Integrating innovative paradigms and digital technologies into financial teaching and literacy

RETHINK FINANCE CHANGING PARADIGMS IN FINANCE

Edited by Diana Marieta Mihaiu and Marta Maciejasz

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Contents

From traditional finance to sustainable finance. Analyzing the link between the ESG score and financial performance of companies

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1. Introduction

Currently, the finance theory is going through a paradigm shift, i.e. we are witnessing a transition from traditional finance to sustainable finance, at least in theory. It remains to be investigated whether or not this change in the approach to financial decisions has been integrated in the financial practice. For the clarity of the approach, we will proceed to explain the two previously mentioned concepts.

Traditional finance refers to concepts, organizations, and methods that facilitate the management of financial assets, and investments. The key principles of traditional finance are the following:

– The foundation of financial decisions is the time value of money and the rational choice theory.

– The investment decisions rely on the interplay between risk and return. To balance risk and return and meet investing goals, strategies for asset allocation, diversification, and risk management are used.

– The efficient markets hypothesis (EMH) is still a pillar of traditional finance, despite criticisms and empirical difficulties (information asymmetry, financial markets inefficiencies). According to this theory, it is practically impossible to regularly outperform the market through active trading or stock selection because asset prices reflect all available information.

– Maximizing shareholders' wealth and maximizing financial returns make the main objective of the company's management.

Sustainable finance seeks to align financial activities with sustainable development goals, balancing economic prosperity with environmental protection and social equity. This approach recognizes that traditional financial models often generate negative externalities (e.g. pollution, social inequality, biodiversity loss, systemic risks), leading to long-term risks and societal harm. Sustainable finance aims to address these shortcomings by promoting investments that generate positive environmental and social impacts while

delivering financial returns. The key principles of sustainable finance are the following:

– incorporating environmental, social, and governance (ESG) factors into financial decision-making.

– sustainable investing theory: fostering investments that have a positive impact on the environment and society, while providing competitive returns to investors.

– long-term value creation and long – term resilience.

The approach to sustainable finance has intensified in the European Union (EU) since 2018 when the European Commission developed and approved the Sustainable Finance Action Plan (SFAP) as part of the EU's wider Sustainable Finance Framework and European Green Deal. In 2021, the EU's concerns in this direction developed with the implementation of the EU Sustainable Finance Disclosure Regulation (SFDR) level I, following the implementation for level II.

On the background of this transition, from traditional finance to sustainable finance, we propose to analyze three aspects:

i. The scientific concerns in the field of sustainable finance, identifying the emerging scientific themes in this field of research.

ii. The degree of sustainable finance principles integration in the activity of public companies, related to all sectors of activity, from the following regions: North America, Developed Europe, Developed Asia Pacific.

iii. Confirmation that the companies that have integrated the principles of sustainable finance in their activity and report this aspect by calculating the ESG score, have managed to generate an improvement in the financial performance and the market value, in the medium-long term of the analyzed companies.

We believe that by achieving these three objectives, we manage to offer a complete and real picture of the stage at which the adoption of the sustainable finance principles is at the present moment, in the year 2024, and to capture the possible differences in adoption that may exist between different sectors of activity and/or between geographic regions.

Although studies on sustainable finance, ESG reporting and disclosure are numerous (as can be seen in the literature review), there is still, to our knowledge, no chapter that treats these three aspects on such an extensive data set.

The present chapter is structured as follows: in the introduction, the objectives of the chapter are defined; the second part, which contains the literature review that shows the results of the research undertaken up to now in this field; the third part contains a bibliometric analysis related to the concept of sustainable finance, which has the role of capturing, from the point of view of scientific concerns, the research stage of this concept, the regions in which it is researched more intensively; the fourth part of the

chapter contains the methodology used and data analysis, followed by the results and final conclusions.

2. Conceptual boundaries regarding traditional finance and sustainable finance

Whilst traditional economic theory focuses on labor and capital, current times require integrating also new dimensions and concerns, more specifically of an environmental nature, as well as social issues and governance aspects. Admittedly, resources are finite and even though some are replenishable, there is a replacement rate which needs to be considered in order for balance to be attained. Nowadays, resources are consumed at a higher pace than their replacement rate and this creates a wide range of serious and pressing issues such as resource depletion, biodiversity loss, land-use change, climate change, poor air quality, nitrogen and phosphorus flows, greenhouse gases levels, declining ecosystem health and system destabilization, air pollution and plastic pollution. To these implications we can add economic disparities and social inequalities generated by businesses; here we identify externalities like: poor working conditions, child labor, internationalization of social and environmental externalities, hunger, poverty, living below minimum social standards, lack of healthcare, limited fresh water access. By consequence, there arises a need to understand systems, thinking more exactly how all these aspects are connected and what the consequences of the events and phenomena which take place will be – and this is a matter of sustainability.

So, what is sustainability? Why does it matter and how does it pertain to finance? We can start from here: both sustainability and finance contemplate the future.

One of the more common and broadly used definitions is the one given by the UN. In 1987, the United Nations Bruntland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs," at the same time as casting an unbreakable bond between development and environment. Consequently, sustainable development implies an integrated approach which considers economic development in the broader context of environmental concerns.

In this context, the most used and popular framework is that of "the triple bottom line", particularly environment, economy and equity (or planet, people, profit; Elkington, 1997), which proves the broadened vison from shareholder value to stakeholder value. So that, in order for a successful human society to be developed, there is a need to comprehend how these three pillars are

connected, not only in the short run, but in the long term as well, not only for a short-term growth, but with long-term stability in mind.

In traditional finance demarches, the optimal combination of financial return and risk is sought after in order to maximize shareholder value. Moreover, historically, businesses have only had a social obligation to use their resources and engage in profitable endeavors as long as they operated within the legally binding rules. Still, societal needs ultimately constitute the source of product demand (Roberts, 2004) and externalities are not completely dissociable from production decisions (Hart & Zingales, 2017a). Therefore, it is critical to expand corporate goals from shareholder value to stakeholder value, which soundly incorporates social, environmental and financial value, while mitigating the strong behavioral bias towards growth-based short-term objectives. The argument against corporate philanthropy is strong, while the argument in favor of integrating sustainability into strategy and finance is even stronger, bringing ethics to the forefront of current topical debates.

Sustainable finance is a concept derived from the larger concept of business sustainability. Although, de facto, financial theory does not factor in value for natural resources apart from the envisaged cash flow, currently, in an effort to mitigate environmental changes and challenges, we are transitioning to a desideratum of circular and low carbon economy. Certainly, by consequence this sustainability transition needs sustainable finance, especially when long-term projections are made and the wider context is crystalized. "While an early transition allows for a gradual adjustment of our production and consumption patterns, a late transition will cause sudden shocks and lead to stranded assets, which have lost their productive value" (Schoenmaker & Schramade, 2018).

The UN created the 2030 Agenda for Sustainable Development to direct the shift towards an inclusive and sustainable economy, which will automatically necessitate behavioral change. In the UN's view, economic, social and environmental factors are the three connected facets of sustainable development as an integrated concept.

According to Levine (2005) the financial system holds an important array of roles: preparing ex ante information regarding potential investments and capital allocation; investment monitoring and corporate governance implementation; facilitating trading, diversification and risk management; savings mobilization; facilitating goods and services exchange. Of these, the first three roles are especially relevant for sustainable finance.

The financial system's primary role is to distribute resources to the most beneficial or productive uses and nowadays these uses should consider sustainability goals as well when devising adequate strategies. Finance may take the lead in directing capital into environmentally friendly businesses and initiatives,

hastening the shift to a low-carbon and more circular economy. What is more, sustainable finance tackles the issue of how finance (meaning investing and lending demarches) impacts environmental, social and economic matters. Also, investors can have an impact on the corporations they invest in; long-term investors can influence corporations to adopt sustainable business practices in this manner. Additionally, finance may assist in addressing the inherent ambiguity surrounding environmental issues, as it acknowledges the pricing risk for valuation purposes.

Arguably, this evolution and paradigm shift from traditional finance to sustainable finance, harbors the potential to shift from profit maximization (and finance as a goal) towards finance as a means of bringing about a positive change with beneficial impacts over environmental, social and economic vectors and areas (Schoenmaker & Schramade, 2018). According to Schoenmaker (2017b), short-termism and insufficient private efforts are considerable obstacles in the way of sustainable finance; later, he added aversion to change to this list (Schoenmaker, 2017a). Furthermore, other authors identified different hindrances, such as the following: the conventional short-term character of financial reasoning, the undertheorization of the sustainable finance concept, as well as the paucity of data regarding the effects of sustainable finance on the environment and society (Cunha, Meira & Orsato; 2021).

For comprehension, we should also mention the concept of sustainable investment, which encompasses ethical and financial paradigms alike (Widyawati, 2019). Sustainable investment or socially responsible investment (SRI) seek to obtain financial return while taking into account the impact over the society as well as factors of an environmental, social and governance nature, in an effort to better correlate risk and opportunity. It includes a wide range of strategies and approaches towards investment, with different degrees of rigor (Revelli, 2017), which are based on publicly or privately available metrics, inherently requiring additional analytical steps. We can mention here: ESG (environmental, social and governance criteria) compliant investment, best in class on relevant ESG issues (either in general or by industry), norms-based screening (like the Paris Climate Accord or the UN Global Compact), exclusion (based on ethical considerations), engagement (in companies with the intention of altering its practices or policies), sustainability themed investment (in companies which pursue sustainability objectives) and impact investment (requiring measurement and reporting of social and environmental performance).

From the above-mentioned strategies, two seem quite similar, as they both entail the same dimensions range: ESG compliant investment and impact investment; while the first describes how a company operates, the second depicts whose a company is and what it does in the world, going one step further with

encompassing the business' impact on society at large, increasing transparency and its accountability.

As SRI markets evolve, legitimacy is assured by ESG rating agencies and politically engaging with other macro actors in the financial system (Giamporcaro & Gond, 2016). Hence, understanding how ESG measurements contribute to the development of SRI markets is crucial for fostering the growth of new markets, particularly in emerging nations.

As far as parties involved in sustainable finance and investment are concerned, Cunha, Meira, and Orsato (2021) map and integrate the key components of the concepts based on a comprehensive evaluation of 166 publications in the literature on the subject, identifying four key participants in the field: providers, recipients, supporters, and beneficiaries.

Daugaard (2020) describes the prevalent emerging themes on ESG compliant investing: fixed income, fund flows, the human element, climate change and the rise of non-Western players; he also described the relevant topics addressing: the heterogeneous nature of ESG investing, its literature origins, its motivations and costs. Widyawati (2019) maps the scientific literature in an effort to comprehend the importance of ESG metrics and demonstrates the significance of ESG indicators in the SRI space because they serve two vital functions: they facilitate the SRI market and provide as a proxy for sustainability success. Viviers and Eccles (2011) analyze the research pertaining to ESG criteria investment.

Some authors raise the following question: rather than aiming for an ESG utopia, should ESG philosophy necessitate grounding in a standardized or financialized logic? At the moment, there is a possibility that the incorporation into financial processes of ESG criteria might be considered an ESG philosophy due to the way financial strategies and goals have absorbed ethical stakes (Revelli, 2017). On the other hand, as suggested by Janicke and Jaco (2012) an emphasis on sustainability will equate to the Third Industrial Revolution. These new realities call for revisions to the existing valuation framework in a manner that takes into account all social and environmental implications of a company's actions.

Nonetheless, there is a considerable part of the research body that argues that shareholder wealth maximization lacks relevance for sustainable wealth creation and that strong environmental, social and governance performance will become the new standard. For example, Porter and Kramer (2011) argue that the value creation paradigm as it exists now is out of date and a more appropriate thinking frame for value creation would be that of a "shared value", which should render benefits for both: community and company. Likewise, Fatemi and Fooladi (2013) state that companies which do not implement the sustainable value creation strategy will fall behind their industry and see their market values gradually diminish.

The company may be able to buy itself some time if it decides to either externalize or ignore these effects. Nonetheless, the expenses associated with ex-post settlement will greatly surpass their ex-ante levels and these businesses may in fact have a far greater chance of failing (Fatemi and Fooladi, 2013). Empirical findings like those of Flammer (2011), who notes that bad environmental news has impacted the company value at an increasingly negative rate over three decades since 1980 (an average of 0.42% drop in the stock price during 1980-1989, 0.66% drop in 1990-1999, and 1.12% drop during 2000-2009), offer additional support. Additionally, she finds that an average boost in stock returns of 0.84% is rewarded for favorable news about a company's environmental behavior. However, in more recent years, the positive investor response to good environmental news has tapered down (Schoenmaker & Schramade, 2018). Other researchers, such as Friede (2019) and Avetisyan and Hockerts (2017) conclude that investors recognize that ESG is crucial for the practice of SRI. Then as well, Hawn and Ioannou (2012) investigate how company performance is affected differently by symbolic and substantive corporate ESG actions, using data from 2,261 firms in 43 countries between 2002 and 2008. According to their findings, symbolic ESG initiatives have a greater beneficial effect on the market value of the company when there are more intangibles present. By contrast, Atz et al. (2023) conducted a chapter of 1,141 original peer-reviewed papers and 27 meta-reviews (which were based on around 1,400 underlying investigations), published between 2015 and 2020, and their overall findings indicate that, on average, ESG investing has produced financial results that are identical to those of traditional investing (one out of every three studies showing better performance).

On the one hand, previous studies were focused on the link between CSR (Corporate Social Responsibility) and market value through Tobin's Q. Since ESG started to come into mainstream research, the focus changed into this direction. These studies showed that companies with ESG improvements have seen an increase in their corporate market value (Zhou, Liu & Luo, 2022; Broadstock et al., 2021; Lins et al., 2017).

On the other hand, the research has been focused on public listed companies, also on the link between, ESG as metric for sustainable performance, ROA as metric for operational performance, ROE as metric for financial performance, and Tobin's Q as metric for market value performance of the companies (Alareeni & Hamdan, 2020; Velte, 2017).

Concerns on how SRI investors' moral convictions can be incorporated into investment research are common. ESG measures provide investors with an understanding of the integration process by illustrating the range of ESG dimensions and measurements from which they can select to convert their

convictions into investment criteria (Heinkel et al., 2001). Moreover, research shows that investors who do not know much about the ESG measures that are accessible are unwilling to make SRI investments (Escrig-Olmedo, Muñoz-Torres, & Fernández-Izquierdo, 2013; Giamporcaro & Pretorius, 2012). Thus, it is likely that the growth of the SRI market is hampered by a lack of knowledge regarding ESG indicators.

According to Ziolo, Bak, and Cheba (2021), the group of countries under analysis achieve more Sustainable Development Goals (SDGs) when the financial model is more sustainable; the authors identified a high correlation between the sustainable finance model and the sustainability of the economy, society, and environment. Using the BRICS countries as a case chapter, Guang-Wen et al. (2023) evaluate the relationships between economic growth, environmental pollution, financial development, and the use of renewable energy in light of the goals of SDG8, SDG13, SDG10, and SDG7. They find that these variables are influenced by one another over time, which also confirms the cross-linkages between the four SDG of concern.

Servaes and Tamayo (2013) find that CSR efforts increase the firm's worth when they are accompanied with high public awareness, as proxied implicitly by advertising intensity. Similarly, Dimson, Karakas, and Li (2011) show that the market responds more strongly when a company engages in corporate governance or climate change, while identifying that companies that successfully launch corporate social responsibility (CSR) engagement have an average 4% anomalous return. This is in line with the studies by Plumlee et al (2010) and El Ghoul, Guedhami, Kwok and Mishra (2011), which demonstrate that US companies with better CSR performance receive better priced equity financing. According to Barnea and Rubin (2005), there is a positive correlation between CSR spending and a firm's value at low levels, which however turns negative if CSR expenditures increase over a particular threshold. Goss and Roberts (2011) have also reported on this type of nonlinear relationship as their examination of borrowing costs reveals that borrowing costs are greater for enterprises at the bottom end of the CSR spectrum.

Statman (2005) examines the question from the standpoint of investments and finds that, in the 1990s and the early 2000s, SRI indexes outperformed the S&P 500 index, with the exception of four socially responsible company indexes, whose returns were compared with the latter. According to Statman and Glushkov (2009), an investment strategy that would have yielded an excess risk-adjusted return of 6.12% annually from 1992 to 2007 would have involved going along with CSR leaders and short with laggards. Conversely, Bello (2005) notes that there is no statistically significant difference between socially responsible and conventional funds with respect to returns

and diversification when comparing the features of mutual funds that invest in responsible firms with a group of conventional funds that were chosen at random.

In their proposal for future research on sustainable finance, Kumar et al. (2022) make a number of recommendations, including creating and promoting novel instruments for financing sustainability, enhancing and controlling the profitability and returns of sustainable financing, increasing the sustainability of finance, creating and coordinating frameworks and policies for sustainable finance, addressing the issue of corporate sustainability reporting that is deceptively labeled as sustainable finance, highlighting the impact of behavioral finance on sustainable finance, and utilizing novel technologies like blockchain, artificial intelligence and internet of things (IoT).

Arguably, research indicates that there is a great deal of variation in the conceptualization of SRI (Höchstädter & Scheck, 2015), despite a propensity to concentrate on financial ideas, namely the financial success of SRI portfolios (Capelle-Blancard & Monjon, 2012). Concerns about the transparency and consistency of the metrics currently in use have also been brought up by the ESG literature (Dorfleitner, Halbritter, & Nguyen, 2015; Semenova & Hassel, 2015). Nonetheless, there is a lack of awareness regarding the significance of ESG indicators and a poor mapping of the diversity of SRI literature.

In conclusion, most of the empirical data that are currently available offer strong support for the idea that businesses are rewarded for their sustainability efforts. Furthermore, the increasing number of data suggests that over time, the markets' assessment of the company is being adjusted to account for expectations of ever-better societal and environmental performance. The only practical course of action, according to these data and the exponential rise in the ex-post and ex-ante costs of compensating for social and environmental harm, is sustainable value creation. A market value premium will be awarded to early adopters of this framework, to those that forgo the conventional paradigm, which places an emphasis on the short term, and adopt the sustainable value creation model instead. Understandably, businesses that decide against using the previously mentioned approach will fall behind in terms of adding value for their investors and will reflect the inherent consequences on their market value and valuation prospects.

3. Analyzing scientific concerns in the field of sustainable finance

Reviewing the literature, bibliometric studies can contribute to developing the quantitative understanding of scholarly communication patterns, knowledge

dissemination, and impact within the field of finance. By analyzing citation networks, publication trends, and collaboration dynamics, bibliometrics provide valuable insights into the evolution of financial research, the influence of key authors and journals, and emerging research themes. Furthermore, these studies enable researchers and policymakers to make informed decisions regarding resource allocation, funding priorities, and strategic collaborations in the ever-evolving landscape of financial scholarship.

The objectives of this sub-chapter are the following:

- Exploring the diversity of documents within the realm of sustainable finance;
- Determining the annual citation count for publications related to sustainable finance;
- Assessing the impact of the top 15 journals in sustainable finance;
- Unveiling the influence of prolific authors in the field of sustainable finance;
- Identifying countries with high citation rates in sustainable finance literature;
- Analyzing the co-occurrence network of preferred keywords in sustainable finance;
- Identifying the most relevant affiliations within the theme of sustainable finance.

The chapter follows three steps for the data collection process. The selected database is Web of Science due to the size and the high quality of the documents indexed. On the second step, we used the following keywords regarding sustainable investments using the "OR" operator: "sustainable finance"; "sustainable invest*"; "esg invest*"; "ethical invest*"; "sustainable wealth creation"; "sustainable value creation"; "impact investment".

Results were refined by WoS category: Management, Business, Economics, Environmental Sciences, Green Sustainable Science Technology and Business Finance and by language: English.

For the data analysis, R Studio was used with the bibliometrix package and Biblioshiny as a graphic interface (Aria & Cuccurullo, 2017).

The highest number of documents (including articles, books, chapters, and reviews) published was in 2023, showing an increasing interest in this field.

The examination of the WoS core collection reveals a compelling trend: the annual scientific production from 1979 to 2023 shows a steady increase (see Figure 1). This pattern signifies a sustained and progressive growth in the generation of scholarly output across diverse domains. It reflects the ongoing evolution and dynamism within the scientific community, driven by factors such as technological innovation, expanding research interests, and global collaboration. This upward trajectory underscores the resilience and adaptability of

Table 1. Main information about the data exported

Period	1979-2023
Sources	682
Number of Documents	2063
Annual growth rate	15.31%
Citation per document	18.5
References	80587
Keywords	4943
Single authored documents	375

Source: authors' own elaboration

scientific inquiry in responding to evolving challenges and advancing knowledge frontiers over the decades.

Figure 2. illustrates the changing landscape of citations over time, with a notable peak occurring in 2001. During this year, scholarly articles were attracting an average of 18.5 citations per article, amounting to roughly 8.57 citations annually. What is truly remarkable is the surge in 2001, where articles were

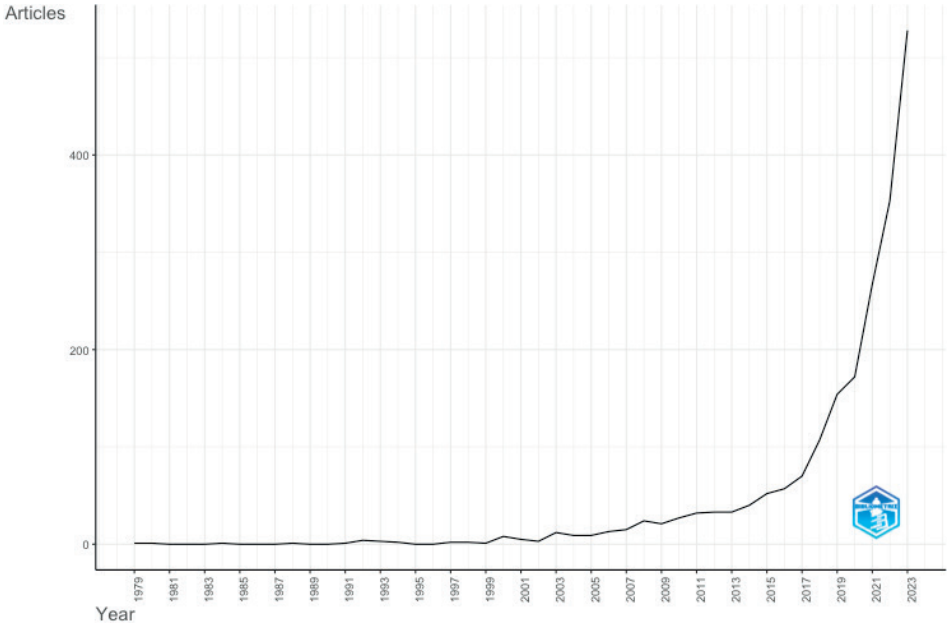

Figure 1. Annual scientific production

Source: own computation based on bibliometrix package in R Studio

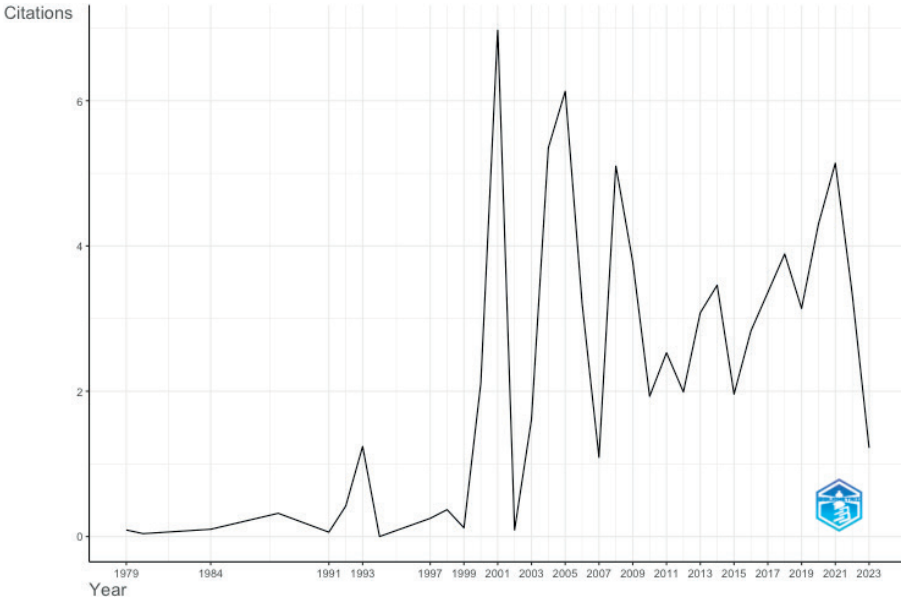

Figure 2. Average citations per year

Source: own computation based on bibliometrix package in R Studio.

being cited an astonishing average of 167.2 times each. This signals a significant moment in the academic world, suggesting a flurry of impactful research and widespread recognition within the scholarly community.

In this research field, according to the WoS, several sources stand out as particularly relevant. Among them are "Sustainability", "Journal of Business Ethics", "Journal of Sustainable Finance & Investment", and "Journal of Cleaner Production" (see Figure 3). These sources serve as pillars within the niche, consistently publishing high-quality research that contributes significantly to the discourse on sustainability, business ethics, sustainable finance, and environmentally friendly production practices. Their prominence underscores their influence in shaping scholarly conversations and driving progress in these critical areas. Researchers looking to stay abreast of the latest developments and insights in this field often turn to these reputable sources for valuable information and perspectives.

Expanding on the research, Bradford's Law categorizes sources into three distinct zones, as seen in Figure 4, providing valuable insights into the distribution of scholarly output within the field. The first zone, often referred to as the grey zone (Zone 1), comprises 14 of the most representative journals in terms of citations. These journals are considered central to the field, capturing a significant portion of the citations, and serving as primary sources of authoritative research.

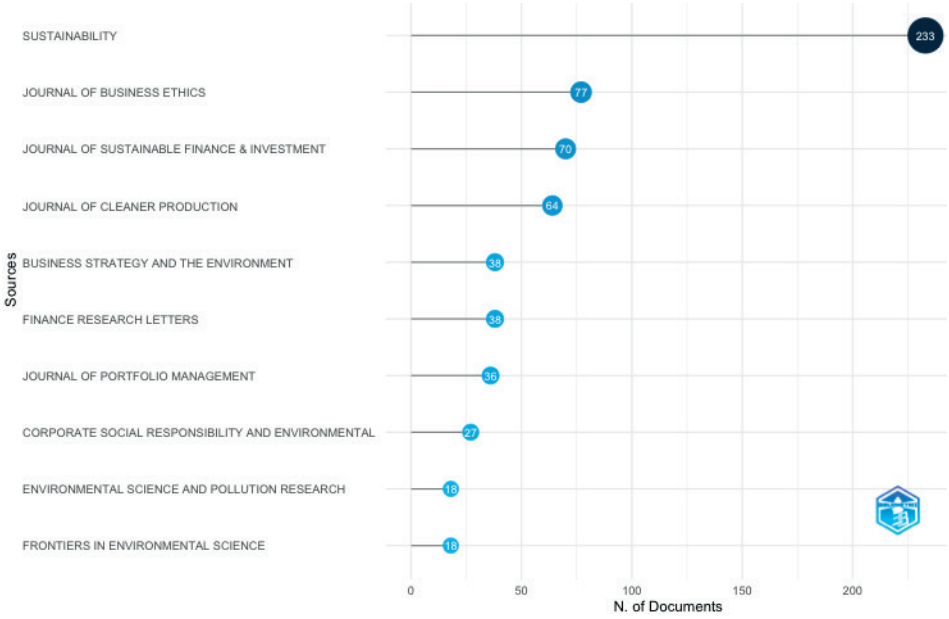

Figure 3. Most relevant sources
Source: own computation based on bibliometrix package in R Studio.

Moving beyond the grey zone, Zone 2 encompasses 121 journals that exhibit a moderate level of citation activity. While not as highly cited as those in Zone 1, these journals still contribute substantially to the body of knowledge in the research field. They offer a broader range of perspectives and topics, catering to diverse interests and providing valuable avenues for scholarly discourse and dissemination.

Finally, the third zone consists of journals with fewer citations, representing a long tail of publications that receive comparatively lower levels of attention. While these journals may not command the same level of influence as those in Zones 1 and 2, they nonetheless contribute to the diversity of scholarship within the field, offering niche insights and specialized research findings.

By understanding the distribution of sources across these zones, researchers can gain a nuanced understanding of the scholarly landscape, identify key publications for further exploration, and discern trends in citation patterns within the research field.

The productivity trends of the most relevant sources are depicted in the graph below. Notably, during the period from 1979 to 1987, there was minimal interest in these journals, with limited to no publications recorded. However, the situation began to change in subsequent years.

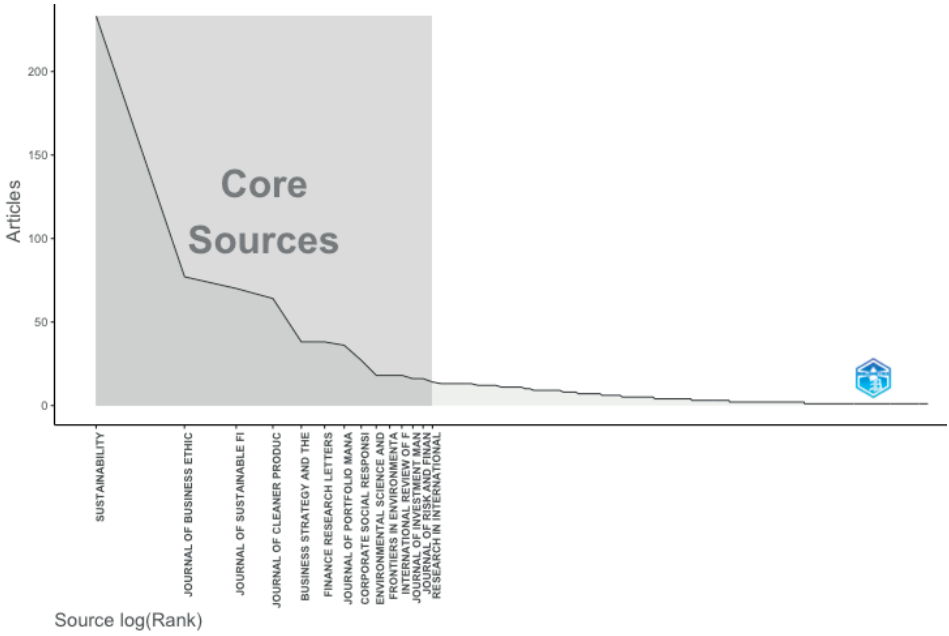

Figure 4. Core sources by Bradford's Law
Source: own computation based on bibliometrix package in R Studio.

Publications in the "Journal of Cleaner Production" first emerged in 2003, marking the beginning of its contribution to the field. Similarly, the "Sustainability" journal commenced its publications in 2016, followed by the "Journal of Sustainable Finance & Investment" in 2018.

Over the years, there has been a notable increase in publications across all journals, particularly evident in recent times (2016-2023). By 2023, the "Sustainability" journal led the pack with the highest number of publications, totaling 233. It was closely followed by the "Journal of Business Ethics" with 77 publications, and the "Journal of Cleaner Production" with 64 publications.

This visualization highlights the growing interest and activity within these journals, reflecting the evolving significance of sustainability, business ethics, and related topics in academic discourse and research (see Figure 5).

According to Figure 6, among the most relevant authors, Chiappini stands out with 15 documents, followed by Rutkauskas with 11, and Naeem with 9 publications. This distribution highlights the notable contributions of these authors to the research domain under analysis. Conversely, the remaining authors have fewer than 8 works in the field of chapter, suggesting varying levels of involvement or impact. This disparity underlines the significance of certain researchers in shaping the discourse and advancing knowledge within

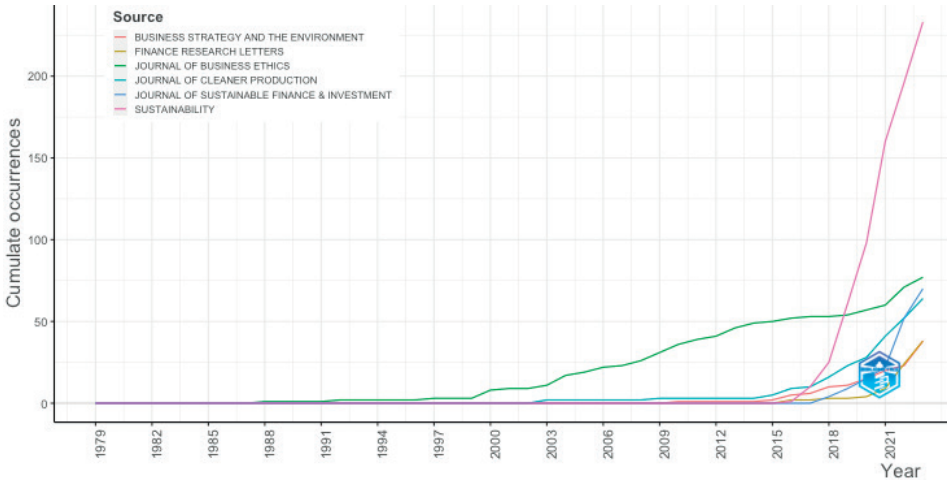

Figure 5. Sources' production over time
Source: own computation based on bibliometrix package in R Studio.

the research domain, while also recognizing the diverse contributions from a broader spectrum of scholars.

Regarding the production of the authors over time, we can observe that most relevant articles were written in the last decade.

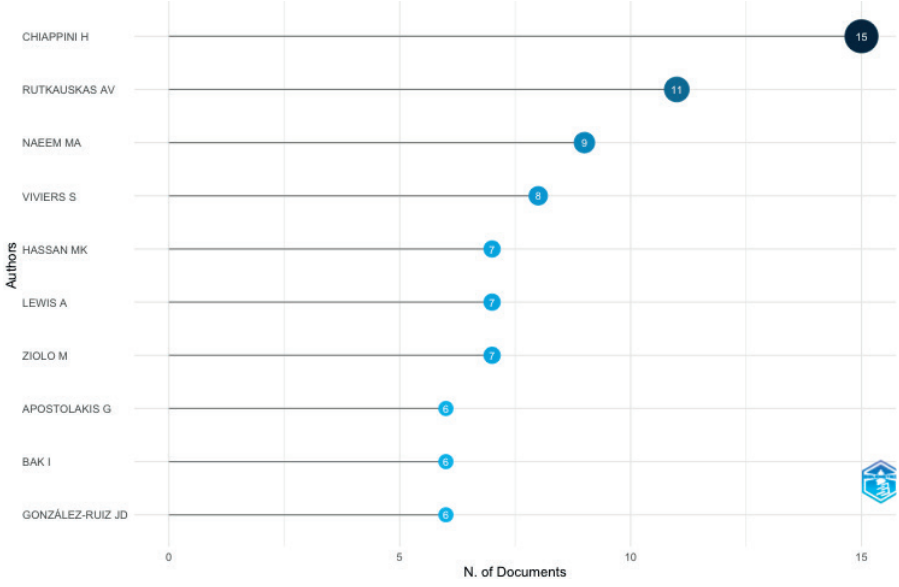

Figure 6. Most relevant authors
Source: own computation based on bibliometrix package in R Studio.

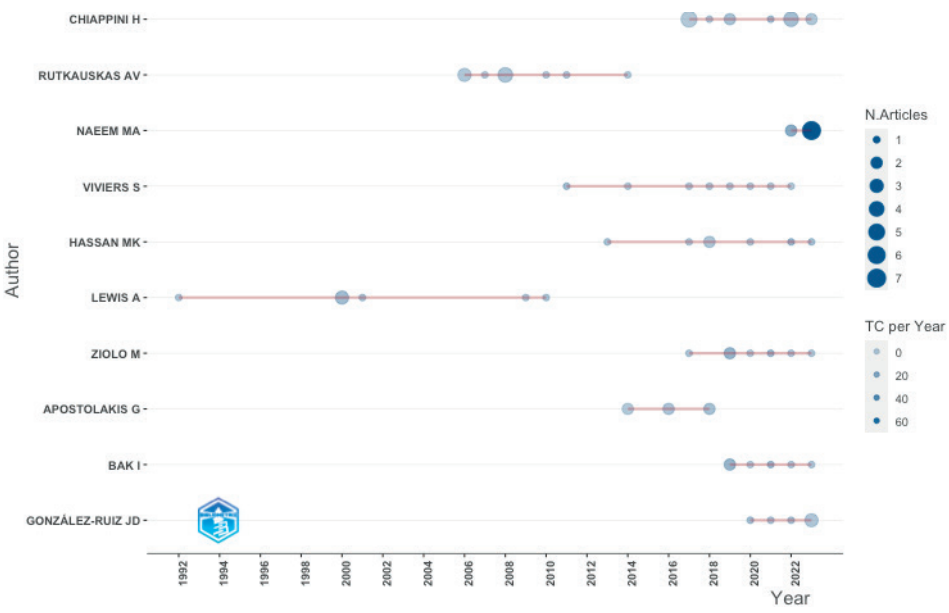

Figure 7. Authors' production over time
Source: own computation based on bibliometrix package in R Studio.

The most relevant affiliations include the Universities of Cambridge and Oxford, with 41 and 36 affiliated authors, respectively. These prestigious academic institutions boast a significant presence in the field of sustainable finance research, attracting top talent and fostering a conducive environment for scholarly inquiry and innovation. The high number of affiliated authors underscores the influential role of these universities in shaping the discourse, driving research agendas, and producing impactful contributions to the advancement of knowledge within the domain of sustainable finance (see Figure 8).

In the figure below, we can see the production over time for the main affiliations in our database, with the University of Cambridge and the University of Oxford initiating the research in this field, and contributing the highest numbers of articles published.

The dominance of China in single-authored articles reflects a robust research culture within the country, where individual scholars are actively contributing to the discourse on sustainable finance. This high number of single-authored articles suggests a strong emphasis on independent research initiatives and the cultivation of expertise by individual researchers in China.

