

https://dspace.org/

An Analysis of ChatGPT as a Tool for Portfolio Stock Selection

Nkabinde, Akanyang

2025
University of the Witwatersrand, Johannesburg
https://hdl.handle.net/10539/49395
Nkabinde, Akanyang . (2025). An Analysis of ChatGPT as a Tool for Portfolio Stock Selection [Master's dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/49395

Downloaded from a DSpace repository. https://dspace.org/



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

AN ANALYSIS OF CHATGPT AS A TOOL FOR PORTFOLIO STOCK SELECTION.

A RESEARCH REPORT SUBMITTED BY
AKANYANG NKABINDE
STUDENT NUMBER: 2330199
CELL: 0790568217
EMAIL: 2330199@STUDENTS.WITS.AC.ZA

SUPERVISOR: MR YOGESH BRAHMBHATT
CO-SUPERVISOR: MR NICHOLAS SCHWENKE
ETHICS CLEARANCE NUMBER: WSOA-2024-11-32W

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF COMMERCE
UNIVERSITY OF THE WITWATERSRAND

Declaration

I, Akanyang Nkabinde, declare that this research report is my own work, except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Commerce in Accountancy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signature: A.H.N

Signed at: Linbro Park on the 31st of March 2025

Acknowledgments:

I would also like to thank and acknowledge my parents and my family, whose unwavering love support helped me to get through the difficult times in preparing this research report. They always helped me to believe that I had the capabilities to finish this research report and have been there for the entire journey.

I would like to thank my supervisor Yogesh Brahmbhatt and my co-supervisor Nicholas Schwenke. Without their many hours of work and sacrifice in guiding me, meetings and reviews, this research report would not have been possible.

I would also like to thank and acknowledge the research committee, particularly Avani Sebastien. Her expertise and guidance on my research topic were invaluable and added a great deal in improving the research topic.

I would also like to thank the University in allowing to pursue this research topic and affording me the resources and funding as well as the opportunity to conduct this research.

Definition of terms

Artificial intelligence- Is a broad term encompassing the application of computational tools to address tasks that have traditionally required human sophistication (Giudic, 2018).

ChatGPT -ChatGPT, a large language model based on OpenAI's GPT architecture, is a state-of-the-art Natural language processing tool designed to generate human-like text based on given prompts. The model leverages a deep learning approach with several layers of attention mechanisms to process and generate language (Pelster & Val, 2024a).

Returns- The change in closing share prices (adjusted for the effects of dividends and distributions received) over the closing share prices at the start of the period expressed as a percentage.

Risk- Measured by the standard deviation of portfolio returns for the purposes of this study.

List of Abbreviations

AI	Artificial Intelligence
GPT	Generative Pre-training Transformer (GPT)
LLMs	Large Language Models
JSE	Johannesburg Stock Exchange
NLP	Natural Language Processing
ML	Machine Learning
RHLF	Reinforcement Learning with Human Feedback
JSE	Johannesburg Stock Exchange
EMH	Efficient Market Hypothesis
GS-EMH	Grossman-Stiglitz Efficient Market Hypothesis

Contents

1. Introduction 1

1.1. Purpose of the study 3

1.2. Research Questions 4

1.3. Hypothesis for Research Question 1 (Portfolio Returns): 4

1.4. Hypothesis for Research Question 2 (Portfolio Risk): 4

1.5. Hypothesis for Research Question 3 (ChatGPT weighted portfolios vs equally-weighted portfolios returns): 5

1.6. Significance of the study 5

1.7. Delimitations 5

1.8. Time Period for Financial Data 6

1.9. Companies to be evaluated by ChatGPT for portfolio selection 6

1.10. Investment Horizon 7

1.11. Comparison Group (Fund Managers) 7

1.12. Risk Measure 7

1.13. Information to be fed into ChatGPT 7

2. Literature review 9

2.1.1. Overview of the literature review 9

2.1.2. Artificial Intelligence and ChatGPT 10

2.1.3. ChatGPT 10

2.1.4. Prompt Engineering 11

2.1.5. Large Language Models and Artificial Intelligence (AI) in Finance and Portfolio Management 14

2.1.6. Modern Portfolio Theory 19

2.1.7. Extensions and Modifications to Modern Portfolio Theory 21

2.1.8. Efficient Market Hypothesis (EMH) and its Implications for Investment Decision-Making 23

2.1.9. The Grossman-Stiglitz Efficient Market Hypothesis (GS-EMH) and its Relevance to Active Management 24

2.1.10. Investment strategies 25

2.1.11. The Active vs. Passive Debate in Emerging Markets (South Africa) 27

2.1.12. Value vs. Growth Investment Strategies 28

3. Method 30

3.1. Method Overview 30

3.1.1. Development of the standardised prompts for the study based on the literature 33
3.2. Population 36
3.3. Sample 36
3.4. Data collection 36
3.5. Data analysis 38
3.6. Ethics 43
3.7. Assumptions 43
3.8. Limitations 45
3.9. Validity 46
3.10. Reliability 48
4. Results 50
4.1. A comparison of the return performance of the ChatGPT portfolios and the existing asset managers portfolios. 50
4.1.1. Testing the average quarterly returns for the normality of the data 50
4.1.2. Discussion 52
4.1.3. Comparison of the equally weighted ChatGPT portfolios and the corresponding fund managed portfolio 54
4.1.4. Best and worst performing ChatGPT portfolios. Growth vs Value investing, which is ChatGPT better suited for? 56
4.1.5. Tables and Graphs for research question 1 60
4.1.6. Table 1 60
4.1.7. Table 2 60
4.1.8. Figure 1 62
4.1.9. Table 3 64
4.1.10. Table 4 64
4.1.11. Table 5 66
4.1.12. Figure 2 67
4.1.13. Figure 3 68
4.1.14. Figure 4 69
4.1.15. Figures 4.1-4.18 71
4.1.16. Figure 5 75
4.2. Research Question 2 Results 77
4.2.1. Tables and Graphs for research question 2 78

