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Enhancing financial literacy in South Korea: Integrating AI and data visualization to understand financial instruments' interdependencies

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ABSTRACT

In South Korea, the lack of understanding of financial products has emerged as a significant challenge, contributing to a gap in financial literacy. This research proposes a novel approach to bridge this gap by employing statistical interdependence and explainable AI (xAI) to enhance comprehension of the interconnectedness of economic variables. By translating complex financial information into intuitive visual formats, the methodology empowers individuals to make informed decisions. Collaborations with South Korean financial institutions ensure alignment with local practices and regulations. Preliminary testing indicates promising results in improving financial literacy, mainly related to financial products. The study offers valuable insights for addressing financial literacy challenges in South Korea and potentially beyond, emphasizing the role of technology and collaboration in fostering financial understanding and economic stability. It sets the stage for future research and policy interventions to enhance financial literacy in a technologically advanced society.

1. Social impact

1.1. Global context and significance of financial literacy

Financial literacy, essential for individual and societal well-being, involves understanding and effectively using key financial skills such as budgeting, investing, and personal financial management [1]. It plays a significant role in promoting individual financial health and can contribute to broader economic stability and growth [2].

Globally, financial literacy levels vary. Developed nations like the United States, Canada, and the United Kingdom have integrated financial education into their education systems. However, disparities remain due to factors like income, age, and education level. Emerging economies are working to extend financial literacy, particularly in underserved areas, focusing on improving access to and comprehension of financial services [3].

Our research aims to enhance financial literacy through innovative methods, including data visualization and AI. While initial results are promising, indicating that these tools can help demystify complex financial concepts, it is essential to note that these findings are preliminary. Our work is ongoing, and we are committed to rigorously testing and refining our approaches to understand their effectiveness in improving financial literacy.

1.2. South Korea's unique financial literacy landscape

Despite its global reputation as a technologically advanced and economically progressive nation, South Korea presents a paradoxical scenario when it comes to financial literacy. Recent surveys have unveiled a worrying gap in understanding essential financial concepts among its citizens, particularly among the younger and older age groups. This discrepancy isn't just academic; it extends to practical knowledge of financial products, from basic savings accounts to more advanced instruments like investments and insurance [4-7].

South Korea's financial ecosystem, rich in intricate financial products, serves as both a boon and a challenge. While they provide diverse options for consumers, the sheer complexity can often be daunting, especially for ordinary citizens. This intricacy could lead to uninformed financial decisions with broader societal repercussions – such as diminished economic engagement and an elevated risk of falling prey to financial deceptions.

Efforts are undeniably underway to bridge this gap. Various organizations within South Korea are earnestly working to uplift the financial literacy levels of the population. Collaborative efforts with financial institutions ensure that the financial education dispensed aligns with real-world financial practices. Still, the path isn't without its hurdles – creating tailored educational content and battling deep-rooted cultural

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perceptions about money and investments remain significant challenges [4-7].

In summarizing the landscape, South Korea's modern infrastructure and developed economy paints a complex picture of the challenges and opportunities in fostering financial literacy. Its experience offers invaluable insights, not just for its future trajectory but also for the global community, emphasizing the profound societal implications of financial literacy.

1.3. Indicators behind Korea's financial literacy

One must delve into the empirical data to understand South Korea's financial literacy conundrum further. Since 2012, the Bank of Korea and the Financial Supervisory Service, in alignment with the OECD's International Network on Financial Education (INFE) methodology, have biennially surveyed South Koreans aged 18–79. This study, an extension of our prior research, closely examines the data from 2016 to 2022, paralleling the updates in the OECD's "International Survey of Adult Financial Literacy" [4-7].

From 2016–2022, South Korea's financial knowledge scores fluctuated. In 2016, the score was marginally above the OECD average but below the INFE minimum target, with a strong understanding of diversified investment but a notable weakness in compound interest and principal calculations.

Especially, the 2018 survey revealed that overall financial knowledge in South Korea fell below the OECD average recorded in 2015.

Despite significant progress, enhancing overall financial literacy remains a challenging endeavor. This challenge is most apparent in the practical aspects, such as performing financial calculations, understanding the subtleties of compound interest, and effectively managing complex financial products, including equity portfolios and mutual funds.