On the other hand, the United States' leading position in multiple-authored articles underlines the collaborative nature of research in sustainable finance within the U.S. academic landscape. With over 200 documents authored by

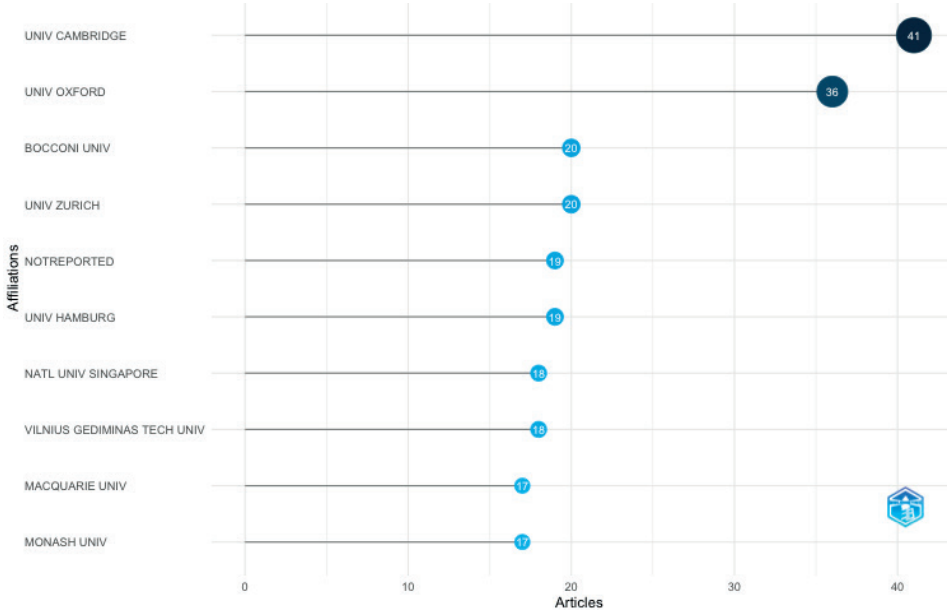

Figure 8. Most relevant affiliations
Source: own computation based on bibliometrix package in R Studio.

multiple scholars, it indicates a culture of interdisciplinary collaboration and knowledge sharing among researchers, institutions, and organizations within the United States.

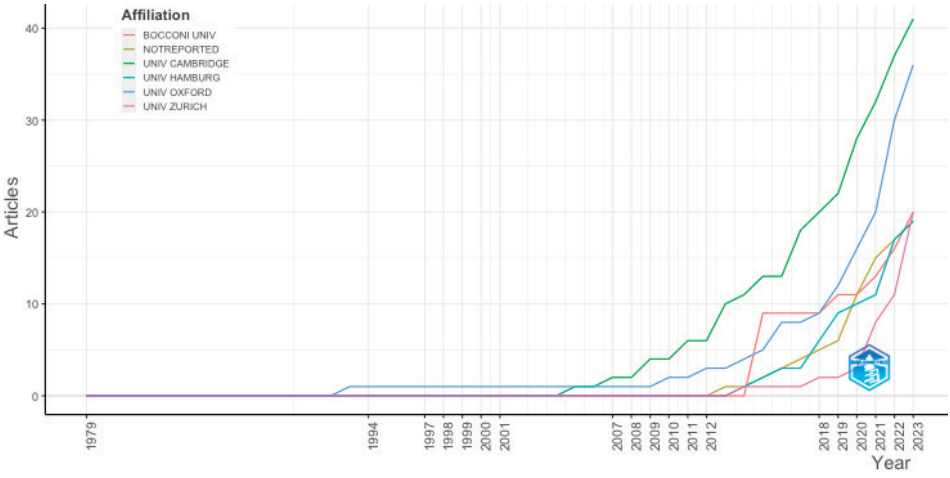

Figure 9. Affiliations' production over time
Source: own computation based on bibliometrix package in R Studio.

The presence of the United Kingdom in both rankings further highlights its significant role in sustainable finance research, demonstrating a balanced approach that combines both individual scholarly contributions and collaborative research efforts.

Overall, these rankings provide valuable insights into the research dynamics and scholarly outputs within the field of sustainable finance, showcasing the diverse approaches and contributions of different countries towards advancing knowledge and understanding in this critical area.

In the figure above, by classifying by country, a high interest can be observed from the USA and China for sustainable investments, followed by the United Kingdom.

The most cited countries in the field include the United States, as seen in Figure 12, leading with 5,968 citations, followed closely by the United Kingdom with 5,707, China with 2,975, and Germany with 2,571. These nations exhibit substantial research output and influence within the domain, reflecting their significant contributions to the scholarly discourse on sustainable finance. In contrast, the remaining countries in the top 10 list have accrued fewer than 2,500 citations each, suggesting a relatively lower level of citation impact compared to the top-ranking countries.

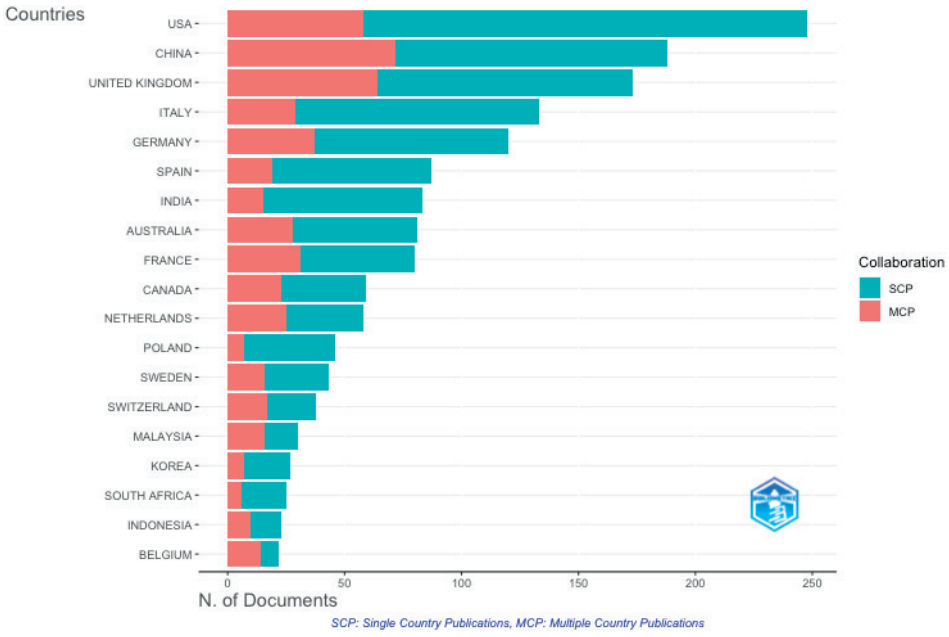

Figure 10. Corresponding authors' countries

Source: own computation based on bibliometrix package in R Studio.

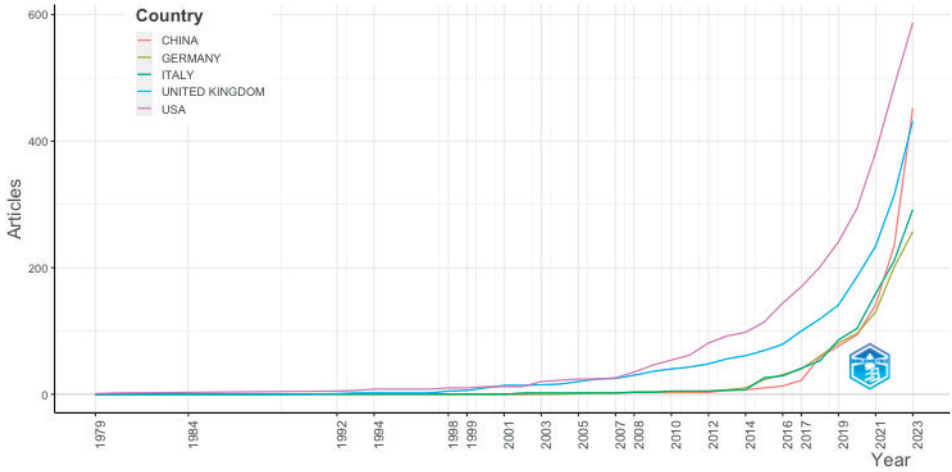

Figure 11. Country production over time
Source: own computation based on bibliometrix package in R Studio.

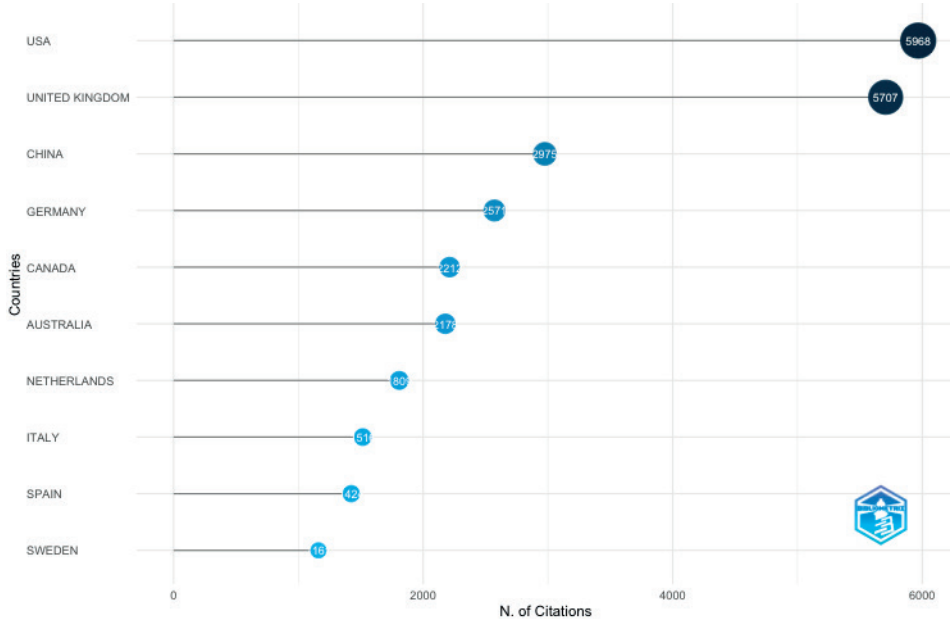

Figure 12. Most cited countries
Source: own computation based on bibliometrix package in R Studio.

The most globally cited documents in the field of sustainable finance are Chava (2008), with 799 citations, and Renneboog (2008), with 756 citations (see Figure 13). These documents represent seminal works or landmark studies that

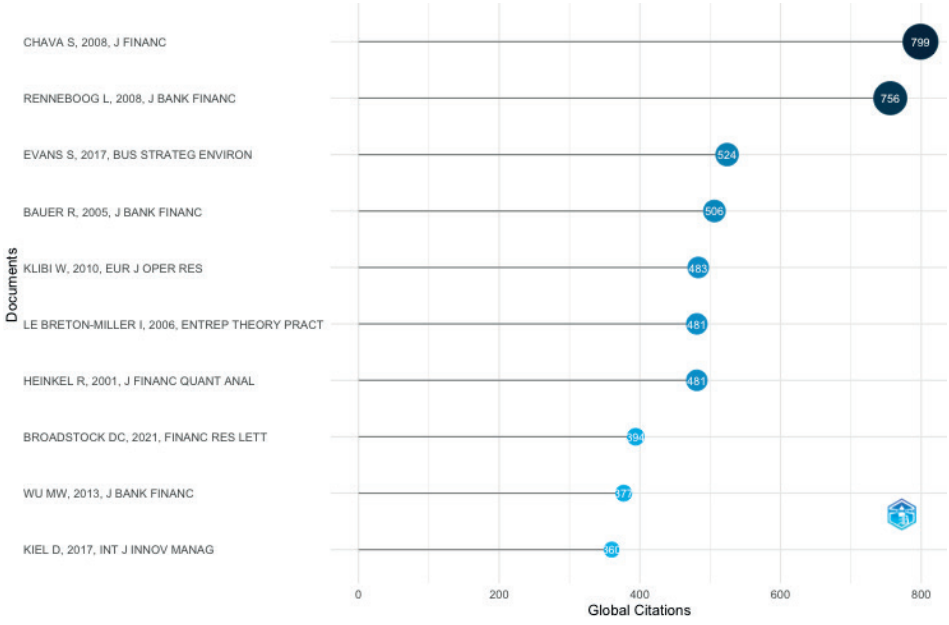

Figure 13. Most globally cited documents
Source: own computation based on bibliometrix package in R Studio.

have had a profound impact on the scholarly discourse and have significantly influenced research, policymaking, and practice within the field of sustainable finance.

The high citation counts for these documents suggest that they have become foundational references for researchers, practitioners, and policymakers seeking to understand key concepts, theories, and empirical findings related to sustainable finance. Their widespread recognition and continued citation over time underscore their enduring relevance and significance within the field, highlighting their pivotal role in shaping the direction and evolution of research and practice in sustainable finance.

Keywords such as "performance," "impact," and "CSR" are the most relevant within the research domain. These terms encapsulate key concepts and themes that are central to understanding and analyzing various aspects of sustainable finance. "Performance" delves into the evaluation of financial and operational metrics, assessing the effectiveness and efficiency of sustainable practices within organizations. "Impact" explores the broader consequences and outcomes of sustainable finance initiatives, including their environmental, social, and economic effects. "CSR" (Corporate Social Responsibility) encompasses the ethical and social responsibilities of businesses, addressing issues such as environmental

stewardship, community engagement, and ethical business practices. Together, these keywords serve as fundamental pillars for researchers seeking to explore, analyze, and contribute to the discourse on sustainable finance and responsible business practices.

Among the top 10 keywords, additional crucial terms include "risk," "investment," "governance," "management," "financial performance," "innovation," and "market." These keywords encompass essential aspects of sustainable finance research, reflecting the multifaceted nature of the field and the diverse factors that influence decision-making, strategy development, and performance evaluation within sustainable finance contexts.

Together, these keywords provide researchers with a comprehensive framework for exploring and analyzing the intricate interplay between financial, environmental, social, and governance factors in sustainable finance contexts (see Figure 14).

Among the interconnected keywords in our research, the most predominant ones are "sustainable finance," "sustainability," "impact investing," "ESG" (Environmental, Social, and Governance), and "sustainable investment." These keywords represent core concepts and themes that are central to the chapter of sustainable finance (Figure 15). They cover a broad range of topics related to

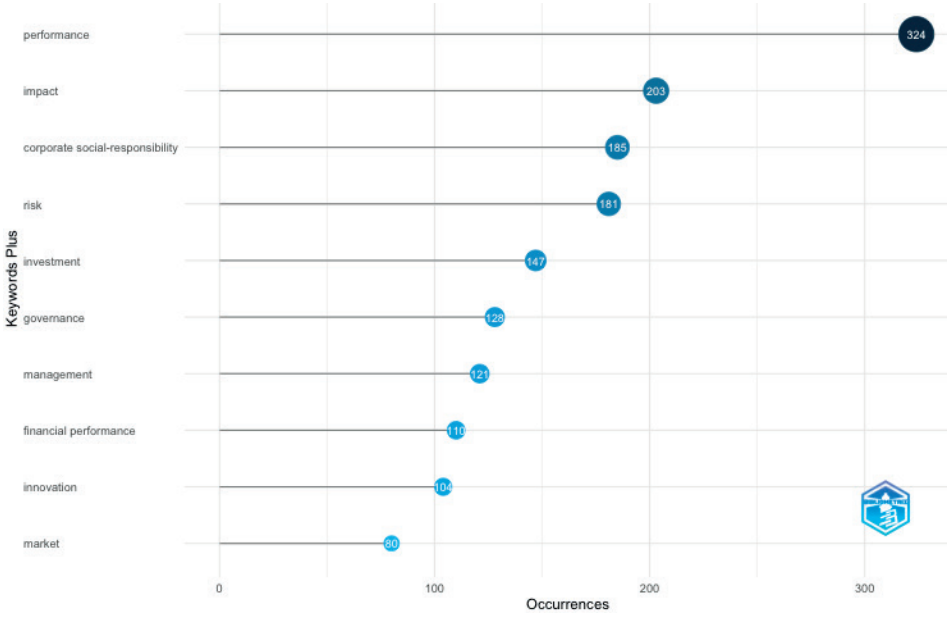

Figure 14. Most relevant words

Source: own computation based on bibliometrix package in R Studio.

Figure 15. Word cloud

Source: own computation based on bibliometrix package in R Studio.

integrating environmental, social, and governance considerations into financial decision-making processes, promoting investments that generate positive social and environmental outcomes alongside financial returns. These interconnected keywords reflect the multifaceted nature of sustainable finance research and stress the importance of addressing sustainability challenges within the financial sector.

Figure 16. reveals a visualization that offers a compelling overview of the key concepts shaping the industry. At the heart of this network lie the central keywords "sustainable finance," "impact investing," and "ESG". These terms serve as the elementary pillars, supporting a structure of interconnected ideas that span the spectrum of responsible economic growth. The visualization network graph reveals the co-occurrence of terms, with lines weaving a tapestry of association between concepts such as "social impact bonds," "corporate social responsibility," and "green bonds." The thickness of these lines narrates the strength of the relationships, indicating areas of focus within the broader conversation.

Moreover, the size of each node in the graph is not merely a design choice but a deliberate representation of the frequency with which these terms appear in related texts and discussions. Larger nodes for terms like "sustainable finance" and "ESG" underscore their prominence and the attention they command in the field.

Colors differentiate clusters of related terms, suggesting subtopics and specific areas of focus within sustainable finance. This color-coding aids in distinguishing between the various facets of the topic, from investment vehicles to overarching goals like the "sustainable development goals."

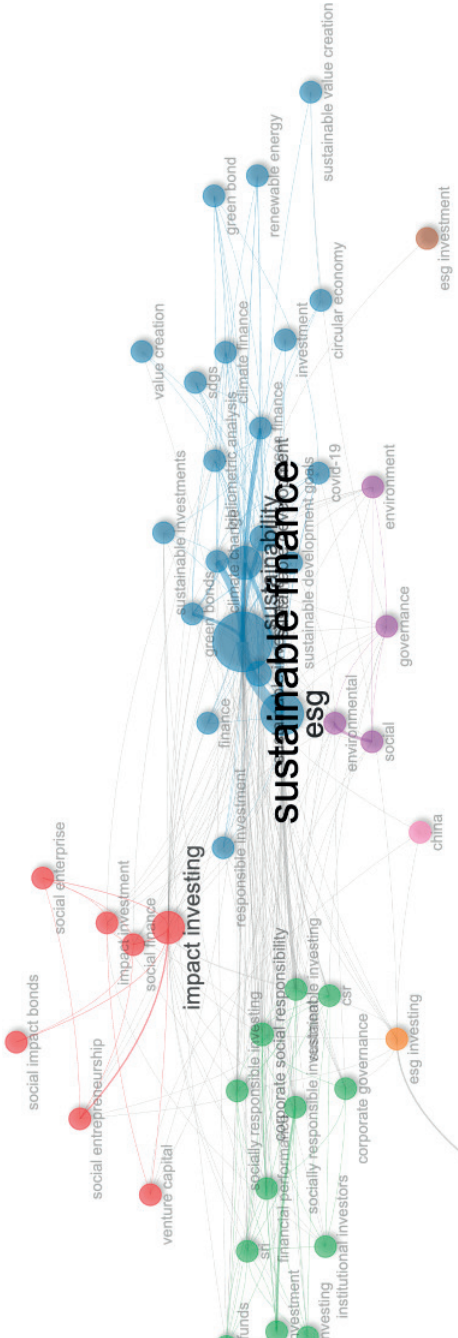

Figure 16. Co-occurrence clusters
Source: own computation based on bibliometrix package in R Studio.

Niche themes within the realm of sustainable finance belong in the areas such as sustainable value, portfolio construction, and portfolio theory.

- ***Sustainable Value***: This theme revolves around the concept of creating long-term value while considering environmental, social, and governance (ESG) factors. It delves into strategies and frameworks aimed at integrating sustainability principles into investment decisions, corporate practices, and organizational strategies. Key topics may include impact investing, sustainable development goals (SDGs), and measuring the societal and environmental impact of investment activities.
- ***Portfolio Construction***: This niche focuses on the process of constructing investment portfolios that align with sustainability objectives. It involves selecting and combining various assets, such as stocks, bonds, and alternative investments, to optimize risk-return profiles while integrating ESG criteria and sustainability considerations. Portfolio construction techniques may include diversification strategies, asset allocation models, and risk management approaches tailored to sustainable investing goals.
- ***Portfolio Theory***: This theme explores theoretical frameworks and models that underpin portfolio management and asset allocation decisions within the context of sustainable finance. It refers to modern portfolio theory (MPT), capital asset pricing model (CAPM), and other quantitative methods used to optimize portfolio performance while incorporating sustainability metrics and constraints. Researchers may investigate the implications of ESG integration on portfolio efficiency, asset pricing dynamics, and investor behavior.

By focusing on these niche themes, researchers can deepen their understanding of the intersection between finance and sustainability, contribute to the development of innovative investment strategies, and address pressing societal and environmental challenges through responsible investment practices.

Motor themes in the field of sustainable finance revolve around ethical density, sustainable investing, and socially responsible investment (SRI).

- ***Ethical Density:*** This concept refers to the degree to which ethical considerations, such as environmental stewardship, social responsibility, and corporate governance, are integrated into financial decision-making processes. Researchers explore how ethical density influences investment decisions, organizational behavior, and market dynamics. They may investigate factors that contribute to variations in ethical density across industries, regions, and investment products, as well as its impact on financial performance and stakeholder perceptions.
- ***Sustainable Investing***: Sustainable investing encompasses investment approaches that aim to generate financial returns while also contributing to positive environmental, social, and governance (ESG) outcomes. It involves integrating

ESG criteria into investment analysis and decision-making, engaging with companies to improve their sustainability practices, and supporting initiatives that promote sustainable development. Researchers examine different strategies within sustainable investing, such as ESG integration, impact investing, and thematic investing, and assess their effectiveness in achieving both financial and non-financial objectives.

- ***Socially Responsible Investment (SRI):*** SRI focuses on investing in companies or projects that align with ethical, social, and environmental values, while also considering financial performance. It involves screening investments based on certain criteria, such as environmental sustainability, human rights practices, and ethical business conduct. Researchers explore the evolution of SRI strategies, the impact of SRI on financial markets and corporate behavior, and the role of institutional investors, asset managers, and regulatory frameworks in promoting responsible investment practices.

By investigating these motor themes, researchers contribute to advancing knowledge and understanding of sustainable finance, disseminating information on investment practices, and driving positive changes towards a more sustainable and responsible financial system.

The development degree, or density, of keywords such as "impact investing," "impact investment," and "social finance" positions them between the motor and basic themes within the field of sustainable finance.

These keywords represent concepts that are central to the motor themes of sustainable investing and socially responsible investment (SRI). Impact investing and social finance involve directing capital towards investments that generate a positive social and environmental influence alongside financial returns. They reflect a proactive approach to integrating ethical, social, and environmental considerations into investment decision-making, in line with the broader goals of sustainable finance.

At the same time, these keywords also exhibit characteristics of basic themes within the field. They serve as primary concepts that underpin the broader discourse on sustainable finance, providing essential frameworks and principles for understanding and analyzing investment practices that prioritize social and environmental objectives. Researchers may explore these keywords to deepen their understanding of the mechanisms, strategies, and outcomes associated with impact investing and social finance, thereby contributing to the advancement of knowledge in the field.

By analyzing the development degree of these keywords, researchers can gain insights into their prominence and interconnectedness within scholarly literature, identifying their role as key drivers of research and practice in sustainable finance.

In the emerging themes section, keywords such as "sustainable value creation," "value creation," and "corporate sustainability" are readily situated. These keywords represent concepts that are gaining increasing attention and significance within the field of sustainable finance.

- ***Sustainable Value Creation***: This keyword emphasizes the importance of creating value for stakeholders in a manner that is economically, socially, and environmentally sustainable. It encompasses strategies and practices aimed at generating long-term value while considering the broader impacts on society and the environment. Sustainable value creation aligns with the principles of sustainable development and responsible business conduct, emphasizing the integration of environmental, social, and governance (ESG) factors into corporate decision-making processes.
- ***Value Creation:*** This keyphrase focuses on the fundamental concept of creating value for shareholders and other stakeholders. It encompasses strategies and activities aimed at maximizing returns on investment, enhancing profitability, and driving growth and innovation within organizations. In the context of sustainable finance, value creation extends beyond financial performance to include broader considerations such as social impact, environmental stewardship, and ethical business practices.
- ***Corporate Sustainability:*** This keyphrase emphasizes the importance of integrating sustainability principles into corporate strategies, operations, and culture. It encompasses efforts to manage environmental, social, and governance (ESG) risks and opportunities, promotes responsible business practices, and contributes to sustainable development goals. Corporate sustainability reflects a holistic approach to business management that seeks to balance financial objectives with social and environmental considerations.

These emerging themes emphasize the growing recognition of the interconnectedness between financial performance, societal well-being, and environmental stewardship within the corporate sector. By chaptering these keywords, researchers can gain insights into evolving trends, emerging practices, and future directions in sustainable finance, contributing to the development of innovative solutions and frameworks for creating value in a sustainable and responsible manner.

We can observe the **centrality of keywords** such as "ESG investing," "performance measurement," and "risk management," which exhibit a high relevance degree between emerging and basic themes analyzed within the field of sustainable finance.

- ***ESG Investing*:** As a central keyword, ESG investing bridges emerging and basic themes by serving as a fundamental concept that underpins the broader discourse on sustainable finance. ESG investing involves integrating environmental,

social, and governance (ESG) factors into investment decision-making processes to assess the sustainability and ethical impact of investments. It represents an emerging theme as it reflects a growing trend towards incorporating non-financial considerations into investment strategies. Simultaneously, it is considered a basic theme as it lays the foundation for understanding the principles and practices of sustainable finance.

- ***Performance Measurement*:** This is another central keyword that connects emerging and basic themes within sustainable finance. It encompasses methodologies and metrics used to evaluate the financial, environmental, and social performance of investment portfolios and companies. While performance measurement is a basic theme essential for assessing investment outcomes, it also plays a critical role in emerging themes such as ESG investing by providing the analytical framework for evaluating the effectiveness and impact of sustainable investment strategies.
- ***Risk Management*:** An intergal keyphrase that straddles both emerging and basic themes within sustainable finance. It involves identifying, assessing, and mitigating risks associated with environmental, social, and governance factors that may affect investment performance. While risk management is a foundational concept in finance, its relevance in the context of sustainable finance is emerging as investors increasingly recognize the importance of managing ESG-related risks and opportunities in their portfolios.

By analyzing the centrality and relevance of these keywords, researchers can gain insights into the interconnectedness between emerging and basic themes within the field of sustainable finance. These keywords serve as focal points for understanding key concepts, trends, and challenges in the integration of sustainability principles into investment decision-making processes, contributing to the advancement of knowledge and practice in sustainable finance.

Basic themes within sustainable finance encompass fundamental concepts that are specific to the field and lay the groundwork for understanding its principles and practices. These basic themes include:

- ***Sustainable Finance:*** This theme focuses on the integration of environmental, social, and governance (ESG) factors into financial decision-making processes. It encompasses investment strategies, financial products, and market mechanisms that aim to generate positive social and environmental outcomes alongside financial returns. Sustainable finance promotes alignment of financial goals with broader sustainability objectives, such as climate change mitigation, social equity, and corporate responsibility.
- ***ESG (Environmental, Social, and Governance) Factors*:** ESG factors represent key considerations that investors evaluate when assessing the sustainability and ethical performance of companies and investment opportunities.

Environmental factors include issues such as climate change, resource depletion, and pollution. Social factors encompass topics such as human rights, labor practices, and community relations. Governance factors relate to corporate governance practices, board diversity, and transparency. Integrating ESG factors into investment analysis helps investors identify risks and opportunities associated with sustainability issues and make informed decisions that align with their values and objectives.

- ***Sustainability*:** This is a core theme within sustainable finance that emphasizes the necessity of meeting present needs without compromising the ability of future generations to meet their own needs. It encompasses economic, environmental, and social dimensions, addressing challenges such as climate change, biodiversity loss, social inequality, and poverty alleviation. Sustainability principles guide investment strategies, business practices, and policy decisions aimed at fostering long-term resilience, prosperity, and well-being for society and the planet.

By focusing on these basic themes, researchers and practitioners gain a solid understanding of the foundational concepts and principles that underpin sustainable finance. These themes provide the framework for assessing the sustainability performance of investments, developing responsible financial products, and advancing policies and practices that contribute to a more sustainable and equitable future (see Figure 17).

A bibliometric analysis offers a comprehensive and visualized overview of various aspects of scholarly publications, including publication characteristics, author contributions, and research trends. By examining metrics such as citation counts, publication frequencies, author affiliations, and keyword co-occurrences, a bibliometric analysis enables researchers to gain insights into the structure and dynamics of the academic landscape within a specific field.

This analytical approach serves as a valuable tool for researchers, academics, and institutions alike. It allows them to identify influential authors, key research topics, and emerging trends, thereby guiding decision-making processes related to funding allocation, collaboration opportunities, and strategic research directions.

Furthermore, a bibliometric analysis facilitates the dissemination of knowledge and facilitates interdisciplinary dialogue by providing a clear and accessible visualization of complex scholarly data. By presenting information in a visually appealing and intuitive manner, it enhances understanding and fosters collaboration among researchers working on related topics across different disciplines and geographical locations.

In summary, a bibliometric analysis plays a crucial role in advancing scholarly inquiry and facilitating evidence-based decision-making in academic and research contexts. It offers valuable insights into the structure, evolution,

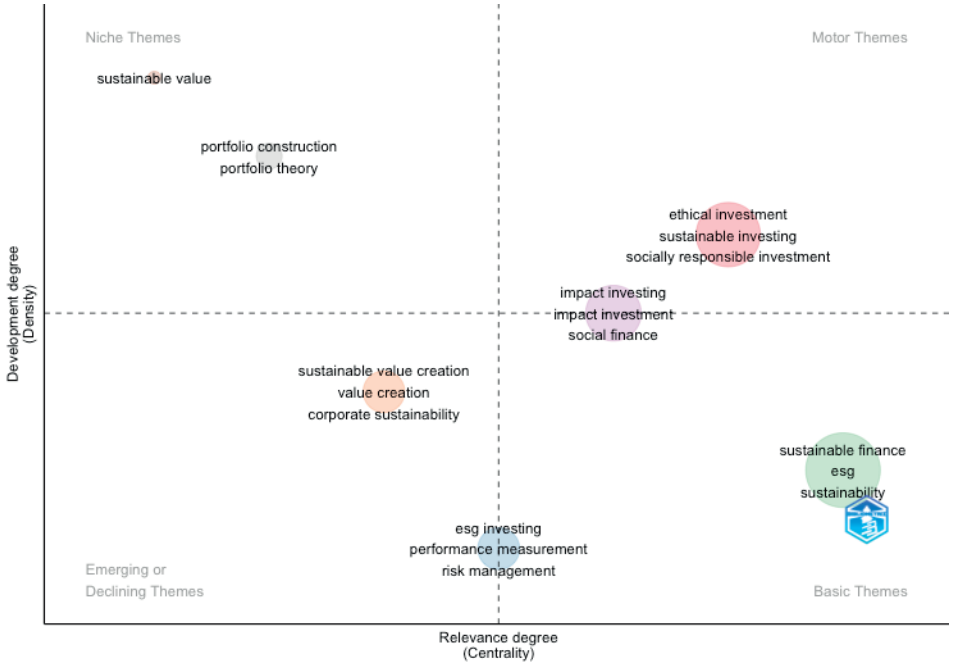

Figure 17. Clustering by coupling
Source: own computation based on bibliometrix package in R Studio.

and impact of scholarly publications, thereby contributing to the advancement of knowledge and the dissemination of research findings within the academic community.

Given the fact that the most papers were published last year, with a 15% growth rate annually, a robust and dynamic research landscape is emerging in the field of sustainable investments. Researchers, practitioners, and policymakers alike have a unique opportunity to shape the future of finance by integrating sustainability principles into investment strategies.

4. Analyzing the degree of sustainable finance principles integration in the company's activity and its influence on the financial performance of companies

4.1. Methodology

In terms of analyzing the sustainability path of the companies listed on the stock market, the ESG (Environmental, Social and Corporate Governance) score has been used as an indicator for this matter. This metric has values between 0 and 100, 0 in this case represents a company that performs at the lowest level

in terms of those 3 pillars (Environmental, Social and Corporate Governance), and up to 100, which means the company is doing an outstanding job in this regard. More and more investors rely on the ESG score evaluation of a company in their portfolio construction, trying to avoid companies that are involved in irresponsible use of resources, negative social media news, unethical practices with suppliers, customers, employees, the local community, etc.

Although this dimension brought by ESG reporting offers an enriched perspective on the analysis of an activity sector, industry, or company, the lack of a standard framework for its measurement makes it difficult to evaluate sustainability, which has a subjective side and is also a relatively recent research field.

In this chapter, to achieve our objective (*Analyze if companies that have integrated the concept of sustainable finance in their core business strategy and report their ESG progress have succeeded in generating an enhanced financial performance in medium to long-term perspective*) the authors have selected the ESG Scores from the ESG data provider Refinitiv, based on the availability criteria. Refinitiv is one of the top 10 ESG providers (Rajan, 2022), and for consistency in terms of accuracy and fair comparisons, their methodology for measuring the ESG Score for the period analyzed, i.e. 2016-2023, has been used.

According to Refinitiv's ESG guide, the scores can be split into 4 segments, as shown in Table 2 below:

Table 2. The 4 segments of ESG score

ESG Score range	Performance
0-25	Poor ESG performance
>25-50	Acceptable ESG performance
>50-75	Good ESG performance
>75-100	Outstanding ESG performance

Source: Authors' construction based on Refinitiv's ESG guide

For the financial performance of the company, three widely used financial measures (Hayes, 2021; Brigham & Houston, 2018) have been selected for this analysis, (1) the Return on Assets (ROA), (2) the Return on Equity (ROE), and the (3) Q Ratio also known as Tobin's Q Ratio:

$$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}} \tag{1}$$

$$\text{ROE} = \frac{\text{Net Income}}{\text{Common Equity}} \tag{2}$$

$$\text{Q Ratio} = \frac{\text{Market Value}}{\text{Book Value}} \tag{3}$$

Also, as in the case of the ESG scores, the data provider for the financial performance measures was the Refinitiv platform (Refinitiv, 2024), for the period 2016-2023.

The sample chapter for this analysis focused on public traded companies, from three main regions, North America, Developed Europe, and Developed Asia-Pacific. All sectors of activity (11) were included in, *Communication Services, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Real Estate*, and *Utilities* based on The Refinitiv Business Classification.

The rationale for selecting these three regions was that in developed countries the adoption of sustainability regulations from stock markets is already set in place and implemented, compared with emerging markets.

Initially, the sample contained 9,243 companies from North America, 5,873 companies from Developed Europe, and 8,185 companies from Developed Asia-Pacific. After analyzing and filtering the database to contain ESG and financial data for the entire period, 2016-2023, the final sample was reduced as shown in Table 3 below:

Table 3. Sample companies based on regions

Region	Total companies	Companies with ESG Score for the period 2016-2023	% of companies with ESG Score from the Total
North America	9,243	1,083	11.72%
Europe	5,873	671	11.43%
Asia-Pacific	8,185	744	9.09%

Source: Authors' own research.

After ensuring that all the companies included in the sample have data for all the metrics selected for the analysis (ESG Score, ROA, ROE, and Q Ratio), in the period mentioned above, the total number of companies was reduced to 2,498 of 23,301, roughly 11%, split into 11 sectors and 3 regions, as shown in Table 4.

The North America region has the highest number of companies (1,083), followed by the Asia-Pacific region (744), and the Developed Europe region (671). In terms of sectors, the Industrials sector has the highest weight (20.33%), and the least falls to the Utilities and Communication Services sectors, approximately 5% each.

Table 4. Sample companies based on regions and sectors of activity

Sector/Region	North America	Developed Europe	Developed Asia-Pacific	TOTAL
Communication Services	47	45	37	129
Consumer Discretionary	136	92	108	336
Consumer Staples	62	52	55	169
Energy	100	37	21	158
Financials	72	41	37	150
Health Care	93	47	51	191
Industrials	191	162	155	508
Information Technology	119	40	57	216
Materials	106	74	108	288
Real Estate	100	45	78	223
Utilities	57	36	37	130
TOTAL	1,083	671	744	2,498

Source: Authors' own research.

To establish if there is a relationship between sustainability (ESG Score) and financial performance (ROA, ROE, and Q Ratio), the authors performed a Pearson's Correlation analysis using IBM-SPSS software at different levels: region based and sector based. To evaluate the strength and direction of relationship between selected variables, the following Table 5 (Wahyuni and Purwanto, 2020) was used:

Table 5. Correlation coefficients interpretation

Correlation coefficient, range of values	Interpretation
0.80 to 1.00 (–0.80 to –1.00)	Very strong positive (negative)
0.60 to 0.79 (–0.60 to –0.79)	Strong positive (negative)
0.40 to 0.59 (–0.40 to –0.59)	Moderate positive (negative)
0.20 to 0.39 (–0.20 to –0.39)	Weak positive (negative)
0.00 to 0.19 (–0.00 to –0.19)	Very weak positive (negative)

Source: Authors' construction based on Wahyuni and Purwanto (2020) chapter.

4.2. Results and discussions

The results of the Pearson's Correlation analysis done at the region level indicate the following (see Table 6):

A) For companies from North America, a very weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.123 and .075) and no correlation with Q Ratio (.019);

B) For companies from Developed Europe, a very weak positive correlation, significant at the .01 level between ESG Score and ROA (.028), no correlation with ROE (.007) and a very weak negative correlation, significant at the .01 level with Q Ratio (-.050);

C) For companies from Developed Asia-Pacific, a very weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.148 and .051), and a very weak negative correlation, significant at the .01 level with Q Ratio (-.027).