4.2.2. Table 6 78
4.2.3. Table 7 79
4.2.4. Table 8 80
4.2.5. Figure 6 82
4.2.6. Table 9 84
4.2.7. Table 10 84
4.2.8. Discussion 85
4.3. Other Interesting observations 89
4.3.1. Portfolio construction 91
4.3.2. Table: 11 98
5. Conclusion 105
6. References 108
7. Appendix 1: Example of the prompts provided to ChatGPT, a repeat of the analysis, and the responses from ChatGPT 114
8. An example of the prompt provided to ChatGPT once the Instructions were loaded and saved in its memory 125
9. An example of the prompt provided to ChatGPT to assign the optimal weightings to the stocks within the portfolios. 126
10. Appendix 2: Method used by the Citywire website to report on fund performance to be used in this study 127
11. Appendix 3: A list of the asset managers' portfolios and their trading strategies that the ChatGPT portfolios will be compared to. 127
12. Appendix 4: An Example of an analysis performed by ChatGPT on Shoprite Limited 139
13. Appendix 5: An example of an evaluation performed by ChatGPT on Sanlam Limited 142

Abstract

Background: Artificial Intelligence has had a significant impact on numerous industries including finance with the financial sector having undergone substantial changes in recent years with the rise of new technologies and increasing reliance on data-driven decision-making processes.

Purpose: The purpose of this study was to explore whether ChatGPT can serve as a tool for assisting with investment strategies that feature reduced costs and are more accessible to the public with the goal being to assess if such AI models could improve stock selection and portfolio creation for the average individual investor.

Method: Portfolios were constructed by prompting ChatGPT to make a decision on whether to invest or not to invest based on whether an investment into that company would meet the investment objectives of a corresponding existing fund managed portfolio. Next the returns as well as the standard deviations (measure of risk) were computed for these portfolios as well as the existing fund managed portfolios. A difference between groups methodology was used to compare the ChatGPT portfolios and the existing fund managed portfolios from a return generation and risk minimization point of view. The Mann-Whitney U test was utilized to determine whether the differences in the ChatGPT and the corresponding existing fund managed portfolios, were statistically significant.

Results: ChatGPT outperformed the existing fund managed portfolios in 9 out of the 18 portfolios from a return generation perspective, indicating some potential of ChatGPT to generate returns. However, the results were not statistically significant, and this study could not conclude that ChatGPT can outperform fund managers in generating portfolio returns. The ChatGPT portfolios had much larger standard deviations and therefore risk levels than those of the existing fund managers. These results were statistically significant indicating that ChatGPT struggles from a risk minimisation point of view. Overall, the findings suggest that ChatGPT has potential as a complementary tool for individual investors and financial professionals, particularly in growth-oriented strategies. However, its inability to minimize

risk and its reliance on generic responses underscore the need for cautious integration into investment practices. The results also emphasize that ChatGPT is not yet equipped to replace professional fund managers due to ChatGPT being unable to minimise portfolio risk and generate stable returns.

Contribution: This study adds to the literature by exploring ChatGPT's ability to recommend stocks and create portfolios based on existing investment strategies of asset managers at reputable asset management companies in South Africa as the use of ChatGPT in finance increases and more individuals turn to the large language model for various tasks.

1. Introduction

Artificial Intelligence has had a significant impact on numerous industries including finance with the financial sector having undergone substantial changes in recent years with the rise of new technologies and increasing reliance on data-driven decision-making processes (Ullah et al., 2024).Natural language processing (NLP) and machine learning (ML) models have emerged as powerful tools for financial analysis and decision-making.

The development of large language models has been a significant achievement in generative artificial intelligence (AI). The best evidence of this has been the creation of ChatGPT, a prominent innovation by OpenAI, using the Generative Pre-training Transformer (GPT) architecture (Khan & Umer, 2024). ChatGPT is a large language model developed by OpenAI that has been trained on large amounts of data to generate human-like responses to text-based inputs. ChatGPT learns from data and generates sophisticated text outcomes post-training autonomously (Khan & Umer, 2024). ChatGPT can be used for various financial applications, including analysing data, managing risk, optimizing portfolios, forecasting market trends, and conducting sentiment analysis (Ullah et al., 2024). The large language model's ability to process vast amounts of data quickly and accurately makes it useful when speed and accuracy are essential, such as high-frequency trading and risk management (Ullah et al., 2024). ChatGPT can also perform several other tasks relevant to the investment industry, including understanding financial market dynamics, named entity recognition, generating financial summaries and reports, forecasting outcomes, and making personalised investment recommendations (Khan & Umer, 2024).

To date there have been a limited number of studies relating to the use of ChatGPT in finance and economics Niszczota and Abbas (2023), however, the landscape of research on the role of ChatGPT in finance is increasing rapidly with several studies having used the large language model in finance research studies recently (Ko & Lee, 2024b). Niszczota and Abbas (2023) found that ChatGPT is becoming financially literate as GPT-4 obtained a near-perfect score of 99% based on basic financial literacy tests. The findings indicate that GPT-4 exhibits

an understanding of financial matters at least at a basic level and that these large language models are becoming better at understanding financial information (Niszczota & Abbas, 2023). This study adds to the literature by exploring ChatGPT's ability to recommend stocks and create portfolios based on existing investment strategies of asset managers at reputable asset management companies in South Africa.

Natural language processing that dissects our spoken and written language and encapsulates Artificial Intelligence, such as ChatGPT, is well suited to dealing with large datasets due to the value ingrained in the narratives around the information in financial reports (Pisaneschi, 2024). Natural language processing has revolutionized the extraction of insights obtained from unstructured data, enabling financial analysts to derive meaningful information from sources such as news articles, social media, and financial reports (Ullah et al., 2024). Given the findings of the tasks that ChatGPT can perform and the unique opportunities ChatGPT presents regarding data sources, this study was a two-fold study where the financial information of a company along with its industry was inputted into ChatGPT, to determine whether ChatGPT can assist investors in deciding whether to invest in a company to firstly maximise returns and secondly minimise the risk of a portfolio. The principles of Modern Portfolio Theory were used as the underpinning theoretical framework for the study.