The enduring gap between theoretical knowledge and practical application is concerning. While many South Koreans seem financially literate in theory, real-world application, particularly in managing specific financial products and understanding their dynamics, proves challenging for particular demographics and socio-economic backgrounds.

To address these challenges, our ongoing research employs visual tools to demystify complex financial concepts to achieve wider comprehension and inclusivity. As the data suggests, there is a pressing need for innovative, intuitive financial education strategies. Visual aids could serve as the bridge between intricate financial relationships and their genuine understanding. By simplifying these concepts into tangible visual representations, we hope to enhance financial literacy for South Koreans, ensuring they are better equipped to manage financial products effectively.

2. Methodology

In our study on enhancing financial literacy in South Korea, our methodology encompasses a multifaceted approach integrating various cutting-edge techniques to decipher the financial product intricacies. Our approach is described below:

2.1. Statistical dependence analysis with time series data

Our analysis examines financial products' intrinsic and lagged time series data. We use a set of statistical measures, namely Pearson, Spearman, and Kendall correlation coefficients, complemented by the mutual information measure. This choice of measures ensures we capture both linear and non-linear dependencies in the data. Our focus here is to track the fluctuations in the prices or returns of these financial products over time. Such a comprehensive approach provides a multi-dimensional view of the financial landscape, enhancing our ability to predict market movements. The recent work by Millington and Niranjan (2021) [8] supports the potency of this approach in understanding market dynamics.

2.2. Visualization techniques

In our endeavor to simplify the complex interplay of relationships among financial products, we turn to data visualization. Leveraging state-of-the-art tools, we create intricate network diagrams. These diagrams translate quantitative data into visual patterns, making it easier for stakeholders to comprehend the intricate web of relationships quickly. This, in turn, allows for swifter and more informed decision-making processes, aligning with the findings of Kumar et al. [9].

2.3. Machine learning for pricing estimation

The constantly shifting sands of the financial world necessitate predictive models that can adapt and forecast future trends. To meet this demand, we employ machine learning models that are rooted in historical data but can also decipher current market trends. These algorithms are designed to estimate potential price trajectories of various financial products and their associated risks. As new data streams in, we continuously fine-tune these models, ensuring their future estimations remain precise and relevant.

2.4. Explainable AI (xAI) for machine learning-driven result analysis

The predictions made by AI models, while powerful, can often seem opaque. To bridge this gap between sophisticated computation and user understanding, we incorporate Explainable AI (xAI) techniques. With xAI, we unravel AI's decision-making process, making its predictions transparent and easily digestible. This not only aids stakeholders in understanding the reasoning behind the predictions but also instills a more profound sense of trust in the data-driven insights.

2.5. Collaboration with financial institutions

Acknowledging the dynamic nature of the financial markets, we have tried to establish collaborations with leading financial institutions. This collaboration is pivotal for two reasons: Firstly, it ensures our forecasts and analyses are grounded in real-world market trends, making them more actionable. Secondly, our access to real-time data from these institutions guarantees that our models and predictions are in tandem with the current pulse of the financial sector.

2.6. Experimental design to test the efficacy of our approach

2.6.1. Experimental setup

- Participants: We selected 200 people through a stratified sampling process, ensuring a balanced representation in terms of gender, age, and educational backgrounds. The sampling process and sample size was selected to balance achieving statistical significance and maintaining feasibility for detailed analysis, though it may be subject to adjustments based on practical considerations.
- Grouping:
- Experimental Group: 100 participants using the visualization tool emphasizing equity portfolios, mutual funds, and bonds.
- Control Group: 100 participants who received standard financial education materials.

2.6.2. Testing and intervention process

- Pre-test Assessment: The pre-test evaluated participants on basic financial concepts (like calculations and compound interest) as well as their practical skills in managing financial products like equity

portfolios, mutual funds, and bonds, providing a baseline for both theoretical and practical understanding.
- Intervention:
- Experimental Group: Introduction to the interactive visualization tool.
- Control Group: Traditional financial literacy training without visual aids.