In addition, the sector-level analysis for each region shows a slightly different correlation results between ESG Score and financial performance:

A) North America region:

a) The Communication Services sector – a very weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.182 and .170) and no correlation with Q Ratio (.070);

b) The Consumer Discretionary sector – no correlation between variables;

c) The Consumer Staples sector – a very weak negative correlation, significant at the .01 level between ESG Score, and ROA (-.089), and a weak positive correlation, significant at the .01 level with ROE, and Q Ratio (.248 and .203);

d) The Energy sector – a very weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.136 and .106) and no correlation with Q Ratio (.041);

e) The Financials sector – a very weak positive correlation, significant at the .01 level between ESG Score, ROA, ROE (.191 and .170), and a weak positive correlation with Q Ratio (.260);

f) The Health Care sector – a weak positive correlation, significant at the .01 level between ESG Score and ROA (.297), a very weak positive correlation with ROE (.112), and no correlation with Q Ratio (.036);

g) The Industrials sector – a weak positive correlation, significant at the .01 level between ESG Score and ROE (.089), and no correlation with ROA, and Q Ratio (.015 and .003);

h) The Information Technology sector – a weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.262 and .209) and no correlation with Q Ratio (-.057);

i) The Materials sector – a very weak positive correlation, significant at the .01 level between ESG Score, and ROA (.115) and no correlation with ROE, and Q Ratio (.052 and -.006);

Table 6. Pearson's correlation results, region level, period 2016-2023

Pearson's ratios by region			ESG_Score	ROA	ROE	TobinQ
North America	ESG_Score	Pearson Correlation	1	.123**	.075**	.019
		Sig. (2-tailed)		.000	.000	.080
		N		8664	8664	8664
	ROA	Pearson Correlation		1	.303**	.038**
		Sig. (2-tailed)			.000	.000
		N			8664	8664
	ROE	Pearson Correlation			1	.078**
		Sig. (2-tailed)				.000
		N				8664
	TobinQ	Pearson Correlation				1
		Sig. (2-tailed)				
		N				
Developed Europe	ESG_Score	Pearson Correlation	1	.028*	.007	-.050**
		Sig. (2-tailed)		.042	.595	.000
		N		5367	5367	5368
	ROA	Pearson Correlation		1	.667**	.201**
		Sig. (2-tailed)			.000	.000
		N			5367	5367
	ROE	Pearson Correlation			1	.286**
		Sig. (2-tailed)				.000
		N				5367
	TobinQ	Pearson Correlation				1
		Sig. (2-tailed)				
		N				
Developed Asia-Pacific	ESG_Score	Pearson Correlation	1	.148**	.061**	-.027*
		Sig. (2-tailed)		.000	.000	.035
		N		5944	5944	5952
	ROA	Pearson Correlation		1	.283**	-.037**
		Sig. (2-tailed)			.000	.004
		N			5944	5944
	ROE	Pearson Correlation			1	.068**
		Sig. (2-tailed)				.000
		N				5944
	TobinQ	Pearson Correlation				1
		Sig. (2-tailed)				
		N				

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Source: Authors' own research in IBM-SPSS.

j) The Real Estate sector – a very weak positive correlation, significant at the .01 level between ESG Score, and ROE (.070) and no correlation with ROA, and Q Ratio (.052 and .024);

k) The Utilities sector – a very weak negative correlation, significant at the .01 level between ESG Score, and ROA (-.128) and no correlation with ROE, and Q Ratio (-.087 and .002);

B) Developed Europe region:

a) The Communication Services sector – a very weak negative correlation, significant at the .01 level between ESG Score, and Q Ratio (-.108) and no correlation with ROA, and ROE (-.012 and -.087);

b) The Consumer Discretionary sector – no correlation between variables;

c) The Consumer Staples sector – a weak positive correlation, significant at the .01 level between ESG Score, and ROE (.204), and no correlation with ROA, and Q Ratio (.057 and .017);

d) The Energy sector – no correlation between variables;

e) The Financials sector – no correlation between variables;

f) The Health Care sector – a weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.357 and .215), a very weak negative correlation with Q Ratio (-.156);

g) The Industrials sector – no correlation between variables;

h) The Information Technology sector – no correlation between variables;

i) The Materials sector – no correlation between variables;

j) The Real Estate sector – a very weak positive correlation, significant at the .01 level between ESG Score, and Q Ratio (-.152) and no correlation with ROA, and ROE (-.065 and -.037);

k) The Utilities sector – no correlation between variables;

C) Developed Asia-Pacific region:

a) The Communication Services sector – no correlation between variables;

b) The Consumer Discretionary sector – a very weak negative correlation, significant at the .01 level between ESG Score, and ROA (-.087), and no correlation with ROE, and Q Ratio (-.039 and -.052);

c) The Consumer Staples sector – a very weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.119 and .136) and no correlation with Q Ratio (-.014);

d) The Energy sector – a weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.308 and .272) and no correlation with Q Ratio (-.109);

e) The Financials sector – a very weak negative correlation, significant at the .01 level between ESG Score, and ROA (-.122), and no correlation with ROE, and Q Ratio (-.024 and -.030);

f) The Health Care sector – a weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.369 and .334) and no correlation with Q Ratio (.015);

g) The Industrials sector – a very weak positive correlation, significant at the .01 level between ESG Score, and ROE (.073), and no correlation with ROA, and Q Ratio (.052 and -.055);

h) The Information Technology sector – a weak positive correlation, significant at the .01 level between ESG Score, and ROA (.231), and a very weak positive correlation with ROE (.189), and no correlation with Q Ratio (.011);

i) The Materials sector – a weak positive correlation, significant at the .01 level between ESG Score, and ROA (.293), a very weak positive correlation with ROE (.086), and a very weak negative correlation with Q Ratio (-.080);

j) The Real Estate sector – a very weak negative correlation, significant at the .01 level between ESG Score, ROA, ROE, and Q Ratio (-.167, -.111 and -.139);

k) The Utilities sector – a weak positive correlation, significant at the .01 level between ESG Score, ROA, and ROE (.261 and .254), and a very weak positive correlation with Q Ratio (-.150);

Furthermore, the evolution of the ESG Score during the period 2016-2023, in the three regions and sectors (11) analyzed compared with the evolution of the financial performance indicators, reveals the following:

As can be seen from the table above, the companies from North America have grown their ESG performance with an average between 3.57% and 6.97% respectively. During the period 2016-2019, only three sectors (Consumer Staples, Utilities and Real Estate) had a good ESG performance. An improvement and a growth in ESG performance started in 2020, with only two sectors (Communication Services and Financials) with an acceptable ESG performance.

Compared with North America region, in Developed Europe, the average growth rates are lower, between 1.40% and 5.73%, but during the entire analyzed period, only one sector (Financials) recorded acceptable ESG performance, and it has been improved to good ESG performance starting from 2020. Also, the highest ESG Scores, on average, can be found in this region, even though the percentage of companies that report ESG in the period analyzed is almost the same, 11.72% for North America and 11.43% for Developed Europe.

Table 7. Average ESG evolution in North America during the period 2016-2023, and the average growth rate

Sector/Year	2023	2022	2021	2020	2019	2018	2017	2016	Average growth rate [%]
Information Technology	58.42	57.42	55.69	51.98	48.87	48.04	45.41	42.07	4.80
Communication Services	49.73	48.14	45.86	44.39	40.69	40.29	38.01	36.59	4.48
Materials	59.78	58.55	56.31	51.98	48.45	45.08	42.09	40.33	5.78
Industrials	58.64	56.95	53.91	50.95	47.10	44.71	42.78	39.81	5.69
Energy	53.03	53.19	50.35	46.94	43.68	40.88	38.07	35.65	5.83
Consumer Discretionary	55.19	53.24	51.14	48.68	46.67	45.01	42.04	39.31	4.96
Consumer Staples	58.94	58.49	56.88	53.30	51.46	50.11	48.44	46.12	3.57
Financials	49.72	49.91	46.98	45.60	43.01	41.04	37.45	35.02	5.14
Health Care	59.08	57.79	55.23	51.42	46.75	44.68	41.55	38.27	6.40
Utilities	60.20	58.97	56.50	54.17	51.51	49.16	47.34	46.06	3.90
Real Estate	60.58	59.26	57.49	53.62	50.11	46.80	42.05	37.81	6.97

Yellow means 'Good ESG performance'; orange means 'Acceptable ESG performance'
Source: Authors' own research.

Table 8. Average ESG evolution in Developed Europe during the period 2016-2023, and the average growth rate

Sector/Year	2023	2022	2021	2020	2019	2018	2017	2016	Average growth rate [%]
Information Technology	64.55	65.27	65.35	62.45	60.16	58.42	57.50	54.87	2.35
Communication Services	66.67	66.52	66.97	64.13	62.60	59.65	57.58	57.28	2.19
Materials	70.07	70.61	69.76	67.02	64.37	61.24	58.89	57.53	2.86
Industrials	65.82	65.13	65.00	63.15	60.24	57.41	54.88	52.93	3.16
Energy	65.24	66.26	65.12	64.54	62.63	60.93	58.62	57.31	1.87
Consumer Discretionary	66.99	66.44	65.75	63.22	60.57	58.89	56.64	54.07	3.11
Consumer Staples	69.76	70.63	69.20	67.39	64.82	64.20	62.45	61.19	1.89
Financials	55.34	55.48	54.60	50.65	46.60	43.47	39.03	37.47	5.73
Health Care	69.29	69.25	68.10	65.34	63.87	58.99	54.07	52.09	4.16
Utilities	69.91	69.68	69.93	68.69	66.65	64.94	63.81	63.41	1.40
Real Estate	62.75	63.92	63.92	61.86	58.91	55.38	53.71	50.29	3.21

Yellow means 'Good ESG performance'; orange means 'Acceptable ESG performance'
Source: Authors' own research.

Table 9. Average ESG evolution in Developed Asia-Pacific during the period 2016-2023, and the average growth rate

Sector/Year	2023	2022	2021	2020	2019	2018	2017	2016	Average growth rate [%]
Information Technology	58,70	57,39	56,59	55,66	52,64	49,32	46,35	43,98	4,21
Communication Services	48,72	46,83	43,93	42,88	41,15	40,31	36,23	34,43	5,09
Materials	48,75	47,73	45,68	43,14	39,95	37,22	35,91	35,08	4,81
Industrials	52,65	51,71	50,14	48,00	46,00	43,78	42,01	40,41	3,85
Energy	41,28	40,61	41,45	38,63	36,77	36,15	33,51	34,49	2,60
Consumer Discretionary	54,36	52,36	50,09	47,76	45,25	42,80	41,44	38,80	4,93
Consumer Staples	57,79	55,81	55,45	54,19	49,40	45,53	41,59	39,03	5,77
Financials	53,96	52,23	51,76	49,97	48,38	46,30	44,43	40,28	4,26
Health Care	58,78	57,42	56,43	54,35	51,41	48,91	44,36	41,33	5,16
Utilities	49,08	47,75	46,49	45,34	44,95	40,96	40,12	38,74	3,44
Real Estate	56,28	55,54	53,67	51,46	49,64	47,04	45,39	40,38	4,86

Yellow means 'Good ESG performance'; orange means 'Acceptable ESG performance'
Source: Authors' own research.

Asia-Pacific is the region that has on average the lowest ESG performance out of the three ones analyzed during the period 2016-2023. It can be noticed that until the end of 2020, more than half of the sectors had an acceptable ESG performance, but in the last three years, they started to improve their performance. Nevertheless, it is the region with the lowest ESG performance, and with the adoption of ESG Score reporting (9.09%) out of the three analyzed. Still, quite far from the outstanding ESG performance range (>75-100).

Developed Europe has the lowest annual average growth rate, but scores the highest in ESG performance, followed by North America, and Developed Asia-Pacific. These results show that significant work still needs to be done to have an impact on financial performance in the long run.

Looking at the results of the financial performance evolution, the link between ESG performance and financial performance is weak as the results of the correlation confirmed above:

Compared with the evolution of the ESG performance, the financial performance in North America is on average above. Three sectors, Consumer Discretionary, Consumer Staples and Financials, outperformed the others, especially when we look at the ROE indicator, but also at ROA, while sectors like Information Technology and Health Care have the highest Q Ratio, meaning that the market overvalues the companies in this sector. It is worth noting that

Table 10. Average ROA, ROE, and Q Ratio evolution in North America during the period 2016-2023

Sector/Indicator	Average ROA [%]	Average ROE [%]	Average Q Ratio
Information Technology	5.69	10.90	9.48
Communication Services	3.71	9.17	3.88
Materials	3.12	9.16	2.92
Industrials	6.37	21.46	4.76
Energy	–0.62	–1.66	1.71
Consumer Discretionary	6.35	14.84	4.83
Consumer Staples	6.80	20.55	5.53
Financials	6.38	29.41	6.15
Health Care	1.20	11.47	10.01
Utilities	2.32	7.70	2.16
Real Estate	3.04	7.61	2.63

Source: Authors' own research.

these two sectors rely on a particular type of assets, intangible assets, assets that are known to be from the accounting point of view more challenging to record precise values. Also, in the North America region, we can find companies with the highest market capitalization in the world (e.g. Microsoft, Apple, Nvidia, Alphabet, Amazon, Meta, Berkshire Hathaway, Eli Lily etc.).

Table 11. Average ROA, ROE, and Q Ratio evolution in Developed Europe during the period 2016-2023

Sector/Indicator	Average ROA [%]	Average ROE [%]	Average Q Ratio
Information Technology	4.87	6.29	7.66
Communication Services	6.63	30.14	8.08
Materials	6.04	12.03	2.80
Industrials	4.77	13.96	4.24
Energy	–0.17	–2.42	1.34
Consumer Discretionary	5.93	13.33	3.31
Consumer Staples	5.04	12.25	3.55
Financials	6.46	16.26	2.75
Health Care	4.13	8.47	15.47
Utilities	2.87	10.53	2.01
Real Estate	4.20	7.50	2.15

Source: Authors' own research.

Looking at the situation in the Developed Europe region, the financial evolution outperforms the ESG one, as mentioned above, in this region the ESG performance has the lowest average growth rate during the analyzed period. In terms of financial performance, sectors such as Communication Services, Materials, and Financials have the highest average ROA, while Communication Services has the highest average ROE and the second highest Q Ratio, after Health Care sector, followed by Information Technology. The discrepancy between the ESG evolution and financial performance evolution in Developed Europe, being the region with the most sectors without correlation between these variables, shows that financial performance is the main driver of overall performance and value creation for European companies.

Table 12. Average ROA, ROE, and Q Ratio evolution in Developed Asia-Pacific during the period 2016-2023

Sector/Indicator	Average ROA [%]	Average ROE [%]	Average Q Ratio
Information Technology	3.41	5.41	2.96
Communication Services	6.15	11.77	2.97
Materials	1.39	–4.69	2.42
Industrials	3.64	7.04	1.86
Energy	–4.34	–5.31	1.56
Consumer Discretionary	4.71	8.28	2.63
Consumer Staples	3.61	7.54	2.75
Financials	5.21	11.27	2.45
Health Care	0.18	1.64	4.17
Utilities	1.93	5.08	1.30
Real Estate	4.97	9.69	1.08

Source: Authors' own research.

Analyzing the results from the Asia-Pacific region, financial performance evolution has a similar trend to the ESG performance. Also, in this region, compared to North America and Developed Europe, where they are very weak or there are no correlations, in Asia-Pacific there are weak positive correlations in most of the sectors between the variables. A similarity with the other two regions is that sectors such as Communication Services and Financials sectors outperformed the other sectors, especially when we look at the average ROA and ROE, the classic benchmarks for financial performance in any fundamental analysis.

5. Conclusions

Scientific concerns in the field of sustainable finance began to gain their momentum starting in 2015. The first five universities with collectives of authors who have significantly contributed to the development of knowledge in this field through numerous published articles are Cambridge University, Oxford University, Bocconi University, Zurich University, and Hamburg University, highlighting the major interest in this topic at the European level. The high interest in this research area is also reflected in the citations attracted by the published articles, with the most citations coming from the USA, the UK, China, Germany, Canada, Australia, the Netherlands, Italy, Spain, and Sweden, indicating a worldwide spread of research interest in sustainable finance.

However, legal regulations regarding sustainable finance emerged a few years later. In the European Union (EU), sustainable finance regulations have intensified since 2018 when the European Commission developed and approved the Sustainable Finance Action Plan (SFAP) as part of the EU's wider Sustainable Finance Framework and European Green Deal. In the US, three regulations have been proposed with applicability starting in 2023, with phased implementation: the Proposal for Climate-Related Disclosure Rules for Public Companies, the Proposal for ESG Disclosure Rules for Investment Companies and Advisers, and the Proposal for Rule to Address Misleading Investment Company Names (Tom Willman, Claudia Goetz, 2023).

In recent years, certain niche research themes have emerged from the general theme of sustainable finance, namely: sustainable value, portfolio construction, and portfolio theory. By concentrating on these specialized areas, academics can enhance their understanding of the relationship between sustainability and finance, aid in the creation of novel investment plans, and use responsible investing techniques to address social and environmental issues. Among these, an emerging theme that is becoming a subject of future research is sustainable value creation. This reflects the business sector's growing understanding of the significance of generating value for stakeholders in a way that is sustainable economically, socially, and environmentally, by implementing strategies meant to produce long-term benefits while considering the broader effects on the environment and society.

Starting with the current stage of research in the field of sustainable finance, we set out to analyze whether companies' practices align with the findings in this area. In this regard the research results during the period between 2016 and 2023, analyzing 2,498 companies from three different regions (North America, Developed Europe and Developed Asia-Pacific)

shows that between ESG performance and financial performance (ROA, ROE and Tobin's Q) at best the link is very weak. Moreover, in the North America region, in 10 out of 11 sectors of activity the correlation is very weak, positive and negative, with one sector without any correlation (The Consumer Discretionary sector). The same situation was found in the Developed Asia-Pacific region; the only difference is that the sector without any correlation is the Consumer Service sector. A different outcome came from the Developed Europe region, where 6 out of 11 sectors showed no correlation, the other sectors having a very weak but positive correlation. We can conclude, based on the results obtained, that sustainable finance is in progress, with the current state showing a weak link between sustainability and financial performance.

Looking at the evolution of the ESG score and financial performance, in each region, and in each sector, we can conclude that the average growth rate of the ESG Score over this period (2016-2023) is around 5% in North America, the Real Estate sector having the highest average growth rate (6.97%), and the Consumer Staples sector with the lowest one (3.57%), followed by Developed Asia-Pacific with an average growth rate of 4.4%, with the Consumer Staples sector being the top performing one (5.77%), a completely opposite situation. The last place is for the Developed Europe region, with a flat 3% average growth rate, where the Financials sector was recording the highest rate (5.73%), and the underperformer being, similar with the North America region, the Consumer Staples sector (1.89%). Even though the Developed Europe region has the lowest growth rate in terms of sustainability, compared with the other two regions, it displayed the highest ESG scores in the period analyzed.

The financial performance shows a better evolution compared to the sustainable one, in the North America region, the Return-on-Equity is 12.78%, followed by the Developed Europe region, 11.67%, and the Asia-Pacific region with 5.25%. The same ranking applies to Tobin's Q, and in terms of Return-on-Assets, the Developed Europe region is ranked first. Also, based on the numbers, we can conclude that the Asia-Pacific region is less financially efficient than the other two regions, which are close to each other.

In terms of limitations, the period analyzed is 2016-2023, since the ESG score started to be measured and considered on a large scale in both research and practice. Moreover, financial information on listed companies is more accessible and made public, compared with the ESG score, which – in most cases – is not a mandatory metric. Nevertheless, it would be more accurate if more companies were considered over a longer period, but the limitation is related to the ESG metric.

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From traditional to digital money: behavioral aspects of money

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Introduction

Money is one of the most popular and widely used tools in everyday life. It has been an element of economy for centuries. Over this time its form has evolved from primitive products to banknotes and coins. Nowadays, the use of electronic money and even virtual money is becoming more and more common. Therefore, questions arise about how this money works, whether it serves the same functions as traditional money and whether it is really a significant alternative to the currently functioning fiat money. In this context, it is natural to ask whether the financial system in its current form can continue to function or whether it will evolve towards a system based on virtual currency. From the economic point of view, money is just a tool. Still, from a wider perspective, it is not an ordinary tool because it is often accompanied by various emotions and sometimes prejudices. Therefore, divergent attitudes towards money are formed, and they cause diverse groups of people to use it in various ways. This paper aims to present virtual money as an alternative to traditional money, the possible consequences resulting from its expansion on the market, and whether respondents from selected countries differ regarding their attitudes towards money.

1. Forms of money and their evolution

Money, a key element of any economy for millennia, has played a fundamental role in shaping human history (Arestis et al., 2010). Although used daily and widely in billions (if not trillions) of economic transactions, it is one of the most complex and fascinating tools in economics in almost every corner of the world. Its historical evolution, from simple barter systems through commodity money to contemporary electronic and digital money forms, demonstrates its unique adaptive qualities as a response to society's ever-changing needs. Money – its importance in the economy, its natural evolution and its influence on

society – makes the subject of broad and multidisciplinary debates and analyses. The basic characteristics of money and its functions have almost always been reflected in the literature on the subject, where they have been defined and analyzed by many eminent thinkers, philosophers, sociologists, and economists over the centuries, if not millennia.

Money has undergone a long and complex evolution, starting with simple barter systems and ending with modern electronic forms. This evolution has been driven by the economic, technological and social needs of human civilization.

Thus, barter, as a system of direct exchange of goods for other goods, was the primary transaction method in early societies. Although this system was not complicated, it faced numerous challenges (Graeber, 2011). According to Graeber, barter often occurred when there was a clear social division of labor or lack of shared social norms, forcing negotiation and direct exchange of goods without the involvement of money. As civilization and economy developed and the evolution of society's needs took place, the barter system began to be ineffective and, at its core, showed significant limitations, such as the need for a double convergence (complementarity) of needs, the difficulty of establishing an exchange ratio between different goods, the lack of a common measure of value, among others.

1.1. The emergence of commodity money

In this context, commodities began to appear to be widely accepted in the process of exchange of goods or services. Consequently, goods which acted as transaction intermediaries became known as commodity money (Menger, 1892). Typical commodities used as commodity money varied according to the region of the world and culture. For example, the following were considered commodity money:

– Cattle: In many ancient societies, especially in Africa and Europe, cattle were considered a valuable commodity and often used as a form of money. Its value was based on its usefulness as a source of food and labor (Fage, 1988).

– Salt: Across cultures, salt was valued for its food-preserving properties and as an essential dietary ingredient. In ancient Rome, soldiers often received part of their wages in salt, leading to the word 'salary' – wages (Kurlansky, 2003).

– Grains: In agricultural societies, grains such as barley and wheat were a dietary staple and of high value. In ancient Egypt or Mesopotamia, grains were often used as a medium of exchange and stored in special warehouses (Postgate, 1992).

While representing an important advance in the evolution of payment systems over simple barter, commodity money was fraught with significant

imperfections. Vulnerable and difficult to distribute without losing value, it could also be subject to fluctuations in value depending on the temporal and geographical context. Despite these limitations, the emergence of commodity money was a significant breakthrough that opened the way for developing more advanced and functional forms of money, including metal money. Precious metals such as gold and silver, due to their durability and the possibility of standardization, gained popularity as a means of payment.

1.2. Development of metal money

Metals such as gold, silver and copper had characteristics that made them a perfect medium of exchange. These were:

1. Durability: Unlike foodstuffs or other commodities, metals do not deteriorate over time, which allows them to be stored for long periods (Redish, 1990).
2. Divisibility: Metals could be easily divided into smaller units without loss of value, allowing accurate pricing and small transactions (Kraay, 1976).
3. Standardization: The ability to cast coins in standard sizes and weights facilitated trade and exchange, eliminating the need to weigh each transaction (Howgego, 1995).
4. Universality: Gold and silver were valued in many cultures, making them a universal medium of exchange, crossing national and cultural boundaries (Cribb, 1986).

Their physical properties and other – equally important – characteristics, such as corrosion resistance, high value per volume, reusability, and the ability to form alloys, made them the dominant form of money in many ancient civilizations (Redish, 1990).

With the rise of the Roman Empire, coins became a powerful tool of imperial propaganda. Emperors used their portraits and symbols on coins to promote their authority and achievements. Standardizing weights and designs across the vast empire facilitated trade and encouraged economic integration (Harl, 1996).

In ancient China, the first coins, known as 'tool coins' or 'shovel coins,' were cast in bronze in the shape of tools, such as knives, shovels, and hoes. These coins were used in the 6th century BC during the Zhou Dynasty. The function of these coins as currencies is both practical and symbolic. On the one hand, they embodied the value of labor and its tools, which could directly reference the wealth and yields produced by an agricultural community. On the other hand, their unique shape may have made them difficult to store and transport – a problem that eventually led to the standardization of their form. Over time, they adopted a more standard circular shape with a square hole in the centre, which

made them easier to store and transport (Hartill, 2005). The standardization of coins also supported the development of trade and exchange on a larger scale, which was crucial to the Chinese Empire and commercial expansion at the time. Adopting a uniform shape and weight of coins allowed facilitating transactions, increased confidence in daily exchanges and strengthened trade ties, which had far-reaching consequences for the Chinese economy and society.

Thanks to its unique properties, metal money was key in developing global trade and financial systems. Its durability, divisibility, and universality made it the dominant medium of exchange throughout almost the entire known world for many centuries, thus shaping world economic history.

1.3. Paper money and its links to metal

With the development of economy and the increase in the number and complexity of transactions, there was a need to expand the money supply. This was to enable the ever-increasing volume of transactions to be handled and to provide an alternative to the limited physical supply of precious metals, traditionally used as a means of payment. In this context, paper money began to gain popularity as an alternative to the rather heavy and, thus, inconveniently transportable metal coins.

The first forms of paper money already appeared in medieval China, where it was used in the form of promissory notes for payment, which in turn could be exchanged as required for metal coins at specific locations (Schwab, 1997). It was, however, in Europe during the Renaissance that paper money began to be used more and more frequently and thus became increasingly important. Issued by private banks, paper money – banknotes (depository receipts), were treated as promises to pay precisely defined amounts of gold or silver. In practice, this meant that when the need arose, the holder of such a note could always go to the bank and exchange it for the appropriate amount of precious metal (Davies, 2002).

1.4. From the gold standard to fiat money

In the second half of the 19th century, many countries with the largest economies in the world, such as the United Kingdom, the United States, Germany and France, adopted the so-called gold standard (Eichengreen, 2008). This was a monetary system in which the value of a country's currency was directly linked to a certain amount of gold. This meant that a monetary unit, such as the pound sterling or the US dollar, had a fixed value expressed in gold. It was incumbent on central banks to hold an appropriate amount of this bullion in the vault as a reserve, the size of which should be correlated with

the value of banknotes in circulation. The size of the reserve was determined by various factors, such as the financial system's stability, monetary policy and international exchange (Eichengreen, 2008).

Adopting the gold standard was intended to ensure monetary stability and curb inflation. Linking the value of money to the physical quantity of gold was intended to ensure that governments would not be able to excessively increase the money supply, which could lead to price increases. At the same time, the system facilitated international trade and investment, as exchange rates were relatively fixed and the currency's value was widely recognised (Bordo, 1981).

This type of money – backed by bullion, survived until the middle of the second decade of the 20th century. Its heyday, however, was between 1871 (the end of the Franco-German War) and 1914 (the outbreak of the First World War), a period known as the Belle Époque. It was an era of relative peace, stability and general prosperity, particularly in France and other western European countries. It was a period that encouraged trade and economic growth. During this period, bullion money reached its peak of popularity and became the dominant form of money in the world. This system was based on gold, the main bullion used to produce coins and other forms of money. Countries pledged to exchange their currencies for gold at a fixed rate, ensuring the money's stability and reliability.

However, the gold standard also had some disadvantages. It made the money supply dependent on the available supply of gold, which could lead to deflation in the case of a shortage of bullion. Furthermore, during economic crises, central banks often had to defend their gold reserves, leading to higher interest rates and further deterioration of the economic situation (Bernanke, 1994).

With the First World War outbreak, the bullion money system began to collapse. Countries started to print more money to finance the war, which led to inflation and a loss of confidence in the financial system.

Eventually, the gold standard was abandoned by most countries in the first half of the 20th century, mainly because of the need to bear the costs associated with financing the war effort in World War I and the Great Depression of the 1930s. It was replaced by a system based on fiat money, in which the currency's value is not directly linked to bullion but depends on confidence in the issuing institution and the monetary policy pursued (Eichengreen, 2008; Ferguson, 2008).

Fiduciary money, from the Latin word 'fiducia' meaning 'trust', is based solely on public trust and not on material value, as was the case with bullion or commodity money. Another familiar name for it is 'fiat' money, from Latin – this can be equated with the phrase 'so be it', while in English it means 'decree' or 'command'. Modern fiat money is commonly accepted as a means of payment. Modern banknotes and coins originating from this system have

no intrinsic value – their value derives from the force of law and the public's trust in state institutions and the financial system (Mankiw, 2012).

It should be emphasised that paper money, initially closely linked to precious metals, has come a long way to become an independent medium of exchange based on public trust and the stability of financial institutions. This evolution reflects not only the ability of financial systems to adapt in the face of changing economic realities and societies' needs, but also reveals a profound transformation in how value (money) is perceived and defined. Initially – at an early stage of evolution, the linking of paper money to precious metals such as gold or silver was intended to ensure its value and stability. These bullions, due to their rarity and durability, were seen as a universal measure of value, and their physical presence in the vaults of central banks guaranteed the credibility of the money issued. However, over time, with economic development and the increasing need for monetary circulation, this system began to show some limitations.

The move away from the gold standard and other forms of linking money to precious metals was the result not only of economic factors, such as the scarcity of bullion or the costs associated with its storage and transportation but also of changes in public confidence and perceptions of the role of financial institutions. Societies began to see that the value of money could be based on the credibility and stability of the financial system and not just on the physical presence of a certain amount of gold or silver deposited in bank vaults. This change in the perspective, however, required the development of strong and independent financial institutions, such as central banks, which would manage the money supply and ensure the system's stability. It also necessitated the development of new monetary policy tools, such as interest rates or open market operations, which would allow flexible responses to changing economic conditions.

The evolution of paper money into an independent medium of exchange is, therefore, a story of technological progress and economic development and changing societies' attitudes towards trust, value and the role of institutions. It shows that financial systems are not static creations but dynamic structures that are constantly evolving and adapting to new challenges and expectations. At the same time, this evolution makes us realise how important public trust in financial institutions and responsible and transparent monetary policy are for stability and economic development.

1.5. Electronic and digital money

With the development of modern technology, especially in the era of digitalization of economy, money has also started to take on an electronic form. Electronic money, often called e-money, exists only in an intangible form and

is stored in electronic banking systems. The dynamic development of this form of money has made using bank accounts, payment cards or online transactions an everyday part of life for many users worldwide.

In the new financial system, devoid of the constraint of gold, central banks control the fiat money supply by introducing appropriately defined monetary policies to achieve financial stability in the economy (Krugman & Wells, 2009). The value (purchasing power) of fiat money can be exposed to inflationary or deflationary processes, depending on the monetary policy decisions taken by these institutions, which have constitutionally guaranteed independence in developed economies.

The development of electronic money has brought many benefits to users, such as convenience, speed of transactions and reduction of costs associated with cash handling, among others. At the same time, however, new challenges have arisen related to the security of IT systems, the protection of personal data and the prevention of money laundering and terrorist financing. As a result, the regulation and supervision of electronic payment systems have become an important element of the financial policies of countries and international organisations (European Central Bank., 2012).

Electronic money is the oldest form of virtual money that appeared with the development of bank IT systems. For this reason, it is the best legally regulated among the previously presented forms of virtual money. Its specificity is that it is treated as a simple substitute for cash, which can be exchanged at any time. Such money is a stock of monetary value in technical devices, such as payment cards, which can be used to make payments to entities other than the issuer. This is how the European Central Bank defines electronic money (e-money). In Poland, the Act on Payment Services defines electronic money as "monetary value stored electronically, including magnetically, issued, with the obligation to redeem it, to make payment transactions, accepted by entities other than the issuer of electronic money" (Electronic money…). This means that electronic money gives the right to make a claim against the issuer for the release of an appropriate amount of money. In contrast, in the case of cash money, the monetary value is expressed by a paper banknote or coin.

Analyzing the classic features of money, it can be concluded that electronic money has all these features. It is:

- widely accepted, as indicated by its definition,
- divisible because it can be used to make transactions on various scales,
- portable, device-independent
- durable, i.e. resistant to various factors,
- limited in quantity, which results from the limited possibilities of its issuance and connection with cash, which it can be converted into at any time,

- legally sanctioned, which is related to the need to obtain appropriate licenses and permits for its issuance.

In addition to these features, it is indicated that electronic money is also (Borcuch, 2009):

- transferable because it allows transactions to be made to different people,
- cheaper to use due to cheaper emissions and transaction costs,
- flexible in terms of technology.

Analyzing electronic money in terms of its function as money, it can be concluded that it is primarily a means of payment. It can also be a means of hoarding, especially overpaid cards, a measure of value, and sometimes a means of exchange. Electronic money is also an international means of payment because, thanks to banking IT systems, this function can be performed more than cash.

On the other hand, a breakthrough in the evolution of money occurred in the first decade of the 21st century thanks to the development of blockchain technology. This was linked to the emergence of cryptocurrencies in late 2008, such as Bitcoin. They differ fundamentally from traditional money (including e-money) in that they operate in decentralised systems based on cryptography and blockchain technology and are not controlled by any central institution or government (Narayanan, 2016). Their emergence has opened new possibilities, such as transactions without intermediaries, greater anonymity or the potential for financial innovations such as smart contracts. At the same time, however, cryptocurrencies carry a few risks, such as the high volatility of their prices, the possibility of being used for illegal activities or challenges to monetary policy and financial stability (Houben & Snyers, 2018).

From the considerations presented, it is evident that money, which has accompanied humanity for millennia, is constantly evolving, moving from simple barter systems to advanced electronic forms, constantly adapting to the new challenges and opportunities that present themselves. The change in the form of money from forms based on tangible value to fiat money and then to electronic and digital forms reflects the dynamic changes in economic processes, technology and society. Modern forms of money, although significantly different from their historical predecessors, still perform the essential functions traditionally attributed to currency, acting as a medium of exchange, a unit of account and a means of storing value.

2. Attitudes towards money

According to the discussion so far, from the economic point of view, money is just a tool, and its possession and use should not cause any hardship. However, considering this issue from a wider perspective, it is not an ordinary tool

because it is often accompanied by various emotions and sometimes prejudices. These emotions and prejudices make the basis for several attitudes towards money and are demonstrated in various behaviors of individuals.

There are many definitions of attitude within psychology, for example:

- "Internal affective orientation that explains human behavior" (Reber, 1985),
- "a relatively persistent tendency to positively or negatively evaluate (…) an object by (…) a person" (Wojciszke, 2006),
- "an individual predisposition to evaluate an object or a certain aspect of the world favorably or unfavorably" (Antonides, 2003),
- "Attitudes are evaluations of people, objects or views" (Aronson, Wilson and Akert, 2006).

The above are just some of the available definitions of attitude, which indicates the lack of agreement among psychologists as to what an attitude is. However, there is no doubt that attitudes may be determined by various factors. Classically, there are three groups of such factors: emotional, cognitive and behavioral. They can also be considered components of attitude, although there is some controversy in this regard.

The lack of compliance between behavior and attitude contributed to distinguishing two levels of attitudes: explicit and latent. The difference between them is that the explicit attitude is conscious and can be determined relatively easily, while the implicit attitude is unconscious and uncontrolled (Aronson, Wilson and Alert, 2006, p. 182). Implicit attitudes are defined as "traces of past experience that may influence the subject's current behavior" (Greenwald and Banaji, 1995).

In the case of money, the dualism of attitudes seems to be quite clearly visible. Although it is often said that money cannot buy happiness, people play lotteries much more often when there is a multi-million jackpot. The declared attitude of indifference towards money does not go hand in hand with behavior.

The study of attitudes towards money has been a subject of interest for scientists for quite a long time. One of the first studies in this area was conducted in 1972 by Wernimont and Fitzpatrick. The respondents (adults) were asked to assess the importance of money, which allowed identifying seven dimensions of attitudes. Another study from 1981 by Rubinstein allowed distinguishing two groups of people with different attitudes towards money: spendthrifts and thrifts. Further research in this area was more advanced and led to the construction of three psychometrically verified scales: the Money Attitude Scale (MAS) by Yamauchi and Templer (1982), the Money Ethic Scale, MES) by Tang (1992) and the Money Beliefs and Behavior Scale (MBBS) by Furnham (1984).

MAS led to isolation of 5 factors that determine a person's attitude towards money, i.e., power prestige, refraining from spending money, distrust, quality, and anxiety. MES pointed out 6 factors that can be summarised in short sentences:

- Money is good
- Money is bad
- Money is a symbol of success
- Money gives respect
- Money gives freedom (power)
- Expenditures must be controlled.

The last scale, MBBS, distinguished 6 other attitudes: obsession with having money, treating money as a symbol of power, refraining from spending money, frugality, feeling of constant lack of money and making efforts to earn money (Tyszka and Zaleśkiewicz, 2004).

Unfortunately, the above scales only allow us to determine explicit attitudes towards money. They do not refer to hidden attitudes. Research using the MAS scale, conducted in Poland in 2002 by A. Chojka, showed that Poles perceive money more negatively than Germans (Tyszka and Zaleśkiewicz, 2004).

Although the study of explicit attitudes is very interesting, it has a serious drawback – it can be relatively easily manipulated by respondents, who may consciously adjust their answers to the researcher's expectations or the norms adopted in a given community. Hence, knowledge about hidden attitudes that determine the actual inclinations of the respondent seems to be more valuable.

To measure implicit attitudes, the Implicit Association Test (IAT) was created (Greenwald et al., 1998), the purpose of which is to determine attitudes towards two opposing categories, in which it is assumed that the respondent has a positive attitude towards one, and negative towards the other, e.g. attitude towards whites vs. blacks. A detailed description of the method and its innovative application to consumer attitudes was presented by Dominika Maison (Maison, 2004).

3. Attitudes towards virtual and fiat money according to own research

The study described in this paper was conducted as an audience survey in Poland, Romania and Ukraine in 2023. The purpose of this study was to diagnose and identify similarities and differences in the attitudes towards national currencies, world reserve currencies and cryptocurrencies, as well as differences in the level of trust in the current financial system in the world. Altogether, 342 respondents participated in the survey, including 148 from Poland, 83 from Romania and 114 from Ukraine. The respondents were mainly young persons

studying economic majors, who were selected by several premises. Firstly, it is believed that young people are more open to adopting new, innovative technologies and thus are more likely to use virtual money. Secondly, students of economic and financial majors are expected to be more open to using new forms of money. Thirdly, it was supposed to be a group with some experience and knowledge in the field of finance, which would make it easier to understand the questions asked in the survey, but still being beginners in the financial market. The structure of respondents is presented in Charts 1-3.

Figure 1 shows the gender structure among the 342 respondents to the survey. At 62.61%, the majority were female, while men represented 37.39% of the participants. Such proportions between female and male students are typical of economic majors, which are generally more often chosen as a field of study by women. At the same time, men are more likely to choose technical majors. Such a gender distribution of respondents may impact perception and attitudes towards innovative forms of money.

Figure 2 shows the respondents' structure by nationality, while Figure 3 shows the structure of respondents concerning their age.

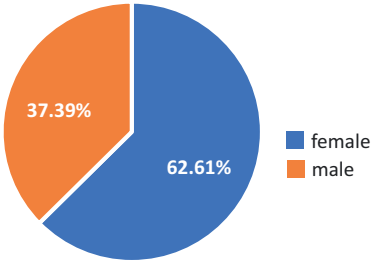


Figure 1. Structure of the respondents by gender

Source: own elaboration based on the conducted surveys.

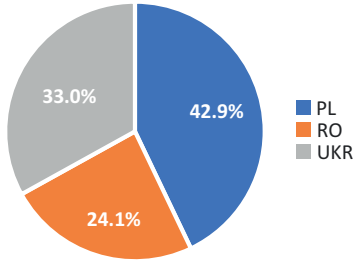


Figure 2. Structure of the respondents by nationality

Source: own elaboration based on the conducted surveys.

