprise competitiveness in crises (clustered around the competitiveness keyword)

Source: author's analysis using VOSviewer (based on Scopus data).

In Figure 7, the following critical success factors (CSFs) for enterprise competitiveness during crises are highlighted based on VOSviewer analysis, co-occurrence patterns and the prominence of specific terms in the keyword map. Notably, "Sustainability", "Competitiveness" and "COVID-19" frequently appear together, suggesting that long-term sustainability and ethical behaviour are essential for surviving disruptions.

1. **Resilience**: which highlights the importance of organisational adaptability and crisis recovery in gaining a competitive edge. This is reflected from the link between competitiveness, performance and SMEs.

2. **Technology adoption**: this critical key factor is reflected in keywords such as industry 4.0, AI and technology adoption. This factor emphasises the importance of using current technologies to retain efficiency, innovation and adaptability during crises.
3. **Digital transformation**: based on the keyword "digitalization" which emphasises technology and process optimisation as a critical success factor (CSF) to sustain innovation and entrepreneurial capacity for adaptation, particularly in times of crisis, this could be another important component.
4. **Stakeholder**: another critical success factor identified through the keyword "stakeholder". It emphasises how important it is for all stakeholders to have solid relationships and use information effectively.
5. **Knowledge management**: it could be another key factor that underscores the need for strong and effective use of information, which is required for well-coordinated, competent decision-making in the face of ambiguity.
6. **Entrepreneurial and strategic approach**: the emphasis on phrases such as entrepreneurship, decision-making and strategic approach conveys a clear message – to successfully go through unpredictable and tough situations, leaders must take the initiative, have an opportunity-seeking mindset and have adaptable strategies.

Figure 8. summarises the important key factors identified through keywords centred on the term "competitiveness".

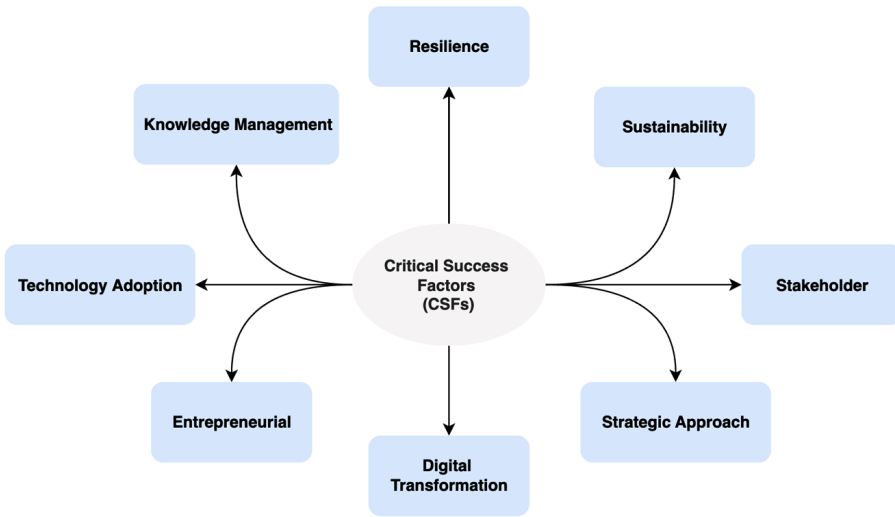

Figure 8. Critical success factors (CSFs) based on terms clustered around "competitiveness"

Source: author's analysis using VOSviewer.

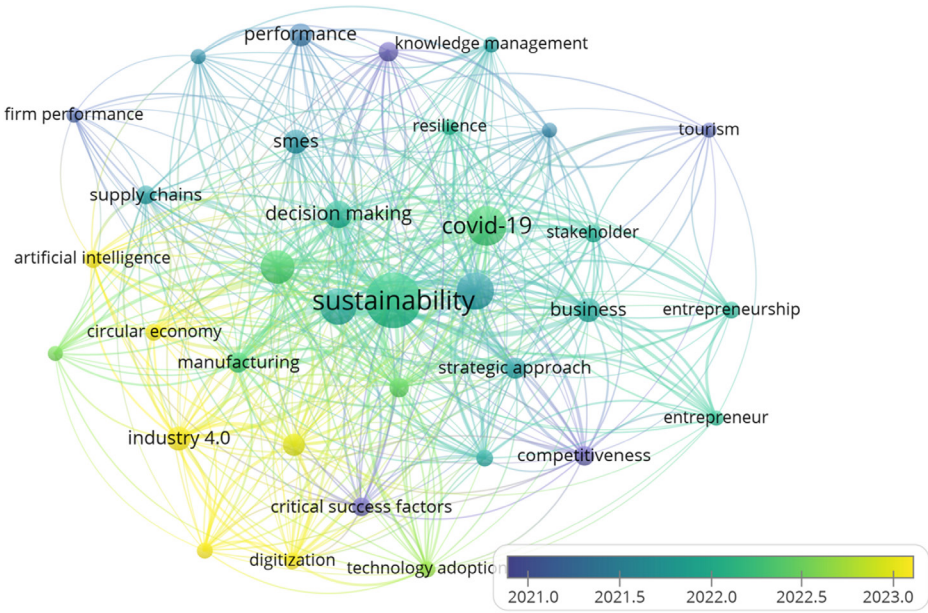

Figure 9. Overlay visualisation of past, current and future research trends on critical success factors for enterprise competitiveness in crises

Source: author's analysis using VOSviewer (based on Scopus data).

Furthermore, Figure 9 displays another output from VOSviewer after uploading all the articles collected from the Scopus database using the defined query. This visualisation illustrates evolving research trends related to critical success factors for enterprise competitiveness during crises. The network of keywords brings to the fore different key topics such as sustainability, decision-making, supply chains and resilience. Moreover, it presents the interconnections among different keywords. The gradient of colour in the map of keywords represents the timeline from 2021 (blue) to 2023 (yellow), indicating the shift in focus areas over time. Darker colours represent earlier studies, pointing out topics like knowledge management and firm performance. In contrast, lighter colours signify more recent research, demonstrating how it increasingly explores themes like artificial intelligence, Industry 4.0, digitization and the circular economy. Hence, there is increased attention on technology-driven and sustainable approaches to enterprise resilience and competitiveness. The visualisation shows that both sustainability and COVID-19 were major factors in how businesses adapted their strategies during turbulent times.

3. Discussion

An in-depth exploration of the critical success factors (CSFs) that influence enterprise competitiveness during crises was the main topic for this bibliometric review. The main findings were structured around four key research questions. Each question was written precisely to offer a unique insight into the evolution, impact and future directions of research in this field. Addressing these four questions systematically does not only offer a broad perspective on the current state of research but also identifies important theme clusters and developing patterns that influence an enterprise's resilience in a rapidly changing environment.

3.1. Evolution and distribution of CSFs in crisis conditions (RQ1)

Scholars' interest in CSFs in crisis conditions for enterprises is growing sharply. This is evident from the increase in the number of publications between 2018 and 2024. This reflects increasing scholarly attention in understanding and developing key strategies that enterprises can use to maintain competitiveness during times of crisis. Also, it's clear from the Scoups data that the number of publications increased dramatically after 2020, which is caused by the global economic disruptions caused by the COVID-19 pandemic, as supported by different sources (Burcă et al., 2024; Javed et al., 2024; Maden et al., 2024; Orjuela et al., 2023). This period during the pandemic emphasised the need for resilient business strategies. Prior to 2018, there was less research on this, which raises the question of whether the 2008 financial crisis simply did not spark the same level of academic interest that the pandemic did.

The distribution of disciplines also yields significant analytical findings: business, management and social sciences predominate, accounting for almost half of all publications, while fields like environmental science and decision sciences add much. This distribution points to an interdisciplinary methodology where competitiveness is not just an economic issue but also a strategic and environmental one in times of crisis. Innovation in enterprise sustainability is supported by the presence of engineering research (6%) that suggests the impact of technical improvements in crisis resilience.

3.2. Influential journals, authors and thought leadership (RQ2)

This question aims to identify the most influential publications and writers in the field of CSFs for competitiveness during crisis, as well as to reveal the schol-

arly networks that propel knowledge development. The top publication outlet with the greatest citation impact was Sustainability (Switzerland). The strategic role that enterprises play in attaining sustainable development is examined in the paper "Strategic transition to sustainability: A cybernetic model" by Štrukelj et al. (2023). Since sustainability frequently involves long-term viability and resilience, the fact that Sustainability publishes such research indicates its involvement in examining the fundamental significance of sustainability in organisational strategy, which is essential when enterprises manage crises. This implies that the idea of sustainability is essential to how enterprises handle crises. Furthermore, journals such as the Journal of Cleaner Production as well as Business Strategy and the Environment emphasise the connection between competitive advantage and environmental responsibility, especially during difficult times.

A focused group of academics are driving the discussion on enterprise competitiveness in crisis situations, as evidenced by a review of important authors. The discussion has benefited greatly from the contributions of A. F. Kineber, S. Luthra and A. Lutfi, who represent a variety of viewpoints on digital transformation, company resilience and strategic decision-making. Although there are still differences in geographical representation, the participation of authors from many countries further suggests a global academic effort to address these issues.

3.3. Geographic and institutional research productivity (RQ3)

The United Kingdom leads in the number of publications on this topic. Based on the geographic distribution of research output, it is followed by China, Malaysia and India. This acts as an indication that corporate competitiveness and crisis management are central to a strong academic infrastructure in these regions. The dominance of Asian and European nations is in line with their vigorous industrial sustainability and economic resilience initiatives.

Moreover, Saudi Arabia and South Africa rank among the top ten contributors. Even though these countries are producing comparatively less research, there is still an increased interest in this field, which may reflect more general economic measures aimed at improving corporate sustainability in the face of global upheavals and financial volatility. Leading universities such as Swansea University, Soochow University and Universiti Malaysia Perlis have also made substantial contributions to knowledge advancement by serving as regional centres for industrial research focused on crises.

3.4. Thematic trends and critical success factors (RQ4)

Using VOSviewer, a keyword analysis reveals important themes in corporate competitiveness in times of crisis. The prevailing themes of sustainability, innovation, supply chain management and digital transformation demonstrate the tactical methods used by businesses to weather disasters. The five thematic clusters – knowledge management, stakeholder engagement, resilience, sustainability and technology adoption – showcase interrelated aspects of corporate success in challenging times.

1. **Sustainability and crisis management**: the popularity of terms like "sustainable development", with 127 occurrences, "COVID-19", with 143 occurrences and "sustainability", with 251 occurrences, indicates that long-term ethical and environmental measures are essential for crisis resilience. Businesses that apply sustainability concepts typically exhibit increased stakeholder trust and flexibility. Numerous articles specifically address how sustainability and enterprise performance are related (Burcă et al., 2024; Matinaro et al., 2019; Setyaningrum & Muafi, 2023), how important sustainable development is in a changing business environment (Burcă et al., 2024), and how supply chain management may incorporate sustainability (Javed et al., 2024; Khan et al., 2023).
2. **Technology adoption and digital transformation**: the use of keywords such as "digitization", with 36 occurrences, "artificial intelligence", with 39 occurrences, and "Industry 4.0", with 66 occurrences, paints a picture of how important cutting-edge technologies are to preserving competitiveness. Moreover, the importance of adopting digital technologies and undergoing digital transformation is a common theme (Calderon-Monge & Ribeiro-Soriano, 2024; Souza et al., 2024; Troise et al., 2022). Businesses that use automation, blockchain and artificial intelligence seem better able to handle operational difficulties and supply chain interruptions (Ayan et al., 2022; Javed et al., 2024; Vongurai, 2024). Moreover, in the post-COVID-19 age, implementing digital technologies is also associated with improving the performance of socially conscious activities (Asokan et al., 2022).
3. **Performance management and resilience**: the correlation between "competitiveness", "decision-making" and "knowledge management" draws attention to the operational and strategic facets of business survival (Mahdi & Nassar, 2021; Martinez et al., 2023; Troise et al., 2022). To lessen the effects of a crisis, resilient businesses place a high value on flexibility (Troise et al., 2022), real-time data analytics and well-informed decision-making (Nisar et al., 2023).
4. **Stakeholder engagement and strategic approaches**: the emphasis on "stakeholder", "entrepreneurship" and "strategic approach" implies that companies that prosper in times of crisis prioritise proactive market strategies (Florek-Paszkowska et al., 2021), leadership agility and cooperative networks

(Philsoophian et al., 2021). Additionally, it emphasises how important leadership choices are to an enterprise's ability to survive a crisis (Chudziński et al., 2022).
5. **Circular economy and sustainability-driven innovation**: businesses are depending more and more on resource efficiency and closed-loop systems to maintain long-term competitiveness (Kiefer et al., 2024), as seen by the rise of the terms "circular economy" and "supply chain" as major themes. Numerous sources emphasise how unsustainable the linear economy is and how improving resource utilisation requires a shift to a circular economy (Kannan et al., 2024; Kiefer et al., 2024).

A change in research focus is also revealed by the keyword co-occurrence timeline. While knowledge management and business performance were the focus of earlier studies (before 2020), more recent studies (2021–2024) have shifted their focus to artificial intelligence, Industry 4.0 and digital resilience. According to this trend, enterprises are not shifting from reactive crisis management to technology-driven, proactive approaches for sustained competitiveness.

3.5. Emerging directions and gaps

1. **Integration of digital and sustainable strategies**: enterprises' approach to crisis responses is changing to balance social, environmental and economic imperatives. This is indicated by the continuous emphasis on digital technologies (digital transformation, digitization) in conjunction with environmental aspects (sustainability, circular economy).
2. **SMEs and crisis adaptation**: although this group of keywords appears frequently, further research may be necessary to fully examine the unique difficulties and creative coping strategies faced by SMEs.
3. **Long-term competitiveness**: Although competitiveness ranks 19th in the list of keywords according to VOSviewer, there is still an opportunity to investigate how these top keywords come together to provide a comprehensive strategy framework that can guarantee both survival and long-term growth after the crisis.

These findings suggest that the academic community is responding not only to empirical disruptions, such as COVID-19, but also to deeper concerns about organisational adaptability, environmental fragility and global interconnectivity. The consistent emphasis on digital transformation, sustainability and stakeholder engagement indicates a shift in how competitiveness is being reconceptualised – not merely as efficiency or profitability, but as long-term viability in complex, uncertain environments. This change reflects both real-world business needs and a broader evolution in scholarly thinking.

Although this review provides a thorough mapping of authors, journals and keywords, its main goal is to explain the evolution of enterprise competitiveness research during crises and its future directions. The bibliometric approach is used to show how disparate discussions in domains such as business, economics, sustainability and crisis management are starting to come together around common issues, in addition to counting publications and visualising keywords. These consist of adaptability to change, resilience and long-term value generation. By classifying and analysing these patterns, the study hopes to inform future research and practice, assisting academics, decision-makers and business executives in developing strategies that are not only reactive but also flexible and proactive.