This study was a quantitative study that involved providing ChatGPT with prompts that included the financial information of companies listed on the Johannesburg Stock Exchange as well as prompting the large language model with the investment strategy of existing funds, for the large language model to decide on whether to invest in that stock. The decision, whether to invest or not to invest in the companies was based on whether investing in the stock would meet the funds' objectives. For the instances where ChatGPT advised the user to invest, that stock was included in the relevant ChatGPT-created portfolio. The returns and the risk of the ChatGPT-created portfolios were then compared with those of the fund-managed portfolios at large institutional investors in South Africa to determine whether there was scope for ChatGPT to assist in providing stock selection advice to individual investors. This study was undertaken using a difference between groups methodology which is discussed in section 3 of this report.

1.1. Purpose of the study

This study aimed to evaluate the potential of ChatGPT, in assisting investors with making informed stock selection decisions. The motivation behind this research arose from the growing incorporation of generative AI models in the financial sector, as highlighted by a survey conducted by the CFA Institute that found that around 14% of investment professionals use ChatGPT for financial and investment tasks, which was the third most prominent reasoning for using ChatGPT among these professionals (Pisaneschi, 2024). This demonstrates the increasing reliance on AI tools in professional investment practices.

Financial literacy is essential for sound financial decision-making, yet it remains a global challenge, with many individuals lacking adequate knowledge to effectively manage their investments (Ullah et al., 2024). This gap may lead financially less-literate investors to turn to tools like ChatGPT to assist in managing their portfolios. As this study explores ChatGPT's potential in supporting informed investment decisions, it recognised that while ChatGPT can democratise financial insights, users with limited financial literacy might rely on the tool. Thus, understanding both the potential benefits and limitations of ChatGPT in addressing this gap is crucial for responsible and effective investment support.

This research aimed to build on the concept of automated financial advisors or "robo-advisors" another AI application that was considered main application of AI in finance. Robo advisors offer benefits like offering lower fees, better transparency, and fewer biases compared to human advisors (Brenner & Meyll, 2020) and (Giudic, 2018). As large language models become more accessible, they hold the potential to democratise financial knowledge and empower individual investors by lowering fees associated with active portfolio management (Pelster & Val, 2024b). The study explores whether ChatGPT can serve as a tool for assisting with investment strategies that feature reduced costs and are more accessible to the public with the goal being to assess if such AI models could improve stock selection and portfolio creation for the average individual investor.

1.2. Research Questions

Research Question 1: How do the average quarterly returns of portfolios created using ChatGPT, compare to those of professional fund managers in South Africa, based on the fund managers' investment strategies?

Research Question 2: How does the standard deviation of quarterly returns, as a proxy for risk, differ between ChatGPT-generated portfolios and professional fund manager portfolios in South Africa?

Research Question 3: How do the average quarterly portfolio returns based on ChatGPT's weightings differ to the average quarterly portfolio returns of equally weighted portfolios?

1.3. Hypothesis for Research Question 1 (Portfolio Returns):

Null Hypothesis (H_0): The average quarterly returns of ChatGPT-generated portfolios are not significantly higher than those of professional fund manager portfolios in South Africa, based on the fund managers' investment strategies.

Alternative Hypothesis (H_1): The average quarterly returns of ChatGPT-generated portfolios are significantly higher than those of professional fund manager portfolios, based on the fund managers' investment strategies.

1.4. Hypothesis for Research Question 2 (Portfolio Risk):

Null Hypothesis (H_0): The standard deviation of quarterly returns for ChatGPT-generated portfolios is not significantly lower than that of professional fund manager portfolios.

Alternative Hypothesis (H_1): The standard deviation of quarterly returns for ChatGPT-generated portfolios is significantly lower than that of professional fund manager portfolios.

1.5. Hypothesis for Research Question 3 (ChatGPT weighted portfolios vs equally-weighted portfolios returns):

Null Hypothesis (H_0): The average quarterly returns of ChatGPT-weighted portfolios are not significantly higher than those of equally weighted ChatGPT created portfolios in South Africa.

Alternative Hypothesis (H_1): The average quarterly returns of ChatGPT-weighted portfolios are significantly higher than those of the equally weighted ChatGPT-created portfolios.

1.6. Significance of the study

As people increasingly turn to AI tools like ChatGPT for various tasks, non-experts in finance may look to use such tools to help with investment decisions due to their perceived analytical capabilities (Dowling & Lucey, 2023).

Generative AI models are already being integrated into the work of fund managers and investment professionals, with increasing adoption as noted by the CFA Institute (Pisaneschi, 2024). These professionals could further benefit from the enhanced efficiency and cost savings of large language models. The study is particularly relevant as companies like Bloomberg have already developed their own large language models, such as BloombergGPT, suggesting a growing trend where more firms may create and incorporate AI models for financial analysis (Wu et al., 2023). If this research proves that Large Language Models can effectively assist in investment decision-making, it could lead to wider adoption of AI tools, altering the cost structure within investment firms. Both fund managers and individual investors stand to gain from the potential reduction in fees and costs associated with using AI for investment decisions by lowering the fees associated with active management.

1.7. Delimitations

Information that ChatGPT was prompted with

To overcome the limitation that ChatGPT may be subject to biases in its training data due to reliance on past data means it may reproduce biases inherent in training datasets as found by Rane (2023) and to improve the validity of the results from prompts provided to ChatGPT, only financial information that was provided to ChatGPT in the prompts was utilised for this

study. This was to ensure that ChatGPT had not been trained on the data it was prompted with, but rather the ability of ChatGPT to analyse financial information and consequently advise on investment decisions was tested without being influenced by information and biases from the internet and biases already present in its database.

1.8. Time Period for Financial Data

The financial data that ChatGPT was prompted with was the most recent financial information available for each company on the Equity RT database at the time of completion of this study i.e. the historical financial information and comparative financial information up until the 2023 or 2024 financial year ends. This was dependant on whether the 2024 financial information had been released or had not been released yet for the particular company under evaluation. The consensus estimates for future years for each company were also included depending on the availability of the consensus estimates for each company. The purpose of this delimitation was to ensure that ChatGPT's analysis is based on the most recent available data making the results relevant to prevailing market conditions at the time this study was conducted.