Figure 3 shows that the survey covered mainly young people, aged 19-24, students of economic and financial majors. Their share of the respondents was 79.42%. For the purpose of the study, it was assumed that the younger generation may be more open to the use of new forms of money.

Figure 4 shows the structure of students by semester of study. Most of them, over 45%, were first-year students, while second-year students accounted for just over 28%. Such a distribution of respondents covers the assumption of the study. This may be relevant for interpreting the results, as the level of knowledge and experience related to economic and financial education can influence the perception of virtual currencies.

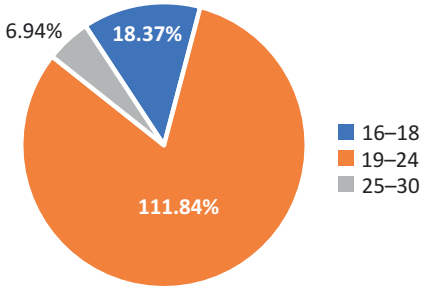


Figure 3. Structure of respondents by age
Source: own elaboration based on the conducted surveys.

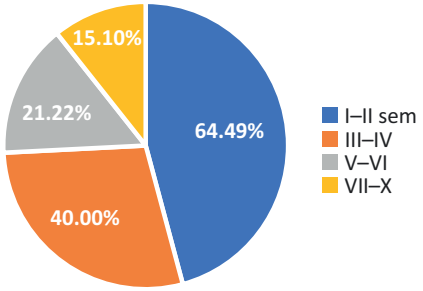


Figure 4. structure of respondents (semester of study)
Source: own elaboration based on the conducted surveys.

The paper questionnaire used in the study consisted of 26 questions related to virtual money and five questions of a demographic nature. Issues connected with attitudes were included in the following questions:

– Which traditional currency issued by the Central Bank do you trust the most? – trust

– Which currencies do you think are more trustworthy? – trust

– What is your trust level in the traditional financial system? – trust

– Would you accept the payment of part of your salary through cryptocurrency? – trust

– Are cryptocurrencies safer than traditional money issued by the Central Bank? – safety

– Do cryptocurrencies store value better than traditional money issued by the Central Bank? – safety

– How do you treat traditional money issued by the Central Bank? – confidence/literacy

– Have you ever used cryptocurrencies as a means of payment? – confidence/literacy

– Do you commit to cryptocurrencies? – confidence/literacy

– Have you ever settled liabilities using cryptocurrencies? – confidence/literacy

– Do you agree with the opinion that cryptocurrencies are worth as much as traditional money? – value

– When you consider buying an item using cryptocurrencies, do you convert its value into traditional currency? – value.

The research question stated in the study was whether there are any differences in attitudes towards fiat money and cryptocurrencies between respondents from different countries. A possible answer to this question (research hypothesis)

was a statement that there are differences in attitudes towards fiat money and cryptocurrencies between respondents from different countries, and they refer to trust, confidence, and perceived value.

To test this hypothesis, respondents were asked which traditional currency they trusted the most. The distribution of the responses to this question is shown in Figure 5.

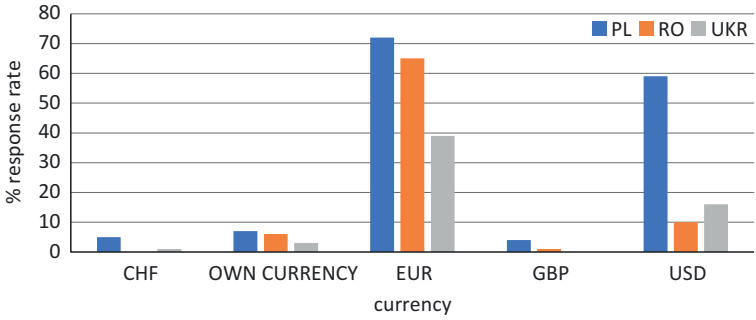


Figure 5. Structure of the responses to the question: What traditional currency issued by the Central Bank do you trust the most? (in %)
Source: own elaboration based on the conducted surveys.

The results revealed that the most trustworthy currency, in the opinion of the respondents from Poland and Romania, is the EUR. This can be related to the geographical proximity of the Euro area, the economic links of the countries and membership in the European Union, as well as the enthusiastic attitude of the society towards the Union. Interestingly, it is not so enthusiastically perceived in Ukraine, where the U.S. Dollar (USD), the world's reserve currency, is the most trustworthy. For Poland and Romania, it is the second most trusted currency. This can be because, in Poland, Ukraine and Romania, the US Dollar (USD) has historically acted as a private reserve currency used in larger transactions (real estate, cars, etc.). On the other hand, the over-representation of the US Dollar in Ukraine may be surprising. This may indicate that in the event of a serious armed conflict (the war that is taking place in Ukraine) these are not the economic ties between the EU and Ukraine that are of key importance there, but the currency of the country that is the "security provider", which is undoubtedly the United States of America. For the CHF (the Swiss franc), the level of trust is relatively low in all of the three countries. So is it as regards the British pound (GBP). Trust in the domestic currency is slightly higher but still very low compared to the Euro and the USD.

Similarly, the respondents were asked about their trust in different types of money. The responses are shown in Figure 6.

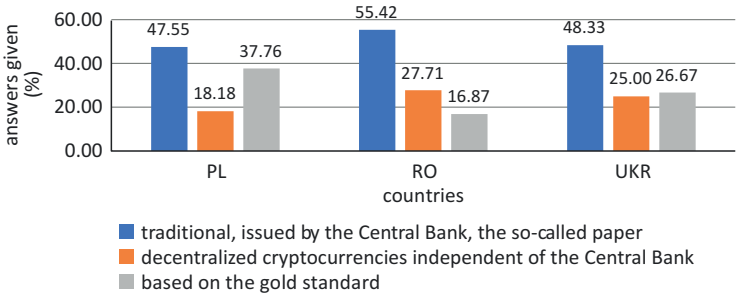


Figure 6. Structure of the responses to the question: Which currencies do you think are more trustworthy? (in %)

Source: own elaboration based on the conducted surveys.

In all of the three countries, most respondents believe that traditional currencies issued by the Central Bank (so-called paper money) are the most trustworthy. The percentage of respondents who share this opinion is over 40% in Poland, about 55% in Romania and almost 50% in Ukraine. Decentralized cryptocurrencies independent of the Central Bank are perceived as trustworthy by a smaller percentage of respondents – around 20% in Poland, 15% in Romania, and 20% in Ukraine. The fewest respondents consider currencies based on the gold standard to be trustworthy – less than 10% in Poland, around 5% in Romania and less than 5% in Ukraine. Overall, the results indicate that in these three countries, traditional currencies issued by central banks are much more trusted than cryptocurrencies or gold-backed currencies. This may suggest some distrust or ignorance of new forms of currencies among the respondents.

Trust and confidence in money are also visible in how people use it. One such manifestation is the tendency to use money in certain circumstances, i.e. accepting payments for work. Ukrainians seem to be more open to using cryptocurrencies in such circumstances than Poles or Romanians. The respondents from Poland and Romania are quite similar in their preferences, although Romanians are more declared – less than 10% respond that they do not know. Poles seem to be the most conservative on this issue.

The next question related to the perception of safety of cryptocurrencies and traditional money. Answers were on a Likert scale (0-10), and the average values for countries are visible in Figure 8.

The respondents generally think that cryptocurrencies are not safer than traditional money, but there is a significant difference between the answers supplied by the Ukrainians and the other nationals. This may result from the fact that traditional money loses its value in the face of war. Its physical

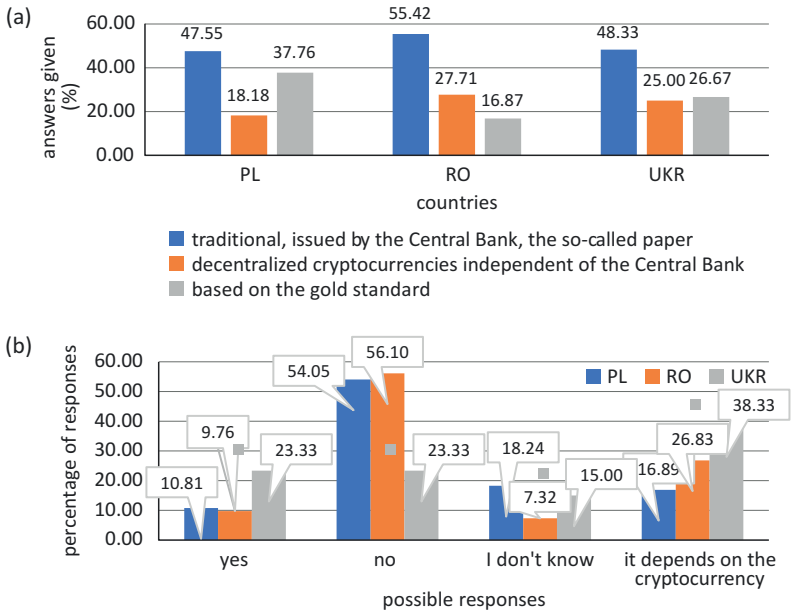


Figure 7. Structure of the responses to the questions: (a) Which currencies do you think are more trustworthy? (b) Would you accept the payment of part of your salary in the form of cryptocurrency? (in %)

Source: own elaboration based on the conducted surveys.

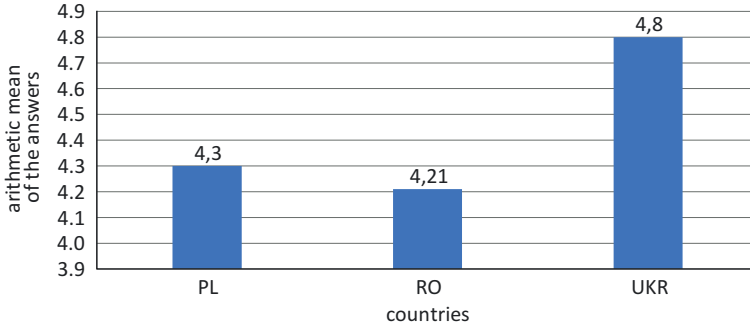


Figure 8. Structure of the responses to the question: Are cryptocurrencies safer than traditional money issued by the Central Bank? (Likert scale 0-10, average)

Source: own elaboration based on the conducted surveys.

form does not protect against damage (fires, explosions, thefts), while cryptocurrencies operate in the virtual space and are not susceptible to this type of danger. This conclusion is confirmed by answers to the next question, whether

cryptocurrencies store value better than traditional money. A positive perception of cryptocurrencies among Ukrainians is well-known.

The respondents were also asked about the level of trust in the financial system based on the Central Bank fiat currencies. The structure of responses to this question is shown in Figure 9.

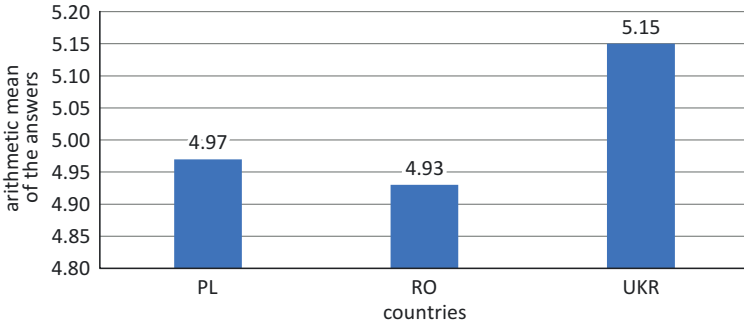


Figure 9. Structure of the responses to the question: Do cryptocurrencies store value better than traditional money issued by the Central Bank? (Likert scale 0-10, average)

Source: own elaboration based on the conducted surveys.

In this case, among all the respondents (PL, RO, UKR) there dominate medium and high levels of trust in the traditional financial system, and a dozen or so respondents (but mainly from PL and RO) even opted for full trust in the financial system. This was not so visible in the case of respondents from UKR. One may be surprised by the high level of trust in the domestic financial system as declared by the respondents from Ukraine. This may indicate that despite the tensions related to the war, the country's financial system is passing

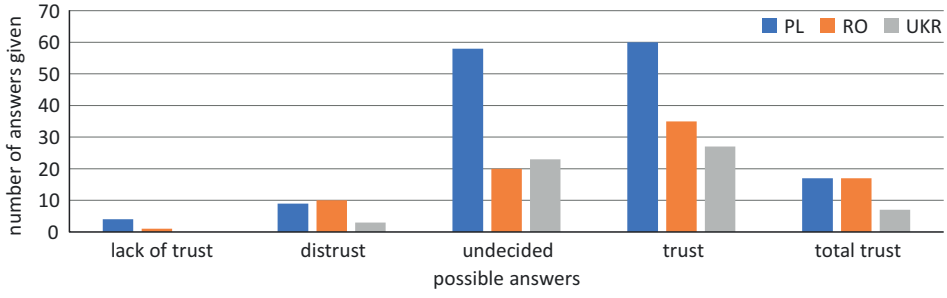


Figure 10. Structure of the responses to the question: What is your trust level in the traditional financial system?

Source: own elaboration based on the conducted surveys.

the test. A dozen or so people from all the countries surveyed do not trust the system. Many respondents cannot easily declare trust or distrust – they remain undecided. Ukrainians most likely wonder what will happen after the war ends: Will the current financial system cope with the consequences of the war? The Polish respondents also showed a high degree of uncertainty in this area, which in turn may result from market expectations regarding inflation and its effects. Romanians seem to have the most positive attitudes towards the traditional financial system.

The respondents were also asked about their perception of the functions of fiat money. The responses are shown in Figure 11.

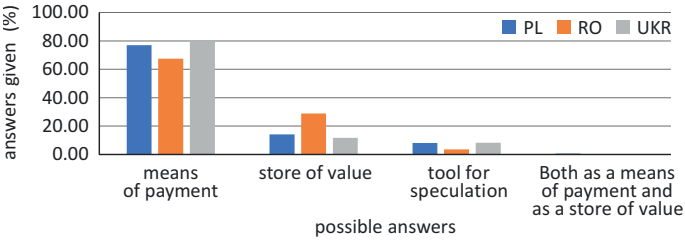


Figure 11. Structure of the responses to the question: How do you treat traditional money issued by the Central Bank? (in %)

Source: own elaboration based on the conducted surveys.

It seems that the majority of young users of money from the three surveyed countries treat it mainly as a means of payment, respectively: about 70% in Poland, about 80% in Romania and over 80% in Ukraine. Far fewer people treat traditional money as a store of value. About 30% of the respondents in this category are in Poland, 15% in Romania and less than 10% in Ukraine. Few respondents consider traditional money to be a tool for speculation – less than 10% in all the three countries. Such a low proportion of the respondents who consider money to be a means of speculation is most likely due to persistent inflation in all the countries surveyed and perhaps also due to the fact that the word "speculation" has a pejorative meaning. At the time of the survey, i.e. in the second and third quarters of 2023, the inflation was decreasing, but it was still high and amounted to 14.7% in Poland, 11.23% in Romania and 17.9% in Ukraine.[1]

There was also a set of questions to testify how frequently respondents use cryptocurrencies and for what purposes. This can decide about their confidence and literacy in this area.

1 Source: https://www.theglobaleconomy.com/

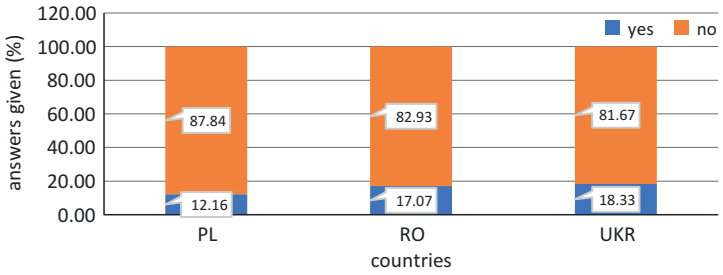


Figure 12. Structure of the responses to the question: Have you ever used cryptocurrencies as a means of payment? (in %)

Source: own elaboration based on the conducted surveys.

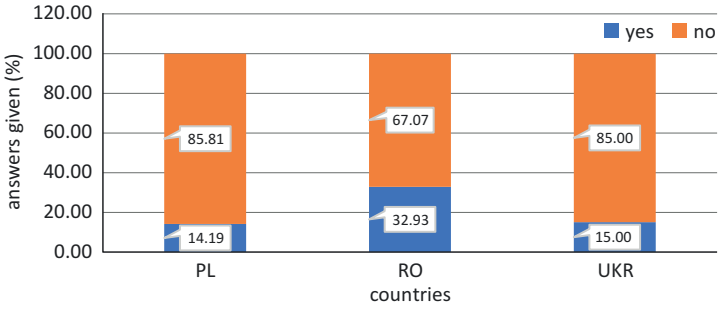


Figure 13. Structure of the responses to the question: Are you committed to cryptocurrencies? (in %)

Source: own elaboration based on the conducted surveys.

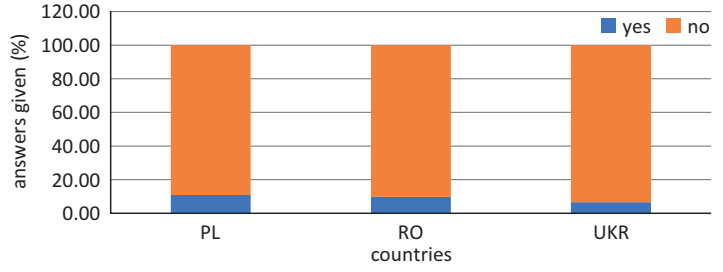


Figure 14. Structure of the responses to the question: Have you ever settled liabilities using cryptocurrencies? (in %)

Source: own elaboration based on the conducted surveys.

It seems that this kind of experience and, as a consequence, literacy remain on a rather low level in all the countries. Only the Romanians seem to have commitments to cryptocurrencies more frequently than other respondents.

The next question concerned the respondents' attitude towards the value of cryptocurrencies. The respondents were asked about their subjective perception of the value of cryptocurrencies in relation to modern fiat currencies. The answers to this question are shown in Figure 15.

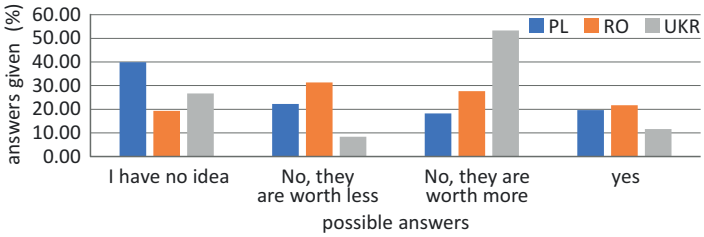
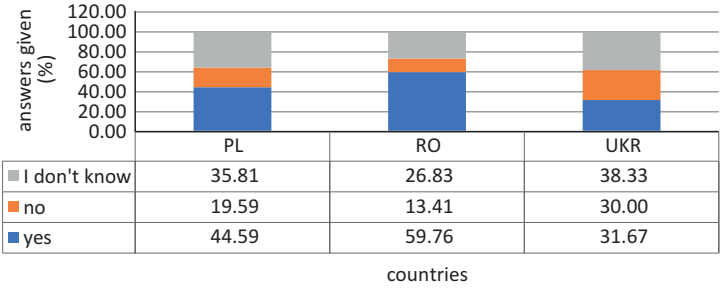


Figure 15. Structure of the responses to the question: Do you agree with the opinion that cryptocurrencies are worth as much as traditional money? (in%)

Source: own elaboration based on the conducted surveys.

Considering the respondents' statements in percentage terms, it can be seen that there is a group who claim that cryptocurrencies are worth more. This is particularly evident in the case of the respondents from Ukraine – about 45%. This may be due to the consequences of the current war in Ukraine and co-related problems in the banking system and the interbank infrastructure system, which gives an advantage to cryptocurrencies. These transactions occur exclusively online, and thanks to blockchain technology, they are decentralized.

Finally, the respondents were asked whether they treat the value of cryptocurrencies as the value in itself or compare it with other currencies while making transactions.



	PL	RO	UKR
I don't know	35.81	26.83	38.33
no	19.59	13.41	30.00
yes	44.59	59.76	31.67

Figure 16. Structure of the responses to the question: When you consider buying an item using cryptocurrencies, do you convert its value into traditional currency? (in %)

Source: own elaboration based on the conducted surveys.

In general, it seems that cryptocurrencies are not treated as a means of direct payment but as objects that must be converted first and then used as money only. This makes cryptocurrencies closer to financial assets than money. Such an attitude is very well seen among the Romanians and the Poles, whereas the Ukrainians decided that cryptocurrencies can be used as a means of value. Still, about one-third of the respondents in each of the countries could not make their decision on this issue.

Conclusion

After analysing and interpreting the obtained research results, it can be concluded that the hypothesis stated at the beginning was confirmed. It should be noted that the respondents' answers from all of the analysed countries do not differ significantly from one another. However, there is visible scepticism towards cryptocurrencies, which are treated as the distant future of the financial system and do not pose a significant systemic threat to it at present. The survey subjects show a relatively high level of confidence in the current shape of the financial system, both domestic and international, and in their own currency as well as other world currencies. However, a much greater level of unambiguity in the answers given by the Romanian respondents is visible. What could it be due to? Well, there may be many reasons, the most probable of which are that the Romanian respondents:

- have better and greater knowledge of virtual money and cryptocurrencies,
- are more confident in this knowledge,
- are more open to changes and less conservative,
- have better experience in the field of economic transformation, which is why they are willing to place more trust in institutions responsible for it.

It should be emphasised here that the authors are aware of the numerous limitations of the survey research and that the results obtained are not representative. However, the researched topic is so new that there is a lack of reliable, international research based on which extensive comparative analyses could be carried out. This study is an attempt to remedy this deficiency.

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Understanding digital native traders: The trading behavior of Generation Z

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1. Understanding Gen Z

The *theory of generations* posed by Karl Mannheim in his famous 1928 essay, "Das Problem der Generationen" ["The Problem of Generations"] states that individuals can be grouped into cohorts based on their year of birth. These cohorts are influenced by notable events of their youth that shape their future development and social consciousness. Typically, a cohort spans approximately 20 years. Currently, we have several cohorts including Baby boomers, Generation X, Millennials, Generation Z, and Generation Alpha.

Generation Z, commonly referred to as Gen Z, is the name given to the cohort of people born between 1996 and 2010. Gen Z is characterized by its unique socio-cultural traits, behaviors, and attitudes shaped significantly by technology, as they are considered to be the first digitally native generation. In a study done by McKinsey in Asia, one-third of the Gen Zers are reported to spend six or more hours a day on their phones, on social media, reading news, shopping online and even working. Their online behavior is different from that of previous generations, as Gen Zers trust the sources of information found online and curated by themselves over any other sources. This is also true when searching for relevant information when making trading and investing decisions.

As Generation Z members become adults, their influence on global economy becomes obvious. Their upbringing in a fully digital and the fast changing world has endowed them with unique perspectives and behaviors distinct from previous generations. Understanding Generation Z is becoming a crucial prerequisite for businesses, policymakers, educators, and societal leaders aiming to align with future trends (Twenge, 2017).

1.1. Digital nativity and technological adoption

The status of Generation Z as digital natives establishes them as crucial participants in shaping the trajectory of technology adoption and digital

innovation in the coming years. Unlike previous generations, they have not needed to "adjust" to digital technology; instead, these technologies form an integral aspect of their upbringing. Since a young age, Generation Z have been introduced to smartphones, tablets, fast internet, and social media. These technological advancements have significantly influenced their cognitive development, social connections, and learning methods (Seemiller & Grace, 2016).

The advent of digital technology has had a profound influence on the learning preferences and educational landscape of Generation Z. The dynamic and participatory character of digital content is challenging traditional methods of teaching. Gen Z learners have a preference for engaging, multimedia content and are more inclined towards visual and interactive learning rather than written information. The ability of this generation to engage in multitasking and quickly assimilate information is well-suited to the characteristics of digital media. As a result, educational institutions are progressively integrating digital tools and platforms into their curricula, adopting a blended learning environment that mixes online and offline experiences to meet the needs of these technologically savvy individuals.

With the arrival of Gen Z in the workforce, their innate familiarity with digital technology is poised to revolutionize professional settings, including the world of trading and investing. This generation possess a collection of digital abilities and perspectives that are extremely flexible and well-suited to the quickly changing technological environment. They now make trading and investment decisions using a wider range of information sources, including social media and advanced AI tools like ChatGPT. Due to their expertise in social media and cutting-edge technologies like artificial intelligence (AI) and blockchain, they are highly valued in the digital economy. This might potentially make them the most skilled generation in trading and investing. Organizations are therefore motivated to reconsider their technology infrastructure, work processes, and corporate culture in order to utilize the potential of this technologically skilled generation.

Gen Z's embrace of technology raises legitimate concerns, especially about the protection of personal data, the monitoring of online activities, and the disparity in access to digital resources. Gen Z's lives are closely connected to data, which raises concerns about their privacy and the protection of their personal information. However, despite the advantages that digital technology brings to Generation Z, there remains a digital divide that prevents many individuals from accessing these resources, which worsens socioeconomic inequities. Tackling these difficulties necessitates further endeavors from all parties involved.

1.2. Shifts in societal values and consumer behavior

Generation Z's values, attitudes, and behaviors deviate from traditional norms, placing greater importance on diversity, mental wellness, and environmental sustainability (Twenge, 2017). Furthermore, the environmental awareness of Gen Z distinguishes them from previous generations. Their worries regarding climate change, pollution, and sustainable living have prompted them to search for environmentally friendly items and endorse companies dedicated to environmental responsibility. Their environmentally sensitive thinking influences their consumption decisions, leading to a high demand for products that are sourced ethically and are environmentally sustainable (Racolta-Paina & Irini 2021).

Having been raised in times characterized by the prevalence of smartphones, social media, and e-commerce, they have become accustomed to the convenience of immediate access to information and effortless online transactions. Gen Z, being born into the digital age, are naturally drawn to firms who have a robust online presence and employ captivating digital marketing methods. Social media platforms such as Instagram, TikTok, and YouTube have a significant impact on consumers' purchase choices, since they prioritize genuine and relatable marketing content.

Moreover, Generation Z prioritize experiences over material goods, which has led to the growth of the experience economy. Their main focus is on allocating funds towards travel, entertainment, and unique experiences that enrich their lives and generate enduring memories. The prioritization of experiences above material belongings has significant consequences for various businesses, including travel, hospitality, entertainment, and leisure.

Furthermore, the frugality and financial convenience of Gen Z set them apart in terms of their shopping behavior. Due to their upbringing during economic recessions and the uncertainty of future economic conditions, they exhibit a more cautious approach towards their expenditures and prioritize affordability. Gen Z are attracted to brands that provide high-quality products at competitive pricing because they prioritize getting the most value for their money. This significant behavioral shift has led to the emergence of brands such as Shein and Temu, who are advertising exactly that and who are appealing to this generation more than almost any other brands right now.

1.3. Educational and workplace transformations

The personality traits and inclinations of Generation Z will significantly influence the evolution of the education sector and workplace culture. Seemiller and Grace (2016) have highlighted that the unique educational objectives, learning approaches, and job aspirations of this generation indicate a departure

from previous norms. This requires a reevaluation of traditional methods in both education and work.

Generation Z's educational preferences emphasize the need for a shift towards learning environments that are both interactive and integrated with digital technologies. This generation, having been raised in the age of digital technology, expect educational experiences that are simultaneously informative and captivating, while also incorporating active participation. Their learning process includes a blend of in-person and online classes, incorporating multimedia resources, virtual classrooms, and digital collaboration tools. The increasing inclination towards technology-based education presents a challenge for educational institutions to reconsider their classroom settings, curriculum design, and teaching approaches to cater to the requirements of technologically savvy students.

Furthermore, Generation Z highly appreciate educational settings that foster collaborative learning, encouraging active engagement between peers as well as between students and instructors. This inclination signifies a shift from conventional lecture-oriented instruction to more project-based and experiential learning approaches. Consequently, educational institutions need to adapt by promoting a culture of collaboration, utilizing technology to assist cooperation, and designing curricula that promote analytical thinking and practical problem-solving.

Traditional employment models are confronted with difficulties arising from Generation Z's demands for satisfactory job satisfaction and work-life equilibrium. This generation actively pursue roles that offer not just economic security but also foster their individual development and fulfillment. The companies of today and tomorrow need to place a high importance on accommodating flexible working options, such as remote work and flexible hours, in order to enable employees to efficiently manage their professional and personal life. That is why a significant number of individuals from Generation Z are considering trading and investing as a profession that offers both economic security and adaptability.

Furthermore, based on their professional aspirations, Generation Z prefer an inclusive and supportive workplace environment that reflects their own values. This includes an important commitment to the promotion of diversity, the maintenance of fairness, and the cultivation of inclusivity, in addition to a dedication to upholding corporate social responsibilities. Employers must modify their approaches and exhibit a steadfast commitment to these principles throughout the entire system in order to attract and retain the most exceptional individuals from this generation. In the realm of commerce and capital allocation, members of Generation Z are unequivocally drawn to organizations that

give precedence to environmental, social, and governance (ESG) considerations. Among this generation, ethical investing has become virtually ubiquitous.

Increasingly, academic institutions, particularly universities, will struggle to engage Generation Z students effectively. Therefore, it is critical that they incorporate technology into the courses and encourage group work at all levels in order to equip the students with the competencies required in the twenty-first century workplace. Furthermore, it involves providing career guidance that aligns with individuals' personal values and aspirations, including opportunities for practical experience through cooperative education programs and internships. In order to inspire and retain Generation Z employees, organizations must reassess work norms, corporate ethos, and opportunities for professional growth. This encompasses the implementation of technological advancements, the provision of flexible work schedules, and the fostering of an inclusive corporate environment that places employee satisfaction and well-being as top priorities.

1.4. Potential for future innovation and societal impact

The particular situation of Generation Z, positioned at the convergence of technological proficiency, progressive ideals, and worldwide connectivity, empowers them with the capacity to be at the forefront of substantial cultural and economic advancements. Gaining insight into their viewpoints and utilizing their skills is crucial for promoting innovation that tackles current issues, such as climate change, inequality, and digital privacy problems (Twenge, 2017).

Generation Z have developed outstanding skills in navigating digital landscapes due to their upbringing in a period of fast technological advancement. The fluency in technology encompasses more than just being skilled with digital tools, but also involves a natural understanding of how technological advancements might be utilized to address complex challenges. They are expected to lead progress in artificial intelligence, blockchain, and other emerging technologies.

The internet and social media have enabled Generation Z to become globally connected, leading to the development of a feeling of global citizenship and empathy towards global challenges. This interconnectivity enables them to cooperate across national boundaries, exchange ideas, and come together for different objectives on an unparalleled magnitude. It enhances their capacity to initiate or participate in worldwide movements focused on addressing issues such as climate change, poverty, and human rights violations.

In order to effectively use the creative capabilities of Generation Z, societies and businesses need to allocate resources towards grasping their viewpoints, motivations, and methods of communication. This entails not only furnishing

people with forums to articulate their views and concerns but also integrating their perspectives into the decision-making procedures.

Furthermore, by fostering mentorship, entrepreneurship, and collaboration, Generation Z can be empowered to actively implement their ideas. Providing financial support, networking opportunities, and implementing policy reforms are essential measures to facilitate their contributions to social and economic innovations.

1.5. Mental health

The socioeconomic climate that Generation Z are growing up in is becoming more complicated and is marked by a broad variety of problems that have never been encountered before. McKinsey's extensive survey reveals that people in the USA, belonging to Generation Z exhibit the least amount of optimism and the highest prevalence of mental health problems compared to previous generations. This is not just a problem in the USA; young people in Europe's Generation Z also confront big problems with the stigmatization of mental health. These challenges are sometimes worsened by concerns related to how they feel themselves. The origins of this widespread pessimism might be attributed to a combination of global issues, such as geopolitical wars, financial instability, and the significant disruptions created by the COVID-19 pandemic on educational systems across the globe. Moreover, the rising phenomenon known as "climate anxiety" clearly demonstrates the serious level of concern that Generation Z hold about the degradation of the environment and the fate of the Earth. Numerous individuals from this generation indicate that these anxieties occupy their thoughts on every single day.

Generation Z find themselves in a dangerous situation due to the high expectations and demanding competition in academia. The current educational framework, prioritizing standardized testing and the significant consequences of college admissions, cultivates an exceedingly tense atmosphere. The environment created by the pressure cooker fosters several psychological stresses, such as increased stress levels, a strong inclination towards perfectionism, and intense performance anxiety. Widespread among Generation Z students are concerns about not succeeding and growing exhausted, as well as a prevalent feeling of being a fraud, all of which are signs of the intense pressures they face as they work hard to achieve their academic and professional goals.

Generation Z face more obstacles due to economic concerns. The volatility of the worldwide economy, combined with increasing living expenses and unpredictable employment prospects, contributes to financial stress and worry among this particular group. A significant number of individuals from

Generation Z enter adulthood burdened by considerable student loan debt, confronted with excessively high housing expenses, and confronted with a job market characterized by fierce competition and restricted prospects. The financial instability contributes to a larger story of uncertainty and vulnerability, as young individuals struggle with the significant challenge of building a secure financial base in an increasingly uncertain global environment. The desire for financial autonomy and achievement, profoundly embedded in the shared consciousness of Generation Z, therefore comes filled with barriers. Although individuals may have ambitions to establish a solid career path, amass wealth, and reach important financial milestones, they often need more preparation to confidently pursue these objectives. The absence of knowledge about financial subjects and the limited availability of resources increase these challenges, resulting in a sense of being lost in unfamiliar economic circumstances.

Generation Z have a complex range of difficulties in the areas of mental health, education, and the economy. The convergence of these various pressures – including financial insecurity, academic stressors, and mental health crises – creates an intricate representation of a generation that is currently undergoing a pivotal period. As Generation Z face these challenging circumstances, their ability to adapt and bounce back will surely influence their future trajectory, as well as the overall social response to the distinct obstacles they encounter.

2. Access to financial markets

As Generation Z (Gen Z) enter adulthood, their involvement in the financial markets not only signifies their transition into maturity, but also marks a new era characterized by rapid technological advancements, dynamic methods of learning, and changing regulatory architecture. This era brings about a significant and fundamental change in the methods by which financial markets are entered, engaged with, and understood. This transformation has vital and far-reaching consequences for investment behavior, radically altering the foundations of financial planning and financial education. The work of Sabri (2011), among others, is essential for understanding these changes, highlighting the significant influence on individuals in Generation Z navigating the banking and finance industries and the intricate structure of policymakers, financial advisors, and educators who have a crucial role in guiding this emerging generation through the complex modern financial ecosystem.

The advent of the digital age has resulted in an unprecedented democratization of the investing field, granting Generation Z extraordinary opportunities to access financial information and investment platforms. There are pros and downsides to the democratization of access to financial markets, which has been

facilitated by the rise of social media and innovations in financial technology. On the one hand, it provides Generation Z with a wide range of resources for autonomous learning and makes it easier for them to get engaged with financial markets. This has the potential to transform traditional investment models by promoting active, knowledgeable, diverse personal finance management. In contrast, social media's wealth of information can lead to paralysis of analysis, a state in which decision-making becomes impossible due to an excess of data. Alternatively, it can lead to impulsive, ill-advised choices driven by temporary news trends or the short-lived euphoria of social media, disconnected from the foundation of sound financial knowledge, coming from education and well-guided experience in the markets.

The adoption of digital platforms, although enabling new opportunities to access financial markets, additionally demands a higher level of proficiency in both digital technology and financial knowledge to navigate effectively. In today's digital era, the financial environment is filled with the dangers of false information and unpredictable internet investing trends. This highlights the urgent need to acquire essential financial education from verifiable, trustworthy sources. Given this situation, educational institutions, as the obvious provider of high quality, reliable financial education, have an important duty to adapt their teaching methods and curriculum in order to provide young adults with the required skills to succeed in the complex environment of today's financial markets.

In addition to the complexity of the markets, laws and regulations are constantly striving to keep pace with the rapid advancement of financial technology and platforms. The slow adoption of this model not only limits the possibility for industry innovation and expansion, but also puts Gen Z investors in danger of encountering a wide range of emerging risks and legal uncertainties. Therefore, there is a pressing requirement for the establishment of regulatory frameworks that are adaptable enough to encompass and promote emerging technologies, while also serving as a safeguard against the inherent risks connected to a rapidly evolving market.

To tackle these difficulties, it is essential to adopt a comprehensive strategy that incorporates extensive financial education into mainstream educational programs and develops sophisticated regulatory regulations specifically designed for the digital era. By equipping Generation Z with the necessary skills and knowledge to effectively manage the intricate digital financial environment, stakeholders can create a cohort of investors that are not just resilient and well-informed, but also actively engaged in shaping their financial destiny. This strategy benefits both individual investors and contributes significantly to enhancing the stability and integrity of the overall financial markets. This is

a collaborative effort that aims to improve the financial knowledge and skills of a whole generation, ensuring they are well-prepared to make educated decisions that will impact their financial well-being and, consequently, the overall economic stability of the world.

2.1. Technological advancements and digital platforms

The blend of technology and finance has ignited a shift in the world of trading and investing, completely reshaping the landscape where Generation Z engage in financial markets. At the heart of this shift lies a series of innovations that have revolutionized the way trading and investing are approached by Gen Z investors. These innovations represent more than improvements; they signify a fundamental shift in how financial instruments are accessed, assessed and traded. This section explores the role played by these innovations in reshaping trading platforms, especially for Generation Z, focusing on aspects such as user interface design, gamification and the integration of machine learning and artificial intelligence algorithms.

Modern digital trading platforms are known for their focus on user experience, which is defined by user interfaces that are easy to use and cater to the expectations of Generation Z, who are knowledgeable about technology. These platforms are all mobile-friendly because smartphones are the preferred devices for Gen Z investors. The user-friendly interface of these systems lowers the learning curve for novice investors, allowing them to quickly analyze sophisticated financial data (or at least to have the perception of doing that). Users can personalize their trading environment with customizable dashboards, which guarantees easy access to essential information and tools. The level of customization and user-centric design is crucial in captivating a generation that greatly value efficiency, personalization, and immediacy in their digital interactions.

In addition to their visual and ergonomic attributes, these platforms provide extensive trading features that allow Gen Zers to execute sophisticated trading strategies with accuracy. Features such as near-real-time market updates, seamlessly integrated research tools, and automated trading options enable users to make well-informed decisions and immediately take action based on them. By enabling users to effectively oversee assets on various devices, this feature enhances the overall experience and allows users to remain linked to the financial markets regardless of their whereabouts. The widespread availability of mobile trading apps has greatly reduced the obstacles for young investors to access financial markets, leading to a more inclusive and participatory investment culture.