Conclusions

Examining the critical success factors (CSFs) that enhance enterprise competitiveness during crises was the main goal of this bibliometric review. In addressing four primary research questions, several important findings emerged. First (RQ1), a descriptive analysis of publication trends from 1998 to 2024 confirmed a steady rise in scholarly attention to crisis-related competitiveness topics, with a marked surge following global disruptions, such as the COVID-19 pandemic. Analysis revealed a distinct shift in publication trends. Before 2018, the scholarly output on this topic was limited. However, a significant surge in research occurred after 2020, suggesting a heightened sense of urgency and scholarly focus driven by the crises precipitated by the COVID-19 pandemic.

Regarding the second research question (RQ2), the analysis shows Sustainability (Switzerland) as the most active journal, with numerous publications focused on enterprise resilience and sustainable initiatives. Furthermore, A. F. Kineber and S. Luthra were among the most prolific contributors to this field. These influences impact current discussions about how businesses may stay ahead of the competition in dynamic market conditions. This is through improved supply chain management, digital transformation or strategic innovation.

Third (RQ3), the geographic distribution of research output indicates that the UK was the most productive nation in crisis-focused competitiveness research, followed by China, Malaysia and India. Strong citation impacts were shown by prestigious universities, such as Swansea University and Soochow University, indicating thriving networks of academic engagement and collaboration in these areas. The inclusion of South Africa and Saudi Arabia in the top ten list presents an increase in the interest of the topic among emerging economies and the expanding

geographical diversity in crisis management research, suggesting its increasing recognition across different economic contexts.

Additionally, regarding (RQ4), a keyword co-occurrence analysis highlighted supply chain management, innovation and sustainability as key themes. While digital transformation and technology adoption highlight the role of advanced technologies in strengthening enterprise resilience, references to COVID-19 draw attention to the recent surge in pandemic-related studies. The frequent reference to SMEs, stakeholders and the circular economy highlights the raising awareness of the value of sustainability principles and a variety of organisational structures for crisis preparedness and long-term competitive advantage.

In summary, this bibliometric review identified several key themes central to enhancing enterprise competitiveness during crisis conditions. Based on keyword co-occurrence patterns and thematic clustering across 1,792 articles, the following five critical success factors (CSFs) consistently emerged as the most influential:

1. Sustainability – integrating long-term environmental and social objectives into business strategy to enhance resilience and stakeholder trust.
2. Digital transformation – adopting advanced technologies to drive innovation, operational agility and adaptability in uncertain environments.
3. Organisational resilience – the capacity to absorb shocks, recover from disruptions and maintain continuity in performance.
4. Stakeholder engagement – fostering strong relationships with internal and external stakeholders to support coordinated crisis response.
5. Knowledge management – leveraging institutional learning, data analytics and information flow to support timely and informed decision-making.

These five CSFs form the conceptual foundation for enterprise crisis preparedness and long-term competitiveness. They offer a strategic framework for both academic inquiry and managerial practice in increasingly volatile environments.

Implications for practice: The results of this study offer practical guidance for enterprise leaders and policy decision-makers navigating crisis situations. Rather than relying on academic literature, the following actionable priorities can be integrated directly into planning and operations:

1. Embed sustainability in core strategies: focus on long-term value by incorporating environmental and social considerations into key business decisions. This approach enhances stability and reputation during times of disruption.
2. Advance digital readiness: strengthen technological infrastructure by adopting tools like artificial intelligence and data platforms, enabling real-time decision-making and operational flexibility in unpredictable conditions.

3. Enhance supply network robustness: mitigate risk by broadening supplier bases, utilising digital monitoring tools and reinforcing localised or diversified sourcing strategies.
4. Foster inclusive communication with stakeholders: maintain clear, consistent dialogue with employees, partners and public institutions to improve coordination and trust throughout periods of uncertainty.
5. Develop organisational learning systems: capture and systematise crisis experiences to inform future decisions. Encouraging reflective practices and internal training will support ongoing adaptation.

Governments can facilitate these actions by offering financial and infrastructure support, promoting sustainability-focused incentives and encouraging collaboration between sectors. By doing so, enterprises can become more adaptable, future-focused and better equipped to maintain competitiveness in volatile environments.

Limitations: Even though this bibliometric review paper is based on a solid scientific approach, it has certain limitations. Firstly, relying on the Scopus database may lead to missing some publications in other databases, such as Web of Science or Google Scholar. Secondly, depending on English-language articles may result in missing important research published in other languages. Thirdly, the bibliometrics' quantitative emphasis is unable to adequately capture contextual specificities or qualitative subtleties, such as regional business practices or industry quirks, that may have an impact on how enterprises deal with crises.

Future research directions: Extending data sources to encompass various bibliographic databases – such as Web of Science, and others – in future studies will enhance the breadth and depth of coverage. Additionally, to verify whether the main factors for the success of an enterprise are consistent across contexts or dependent on specific situations, comparing various crises, such as financial downturns, natural disasters and health emergencies, is critical. Furthermore, detailed case studies of successful enterprises or national economies could clarify how theoretical factors translate into actionable plans in the real world. Additionally, it may be necessary to further examine the distinct challenges and innovative responses encountered by Small and Medium-sized Enterprises (SMEs). Lastly, researchers could explore longitudinal or network-based approaches to understand how cooperative relationships among universities, industries and governments influence ongoing innovations in crisis preparedness and competitiveness.

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Enhancing financial inclusion through Shari'a-compliant microfinance: A case study of Al-Amal Microfinance Bank in Yemen

Mourad Hamadi[1] **Abdelfateh Tebani**[2]
Abdeslam Hetatache[3]

Abstract

This study explores the role of Shari'a-compliant microfinance in advancing financial inclusion and improving socio-economic conditions, with a particular focus on serving the financial needs of marginalised populations in rural areas. Through a case study of Al-Amal Microfinance Bank in Yemen, the research highlights the bank's effectiveness in expanding access to financial services via tailored solutions and strategic outreach. By deploying a network of financial and non-financial agents in remote areas, alongside digital banking platforms, Al-Amal Bank successfully mitigates barriers such as distance, cost and accessibility. The integration of electronic services further enhances financial access, contributing to more inclusive development across the country.

Keywords

- Shari'a compliant microfinance
- financial inclusion
- financial integration
- electronic banking services

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[1] Ferhat Abbas University Setif 1, El Bez Campus, Sétif 19137, Algeria, mourad.hamadi@univ-setif.dz
[2] Ferhat Abbas University Setif 1, El Bez Campus, Sétif 19137, Algeria, corresponding author: abdelfateh.tebani@univ-setif.dz; fatehfate@yahoo.fr
[3] Ferhat Abbas University Setif 1, El Bez Campus, Sétif 19137, Algeria, abdeslam.hetatache@univ-setif.dz

Introduction

Financial inclusion is widely recognised as a critical driver of economic and social development. In response, many countries have prioritised the promotion of financial integration and the removal of barriers that hinder equitable access to financial services. This emphasis stems from the close linkage between financial inclusion, macroeconomic stability and sustained economic growth. By increasing competition among financial institutions and encouraging product innovation, financial inclusion enhances service quality and broadens customer outreach.

In pursuit of broader societal welfare and sustainable development, many countries have actively designed innovative financial products and services aimed at promoting financial inclusion. These efforts are primarily targeted at extending access to financial services across all segments of society, particularly among economically disadvantaged populations. Microfinance has become a key tool in this effort, empowering individuals in underserved communities and fostering both social and economic autonomy.

Yet traditional microfinance is proving largely ineffective, particularly in the Arab world (Allegret et al., 2018). Numerous micro and small projects are challenged to be financially viable for operational reasons (e.g. the high cost, the scale). These problems are exacerbated by religious considerations; a large part of the population is reluctant to use mainstream interest-based finance institutions.

As a result, there is an urgent need to explore alternative funding mechanisms that are better suited to the specific nature of small-scale and community-based projects. These mechanisms must consider variables such as project size, business activity, income levels and profit potential. In this regard, Islamic finance presents a viable and culturally congruent alternative to conventional financial systems. Rooted in ethical principles that prohibit interest (riba) and emphasise social justice, Islamic finance relies on profit-and-loss sharing arrangements and risk-sharing instruments. This structure aligns closely with the values and preferences of communities that seek financial services consistent with their religious beliefs.

1. Literature review

The literature on the role of Shari'a-compliant microfinance in promoting financial inclusion emphasises its significance as a powerful tool for promoting inclusive economic growth and reducing poverty. Scholars and researchers have explored various dimensions of this topic, providing insights into the mechanisms and im-

pact of Shari'a-compliant microfinance on expanding financial access and fostering inclusive development. Key themes and findings include:

1.1. General concepts about financial inclusion

The term "financial inclusion" was first introduced in 1995 by Leyshon and Thrift in their study of financial services in Southeast England, which examined how the closure of bank branches affected residents' access to formal banking systems (Leyshon & Thrift, 1995; Mazumder & Korhonen, 2019). By 1999, the concept gained wider recognition and was increasingly used to explore the specific factors that determine individuals' access to formal financial services (Bramley & Besemer, 2018).

1.1.1. Financial inclusion definition

Consistent terminology is essential for analytical clarity in financial inclusion research. According to the World Bank (2022), financial inclusion refers to individuals and businesses having access to useful and affordable financial products and services – including payments, savings, credit and insurance – that are delivered responsibly and sustainably. In contrast, financial access refers specifically to the availability of financial services, while financial usage involves the regularity, frequency and depth of use.

The term financial integration is sometimes used to describe the process of incorporating informal or excluded populations into the formal financial system, but this should not be conflated with broader economic integration. Finally, financial sustainability refers to the ability of financial institutions to continue delivering services over the long term without external subsidies. These definitions serve as the framework for evaluating Al-Amal Bank's contributions throughout this study.

A key objective of financial inclusion is to prevent individuals from turning to informal financial channels, which are often costly, poorly regulated and prone to exploitation (Arab Monetary Fund, 2015). By offering access to secure and regulated services, financial inclusion promotes consumer protection and financial stability.

More comprehensively, financial inclusion encompasses the ability of individuals – particularly those with limited incomes – and businesses, including micro and small enterprises, to access and effectively use a broad range of high-quality formal financial services, such as payments, savings, credit, transfers and insurance. These services must be delivered responsibly, affordably and sustainably, within a sound legal and regulatory framework (CGAP, 2004). It also involves regulatory initiatives aimed at expanding financial access equitably across all societal seg-

ments, including marginalised populations, while ensuring fairness, transparency and cost-efficiency (Anderloni & Carluccio, 2007; Saber, 2023).

1.1.2. Financial inclusion dimensions

In recent years, the concept of financial inclusion has expanded to encompass four core dimensions: (1) ease of access to financial services, (2) compliance with regulatory and supervisory standards, (3) financial sustainability of service providers, and (4) market competition among financial institutions to enhance service quality and affordability (Khan & Siddiqui et al., 2022).

Access to financial services

This dimension refers to individuals' ability to obtain financial services from formal institutions. It involves identifying and overcoming access barriers such as high service costs, lack of documentation or geographic distance from service points. Data on accessibility is typically gathered through institutional records and user surveys.

Financial services usage

This refers to the extent and frequency with which clients utilise financial services offered by banking institutions. Measuring usage requires tracking user behaviour over time, including how often and how regularly individuals engage with services such as savings, credit and digital payments.

Financial services quality

Assessing service quality is particularly challenging due to its subjective and multi-dimensional nature. While financial inclusion initiatives in developing countries have made strides in improving access, disparities in the quality of services remain. Stakeholders must therefore focus on developing reliable indicators to measure, compare and improve service delivery across institutions, based on client satisfaction, responsiveness and efficiency.

1.1.3. The importance of financial inclusion

In recent years, the importance of financial inclusion has become evident, especially for its role in promoting equitable access to financial services and favouring economic actors to participate fully in the formal economy. This is particularly crucial for small and medium enterprises (SMEs), which serve as key contributors to economic growth, employment and export development.

Despite numerous efforts by Arab countries to support SMEs, their contribution to national economies remains uneven. In oil-producing countries, SMEs contribute around 22% to GDP, while in more diversified, oil-importing Arab economies, this figure can reach as high as 80% – significantly above the average of 40% observed in developing countries. This underscores the sector's potential to diversify sources of national income.

Egypt leads the region with SMEs contributing 80% to GDP, followed by Tunisia at 73% and the UAE at 49%. In contrast, the contributions are lower in Morocco (29%), Lebanon (27%) and Saudi Arabia (22.3%) (Nasr & Rostom, 2013). In terms of public sector employment, SMEs account for just 10% to 49%, which falls short of the 60% average in developing economies. These figures highlight the structural and financial challenges limiting the sector's ability to generate employment.

To address these gaps, many Arab nations are implementing strategies aimed at enhancing financial inclusion for SMEs. Studies estimate that narrowing the financial inclusion gap could lead to a 0.3% annual GDP growth in emerging markets, and up to 5% in certain Arab countries, provided that financing access and regulatory barriers are effectively addressed (Dahbia & Soumia, 2020).

1.2. General concepts about Shari'a-compliant microfinance

According to the International Finance Corporation (2017), approximately 70% of micro, small and medium-sized enterprises (MSMEs) in emerging markets face significant barriers to accessing formal financing — a finding further reinforced by the World Bank's MSME finance gap assessment (Bruhn et al., 2017).

The estimated credit gap reaches $5.2 trillion globally, rising to $8.1 trillion when informal sector enterprises are included. This substantial shortfall underscores the urgent need for innovative and inclusive financial models tailored to underserved segments.

1.2.1. Definition and principles of Shari'a-compliant microfinance

Islamic microfinance, also known as Shari'a-compliant microfinance, brings together the core values of Islamic finance with the development goals of traditional microfinance. Its primary focus is to support low-income and marginalised communities by providing financial services such as savings accounts, small loans, money transfers and insurance in ways that align with Islamic legal and ethical principles. These services are offered through financial contracts that avoid interest (riba), encourage risk-sharing between lender and borrower, and emphasise fairness, accountability and social equity.

Scholars offer multiple definitions, but they converge on core themes. Messah and Bessachi (2023) describe Islamic microfinance as the provision of cash or in-kind financing to support microenterprises, following Shari'a and national regulations. Ghanem (2010) emphasises the use of structured Islamic financial contracts to enable the poor to access formal financial services, contribute to economic development, and ensure compliance with both religious and technical standards.

In essence, Islamic microfinance is not merely a religious variant of microfinance; it represents a comprehensive framework that aligns economic activity with ethical and social objectives, making it particularly suitable for Muslim-majority societies with low financial inclusion rates.

1.2.2. Comparing Islamic and conventional microfinance models

While both conventional and Islamic microfinance aim to extend financial services to underserved populations, they are grounded in distinct philosophical and operational principles. Conventional microfinance is generally based on interest-bearing loans and market-driven repayment models, often supported by donor funding or social investment. In contrast, Shari'a-compliant microfinance prohibits *riba* (interest), emphasises risk-sharing and embeds social justice principles through non-profit mechanisms such as *Zakat*, *Qard al-Hasan*, and *Waqf* (Karim et al., 2008; Abdul Rahman, 2007).