The knowledge period cut-off date for ChatGPT is continuously being updated, which may overlap with this study's sample period and influence the results. To overcome this limitation, this study used a modified prompt to ensure that the large language model did not use information from its knowledge database and financial information that may fall outside the time period under evaluation for the purposes of this study. The instructions in the prompts provided to ChatGPT, therefore, included "forget all your prior knowledge and only use the information from the documents that I provide you with"

1.9. Companies to be evaluated by ChatGPT for portfolio selection

The study focused exclusively on companies listed on the Johannesburg Stock Exchange (JSE), excluding international markets or other stock exchanges. ChatGPT was utilised to evaluate all the companies on the JSE. This is because the fund-managed portfolios had different investable universes. E.g. the portfolio only invests in mid to small-cap stocks on the JSE and another portfolio might a different investable universe where it includes stocks

from the entire JSE. As a result of these differences, to make fair comparisons the study needed to ensure that all the companies on the JSE were evaluated.

1.10. Investment Horizon

This study evaluated portfolio performance over a short-term investment horizon of 1 year, excluding longer-term performance evaluations. The study only compared the risk and returns for the ChatGPT and fund-managed portfolios for the 2023 quarterly periods. This kept the research manageable due to time constraints while achieving the purpose of the study, to evaluate whether ChatGPT portfolios can outperform fund-managed portfolios from a return maximisation point of view and a risk minimisation perspective both of which can be evaluated in the short term. This has been included as an area for future research in the conclusion section of this report.

1.11. Comparison Group (Fund Managers)

The study compared ChatGPT-generated portfolios to funds managed by the five largest asset management firms in South Africa, excluding smaller fund managers and international asset management companies. This delimitation narrowed the scope of the research to prominent players in the South African asset management industry, providing a clear and relevant benchmark for comparing the performance of ChatGPT-generated portfolios using the difference between groups methodology.

1.12. Risk Measure

The study measured portfolio risk using standard deviation of returns and excluded other risk metrics such as beta or maximum drawdown. This simplified the analysis and kept the focus on one widely accepted measure of risk, making the results easier to interpret and compare across portfolios. This is also in line with the risk metric used in Modern Portfolio Theory which is the underpinning theoretical framework for this study (Beyhaghi & Hawley, 2013).

1.13. Information to be fed into ChatGPT

Financial statements including the income statement, balance sheet, statement of cash flows, financial ratios, and consensus estimates for the financial information where

applicable were included in the prompts provide to ChatGPT. The financial information provided to ChatGPT was the most recent financial information along with consensus estimates. The most recent information where all the companies have completed year-ends i.e. up until 2023 or up until 2024-year end as stated above. ChatGPT was also provided with the industry that each company operates in and was able to identify industry-specific risks and incorporate these into the investment decisions so far. This was provided to provide ChatGPT with some context to incorporate both financial information as well as industry outlook to come to an investment decision.

2. Literature review

2.1.1. Overview of the literature review

Section 2 of the research report relates to prior literature and how this research aims to fill a gap in the existing literature. First, the concepts of Artificial Intelligence (AI) as well as ChatGPT are introduced to give the reader an understanding of what these tools are. Next prompt engineering is discussed to explain to the reader how ChatGPT works, and this relates to how the researcher interacted with ChatGPT during the data collection phase. The use of large language models (LLMs) and AI in finance and portfolio management are then discussed, which is the main theme of this research paper. Modern Portfolio Theory is then discussed, which is the underpinning theoretical framework for this research paper, followed by the Efficient Market Hypothesis and the Grossman-Stiglitz Efficient Market Hypothesis and how they relate to this research report. The literature review then discusses investment strategies with a particular focus on active investment strategies and delves into value vs growth investment strategies. This covers the investment strategies of the 18 existing fund managed portfolios to which the corresponding ChatGPT portfolios are compared.

Overall, the sections that are presented in this literature review, speak to the research questions. The literature review speaks to how the literature influenced the research questions and stated hypothesis on whether ChatGPT could outperform fund managers in generating portfolio returns and minimising the portfolio risk. This is embedded in the discussion on Modern Portfolio theory, investment strategies overall, namely active and passive investment strategies, which ultimately filters down into growth vs value investing, all of which were key in creating the ChatGPT portfolios based on the existing fund managers investment strategies which are rooted in the aforementioned strategies. This all takes place on the backdrop of the markets being efficient, a key assumption in Modern Portfolio Theory which is also discussed in this literature. This coupled with an understanding of AI in general and large language models sets the background of how the research questions came about and how the related hypothesis were developed.

2.1.2. Artificial Intelligence and ChatGPT

Artificial intelligence is the starting point in the discussion of generative artificial intelligence and large language models, and it is important to define what artificial intelligence is before delving into what ChatGPT is, which was the model of focus in this study. Artificial intelligence is a broad term encompassing the application of computational tools to address tasks that have traditionally required human sophistication (Giudic, 2018). Artificial Intelligence is the use of advanced techniques to obtain insights from large datasets, combining a variety of data types obtained from a variety of sources where the models can utilise the ability of computers to perform complicated tasks by learning from past experience (Giudic, 2018). Language chatbots are an emerging technology that benefit a range of industries (O'Leary, 2023).

2.1.3. ChatGPT

ChatGPT, a large language model based on OpenAI's GPT architecture, is a state-of-the-art natural language processing tool designed to generate human-like text based on given prompts. The model leverages a deep learning approach with several layers of attention mechanisms to process and generate language (Pelster & Val, 2024a). Due to its extensive training data and advanced architecture, ChatGPT excels at multiple applications, such as content generation and translation, and complex tasks, such as code writing (Pelster & Val, 2024a). ChatGPT was the focus of this study as a result of its popularity due to the perceived quality of response output from the model (Dowling & Lucey, 2023).

Despite the proficiency of the foundational GPT models in both understanding and generating text, there remained a gap in aligning their outputs with human preferences. To address this, OpenAI implemented a two-phase approach consisting of supervised fine-tuning and reinforcement learning with human feedback (RLHF) to develop ChatGPT (Pisaneschi, 2024). The first phase, supervised fine-tuning, involved training the model to replicate human responses by using datasets in which AI trainers played both roles of user and an AI assistant. This method exposed the model to a variety of conversational scenarios, shaping its interaction style to be more reflective of human behaviour. In the second phase, OpenAI employed RLHF, where the model produced several responses, which AI trainers then

ranked. The model subsequently learned from this feedback, refining its future responses to similar prompts, thus enhancing its performance over time (Pisaneschi, 2024).