The integration of algorithmic trading, machine learning, and artificial intelligence into digital trading platforms represents an important development in the analysis of market data and execution of deals. These tools provide advanced analytical capabilities, allowing individuals from Generation Z to interpret complex market patterns and forecast future trends with greater precision. Algorithmic trading systems are capable of automating trade execution by following established parameters, hence improving timing and price to get higher profits. Artificial intelligence algorithms can analyze large volumes of data to detect trading opportunities and mitigate risk. This enhances the decision-making process by providing insights that would be challenging, if not impossible, for human traders to identify on their own.

Social investing apps such as Robinhood, Acorns, and Coinbase have played a crucial role in making financial markets accessible to a wider audience, particularly Generation Z, by providing user-friendly platforms that align with their digital-first preferences. By reducing the financial and educational obstacles, these companies have expanded access to stock, ETF, and cryptocurrency trading for a wider range of individuals. This democratization extends beyond traditional assets, promoting diversification of investment portfolios and introducing young investors to a broader range of financial instruments. The extraordinary success of these platforms as noted by Monti et all (2014), highlights an important transition towards inclusion and empowerment in the financial industry, driven by technological advancements. The influence of these platforms on the investment behavior of Generation Z underscores the necessity for research on their enduring impact on market stability and investor conduct. Based on a 2021 survey conducted by SurveyMonkey on about 6,000 respondents in the United States, it was found that among Gen Z individuals, Robinhood is the preferred platform for investing, with 32% of Gen Zers using it. Following closely behind is Coinbase, which is used by 17% of Gen Z investors, representing the greatest usage rates across all generations. According to the same report, 39% of Gen Zers utilize platforms that do not impose account fees or trade commissions, while only 28% use platforms that do charge such fees. When seeking investing advice, only 32% of individuals from Generation Z have the most trust in their financial advisor, while a larger percentage (38%) rely on their family for guidance, which is significantly higher compared to earlier generations.

2.2. Regulatory changes and their impact

The regulations governing financial markets are constantly being adjusted to the growing digital transformation, which is having a substantial impact on

Generation Z's capacity to access and their becoming involved in these markets. Regulations aimed at protecting inexperienced investors and guaranteeing fair access to market information play a crucial role in shaping the financial environment for the younger generation. The Jumpstart Our Business Startups (JOBS) Act in the United States is an excellent illustration of this development as it enables individuals to participate in crowdfunding and early-stage investments. The recent legislation has expanded the range of investment options that younger investors can access, making it possible for them to invest in potentially profitable projects that were previously only open to experienced investors (Stemler, 2013).

Generation Z must possess a strong ability to adapt and a solid understanding of financial matters in order to navigate the complexities of modern financial markets, especially in light of changing regulations. These young investors can make educated trading and investment selections because they have a thorough grasp of how regulatory changes affect the global economy. Strategic decisions are vital for establishing long-term financial stability and adapting to constant changes in the environment.

Amidst this constantly changing landscape of the financial markets, the ability to adapt is crucial for investors belonging to Generation Z. Changes in regulations have the power to change how markets work, redefine where people spend their money, and adjust how risks are evaluated. This requires a careful and adaptable approach to creating investment strategies. Developing such flexibility enables Gen Z investors to take advantage of future possibilities and successfully navigate potential challenges.

Financial literacy is a fundamental prerequisite that empowers individuals to make informed decisions regarding investments. Having a solid understanding of fundamental investment principles, such as asset allocation, risk management, and portfolio diversification, enables Generation Z investors to deal with changes in regulations and comprehend how they impact investment opportunities. Investors who are knowledgeable about finances are able to accurately assess the effects of regulatory changes on different types of assets, sectors, or regional markets. This allows individuals to make informed investing decisions that are in line with their financial objectives and to eliminate eventual risks. Changes in securities regulation or tax frameworks can substantially impact how individuals allocate their assets, choose investment instruments, and optimize their taxes.

Insights from the CFA Institute reveal that a significant fraction of Generation Z investors in the United States began their investment endeavors before turning 18, highlighting their early involvement in the financial markets. A considerable portion of individuals from the present generation show a notable inclination towards cryptocurrencies. Over 50% of Gen Z investors actively invest

in crypto assets, in addition to stocks and mutual funds. Gen Z demonstrate a greater inclination towards investing in stock options, especially those that prioritize Environmental, Social, and Governance (ESG) factors, compared to previous generations. However, they show less interest in setting up retirement accounts. Unlike Millennials, Gen Zers display a lower inclination towards utilizing exchange-traded funds (ETFs) and mutual funds in their investment portfolio. Instead, they are inclined to invest in stock options, which showcases their strategic emphasis on long-term gains rather than short-term profits. The investment behavior of Generation Z is characterized by a combination of regulatory understanding, financial knowledge, and agile methods. This unique approach enables them to effectively navigate the intricate nature of the modern financial ecosystem.

2.3. The evolution of financial education

Financial literacy is an essential foundation that provides Generation Z with the required skills to navigate the complex landscape of today's financial markets. Incorporating financial education in academic curriculums and increasing online resources and tools have greatly improved Generation Z's understanding of financial principles, risk management strategies, and strategic investing methods. The importance of financial education in empowering young investors highlights the critical necessity for continued research to determine the most successful approaches and resources to enhance financial literacy among young people.

Conventional methods of financial education have primarily focused on core ideas such as budgeting, saving, and basic principles of investment. However, the changing social environment requires a comprehensive and flexible approach to financial literacy that goes beyond these fundamental concepts. Historically, financial education has typically been provided through established educational systems, such as schools and universities, sometimes supplemented by workshops or seminars.

However, the widespread adoption of digital technologies has completely transformed the world of financial education, introducing innovative platforms and tools specifically designed for learning. Generation Z, characterized by their unprecedented access to knowledge, demonstrates a distinct inclination towards interactive and readily available learning experiences. Financial education programs are now utilizing digital platforms, smartphone applications, and gamified learning experiences to engage Gen Z's attention in financial topics. The current generation demonstrates a significant preference for online learning platforms like Coursera or Udemy, along with a strong liking for gamified learning experiences, which deserve further investigation.

Although digital platforms offer many prospects for innovative financial education techniques, established educational systems are crucial for teaching fundamental financial literacy abilities. Incorporating financial education into educational programs guarantees equal opportunity for children from diverse backgrounds to acquire essential financial information and skills. Recognizing the varied learning preferences and backgrounds of Generation Z, educational institutions are responsible for creating tailored learning experiences. This may involve integration of multimedia materials, interactive simulations, and experiential learning activities with the goal of actively involving students and improving their comprehension of financial topics. Schools may ensure that every student has the opportunity to develop essential financial skills by implementing diverse learning methods that cater to different learning styles. Partnerships among academic institutions, financial companies, and edtech enterprises can enhance the financial learning experience for students, providing a more sophisticated and thorough comprehension of financial literacy.

The involvement of Generation Z in the financial markets is closely connected to a combination of technological advancements, regulatory changes, and enhanced financial knowledge. It is essential for scholars, policy makers, and financial sector experts to closely observe and understand the dynamics of the financial ecosystem as it is shaping and is being shaped by the current generation. The future financial markets will be characterized by inclusivity, technological advancements, and a high level of information, affected by the choices, behaviors, and accessibility of Generation Z. This transformation brings forth a range of possibilities and difficulties for the worldwide economy, emphasizing the significance of providing Generation Z with the essential knowledge and understanding of finance in order to succeed in this shifting environment.

3. Preference for gamification

Gamification utilizes the psychological concepts of reward, competition, and achievement to increase user engagement. Generation Z, who grew up in a digital setting with interactive online games, perceive these platforms to be a familiar and engaging way of participating in financial markets. In fact, when surveyed by the CFA institute, most Gen Z investors declared that they are "in it for the thrill", for the adrenaline rush that comes with it and not as a plan to accumulate wealth. The immediate feedback and reward systems imitate the ones present in video games, attracting individuals with a desire for immediate gratification and recognition of their accomplishments (Deterding et al., 2011). The fact that they are aligned with their digital upbringing and tastes emphasizes the need to comprehend the psychological foundations of gamified finance

to better understand how this generation of investors engage with the trading platforms and how this influences the modern financial markets in general.

Gamification boosts engagement and retention among Gen Z investors by offering them incentives, challenges, and prizes that encourage active involvement. Leaderboards, awards, and virtual badges of achievement foster rivalry and a sense of accomplishment, which serves as a strong incentive for Gen Zers to remain actively involved with the trading platforms for extended periods. By integrating gamification elements and game mechanics trading platforms may cultivate a sense of community, cooperation, and excitement that encourages users to return repeatedly. Trading platforms that incorporate gamification also enhance acquisition of knowledge and cultivation of skills among users from Generation Z. Interactive lessons, simulations, and instructional challenges offer practical experience that aids users in comprehending financial topics, improving trading techniques, and fostering confidence in their skills. Trading platforms utilize gamification to enhance the learning process, making financial education more captivating and easily accessible for Generation Z investors. This empowers them to develop a greater understanding and proficiency in investing. As part of the ReThink Finance project (https://rethink-finance.ro/), the partner universities together with the technology partner have also introduced a gamified trading simulator to enhance the learning experience for students. The findings of this initiative align with the existing research, as it has been observed that the performance of Gen Z players improved by an average of 42% when gamification was incorporated into the simulated trading platform.

Leaderboards, rankings, and challenges are competitive features that stimulate a sense of rivalry among Generation Z users, leading to increased engagement and retention. Leaderboards display the performance of users compared to others, promoting friendly competition and motivating users to strive for better results. Challenges, such as trading contests or financial simulations, offer users a chance to assess their abilities, compete with others, and obtain acknowledgment for their accomplishments. By harnessing the competitive inclination of Generation Z, gamified trading platforms establish a dynamic and captivating user experience that fosters ongoing involvement.

Trading platforms that are gamified integrate features of advancement and accomplishment that attract Generation Z's inclination for ongoing advancement and enhancement. Features such as leveling systems, experience points, and unlocking rewards offer users distinct milestones and objectives to strive for, fostering a feeling of advancement and achievement. As users progress through levels, gain access to new features, or achieve prestigious badges, they feel a sense of contentment and satisfaction that drives them to keep using the platform and working towards more achievement.

By allowing Gen Z users to customize their trading experience to their interests and preferences, these platforms increase engagement and retention. Users of gamified trading platforms are able to customize their experience in many ways, for example by creating their avatars, tailoring their profiles, and choosing their own goals. Users can showcase their unique personalities and personalize their trade experiences according to their preferences. These innovations boost user engagement and retention over the long by making them feel more connected to the platform.

Gamified trading platforms utilize feedback and progress-tracking techniques to boost user engagement and retention. These mechanisms offer users valuable insights into their performance and progress. Performance data, progress bars, and achievement notifications enable users to monitor their trading activity, track their progress toward targets, and celebrate milestones.

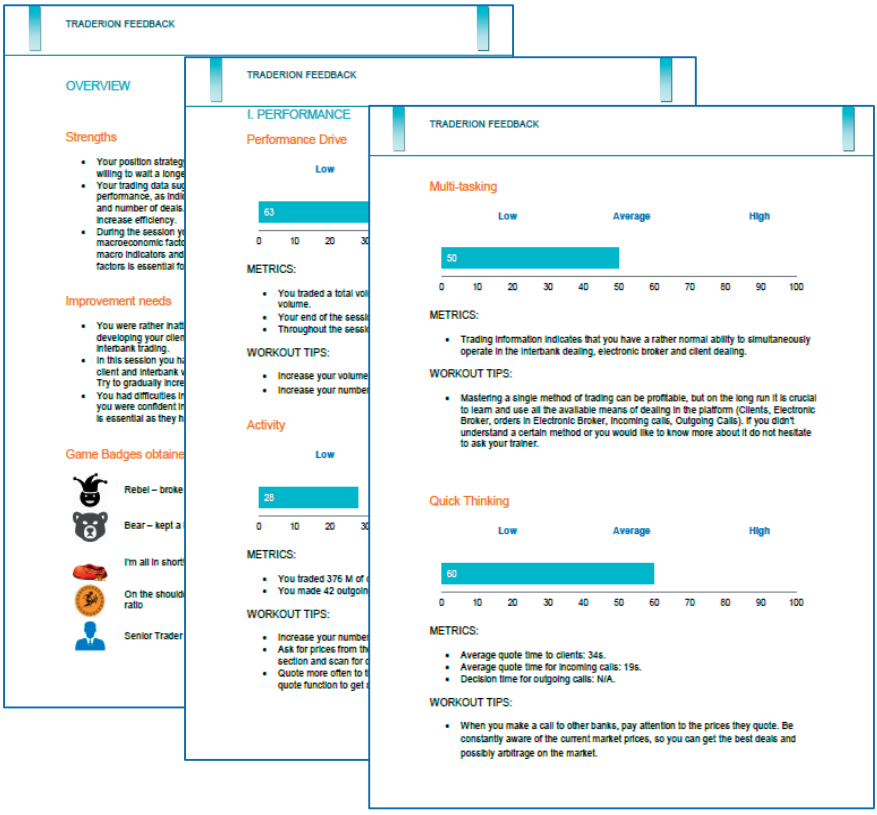

Figure 1. Sample performance report from Traderion simulator

Source: https://simulator.traderion.com/dashboard/– reprinted with permission from Bold Tehnologies SRL

The immediate feedback provided enhances users' perception of accomplishment and advancement, inspiring them to sustain their involvement with the platform and pursue additional achievements. For example, Traderion simulator used in the RethinkFinance project mentioned above collects 150.000 data points/user/hr and uses that data to better understand the behavior of the investors and predict their future performance. This all aggregates in a performance report, itself gamified, that is shared with the user. In these reports (see the figure above), the users are benchmarked against each other, using peer pressure to stimulate competition and, thus, to increase their engagement.

The implementation of gamification in trading platforms fosters social contact and community involvement among users from Generation Z, thus boosting user retention through peer-to-peer interaction and collaboration. Features such as chat rooms, forums, and social networks facilitate the connection between users who have similar interests, allowing them to exchange trading methods and engage in real-time discussions on market movements. This sense of community cultivates a nurturing and collaborative atmosphere where users may acquire knowledge from one another, seek guidance, and celebrate achievements collectively, enhancing their affiliation with the platform and augmenting their probability of maintaining active participation.

3.1. Social dynamics and community engagement

Trading platforms that use gamification frequently include social elements, such as the option to share accomplishments or compete with friends. These aspects align with Generation Z's preference for community and social engagement. Such elements not only improve the user's experience, but also encourage a feeling of inclusion and competition, which motivates them to stay engaged with the platform (Hamari, 2013). The social elements of gamified platforms align with Generation Z's inclination towards cooperative and collective interactions, highlighting the significance of social dynamics in their financial involvement.

Social dynamics enables Gen Z traders to engage in networking and seize professional development possibilities. Trading communities offer members the chance to engage with industry experts, influential thinkers, and other traders who have similar interests and objectives. These contacts can result in mentorship possibilities, professional growth, and collaborative projects within the financial sector. By engaging in networking activities with others who share similar interests and by establishing connections within the trading community, young traders from Generation Z can broaden their professional connections, acquire valuable knowledge and perspectives, and unlock fresh prospects for development and growth in their trading careers.

Community engagement is essential for Generation Z's trading activities as it facilitates cooperative learning and communal problem-solving. Gen Zers utilize trading communities, forums, and social networks as platforms to engage in idea exchange, market trend discussions, and collaborative investment strategy development. By using the combined knowledge of the community, individuals from Generation Z can get valuable insights, varied perspectives, and unique viewpoints that strengthen their ability to make informed decisions and ultimately improve their investment results.

Community participation promotes cooperative learning and the acquisition of skills among Gen Z traders. In trade communities, individuals with different degrees of experience and competence collaborate to acquire knowledge from one another and exchange optimal methods. Inexperienced traders can get advantages from the advice and direction of more knowledgeable individuals, while experienced traders can improve their abilities and stay updated on new trends and techniques. Gen Z traders experience accelerated growth and development through a peer-to-peer learning dynamic, which provides them with the required information and skills to thrive in the competitive trading industry.

Community participation cultivates responsibility and self-control among Gen Z traders by establishing a supportive atmosphere, where members mutually enforce accountability for their actions and choices. In trade communities, members establish objectives, monitor their advancement, and communicate their achievements and challenges with their peers. Gen Z traders are motivated to remain disciplined, follow their trading strategies, and retain a long-term outlook, despite any short-term difficulties or setbacks, due to this shared responsibility. Gen Z traders foster a culture of discipline and responsibility within their community by mutually holding each other responsible and openly discussing their experiences. This promotes responsible trading methods and ensures beneficial outcomes for all members.

Community interaction offers emotional support and encouragement to Gen Z traders, especially during periods of uncertainty or market turbulence. In trading communities, members support one another by delivering words of encouragement, sharing personal stories, and providing reassurance during difficult times. The friendship and solidarity among Gen Z traders enhances their resilience, enabling them to withstand market volatility and handle trading's ups and downs with confidence and drive. Community participation among Gen Z merchants fosters a supportive atmosphere, cultivating a sense of belonging and camaraderie, which in turn enhances their general well-being and resilience.

Community engagement is crucial for Generation Z in trade as it offers chances for sharing knowledge, collaborative learning, emotional support, networking, and accountability. Gen Z traders may improve their abilities, broaden

their connections, and successfully traverse the intricacies of the financial markets by actively engaging in trading forums and interacting with their peers. Community participation will continue to be essential for the success and growth of Gen Z traders in the ever-changing world of trading.

3.2. Economic factors and market access

The rise and widespread use of gamified trading platforms is a notable trend in today's financial world, especially in terms of how Generation Z engage with and understand investing prospects. Guiso and Sodini (2012) emphasize that younger investors are increasingly drawn to these platforms due to their innovative trading approach, characterized by low or no commission fees, minimal initial investment requirements, and user-friendly interfaces accessible on mobile devices. This approach successfully reduces the conventional obstacles that could hinder those with less money or experience from entering the financial market.

The attractiveness of gamified trading platforms extends beyond mere convenience for Generation Z. These platforms not only serve as an entry point to the world of investment, but also align with their users' ideals and meet their expectations. Given their typically constrained financial means compared to earlier generations, the prospect of engaging in investment activities with minimal initial cash is especially appealing. This generation highly appreciate the potential to increase their wealth, even if they have limited initial resources. They also love the opportunity to study and participate in financial markets through a gamified experience that provides real-world value and results.

Furthermore, the notion of economic democratization is of utmost importance in this context. Trading systems that incorporate gamification adhere to the notion of enhancing accessibility and fairness in financial markets, which closely corresponds with Generation Z's broader expectations for equality and inclusiveness. These platforms disrupt conventional ideas about who can invest by making investment possibilities accessible to a wider range of people, thereby reducing socioeconomic barriers and promoting a more inclusive financial ecosystem. Inclusivity is more than just granting access; it also involves offering the essential tools and resources for well-informed and strategic investment decisions, so enhancing the capabilities of young investors.

Essentially, the emergence of gamified trading platforms is not a standalone occurrence, but rather connected to larger economic reasons and changes in the attitudes of different generations towards finance and investment. The popularity of these platforms with Generation Z is a result of the combination of technology advancements, financial accessibility, and a rethinking of the concept of investing in the digital era. These platforms have a crucial role in

determining the future of personal finance and investment, indicating a move towards financial experiences that are more accessible, fair, and captivating.

3.3. Implications for financial literacy and investment behavior

Although gamified trading platforms offer several advantages, it is important to carefully evaluate their influence on financial literacy and investment behavior. The process of simplifying and incorporating game-like elements into trading might result in a superficial understanding of financial markets and a failure to fully appreciate the associated dangers (Lusardi & Mitchell, 2014). Furthermore, the prioritization of immediate profits and frequent buying and selling goes against the established financial principles of sustained long-term expansion and portfolio diversification.

Although gamified trading systems have the potential to offer advantages, they are nonetheless susceptible to behavioral biases and hazards that can negatively impact users' financial literacy and investment behavior. The presence of real-time input, social comparison, and fast pleasure might worsen cognitive biases, as illustrated in Figure 2 below.

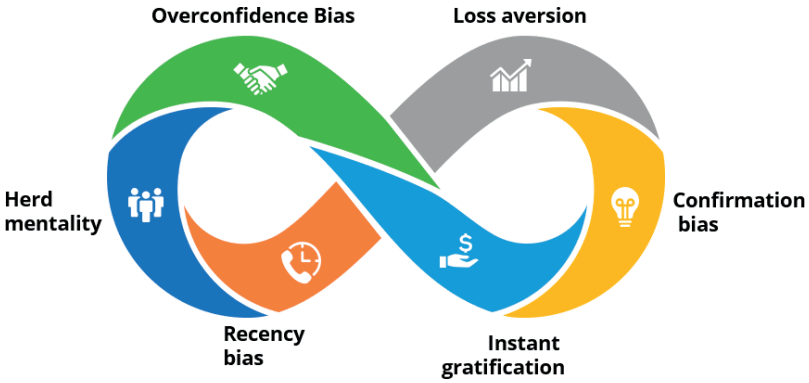

Figure 2. Most common trading biases in Gen Z investors
Source: The author's original work

Biases such as overconfidence, herd mentality, loss aversion, confirmation bias, instant gratification, and recency bias are the most common among the investors in Gen Z and a direct result of their developed attitudes to life.

1. **Overconfidence bias** – occurs when individuals overestimate their abilities or knowledge, leading them to make overly optimistic assessments of their investment prospects. In the context of gamified trading platforms, features such as achievement badges, leaderboard rankings, and virtual rewards may reinforce users' perceptions of their investment prowess, fostering a sense of

overconfidence. Overconfidence may result in individuals engaging in speculative trading strategies, assuming unwarranted risks, and underestimating the potential negative consequences of their investment choices.

2. **Herd mentality** – means the tendency to follow the crowd rather than make independent judgments, can be exacerbated by the social and competitive elements of gamified trading platforms. Users may feel pressure to emulate the investment strategies of top performers or follow the prevailing sentiment among their peers, leading to a herd-like behavior, where individuals mimic the actions of others without conducting their own research or analysis. This herd mentality can amplify market volatility, contribute to asset bubbles, and increase the likelihood of groupthink and irrational decision-making.

3. **Loss aversion** – refers to the tendency for individuals to prefer avoiding losses over acquiring equivalent gains, leading them to make risk-averse decisions to protect against potential losses. In the context of gamified trading platforms, users may be particularly sensitive to losses due to the emotional impact of seeing their virtual portfolio decline in value or their ranking drop on leaderboards. Fear of loss may prompt users to sell winning positions prematurely, hold onto losing positions in the hope of recovery, or avoid taking calculated risks that could lead to long-term gains.

4. **Confirmation bias** – occurs when individuals seek out information that confirms their existing beliefs or opinions while disregarding or discounting contradictory evidence. In the context of gamified trading platforms, users may selectively focus on positive feedback, such as earning badges or achieving milestones, while ignoring warning signs or negative indicators that suggest their investment strategy may be flawed. This bias can lead users to become overconfident in their investment decisions and overlook potential risks resulting in financial losses.

5. **Instant gratification** – gamified trading platforms often provide users with instant feedback and rewards for their actions, fostering a desire for immediate gratification. Features such as real-time notifications, quick-win challenges, and instant rewards may reinforce users' preference for short-term gains over long-term investment objectives. This bias can lead users to prioritize speculative investment strategies that offer immediate thrills but may not align with their risk tolerance.

6. **Recency bias** – occurs when individuals give more weight to recent events or experiences when making decisions, leading them to overlook historical data or trends that may provide valuable context. In the context of gamified trading platforms, users may be influenced by recent market movements or short-term performance metrics, such as daily gains or losses, rather than considering broader market dynamics or fundamental factors that drive long-term

investment outcomes. This recency bias can distort users' perceptions of risk and return, leading to impulsive or emotionally driven investment decisions.

Investors from Generation Z are highly susceptible to behavioral biases while using gamified trading systems. For a more exciting trading experience, some platforms include gamification features like leaderboards, medals, and awards. Negative financial consequences may result from these biases' ability to influence investors to make decisions that are not necessarily wise or financially beneficial to them. Investors are susceptible to a variety of biases which causes them to believe they can accurately forecast market moves, and loss aversion, which causes them to hang onto unsuccessful investments for too long or sell successful ones too quickly.

Understanding and addressing these cognitive biases is essential for the creators of gamified trading systems, educational institutions, and regulatory bodies. By recognizing the psychological aspects involved, they can create methods and features that assist in reducing the influence of these biases. Examples of potential solutions include offering instructional materials to enhance users' understanding of prevalent biases, creating user interfaces that promote thoughtful consideration prior to engaging in transactions or establishing safeguards to mitigate overly dangerous behaviors. One notable aspect is the inclusion of bias identification in trading simulators. This function is specifically meant to assist traders in recognizing and diagnosing their biases in a risk-free setting, thereby enhancing their performance in the actual market.

Moreover, developers and regulators can enable users to make decisions that are more in line with their long-term financial objectives and risk tolerance by endorsing responsible investing practices. This could entail developing tools that assist users in establishing and adhering to their investment plans, or offering individualized feedback depending on their trading activity. The ultimate objective is to establish an environment in which users are assisted in making well-informed choices, without being influenced by behavioral biases, therefore boosting their total financial wellbeing.

By directly addressing the obstacles posed by behavioral biases, gamified trading systems have the potential to transform into more than just immersive trading experiences. These spaces might be great resources for people looking to learn more about personal finance or get some extra help along the way. The area of individual financial planning and investing may then benefit from this.

4. Social trading and cooperation

Social trading platforms combine elements of social networking, such as sharing, commenting, and following, with conventional trading activity. The

social dimension of these platforms goes beyond replicating the social media experience; it aims to convert investing into a cooperative and transparent endeavor. Users have the opportunity to witness and acquire knowledge from the trading decisions made by others. This allows them to get valuable insights into market patterns and investing techniques, all without requiring a traditional financial education. The peer-to-peer learning paradigm goes well with preferences of Generation Z, who value transparency, community engagement, and collective knowledge sharing. Social trading platforms utilize the collective intelligence of a large group of people to democratize the availability of investment knowledge, making it easier for a younger, technologically adept audience to acquire and comprehend.

Furthermore, these platforms are in line with the values of Generation Z as they encourage the development of a community and foster collaborative learning. Social trading differs from traditional individual trading settings by promoting open discussions among users regarding their opinions, strategies, and rationales behind their trades. This fosters a supportive community where individuals can collectively develop and acquire knowledge. This cooperative setting not only reduces the psychological obstacles for inexperienced investors, but also enhances a more comprehensive financial environment.

The study conducted by Bucher, Fieseler, and Lutz (2016) highlights the significance of these platforms in connecting the intricate world of financial markets with a generation that prioritizes transparency, cooperation, and social connection. Social trading platforms empower Generation Z by creating a space where investment knowledge is freely shared and discussed. This enables them to confidently engage with financial markets, representing a notable change in how financial education and participation are approached in the digital era.

4.1. The impact on investment behavior

Social trading platforms have greatly transformed the investing scene, particularly for Generation Z, by providing a model that prioritizes active involvement and openness in financial operations. These platforms provide a distinctive opportunity to access the trading methods and performance data of both peers and experienced investors, essentially transforming investment into a shared learning experience. Novice investors might gain confidence and overcome traditional hurdles by closely observing and imitating the strategies of successful traders in order to understand the complexities of financial markets. According to Pan, Altshuler, and Pentland (2012), this paradigm promotes a dynamic in which learning through observation and imitation becomes a crucial way to enter the world of investment.

According to Rohit et all (2024), Gen Z investors are the group of investors with the highest risk tolerance, followed by Gen Y and Gen X. Their analysis, which is also supported by various other research reports from Nasdaq, Fortune or the CFA Institute, indicates that Gen Z investors are more are more inclined to invest in riskier financial instruments than older generations. Social trading platforms have democratized the access to virtually any financial instrument for each generation. Nevertheless, the accessibility and the capacity to imitate profitable investment strategies without a profound comprehension of the fundamental principles carry inherent risks. Although social trading platforms provide equal access to financial opportunities, they also foster situations where users may excessively depend on seeming achievements of others. Generation Z's view of risk may be distorted by their dependence on high-return strategies, as the visibility of these methods may not always appropriately reflect the accompanying risks. The social dimension of trading, although beneficial for acquiring knowledge and active participation, might unintentionally result in a collective mindset, where users blindly adopt trends without critically evaluating their feasibility or considering the potential consequences on their individual financial objectives.

Moreover, the focus on social learning and sharing strategies brings up significant concerns regarding the cultivation of autonomous critical thinking abilities in making investment choices. Although social trading promotes learning and exposure to various techniques, it presents the difficulty of ensuring that users cultivate the capacity to independently analyze and make investment decisions. The existence of this tension highlights the importance of adopting a well-rounded strategy when interacting with social trading platforms. This strategy should involve not just taking advantage of the educational benefits of social learning, but also implementing measures to promote financial literacy and critical thinking.

Essential elements of social trading platforms for Generation Z investors should include educational resources, risk management tools, and features that promote careful analysis of investment decisions. These components can help find a balance between learning from others and making independent, informed decisions. Through the integration of these components, social trading can transform into a comprehensive educational setting that not only reduces the initial requirements for inexperienced investors, but also nurtures a more knowledgeable and discriminating cohort of investors. Adopting a well-balanced strategy towards social trading is essential to guarantee that the use of technology to make investment accessible to everyone results in favorable results for individual investors and the wider financial community.

4.2. Enhancing financial literacy through cooperation

Social trading platforms provide a distinctive opportunity to improve financial literacy among Generation Z. The collaborative nature of these platforms allows users to acquire knowledge from one another through firsthand observation, conversations, and exchange of shared experiences. This collaborative educational setting has the potential to accelerate the process of gaining financial information and skills, hence fostering a generation of investors who are more educated and actively involved (Kromidha, & Li, 2019).

Nevertheless, whereas social trading platforms seem to have advantages in fostering financial literacy, doubts persist over their sustained efficacy. Although social trading platforms provide a unique and captivating method for learning about investments, the extent and long-lasting nature of the knowledge gained from them requires additional empirical research. Social trading platforms offer interactive and collaborative learning opportunities that can greatly improve the immediate comprehension and practical application of financial ideas. However, it is crucial to investigate if this leads to long-term financial literacy.

Furthermore, investigating the impact of social trading on the development of users' critical thinking and independent decision-making abilities is another important topic of study. Striking a balance between acquiring knowledge from others and cultivating the skill to independently examine and evaluate investment opportunities is essential for achieving true financial literacy. The educational value of social trading extends beyond the mere replication of successful deals, as it has the potential to enhance one's understanding of financial markets in a more profound and complete manner. To achieve this, it is necessary to meticulously develop social trading platforms that actively promote users' involvement in the critical evaluation of the methods they witness. Features such as comprehensive trading explanations, discussion forums, and decision-making tools can augment the educational proficiency of Gen Z investors. This literacy extends beyond the mere ability to carry out trades; it includes an in-depth understanding of market dynamics, risk evaluation, and the psychological variables that impact investing choices. Social trading platforms have the potential to greatly enhance financial education by offering a practical environment where theoretical information can be applied and evaluated.

Therefore, it is important to closely examine the effectiveness and long-term effects of social trading platforms, despite the fact that they offer a tremendous chance to improve financial literacy among Generation Z. Regularly assessing the impact of these platforms on users' comprehension of financial markets and their capacity to participate in responsible investment practices is crucial. Investigating these factors will be essential in identifying the most efficient

methods to utilize social trading for educational objectives, guaranteeing that it has a good impact on the growth of a financially knowledgeable and skilled generation of investors. Continuing to explore social trading platforms is crucial for effectively navigating the problems and opportunities they bring. The goal is to fully utilize their potential as tools for authentic financial empowerment.

4.3. Implications for the Financial industry

The rise of social trading as a favored approach to engaging with financial markets among Generation Z highlights a period of significant change in the financial industry. The transition towards a more cooperative and technology-driven approach to investing requires a deliberate reaction from financial advisors, investment institutions, and regulatory agencies. Each of these entities encounters distinct obstacles and opportunities.

Financial advisers and institutions must undergo a thorough revaluation of how investment services are structured and provided in order to accommodate the preferences of Generation Z. This goes beyond simply adding the latest digital tools. Social trading platforms are popular because they allow users to learn from and make investing decisions with the help of a community. This indicates a rising need for services that are both technologically advanced and socially interactive. To stay up-to-date and maintain a competitive edge, traditional financial institutions may need to consider incorporating social trading elements into their services. This could involve implementing features like community forums, collaborative investment initiatives, gamification, or tools that facilitate open sharing and discussion of investment strategies among users. These adjustments could facilitate the connection between traditional investment techniques and desires of a generation that values openness, cooperation, and the ability to tap into shared knowledge.

The regulators have the difficult responsibility of ensuring that the democratization of investing through social trading does not undermine the reliability of information or expose users to excessive risks. The intrinsically social character of these platforms, although advantageous for acquiring knowledge and fostering involvement, also gives rise to apprehensions over the possibility of spreading false information, following the crowd without critical thinking, and experiencing financial losses. Regulators must establish principles and frameworks that foster openness and accountability, guaranteeing users' access to dependable information and platforms' adherence to ethical standards. Ensuring safety of investors, particularly those who are inexperienced in the financial markets, from the potential hazards of social investment while still allowing for innovation requires a careful calibration.

With the increasing popularity of social trading, there is a need for research to explore its long-term effects on financial behavior and the industry as a whole. The impact of Generation Z's interaction with these platforms on their investing strategies, willingness to take risks, and level of financial knowledge are crucial inquiries that will determine the trajectory of the financial industry. Gaining a comprehensive understanding of these dynamics is crucial to formulate methods that effectively utilize the advantages of social trading, such as improved accessibility to financial markets and expanded financial knowledge, while also minimizing its potential disadvantages.

Ultimately, the increasing popularity of social trading among Generation Z poses both obstacles and prospects for the financial sector. To fully embrace the collaborative nature of social trading and prioritize the safety and education of investors, financial institutions, advisors, and regulators must work together. By strategically and proactively addressing these difficulties, the financial sector may exploit the innovative capacity of social trading to foster a more comprehensive, knowledgeable, and involved generation of investors.

5. Impact of social media and influencers on trading behavior

The instant availability of information on social media platforms can result in fast trading decisions, frequently influenced by popular trends and viral content rather than a thorough analysis. The desire not to miss out on profitable investments has driven numerous Gen Z investors to engage in speculative trading activities, including a significant increase in trading cryptocurrencies and meme stocks. The Gamestop case is notorious in that regard and we will explore it in more detail in the next section.

Over the past few years, influencers have established a prominent position on social media platforms, gathering a substantial number of followers that expand their reach and influence in various areas, including the financial industry. The emergence of the term "finfluencer," which combines the words "financial" and "influencer," has been a direct consequence of this phenomenon, serving as a means to categorize these individuals. These individuals, ranging from seasoned investors to prominent celebrities involved in endorsing cryptocurrencies, have played a crucial role in influencing the financial choices of Generation Z. Financial influencers seem to be contesting the assumption that professional investment counsel is the only source of credible financial advice and that formal financial education is important for informed investment decisions. Gen-Z investors believe financial influencers provide an essential service and are a cost-effective and engaging alternative to receiving expert financial advice. Financial influencers utilize their platforms to distribute investment

advice, disclose personal stories regarding their investment experiences, and predict trends in different markets (Khamis, Ang, & Welling, 2017). Their power to influence is not only a function of their social media presence, but is firmly based in the perceived authority, competence, and trustworthiness they command among their followers. A significant majority of Gen Z investors consider the number of followers a financial influencer has to be an accurate measure of their credibility, and are not concerned with official qualifications or even prior experience.

The impact of these social media influencers on young investors, especially those from Generation Z, is significant. Influencers can shape views, influence opinions, and impact investment habits on a significant level through their posts, stories, and videos. The bond between influencers and their followers is defined by a distinct combination of admiration, trust, and aspiration, resulting in the persuasive power of their recommendations. Inexperienced investors, enticed by the appeal of rapid profits and influenced by the advice of admired influencers, may end up imitating sophisticated trading strategies and investing in unstable markets without a thorough comprehension of the associated risks. The COVID-19 pandemic expedited this phenomenon, as a significant number of individuals from Generation Z further intensified their online activity and actively sought out information, especially financial information.

This phenomenon illustrates a crucial characteristic of the digital era, because there is an abundance of knowledge and unequaled access to expert points of view. However, it also raises concerns regarding the level of financial literacy among young investors and the extent to which decisions are affected by trends and individuals rather than sound financial concepts and risk evaluations. The use of influencers for financial advice highlights the importance of improving educational initiatives to provide young investors with the required skills and understanding to make wise decisions in investment markets, distinguishing between legitimate possibilities and risky operations. Social media and influencers have a substantial impact on the financial literacy and market dynamics of Generation Z. Financial information available on social platforms can improve financial literacy by introducing young investors to various investing concepts and techniques (Kromidha, & Li, 2019). However, the dependence on influencers for investment advice raises concerns over the extent and caliber of financial comprehension among Generation Z. The phenomenon of herd behavior, which is triggered by influencer endorsements, can result in increased market volatility and the formation of speculative bubbles, as evidenced by some of the more recent rises in meme stocks and cryptocurrencies (Baker, Pan, & Wurgler, 2012).

The increasing effect of social media and influencers on trading behavior highlights the necessity for strong regulatory frameworks to safeguard inexperienced investors against disinformation and speculative risks. Regulatory organizations must navigate the delicate task of striking a balance between fostering innovation and facilitating access to financial markets, while also safeguarding the interests of investors (Arner, Barberis, & Buckley, 2016). Establishing protocols for transparent and accountable communication by influencers, in addition to implementing efforts to enhance financial literacy, are essential measures in tackling these difficulties.

The convergence of social media, influencers, and financial markets signifies a fundamental change in how Generation Z participates in investment activities. Although social media offer excellent opportunities for financial education and involvement, the impact of social media influencers on trading decisions presents issues that deserve a careful thought. It is crucial to improve people's understanding of finance, guarantee the accuracy of financial data, and safeguard young investors from possible dangers to fully utilize the advantages of this phenomenon.

A case study
The GameStop Phenomenon

Introduction

In late January 2021, the financial world witnessed an unprecedented event that would become known as the "GameStop Phenomenon." This case study examines the circumstances surrounding GameStop, a physical video game retailer, that experienced a significant and sudden increase in its stock price, contrary to conventional market predictions. This event emphasized the increasing impact of individual investors in the retail sector, the potency of social media in the stock market, and prompted inquiries on market manipulation, short selling, and the future of stock trading.

GameStop Corp., a company that primarily sells video games and related items in physical stores, has faced significant challenges in recent years due to the increasing popularity of digital distribution and the negative effects of the COVID-19 pandemic. As of mid-2020, GameStop's stock was subject to significant short selling, as hedge funds and other institutional investors were placing bets on the company's continued decrease in value.