One major limitation of conventional microfinance is its tendency to replicate commercial lending logics, which may impose high repayment burdens on low-income borrowers. Studies have shown that interest-bearing loans, even when small, can exacerbate indebtedness if not carefully managed (Dev, 2006). Islamic microfinance attempts to mitigate this risk through *Murabaha* (cost-plus sale), *Mudarabah* (profit-sharing) and *Ijara* (leasing), where financial risk is shared and economic activities must have a productive basis (Iqbal & Mirakhor, 2012).

Despite these ethical and theoretical advantages, Islamic microfinance has its own constraints. These include regulatory ambiguities, lack of standardisation and higher operational costs due to Shari'a compliance requirements (El-Zoghbi & Tarazi, 2013). Moreover, its outreach is often narrower, as many Islamic microfinance providers are relatively small and concentrated in certain regions.

In this context, Al-Amal Bank's model represents a hybrid approach. It combines Islamic financing instruments with digital delivery platforms and donor-backed programs to scale outreach. Unlike many Islamic MFIs that operate in isolation, AMB works in partnership with public and international stakeholders, making it a compelling case of applied Islamic finance in a fragile state environment. This positions it uniquely in the literature and offers practical insights into scaling inclusive finance without compromising religious adherence.

1.3. The importance of Islamic microfinance in achieving financial inclusion

The Islamic finance sector plays a vital role in promoting financial inclusion, particularly among individuals who voluntarily abstain from conventional banking due to religious beliefs. Islamic microfinance is uniquely positioned to bridge this gap by offering ethically aligned, Shari'a-compliant financial products to underserved populations. Its contributions to the financial inclusion agenda are multifaceted, addressing both structural and cultural barriers to access.

1.3.1. The role of Islamic microfinance in promoting financial inclusion

Islamic microfinance adds value to the financial inclusion agenda in several ways, including the following key aspects:

Risk sharing through integration

Profit- and risk-sharing contracts offer a practical and Shari'a-compliant alternative to conventional debt-based financing. These instruments, including *Mudarabah* and *Musharakah*, facilitate equitable financial access while promoting shared responsibility between institutions and clients. They have been applied effectively in microfinance, SME financing and micro-insurance contexts to expand outreach among underserved populations (Walters, 2011).

Islamic integration through redistribution tools

The Islamic financial system integrates distinctive wealth redistribution mechanisms such as Zakat, Sadaqah, Waqf and Qard al-Hasan. These non-profit-based tools complement commercial risk-sharing instruments and are specifically designed to support low-income individuals. Their integration into microfinance strategies fosters a more holistic approach to poverty alleviation and inclusive growth. With deep historical roots, these instruments have long been embedded in Islamic societies as means of social justice and community welfare (Iqbal & Mirakhor, 2012).

Inclusion of segments excluded for religious or cultural reasons

Conventional measures of financial inclusion within an economy typically focus on the coverage of the population by commercial bank branches and ATMs, alongside the aggregate volumes of deposits and loans involving low-income households and SMEs. Nevertheless, it is crucial to recognise that the presence of financial services does not inherently guarantee true financial inclusion. This distinction is particularly evident in numerous Muslim-majority societies, where

a considerable portion of the populace voluntarily abstains from engaging with traditional financial services, irrespective of their accessibility and affordability, due to prevailing religious or cultural factors (Sain et al., 2016).

1.3.2. Recent surveys and regional examples of demand for Islamic microfinance

Empirical studies have consistently shown strong demand for Islamic microfinance across a range of Muslim-majority countries. In Jordan, surveys conducted by the U.S. Agency for International Development and the International Finance Corporation revealed that between 25% and 32% of respondents cited religious beliefs as a primary reason for avoiding conventional loans. Similarly, a 2006 study in Algeria found that 20.7% of small business owners refrained from seeking credit due to religious objections (Haneef et al., 2014).

In Yemen, an estimated 40% of poor households express a clear preference for Islamic financial services, even if such services come at a higher cost. Likewise, a 2000 report from Bank Indonesia noted that 49% of rural residents believed interest-based transactions to be prohibited and preferred to bank with Shari'a-compliant institutions.

Globally, the level of self-exclusion from traditional financial systems is striking. According to Honohan (2008), approximately 72% of the population in Islamic countries abstains from using conventional banking services. Many of these individuals – particularly those lacking sufficient guarantees or collateral – remain unserved by existing financial institutions. Despite the growing number of Islamic microfinance providers, the sector still falls short of meeting total demand. It is estimated that more than 650 million people in Muslim-majority countries live on less than two dollars a day, underscoring the urgency of expanding inclusive and Shari'a-compliant financial solutions (El-Zoghbi & Tarazi, 2013; Hersi, 2018).

1.3.3. The importance of Islamic financial services in promoting financial inclusion

Bridging the financial inclusion gap for microenterprises in emerging markets and developing economies offers substantial economic and fiscal benefits. According to Blancher et al. (2019), increased access to finance for micro and small businesses contributes directly to higher employment rates and improved labour productivity, both of which are key drivers of annual GDP growth.

Financial inclusion also enhances job creation across diverse income groups. Macroeconomic analyses show that a 1% increase in credit to small and medium enterprises (SMEs) can reduce the unemployment rate by approximately 0.1% in

emerging economies – and by up to 0.2% in regions such as the Middle East, North Africa, Afghanistan, Pakistan and Central Asia (Blancher et al., 2019).

In addition to employment and growth benefits, improved financial inclusion strengthens macro-fiscal policy by broadening the tax base and improving tax collection. The same IMF study highlights that countries with wider financial access tend to report higher revenues and expenditures relative to GDP, indicating a more effective public finance environment.

Moreover, financial inclusion contributes to systemic financial stability – especially when supported by robust risk management frameworks and sound financial oversight. As banks and microfinance institutions diversify their lending portfolios by including microenterprises, their exposure to sector-specific risks is reduced, enhancing overall resilience (Blancher et al., 2019).

1.3.4. Benefits of increased financial inclusion for microenterprises

Bridging the financial inclusion gap for Microenterprises in emerging market and developing economies can bring several benefitss (Blancher et al., 2019):

- increase in annual economic growth by increasing employment and labour force productivity;
- increase in employment across all income groups in different countries. Macroeconomic surveys indicate that a 1% increase in credit to SMEs results in a 0.1% reduction in the unemployment rate in a sample of emerging market and developing economies, and by up to 0.2% in the Middle East, North Africa, Afghanistan, Pakistan, the Caucasus and Central Asia countries;
- increased financial inclusion of microenterprises is accompanied by increased effectiveness of macro fiscal policy, including improved tax collection;
- greater international revenue and expenditure (as a share of GDP), associated with broader financial inclusion, according to IMF findings;
- stronger financial stability, provided that strong risk management and financial control frameworks are in place. Increasing the provision of financing to micro, small and medium-sized enterprises can contribute to financial stability by allowing banks to diversify their credit portfolios and increase their risk exposure.

2. Methodology

Our study employs a qualitative case study methodology to explore how Islamic microfinance contributes to financial inclusion, with a particular emphasis on Al-

Amal Microfinance Bank (AMB) in Yemen. This case study approach is especially well-suited for acquiring deep, context-specific understanding, particularly within challenging settings like Yemen, a nation marked by instability, limited financial access and a strong commitment to Islamic principles.

2.1. Research design and approach

A descriptive and analytical design was employed:

- the descriptive component captures observable patterns in financing, savings and inclusion using institutional data from AMB,
- the analytical component involves interpreting these patterns in relation to the bank's Shari'a-compliant mechanisms, outreach strategies and digital innovations.

2.2. Data sources

The study relies exclusively on secondary data, including:

- Al-Amal Bank's annual and strategic reports (especially for 2021),
- publications from the Central Bank of Yemen and international development institutions (e.g. World Bank, CGAP, IMF),
- peer-reviewed literature on financial inclusion and Islamic finance in fragile contexts.

These sources were selected due to their credibility, accessibility and relevance to the research questions.

2.3. Analytical techniques

1. Content analysis was employed to examine reports and documents for qualitative insights on AMB's strategy, services and outreach.
2. Trend analysis was applied to financing and savings data to assess AMB's impact over time.
3. Comparative figures (2017–2021) were evaluated to track growth rates and operational performance indicators.

2.4. Methodological considerations and study limitations

This study is based solely on secondary data, including institutional reports, academic publications and development agency documents. Due to ongoing conflict, logistical constraints and resource limitations in Yemen, no primary data (e.g. interviews or surveys) were collected. Consequently, empirical testing or econometric modelling was not feasible.

Instead, the study employs basic descriptive statistics – such as growth rates in financing and service coverage – to analyse Al-Amal Bank's performance over time. While this approach does not support causal inference or hypothesis testing, it remains appropriate for exploratory, single-case research. It provides contextual insights into a relatively under-studied area, offering value in theory-building and policy reflection.

Nevertheless, several limitations must be acknowledged:

- the single-case design restricts generalisability to other contexts or institutions;
- informal or recent developments may be missing from the secondary data used;
- some referenced materials lacked verifiable links, limiting reproducibility and transparency.

Future research should consider multi-country comparisons, incorporate primary client-level data or apply quantitative techniques to more robustly evaluate the impact of Shari'a-compliant microfinance on financial inclusion outcomes.

3. Results and discussion

While this study highlights the positive relationship between Al-Amal Bank's initiatives and improved financial inclusion outcomes, it does not claim a direct causal effect. The observed trends may also reflect the influence of external factors, including donor-funded humanitarian programs, the expansion of mobile infrastructure, policy reforms by the Central Bank of Yemen, and broader economic recovery dynamics. Due to the study's reliance on secondary data and its single-institution scope, the findings should be interpreted as indicative rather than conclusive, offering contextual insights rather than generalisable proof.

3.1. The role of Al-Amal Bank in promoting financial inclusion in Yemen. The establishment of Al-Amal Bank

Al-Amal Microfinance Bank (AMB) is the first institution of its kind in both Yemen and the broader Middle East and North Africa (MENA) region, dedicated exclusively to microfinance. It was founded under Law No. 23 of 2002 and officially commenced operations in January 2009, operating under the supervision of the Central Bank of Yemen (Al-Amal Microfinance Bank, n.d.).

As a non-profit financial institution, AMB aims to deliver sustainable financial services to low-income individuals and marginalised groups. Its primary beneficiaries include micro- and small-scale entrepreneurs who often face barriers to accessing conventional credit. The bank provides a comprehensive suite of Shari'a-compliant services – including financing, savings, insurance, domestic and international transfers, currency exchange and digital payments – all tailored to the needs of underserved communities (Al-Amal Bank, 2021).

Al-Amal Bank was established as a result of joint cooperation between the Government of Yemen, the Arab Gulf Program for Development and the private sector, with contribution rates distributed as follows: 45% Social Fund for Development, 34% Arab Gulf Program for Development, 20% Private Sector.

3.2. The role of Al-Amal Bank in enhancing the inclusion of financing services

This subsection includes discussion of financing indicators, guarantee letters and the new "Al-Amal Education" product.

3.2.1. Financing indicators

During the year 2021, Al-Amal Bank achieved growth in the financing portfolio, which is shown in Figure 1.

The data illustrates that between 2017 and 2021, Al-Amal Bank significantly expanded its financing portfolio. The number of loans disbursed increased steadily over this period, reflecting the institution's strategic focus on productive financing, particularly for micro and small enterprises. In 2021 alone, the financing portfolio grew by 50%, more than doubling the 20% growth rate recorded in the previous year – a testament to the bank's growing outreach and operational efficiency.

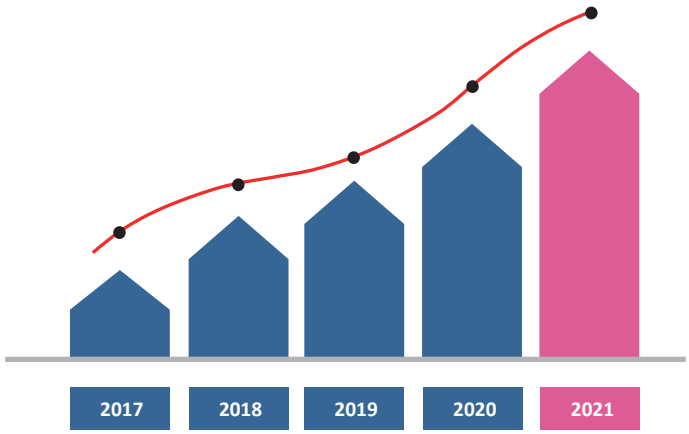

Figure 1. Number of financings granted by Al-Amal Bank during the period 2017–2021

Source: (Al-Amal Bank, 2021, p. 18).

3.2.2. The letters of guarantee

The bank also strengthened its guarantee services, which play a vital role in improving clients' access to credit by offering assurances to third parties. In 2021, both the number and total value of letters of guarantee issued increased markedly across several currencies, including the Yemeni rial, US dollar, euro and pound sterling. This growth signals growing confidence in the bank among international partners and business stakeholders (Al-Amal Bank, 2021).

Letters of guarantee offered by Al-Amal play a critical role in expanding access for microentrepreneurs who lack traditional forms of collateral. In Yemen, where formal property documentation and asset registration are often inaccessible, these instruments allow clients to engage in contractual business activities without risking their limited assets. This innovation reflects a context-sensitive adaptation of Islamic finance principles, making enterprise participation viable for informal-sector entrepreneurs.

Table 1. Guarantee letters provided by Al-Amal Bank during 2020–2021

Letters of guarantee	2020 Indicators		2021 Indicators		Growth rate %	
	Number	Value	Number	Value	Number	Value
Yemeni rial (YR)	10	14,168,300	27	105,036,632	170	641
US dollar	9	50,148.15	67	203,469	644	306
Pound sterling	0	0	9	16,211	100	100
Euro	0	0	7	21,209	100	100

Source: (Al-Amal Bank, 2021, p. 19).

Through the Table 1, it is clear that Al-Amal Bank is achieving a growth in the number and value of letters of guarantee granted during 2021 compared to the previous year and in various currencies, which proves the confidence of international dealers in it.

3.2.3. New Product

The same year, Al-Amal launched the "Al-Amal Education" financing product, designed to support school and university students by covering tuition costs at partnered institutions. Within just three months of its launch, the product financed 69 students, disbursing a total of YR15 million. This initiative reflects the bank's broader mission to promote human capital development through targeted financial inclusion tools.

3.2.4. Youth Entrepreneurship and Financial Inclusion Initiative (PSYEFI)

It is a project funded by the European Union, and the indicators of the project during the year 2021 were as follows in Table 2.