It was found that ChatGPT does not understand information as people do but rather regurgitates patterns that it has learned. Since ChatGPT's responses are based on patterns in its training data, this can lead to incorrect outputs when given ambiguous, or misleading prompts (Pelster & Val, 2024b). This formed a limitation of this study and illustrates that the prompts to be utilised when using ChatGPT are critical in maintaining the validity of the results obtained based on ChatGPT's responses. This study acknowledged this limitation and used carefully constructed prompts to reduce misinformation in ChatGPT's responses, despite this, there were still instances of misinformation and hallucinations, although the number would have been higher had prompt engineering not been utilised in the study.

Data analysis is a critical aspect of investment decision-making processes. Despite the above-mentioned hallucinations, ChatGPT can analyse large amounts of financial data and extract meaningful insights from it (Ullah et al., 2024). ChatGPT can identify patterns and trends in the data that may not be apparent to human analysts. For example, prior research has found that ChatGPT can analyse the financial statements of companies and identify potential risks and opportunities, which can assist investors in making informed decisions about their investments (Ullah et al., 2024). As a result, the large language model's ability to analyse financial data was tested against that of fund managers at large institutional investors to determine whether ChatGPT could outperform the fund managers in generating returns, minimising portfolio risk and whether ChatGPT had an ability to allocate funds to the portfolios it had created.

2.1.4. Prompt Engineering

Prompt engineering involves refining input prompts to direct large language models (LLMs) like ChatGPT to produce accurate and relevant responses (Mungoli, 2023). It is a technique to guide the responses of large language models such as ChatGPT (Nyakundi, 2023). Mungoli (2023) found that significant improvements were found in ChatGPT's responsiveness across a multitude of tasks due to the use of effective prompt engineering. Mungoli (2023) found that

the model generated more accurate, relevant, and contextually appropriate responses by carefully generating input prompts. Due to aforementioned findings and the fact that this study utilised prompting techniques to evaluate ChatGPT's ability to provide equity selection advice, prompt engineering was incorporated into the study.

As mentioned above, generating the prompt is essential to achieving the most accurate responses from ChatGPT. By carefully crafting input prompts, researchers and developers can guide the large language models to produce more accurate, relevant, and valuable responses from these models (Nyakundi, 2023). In their study, Mungoli (2023) selected a range of prompt engineering strategies to apply to the input prompts in their dataset. These strategies included rewriting prompts to clarify and remove ambiguity, incorporating contextual information, providing background information, providing explicit instruction, and utilising templates to guide the model's response structure. The study found that the most effective strategies included providing explicit instructions, incorporating contextual information, and using templates (Mungoli, 2023). This presents some similarities for effective, prompt engineering, as suggested by Barrett (2023) who suggested the use of a CREATE framework for effective prompt engineering. The CREATE framework stands for clarity, relevant information, examples, avoiding ambiguity, tinkering, and evaluating responses (Barrett, 2023).

A helpful method to assist in effective prompt engineering is to give the large language models time to "think" such as instructing the model to work out its solution before rushing to a conclusion. Splitting complex tasks into simpler subtasks can assist in more effective prompt engineering. Writing clear instructions such as asking for brief replies if the outputs are too long or if the outputs are too simple, asking for expert-level responses, and including details in your prompt to get more relevant answers (OpenAI, 2024). According to OpenAI (2024), the creators of ChatGPT, large language models can confidently invent fictitious answers, but providing reference text to the models can assist them in answering with fewer fabrications. The generation of the prompts and specific details that were utilised to generate the prompts that were used in this study are discussed in more detail below.

The abovementioned method is also known as in-context learning because it involves giving the model training examples inside the prompt, which increases the probability of the correct next words given the previous words. The method heavily relies on the user's ability (and therefore the researcher in this case) to develop a well-thought-out prompt tailored to the model's capabilities (Pisaneschi, 2024). According to the CFA Institute, this is where prompt engineering is important in getting the right answer. They recommended that professionals could use the following list when building a prompt. Large language models have an autoregressive nature and perform better when they have time to "think" through their answer step by step, saving their final answer for the end of their response. They perform better with chain-of-thought reasoning which is similar to the advice OpenAI gives in creating the prompts (Pisaneschi, 2024). Prompting the model to think through its answer step by step has been shown to increase its accuracy dramatically. Providing the models with more examples of its intended output was also found to be effective as this is synonymous with providing the model labelled data, thus improving its output (Pisaneschi, 2024).

In this study, ChatGPT was prompted with different prompts based on the historical financial information, the industry the company operates in, as well as forward-looking information in the form of consensus estimates related to the companies under evaluation in order for the model to make an eventual investment decision for each company. Various studies found that historical financial information is value-relevant for investors and investors take this information into account when making investment decisions (Ighosewe, 2022) and (Obaidat, 2016).

The prompts that were provided to GPT are discussed in more detail in section 3, the method section. These were based on the literature on the literature on the use of ChatGPT in finance and the theoretical literature which have been discussed to guide the user as to how the prompts for this study were formulated along with an example of the prompts and an evaluation carried out by ChatGPT in appendix 1 of this report.

2.1.5. Large Language Models and Artificial Intelligence (AI) in Finance and Portfolio Management

2.1.5.1. Research on large language models in finance in a broader context

In finance, large language models (LLMs) can be used for several activities, which include but are not limited to automated customer support, financial analysis, fraud detection, algorithmic trading, personal finance management, regulatory compliance, education, or consulting (Pisaneschi, 2024). Dowling and Lucey (2023) attempted to utilise ChatGPT for finance research and they found that ChatGPT can generate plausible-seeming research studies for well-ranked journals. Cherry et al. (2023) found that advancements in Machine Learning (ML) and Artificial Intelligence (AI) have led to breakthroughs in Natural Language Processing (NLP), where NLP models can be trained to (amongst other applications) identify the sentiment of text within its context. Their study looked at the use of Fin BERT, another large language model, in impression management.