The Surge

The turning point occurred when a cohort of individual investors, predominantly from the subreddit r/wallstreetbets, initiated the acquisition of GameStop shares and options. These moves were partially motivated by the significant short interest in GameStop, which made it susceptible to a short squeeze. A short squeeze is a trading tactic that compels short sellers to repurchase shares at elevated prices, thus driving up the stock price further.

From January 11 to January 27, 2021, the stock price of GameStop had a significant increase of more than 1,500%, reaching a record-breaking peak of $483 on January 28. The remarkable surge in value was unparalleled for a firm of GameStop's type, resulting in significant financial losses for hedge funds that had bet against its success, most notably Melvin Capital Management. To restore stability, Melvin Capital Management had to get a capital injection of $2.75 billion.

What happened?

The GameStop saga demonstrated the empowerment of individuals, particularly Gen Z investors, who, by utilizing collective action on platforms such as Reddit, Discord, and Twitter, were able to exert a substantial influence on the stock market. The adoption of commission-free trading applications such as Robinhood enabled this widespread mobilization by eliminating conventional obstacles to stock trading and attracting a significant volume of trades, to the extent that the market instability compelled trading platforms like Robinhood to temporarily impose restrictions on the trading of GameStop and other stocks undergoing comparable surges. This decision resulted in extensive criticism and allegations of market manipulation, igniting discussions over the functions and obligations of brokerage platforms, market fairness, and protecting the interests of investors.

Implications

The GameStop controversy has brought attention to the increasing impact of Generation Z retail investors in the stock market. Unlike institutional investors, retail investors, who are enabled by social media and commission-free trading apps, can collectively generate substantial market fluctuations. The democratization of investing disrupts conventional market dynamics and power structures, prompting a reassessment of market liquidity, volatility, and the possibility of concerted actions by individual investors resulting in short squeezes or similar events in the future.

Furthermore, this occurrence has provided an insight into the psychological dimensions of investments, specifically among investors from Gen Z. The incorporation of game elements into trading, along with a robust community feeling, has demonstrated that financial choices can be influenced by social identity and collective action to the same extent as conventional financial analysis. This trend highlights the necessity for financial knowledge and awareness, as inexperienced investors navigate the complex dynamics of the stock market. The GameStop event has accelerated conversations over the role of technology in trading, particularly about trading platforms such as Robinhood. The move by certain platforms to limit trading has prompted inquiries on market accessibility, the obligations of brokers to their clients, and the necessity for a strong technology framework to facilitate fair and transparent trading. Consequently, there is a demand for regulatory frameworks that guarantee these platforms operate in the best interest of the market and their clients.

Conclusion

The GameStop phenomenon might be viewed as a harbinger of a new era in investing, when community-driven investment techniques coexist with traditional ones. This trend

may foster the creation of novel financial products and services specifically designed to cater to the requirements and preferences of retail investors. It also implies that the financial sector might have to adjust to a more knowledgeable, connected, and empowered group of investors that utilize social media and technology as tools to make investment decisions. To summarize, the consequences of the GameStop phenomenon go far beyond the initial increase in stock prices. They address the fundamental aspects of market operations, investor behavior, and regulatory frameworks. The lessons learned from the GameStop incident are expected to have a significant impact on the future trajectory of reforms, technological improvements, and the democratization of investment in the evolving financial market.

Source: The author's original work

6. Conclusion

The widespread adoption of social media has fundamentally altered the financial information environment, presenting both exceptional prospects and tremendous obstacles for Generation Z investors. The proliferation of misleading information is a significant issue since it makes it exceedingly challenging to make informed financial decisions. The fluid and inclusive features that characterize social media platforms, while enabling the sharing of ideas and data, also foster an environment favorable to the dissemination of speculative or deceptive content. For investors belonging to Generation Z, social media can be both advantageous and disadvantageous. While it offers convenient access to a wide range of financial guidance and market analysis, it also contains a multitude of false information and prejudiced viewpoints disguised as expert counsel. The dilemma lies in the inherent complexity of distinguishing reliable information from speculative or intentionally deceptive content. This problem is made worse by the algorithms that drive these platforms, which frequently promote user interaction at the expense of accuracy. As a result, consumers are led into a labyrinth of unsubstantiated and potentially dangerous financial guidance.

Users and social media platforms must collaborate to combat misinformation. Platforms have a major obligation to oversee content and guarantee that users are not subjected to fraudulent or misleading material. This involves the creation of more advanced algorithms and verification methods to identify and eliminate deceptive information, along with offering distinct indications of a source's trustworthiness. Nevertheless, the platforms are not solely responsible for the task. Gen Z investors should also embrace a proactive approach to their financial education. This entails gathering information from various sources, assessing the reliability of financial advice, and maintaining a cautious attitude towards investment prospects that appear profitable but lack sufficient evidence or support.

Although there are difficulties, social media are a great promise to improve financial literacy among Generation Z. The crucial factor is to utilize the platforms' wide reach and the impact of trusted authors to distribute accurate and valuable financial information. Social media platforms can serve as channels for educating young investors about responsible trading practices, risk management fundamentals, and the significance of adopting a long-term perspective on financial planning by collaborating with financial experts, educators, and regulated financial institutions. The educational information can be presented in different formats, such as interactive webinars, tutorials, engaging infographics, and essays, all customized to cater to the tastes and behaviors of Generation Z.

The correlation between social media, influencers, and trading behavior among Generation Z indicates a significant change in the dynamics of financial markets. The widespread availability of financial information through social media has empowered Gen Z investors to actively engage in the financial ecosystem, with few obstacles to the entrance. Nevertheless, this process of democratization involves an obligation to cautiously navigate across the dangerous waters of misinformation. As Generation Z assume a dominating position in the market, the changing dynamics of this connection will have a substantial impact on both personal financial stability and the overall market dynamics. The achievement of favorable results depends on the combined endeavors of social media platforms, financial educators, and investors themselves to cultivate an atmosphere where precise, trustworthy, and instructive financial content becomes the standard rather than an exception.

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Neurofinance: the hype and reality of innovative approaches to financial behavior

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1. Introduction

In the evolving discourse of financial psychology, the term 'neurofinance' exemplifies the interdisciplinary fusion of neuroscience and financial studies, though it lacks a universally accepted definition. Coined by David Edwards in 2004 as a new scientific frontier integrating neurotechnology to examine trading behaviors, the field gained early empirical support from Gehring and Willoughby's 2002 work. They used electroencephalography (EEG) to explore how the brain responds to financial gains and losses, noting more significant activity in response to losses, particularly in areas like the anterior cingulate cortex (Edwards, 2004; Gehring & Willoughby, 2002; Rocha et al., 2013). Tseng, in 2006, further defined neurofinance, linking it to behavioral finance through the Adaptive Market Hypothesis, marking its emergence as a distinct academic field (Tseng, 2006). Despite its growing presence in scholarly discussions and its potential to elucidate the cognitive and physiological bases of financial decision-making, the application of the term 'neurofinance' has sometimes extended into studies lacking robust neuroscience methodology, thereby clouding its academic precision.

Despite the growing use of 'neurofinance' in academic circles, there is a lack of a standardized definition endorsed by major international financial organizations such as the World Bank or the International Monetary Fund. Nonetheless, definitions provided by prominent institutions elucidate the scope of neurofinance with nuanced depth. The National Centre for Biotechnology Information (NIH) describes neurofinance as an investigation into the brain's activity during financial agents' decision-making processes, emphasizing the impact of genetic traits, implicit memory, and risk perception on financial choices (National Center for Biotechnology Information, 2021). Similarly, Aalto University defines neurofinance through the lens of operational magnetic resonance imaging, highlighting how risk-related decision-making is influenced by prior experiences and neural activity associated with mood and reflection (Aalto University, 2014).

Drawing on these descriptions, neurofinance can be conceptualized as an interdisciplinary field that merges neuroscience with financial decision-making analysis. It studies how various brain processes, influenced by individual experiences and biological traits, determine the choices made by financial agents. This emerging definition synthesizes the collective insights from neuroscientific and financial research, providing a framework for understanding the complex interplay between the brain's neural mechanisms and economic behaviors.

In examining the dynamic role of 'neurofinance' within scholarly discourse, the authors employed the Google Books Ngram Viewer, a potent analytical tool that traces the frequency of term usage across an extensive corpus of literature over time. This analysis revealed an intriguing trend: the incidence of the term 'neurofinance' began escalating in the early 2000s, reaching a peak around 2019, thus reflecting a burgeoning interest in this specialized field. Contrasting 'neurofinance' with more prevalent financial terms such as 'behavioural economics' and 'behavioural finance' elucidates its niche status, predominantly frequented by experts entrenched deeply within the financial academia. Moreover, a comparative study of linguistic trends between British and American English unveiled a striking disparity: 'neurofinance' scarcely appears in British literature, whereas its presence in American publications is markedly more pronounced, suggesting that the term – and perhaps the discipline itself – is significantly more embedded within American financial culture than its European counterpart. This linguistic divergence underscores the regional influences shaping the adoption and integration of financial nomenclature and concepts.

Neurofinance epitomizes the quintessential interdisciplinary field. This emerging domain synthesizes insights from neuroscience, psychology, and finance to elucidate the complex neural and psychological processes that underpin financial decision-making. By integrating financial theories with neuroscientific insights, neurofinance seeks to unravel the pervasive irrationality observed in financial behaviors and the inherent inefficiencies of markets. Adjacent to neurofinance in this scholarly interplay is behavioral finance, which, while closely related, distinguishes itself by focusing primarily on the psychological factors influencing financial decisions. Behavioral finance interprets individual conducts within economic contexts through psychological lenses, contrasting with neurofinance's emphasis on the underlying neural mechanisms. This intricate interconnection underscores neurofinance's role as a profoundly interdisciplinary pursuit, bridging diverse academic realms to foster a deeper understanding of the cognitive dynamics that drive financial behaviors.

Within the innovative realm of neurofinance, where neuroscience intersects with financial theory, there is a concerted effort to decode the complex neural mechanisms that shape economic behaviors. This discourse aims to dissect the

extent to which cutting-edge neuroscientific methods can provide profound insights into the often irrational realms of financial decision-making. This chapter navigates through various facets, from the emotional and cognitive biases disrupting rationality in investments to demographic influences and personality traits shaping financial choices.

At the heart of this exploration lies the fundamental proposition that emotional responses – fear, excitement, and overconfidence – profoundly affect financial decisions, often veering them away from logic. Such phenomena, coupled with cognitive biases like anchoring and the detrimental effects of stress on decision-making capabilities, suggest a neural basis for financial behaviors that traditional economic theories struggle to fully explain. The investigation further delves into how individual characteristics, including risk tolerance and impulsivity, contribute to diverse financial strategies and outcomes.

By integrating neuroscientific findings into financial behavior analysis, the chapter posits a promising pathway towards more sophisticated and effective economic strategies. This integrative approach not only illuminates the biological processes influencing decision-making, but also offers practical tools for enhancing financial judgement and mitigating risk through heightened awareness and control of one's biases.

As this discourse unfolds, it becomes apparent that the implications of such an interdisciplinary approach are vast, extending beyond individual investors to influence broader economic policies and practices. The introduction of neurofinance offers a beacon of understanding, potentially transforming traditional finance by providing deeper, scientifically grounded insights into the very fabric of human economic behavior.

2. Understanding the human brain

The human brain, an organ of profound complexity, serves as an intricate nexus of communication, orchestrating a diverse spectrum of functions from fundamental motor activities to complex cognitive operations. The visual exploration presented by Neuralink offers an enlightening journey through the detailed architecture and capabilities of the human brain, shedding light on its structure, functions, and remarkable capacities (Neuralink, 2021).

Central to this examination is the understanding that the human brain surpasses the sum of its constituent cells and synapses, manifesting as a symphony of interconnected regions, each contributing distinctly to our cognitive abilities, emotional experiences, and sensory perceptions. The brainstem regulates essential life functions such as breathing and heart rate, while the cerebral cortex is involved in higher-order processes like thought, memory,

and decision-making (Bear et al., 2007). This intricate organization allows for the nuanced orchestration of thoughts and behaviors that characterize human intelligence and emotional depth.

Moreover, the neural circuits within the cerebral cortex facilitate complex cognitive functions such as language, problem-solving, and abstract thinking, revealing the brain's capability to process vast amounts of information and adapt to new challenges (Purves et al., 2018). The integration of sensory information – from visual inputs to tactile sensations – further exemplifies the brain's capacity to synthesize data from the external environment, influencing our perception and interaction with the world around us.

2.1. Overview of the brain's structure and functions

The human brain, an exceedingly complex organ, comprises approximately 86 billion neurons, each intricately connected via synapses and communicating through electrical signals. This neuronal activity, which can be measured and analyzed, is foundational to understanding cognitive and behavioral functions (Azevedo et al., 2009).

The brain is divided into distinct regions, each specialized to perform critical functions. These regions operate synergistically to orchestrate bodily movements and cognitive processes.

Among the cortex's notable areas contributing to perceptual experiences are:

- **Visual cortex.** Located in the occipital lobe, the visual cortex is crucial for processing visual information from the eyes, essential for recognizing objects, identifying faces, and understanding scenes. It interprets signals from the retina, progressing from basic inputs like light and shadow to more complex perceptions such as shapes, colors, and motion. This region not only passively receives visual signals, but also actively helps in prioritizing relevant visual information, enhancing tasks like reading by quickly recognizing letters and words. Its role extends beyond physical sight, influencing our spatial awareness, emotional responses to visual stimuli, and overall cognitive functions, affecting daily decision-making processes (Tootell et al., 1998).
- **Auditory cortex.** The auditory cortex plays a fundamental role in how we perceive and interpret sound, enriching our auditory experiences and comprehension. Located in the temporal lobes, this brain region is key to distinguishing various sound qualities such as pitch, volume, and tone, which are crucial for understanding spoken language and appreciating music. Its ability to process and interpret auditory signals, supports basic communication but also enhances our enjoyment of sound's subtleties, from the complex layers of a symphony to the emotional tone in a friend's voice (Rauschecker, 1998). The

auditory cortex helps us navigate social interactions by picking up nuances in speech, contributing to our understanding of context and emotional cues in conversations. This area does more than just process sound; it connects us to the world in a way that shapes our perceptions, relationships, and emotional landscapes.

- **Somatosensory cortex.** Essential in our interaction with the world, the somatosensory cortex is a key player in processing tactile sensations, enabling us to detect and respond to various physical stimuli. Situated in the parietal lobe of the brain, this region maps the body's surfaces, translating touch, pressure, temperature, and pain into neural signals that inform us about our surroundings and our own bodies (Kaas, 1993). This sensory processing not only alerts us to potential dangers, like a hot surface, but also plays a critical role in delicate tasks such as manipulating tools or feeling the texture of objects. The somatosensory cortex enhances our understanding of the physical world, contributing significantly to our motor skills by providing critical feedback during movement, allowing for refined motor actions. This feedback loop is vital for complex activities, from playing a musical instrument to typing on a keyboard, where precise touch is paramount. By transforming sensory input into discernible information, the somatosensory cortex enriches our interactions, ensuring our movements are both purposeful and informed.
- **Motor cortex.** The motor cortex is centrally involved in planning and executing voluntary movements, playing a crucial role in our ability to perform coordinated actions. Located in the frontal lobe, this area of the brain sends signals to various body parts to initiate movement, allowing for precision in everything from picking up a cup to dancing to complex rhythms (Penfield & Boldrey, 1937). It is not only about initiating movements but also about controlling their strength and direction, ensuring that each motion is as intended. This precise control is vital for tasks that require fine motor skills, such as writing with a pen or threading a needle. Additionally, the motor cortex is engaged when we learn new physical tasks, adapting and refining our movements as we practice and improve. Its functionality illustrates the brain's remarkable ability to translate thought into action, enabling us to interact seamlessly with our environment.

Moreover, the multifaceted functionalities of the brain underpin numerous aspects of our daily existence, providing the cognitive architecture for both mundane activities and complex intellectual tasks. This cerebral versatility facilitates our engagement with the world through various sensory, motor, and cognitive channels, allowing us to navigate, interact, and comprehend our surroundings with remarkable efficiency. It is the brain's intricate network of neurons and synapses that orchestrates everything from the automatic reflexes that manage

our basic survival functions to the advanced reasoning processes that define human ingenuity and creativity. As such, understanding the brain's capabilities not only illuminates the mechanisms behind our actions and behaviours, but also highlights the profound influence of neurological health on overall quality of life, emphasizing the essential role of neuroscience in enhancing human potential. To further illustrate these capabilities, the following diverse functions of the brain are considered:

- **Motor function.** The brain's regulation of both voluntary and involuntary movements is critical for efficient interaction with and navigation through the environment, a capability that underscores the sophistication of neural control systems. Governed by the motor cortex and associated neural pathways, these movements range from conscious actions, like walking or writing, to reflexive responses, such as blinking or adjusting posture. This oversight allows individuals to perform a variety of tasks seamlessly, adapting to new situations and learning complex physical skills over time. For example, the coordination involved in playing a musical instrument or participating in sports illustrates the brain's ability to fine-tune motor functions through practice and repetition (Wolpert, Ghahramani & Jordan, 1995). Moreover, these motor functions are not isolated: they are integrated with sensory feedback, which continuously informs and refines our movements based on the changing environment. This dynamic interplay ensures that interactions with the world are both purposeful and adaptive, highlighting the brain's central role in mediating physical engagement with the surrounding environment.
- **Cognitive function.** The cognitive functions of human brain, which encompass essential abilities such as thinking, learning, memory formation, and problem-solving, are all facilitated by complex neural processes. These cognitive capacities are not merely mechanical operations but involve highly dynamic and interconnected neural pathways that enable individuals to process and store information, devise solutions to problems, and retrieve memories when needed. The hippocampus, for instance, plays a pivotal role in how memories are formed and recalled, allowing people to learn from past experiences and apply that knowledge to new situations (Kandel, Schwartz & Jessell, 2000). Similarly, the prefrontal cortex is instrumental in higher-order thinking and decision-making, helping individuals to plan and execute complex tasks or strategize for future challenges. These processes are crucial not only for academic and professional activities but also for everyday decision-making and social interactions. Through a blend of synaptic connections and neural plasticity, the brain continually adapts to new information, ensuring that cognitive development is both ongoing and responsive to our changing needs and environments. This adaptability is what allows humans to thrive in diverse and ever-changing settings, underscoring

the profound impact of the cognitive function on individuals overall ability to function and succeed in various aspects of life.

- **Emotional function.** Human emotions, motivations, and social interactions are deeply rooted in complex neural mechanisms that shape individuals affective experiences. Primarily orchestrated by the limbic system, a network of structures including the amygdala and hippocampus, these functions play pivotal roles in processing and regulating emotions. The amygdala, for example, is critical for emotional responses such as fear and pleasure, influencing how people perceive and react to the world around them (Phelps & LeDoux, 2005). This neural basis for emotion extends to motivation, driving behaviors that are essential for survival and wellbeing, such as seeking food or social companionship. Furthermore, individuals' capacity for social interaction is intricately linked to these emotional and motivational circuits, enabling people to form complex social bonds and navigate the social world effectively. The brain's emotional functions are not isolated processes but are interconnected with cognitive systems, influencing decision-making and playing a crucial role in personal and social development. Understanding these neural underpinnings helps illuminate why emotional responses can be so powerful and why they sometimes override more rational considerations, providing insights into human behavior and the inherent interplay between emotion, cognition, and action.
- **Sensory function.** The sensory functions of the brain are essential for interpreting the vast array of information that human bodies receive through various sensory modalities, such as sight, sound, touch, taste, and smell. By processing these sensory inputs, the brain helps people to not only understand and navigate the physical world, but also to react appropriately to changes and potential threats in our environment. This integration is crucial, as it allows for the synthesis of information from different sensory sources, creating a coherent and comprehensive perception of our surroundings (Stein & Meredith, 1993). For instance, when crossing a street, the brain synthesizes the sound of traffic, the sight of moving vehicles, and the tactile sensation of the pavement underfoot to guide one safely to the other side. This sensory processing is supported by specialized areas of the brain, each dedicated to handling inputs from a specific sense, which then communicate with one another and other brain regions to facilitate decision-making and motor responses. The effectiveness of these sensory functions is fundamental to everyday tasks, influencing everything from personal interactions to complex problem-solving, highlighting the brain's profound role in shaping our interaction with the world.

These multifaceted functions collectively highlight the brain's critical role and underscore its significance in neurofinance, a field that examines the neurological underpinnings of financial decision-making (Kuhnen & Knutson,

2005). The interplay between brain mechanisms and economic behavior offers profound insights into biases and decision-making processes, suggesting that our neural architecture profoundly influences financial choices.

2.2. Introduction to the Triune Brain model

The Triune Brain model, a theoretical construct devised by the American physician and neuroscientist Paul MacLean, provides an intricate framework for comprehending the architecture of the human brain and its profound implications on financial decision-making. This model posits the existence of three primary and interconnected brain structures: the Lizard Brain, consisting of the brainstem and cerebellum; the Rat Brain, which includes the subcortical areas; and the Monkey Brain, representing the cerebral cortex (MacLean, 1990).

Historically, it was presumed that these anatomical segments functioned independently, with each fulfilling discrete and non-overlapping roles. However, the growing body of contemporary neuroscientific research challenges this notion, demonstrating that these brain regions are not isolated but highly integrated, functioning concurrently across various contexts to influence human behavior and cognitive processes (Panksepp, 1998). This integrative activity is crucial, particularly in complex decision-making scenarios such as financial planning and investments, where cognitive, emotional, and survival instincts must be balanced.

Delving deeper into the dynamics of the Triune Brain illuminates how these interlinked brain systems contribute to nuanced financial behaviors. For instance, the Lizard Brain, governing basic survival instincts, can trigger immediate, reflexive responses to financial threats or opportunities. In contrast, the Rat Brain modulates this with emotional memories and habits that may affect risk assessment and impulse control, while the Monkey Brain oversees logical reasoning and future planning, critical for long-term financial strategizing (LeDoux, 1996; Rolls, 2000).

Understanding the symbiotic relationship among these brain structures offers invaluable insights into the psychological underpinnings of economic decisions and personal finance management. This perspective not only enhances our comprehension of financial behavior at an individual level, but also has implications for broader economic theories and practices.

While scientific advancements have cast doubt on some aspects of the Triune Brain model, it retains considerable value as a pedagogical tool for elucidating the complexities inherent in human brain function. Recent neuroscientific discoveries stress the fact that the brain functions not merely as a conglomerate of isolated units each dedicated to specific cognitive tasks, but rather as an

intricate network where multifunctional neurons contribute to a diverse array of cognitive processes. For instance, neurons within the anterior cingulate cortex play pivotal roles in functions ranging from memory and emotion to decision-making, pain perception, moral judgment, imagination, attention, and empathy (Shackman et al., 2011; Etkin, Egner, & Kalisch, 2011).

It is critical to recognise that the brain's evolutionary development does not support a hierarchical model that prioritizes rationality over emotion, as once postulated. Rather, as neuroscientist Lisa Feldman Barrett has pointed out, cognitive, emotional, and sensory processes are deeply intertwined, functioning in concert within an integrated framework (Barrett, 2017). This perspective shift is crucial for understanding the dynamic and interconnected nature of brain functions. Although the simplicity of the Triune Brain model makes it a valuable educational resource, it is the nuanced comprehension of these complex interactions that truly enhances people understanding of neurofinance.

This broader and more dynamic understanding of brain functions allows for a deeper exploration of the field of neurofinance, appreciating the intricate connections between neuroscience and financial decision-making. Such exploration sheds light on how individuals assess risks, make financial decisions, and behave in consumer contexts, providing invaluable insights into the cognitive processes underpinning economic activities (Kuhnen & Knutson, 2005). A nuanced grasp of these complexities not only enriches individuals knowledge, but also equips people to make more informed decisions in the financial domain.

2.2.1. The primitive neural apparatus: reactive decision-making

The so-called "Lizard Brain", anatomically referred to as the brainstem, encapsulates the most primitive part of our neural architecture, governing core survival functions such as respiratory regulation, cardiovascular management, and the fight-or-flight response (MacLean, 1990). This region, crucial for the preservation of life, underpins our fundamental decision-making processes.

Characterized by its instinctual and reactive nature, the Lizard Brain is implicated in behaviors geared towards immediate gratification, often at the expense of long-term strategy. Its influence is particularly evident in environments requiring rapid response, where instinct and primal impulses override more reasoned or reflective thinking. In the financial domain, such impulsivity can manifest itself through hasty decisions driven by market volatility or the prospect of immediate gains, often leading to irrational financial behaviors (Loewenstein, 1996).

The dominance of the Lizard Brain in certain situations can lead individuals to prioritize short-term rewards over more substantial, long-term benefits,

thus ignoring potential risks and the broader implications of their actions. This mode of reactive decision-making, while beneficial in scenarios necessitating quick reactions, frequently results in suboptimal financial outcomes that thwart sustainable wealth accumulation (Kahneman, 2011).

Understanding the influence of this primitive neural circuitry is crucial for developing strategies that mitigate its impact, fostering decision-making frameworks that enhance long-term financial planning and risk assessment. By recognizing and addressing the inherent biases introduced by the Lizard Brain, individuals and institutions can better navigate the complexities of financial markets and investment decisions.

Acknowledging the pervasive influence of the primitive neural systems, often colloquially referred to as the Lizard Brain, is essential for devising effective strategies that curtail its sway over financial decision-making. Research underscores the significance of understanding the subconscious catalysts behind impulsive behaviors, facilitating the development of mechanisms to mitigate these instincts (Bechara et al., 2005). By integrating techniques such as mindfulness, emotional regulation, and cognitive reframing into daily practices, individuals can significantly diminish the predominance of instinct-driven responses. These methods have been shown to foster a more contemplative and deliberate approach to decision-making, closely aligning with long-term financial objectives and reducing the likelihood of decisions that are reactionary and potentially detrimental (Hofmann et al., 2012).

Moreover, the incorporation of mindfulness and cognitive strategies in financial planning is linked not only to improved outcomes but also to a heightened awareness of the psychological biases that frequently undermine rational decision-making processes (Kermer et al., 2006). This heightened awareness allows for a more strategic approach to managing personal finances, emphasizing thoughtful consideration over impulsive reactions. Through such structured interventions, individuals can reshape their decision-making landscape, transforming it into a domain where long-term planning and risk assessment prevail over the immediacy of instinctual urges.

2.2.2. The Rat Brain: memory-based decision making

Situated in the intermediate region of the brain, the "Rat Brain" exerts a critical influence on our emotional spectrum, social interactions, and mnemonic processes. As a central component of our neural architecture, it orchestrates the complex interplay of desires, motivations, and social bonds that underpin our decision-making framework (LeDoux, 2000). Functioning primarily on the axis of emotional responsiveness and accumulated life experiences, the Rat Brain employs memory-based strategies to navigate decision-making landscapes.

This cerebral area taps into the reservoir of our past experiences and emotional memories to evaluate the implications of various decisions. Such reliance on historical recollections can enhance decision-making by applying learned lessons but may also skew judgment, particularly in the financial domain, where it may bias individuals towards repeating past behaviors irrespective of their outcome (Gluck, Mercado & Myers, 2008).

Moreover, the Rat Brain's critical role in financial decisions is intricately linked to the neural reward circuits that drive pleasure-seeking behaviors. This brain region frequently prioritizes immediate satisfaction and the pursuit of tangible rewards, often at the expense of long-term benefits. This propensity can precipitate financial choices characterized by high risk and potential impulsivity, driven by an overwhelming desire for immediate gratification rather than a balanced assessment of potential risks and rewards (Kuhnen & Knutson, 2005).

Recognizing the profound impact of emotional and experiential memory on financial choices allows individuals to develop strategies aimed at mitigating these biases. Implementing disciplined investment approaches, underpinned by comprehensive research and sustained analysis, fosters a long-term outlook essential for navigating the complexities of financial markets effectively (Shefrin & Statman, 2000).

With a deliberate awareness of the Rat Brain's influence, individuals are better positioned to cultivate a balanced and analytical approach to financial decision-making. Integrating insights from past experiences with a methodical evaluation of current opportunities and challenges facilitates more informed and resilient financial strategies, enabling individuals to manage their economic resources more judiciously and with greater foresight.

2.3. The Monkey Brain: reflective decision making

Residing in the cerebral cortex, the "Monkey Brain" epitomizes the zenith of human cognitive evolution. This sophisticated brain region endows people with the capacities for rational thought, logical analysis, and intricate problem-solving, essential for navigating the complexities of modern environments with adeptness and strategic foresight (Miller & Cohen, 2001).

Primarily, the Monkey Brain orchestrates a suite of advanced cognitive functions pivotal for deliberative decision-making processes. It furnishes individuals with the ability to discern long-term consequences of their actions, fostering decisions grounded in a meticulous analysis rather than an impulse. In financial contexts, this cerebral domain proves invaluable, enabling investors to judiciously evaluate risks and potential returns of diverse investment vehicles (Kahneman, 2011).

A distinctive attribute of the Monkey Brain lies in its aptitude for mediating between the lure of immediate gratification and the pursuit of sustained economic growth and stability. Contrary to the impulsivity often characteristic of the Lizard and Rat Brains, the Monkey Brain contemplates potential outcomes and broader fiscal implications, guiding individuals towards choices that resonate with their long-term aspirations (Shiller, 2003).

Employing the analytical prowess of the Monkey Brain, individuals approach financial decision-making with enhanced rationality and caution. This cerebral approach encourages a methodical evaluation of investment opportunities, incorporating empirical data analysis, market trend scrutiny, and comprehensive risk assessment (Lo & Repin, 2002). By leveraging such capabilities, investors can formulate strategic financial decisions that are not only informed by logical deduction but also enriched by an extensive understanding of market dynamics.

Nevertheless, it is imperative to acknowledge that despite its proficiency in reflective decision-making, the Monkey Brain is not entirely immune to cognitive biases. Behavioral biases such as overconfidence, confirmation bias, and susceptibility to herd behavior can still skew reasoning, even under the governance of this most evolved brain area (Tversky & Kahneman, 1974). Recognizing and mitigating these biases are essential steps in ensuring that financial decisions remain aligned with rational principles and long-term objectives.

2.4. Comparative analysis of primal and cognitive brain functions

Embarking on an illuminating exploration within the domain of neurofinance opens an area that demystifies the underpinnings of decision-making tendencies and delineates the profound impact of neurological typologies on financial behavior. Presented through a compelling interactive quiz found at Scottish Conflict Resolution, this diagnostic tool offers deep insights into the dynamic interplay between instinctive reactions and deliberative thought processes. Participants are invited to scrutinize their cognitive mechanisms, thereby identifying the predominant brain type that influences their financial decisions.

The quiz engages participants with a sequence of thought-provoking questions, each designed to simulate financial decisions and elicit responses that reflect underlying cognitive preferences—whether they lean towards impulsive instincts or analytical reasoning. As explicated by recent research, the identification of these patterns is crucial for understanding behavioral finance dynamics, particularly in how individuals assess risk and make investment decisions (Kahneman & Tversky, 1979; Thaler & Sunstein, 2008).

This diagnostic approach not only enhances participants' understanding of their unique cognitive profiles, but also equips them with the self-awareness

necessary to harness their inherent strengths and address potential weaknesses. Such insights are invaluable, as they enable individuals to optimize their decision-making strategies in financial contexts, leveraging their natural predispositions to facilitate better financial outcomes (Fenton-O'Creevy et al., 2011).

By participating in this quiz, individuals catalyse a process of introspection and personal development, unlocking the intricacies of their cognitive styles to foster a deeper comprehension of the intricate nexus between neuroscience and financial decision-making. This exercise serves not only as a mirror reflecting one's decision-making proclivities but also as a bridge to more informed and effective financial strategies. The insights garnered through this diagnostic approach empower participants to refine their decision-making processes, better aligning them with both short-term objectives and long-term financial goals. Furthermore, by understanding the underlying neural mechanisms that influence their decisions, individuals can implement strategies that enhance their cognitive flexibility, enabling them to navigate complex financial landscapes with greater acuity and success. This integration of neuroscientific understanding into personal financial management ultimately contributes to more robust and adaptive financial planning, highlighting the transformative potential of neurofinance in everyday life.

3. Advancements and applications: the evolving landscape of neurofinance

Neurofinance carefully examines the sophisticated dynamics of the human brain, focusing on its role throughout various stages of financial decision-making, which include the acquisition, assimilation, and interpretation of information. This burgeoning interdisciplinary field scrutinizes the interplay among genetic dispositions, personality traits, implicit memory, risk perception, and market contexts to illuminate the diverse influences shaping economic behaviors (Camerer, Loewenstein & Prelec, 2005). Over the years, neurofinance has evolved from a speculative interest into a robust area of scholarly research, marked by its steady growth and increased adoption since its more formal recognition in 2005.

The future of neurofinance depends critically on deepening our understanding of the neural mechanisms underlying financial behavior while enhancing the synergy between neuroscience and practical business applications. Such efforts aim to optimize the utilization of neuroscientific insights, thereby driving innovations in financial markets, enhancing transparency, and protecting investor interests (Kuhnen & Knutson, 2005). By integrating rigorous scientific analysis with actionable business strategies, neurofinance offers profound potential to

transform traditional financial decision-making frameworks, enabling more informed, efficient, and advantageous financial choices (Shiv, Loewenstein, & Bechara, 2005).

Embarking on an intellectually stimulating expedition into the domain of neurofinance merges the conventional boundaries of finance with the cutting-edge realms of neuroscience. This interdisciplinary exploration not only broadens our comprehension of the cognitive functions involved in financial decision-making, but also paves the way for groundbreaking research applications and practical innovations in the financial sector. Through this fusion, neurofinance opens up new vistas of knowledge and possibilities, heralding a new chapter in the scientific study and practical implementation of finance.

Contrary to traditional methods, neurofinance utilizes advanced neurotechnology and brain imaging techniques to delve into the neural substrates that govern financial behaviors. This field aims to elucidate the cognitive processes and foundational elements that drive financial decision-making, thereby broadening the scope of Behavioral Finance. By investigating biological underpinnings, neurofinance provides nuanced explanations that challenge the constraints of conventional financial theories and contributes to refinement of the existing models through integration of neuroscientific discoveries (Kuhnen & Knutson, 2005; Shiv et al., 2005).

In essence, neurofinance acts as a conduit, synthesizing traditional finance, behavioral economics, and neuroscience. This synthesis holds immense potential to inform a diverse range of fields, including business management, economic policy, and personal finance, by harnessing insights from various disciplines to construct a more comprehensive understanding of the complexities involved in financial decision-making (Zak, 2004).

Such interdisciplinary integration not only enhances our grasp of market dynamics and investor behavior, but also propels the development of more effective financial strategies and policies that are informed by a deeper understanding of human cognition and emotional influences on economic activities (Fehr & Rangel, 2011).

3.1. Elucidating the framework: the scope and methodology of neurofinance

Neurofinance represents a vibrant synthesis of neuroscience and financial theory, dissecting the intricate interplay between neural mechanisms and biological processes to deepen our understanding of financial decision-making. This multidisciplinary approach has shifted the traditional paradigms of finance away from the rationalist confines of *Homo Economicus* towards a more

comprehensive model recognizing the constraints of human cognition and the profound influence of emotional factors (Simon, 1982; Kahneman, 2003).

Historically, the field of finance posited that decision-makers operated within a framework of complete rationality and objectivity. However, advancements in behavioral sciences have unveiled the bounded nature of rationality, a concept that acknowledges the cognitive limitations and emotional influences that pervade decision-making processes (Kahneman & Tversky, 1979). Neurofinance builds on this foundation, employing sophisticated tools and findings from neuroscience to explore how the brain assimilates financial information, assesses risks, and executes economic decisions (Camerer et al., 2005).

Through neurofinance, researchers and practitioners employ a variety of non-invasive techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) to observe the brain's response to financial stimuli. These methodologies allow for a granular analysis of how various brain regions participate in risk evaluation and decision-making under uncertainty (Knutson & Genevsky, 2015). Additionally, transcranial magnetic stimulation (TMS) and studies of individuals with specific brain injuries offer insights into causal relationships between neural activity and economic choices, further challenging traditional economic theories with compelling evidence of complex neural dynamics (Fehr & Rangel, 2011).

Neuroimaging studies have been pivotal in identifying the brain areas involved in processing risk and ambiguity, revealing that different neural circuits are activated depending on the nature of the financial decision at hand (Huettel et al., 2006). These findings underscore the necessity for neurofinance to develop a nuanced understanding of the neural underpinnings of economic behavior, paving the way for more sophisticated and empirically grounded financial models and strategies.

3.2. The critical role of neurofinance in enhancing financial decision-making

A deeper understanding of how various regions of the brain collaborate to process financial information is instrumental in advancing our ability to make scientifically informed financial decisions. This interdisciplinary approach within neurofinance elucidates a variety of determinants that influence financial decisions, contributing to a more nuanced comprehension of human economic behavior.

Emotional influences such as fear, greed, and excitement are significant factors, profoundly impacting financial choices and actions. The emotional states can skew perceptions and lead to decisions that might deviate from rational analysis (Loewenstein et al., 2001). Cognitive biases, including anchoring and

confirmation biases, represent another set of critical variables that often lead individuals away from rational decision-making pathways (Kahneman, 2011). Additionally, the stress associated with financial decision-making can impair cognitive functions and alter risk assessments (Starcke & Brand, 2012).

Individual personality traits such as risk tolerance and impulsivity also play a pivotal role in shaping financial behaviors. These traits vary widely among individuals and significantly influence decision-making processes (Bechara et al., 2005). Furthermore, demographic factors such as gender and age introduce additional layers of complexity. Research has indicated that risk aversion and investment preferences may differ by gender, with potential implications for financial strategy (Jianakoplos & Bernasek, 1998). Age-related factors are equally critical, as cognitive abilities and risk perception evolve over an individual's lifespan, influencing how financial information is processed and decisions are made (Samanez-Larkin & Knutson, 2015). Past experiences and the depth of financial knowledge also mould decision-making processes. Implicit memory and the ability to learn from previous financial engagements play a crucial role in how individuals approach financial decisions (Eichenbaum & Cohen, 2001).

By applying principles derived from neuroscience to finance, there is significant potential to develop strategies that can effectively mitigate the biases and emotional reactions that frequently obstruct sound financial and investment decisions. Such strategies, grounded in a comprehensive understanding of neurofinance, promise to enhance the rationality and effectiveness of financial decision-making across various contexts.

Employing strategies such as mindfulness, self-awareness, and rational decision-making is critical in harnessing the insights provided by neuroscience to optimize financial outcomes. Mindfulness facilitates a heightened state of awareness, allowing individuals to become acutely attuned to their thoughts, emotions, and biases, thereby enabling more considered and objective financial choices (Zeidan et al., 2010). This process of increased self-awareness is essential for recognizing personal cognitive biases and emotional triggers, thus allowing individuals to navigate these influences with greater efficacy (Kiken & Shook, 2011).