Table 2. PSYEFI indicators for 2021

Description	Completed	Amount (YR)	New job opportunities created	Number of male beneficiaries	Number of female beneficiaries
In-kind grants	4,341	1,067,642,500	18,347	2,162	2,178
Training grants	1,157	–		650	507

Source: (Al-Amal Bank, 2021, p. 19).

In 2021, Al-Amal Bank implemented the Project to Support Youth Entrepreneurship and Financial Inclusion (PSYEFI), funded by the European Union. The initiative was designed to empower young Yemenis – particularly those whose businesses were disrupted by conflict – by offering both financial and non-financial support.

The project disbursed in-kind grants totalling over YR1.06 billion to 4,341 young entrepreneurs, generating approximately 18,347 job opportunities. In addition, 1,157 youth participants benefited from training grants designed to enhance their entrepreneurial and financial skills. Notably, the program demonstrated strong gender inclusion, reaching nearly equal numbers of male (2,162) and female (2,178) beneficiaries.

Al-Amal Bank's support extended beyond funding: it encouraged savings practices by offering no-fee deposit accounts and promoting a culture of financial planning among the youth. Through this initiative, the bank not only contributed to post-conflict economic recovery but also reinforced its broader mandate of inclusive development.

3.2.5. The role of Al-Amal Bank in promoting the inclusivity of savings products

The savings portfolio is one of the most important sources of funding for the bank's various activities, as shown in Figure 2.

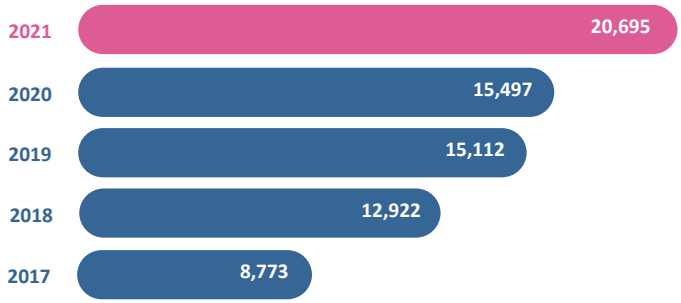

Figure 2. Saving portfolio growth for the period 2017 through 2021 (YR million)

Source: (Al-Amal Bank, 2021, p. 22).

Al-Amal Bank has achieved notable growth in its savings portfolio between 2017 and 2021. By the end of 2021, total savings deposits reached YR20.6 billion – representing a 34% increase over the previous year. This steady growth reflects the bank's ongoing commitment to fostering a savings culture among underserved populations.

To increase financial participation, the bank launched targeted marketing campaigns and introduced simplified, Shari'a-compliant savings products. These services were designed to be user-friendly and fee-free, removing common barriers that discourage low-income individuals from saving through formal channels.

Importantly, the bank invested in inclusive digital design by ensuring its mobile banking services functioned not only on smartphones but also on basic mobile phones. This step reduced the cost of access for clients who might otherwise view mobile compatibility as an unaffordable entry cost. The absence of transaction restrictions and reduced service charges further encouraged saving behaviours, contributing to the bank's financial sustainability and client retention.

3.3. The role of Al-Amal Bank in promoting inclusion using financial Technology

This section covers digital platforms, cost reduction and service quality improvements.

3.3.1. Leveraging financial technology for inclusive access

Al-Amal Bank has made significant strides in expanding financial inclusion through digital innovation. Central to this effort is the PYES mobile application, which enables customers to access a wide range of Islamic financial services – including digital financing, savings accounts, domestic and international transfers, bill payments and e-commerce integration. The bank supports these services through an extensive network of over 5,400 agents and 3,300 service points, ensuring nationwide coverage, even in remote rural areas.

In 2021, digital service usage increased substantially. The number of active accounts rose by over 50%, while transaction volumes reached YR72 billion, marking a 34% growth over 2020. The number of points of sale expanded more than sixteenfold, from 256 in 2020 to 4,383 in 2021 – a direct reflection of the bank's commitment to technological inclusion (Al-Amal Bank, 2021).

Al-Amal Bank's deployment of digital tools – particularly the PYES application and mobile-compatible services – directly addresses structural barriers such as geographic isolation, low infrastructure and cost constraints. By eliminating the need to visit physical branches, the bank reduces the exclusion of rural populations, especially women and youth, who may face additional mobility limitations. In fragile contexts like Yemen, where security and travel are unpredictable, digital inclusion becomes not only a convenience but a resilience mechanism that ensures continuity of service delivery despite conflict disruptions.

3.3.2. Electronic services provision

Al-Amal Bank provides all its banking services through the PYES application, including electronic Islamic financing, savings accounts, money transfers, rural area services, expatriate transfers at competitive rates, electronic payment and bill settlement services free of charge, as well as integration with e-commerce platforms. In addition to using the application on their mobile phones to perform most operations, Al-Amal Bank offers PYES service through 3,300 service points spread across all Yemeni governorates and directorates to cover all urban and rural areas. Al-Amal Bank also provides a service for dispensing humanitarian aid from donor organisations through electronic accounts without the need to stand in queues at aid distribution centres. The electronic service indicators have evolved during the year 2021, as shown in Table 3.

Table 3 shows that Al-Amal Bank achieved growth in electronic service indicators during the year 2021 compared to 2020. The COVID-19 pandemic contributed to an increased reliance on electronic means in delivering services and achieving financial inclusion goals by enabling customers to access all the bank's services electronically.

Table 3. Electronic service indicators for 2021

Indicator	2020	2021	Growth rate
Number of accounts	66,684	100,362	50.5%
The value of the operations (YR billion)	53	72	34%
Number of agents	3,040	5,434	78.75%
Number of Points of Sale (POS)	256	4,383	1,612%

Source: (Al-Amal Bank, 2021, p. 27).

3.3.3. Reducing cost barriers

Al-Amal's digital services are designed to minimise financial burdens on clients. All basic financial operations – including transfers, savings and bill payments – are offered free of charge. Transfer commissions through the PYES system are 40% lower than traditional market rates, and expatriate remittances benefit from internal currency exchange rates rather than costly third-party fees.

3.3.4. Enhancing service quality

The bank's electronic platforms significantly improve service efficiency, reducing the time and effort required to conduct transactions. With mobile-based access, clients can manage their finances without visiting a branch. The bank also uses a Customer Relationship Management (CRM) system to address client feedback and enhance responsiveness. By the end of 2021, Al-Amal had established 333 branches and supported clients through 5,434 agents – a testament to its operational scale and client outreach strategy.

3.4. The role of Al-Amal Bank in promoting the inclusion of social transfers

Al-Amal Bank plays a leading role in the delivery of social cash transfer programs in Yemen. As one of the most trusted and financially integrated institutions operating in conflict-affected areas, the bank has built a strong capacity to reach low-income households with efficiency and transparency.

By integrating humanitarian aid disbursement with formal financial accounts, Al-Amal Bank is not merely transferring funds but onboarding new users into the financial system. This linkage between social protection and financial inclusion creates a pathway for sustained engagement, encouraging savings behaviour and future credit eligibility. The bank's growing client base across diverse regions may reflect a combination of trust-building strategies, cultural alignment and supportive ecosystem factors, including donor collaboration and digital outreach.

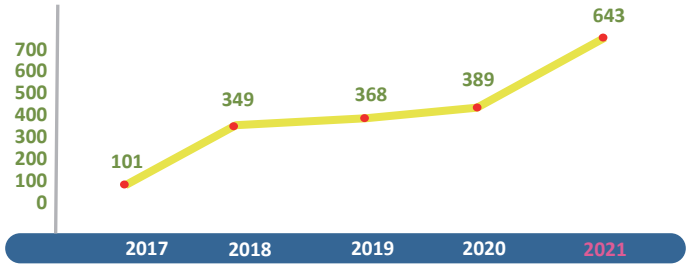

Figure 3. Evolution of social transfers distributed during the period 2017–2021 (USD million)

Source: (Al-Amal Bank, 2021, p. 24).

As shown in Figure 3, between 2017 and 2021, the value of social transfers facilitated by Al-Amal Bank increased significantly. In 2021 alone, the bank disbursed YR161 billion (equivalent to USD 643 million) to over 3.7 million beneficiaries across the country. These funds were distributed in collaboration with 37 international and local humanitarian and development organizations (Al-Amal Bank, 2021).

The bank's digital infrastructure – particularly its mobile account system and wide agent network – enables it to disburse aid securely without requiring beneficiaries to visit distribution centres. This system is especially valuable in rural or conflict-affected areas, where physical access to financial institutions is limited.

By streamlining the delivery of social aid and integrating it into its formal financial services framework, Al-Amal Bank not only contributes to immediate poverty relief but also helps bring marginalised populations into the formal financial ecosystem. Its leadership in this domain demonstrates how Islamic microfinance institutions can effectively bridge humanitarian assistance and long-term financial inclusion.

Conclusions

In conclusion, this study has shown that Shari'a-compliant microfinance constitutes a powerful and inclusive model for enhancing financial inclusion in developing and predominantly Muslim societies. The case of Al-Amal Microfinance Bank (AMB) in Yemen illustrates the capacity of Islamic microfinance to effectively address the financial needs of underserved populations, particularly in fragile and conflict-affected states. AMB's integration of Islamic financial principles with modern technology and community engagement initiatives has enabled it to provide equitable access to finance for poor, rural and marginalised groups.

Islamic microfinance, when structured according to Shari'a principles, offers ethical and interest-free financial services that appeal to individuals who abstain from conventional banking for religious reasons. Its use of diverse financing tools – such as *Murabaha*, *Mudarabah*, *Salam* and *Qard al-Hasan* – ensures flexibility in addressing the varied needs of clients, including microentrepreneurs, small farmers, students and informal workers. These instruments also allow institutions to support a wide range of economic activities while maintaining Shari'a compliance.

The findings highlight that Al-Amal Bank has made significant contributions in multiple dimensions of financial inclusion. It has expanded its outreach geographically by utilising mobile applications and digital platforms, minimising traditional banking barriers such as branch access and service costs. The development of new financial products like education finance and youth entrepreneurship support shows the institution's commitment to designing client-centred solutions. Moreover, its role in facilitating savings mobilisation, social transfer disbursement and financial training for youth and women underscores its broader social and developmental impact.

Importantly, the introduction of e-financial services by the bank – including the PYES application and its network of agents and service points – highlights how Islamic microfinance could adapt to technological developments in enhancing access, efficiency and service provision. The diversity of the institution's clientele from a wide range of local communities is evidence that they have succeeded in building trust and are seamlessly integrating into communities.

Still, there are some challenges. These include limited financial resources, infrastructure deficiencies, regulatory constraints and the nonexistence of comprehensive national strategies supporting Islamic financial inclusion. This case study also reveals the need for further integration of Islamic microfinance into broader financial ecosystems, including formal support structures and government policies.

To maximise the developmental potential of Islamic microfinance, policymakers and financial institutions must enhance collaboration, invest in capacity building, and adopt a proactive approach to product innovation and digital transformation. Furthermore, financial literacy campaigns and supportive regulatory environments are essential to build public trust and ensure responsible usage of financial services.

Overall, Islamic microfinance is not merely a religious alternative; it is a practical, scalable and socially aligned mechanism for addressing structural financial exclusion. The experience of Al-Amal Bank provides valuable insights for other institutions and countries aiming to achieve inclusive growth, reduce poverty and promote financial justice through ethically guided finance.

Recommendations: Based on the findings of this study, several targeted recommendations are proposed to strengthen the role of Islamic microfinance in advancing financial inclusion, particularly in fragile and low-income settings such as Yemen:

1. Institutional expansion – encourage more Islamic financial institutions to create dedicated microfinance windows or subsidiaries targeting underserved populations. Special incentives should be considered for outreach in rural and conflict-affected areas.
2. Shari'a-compliant product diversification – expand the portfolio of Islamic microfinance instruments, including Shari'a-compliant venture capital models and agricultural financing tools like Salam and Istisna'a to meet the unique needs of small-scale farmers and microenterprises.
3. Strengthening public-private partnerships – facilitate coordination between governments, regulators, NGOs and Islamic microfinance institutions to align inclusion efforts with broader national financial strategies.
4. Digital innovation and infrastructure – invest in mobile infrastructure and digital financial solutions to expand low-cost delivery channels. Technology must be tailored for fragile environments, including offline-compatible tools and low-bandwidth solutions.
5. Financial literacy and inclusion campaigns – launch national awareness programs to promote understanding of Islamic financial tools, especially among women, youth and displaced populations.
6. Regulatory framework reform – develop clear regulatory standards for Islamic microfinance to reduce ambiguity in product design and supervision. Coordination between Shari'a boards and central banks is essential for scaling operations without compromising compliance.
7. Addressing operational risks – recognise the complexity of Islamic contracts, which often require specialised legal and accounting structures. Risk-sharing models must be accompanied by strong client screening and monitoring systems to maintain institutional sustainability.
8. Mitigating dependency on donor funding – many Islamic MFIs rely heavily on donor or philanthropic funding. Long-term sustainability requires creating revenue-generating models and blended finance strategies that combine ethical principles with financial viability.
9. Impact evaluation and data systems – introduce standardised performance metrics to assess social and financial impact. Reliable data is necessary not only for strategic decision-making but also for securing investor and donor confidence.

Together, these actions can amplify the developmental impact of Islamic microfinance and deepen its contribution to inclusive economic growth.

Future research directions: Future studies could explore the impact of Islamic microfinance through comparative case analyses across different countries or institutional models. Incorporating primary data from clients and practitioners would provide deeper insight into user experiences and long-term outcomes. Additionally, research on the role of regulatory frameworks and digital innovations in shaping the effectiveness of Shari'a-compliant microfinance would be valuable.

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Strengthening the image of Marseille through nautical architectural infrastructure: Analysis of the modernisation of the Roucas Blanc Marina for the 2024 Summer Olympics

Daria Sarol[1]

Abstract

Architectural investments in sports infrastructure serve marketing purposes, particularly place branding and city image creation. The article examines the modernisation of the Roucas Blanc facilities, Marseille, for 2024 Summer Olympics nautical events. It discusses tourism and image-related benefits. The study used a mixed method. Firstly, secondary materials, including Marseille's official project documents and development strategies were collected and analysed. Secondly, field studies with photographic documentation of the modernised Roucas Blanc Marina focused on functionality and architectural solutions. Thirdly, a survey among coaches of the Polish sailing team preparing for the Olympics was conducted. Despite the shortage of respondents ($n = 6$), the survey provided expert opinions on the port facilities. The documents confirmed that nautical infrastructure is a cornerstone of Marseille's promotional strategy. The photographs revealed architecturally and functionally coherent development and facilities well integrated into the surroundings. The coaches appreciated the facility's modernity and indicated their intention for future training camps there. The study confirmed that the Roucas Blanc Marina modernisation strengthens Marseille's image and can promote the long-term sports tourism development. The limited survey scope and the scarcity of data following the Games indicates the need for further long-term analyses of the impact these investments have exerted on the city.