Rane (2023) delves into the transformative potential and challenges of generative AI models like ChatGPT within the finance and accounting sectors. They identified several key applications for ChatGPT and similar AI tools, highlighting how they streamline processes, reduce operational errors, and assist in complex decision-making. Specific applications include Customer Support and Engagement, as ChatGPT serves as a powerful tool for customer-facing functions by automating responses to inquiries, providing tailored financial advice, and helping clients make informed decisions. By interacting with clients in real-time, ChatGPT enhances customer engagement and satisfaction while reducing the need for human customer service representatives. ChatGPT can process extensive datasets, identifying trends, anomalies, and patterns crucial for making timely investment and financial decisions. Its predictive capabilities enable it to assist in financial forecasting, helping finance professionals anticipate market trends based on historical data and model-driven predictions. By analysing transactions and user behaviours, ChatGPT supports fraud detection, identifying unusual activities and flagging them for further investigation. In compliance, ChatGPT assists organisations in meeting industry regulations by generating reports, monitoring transactions, and ensuring adherence to financial standards. These

examples illustrate the growing research around the use of large language models in a broader context.

2.1.5.2. Research on the use of large language models in finance in a more focused context

Ullah et al. (2024) discussed the fact that Artificial Intelligence in finance offers substantial benefits, particularly in investment decision-making, by processing vast datasets swiftly and accurately, which is more closely related to the use of ChatGPT in this study. They found that AI-powered tools, can assist investors by analysing data, providing insights, and identifying optimal portfolio mixes. Additionally, AI enhances risk management by identifying and recommending strategies to mitigate potential risks. By leveraging historical data and pattern recognition, AI can forecast market trends, offering valuable insights into market movements. Although not explicitly asked to forecast market trends, in this study, asking ChatGPT to analyse companies listed on the Johannesburg Stock Exchange (JSE) and decide on whether to invest in that company based on whether that company would meet the objectives of particular investment strategies was, in essence, asking ChatGPT to predict whether that company would assist a portfolio to enhance its performance

In their study Ullah et al. (2024) referenced prior literature which found that mutual funds that employ AI analysts tend to have higher fund flows and better performance compared to those that do not. Additionally, the literature found that the presence of AI analysts can also reduce the sensitivity of fund flows to past performance, which indicates that AI analysts can provide more stable and reliable information to investors. The results suggest that AI analysts have a positive impact on individual investor activities in mutual fund investments, in the same way that ChatGPT has potential benefits for individual investors participating in the stock market.

Lopez-Lira and Tang (2023) found that ChatGPT predicts stock market returns from news headlines, illustrating that ChatGPT scores and realized stock returns daily are positively correlated. Oehler and Horn (2024) found that ChatGPT provides better advice for one-time investments than robo-advisors by creating portfolios and comparing the performance of those portfolios with that of different robo-advisors by taking into account investors' risk

appetite. Romanko et al. (2023) used ChatGPT to obtain a universe of stocks from the S&P500 market index that were potentially attractive for investing and subsequently compared various portfolio optimisation strategies that utilised the AI-generated trading universe, evaluating those against quantitative portfolio optimisation models and comparing them to some of the popular investment funds. Their findings indicate that ChatGPT is effective in-stock selection but may not perform as well in assigning optimal weights to stocks within the portfolio. Using a live experiment, Pelster and Val (2024b) found a positive correlation between ChatGPT-4 ratings and future earnings announcements and stock returns and that ChatGPT-4 adjusts ratings in response to earnings surprises and news events information in a timely manner and that an investment strategy based on ‘’attractiveness ratings” by ChatGPT-4 yields positive returns.

Lopez-Lira and Tang (2023) and Pelster and Val (2024a) investigated ChatGPT’s capacity for text data analysis through its language model capabilities, whereas Ko and Lee (2024a)’s research delved into the financial acumen ChatGPT possesses, from a portfolio management perspective. Ko and Lee (2024a) widened their scope to include a variety of asset classes such as bonds, commodities, currencies, and cryptocurrencies. This study is similar to that conducted by Kim (2023) who proposed a quantitative investment approach that incorporates recommendations from ChatGPT. Based on ChatGPT’s general understanding of the economy and financial market movements, they asked ChatGPT to recommend asset classes under various economic conditions. The empirical results showed that asset class recommendations based on economic indicators of ChatGPT can improve portfolio efficiency (Kim, 2023). Oehler and Horn (2024) limited their focus to several specific asset classes. Romanko et al. (2023) focused only on constructing equity portfolios which is aligned with the method employed in this study. Although all related studies leverage ChatGPT to assist in investment decision-making, to the best of this researcher’s knowledge no research has directly examined its ability to provide portfolio selection advice by constructing portfolios and comparing them with those created by existing asset managers. This study aimed to fill that gap by using prompt-based guidance to assess ChatGPT’s stock selection ability against that of existing fund managers.

For risk Management and Portfolio Optimisation, in finance, ChatGPT can evaluate the risk levels of portfolios, assess diversification needs, and recommend adjustments. By analysing market variables, ChatGPT enables financial managers to optimise portfolios, balancing risk and expected returns. This is particularly relevant in contexts requiring quick decision-making and real-time adjustments to portfolio strategies, although Romanko et al. (2023) found that ChatGPT may struggle to assign the optimal weights to stocks, another key aspect that this study has also expanded on in the results section of this report.

While these applications showcase ChatGPT's advantages, Rane (2023) emphasises that generative AI poses substantial challenges, particularly regarding data security, ethical concerns, and regulatory. Due to the vast amounts of data required for AI operation, there are heightened risks of data breaches and unauthorised access to sensitive information. Ethically, ChatGPT's reliance on past data means it may reproduce biases inherent in training datasets, potentially leading to biased advice and decisions. Furthermore, ChatGPT's interpretive limitations mean it may lack the contextual understanding needed to navigate complex financial nuances, underscoring the importance of human oversight when making high-stakes decisions.

The insights from Rane (2023) align well with this study's objectives, particularly regarding ChatGPT's applications in portfolio optimisation, risk management, and financial decision-making. By examining ChatGPT's role in enhancing investment decisions, data analysis and trend identification, the paper underscores the potential for ChatGPT to serve as an accessible tool for a wide range of investors. This complements the current study's goal of assessing ChatGPT's viability as a decision-support tool for individual investors, especially those who may benefit from AI-driven insights to make informed decisions with reduced active portfolio management costs.