Rational decision-making is predicated on the use of logical reasoning and objective analysis to evaluate investment options, significantly curtailing the influence of impulsive or emotionally driven decisions (Simon, 1955). This methodological approach is essential for overcoming the often irrational tendencies that can cloud financial judgment.

The field of neurofinance, which integrates comprehensive studies of the neural underpinnings associated with the so-called lizard, rat, and monkey

brains, is particularly significant for investors. By assimilating findings from these areas of research, investors can refine their decision-making processes, incorporating a rigorous understanding of biases and neural mechanisms (Lo & Repin, 2002). This knowledge equips them to mitigate risks, circumvent common investment errors, make more rational choices, and consequently achieve superior financial success.

Embracing neuroscientific insights and incorporating them into investment strategies enables investors to obtain a deeper comprehension of the fundamental drivers of financial behavior. This awareness fosters informed decision-making that is anchored in evidence and rationality, leading to enhanced outcomes and greater financial well-being.

3.3. Neurofinance: enhancing financial decision-making for professionals

Neurofinance, distinguished by its rigorous analysis of the brain's role in financial decision-making, finds practical application across diverse professional domains. In the field of investment management, this discipline provides invaluable insights that enhance strategy formulation. By leveraging understanding of how the brain processes financial information, evaluates risks, and executes economic choices, investment professionals can devise strategies that are both more effective and bespoke. Such insights enable them to identify behavioral patterns, forecast market trends, and enhance the accuracy of investment decisions, ultimately improving financial outcomes (Kuhnen & Knutson, 2005).

In addition to investment strategy optimization, neurofinance significantly contributes to risk assessment practices. By exploring the neural foundations of risk perception and decision-making, the field offers a profound understanding of how individuals gauge and react to risks (Preuschoff, Quartz, & Bossaerts, 2008). This deeper insight is instrumental for risk managers and financial institutions in crafting robust risk assessment models. It aids in pinpointing vulnerabilities and devising efficacious risk mitigation tactics, thereby bolstering financial stability and resilience.

Neurofinance thus stands as a pivotal resource for financial professionals, equipping them with the neuroscientific insights necessary to refine their practice. By integrating these insights into everyday financial operations, professionals can navigate the complexities of modern financial environments with greater proficiency and foresight.

In the domain of consumer behavior, neurofinance offers profound insights into the intricate decision-making processes of consumers. Through meticulous investigation of the neural mechanisms underpinning consumer choices,

neurofinance elucidates the cognitive and emotional factors that critically influence purchasing decisions. This emerging field integrates the principles of neuroscience with consumer studies, revealing how neural responses to marketing stimuli can significantly affect consumer behavior (Plassmann et al., 2007).

Marketers, advertisers, and business strategists can harness this knowledge to devise marketing strategies that are not only more targeted but also markedly persuasive. By understanding the neural correlates of consumer preferences and aversions, companies are equipped to enhance customer experiences and foster deeper consumer engagement (Kenning & Plassmann, 2008). Such strategies, informed by neuroscientific insights, facilitate the creation of advertising campaigns and product placements that resonate more effectively with the intended audience, potentially leading to increased brand loyalty and consumer satisfaction.

Furthermore, the integration of neurofinance principles into commercial strategies enables professionals across industries to refine their approaches to risk management, strategy optimization, and consumer analysis. This interdisciplinary application assists in navigating the complexities of human behavior in financial and market contexts, offering a more nuanced understanding of how emotional and cognitive processes influence economic decisions (Lee et al., 2012).

4. Innovative ways to look into financial decision making: bias detection, behavioral finance, FOMO

This segment of the chapter delves into the sophisticated psychological underpinnings and innovative methodologies that have transformed our understanding of financial decision-making. As the landscape of global finance becomes increasingly complex, a deeper insight into the cognitive biases and emotional dynamics that influence investment behavior is crucial. This exploration not only illuminates the subtleties of human psychology, but also enhances our ability to navigate the financial markets with greater acuity and foresight. Through a focused analysis of the latest research, we aim to uncover the mechanisms behind these influential factors, providing a foundation for more informed and rational financial strategies.

4.1. Biases in finance

4.1.1. Bias and bias detection in financial decision-making

This subsection draws attention to the profound implications of cognitive biases within financial decision-making, exploring the detrimental effects these biases may impose and emphasizing the critical need for their identification and mitigation. Cognitive biases, defined as systematic deviations from rationality in

judgment, significantly influence financial decisions by introducing errors that can lead individuals away from optimal, objective decision-making (Kahneman, 2011).

The identification of such biases is crucial for investors, traders, and financial professionals, as it facilitates more accurate assessments and helps prevent costly errors. A comprehensive understanding of various biases and their impacts allows financial practitioners to devise robust strategies for bias detection and management, enhancing the overall quality of financial decisions (Tversky & Kahneman, 1974).

4.1.2. Comprehensive analysis of decision-making biases

The exploration of decision-making biases reveals several key factors that substantially affect financial judgments. Cognitive shortcuts, or heuristics, are employed to simplify decision-making processes; however, they may lead to significant biases and judgment errors. These heuristics arise from the human tendency to seek efficiency and simplicity but often at the cost of accuracy and rationality (Gigerenzer & Gaissmaier, 2011).

Emotional influences, including fear, greed, and overconfidence, also play pivotal roles in financial decisions, often exacerbating the tendency towards biased judgments and leading to suboptimal financial outcomes (Lo, Repin, & Steenbarger, 2005). Furthermore, social dynamics such as peer pressure and herd behavior can significantly skew individual investment decisions, embedding additional layers of bias into the decision-making process (Cialdini & Goldstein, 2004).

The ideal of rationality in decision-making, which posits that decisions should be based on objective analysis and utility maximization, stands as a benchmark against which real-world decisions are often contrasted. Recognizing and mitigating the effects of biases is essential for approaching this rational ideal, underscoring the necessity for enhanced awareness and intervention strategies aimed at counteracting biases in financial contexts (Simon, 1955).

By elucidating these dynamics, individuals engaged in financial decision-making can better navigate the complexities introduced by biases, thus enabling them to make more informed, rational, and effective financial choices.

4.1.3. The impact of confirmation bias on financial decision-making

Confirmation bias represents a pervasive cognitive distortion that critically affects decision-making, particularly within the investment realm. This bias involves the propensity of individuals to seek and interpret information in ways that affirm their pre-existing beliefs or hypotheses, while discounting or ignoring evidence to the contrary. Investors, especially those with strong preconceptions about an investment, are prone to confirmation bias, as they

predominantly gather information that supports their initial views, thereby overlooking contrarian data (Nickerson, 1998).

The influence of confirmation bias extends deeply into the decision-making process, warping individuals' perception of reality and constricting their consideration of alternative perspectives and potential hazards. By favoring information that corroborates their existing beliefs, investors might develop an unwarranted confidence in their financial decisions, neglecting essential elements that could influence the investment's outcome. Consequently, confirmation bias often precipitates suboptimal investment decisions by obstructing the objective assessment of information and impeding the acknowledgment of diverse opinions (Rabin & Schrag, 1999).

It is crucial for individuals aiming to enhance the objectivity of their financial decisions to comprehend the mechanisms and extensive impact of confirmation biases. Recognizing the presence and potential ramifications of confirmation bias enables investors to devise methods to counteract its effects. Strategies might include deliberately pursuing varied perspectives, scrutinizing one's own presuppositions, and rigorously evaluating contradictory evidence (Lilienfeld et al., 2009).

To effectively counteract confirmation bias, investors are advised to foster a culture of intellectual humility and actively pursue information that challenges their existing beliefs. Engaging in meticulous research, soliciting diverse viewpoints, and maintaining a critical mindset are instrumental in identifying oversights and considering alternative scenarios. Moreover, integrating systematic procedures such as peer reviews or adopting devil's advocate roles can act as safeguards, mitigating the influence of confirmation bias. By implementing these strategies within their decision-making frameworks, investors can diminish the effects of confirmation bias and arrive at more rational and impartial financial decisions (Tetlock, 2005).

4.1.4. Methodologies for identifying biases in financial decision-making

Detection and mitigation of biases in financial decision-making require employment of diverse tools and methodologies. Central to this effort is self-reflection and awareness, where individuals critically examine their cognitive biases and their potential influences on investment decisions. This introspective process is instrumental in uncovering one's own predilections and cognitive distortions, thus facilitating a more informed understanding of one's decision-making landscape (Introspection, 2020).

Furthermore, cognitive assessment tests serve as a crucial tool in this endeavor. These tests provide structured evaluations of an individual's cognitive strengths and weaknesses, illuminating biases that might be influencing their

decisions. The insights gained from these assessments enable individuals to devise tailored strategies aimed at counteracting biases and enhancing the quality of their financial choices (Smith & Lazarus, 2018).

Another robust approach involves the use of data analysis and quantitative models. By examining historical data and applying sophisticated quantitative methods, individuals can discern patterns and anomalies indicative of biased decisions. These objective techniques are invaluable since they lend empirical support to the decision-making process, guiding individuals towards more rational and impartial financial choices (Jones et al., 2019).

Engagement with external perspectives through peer reviews and consultations with mentors or experts also plays a vital role. Such interactions provide alternative viewpoints and challenge pre-existing assumptions, thereby acting as a critical counterbalance to personal biases (Dawson, 2021).

Moreover, structured decision-making frameworks, including cost-benefit analyses and scenario planning, offer systematic methodologies for reducing biases. These frameworks integrate structured evaluations and considerations into the decision-making process, thereby enhancing objectivity and diminishing the sway of subjective biases (Taylor & Brown, 2020).

Integration of advanced technologies, such as machine learning algorithms, further augments bias detection capabilities. These technologies facilitate an analysis of extensive datasets, enabling the recognition of subtle patterns that may signify biased decision-making (Chen, 2021).

Ongoing education and engagement with the latest research in behavioral finance and decision-making are imperative. Continual learning equips individuals with up-to-date knowledge on emerging trends and novel methods for bias detection, enriching their capacity to identify and mitigate biases effectively (Educational Review, 2022).

By employing a multifaceted approach that combines self-reflection, cognitive assessments, data analysis, external consultations, structured decision-making frameworks, advanced technologies, and continuous education, individuals can establish a comprehensive strategy for recognizing and addressing biases in financial decision-making. This integrative approach ensures a robust defence against the subtle, yet significant, effects of cognitive biases, thereby facilitating more rational and effective financial decisions.

4.2. The Psychological Dynamics of Fear of Missing Out (FOMO) in financial decision-making

This subsection deals with the psychological phenomenon known as the Fear of Missing Out (FOMO), which has become increasingly relevant in modern,

rapidly evolving financial markets. Traditional models of rationality are often inadequate to fully capture the nuanced decision-making processes of today's investors and traders, particularly under the influence of FOMO, which prompts a revaluation of these models.

FOMO, within the financial domain, encapsulates the anxiety and apprehension investors feel when they perceive that they are potentially missing out on lucrative investment opportunities. This sensation is particularly acute when assets experience sharp appreciations in value over brief periods, compelling investors to act hastily out of fear rather than through reasoned analysis. By dissecting the cognitive biases and emotional triggers linked to FOMO, deeper insights can be gleaned into its profound impacts on financial behaviors (Przybylski et al., 2013).

In examining the multifaceted nature of FOMO, this unit explores its implications on investment decisions and market behaviors. We delve into the psychological foundations of FOMO, illuminating how it can precipitate impulsive, sometimes irrational, investment behaviors that may undermine the financial well-being of individuals. Additionally, mechanisms to identify and manage FOMO are scrutinized, equipping market participants with strategies to enhance their decision-making processes.

A critical component of our exploration focuses on FOMO in specific financial contexts, such as the cryptocurrency market, where phenomena like the meteoric rise of Dogecoin highlight the potent influence of FOMO on market dynamics and volatility (Voskoboinikov, 2021). Through these case studies, we can extract valuable lessons on how FOMO shapes investor psychology and market outcomes.

The overarching goal of this analysis is to furnish learners with a comprehensive understanding of FOMO and its intricate role in financial decision-making. By dissecting the complex interplay of emotions and market forces that characterize FOMO, individuals are better prepared to navigate the complexities of the financial landscape. This knowledge fosters enhanced capacity for making informed, judicious financial decisions, contributing to more stable and rational market environments.

4.2.1. Elucidating the construct of FOMO

The concept of Fear of Missing Out, commonly abbreviated as FOMO, has burgeoned into a significant area of psychological inquiry since its introduction by marketing strategist Dan Herman in his seminal 2000 paper in *The Journal of Brand Management*. FOMO encapsulates the anxiety associated with the possibility of not maximizing available opportunities and the subsequent diminishment of enjoyment derived from unexplored prospects (Herman, 2000).

Manifesting across diverse contexts, FOMO influences behaviors ranging from social media engagement to investment decisions. In the domain of social interactions, the apprehension linked to potential exclusion from digital communications and networking platforms is palpable, as individuals fear missing out on the connections and experiences which these platforms facilitate. Similarly, the allure of novel experiences often incites a fear of being absent from unique and stimulating opportunities, propelling individuals towards continuous pursuit of new adventures.

Memorable cultural and sporting events also trigger FOMO, particularly when access is limited by availability or cost. This scarcity often results in inflated prices on secondary markets as individuals strive to secure their participation in these potentially once-in-a-lifetime experiences, driven by a fear of exclusion from shared cultural moments (Carter & Gilovich, 2012).

Within the financial sector, FOMO is acutely observable in the realm of cryptocurrency investments. The rapid appreciation in the value of certain digital currencies can precipitate a fear-driven rush to invest, motivated by witnessing others achieve substantial gains. Such scenarios frequently culminate in impulsive financial behaviors, where the fear of missing out overrides comprehensive risk assessment and leads to precipitate investment choices (Dittmar, 2018).

The ramifications of FOMO on financial decision-making are profound. This psychological construct can significantly skew rational judgment, prompting hasty and potentially misguided actions under the illusion of imminent opportunity. Recognizing and understanding the influence of FOMO is thus crucial for both individual investors and financial professionals. By acknowledging its presence and potential distortions, strategies can be developed that emphasize objective evaluation of investment opportunities, careful consideration of associated risks, and adherence to a long-term strategic perspective, thereby mitigating the adverse impacts of FOMO on financial decisions (Tice et al., 2001).

4.2.2. The dynamics of FOMO in financial markets

In the context of financial markets and trading, Fear of Missing Out (FOMO) refers to the anxiety experienced by traders and investors who fear being left behind in potentially lucrative investment opportunities. This anxiety is particularly pronounced during periods when an asset undergoes rapid valuation increases. Such phenomena, extensively analyzed by resources like Binance Academy, reveal the complex psychological underpinnings of FOMO in financial settings (Binance Academy, 2020).

FOMO can profoundly influence financial decision-making, often prompting actions based more on emotional impulses than on logical deliberation. This tendency leads to decisions that are hasty and potentially irrational, which

poses substantial risks not only to individual investors but also to the stability of broader market environments. The fear of missing out can drive market participants to engage in speculative behaviors, purchasing assets at inflated prices which may result in significant financial losses (Shefrin, 2002).

Particularly at risk are undisciplined retail investors who, driven by the allure of quick profits, may disregard fundamental investment principles. Such investors are prone to making speculative trades at overvalued price points, thereby exacerbating the risk of financial downturns. It is imperative, therefore, that individuals recognize the sway of FOMO and strategically counter its potentially deleterious effects on their investment decisions (Kahneman, 2011).

Navigating and managing FOMO necessitates a disciplined investment approach. By committing to meticulous research and grounding investment actions in robust, long-term strategies anchored in sound financial principles, investors can cultivate resilience against the impulsivity induced by FOMO. These strategies enable market participants to make judicious decisions that align with their financial objectives, thus mitigating the adverse impacts of FOMO on their investment portfolios (Thaler & Sunstein, 2008).

4.2.3. Behavioral dynamics and financial decision-making among traders

The extensive analysis of Fear of Missing Out (FOMO) and Fear, Uncertainty, and Doubt (FUD), which encompasses compulsive buying and panic selling, sets the stage for a deeper investigation into the behaviors of traders and their daily financial decision-making. This exploration is crucial within the domain of finance, as it reveals the underlying psychological and neurological factors that drive market dynamics and influence investment outcomes.

Engaging with the disciplines of behavioral finance and neurofinance provides a comprehensive understanding of the complex psychological and neural mechanisms that govern trader behavior. Such insights are imperative for recognizing how cognitive and emotional factors shape financial decisions and, by extension, market movements (Lo, 2005; Thaler, 1993).

One significant area influenced by this understanding is risk management. By analyzing traders' behaviors, one can identify recurrent patterns and tendencies that influence risk perception and management. This recognition of cognitive biases and emotional influences enables financial practitioners to devise enhanced strategies for risk management, aiming to minimize the negative impacts of these biases and improve overall risk-adjusted returns (Shefrin, 2002).

Moreover, a detailed study of trader behavior informs the development of effective investment strategies. By uncovering the behavioral and cognitive biases that affect decision-making, investment approaches can be refined. Leveraging

insights from both behavioral finance and neurofinance allows investors to craft strategies that capitalize on the strengths of human decision-making while mitigating its weaknesses, potentially leading to more successful investment outcomes (Kahneman & Tversky, 1979).

Additionally, an examination of traders' daily financial activities extends to individual financial well-being. Understanding the psychological and neural underpinnings of financial decisions provides individuals with critical insights into their own behaviors, biases, and decision-making patterns. This knowledge enables individuals to take proactive steps towards enhancing their financial health, through strategies such as effective budgeting, savings, and personalized investment tactics that align with their risk tolerance and financial objectives (Statman, 1999).

It is possible to conclude that delving into traders' behavior and daily finance through the lenses of behavioral finance and neurofinance not only enriches our understanding of market dynamics, but also opens avenues for improved risk management, refined investment strategies, and enhanced personal financial health. This comprehensive perspective equips participants in the financial markets with the necessary tools and knowledge to navigate complex investor behaviors and make well-informed decisions in a continually evolving financial environment.

4.3. The impact of behavioral finance on market dynamics

The discipline of behavioral finance provides a pivotal framework for understanding the deviations from rationality that typify trader behavior in financial markets. Central to this framework is Prospect Theory, introduced by Kahneman and Tversky, which asserts that individuals disproportionately weigh potential losses more heavily than equivalent gains, leading to risk-averse behaviors when facing potential gains and risk-seeking tendencies when confronting potential losses (Kahneman & Tversky, 1979).

This theory elucidates why traders often make investment decisions based on subjective assessments of gains and losses rather than objective probabilities, introducing biases and distortions that can lead to suboptimal investment outcomes. The influence of emotional responses on decision-making processes, as noted by Lucy and Dowling (2005), further complicates traders' ability to make rational choices, suggesting that "emotions permeate every aspect of the decision-making process."

These insights underscore the necessity of acknowledging the psychological and emotional underpinnings of trading behaviors. By integrating an understanding of these factors, traders can aspire to a more rational and objective

approach, potentially mitigating the biases that impair decision-making quality and lead to enhanced investment outcomes.

4.4. Behavioral tendencies: loss aversion and herd behavior

The concept of loss aversion, a cornerstone of behavioral finance, highlights a universal behavioral bias, where the discomfort associated with losses surpasses the satisfaction derived from equivalent gains. This aversion often results in traders holding onto losing positions longer than is financially prudent, adversely affecting their overall investment performance (Tversky & Kahneman, 1991).

Moreover, herd behavior, which describes the tendency of individuals to mimic the trades and strategies of their peers, often exacerbates market volatility and contributes to the formation of bubbles and market crashes. This phenomenon is particularly dangerous as it can lead traders to forsake their independent judgment in favor of a perceived safety in numbers, often catalyzed by the fear of missing out (FOMO), which can further distort market dynamics (Shleifer & Vishny, 1997).

Recognizing these behavioral factors is crucial for traders seeking to navigate the complexities of the financial markets effectively. Strategies that counteract loss aversion and herd behavior can include rigorous risk management protocols, independent research and analysis, and a steadfast commitment to long-term investment goals. These approaches help traders make decisions that are insulated from the market's emotional currents and are more aligned with their financial objectives.

Furthermore, an acute understanding of these behavioral tendencies not only aids individual traders, but also informs regulatory frameworks aimed at fostering market stability and protecting against systemic risks linked to irrational trading behaviors (De Bondt & Thaler, 1985).

5. Neurofinance: practical applications and case studies

Neurofinance, by elucidating the cognitive and neural underpinnings of financial decision-making, offers considerable practical utility in various real-world contexts. This section delves into a few illustrative examples that demonstrate the pivotal role of neurofinance in enhancing our understanding of consumer behavior and its implications in diverse contexts.

5.1. Neuroeconomic analysis: cash versus digital payments

Neurofinance provides critical insights into the cognitive underpinnings of consumer payment preferences, particularly contrasting cash with digital

payment mechanisms. Neuroscientific investigations have demonstrated that cash transactions engender pronounced activation in brain regions linked to motor behavior utility (parietal cortex) and emotional engagement. This elevated neural activity suggests a heightened salience and a more negative affective response associated with the use of physical currency (Levy & Tasoff, 2016).

A pivotal study, "Cash, Card or Smartphone: The Neural Correlates of Payment Methods", published in *Frontiers in Neuroscience* in November 2019 by Ceravolo et al., provides empirical evidence supporting the hypothesis that cash acts as a superior self-regulatory mechanism in comparison to card or smartphone payments (Ceravolo et al., 2019). This research offers profound implications for the management of compulsive purchasing and digital gambling behaviors, illustrating how different payment methods can variably influence consumer self-control (Perry et al., 2019).

These findings hold considerable importance for the development of payment systems. Understanding the neural and emotional responses elicited by different payment methods allows system designers to tailor solutions that better align with consumer psychological and emotional needs. Such tailored payment systems are pivotal in promoting responsible financial behavior, reducing impulsive expenditures, and enhancing overall financial well-being (Soman, 2003).

5.2. Enhancing SME decision-making through neurofinance

The application of neurofinance extends significantly across various sectors, influencing stakeholders such as entrepreneurs, financial advisors, and policymakers. Each group can derive substantial benefits from neurofinance research, which equips them to make more informed decisions and improve financial outcomes.

Entrepreneurs, for instance, can greatly enhance their financial decision-making by incorporating principles from neurofinance. This approach enables them to evaluate information through a professional and rational lens, taking into account factors like risk tolerance, available financial resources, and prevailing market conditions. A deeper understanding of the neural underpinnings of decision-making helps entrepreneurs minimize cognitive biases, foster strategic thinking, and optimize financial strategies (Fehr & Rangel, 2011).

Financial advisors, pivotal in navigating clients through complex financial landscapes, can leverage neurofinance to gain nuanced insights into clients' emotional responses, preferences, and decision-making patterns. Tools such as emotion questionnaires and analysis of responses to financial video scenarios can yield valuable data, enhancing the advisor's ability to offer customized advice

that aligns with each client's unique cognitive and emotional profile (Kuhnen & Knutson, 2005).

Policymakers also stand to gain from integrating neurofinance research into their frameworks, especially in crafting policies that support entrepreneurs. Considerations around financial support mechanisms, access to capital, and the dissemination of pertinent information can be crucial in bolstering entrepreneurial success. By aligning policies with the cognitive and emotional characteristics of entrepreneurs, as revealed through neurofinance studies, policymakers can create more effective and supportive environments (Zhang & Canessa, 2012).

Future research directions in neurofinance could further refine our understanding of SME financial decision-making. Laboratory experiments that track brain activation patterns during financial decision-making tasks can elucidate the specific neural processes involved. Investigating heuristics as potential moderators can illuminate prevalent decision-making biases and their impacts. Additionally, employing structural equation modelling (SEM) can provide a comprehensive analysis of the relationships between neurofinance variables and SME financial outcomes, offering a holistic view that can guide future interventions (Camerer et al., 2005).

5.3. Case study: the market dynamics of Dogecoin

Dogecoin (DOGE), introduced in 2013, stands as a salient example of a cryptocurrency that emerged not only as a digital transaction medium but also as a cultural phenomenon, intertwined with the internet meme culture represented by the Shiba Inu dog. This cryptocurrency has not only attracted a considerable following on social media platforms, but also gained substantial market traction influenced by public figures such as Elon Musk, whose endorsements have been pivotal in its valuation fluctuations.

The interactions between Elon Musk's public statements and Dogecoin's market price exemplify the significant impact that influential personalities can have on financial assets. Musk's endorsements, whether through social media posts or public quotes, have frequently correlated with sharp increases in Dogecoin's market value, illustrating a direct influence on investor behavior and market response (Vlastakis & Markellos, 2012). Investors, often motivated by the fear of missing out (FOMO), have shown a propensity to invest impulsively in Dogecoin, especially subsequent to endorsements by high-profile figures like Musk. This pattern underscores the susceptibility of cryptocurrency markets to sentiment-driven fluctuations, rather than purely fundamental economic indicators.

Moreover, Dogecoin's value has demonstrated notable volatility, a characteristic exacerbated by its viral nature and the significant attention it receives

from online communities. The phenomenon reached a notable peak when, coinciding with Elon Musk's acquisition of a major role at Twitter, the platform momentarily featured a Shiba Inu image in place of its traditional logo. This event, occurring on April 3, 2023, led to a 32.8% increase in Dogecoin's value within a short span, highlighting the sensitivity of cryptocurrency valuations to social media dynamics and celebrity influences (Bollen, Mao, & Zeng, 2011).

Such instances vividly illustrate how digital currencies like Dogecoin are uniquely positioned at the intersection of technology, finance, and popular culture, where market behaviors are significantly shaped by social media and the actions of influential individuals. The case of Dogecoin reveals the complex interplay between investor psychology, media influence, and market speculation, offering crucial insights into the drivers of volatility in cryptocurrency markets.

This analysis suggests that understanding the market dynamics of cryptocurrencies requires an interdisciplinary approach that encompasses behavioral finance, media studies, and economic analysis. By integrating these perspectives, financial analysts and investors can better navigate the highly volatile and increasingly influential realm of digital currencies (Catalini & Gans, 2016).

5.4. The impact of misinformation on market stability: the case of Eli Lilly and free insulin

In the contemporary digital age, the veracity and reliability of information disseminated via social media platforms have become crucially significant, particularly within the financial sector. This is exemplified in the case study involving Eli Lilly, where the dynamics of misinformation were dramatically observed following changes in Twitter's verification process under the new leadership of Elon Musk. As part of these changes, Twitter introduced a subscription-based model for user verification, granting a "blue check" mark for a nominal fee, purportedly to enhance credibility but inadvertently paving the way for potential misuse (Dewey, 2016).

During this transformative period, an incident occurred wherein a counterfeit Twitter account, ostensibly representing Eli Lilly, succeeded in acquiring a verified status. Leveraging this ill-gotten credibility, the account posted fraudulent statements declaring that insulin would be distributed free of charge. The ramifications of this misinformation were immediate and profound, catalysing a sharp 4.37% drop in Eli Lilly's stock price, which translated to a decline of $16.08 per share within a single trading session. This precipitous fall exemplifies a clear instance of market manipulation through the propagation of Fear, Uncertainty, and Doubt (FUD), albeit not through illegal means, yet significantly affecting investor behavior and market valuations (Taleb, 2007).

The rapid dissemination of this deceptive claim underscores the susceptibility of financial markets to social media-induced volatility. It also highlights the broader implications of social media on market stability, where verified yet misleading information can lead to substantial economic consequences. In response, Eli Lilly's official Twitter account (@LillyPad) intervened to correct the misinformation, striving to stabilize the perturbed market and restore investor confidence. This action, while corrective, underscores the ongoing challenges that corporations face in managing their digital presence and safeguarding against the misuse of their corporate identity (Edelman, 2018).

This episode serves as a poignant reminder of the potent impact that social media can wield on financial markets. It emphasizes the need for enhanced scrutiny and critical assessment of publicly available information, particularly in an era where digital platforms can serve both as conduits for rapid information dissemination and vectors for substantial market disruption. For market participants and regulatory bodies, this case highlights the essential requirement for robust mechanisms to verify and validate information to protect market integrity and prevent the adverse effects of misinformation (Kshetri & Voas, 2017).

5.5. Case study: the collapse of Silicon Valley Bank

Established in 1983, Silicon Valley Bank (SVB) became a cornerstone in the financial sector, specifically serving high-growth sectors such as technology, innovation, life sciences, and venture capital. Based in Santa Clara, California, SVB was integral to the Silicon Valley ecosystem, supporting start-ups and emergent technology enterprises with critical financial services. Its role was not only to provide banking solutions, but also to foster the innovative processes that drive the tech industry forward (Smith & Walter, 2018).

Despite its initial success and pivotal role within the industry, SVB's eventual downfall was precipitated by a confluence of internal mismanagement and strategic misalignments. These issues, which culminated in a significant erosion of its operational integrity and financial stability, offer a stark illustration of the fragility of financial institutions under the strain of inadequate governance (Jones & Serrasqueiro, 2017).

The collapse of SVB sent shockwaves across the global financial landscape, underscoring the critical need for financial entities to recalibrate their risk management practices. It also highlighted the emergent challenges posed by social media, where rapid dissemination of information can exacerbate financial instability and influence public perception dramatically (Brown & Spencer, 2019).

This case study examines the systemic failures that led to the downfall of SVB, emphasizing the indispensable nature of robust risk management

frameworks and the implementation of effective governance structures. It also discusses the necessity of adapting to the digital age, where social media's role as a double-edged sword affecting reputational risk must be integrally managed within financial institutions' strategic planning (Edelman, 2020).

Analyzing the SVB collapse provides invaluable lessons for financial professionals, regulators, and academia. It reinforces the imperative for vigilance, transparency, and accountability to safeguard the stability and sustainability of financial institutions. Moreover, it serves as a clarion call for a proactive approach in navigating the complex and interconnected digital landscape that modern financial entities operate within (Schwarcz, 2021).

Conclusions

Neurofinance, while a nascent field within the academic landscape of finance, holds potential as a distinct discipline. Its emergence marks an evolution in understanding financial decision-making through a neuroscientific lens. Indeed, its empirical ascendancy signals a burgeoning interest in finance and behavioral economics. This chapter has conducted a comprehensive analysis of neurofinance, examining it from a theoretical perspective through an extensive literature review and from a multidisciplinary standpoint. Additionally, we have explored neurofinance from a practical viewpoint by analyzing specific case studies, which have provided empirical insights into the application of neuroscientific methods in understanding financial behaviors and decision-making processes.

Fundamentally, the enduring relevance of neurofinance hinges on its ability to enrich traditional financial theories. It serves as a bridge between classical financial principles and cutting-edge scientific insights, offering a multidimensional approach to understanding market behaviors and decision-making processes. As neurofinance continues to evolve, it is crucial to ensure that its innovative approaches enhance rather than overshadow the foundational tenets of finance. This includes maintaining a commitment to disciplinary rigor and prudential aspects inherent in the field.

The potential of neurofinance extends beyond academia, promising to revolutionize financial curricula and teaching methodologies. By integrating neuroscientific findings with financial theories, it offers a comprehensive framework to examine the neural correlates of economic behaviors, thereby enhancing both theoretical knowledge and practical decision-making skills. However, the boundaries between the visionary scope of neurofinance and its practical application remain fluid. The delineation between its perceived promise and its tangible benefits – between what might be considered 'fiction' and 'traction' – is critical. This balance ensures that while neurofinance attracts interest and

fosters new research avenues, it remains anchored in empirical validity and educational efficacy.

As this discourse unfolds, it is evident that the integration of neurofinance into financial scholarship and practice has profound implications. These extend from individual financial behaviors up to broader economic and regulatory frameworks. Thus, there is a clarion call to the academic community to monitor and shape the trajectory of neurofinance. This vigilance will maximize its value, both as a scholarly topic and as a methodological innovation, while safeguarding against the ephemeral trends that often distract from sustained academic inquiry and depth.

Ultimately, as we advocate for a sustained engagement with neurofinance, it is imperative to remain cognizant of the broader academic and cultural trends that influence its adoption and adaptation. Just as the waves of interest in blockchain and artificial intelligence have shown, academic foci can shift dramatically. In maintaining a critical, informed perspective, the academic community can ensure that neurofinance develops into a robust field that substantively contributes to our understanding of the complex interplay between the brain and economic behavior, rather than ebbing away as yet another fleeting academic trend.

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Behavioral asset allocation: from efficient to effective portfolios

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1. Loss aversion during economic crises

1.1. Results of a questionnaire[1]

Today's investors are called upon to make choices under conditions of great uncertainly and in a difficult environment. Throughout our lives, we must make decisions under conditions of uncertainty – i.e. before future outcomes are known. In order to make such decisions, a high degree of confidence in the available data is necessary. Nevertheless, each decision contains some degree of uncertainty that affects its outcome. Deciding to get married or to have a child; deciding which school or university to attend; booking a summer vacation or a ski trip: there are countless examples of "choices under conditions of uncertainty".

A specific and worrying type of uncertainty affects financial choices. We perceive investment choices as more uncertain than other decisions, since these choices have to do with "the market". By their very nature, markets set prices that vary day by day (or even hour by hour)! The fact that prices change every day contributes to our perception of finance as something quite particular; real estate does not give us the same impression. This has nothing to do with bricks and mortar (a company we have shares in is just as concrete), but with the fact that real estate prices do not change by the day.

We are emotionally invested in "money", but this does not make us greedy or mean. The fact is that our money contains our values, our sacrifices or those of our families. It represents a worry-free old age, the joy that our children give us, the achievement of important goals. We have an emotional connection to "money".

Our savings are very important. We save money because we have ambitious goals. Financial markets offer many opportunities, but also plenty of risks. Some

1 Bertelli R. (2017)

behaviors come naturally. We can defend ourselves from being excessively emotional and making mistakes by setting clear goals and not fretting over them. We often feel secure when we buy real estate, and we do not worry if prices drop this year. We have long-term goals and we tell ourselves that prices will bounce back. Real estate has long-term value, and this is reassuring.

But when we are dealing with stocks and mutual funds, it is very difficult for us to think in terms of value rather than price. We are under the impression that decisions need to be made quickly, urgently. When a sudden thunderstorm breaks out we must urgently seek shelter, otherwise we will get soaked. And what about when prices drop precipitously? We can calmly say that they will rise just as they have fallen. And our clothes stay perfectly dry. This is what experience teaches us.

Instead of looking at financial markets through our timeframe, we adapt to market timeframes. And the timeframes of financial markets are not "natural". The market is faster than we are, it is more global than we can possibly imagine. Certain market storms come from very far away and at a surprising speed – and they pass just as quickly. And we feel a little awkward when we rush to buy a raincoat, pay for it, and the sun is shining by the time we are back outside.

The timeframe necessary to assess the outcome of our decisions is usually much longer than financial market responses. When we move into a new house, buy a new car, or decide to study a foreign language; when our child decides which college to attend or gets married: these are all difficult choices, whose outcomes can only be evaluated in the long run.

Imagine that there are daily odds on your child finding a job after graduation. What would change in terms of which major to choose? If in the last year engineering gains 20% and medicine loses 35%, does this mean that by the end of her college career (in 5-6 years) your child will have an easier time finding a job if she chooses engineering? I think all of us would tell our children: "Your success does not depend on the major you choose, but on your commitment; and your commitment depends on you choosing something you like and that motivates you." We do not apply the same wisdom to financial choices.

In other words, a long-term outlook – OUR outlook, the one we use for the choices we make – does not seem to apply to financial markets. Is it a problem with finance, or is it **our** problem? Behavioral finance shows us that it is mostly our problem. Simply put, we do not know how to invest. Investors systematically make mistakes – in terms of reasoning and preferences – that are difficult to reconcile with rational choices. These mistakes are reflected in "behavioral anomalies" resulting in low participation in the stock market, perception errors regarding risk/revenue ratios, poor diversification, and excessive portfolio changes (Linciano, 2010).

In summary, we can say that it has been proven that we do not know how to invest successfully. We make mistakes in what we buy (stocks, bonds, funds), in when we buy and sell, in taking on risk (which can be unnecessary or indispensable), and in succumbing to performance anxiety (Barberis and Thaler, 2003). While this generally holds true, during times of market stress conditions can arise that lead to a change in our value system. Mister Hyde wins when we are under stress, and causes us to make mistakes that we acknowledge once we are back to being Doctor Jekyll (Ariely, 2010).

On behalf of *Il Sole – 24 Ore*, an Italian financial newspaper, I put together a simple questionnaire to assess attitudes towards financial investments. It was published during a time of market stress (20 February 2016), (Bertelli, 2016). It comprises five simple questions, and about 3,000 readers took part. The results are interesting, in part because *Il Sole*'s readers are far more competent than average nationals regarding financial matters, and keep constantly abreast of the evolution of the market. The questionnaire, which was published in the newspaper on a Saturday, was available online for a full week.

Unfortunately, it was not possible to collect information on the participants, other than they are readers of a financial newspaper, who took part in the questionnaire on a voluntary basis. Additionally, the questionnaire was published during a time of strong market volatility. Here are *Il Sole -24Ore*'s headlines:

– Wednesday 10/2/2016: "The crisis shakes up markets and interest rates. Milan stock exchange –3.2%",

– Friday 12/2/2016: "Stock markets and oil prices crash. Rising spread",[2]

– Saturday 13/2/2016: "Markets in the eye of the storm",

– Tuesday 15/2/2016: "Stock markets and bonds rise, led by banking and automotive sectors",

– Thursday 18/2/2016: "Stock markets and oil prices rally. Milan stock exchange up 2.5%".

The questionnaire contents and answers are summarized in the table at the end of this section. Here we comment on the answers provided by the majority.

– 44% of the sample subjects stated: "The destination of my savings (goals, timeframe of investment) is very clear to me and my investment choices do not depend on short-term market trends." In the face of losses of 20% from the beginning of 2016, 60% of the readers claimed they would not worry. Indeed "volatility of 20% is normal for the stock market. Perhaps it is an opportunity to buy."

2 The difference between the interest rate on ten-year Italian treasury bonds and ten-year German bonds. This is a measure of market stress closely watched by private investors in Italy, who together with Italian banks are among the main holders of Italian treasury bonds.

– 38% of the sample of readers replied that, when gauging the opportunities provided by high-yield bonds, they would ask their stock broker "whether the purchase of high-yield bonds is coherent with their investment goals and timeframe."

– 46% of the readers said that in the face of significant losses registered by a balanced fund during the first trimester of the year, "too little time has passed to evaluate the investment."

These were the most frequent responses. They are those of a perfect investor and financial planner, who is aware of risks and invests in accordance with set goals and timeframes. This is too good to be true. Perhaps readers of *Il Sole – 24 Ore* are not a representative sample of Italian investors. Leaving majorities aside, as they might be distorted by the nature of the sample, we can say that 56% of respondents do not have such clear ideas; 40% worry about short-term market trends; 62% do not consult their stock broker to assess risky investments; and 54% assess the results of a balanced fund too frequently. Nevertheless, the impression is that the average respondent is an investor who carefully evaluated his or her response, and in most cases behaves ideally.