Keywords

- sailing infrastructure
- nautical architectural infrastructure
- 2024 Summer Olympics
- Roucas Blanc Marina

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[1] Gdańsk University of Technology, ul. Gabriela Narutowicza 11/12, 80-233 Gdańsk, Poland, darsarol@pg.edu.pl

Introduction

Cities all over the world are increasingly searching for ways to strengthen their image and attract new target groups, including both athletes and tourists. Investments in sports infrastructure are one of the tools used for this purpose, as they can thoughtfully contribute to the development and promotion of a city (Berg et al., 2002). The development and modernisation of sports facilities allow not only to improve the quality of residents' lives and advance tourism, but also to create a recognisable image, which is in line with the ever more popular strategies of the city as a "megaproduct" (Kaźmierczak, 2007). In coastal areas, nautical infrastructure, especially marinas and yacht harbours, becomes particularly significant. When properly integrated into the coastline, such infrastructure can contribute to enhancing the landscape and stimulating recreation (Martín & Yepes, 2019).

In a broader context, it is worth referring to contemporary trends in place marketing (Kotler et al., p. 142) and urban planning strategies in cities where tourism and sports are becoming increasingly relevant (Stockholms stad, 2018). Such initiatives draw on the principles of the theory of needs (Maslow & Frager, 1987), attempting to satisfy both the basic expectations of visitors (attractiveness of space, easy access to services) and the more complex desires related to contact with culture or nature. Barcelona is one example of a city that has used sport to enhance its image. The modernisation of the waterfront and the Olympic Port for the 1992 Olympic Games became a turning point in the international perception of the city (Berg et al., 2002). Although studies have discussed the impact of major sporting events on urban development (Chalkley & Essex, 1999), relatively little attention has so far been paid to the analysis of marinas and their potential to enhance a destination's image (Raviv et al., 2009). This indicates a research gap in terms of a thorough understanding of how sporting nautical infrastructure can support city marketing and fit into the overall urban strategy (Mason, 2012). France, which secured the right to host the 2024 Summer Olympics after three consecutive attempts (Jastrząbek, 2023), has proposed ambitious revitalisation measures in Marseille. The Roucas Blanc Marina, which was modernised with sailing events in mind, became part of this strategy. The example of Marseille perfectly illustrates the range of opportunities and challenges facing port cities that want to take advantage of sport for promotion and development.

Studies to date suggest that sporting events act as a catalyst for infrastructure improvements (Chalkley & Essex, 1999), but success in creating a new image of a place depends on various factors. A coherent urban vision and a long-term promotional strategy are crucial (Collins et al., 2019). In the context of Marseille, the modernisation of Roucas Blanc Marina may constitute a lasting Olympic leg-

acy, provided that it serves residents, tourists and athletes for years to come, as intended in the project (SAFEGE SAS, 2021; Société de Livraison des Ouvrages Olympiques, n.d.).

Thus, the question remains: to what extent does modern, sustainable nautical infrastructure have the potential to generate long-term promotional benefits for port cities? Can investments in ports – as was the case in Barcelona – contribute to comprehensive revitalisation and a lasting change of image, or are such initiatives at risk of being a mere one-off spectacle associated with a major sporting event (Collins et al., 2019)? In the case of Marseille, despite numerous promises and ambitious development plans (Établissement Public d'Aménagement Euroméditerranée, 2019; Métropole Aix-Marseille-Provence, 2022), it remains to be seen whether and how the modernisation of Roucas Blanc Marina will translate into the long-term promotion of the city.

To answer these questions, in this paper, the following thesis is put forward: the architectural infrastructure of the marina influences the creation of the city's image and can act as a marketing tool to attract contestants and tourists.

The subsequent sections of the study discuss the field and survey research conducted, the aim of which was to empirically verify the importance of the architectural facilities of the marina in shaping the brand of Marseille. Such an analysis helps not only to fill a research gap in the existing scientific literature, but also contributes to a better understanding of place marketing strategies in the context of seaside sports destinations.

1. Literature review

The scientific literature on the architectural infrastructure of a marina demonstrates how it influences the image of a city; it also shows how such architecture can be used as a marketing tool to attract competitors and tourists. Sporting events (e.g. international competitions) offer a great opportunity to promote a city. Individual events such as the Olympic Games can attract the attention and resources required for large infrastructure and social projects. A classic example is Barcelona, which used the 1992 Olympic Games to comprehensively revitalise and promote itself as an internationally attractive city. As a key revitalisation activity, the city's waterfront was significantly redeveloped, bringing the city closer to the sea (Berg et al., 2002).

The Olympic Port in Barcelona was built from scratch before the 1992 Olympic Games, transforming the former industrial port area into a modern public space which has become a significant element of the city's infrastructure and a tourist

attraction (Port Olímpic de Barcelona, n.d.). As Ikiz (2016) points out, the growing interest in marinas and yacht tourism contributes to strengthening the image of the city of Muğla as an international destination. He suggests that investments in marina infrastructure and effective promotion can support the city in competing with other European tourist destinations. Key actions involve hosting international sailing events, developing environmentally friendly marinas and improving service quality.

Attempting to change a city's image through hosting a sporting event may not always be successful. A single event may not be enough to successfully rebrand a city; consistent, long-term measures and infrastructural solutions are needed. One example is the 2012 Volvo Ocean Race (VOR) final in Galway, Ireland. The event failed to provide the impetus for the revitalisation and redevelopment of the seaport and did not result in the creation of Galway's image as a city associated with the sea (Collins et al., 2019).

Research on the factors influencing the attractiveness of marinas for competitive sailors and tourists was conducted in Denmark and the UK using the Kano model (Shen et al., 2021). The results of the study provide guidance for future strategic decisions in marina destination management.

In conclusion, the examples of Barcelona and Muğla show that investments in marinas and the organisation of prestigious sailing events contribute both to socio-economic revitalisation and prompt the creation of a new brand for the place. On the other hand, cases such as that of Galway prove that a single event cannot guarantee a lasting change in the image if it is not accompanied by comprehensive and long-term promotional activities and coherent development strategies. Furthermore, a multifaceted approach (territorial, local, internal) is needed to better understand the relationship between marinas and their surroundings and to fully capitalise on their tourism and sports potential. However, there are still relatively few publications that focus on the architectural dimension of marinas in the context of city promotion, which indicates an existing research gap and the need for further, multifaceted analyses.

2. Materials and methodology

In order to verify the thesis that the architectural infrastructure of the marina influences the creation of the city's image and can serve as a marketing tool to attract competitors and tourists, a mixed method was used; it comprised document analysis, field research and surveys. The research was conducted in Roucas Blanc Marina, which had been selected for the 2024 Summer Olympics in Marseille.

Based on the analysis of data contained in the strategy literature and published documents as well as the official website, information on Marseille's aspirations to promote the city and create its image through sailing infrastructure was obtained. The assumptions resulting from the above analysis were subjected to a dual-stage verification using the following methods:

- field research (Akšamija, 2021) of the modernised architectural infrastructure of the Roucas Blanc Marina,
- questionnaire surveys (Akšamija, 2021) conducted among coaches.

The photographs taken during the field research following the modernisation of Roucas Blanc Marina formed the basis for the assessment of elements relevant to athletes, residents and tourists, as well as the urban aspect affecting the aesthetics of the investment and its coherence with the surroundings. The questionnaire surveys were used to gather coaches' opinions on the architecture of Roucas Blanc Marina and its potential as a model training centre worth returning to. The information regarding the port's special features and values, contained in the documents, was also verified based on their opinions. A representative group of sailing coaches from the Polish national team took part in the survey. This group is by nature a small, highly specialised community. This specific nature of the group implies that even with a relatively modest number of respondents, it is possible to obtain significant information on professional opinions. Coaches, being the people who train athletes at the highest level, use flexible training methods, but also adapt to local conditions and jointly oversee training with the athletes, drawing on their experience and tacit knowledge developed over years of practice (Saury & Durand, 1998). They are, therefore, excellent respondents and a source of knowledge in the assessment of the Marina and its functionality.

The chosen mixed research method was applied deliberately to verify the thesis on multiple levels. This approach made it possible to examine the issue from different perspectives and increase the reliability of the results. The literature analysis was verified through expert opinions and empirical research conducted on-site. This approach ensured not only theoretical but also practical confirmation of the research assumptions.

3. Results

In 2021, the following documents in which the strengthening of the image of Marseille through nautical infrastructure was emphasised were made publicly available:

- Project Declaration entitled Modernisation of the Roucas Blanc nautical stadium and implementation of seaside investments in view of the organisation of the 2024 Olympic Games in Marseille (SAFEGE SAS., 2021),
- Public Tender documentation, concerning the presentation summary of the Roucas Blanc Water Sports Stadium Modernisation project (Ville de Marseille, 2021).

The Roucas Blanc Marina was established in the 1970s as part of the extension of Prado Park, which is located to the north. The location of the marina offers many advantages. The city of Marseille is defined as a "port city", highly appealing to tourists. The local waters enjoy an international reputation. Marseille has hosted prestigious regattas such as the ISAF World Sailing Days in 2002, the Student Yachting World Cup in 2009 and 2017, and the annual SNIM Regatta as part of the Mediterranean International Maritime Week. Before it was decided to organise the Olympic Games in Roucas Blanc Marina, a convincing conceptual design of the sailing infrastructure had to be presented.

In 2020, the contract for the modernisation project of Roucas Blanc Marina – *Marina Roucas Blanc for the 2024 Olympic Games* – was awarded to Jacques Rougerie from Tangram Architectes Associés and Carta from Reichen & Robert Associés. The project was supervised by Solideo, a specially appointed public institution that worked in parallel with the 2024 Olympic Games Committee. The difference between the two organisations lay in the scope of the investments they implemented or supervised. The Committee was responsible for temporary facilities used exclusively during the event, while Solideo was responsible for permanent infrastructure and permanent investments. The infrastructure implemented and supervised by Solideo, including the Roucas Blanc Marina, was to be converted into public facilities, starting in 2025. Environmentally advantageous characteristics of the newly designed Roucas Blanc Marina are described on the official Solideo website. The sports infrastructure is designed following the principles of sustainable development, using low-emission concrete and biological materials. The project achieved a silver rating and met the conditions for a gold rating according to the Sustainable Mediterranean Construction Commission. The marina has been awarded the EFFINATURE certificate (Société de Livraison des Ouvrages Olympiques, n.d.).

Based on the project *Marina Roucas Blanc for the 2024 Olympic Games*, a thorough modernisation of Roucas Blanc Marina was commenced. The former lack of a coherent plan for the layout of the port space resulted in the architecture and land use plan hindering smooth and safe communication. The storage and workshop space was unsuitable for storage and repairs of the evolving sailing equipment. Furthermore, the marina failed to blend visually with its surroundings. The Project Declaration documents and Public Tender Documentation for the *Marina Roucas Blanc for the 2024 Olympic Games* project outline solutions to these problems.

The port redevelopment project consisted of constructing five groups of buildings in the southern sector and modernising just one building in the northern sector. The buildings were designed in a radial layout around the sailing basin. Each building in the southern sector provided the necessary storage space. In one of them, namely Pole France Voile club headquarters, the height of the central part of the building was increased so that the competitors could bring their boats in without having to fold the masts. Two buildings called the "Technical Centre", also being part of the southern sector, will be additionally dedicated to the workshop function relating to the repair of sailing equipment.

Smooth communication and safety inside the port were ensured by:

- designation of separate roads and gates with access control,
- fencing, selective entry and separation of technical traffic from pedestrian traffic,
- a special circuit for vehicles with trailers during sailing events.

According to the architectural concept, the low, predominantly two-storey facilities were to be harmoniously integrated into the surrounding area. This ensures that visitors to the port area have an unobstructed view of both the marina and the seascape.

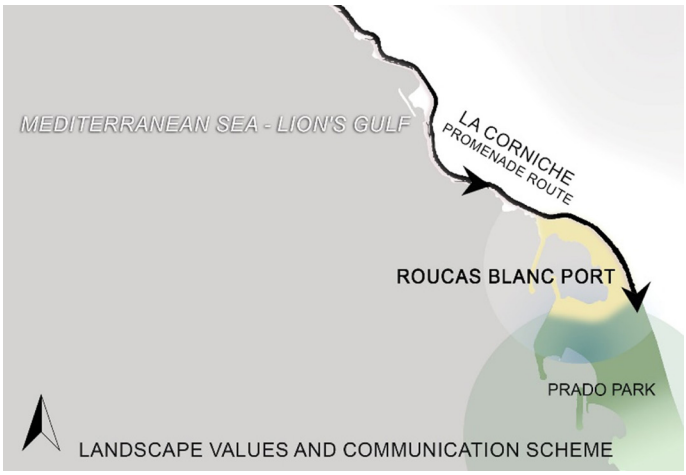


Figure 1. Landscape values and communication scheme

Source: author's own elaboration.

Through the realisation of the project, the entire southern area (except the technical zone) will be made accessible to the public during the day. Before the modernisation, access to the coastline in the harbour area was impossible for residents and tourists. The newly modernised marina will be a tool in the development of sports and tourism, serving as a link connecting two recognisable areas of the

city: the Corniche promenade and Prado Park (Figure 1). Comprehensive architectural and spatial solutions regarding the efficiency and comfort of using Port Rocus Blanc will significantly contribute to strengthening the image of Marseille. According to official statistics, Marseille welcomed 16.2 million tourists in 2023 (covering both commercial and private accommodation). Preliminary estimates for 2024 suggest that, once non-commercial stays are included, this figure rose by 6 %, a trend confirmed by initial Flux Vision analyses (Office Métropolitain de Tourisme et des Congrès de Marseille, 2024; Provence Tourisme, 2025).

The modernisation of Roucas Blanc Marina as part of the Olympic sailing infrastructure in Marseille aligns with the implementation of several key strategic objectives pursued by the Euroméditerranée Urban Development Agency until 2030 (Établissement Public d'Aménagement Euroméditerranée, 2019), as shown in Table 1.

Table 1. Summary of the Roucas Blanc Marina modernisation project characteristics and alignment with key objectives of the Marseille Euroméditerranée strategy

Strategic goals of Euroméditerranée	Features of modernisation of Roucas Blanc Marina in line with Euroméditerranée strategy
Urban integration and waterfront development	– Roucas Blanc Marina is becoming an important facility for seaside sports infrastructure. – It facilitates access to the coast, integrating it into city life and improving the connection between the coastal areas and the rest of Marseille.
Sustainable development	– The marina has been modernised with environmentally friendly materials and energy-saving. – The infrastructure was designed with a view to providing long-term use of the facilities (Olympic legacy), which aligns with the vision of an "eco-city".
Strengthening of cultural and tourist aspects	– The organisation of the Olympic sailing competition strengthens the city's international image. – Once renovated, Marina Roucas Blanc will attract more sailing events, increasing tourist traffic and promoting Marseille as a sports and leisure centre.

Source: author's own study based on the Euroméditerranée Strategy.