The risks associated with data biases and interpretive errors imply that users must understand the limitations of AI-driven advice, an area that is covered by this research both in the literature review section as well as in the limitations section of the method. This study sought to evaluate how effectively ChatGPT can democratise financial knowledge while

recognising the responsibility required in using AI-generated insights in decision-making by providing insights into the use of ChatGPT in stock selection.

Ullah et al. (2024) examine the influence of ChatGPT on investment decision-making among Pakistani stock market investors, focusing on five main ChatGPT usage dimensions: data analysis, risk management, portfolio optimisation, market trend forecasting, and sentiment analysis. Each of these dimensions contributes uniquely to enhancing investment decisions, especially among users with high levels of financial literacy. The study's methodology involved survey data collected from 388 investors, with results indicating that ChatGPT's analytical capabilities positively impact investment decisions, particularly among financially literate users who can effectively interpret AI outputs.

ChatGPT's data processing capabilities allow it to sift through large datasets efficiently, providing insights that would otherwise require significant time and expertise. This feature aids investors by delivering streamlined, actionable insights based on extensive data analysis, helping them make quicker decisions. ChatGPT can identify and assess potential risks by analysing historical data and current market conditions. For investors, this capability means receiving timely warnings about high-risk investments or volatile assets, thus improving risk management (Ullah et al., 2024). Through historical data analysis, ChatGPT forecasts market trends, allowing investors to anticipate potential market shifts and make proactive decisions. This capability is particularly valuable in emerging markets like Pakistan, and in the case of this study, South Africa, where timely forecasting can offer a competitive advantage (Ullah et al., 2024). Using its natural language processing abilities, ChatGPT analyses sentiment by examining text-based data such as news articles and social media posts. This feature provides investors with insights into public sentiment about specific stocks or sectors, enabling them to incorporate sentiment into their decision-making (Ullah et al., 2024). ChatGPT can support investors in constructing diversified portfolios tailored to their risk tolerance and financial goals. By suggesting combinations of stocks and asset allocations, it can assist investors in balancing returns and risk exposure. Ullah et al. (2024), aligned closely with the traditional functions of financial advisors which was a key theme for this research, namely, to determine whether this was the case in the South African market

and consequently whether ChatGPT could outperform fund managers at the 5 largest asset management companies in South Africa.

Their study finds that financial literacy significantly moderates the effectiveness of ChatGPT in these dimensions. Investors with higher financial literacy are better able to understand and utilise ChatGPT's outputs, enabling more informed decisions. Those with limited financial literacy, however, may struggle to interpret ChatGPT's insights, which could lead to less effective or even misguided investment decisions. Ullah et al. (2024) conclude that while ChatGPT holds potential as an accessible tool for data analysis and risk management, its effectiveness largely depends on the user's ability to interpret and act on AI-generated insights. Financial literacy, therefore, plays a crucial role in the successful application of ChatGPT for investment purposes, especially in a market context like Pakistan's, where financial literacy levels are varied. This study however set out to determine whether ChatGPT had the ability to outperform fund managers and consequently could assist investors who were not finance professionals and were not financially literate, contrary to the findings of Ullah et al. (2024).

2.1.6. Modern Portfolio Theory

Modern Portfolio Theory, pioneered by Markowitz in the 1950s, provides a framework for optimizing portfolios based on the trade-off between risk and return. Modern Portfolio Theory introduces the concepts of diversification, correlations between asset returns, and portfolio optimisation, aiming to maximize returns for a given level of risk or minimise risk for a desired return (Beyhaghi & Hawley, 2013). Risk is quantified by the variance of asset returns, while portfolio risk is assessed through the variances and covariances of individual assets (Edwin J. Elton & Gruber, 1997). The theory assumes that markets are efficient and that investors are rational, making decisions based on mean-variance optimisation (Fabozzi et al., 2002). It also introduces different forms of market efficiency, particularly under the Efficient Market Hypothesis, which posits that asset prices reflect all available information, making it difficult for investors to consistently outperform the market (Heymans & Santana, 2018). However, information asymmetry and high information processing costs challenge the applicability of the Efficient Market Hypothesis (Heymans & Santana, 2018). This theory has been utilised

as the underpinning theoretical framework for this study, although some assumptions were not adopted, and others were not adopted in their entirety for the purpose of this study. This has been discussed in more detail under the assumptions section in the method section of this research report.

The theory has been extended by Sharpe, who differentiated between systematic risk and idiosyncratic risk, with the latter being reducible through diversification, a theme that was central to this research report to determine whether ChatGPT could reduce portfolio risk, more than existing fund managers (Beyhaghi & Hawley, 2013). Despite Modern Portfolio Theory's widespread use in asset allocation and portfolio management, it faces criticism for its reliance on assumptions like investor rationality and the normal distribution of returns, which do not always hold in practice (Beyhaghi & Hawley, 2013). Active and passive portfolio strategies, informed by Modern Portfolio Theory, continue to guide investment decisions. This study utilised active investment strategies in constructing ChatGPT-created portfolios (Fabozzi et al., 2002).

Enhancements to Traditional Portfolio Optimisation Models- AI and Predictive Modelling in Investment Decision-Making

A study by Moeini Najafabadi et al. (2020) explores two key decision-making approaches for optimising stock market investments, forecasting, and Markowitz-based portfolio optimisation. The forecasting approach leverages historical data to predict future market trends, while the Markowitz model focuses on analysing risk and return to construct a diversified portfolio. Moeini Najafabadi et al. (2020) argue for combining these two methods, highlighting that a data-informed forecasting model, when used with a risk-return optimisation approach, can help investors make balanced and informed decisions. Additionally, the paper emphasizes the importance of continuous monitoring and portfolio adjustments to maintain alignment with evolving market conditions.