I did put a trick question in the questionnaire, however, one of the classics of behavioral finance, namely loss aversion. Let us see how the knowledgeable readers of *Il Sole* responded to the stress of making choices under uncertain conditions, a (mysterious and worrying) coin toss. Here is the question:

Coin toss. Which alternative do you prefer?

– *1000 consecutive tosses. Heads I win 15 euros, tails I lose 10*

– *100 consecutive tosses. Heads I win 10 euros, tails I lose 5*

– *10 consecutive tosses. Heads I win 6 euros, tails I lose 1*

– *1 toss only. Heads I win 5 euros, tails I lose nothing*

Most of the 3,000 readers (to be exact, 48.85% of a sample of 3,014) answered: "1 toss only". It is all too clear why: it was the only alternative that ensured no losses. These 1,462 people literally threw away the 2,500 euros – more or less – they would have gained with the first option. Of course, this has an emotional cost, as winnings are not certain. Loss aversion translates into a feverish search for certainty, at any price.

By doing this, investors miss out on important opportunities. Why? Basically because there is a lack of trust, and this fuels fear under conditions of stress, even when fear is entirely groundless, as in this case, when the distribution of loss probabilities is largely intuitive. The law of small numbers prevails in the minds of many people, even when it is obvious that it is the law of large numbers that governs the phenomenon at hand. The likelihood of sustaining losses after 1,000 coin tosses is one out of an eleven-digit number (7 out of 100 billion to be exact). Within a 99% confidence interval we will

earn 1,581 euros. Is this really too much uncertainty for our weak hearts? Or is our mind playing tricks on us? The "second choice" was – predictably enough – 10 coin tosses (20.46% of the readers). Why was it predictable (Ariely, 2010)? Because in behavioral finance losses count twice as much as earnings (Pompian, 2006). And earning 6 euros while risking losing one seems reasonable. "It's worth it."

In summary, 70% of the readers of a financial newspaper fell into the loss aversion trap in a context in which this cognitive attitude is entirely groundless. In addition, most of these people have clearly proven they have a rational approach to the other issues in the questionnaire. Doctor Jekyll and Mister Hyde is indeed an appropriate metaphor. When faced with the same question, my mother, who was a youthful 86 years old, answered c): better to win 6 and lose 1. Then, over the phone she told me: "I know, I was wrong, I should have picked 1,000 coin tosses." "Mom," I replied. "It's only a matter of timeframe." I know I can kid around with my mother …

Table 1. Questionnaire results

ARE YOU SURE YOU KNOW HOW TO INVEST
(AND NOT LOSE YOUR MONEY?)

Question	Number of answers	%
1) Which of the following statements do you most agree with?		
a. I do not have a precise timeframe for investment. I prefer to be free to decide on the basis of market trends.	464	15.45
b. The destination of my savings (goals, investment timeframe) is very clear to me, but I prefer to make my investment choices (stocks and funds) on the basis of market trends.	511	17.01
c. The destination of my savings (goals, investment timeframe) is very clear to me, but my investment choices do not depend on short-term market trends.	1336	44.48
d. I prefer short-term investments that minimize risk and aim to achieve earnings (avoiding losses).	692	23.04
2) At the beginning of 2015 you invested 100,000 euros in a stock market fund. Since early 2016 it has lost 20%. Which of the following statements do you most agree with?		
a. I am not worried. Volatility of 20% is normal in the stock market. Perhaps it is an opportunity to buy.	1809	60.24
b. I am worried. I wish I had not invested in that fund. I let my broker convince me, and now (I knew it) I am losing money. I won't sell, but from now on no more stocks.	501	16.68

Table 1. cont'd

Question	Number of answers	%
c. I am emotionally affected by the volatility of stock markets. I figured I would have earned something. It is not the right solution for me. As soon as the market rallies a bit, I will sell. I do not want to be trapped by stocks like in 2007, when I bought bank stock and lost 70%.	426	14.18
d. I am thrilled; market crashes like this one are always great opportunities to buy. I have seen 'sale' prices for certain stocks: I will sell my fund and rush to buy stocks.	270	8.99
3) Coin toss. Which of the following alternatives do you prefer?		
a. 1000 consecutive tosses. Heads I win 15 euros, tails I lose 10.	670	22.31
b. 100 consecutive tosses. Heads I win 10 euros, tails I lose 5.	258	8.59
c. 10 consecutive tosses. Heads I win 6 euros, tails I lose 1.	619	20.61
d. 1 toss only. Heads I win 5 euros, tails I lose nothing.	1467	48.85
4. An expert I trust told me it is a good time to buy high-yield bonds. She told me it is a risky investment. Why of the following alternatives do I most agree with?		
a. I look for a good bond to invest in, while seeking all necessary information.	706	23.51
b. I do not trust high-yield bonds since I don't know what they are	690	22.97
c. I ask the expert if buying high-yield bonds is in keeping with my investment goals and timeframe.	1168	38.89
d. I ask the expert what the return is on a high-yield bond, so I can decide based on the numbers.	454	15.12
5) I invested 100,000 euros in a balanced fund at the beginning of the year, once the treasury bonds in my portfolio expired (I did not renew them). At the end of the year I have about 115,000 euros. At the end of the first trimester of the following year, after some market turmoil, my fund is now worth 105,000 euros. Which of the following statements do I most agree with?		
a. I am losing 10,000 euros, I am not satisfied	336	11.19
b. I am earning 5,000 euros, I am not satisfied.	425	14.15
c. I am earning 5,000 euros, I am satisfied.	853	28.41
d. Too little time has passed to evaluate the investment	1411	46.99

Source: Il Sole 24 Ore and author's own elaboration

1.2. A problem of value perception

I want to analyze the results of the questionnaire in light of some key conclusions of Kahneman, regarding the way we "perceive" value when we "see" (in a WYSIATI logic) potential gains and losses.

The theme is that of extended framing or narrow framing. Our example of a coin toss can be represented as follows:

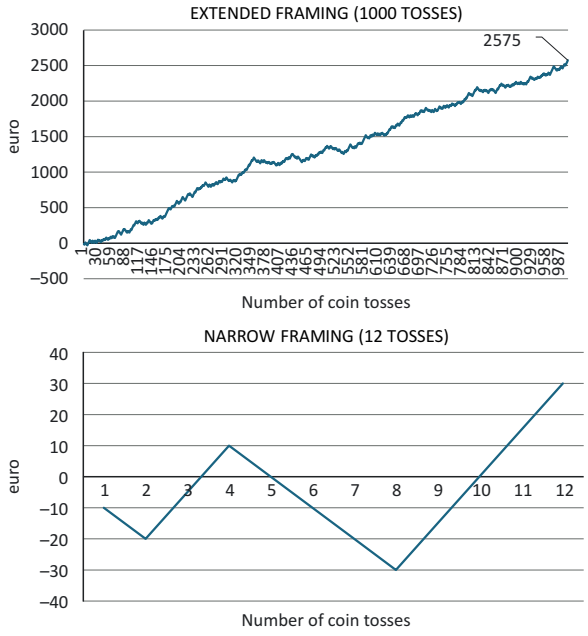

Figure 1. Narrow Framing and Extended Framing
Source: author's own elaborations.

The "perceived" value after 1000 coin tosses, certainly random but always positive (with a very high confidence interval) and of significant amount, is completely different from the perceived value after 12 coin tosses (the lower graph is simply a zoom on the first twelve events in the upper one).

The frequent observation of the results of an investment (or a game) undoubtedly favours an approach of "narrow framing" compared to that based on a "broad framing." Associating this tendency with "loss aversion" (where losses count twice as much as gains to our minds), we arrive at the analysis that Kahneman proposes for Samuelson's problem: "It is known that Paul Samuelson (…) once asked a friend if he would be willing to make a bet, by flipping a coin, in which he could lose 100 *or win* 200. The friend replied: 'I do not wish to bet, because losing 100 *would hurt me more than winning* 200 would please me. But I will if you promise to let me make a hundred such bets.'"

The "broad framing" is a solution that allows us to see the benefits of risky options that conceal from our eyes a risk premium, which is clearly present.

Kahneman draws these provocative conclusions: "The combination of loss aversion and narrow framing is a costly trap. Individual investors can avoid this trap (…) by reducing how often they check on the performance of their investment. Following daily fluctuations closely is a losing idea, because the pain of small frequent losses outweighs the pleasure of equally frequent small gains. Once a quarter may be more than sufficient for individual investors." Furthermore, he adds shortly after: "A commitment to not change one's position for long periods (the equivalent of holding onto an investment) enhances financial performance."

1.3. Il VALUE TEST

Nathan Novemsky and Daniel Kahneman find that, consistent with prospect theory, loss aversion provides a complete account of risk aversion for risks with equal probability to win or lose (Kahneman and Novemsky, 2005). The "loss aversion ratio" is in the range of 1.5 to 2.5 (Kahneman, 2011).[3]

Consider the following example:

T	50%	15
C	50%	–10

TT	25%	30
TC	25%	5
CT	25%	5
CC	25%	–20

TTT	12.50%	45
TTC	12.50%	20
CTT	12.50%	20
TCT	12.50%	20
TCC	12.50%	–5
CTC	12.50%	–5
CCT	12.50%	–5
CCC	12.50%	–30

TTTT	6.25%	60
TTTC	6.25%	35
TTCT	6.25%	35
TCTT	6.25%	35
CTTT	6.25%	35
TTCC	6.25%	10
TCTC	6.25%	10
CTCT	6.25%	10
CCTT	6.25%	10
CTTC	6.25%	10
TCCT	6.25%	10
CCCT	6.25%	–15
CCTC	6.25%	–15
CTCC	6.25%	–15
TCCC	6.25%	–15
CCCC	6.25%	–40

Figure 2. Coin tosses: distribution of results
Source: author's own elaboration

In the example, the coin toss (narrow framing) is repeated 2, 3, 4 times (framing extension). What are the effects on the "perceived value"?

3 See Chapter 26 and the application on Chapter 31 "Risk Policies".

With a loss aversion ratio (LSA) of 2, the following results are obtained:

LOSS AVERSION RATIO	2

T	50%	15
C	50%	–10

TT	25%	30	#
TC	25%	5	0
CT	25%	5	0
CC	25%	–20	#

TTT	12.5%	45	
TTC	12.5%	20	20
CTT	12.5%	20	20
TCT	12.5%	20	20
TCC	12.5%	–5	20
CTC	12.5%	–5	20
CCT	12.5%	–5	20
CCC	12.5%	–30	##

TTTT	6.25%	60
TTTC	6.25%	35
TTCT	6.25%	35
TCTT	6.25%	35
CTTT	6.25%	35
TTCC	6.25%	10
TCTC	6.25%	10
CTCT	6.25%	10
CCTT	6.25%	10
CTTC	6.25%	10
TCCT	6.25%	10
CCCT	6.25%	–15
CCTC	6.25%	–15
CTCC	6.25%	–15
TCCC	6.25%	–15
CCCC	6.25%	–40

EXPECTED RETURN	**2.50**	**5.00**	**7.50**	**10**
PERCEIVED RETURN	**–2.50**	**0.00**	**1.88**	**3.75**
GAINS	**15.00**	**40.00**	**105.00**	260
PERCEIVED LOSSES	**20.00**	**40.00**	**90.00**	200
VALUE TEST	**0.75**	**1.00**	**1.17**	**1.30**

MEAN	2.5	MEAN	5.00	MEAN	7.50	MEAN	10.00
ST.DEV	12.5	ST.DEV	17.68	ST.DEV	21.65	ST.DEV	25.00

Figure 3. Coin tosses: distribution of results and Value Test
Source: author's own elaboration

In the example, we can appreciate the difference between the expected return and the "perceived return," where losses are multiplied by two. The table also shows the standard deviations of the 4 alternatives.

The simple test we propose is the ratio between perceived gains and perceived losses. For example, in the case of 4 coin tosses, it is 260/200 = 1.3.

As can be seen, as the number of coin tosses increases, the perceived value increases, too.

I have realized a simple «Value Test» freely based on the Kahneman examples, transforming the multiple coin tosses (extended framing) in an equivalent (mean variance) one coin toss (narrow framing).

The Value Test is the Gain/Loss Perceived Ratio.

Given Mean (*m*) and Standard Deviation (*s*) we can determine an «equivalent» coin toss.

For example, if

m = 10

s = 25

Gain (50% probability) = 35

Loss (50% probability) = -15

The Value Test is Gain/(-LSA*Loss), where LSA = Loss Aversion Ratio

The simple relation is 50% probability gain [1] G = m+s[(1-p)/p)^0.5] and 50% probability loss [2] L=(m-pG)/(1-p), where p is the probability (50% in this case).

2. Performance and risk perception under prospect theory

2.1. The S&P 500 example

2.1.1. Weekly data

Given the weekly returns of the S&P 500 from 31/5/2013 to 19/5/2023, let us calculate the mean and standard deviation of the historical series and the probability of having positive weekly results (as the ratio between positive or null cases and total cases) and negative weekly results. Using [1] and [2], we determine G and L that explain the mean and standard deviation. We then transform the result into an equivalent "coin toss", still using [1] and [2].

As can be seen from Table 2, the weekly S&P 500 data "equates" to a coin toss of +2.51% and -2.09%.

With these data, it is possible to construct the VALUE TEST proposed (assuming a loss aversion ratio of 2) as a simple ratio between 2.51% and twice 2.09% = 0.6. This means that the perceived value by an investor in the S&P 500 over the ten years used as an example is negative, as the gains do not adequately compensate for the losses. Note that the annualized average return over the period was 10.83% (geometric mean of 9.90%) with an annualized standard deviation of 16.58%.

With the sole purpose of visualizing the investor's perception, we reconstructed the actual and perceived performance of the index. The perceived index was

Table 2. S&P 500 Weekly Mean, variance and coin toss

	Mean	0.2084%
	St. Dev.	2.2992%
prob +	57.9%	2.17%
prob –	42.1%	–2.49%
	Mean	0.2084%
	St. Dev.	2.2992%
	50%	**2.51%**
	50%	**–2.09%**
	Mean	0.2084%
	St. Dev.	2.2992%

Source: author's own elaboration.

constructed very simply by multiplying the negative weekly returns by two. In this way, the cognitive effects of loss aversion were emphasized instrumentally.

Given the "manipulated" historical series S&P PERC, it is possible to present the perceived mean and standard deviation. This is a mere quantitative representation of a qualitative concept, which will be useful later on. The comparison between actual and perceived mean and standard deviation on the weekly data is as follows:

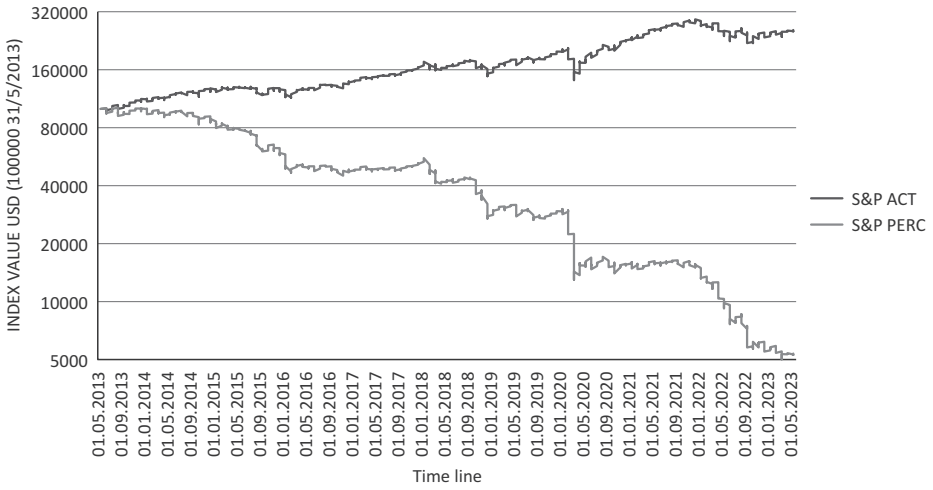

Figure 4. Weekly S&P 500 actual and perceived quotes (2013-2023)
Source: author's own elaboration.

Table 3. Mean Variance actual and perceived

	ACT	PERC
Mean	0.084%	**–0.49%**
St. Dev.	2.2992%	**3.61%**

Source: author's own elaboration

2.1.2. Monthly data

To experiment with the extension of the observation frame, we propose applying the same methodology from the previous section to the same historical series, but using monthly returns (from 31/5/2013 to 30/4/2023). We expect that by extending the framing, the perceived value will increase. The results are presented in Table 4.

Table 4. S&P 500 Monthly Mean, variance and coin toss

	media	0.8841%
	dev.st	4.2982%
prob +	66.4%	3.94%
prob –	33.6%	–5.16%
	media	0.8841%
	dev. St	4.2982%
	50%	**5.18%**
	50%	**–3.41%**
	media	0.8841%
	dev.st	4.2982%

Source: author's own elaboration

It is thus possible to apply the VALUE TEST by taking the ratio between 5.18% and twice 3.41%. The result is 0.76%, which is better than the case of weekly returns but still less than 1.

Please note that the switch from weekly returns to monthly returns implies that the investor evaluates the investment (or "sees" the investment return) less frequently. WYSIATI. If one aims to create a visualization similar to the one proposed in the previous paragraph, a trend can be noticed that highlights the enhancement of perception.

The comparison between actual and perceived mean and standard deviation is as follows:

Table 5. Mean Variance actual and perceived

	ACT	PERC
media	0.8841%	**–0.38%**
dev.st	4.2982%	**6.55%**

Source: author's own elaboration

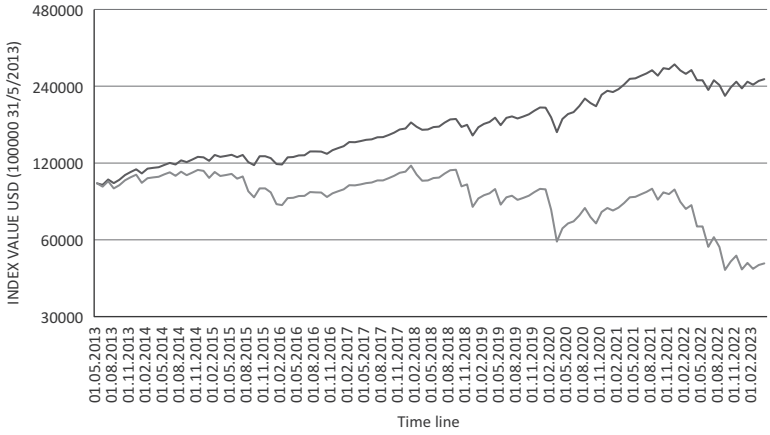

Figure 5. Monthly S&P 500 actual and perceived quotes (2013-2023)
Source: author's own elaboration.

2.1.3. Yearly data

To complete this exercise, we also quickly present the results on annual returns (from 31/5/2013 to 31/5/2023). Naturally, the effect is as expected, and

Table 6. S&P 500 Yearly Mean, variance and coin toss

	media	10.2526%
	dev.st	12.0490%
prob +	70.0%	18.14%
prob –	30.0%	–8.15%
	media	10.2526%
	dev. St	12.0490%
	50%	**22.30%**
	50%	**–1.80%**
	media	10.2526%
	dev.st	12.0490%

Source: author's own elaboration.

the VALUE TEST is highly positive (partly due to the random choice of the annual observation period of returns), amounting to 6.21. The data from the exercise are summarized in the following table.

3. Efficient portfolios vs. effective portfolios

3.1. Application of the value test to some financial markets

Using the methodology presented in the previous section, for the same time frame with monthly intervals, we analysed several monetary and bond indices. The objective is to construct an effective and "perceived" risk-return map, on the basis of which portfolios with different levels of risk (both actual and perceived) can be constructed. The actual construction of the portfolio will be discussed in the next section.

The indices used are as follows:

EMUCASH: JPM Cash EUR 3M (EUR) – TRI (Total Return Index) [source: Exact, Analysis]

BD02Y: BD Benchmark 2 Year DS Govt. Index – Total Return Index [source: Datastream]

BD05Y: BD Benchmark 5 Year DS Govt. Index – Total Return Index [source: Datastream]

BD10Y: BD Benchmark 10 Year DS Govt. Index – Total Return Index [source: Datastream]

US02Y: US Benchmark 2 Year DS Govt. Index – Total Return Index [source: Datastream]

US05Y: US Benchmark 5 Year DS Govt. Index – Total Return Index [source: Datastream]

US10Y: US Benchmark 10 Year DS Govt. Index – Total Return Index [source: Datastream]

EMUCORP: ER00.ML-ICE BofAML EMU Corporate Index (EUR) – TRI [source: ICE]

HYUSA: H0A0.ML-ICE BofAML US High Yield Master II Index (USD) – TRI [source: ICE]

These indices are representative of different sources of risk and can succinctly and approximately depict typical asset classes of a portfolio. Given the goal of this work is to present a method of analysis rather than concrete results and applications, we deemed it sufficient to limit ourselves to these data.

The results obtained are summarized in Table 7:

During the examined period with a monthly observation frequency (WYSIATI), higher volatility and lower returns were perceived compared to the actual data. It is interesting to note that all perceived returns are negative.

Table 7. Financial Markets actual and perceived volatility and returns

	ACTUAL		PERCEIVED		
	VOLA	RETURN	VOLA	RETURN	VALUE TEST
SP500	14.89%	10.61%	22.7%	–4.54%	0.76
US10Y	6.93%	1.57%	10.3%	–6.58%	0.57
US05Y	3.83%	1.04%	5.7%	–3.30%	0.59
US02Y	1.35%	0.81%	1.9%	–0.29%	0.71
BD10Y	6.51%	0.88%	10.1%	–7.51%	0.54
BD05Y	3.05%	–0.28%	5.0%	–4.20%	0.47
BD02Y	0.89%	–0.59%	1.5%	–1.89%	0.34
HYUSA	7.59%	4.24%	12.1%	–2.79%	0.69
EMUCORP	4.68%	1.01%	7.7%	–3.84%	0.57
EMUCASH	0.17%	–0.06%	0.2%	–0.30%	0.40

Source: author's own elaboration.

We calculated the VALUE TEST by transforming each asset class into an equivalent coin toss, following the procedure indicated in sub-section 2.3. All the values are below one. This result can be interpreted as a potential and generalized degree of investor dissatisfaction with financial investment, as it is perceived as not capable of producing satisfactory results.

Figure 6 shows the actual and perceived risk-return map. It represents the overall perception of value in terms of risk and return, clearly indicating the loss of one of the fundamental narratives that drive financial investment: higher risk corresponds to higher expected return.

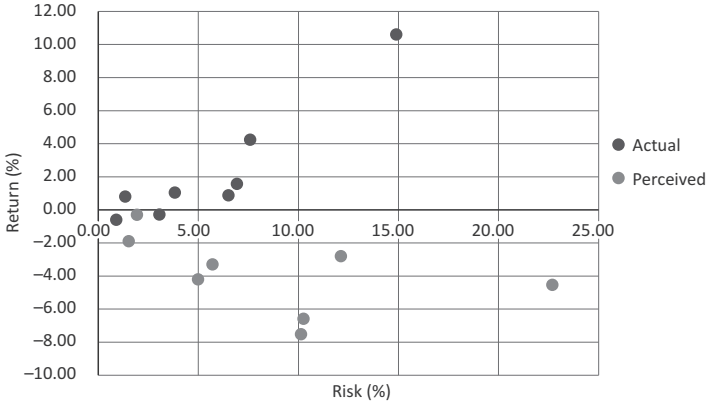

Figure 6. Risk and Reurn Map (Actual and Perceived)
Source: author's own elaboration.

3.2. Actual efficient frontier and "perceived frontier"

Based on the data presented in the previous subsection, we have constructed efficient (historical, of course) portfolios with varying degrees of risk. The objective is to demonstrate that the perception of value improves when considering not the individual asset class (narrow framing) but the entire portfolio (broad framing). This is somewhat expected, given that we seek the best actual risk-return combination, which should result in a lower tendency to produce periodic negative returns.

However, the outcome of this simple exercise allows for further reflections. Considering the variance-covariance matrix of the individual asset classes (constructed from actual data), it becomes straightforward to build "optimal" portfolios for each risk level. We did not focus on the actual degree of diversification of the portfolio (just by looking at the data in Table 4, one can infer the characteristics of the corresponding efficient portfolio).

Using the asset classes described in Subsection 3.1, we constructed 5 portfolios: PTF_V1 (annualized volatility 1%); PTF_V3 (annualized volatility 3%); PTF_V5 (annualized volatility 5%); PTF_V7 (annualized volatility 7%); PTF_V10 (annualized volatility 10%).

Once the five "optimal" portfolios (maximum return given the volatility) had been constructed, we conducted the analyses according to the previously described approach. Table 8 summarizes the results achieved, compared with the individual asset classes.

Traditional portfolio optimization appreciably enhances the value of the VALUE TEST. However, the increase in volatility, considering the Loss Aversion Ratio (LSA) of 2, leads to VALUE TEST values that decrease as risk increases. Furthermore, consistently, as risk increases, the perceived return tends to decrease.

Representing the five portfolios on an efficient frontier (obtained through mere interpolation) clearly reveals the distance between the actual value and the perceived value of the portfolios (Figure 7).

One of the theoretically most consistent and robust assertions in the ex-ante construction of asset allocation – the expected risk-return relationship – poses significant perceptual challenges ex-post to investors, even when the hypothesized ex-ante relationship is actually realized ex-post. In other words, the value attributed to the strategic asset allocation phase of the investment is distorted in the eyes of the investor, generating perceptions of value loss and practical inefficiencies.

If we chart the performance of the five portfolios over the analyzed period, the correct (and obvious, ex post) risk-return relationship becomes entirely evident (Figure 8).

Table 8. Actual and Perceived Efficient Portfolios

	ACTUAL		PERCEIVED		
	VOLA	RETURN	VOLA	RETURN	VALUE TEST
SP500	14.89%	10.61%	22.7%	–4.54%	0.76
US10Y	6.93%	1.57%	10.3%	–6.58%	0.57
US05Y	3.83%	1.04%	5.7%	–3.30%	0.59
US02Y	1.35%	0.81%	1.9%	–0.29%	0.71
BD10Y	6.51%	0.88%	10.1%	–7.51%	0.54
BD05Y	3.05%	–0.28%	5.0%	–4.20%	0.47
BD02Y	0.89%	–0.59%	1.5%	–1.89%	0.34
HYUSA	7.59%	4.24%	12.1%	–2.79%	0.69
EMUCORP	4.68%	1.01%	7.7%	–3.84%	0.57
EMUCASH	0.17%	–0.06%	0.2%	–0.30%	0.40
PTF_V1	**1.00%**	**0.93%**	**1.5%**	**0.10%**	**0.87**
PTF_V3	**3.00%**	**2.70%**	**4.5%**	**–0.16%**	**0.85**
PTF_V5	**5.00%**	**4.10%**	**7.5%**	**–0.82%**	**0.81**
PTF_V7	**7.00%**	**5.47%**	**10.6%**	**–1.51%**	**0.79**
PTF_V10	**10.00%**	**7.51%**	**15.2%**	**–2.54%**	**0.78**

Source: author's own elaboration.

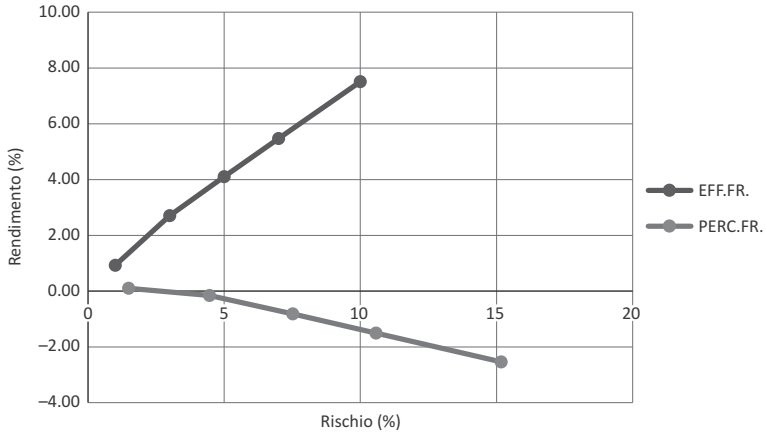

Figure 7. Efficient and Perceived Frontier
Source: author's own elaboration.

However, in terms of perception, this apparent elegance, order, and theoretical coherence often translate into a highly distorted view. Here, values are not correctly ordered, and portfolios appear confused and disordered (Figure 9).

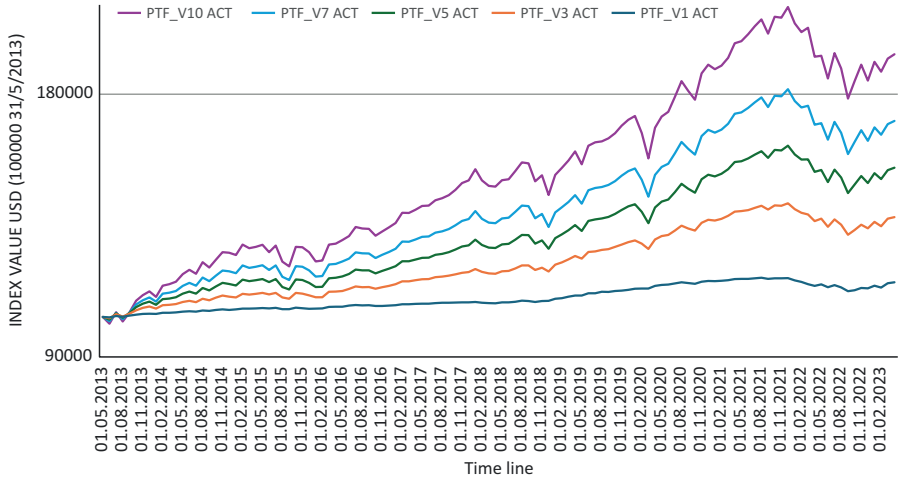

Figure 8. Efficient portfolios: actual path since 2013
Source: author's own elaboration.

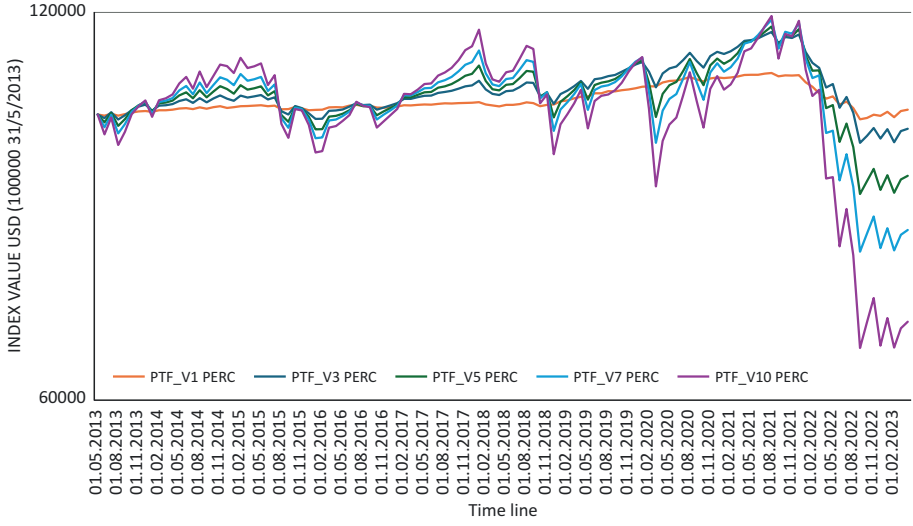

Figure 9. Efficient portfolios: perceived path since 2013
Source: author's own elaboration.

It is obviously not easy to find a technical solution to a psychological-cognitive problem. Daniel Kahneman, with his concept of "what you see is all there is" (WYSIATI), suggests minimizing the frequency of periodic observation of investment results. This approach forces the investor to adopt a broader framing, reducing the impact of myopic decision-making.

As we have seen from our earlier exercise, extending the observation horizon significantly improves the VALUE TEST outcome.

3.3. Dynamic Asset Allocation and value perception

The question we want to address now is: given the same temporal framing for observation, can appropriate dynamic portfolio activities lead to an increased perceived value?

Intuitively, the answer is positive. Activities that manage to reduce drawdown phenomena undoubtedly create a perceived value, even if they do not add any actual value to the portfolio. In this sense, there is a conflict between the efficiency and (behavioral) effectiveness of asset allocation and portfolio management.

This is not the setting to propose concrete models of active portfolio management. The provocation we put forth is to evaluate these models not only (and perhaps not even primarily) in terms of theoretical financial efficiency, measured by various risk-adjusted performance indicators, but also in terms of their effectiveness in enhancing the investor's perception of value.

To provide an idea of a different evaluation perspective, we conducted a Monte Carlo simulation that assigns a defined probability of success each month in predicting the next month's performance of the stock index (S&P 500 in our example). If the prediction is successful, the investment realizes the higher of zero and the index performance (simulating a cash allocation in the case of negative returns). If the prediction is unsuccessful, the investment realizes the lower of zero and the index performance.

Thus, a management strategy is constructed with a certain probability of reducing negative volatility, resulting in significant benefits to the perceived value, considering the typical LSA (loss aversion ratio). To moderate the increase in performance due to the high probability of success in reducing negative events, the index performance is arbitrarily adjusted by a factor of 0.85. In this way, when the index rises and the prediction is correct, only 85% of the performance is accounted for. This parameter value was calibrated to achieve an average return of the simulated strategy equal to that of the stock index. The monthly success probability of the prediction was set at 70%. This is a high value, warranting caution. For our descriptive and provocative purposes, we considered it reasonable to maintain this level.

The results are summarized in Table 6. The table presents all the data already discussed in Table 9, along with the results of the Monte Carlo simulation.

The simulation (DAASP500) achieved a return of 10.66% (equal to that of the index over the period). The volatility is much lower (9.33% versus 14.89%), but

it is crucial to note that the simulated portfolio is not fully invested throughout the entire period, tactically alternating between S&P 500 and Cash (zero yield).

In purely financial terms, the efficiency of the dynamic allocation is clearly much higher (and expected, given the initial assumptions) compared to full investment in the index.

The interesting part is the "perceived" aspect. By reducing drawdown phenomena (with a good probability of success), the "perceived" return is positive (the only case in Table 9) and much higher than that perceived from the index. The VALUE TEST exceeds the unitary threshold, indicating a substantial improvement in the perceived value through dynamic portfolio management.

Table 9. Dynamic Asset Allocation Simulation: Value Test

		ACTUAL		PERCEIVED		
		VOLA	RETURN	VOLA	RETURN	VALUE TEST
	SP500	14.89%	10.61%	22.7%	-4.54%	0.76
	US10Y	6.93%	1.57%	10.3%	-6.58%	0.57
	US05Y	3.83%	1.04%	5.7%	-3.30%	0.59
	US02Y	1.35%	0.81%	1.9%	-0.29%	0.71
	BD10Y	6.51%	0.88%	10.1%	-7.51%	0.54
	BD05Y	3.05%	-0.28%	5.0%	-4.20%	0.47
	BD02Y	0.89%	-0.59%	1.5%	-1.89%	0.34
	HYUSA	7.59%	4.24%	12.1%	-2.79%	0.69
	EMUCORP	4.68%	1.01%	7.7%	-3.84%	0.57
	EMUCASH	0.17%	-0.06%	0.2%	-0.30%	0.40
	PTF_V1	**1.00%**	**0.93%**	**1.5%**	**0.10%**	**0.87**
	PTF_V3	**3.00%**	**2.70%**	**4.5%**	**-0.16%**	**0.85**
	PTF_V5	**5.00%**	**4.10%**	**7.5%**	**-0.82%**	**0.81**
	PTF_V7	**7.00%**	**5.47%**	**10.6%**	**-1.51%**	**0.79**
SIMU	**PTF_V10**	**10.00%**	**7.51%**	**15.2%**	**-2.54%**	**0,78**
10000	**DAASP500**	**9.33%**	**10.66%**	**13.3%**	**5.99%**	**1.03**
PROB						
70%						
RETURN						
85%						

Source: author's own elaboration.

In our judgment, the results of this provocative exercise compel a revaluation of traditional strategic asset allocation policies.

4. Concluding considerations

"What you see is all there is" (WYSIATI), as Daniel Kahneman frequently reminds us. In financial markets, investors are "forced" to see many things. Some of these things are better left unseen, as they lead to poor and shortsighted decisions, reducing both well-being and wealth. Observing prices often results in reasoning that is systematically framed narrowly, leading to a refusal to take risks that would result in higher returns over time and consequently a loss of well-being. The solution proposed by the cognitive psychologist is to reduce the frequency of portfolio value observations and to "lock in" a portion of the investment. This forces an expansion of the framing and the acceptance of favourable choices that might not appear so under a narrow framing.

We have proposed a simple method to "transform" any financial investment with a known mean and variance into an equivalent "coin toss." The "coin toss" effectively synthesizes the investor's perception of value (or lack thereof). When the positive returns in the case of "heads" are appropriately balanced by the negative returns in the case of "tails," the investor is willing to accept the opportunity.

On this basis, we have proposed a very simple VALUE TEST, which can be constructed given the mean and variance data. The fundamental cognitive psychological parameter is the Loss Aversion Ratio, set at 2 (losses count twice as much as gains). The rest of our work was merely an exercise in applying this concept to different markets, portfolios, and efficient portfolios over a ten-year period with monthly frequency. The objective was to find a way to quantify and visualize (and thereby perceive) the difference between the actual and perceived value by the investor.

This exercise allowed us to understand that the perceived value of an efficient financial portfolio by an investor is very low. The risk-return relationship is called into question. The ranking of portfolios is inverted: higher risk corresponds to a lower perceived value.

Given the structure of the exercise, it is easy to notice that these results do not depend on the chosen time period but on the cognitive distortion with which the results are systematically evaluated. Of course, changing the observation period will alter the numerical results, but the perceived ranking will remain the same. Consider, for instance, the perception of low value of an investment in the S&P 500 index, which has grown by over 10% annualized with an annualized volatility of 14%.

Aside from the drastic solution proposed by the cognitive psychologist – locking in the investment and not periodically checking the results – is there any alternative in constructing asset allocation for the investor?

Certainly, it is necessary to shift the focus from efficiency to effectiveness in the solution. By effectiveness, we mean the ability of a portfolio to be perceived as having a positive value by the investor when it indeed possesses one. This should not be achieved by seeking an impossible extra-efficiency. Or at least this is the aspiration. Because if the solution were to involve creating impossible portfolios, it would not be a viable solution. And we would ultimately have no choice but to turn to the psychologist.

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