The implementation of investments in the port's infrastructure constitutes an ambitious project in line with the broader strategy of the Economic Development Programme 2022–2027 for Marseille and the entire Aix-Marseille-Provence area and is founded on five key pillars (Métropole Aix-Marseille-Provence, 2022). These include the aim of increasing the attractiveness and international influence of the area. Providing infrastructure to enable the organisation of sailing competitions as part of the Olympic Games emphasises Marseille's global image as a sports city.

The photo documentation created as a result of field research shows the architectural qualities of the Roucas Blanc Marina (Figures 2 and 3).

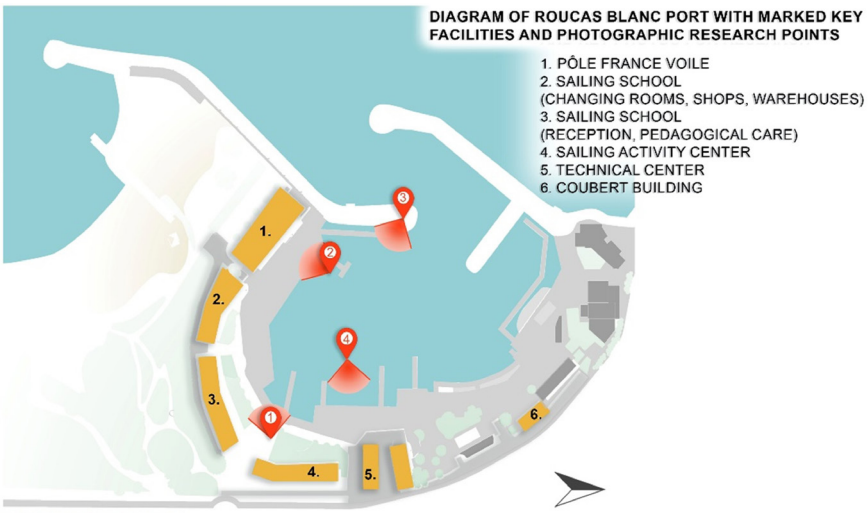


Figure 2. Plan of Roucas Blanc Marina with key facilities and spots for taking photographs for surveys

Source: author's own elaboration.

Figure 3. Photographic documentation

Source: author's own elaboration.

In the first photo, a large space for preparing equipment and wide slipways for launching or pulling boats ashore can be seen. The second photo shows the architectural simplicity of the Pôle France Voile club building. The building is high enough to allow yachts to be brought in without having to lower the mast. The third photo presents the harmonious integration into the surrounding context, achieved through the consistent design of the facade colour and building height. The fourth photo features the port buildings, which provide a clear view thanks to their predominantly two-storey design. The buildings of the frontage bordering the waterfront development can be easily seen from behind the Roucas Blanc Marina complex.

The questionnaire survey was conducted on a representative group of respondents. The survey was taken by coaches of the Polish national team who came to Marseille before the 2024 Olympic Games and used the facilities of the modernised Roucas Blanc Marina. Out of ten coaches, six participated in the survey, which represented 60% of the team.

The survey consisted of four questions: three close-ended questions requiring respondents to choose an answer from the available options, and one open-ended question (Figure 4). The unanimous response of all coaches to question 1 shows that, from their point of view, training camps abroad during periods of bad weather are absolutely necessary. According to the answers to question 2, all coaches who took part in the survey had the opportunity to stay at Roucas Blanc Marina, which means that they were able to comment on its functionality and architecture. Question 3 shows that the majority of coaches (67%) believe that it is worth returning to Marseille for training camps, not only for championship regattas. In answer to question 4, which was an open-ended question, the respondents emphasised that the port facilities of the marina, the storage and social infrastructure, the wide slipways for launching boats, and the fact that it is a "modern facility that meets all the criteria for specialised training" prompt them to use the port.

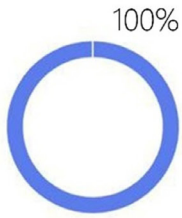
4. Discussion

The study focused on verifying the thesis that the architectural infrastructure of a sailing port influences the creation of the city's image and can serve as a marketing tool to attract competitors and tourists. The results obtained from the analysis of design materials, photographic documentation and surveys conducted among sailing coaches indicate that the modernisation of Roucas Blanc Marina has a significant promotional and tourist potential. The modern and functional architectural solutions have been well received by users, which confirms the efforts of the

1. Do you go to training camps abroad? (apart from direct preparations for championship class regatta)

6 Answers

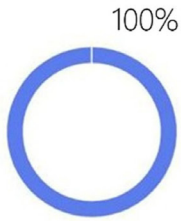
- Yes, because it gives you the opportunity to train when the weather conditions are not right in Poland (6)
- Yes, because you can take advantage of the well-designed infrastructure of the Sailing Base facilities (0)
- No, it is not necessary (0)



2. Did you know about the Roucas Blanc Sailing Stadium in Marseille before the Olympics?

6 Answers

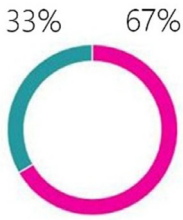
- Yes, I knew and I was at this Sailing Base. (6)
- Yes, I knew, but I didn't have the opportunity to visit this place before. (0)
- I did not know. (0)



3. Knowing that Port Roucas Blanc is an Olympic facility that meets the requirements of being the host of this event, would you choose to train here outside of the master class regatta?

6 Answers

- Yes, it is an attractive and worth checking out direction. (0)
- Yes, it is worth going there again. (4)
- No, it is not relevant to the racing class I sail/train on. (2)



4. What aspects of the architectural space of the Marseille Stadium do you find attractive and enticing people to use its facilities?

5 Answers

Storage and social infrastructure and a hotel within the marina.
A highly modern facility that meets the criteria for specialised training.
Harbour, slip, sanitary facilities.
Lots of greenery, simplicity, plenty of space.
Wide boat launching ramp.
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Figure 4. Presentation of survey results

Source: author's own elaboration.

Marseille authorities to strengthen the city's international recognition. The strength of the analyses conducted lies in their multifaceted nature: both secondary sources (documents and planning materials) and primary sources (field research and surveys) were considered. In addition, a representative group of coaches provided valuable expert knowledge due to their specialised needs and experience in preparations for the Olympic Games. However, the study is limited insofar as the surveys were conducted among a small number of respondents (due to a low number of coaches in the team). Furthermore, the analysis was performed before the official start of the Olympic Games, making it impossible to fully capture the impact of this event on the further development of tourism and the image of Marseille.

The results of the above study correspond with the conclusions from the literature on the use of sports infrastructure as a tool for city promotion (Berg et al., 2002). In the case of Marseille, the study confirms that investments in modern sailing facilities can create a lasting legacy and are not limited to a single sporting event. However, it has also been shown that with no comprehensive and long-term maintenance and promotion measures, the marketing effect may be less pronounced, as research on ports and sailing events in other cities has shown (Collins et al., 2019).

The presented analysis is of practical importance as it can serve as a reference point for decision-makers in the planning or implementation of investments in coastal sports infrastructure. The identified key elements – such as the appropriate scale of development, smooth communication within the port, architectural coherence with the surroundings – may be regarded as guidelines for subsequent projects of this kind. Theoretically, this enriches the body of research on place marketing and the role of nautical infrastructure in creating the image of cities, especially those whose heritage and traditions are strongly connected to the sea.

Further long-term studies are recommended following the completion of the Olympic Games to capture the impact of the event itself on port utilisation, visitor numbers and benefits to local residents. It would be important to expand the sample group by including tourists, local entrepreneurs and other port users in the survey, as this would provide a more comprehensive picture of how the modernised infrastructure functions. In future studies, systematised evaluation tools (e.g. the Kano model, indicator analyses) can be introduced to measure the degree of user satisfaction and translate it into real economic and image-related benefits (Shen et al., 2021).

The study confirms that the modernisation of Roucas Blanc Marina is likely to contribute to creating the image of Marseille as an attractive sports and tourist centre, thereby supporting the city's development strategy. Further research, conducted over a longer period and involving more stakeholder groups, will help to consolidate these conclusions and develop even more effective methods with which to implement similar projects in other port cities.

Conclusions

The conducted research revealed that the modernisation of Roucas Blanc Marina has had a favourable impact on Marseille's image, especially as a sports and tourist centre. Modern sailing infrastructure increases the city's recognition, constituting a coherent element of the promotional policy. The mixed method (document analysis, field observations, coach survey) in the study demonstrated the significant potential for the architectural design of the harbour.

From a theoretical point of view, the themes of architecture, sport and place marketing intertwine here. The Marseille authorities can benefit in the long term from a sustainable development concept and the continuation of promotional activities, as confirmed by experts from the sailing community. The relatively small number of coaches surveyed is a limitation, as is the lack of data following the Olympic Games. Nevertheless, the findings suggest that such investments can attract tourists and competitors, strengthening the city's economic and promotional potential. Further research should extend over a longer time frame and include a broader group of users. The port's modern character is not limited to the sporting event itself – it has the potential to provide lasting added value for the development of Marseille, emphasising its connection to the sea and strengthening the city's international brand.

It is essential to recognise that the pursuit of comprehensive economic self-sufficiency was not a core objective of the marina initiative (Ville de Marseille, 2023, 2024). Instead, the facility is designated for educational and athletic applications. The program *Tous les Marseillais sur l'eau* aims to offer mandatory sailing instruction to 11,000 primary school students annually at this harbour. Coupled with its Effinature certification and collaborations with the French Sailing Federation and private sector sponsors, the Marseille marina aligns with the guidelines set forth by the International Olympic Committee (IOC) Legacy and the Organisation for Economic Co-operation and Development (OECD). This positions the project with a favourable social impact, despite the anticipated reliance on partial operational subsidies (International Olympic Committee, 2021; OECD, 2010). Historical examples from the Olympic ports in Barcelona (1992) and London (2012) indicate that similar facilities can act as catalysts for waterfront revitalisation, sports education and tourism, thereby avoiding the pitfalls of becoming "white elephants" (Berg et al., 2002; Sadd & Nguyen, 2023). However, prior experiences and existing literature delineate that such outcomes are not assured. This is exemplified by the Olympic port in Rio (2016), where Brazil experienced its most severe economic downturn during the lead-up to the Games (Neri, 2020).

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The international retirement savings dilemma: Insights from U.S. IRAs with global relevance

Brian E. Porter[1]

Abstract

This study evaluates the long-term financial outcomes of Roth and traditional IRAs, with their different tax advantages. Global applicability to countries with similar types of retirement plans is emphasized. A full factorial simulation assessed 54 unique combinations of IRA type, investment mix, and tax rates during working and retirement years. Results indicate that investment type plays a more critical role than IRA type in determining outcomes. Portfolios with significant exposure to the S&P 500 consistently achieved higher ending balances and longer-lasting funds compared to portfolios relying on lower-yield investments. Traditional IRAs, leveraging frontend tax advantages, performed best when tax savings were reinvested, though Roth IRAs provided tax-free withdrawals, maximizing backend benefits.

Key findings include the importance of starting early, maintaining significant equity exposure throughout life for higher returns, and understanding that IRA type often has a marginal impact relative to investment strategy. The study highlights that the most effective strategy is situational, influenced by factors such as tax rates and market conditions. These insights, while grounded in U.S. data, offer guidance for retirement planning systems globally. Policymakers and individuals are encouraged to prioritize early, consistent, and aggressive investment strategies to optimize retirement outcomes.

Keywords

- retirement
- financial planning
- personal investing
- taxes
- portfolio analysis

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[1] Hope College, 160 Van Zoeren Hall, Holland, Michigan 49422, USA, porter@hope.edu

Introduction

In the United States, individual retirement accounts (IRAs), both traditional and Roth, offer valuable opportunities for tax-advantaged retirement savings. Ideally, individuals would maximize contributions to both types of IRAs, but for most people, this is not financially feasible. Therefore, many are left with the crucial decision of choosing between a traditional IRA and a Roth IRA.

Many countries face similar challenges regarding retirement savings, offering various investment plans for individuals to choose from. While this study focuses on the United States as a case study, the issues discussed have global relevance and can be applied to retirement systems in other countries facing similar dilemmas. The goal is for the results to be applicable not only in the U.S. but also in other countries that offer retirement investment choices.

When investing for retirement in the United States, the two common individual account options are the traditional IRA and the Roth IRA. Both offer tax advantages, but they differ primarily in the timing of those tax benefits as summarized in Table 1.

Table 1. Summary of tax benefits: traditional vs. Roth IRA

Tax treatment	Traditional IRA	Roth IRA
Contributions (during working years)	**Not taxed:** contributions reduce taxable income	**Taxed:** contributions do not reduce taxable income
Withdrawals (during retirement)	**Taxed:** withdrawals are taxed as ordinary income	**Not taxed:** no tax on withdrawals, neither original contributions or investment earnings

Source: own study.

Because the traditional IRA offers a frontend advantage, as contributions are tax-deductible, this allows individuals to invest more each year compared to a Roth IRA. For instance, someone in the 20% tax bracket who budgets $1,000 for retirement contributions could effectively invest $1,250 in a traditional IRA. This is because the $1,250 contribution would result in a $250 tax deduction, reducing the net cash outflow to $1,000. In contrast, Roth IRA contributions are made with after-tax dollars, offering no frontend tax break but providing tax-free withdrawals in retirement.

The Roth IRA's main appeal is its backend advantage – both the original contributions and any earnings can be withdrawn tax-free in retirement. This means that every dollar in a Roth IRA goes further than in a traditional IRA once with-

drawals begin. For example, for someone in a 15% tax bracket, a $1,000,000 Roth IRA is equivalent to $1,176,471 in a traditional IRA after taxes.

Choosing the better option depends on various factors, many of which are difficult to predict. One such factor is tax rates, both during the working and retirement years. Ideally, one would prefer to be taxed at a lower marginal rate. If the marginal tax rate is expected to be higher during the working years, a traditional IRA with its frontend tax break might be more beneficial. Conversely, if the tax rate is anticipated to be higher during retirement, the Roth IRA's tax-free withdrawals could be more advantageous.

Though using tax rates to guide the choice between traditional and Roth IRAs is common advice, it is not possible to know what actual tax rates will be. Furthermore, the concept is vague. For example, how significant must the difference in tax rates be to affect cash flows? If tax rates remain the same during both working and retirement years, will the total cash flow be equivalent between the two IRAs?

This study aims to provide a clearer understanding of the financial consequences associated with selecting between a traditional and Roth IRA. While grounded in the U.S. retirement savings framework, the analysis aspires to offer insights that may be relevant in international contexts where similar investment vehicles exist. By addressing the complexities of retirement planning – particularly in light of widespread financial illiteracy in the United States (Fisch et al., 2019) and globally (Turner & Muir, 2012) – the study seeks to offer practical guidance for individuals navigating long-term savings decisions, both in the United States and in countries with comparable retirement systems.