2.6.3. Evaluation and analysis

- Post-test Evaluation: Both groups were retested on the same financial concepts and practical skills one month later. The post-test for the experimental group included additional questions related to the content of the visualization tool to assess its impact directly.
- Data Analysis Techniques:
- T-Tests: Employed to compare the mean score improvements between the experimental and control groups.
- Additional Statistical Analyses:
- ANOVA: Conducted to analyze how improvements in financial literacy varied across different demographics including gender, age, and education level.
- Multilevel Regression Models or Multivariate Regression Models: Investigation of how different demographic factors, such as age, gender, and education level, interact with the effectiveness of our educational intervention.

2.7. Summary of methodology

In our proposed study to boost financial literacy in South Korea, we integrate statistical analysis, data visualization, machine learning, explainable AI (xAI), and partnerships with financial institutions. We intend to analyze financial products using time series data, applying visualization tools like network diagrams to elucidate complex financial relationships (Choi & Kim, 2023) [10].

We anticipate developing data analysis and machine learning models, augmented with data visualization and explainable AI, to predict market trends and assess risks. Collaborating with financial institutions will be key to ensuring our analysis remains relevant to the market. We aim to test our approach on a group of 200 investors, dividing them into segments to use our visualization tool alongside standard financial education.

We plan to employ various robust statistical models to assess the impact of our methods on financial literacy across various demographics.

Our research methodology explores whether our methods can enhance understanding of financial concepts, which may lead to more informed financial decisions. We are committed to refining our approach continuously, with the goal of gaining a clearer insight into its effectiveness in improving financial literacy.

3. Results and implications

Our research explores making complex financial data accessible through intuitive visual formats to improve financial literacy.

Our approach, which combines clear visualizations with detailed explanations, seeks to make financial concepts more understandable to a diverse audience. We recognize that while this can contribute to economic progress, it is one of many factors and does not guarantee a more resilient financial market.

Developed in South Korea, our methodology has the potential for global application. We face challenges, including refining our visualization tools and enhancing our machine-learning models to serve a wider audience better. These are crucial steps in our ongoing journey of innovation.

In the context of the rapidly evolving digital financial sector, our study introduces a technology-driven method to help understand financial products, addressing a widespread challenge. To validate our proposed methods we developed a testing methodology Section 2.6 designed to thoroughly evaluate the effectiveness of our approach.

We are dedicated to continuous research and development, understanding that our efforts are just one part of a larger journey toward understanding the financial market for people. We contribute to a broader societal mission and the global dialogue on financial education.

Moving forward, we try to offer valuable insights that can augment current efforts in financial literacy and shape future approaches in this rapidly changing digital landscape. Our focus is to produce reliable and practical results that contribute meaningfully to enhancing financial literacy.

Ethics statements

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Declaration of Competing Interest

There is no competing interest in this paper.

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Direct Submission or Co-Submission?

Co-submissions are papers that have been submitted alongside an original research paper accepted for publication by another Elsevier journal No.

Appendix

SPECIFICATIONS TABLE (All sections are mandatory unless marked otherwise).

Subject area	2000: General Economics, Econometrics and Finance
Category/categories of societal impact	Economic

(*continued on next page*)

(*continued*)

Subject area	2000: General Economics, Econometrics and Finance
Sustainable Development Goals (SDGS) the research contributes to	*GOAL 8: Decent Work and Economic Growth* *GOAL 9: Industry, Innovation and Infrastructure*
Resource availability [optional]	
Related research article OR Related supporting information Please provide a link to the webpage if relevant	*Published Paper* *Choi, I., & Kim, W. C. (2022). Analyzing and utilizing thematic stocks based on text mining techniques and information flow-based networks: An example of the Republic of Korea's mask-themed stocks. Ind. Eng. Manag. Syst., 21(2), 244–266.* *Choi, I., & Kim, W. C. (2023). Estimating Historical Downside Risks of Global Financial Market Indices via Inflation Rate-Adjusted Dependence Graphs. Res. Int. Bus. Fin., 102077.* *Choi, I., Yun, W., & Kim, W. C. (2022). Improving data efficiency for analyzing global exchange rate fluctuations based on nonlinear causal network-based clustering. Ann. Oper. Res., 1–36.* *Working Paper* *Choi, I., Koh, W., Koo, B., & Kim, W. C. (2023). Network-based Exploratory Data Analysis and Interpretable Three-Stage Deep Clustering for Financial Customer Profiling. Eng. Appl. Artif. Intell., In Revision.*
Stage of research	*In Progress*

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