1. Literature review

The landscape of retirement planning in the United States underwent a transformative shift in 1980 when Ted Benna introduced the first 401(k) (defined contribution) employee savings plan for his employees at the Johnson Company (Porter, 2017). The implementation of 401(k) plans marked the beginning of a trend where defined contribution retirement plans became increasingly popular, as traditional defined benefit plans gradually phased out. Between 1983 and 2016, the percentage of workers covered by defined benefit pensions plummeted from 62% to 17% (Sklansky, 2023). Today, the defined contribution 401(k) is the most widely used employer-sponsored retirement plan in the U.S., and the number of individuals investing for retirement continues to grow.

This shift is not unique to the United States; it reflects a broader global trend. Retirement systems worldwide are increasingly transitioning toward defined contribution plans, as part of efforts to balance the roles of government, the private sector, and employers in securing retirement income (Cohen, 2022). As early as 2005, over 30 countries had already implemented individual retirement accounts, reflecting a widespread move to strengthen retirement security (Kritzer, 2005). For example, the United Kingdom's Individual Savings Account (ISA) mirrors the U.S. Roth IRA, while the Self-Invested Personal Pension (SIPP) parallels the traditional IRA (De Villa, 2024). Similarly, Germany's Level 3 Private Pension and Base Pension correspond to Roth and traditional IRAs, respectively (German IRA, n.d.). Other countries with some form of individual defined contribution retirement plans include Australia, Canada, Japan, New Zealand, Austria, Singapore, Czech Republic, Denmark, Greece, Finland, Ireland, Netherlands, Slovenia, and Spain (Baldwin, 2015; Cannon & Tonks, 2013).

This global alignment is driven by growing challenges facing traditional pension systems. Many developed nations, particularly in Europe, have historically relied on pay-as-you-go social security programs, which now face significant unfunded liabilities due to aging populations and increased life expectancy (Gruber & Wise, 2002; Miles & Timmermann, 1999). France exemplifies these challenges: in April 2023, rising pension costs prompted President Emmanuel Macron to raise the retirement age from 62 to 64, despite strong labor union opposition (Armstrong, 2023; Cohen, 2024). The worldwide proliferation of individual retirement accounts underscores a collective effort to shift responsibility toward individuals while addressing the financial pressures associated with demographic change and strained public resources. Because retirement savings and funding support for the elderly are common concerns across countries, comparative studies have emerged. Examining and learning from other countries' experiences with defined contribution systems is both relevant and beneficial (GAO, 212; Kritzer, 2005).

In the United States, there is limited and inconclusive quantitative research comparing the two government-sponsored retirement plans: the traditional IRA and the Roth IRA. LaChance (2012) found that choosing a traditional IRA over a Roth creates small welfare losses in only a few situations, specifically for those with higher incomes. However, Loudenback (2024) finds that the choice between a Roth IRA and traditional IRA is situational, depending on how much you earn and projected income during retirement. Similarly, Kotlikoff et al. (2008) found that middle-income, single-parent households benefit slightly more from Roth accounts; other single and married households generally fare better with a traditional IRA. Yet, future tax changes can dramatically change these findings. A behavioral study finds that regardless of selected IRA, savings is typically suboptimal and is influenced by gender, patience, and risk aversion measures (Bohr et al., 2023).

These mixed and inconclusive findings underscore a key research problem: individuals and policymakers often lack clear, evidence-based guidance on which retirement account structure is most advantageous under varying financial conditions. This study examines three critical factors that influence long-term retirement outcomes: the type of IRA (Traditional vs. Roth), the investment strategy employed during both the accumulation and withdrawal phases, and the applicable tax rate. The objective is to determine whether specific combinations of these variables lead to systematically better outcomes, thereby helping investors make more informed decisions. In addition, the growing global prevalence of individual retirement accounts raises the question of whether findings from the U.S. context can be adapted to countries with similar tax-deferred and tax-exempt retirement savings frameworks. To explore these questions, the study uses a historical simulation based on actual market data from 1984 to 2024 and projects retirement outcomes under different conditions. The analysis aims to strike a balance between clarity and analytical rigor, offering insights that are both meaningful and accessible.

2. Methodology

A simulation was developed to compare the performance of the traditional IRA (frontend tax benefit) and Roth IRA (backend tax benefit). The simulation has two distinct parts, the working/investing (W/I) years and the retirement/withdrawal (R/W) years. A summary of the key assumptions used in the simulation is provided in Table 2.

The W/I section of the simulation is used to replicate the working years when an individual is investing for retirement. The purpose of this portion of the simulation is to determine the total investment amount at the end of the W/I years that can be drawn from during R/W years. During the W/I years it is assumed that, regardless of whether investing in the Roth or traditional IRA (or blend of both), there are only two investment choices, either an S&P 500 index fund (equities) or a cash investment earning the average one-year CD rate (which also approximates inflation). All funds are invested in either S&P index fund, the CD, or a mix of both, consisting of 50% S&P index and 50% CD. The “mix” investment portfolio is rebalanced yearly to maintain 50% S&P and 50% CD mix. The simulation uses real historical data for the S&P 500, money market rates, and inflation. The data collected and used in the simulation was the actual annual closing prices on the first business day of the new year for the S&P 500 and the current one-year CD rate, for 1984 to 2024.

During the W/I years, it is assumed that an annual investment is made. Each year, on the first working day of the year, an investment is purchased. The first

investment was made on January 2, 1984. Annual investments were then made for the first working day of the year with the last investment made on January 2, 2024. A total of 41 investments were made. The first investment amount, in January 1984, was $2,000. This was determined by calculating the present value of $7,000 in January 2024, discounted at the inflation rate over the past 40 years. This was to approximate an annual investment of $7,000 each year in today's (2024) terms, which reflects a realistic average contribution amount (Chang, 2023). Each subsequent year, after 1984, the investment amount was increased by the approximate inflation amount (estimated by the one-year CD rate). Following this pattern, the final investment, in January 2024, was $7,006 (very close to the target $7,000).

Another assumption of this simulation is that the frontend tax savings from the traditional IRA will be invested. There are two situations for which this is applicable, the 100% investment in the traditional IRA and also the blended portfolio of 50% Roth IRA and 50% traditional IRA. The total yearly investment amount for a 100% traditional IRA, including the additional amount because of the frontend tax break, is computed by taking the yearly Roth investment divided by 1 minus the tax rate during the W/I years. For example, if the tax rate (savings is 20%) and the Roth target investment amount is $2,000, then the traditional IRA investment amount is $2,500, computed as: $2,000 / (1 – 0.20). As shown by this example, a $2,500 traditional IRA investment is a net cost of $2,000, after the $500 tax savings ($2,5000 × 0.2). Similarly, with a blended IRA, 50% of the investment goes into a Roth IRA and 50% into the traditional IRA, there is a tax saving (from the traditional IRA investment). The calculation of total yearly investment for the blended IRA portfolio, including the additional amount resulting from the frontend tax break, is computed by taking the yearly Roth investment divided by 1 minus one-half the tax rate during the W/I years. For example, if the tax rate (savings is 20%) and the Roth target investment amount is $2,000, then the total blended IRA investment amount is $2,222, computed as: $2,000 / (1 – 0.1). Half of this amount, $1,111 is invested in the Roth IRA and half in the traditional IRA. As shown by this example, a $2,222 Blended IRA investment is a net cost of $2,000, after the $222 tax savings from the $1,111 invested in the traditional IRA ($1,111 × 0.2).

Granted, the assumption that the frontend tax savings from the traditional IRA being invested each year may not be the situation for all investors (Beshears et al., 2014). If the tax savings are not taken advantage of, by increasing the investment amount, this naturally will decrease the results. Although not a factor examined in this study, it would be interesting to examine the impact of the two possibilities. Either the tax savings obtained with the traditional IRA is used to increase the amount invested or it is not.

The investment on January 2, 2024 represents the final investment for the W/I years. This will have been 40 years with 41 investments, a realistic approximation of the number of years one might invest for retirement. For example, if an

individual completes university at the age of 22 and begins investing annually for retirement immediately after graduation, 41 annual investments would take the individual to 62 years of age, a good approximate age for retirement. According to a 2024 MassMutual retirement happiness study, although 63 years of age is the ideal age for retirement, the average actual retirement age is 62 (MassMutual, 2024).

Immediately after the final investment, it is assumed that the individual retires and is now in the R/W stage of the simulation. On the same day as the final investment, the first withdrawal is taken for the first year of retirement. Subsequent withdrawals are taken on the first working day of the year. Just as the annual investment amount is realistic, so is the withdrawal amount. On January 2, 2024 a withdrawal is taken from the investment that is equal to $60,000 after taxes. This is slightly higher than the average spending of a retiree of $54,975 in 2022, based on the U.S. Bureau of Labor Statistics (Farrell & Allamani, 2024). Although the annual withdrawal amount was not a factor examined in this study, it is a possible factor to examine in the future. Does a withdrawal amount higher or lower than $60,000 impact results?

For the Roth IRA, since there are no taxes because of the backend tax advantage, the first-year withdrawal amount will be equal to $60,000. However, for both the traditional IRA and the blended IRA (50% Roth and 50% traditional) the withdrawal will be greater than $60,000 because of taxes. For the 100% traditional IRA the total withdrawal amount, including the additional amount to pay for taxes, is computed by taking the yearly Roth withdrawal amount divided by 1 minus the tax rate during the R/W years. For example, if the tax rate is 20% and the Roth withdrawal amount is $60,000, then the traditional IRA withdrawal amount is $75,000 computed as: $60,000 / (1 – 0.20). A $75,000 withdrawal will result in net withdrawal of $60,000 after paying $15,000 in taxes ($75,000 × 0.20). A blended portfolio also requires a greater withdrawal amount resulting from the portion that is taken from the traditional IRA that will be taxed. Within the blended portfolio, to maintain an equal amount of money in the Roth and traditional IRA, an equal amount is taken from both IRAs each year so that after taxes are paid, the net amount remaining will equal the target withdrawal amount, in this case $60,000. The calculation of total yearly withdrawal for the blended IRA portfolio is computed by taking the yearly Roth investment divided by 1 minus one-half the tax rate during the R/W years. For example, if the tax rate (savings is 20%) and the Roth target withdrawal amount is $60,000, then the total blended IRA withdrawal amount is $66,667, computed as: $60,000 / (1 – 0.1). Half of this amount, $33,333 is withdrawn from the Roth IRA and half from the traditional IRA. This will result in a net withdrawal of $60,000 after the resulting tax of $6,667 from the traditional IRA withdrawal ($33,333 × 0.20).

Each subsequent year during the R/W years the amount withdrawn, after taxes, is increased by an estimated inflation rate of 3%. This then continues an ap-

proximate net annual withdrawal of around $60,000, each year. Additionally, each year the investment balance is increased based on how it is invested, either an S&P index fund, a CD money market, or a mix of both, consisting of 50% S&P index and 50% CD. With a "mix" investment, at the end of each year the portfolio is rebalanced to maintain 50% S&P and 50% CD mix.

Table 2. Summary of simulation assumptions and parameters used in the study

Category	Assumption
Simulation structure	Two phases: Working/Investing (W/I) years and Retirement/ Withdrawal (R/W) years.
Annual investment (W/I years)	Made on first business day of each year; 41 total investments from 1984 to 2024.
Investment type	Only traditional IRA, only Roth IRA, or 50/50 blend.
Investment options	Only S&P 500 Index Fund, 1-year CD, or 50/50 mix.
Data used (W/I years)	Historical S&P 500 closing values and 1-year CD rates from 1984 to 2024.
Investment amount	$2,000 in 1984, increasing annually by inflation (CD rate), reaching ~$7,000 in 2024.
Tax savings reinvestment	Assumes traditional IRA tax savings are reinvested (applies to traditional and blended IRAs).
Annual withdrawal (R/W years)	2024 to 2070; until money is depleted up to maximum 47 years.
Withdrawal amount	$60,000 (after-tax) withdrawn on first day of retirement; increases by 3% annually (inflation).
Tax treatment withdrawals	Grossed-up to meet $60,000 or inflation-adjusted equivalent (applies to traditional and blended IRAs).
Growth assumptions (R/W)	S&P 500 return = 7%, CD/inflation rate = 3%.
Rebalancing	50/50 mix portfolios of S&P 500 and CD are rebalanced annually to a 50/50 mix during both W/I and R/W phases.

Source: own study.

Unlike the W/I years that used actual past historical data from 1984 to 2024, there is no actual data for the R/W years. Therefore, both the S&P 500 return and the CD money market rate (or inflation rate) are estimated. During the retirement years, the S&P 500 return is estimated to be a constant 7%. This is a conservative estimate, based on the average historical return of the S&P 500 being 9.9% since its inception in 1957 to 2023 (Maverick et al., 2025). However, many analysts believe the future return on the stock market will be lower than historical returns (Erdogan & McMoore, 2025). The inflation rate and one-year CD rate are estimated to be 3%. This is slightly lower than the average inflation rate for the past 50 years, which was approximately 3.3%, and similar to recent years, which was

approximately 3.0% for the past 10 years (Srinivasan et al., 2025). Again, neither the S&P return nor the inflation rate are factors examined in this study (e.g., by varying these rates), but they might be useful to explore in future research.

Factors examined

The simulation is used to examine four factors to compare the performance of the Roth IRA (backend tax advantage) with the traditional IRA (frontend tax advantage). They are as follows:

1. IRA type (3 levels)
2. Investment choice during W/I years (3 levels)
3. Investment choice during R/W years (3 levels)
4. Tax rate during R/W years (2 levels)

The first factor examines the IRA blend used for retirement investing. The factor has three levels. There are two IRA choices, either the Roth IRA, with the backend tax advantage, or the traditional IRA, with the frontend tax advantage. The simulation looks at three possible blends. Either 100% of money is invested in the Roth IRA or 100% of money is invented in the traditional IRA, or money is split equally between both the Roth IRA and the traditional IRA. Even though this study only looks at three different blends between the Roth IRA and the traditional IRA, future research may want to look at the impact of various blend percentages. Is there one that is preferable depending on circumstances?

The second and third factors examine the investment choice within the IRA or IRAs. For each factor, there are three levels. The second research factor specifically examines the choice during the W/I years. The third research factor specifically examines the choice during the R/W years. There are two investment choices, either an S&P 500 index fund or a CD money market earning approximately the rate of inflation. The simulation looks at three possible mixes. Either 100% of the invested money is in the S&P 500 index fund or 100% of invested money is the CD or the investment money is split equally between both the S&P 500 index fund and the CD. The mix during the W/I years may be different from the mix during the R/W years.

The fourth and final factor examines the tax rate during the R/W years. This factor has two levels: either the tax rate during the R/W years is identical to the W/I years, at 20%, or it is lower during the R/W years, at 15%. One reason the tax rate may be lower in the R/W years is that earned income is typically reduced in retirement, resulting in a possibly lower marginal tax rate.

3. Results and discussion

A full factorial design was conducted to simulate all combinations. Below is the list of the four factors and the corresponding code.

1. IRA type:

- Roth IRA (R),
- Traditional IRA (T),
- Blend of 50% Roth IRA and 50% traditional IRA (B).

2. Investment choice during W/I years:

- S&P 500 Index (S),
- CD, Money Market, Inflation rate (C),
- Mix 50% S&P 500 Index and 50% CD (M).

3. Investment choice during R/W years:

- S&P 500 Index (S),
- CD, Money Market, Inflation rate (C),
- Mix 50% S&P 500 Index and 50% CD (M).

4. Tax rate during R/W years:

- 20% (H),
- 15% (L).

Based on the above, a simulation with the code TSML would represent a situation that invests entirely in a traditional IRA, has an investment mix of 100% S&P 500 index during the W/I years, a mix of both S&P 500 and CD during the R/W years, and a 15% tax rate during the R/W years. A full factorial analysis of the four factors, at various levels, was conducted, yielding 54 unique situations. Each was evaluated on three different measures, as follows:

1. Value of the IRA at the end of the W/I years that will be available during the R/W years.
2. Given similar withdrawal amounts across all simulations, the number of years until retirement savings is depleted.
3. Taxes paid in total, during both the W/I years and the R/W years.

Table 3 shows all results, sorted by investment total. Table 4 is sorted by years until depleted and Table 5 is sorted by total taxes paid.

Table 3. Results of simulation sorted by investment total

Strategy*	Investment total	Years until depleted	Total taxes paid
TSSH	$1,372,172	47	$1,505,948
TSSL	$1,372,172	47	$1,062,998
TSML	$1,372,172	24	$364,507
TSMH	$1,372,172	22	$458,052
TSCL	$1,372,172	19	$265,937
TSCH	$1,372,172	18	$351,217
BSSL	$1,219,709	31	$271,938
BSSH	$1,219,709	30	$345,860
BSML	$1,219,709	23	$186,558
BSMH	$1,219,709	22	$232,264
BSCH	$1,219,709	18	$184,779
BSCL	$1,219,709	18	$142,586
RSSH	$1,097,738	30	$51,615
RSSL	$1,097,738	30	$51,615
RSMH	$1,097,738	22	$51,615
RSML	$1,097,738	22	$51,615
RSCH	$1,097,738	18	$51,615
RSCL	$1,097,738	18	$51,615
TMSL	$865,618	16	$213,421
TMSH	$865,618	14	$256,295
TMML	$865,618	13	$165,361
TMMH	$865,618	12	$212,880
TMCL	$865,618	12	$150,262
TMCH	$865,618	11	$192,117
BMSL	$769,439	15	$119,159
BMSH	$769,439	14	$142,590
BMMH	$769,439	12	$123,293
BMML	$769,439	12	$97,719
BMCH	$769,439	11	$114,065
BMCL	$769,439	11	$90,985
RMSH	$692,495	14	$51,615
RMSL	$692,495	14	$51,615
RMMH	$692,495	12	$51,615
RMML	$692,495	12	$51,615
RMCH	$692,495	11	$51,615
RMCL	$692,495	11	$51,615
TCSH	$359,065	5	$79,637

cont. Table 3

Strategy*	Investment total	Years until depleted	Total taxes paid
TCCL	$359,065	5	$56,213
TCML	$359,065	5	$56,213
TCSL	$359,065	5	$56,213
TCCH	$359,065	4	$62,754
TCMH	$359,065	4	$62,754
BCSH	$319,168	5	$64,071
BCML	$319,168	5	$54,504
BCSL	$319,168	5	$54,504
BCCH	$319,168	4	$56,567
BCMH	$319,168	4	$56,567
BCCL	$319,168	4	$49,028
RCSH	$287,252	5	$51,615
RCSL	$287,252	5	$51,615
RCCH	$287,252	4	$51,615
RCCL	$287,252	4	$51,615
RCMH	$287,252	4	$51,615
RCML	$287,252	4	$51,615

*First letter – IRA type: R – Roth, T – Traditional, B – Blend of 50% R and 50% T.

Second letter – Investment during W/I years: S – S&P 500; C – Certificate of Deposit (CD); M – Mix of 50% S and 50% C.

Third letter – Investment during R/W years: S – S&P 500; C – Certificate of Deposit (CD); M – Mix of 50% S and 50% C.

Fourth letter – Tax rate during R/W years: H – 20%; L – 15%.

Source: own analysis.

Table 4. Results of simulation sorted by years until depleted

Strategy*	Investment total	Years until depleted	Total taxes paid
TSSH	$1,372,172	47	$1,505,948
TSSL	$1,372,172	47	$1,062,998
BSSL	$1,219,709	31	$271,938
BSSH	$1,219,709	30	$345,860
RSSH	$1,097,738	30	$51,615
RSSL	$1,097,738	30	$51,615
TSML	$1,372,172	24	$364,507
BSML	$1,219,709	23	$186,558
TSMH	$1,372,172	22	$458,052
BSMH	$1,219,709	22	$232,264
RSMH	$1,097,738	22	$51,615

cont. Table 4

Strategy*	Investment total	Years until depleted	Total taxes paid
RSML	$1,097,738	22	$51,615
TSCL	$1,372,172	19	$265,937
TSCH	$1,372,172	18	$351,217
BSCH	$1,219,709	18	$184,779
BSCL	$1,219,709	18	$142,586
RSCH	$1,097,738	18	$51,615
RSCL	$1,097,738	18	$51,615
TMSL	$865,618	16	$213,421
BMSL	$769,439	15	$119,159
TMSH	$865,618	14	$256,295
BMSH	$769,439	14	$142,590
RMSH	$692,495	14	$51,615
RMSL	$692,495	14	$51,615
TMML	$865,618	13	$165,361
TMMH	$865,618	12	$212,880
TMCL	$865,618	12	$150,262
BMMH	$769,439	12	$123,293
BMML	$769,439	12	$97,719
RMMH	$692,495	12	$51,615
RMML	$692,495	12	$51,615
TMCH	$865,618	11	$192,117
BMCH	$769,439	11	$114,065
BMCL	$769,439	11	$90,985
RMCH	$692,495	11	$51,615
RMCL	$692,495	11	$51,615
TCSH	$359,065	5	$79,637
TCCL	$359,065	5	$56,213
TCML	$359,065	5	$56,213
TCSL	$359,065	5	$56,213
BCSH	$319,168	5	$64,071
BCML	$319,168	5	$54,504
BCSL	$319,168	5	$54,504
RCSH	$287,252	5	$51,615
RCSL	$287,252	5	$51,615
TCCH	$359,065	4	$62,754
TCMH	$359,065	4	$62,754
BCCH	$319,168	4	$56,567
BCMH	$319,168	4	$56,567

cont. Table 4

Strategy*	Investment total	Years until depleted	Total taxes paid
BCCL	$319,168	4	$49,028
RCCH	$287,252	4	$51,615
RCCL	$287,252	4	$51,615
RCMH	$287,252	4	$51,615
RCML	$287,252	4	$51,615

* See Table 3.

Source: own analysis.

Table 5. Results of simulation sorted by total taxes paid

Strategy*	Investment total	Years until depleted	Total taxes paid
TSSH	$1,372,172	47	$1,505,948
TSSL	$1,372,172	47	$1,062,998
TSMH	$1,372,172	22	$458,052
TSML	$1,372,172	24	$364,507
TSCH	$1,372,172	18	$351,217
BSSH	$1,219,709	30	$345,860
BSSL	$1,219,709	31	$271,938
TSCL	$1,372,172	19	$265,937
TMSH	$865,618	14	$256,295
BSMH	$1,219,709	22	$232,264
TMSL	$865,618	16	$213,421
TMMH	$865,618	12	$212,880
TMCH	$865,618	11	$192,117
BSML	$1,219,709	23	$186,558
BSCH	$1,219,709	18	$184,779
TMML	$865,618	13	$165,361
TMCL	$865,618	12	$150,262
BMSH	$769,439	14	$142,590
BSCL	$1,219,709	18	$142,586
BMMH	$769,439	12	$123,293
BMSL	$769,439	15	$119,159
BMCH	$769,439	11	$114,065
BMML	$769,439	12	$97,719
BMCL	$769,439	11	$90,985
TCSH	$359,065	5	$79,637
BCSH	$319,168	5	$64,071

cont. Table 5

Strategy*	Investment total	Years until depleted	Total taxes paid
TCCH	$359,065	4	$62,754
TCMH	$359,065	4	$62,754
BCCH	$319,168	4	$56,567
BCMH	$319,168	4	$56,567
TCCL	$359,065	5	$56,213
TCML	$359,065	5	$56,213
TCSL	$359,065	5	$56,213
BCML	$319,168	5	$54,504
BCSL	$319,168	5	$54,504
RSSH	$1,097,738	30	$51,615
RSSL	$1,097,738	30	$51,615
RSMH	$1,097,738	22	$51,615
RSML	$1,097,738	22	$51,615
RSCH	$1,097,738	18	$51,615
RSCL	$1,097,738	18	$51,615
RMSH	$692,495	14	$51,615
RMSL	$692,495	14	$51,615
RMMH	$692,495	12	$51,615
RMML	$692,495	12	$51,615
RMCH	$692,495	11	$51,615
RMCL	$692,495	11	$51,615
RCSH	$287,252	5	$51,615
RCSL	$287,252	5	$51,615
RCCH	$287,252	4	$51,615
RCCL	$287,252	4	$51,615
RCMH	$287,252	4	$51,615
RCML	$287,252	4	$51,615
BCCL	$319,168	4	$49,028

* See Table 3.

Source: own analysis.

Table 3 highlights that the type of investment is more significant than the type of IRA. Historical data reveals that the S&P 500 Index consistently delivered the highest returns. Consequently, the top 18 portfolios with the highest ending balances were fully invested in the S&P 500 Index. The next 18 portfolios, which achieved slightly lower totals, allocated 50% to the S&P 500 Index in a mixed strategy. In contrast, the lowest 18 portfolios did not include any investments in the S&P 500 Index.

The type of IRA, however, plays a role within these tiers (100% S&P 500, mixed, and 100% CD). Among the portfolios in each tier, traditional IRAs achieved the highest ending balances, Roth IRAs the lowest, and blended IRA types fell in the middle. This performance disparity is primarily due to the traditional IRA's frontend tax advantage, which allows for additional investment in the IRA.

It is crucial to note that the superior performance of traditional IRAs hinges on reinvesting the tax savings into the account. Without this additional investment, the final balance of a traditional IRA would be lower. Unfortunately, prior research has found no evidence that total traditional IRA contributions are higher because of the frontend tax savings (Beshears et al., 2014).

Table 4 reveals that only two of the fifty-four combinations maintain a continually growing balance, as their yearly withdrawals are less than their earnings. After 47 years, the TSSH and TSSL combinations achieved balances of $6,097,239 and $7,552,470, respectively, with both continuing to grow. In contrast, all other combinations depleted their funds within 4 to 31 years.

The most effective strategy, based on the situational returns, is a traditional IRA invested in the S&P 500 during both the W/I years and the R/W years, particularly with a lower tax rate during the R/W years.

An additional insight is that the initial balance at the start of the R/W years is not the sole factor in determining how long the funds last. In some cases, a lower starting balance outperformed a higher one in terms of longevity. This outcome underscores the greater influence of both the investment type during the R/W years and the applicable tax rate during retirement on the depletion timeline.

Lastly, as observed during the W/I years, the type of investment remains critical. The six combinations that lasted the longest – 30 years or more before depletion – all invested in the S&P 500 during both the W/I and R/W years.

Table 5 highlights that paying a significant amount in taxes represents a "win-win" scenario for both the individual and the government. For the individual, maintaining a large retirement balance that is not depleted quickly leads to substantial tax payments over time – a success for the investor and a benefit for the government. This underscores the mutual interest, for both the individual and the government, in ensuring retirement investments are successful.

Notably, the five combinations with the highest total tax payments all involve a traditional IRA. The government's strategy of offering a frontend tax advantage results in larger retirement balances, ultimately leading to higher tax revenues over the long term. This approach of delayed gratification by the government – deferring tax collection until retirement – proves advantageous for the government.

Conclusions

Among the many observations in this study, three key insights emerge.

First, starting early is crucial. Regardless of the type of IRA selected, the most important step is to begin investing as soon as possible – ideally in a tax-advantaged IRA if available. Early and consistent investing allows more time for assets to grow during the working and investing (W/I) years, leading to significantly larger balances by retirement.

Second, the type of investment appears to have a greater impact on outcomes than the type of IRA. While equities carry higher risk, investing in an S&P 500 index fund during both the working and investment (W/I) years and the retirement and withdrawal (R/W) years is a primary driver of strong performance. This finding challenges the conventional guidance to reduce equity exposure with age (Jagannathan & Kocherlakota, 1996). A more aggressive, equity-heavy strategy throughout the life cycle can yield superior returns, provided it aligns with an individual's risk tolerance (Levine, 2016). This conclusion reinforces and expands upon earlier work by Cannon and Tonks (2013), who studied 16 countries using historical data from 1909 to 2000 and employed a different evaluative metric – the dividend replacement ratio (Diamond, 1977).

Third, the type of IRA – Roth versus traditional – is of secondary importance. While one may slightly outperform the other under certain conditions, the differences are typically minor. For example, the impact on how long retirement savings last often amounts to just one or two years.

Given uncertainties about future tax rates, career length, and lifespan, these findings suggest that the choice between IRA types is not a decisive factor. This conclusion should reassure investors: there is no "wrong" choice between account types. Instead, early, consistent, and growth-oriented investing is what matters most. These straightforward, actionable insights can help reduce anxiety around retirement planning. Furthermore, because the framework is intentionally general, the findings may be broadly applicable to other countries with similar retirement systems.

Nevertheless, the study has limitations. One is its reliance on historical market conditions. While actual S&P 500 returns from 1984 to 2024 (averaging 8.44% annually) were used for the W/I years, future returns may differ significantly. The same applies to the R/W years, for which estimated returns were selected to reflect plausible outcomes. Any variation in future returns could influence the conclusions. Additionally, the variety of possible defined contribution retirement scenarios is extensive, and it is not feasible to address all of them within a single study. These limitations highlight opportunities for future research.

Future research could explore a wider range of return scenarios – such as high, moderate, and low returns – as well as patterns like constant versus variable returns. While the expectation is that higher returns produce stronger outcomes, it would be valuable to test whether the study's general conclusions hold under different conditions.

Another potential extension involves dynamic portfolio rebalancing based on age. This study used three fixed investment conditions without reallocation. However, conventional wisdom suggests that asset allocation should shift from equities to bonds over time (Bali et al., 2009). Future studies could evaluate whether incorporating such age-based rebalancing affects the findings.

Lastly, further research could examine similar retirement investment strategies in other countries. While this study was designed to be broadly applicable, country-specific tax laws, retirement structures, or economic factors may influence the results. Comparative studies could test whether the insights presented here hold across different national contexts or require adaptation.

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