This dual approach to decision-making aligns closely with this study, which examined ChatGPT's potential to assist investors in achieving similar outcomes. Like the forecasting approach discussed in the paper, ChatGPT utilises data-driven insights to support informed investment decisions. Assessing ChatGPT's ability to analyse historical data mirrors the

forecasting model's predictive function, while its application in building portfolios based on financial metrics such as risk and return parallels the diversification goals of the Markowitz model. Moreover, Moeini Najafabadi et al. (2020) emphasis on ongoing monitoring and adjustment reinforces the potential value of ChatGPT's accessible insights, particularly for investors with limited financial expertise. Just as their study advocates a combined approach to ensure balanced portfolio performance, this study explores whether ChatGPT can enhance investment strategies by providing data-backed recommendations.

2.1.7. Extensions and Modifications to Modern Portfolio Theory

Sharpe extended Markowitz's work by distinguishing between systematic and idiosyncratic (asset-specific) risks. Diversification, a key principle in reducing idiosyncratic risk, is emphasized, while systematic risk (market) remains unavoidable and cannot be diversified away (Beyhaghi & Hawley, 2013).

This study attempted to utilise the principles of Modern Portfolio Theory to create portfolios that maximise returns while minimising the risk of a portfolio based on the investment advice provided by ChatGPT. Diversification is a central theme in finance, and when constructing a portfolio, the portfolio should be diversified to reduce the risk of the portfolio. (Fabozzi et al., 2002). Diversification means that an investor should not place all their eggs in a basket. This means that investing all your money in investments that may all fail at the same time, i.e., whose returns are highly correlated, is not a prudent investment strategy if one investment does not do well, the other investments will also fail, and thus the portfolio will also fail (Beyhaghi & Hawley, 2013). One of the central themes in the study was evaluating whether ChatGPT could advise on whether to invest in numerous companies and whether this will lead to the creation of a diversified portfolio that may outperform a fund manager's portfolio. By evaluating whether ChatGPT could create a portfolio with numerous industries and lower standard deviations, ChatGPT's ability to create a diversified portfolio was tested. The theme of diversification was particularly evident in this study when ChatGPT was asked to provide the optimal weightings to the stocks in each portfolio that would maximise returns and minimise risk based on the return data provided to the large language model for 2023.

Despite its foundational role, Modern Portfolio Theory faces criticism for its reliance on assumptions like normal distribution of returns and investor rationality, which do not always hold in reality (Beyhaghi & Hawley, 2013). Empirical evidence, especially with the rise of institutional investors, suggests that returns are not independent, and distributions are not normal (Beyhaghi & Hawley, 2013)

One of the most direct and widely used applications of Modern Portfolio Theory is how to allocate assets to a portfolio. As the asset allocation decision is fundamental, most asset managers and financial advisors determine an optimal portfolio for their clients by performing an asset allocation analysis using a set of asset classes. They start by selecting a set of asset classes, for example, domestic large-cap and small-cap stocks, long-term bonds, and international stocks. (Fabozzi et al., 2002). In this study, companies from the Johannesburg Stock Exchange were evaluated by ChatGPT and this included evaluating large, medium, and small-cap stocks. This is to ensure that the returns as well as the risk generated by each of the ChatGPT portfolios are comparable to the existing asset managers' South African equity portfolios which range from large to small cap stock across the Johannesburg Stock Exchange. To obtain estimates of the returns, volatilities, and correlations, asset managers and financial advisors usually start with the historical performance of the indexes representing these asset classes. Those estimates are used as inputs in the mean-variance optimization, resulting in an efficient frontier. Then, they pick an optimal portfolio. The final step is the portfolio being implemented using either index or actively managed funds (Fabozzi et al., 2002).

The ChatGPT-created portfolios were compared to fund-managed portfolios which all have indices that they are compared to. Implicitly, the ChatGPT-created portfolios were also compared to those respective indices although for the purposes of this study the returns were not compared to those respective indices. The fund-managed portfolios that this study used as comparison points were all actively managed portfolios as the ChatGPT portfolios were actively managed as well through the selection of the stocks to include in the portfolio based on an analysis of financial information that ChatGPT was prompted with and the industry of the companies which provided contextual information to ChatGPT.

2.1.8. Efficient Market Hypothesis (EMH) and its Implications for Investment Decision-Making

The Efficient Market Hypothesis (EMH), rooted in Modern Portfolio Theory, posits that asset prices fully reflect all available information, making it difficult to consistently outperform the market through active investment strategies. EMH's conceptualisation of informational efficiency suggests that securities are priced appropriately, as markets act as efficient "clearing houses" that instantaneously reflect information (Heymans & Santana, 2018). EMH categorises market efficiency into three forms—weak, semi-strong, and strong—based on the extent of information incorporated into asset prices.

In weak-form efficiency, all historical prices and volume data are reflected in asset prices, implying that technical analysis alone cannot yield abnormal returns. Semi-strong form efficiency contends that all publicly available information, including historical and new data, is embedded in prices, making both technical and fundamental analysis ineffective for outperforming the market. Lastly, strong-form efficiency assumes that all information, both public and private, is already factored into asset prices, suggesting that even insider information cannot yield excess returns (ğiĠan, 2015).

The practical application of EMH is limited by issues such as the joint hypothesis problem and high information-processing costs, which can lead to information asymmetry among investors (Beyhaghi & Hawley, 2013). Despite extensive amounts of research on the Efficient Market hypothesis, no consensus exists as to whether stock markets are efficient or not, and thus an assumption was made in this study to utilise existing information based on empirical research on the efficiency of the Johannesburg Stock Exchange. Empirical research on the Johannesburg Stock Exchange (JSE) by Heymans and Santana (2018) has found it to be weak-form efficient, indicating that historical information is already factored into prices but that certain information asymmetries may allow informed investors to earn excess returns. This aligns with this study's underlying assumption of weak-form efficiency on the JSE, supporting the use of historical financial data as a basis for investment decisions. Thus, investors, including those relying on actively managed portfolios, may still realise excess returns using strategies based on historical information.

2.1.9. The Grossman-Stiglitz Efficient Market Hypothesis (GS-EMH) and its Relevance to Active Management

The Grossman-Stiglitz Efficient Market Hypothesis, introduced by Grossman and Stiglitz (1980) and further discussed by Wermers (2020), challenges traditional Efficient market Hypothesis by recognising that markets cannot be perfectly efficient. If markets were fully efficient, there would be no incentive for investors to gather costly information, as prices would already reflect all available data. Instead, GS-EMH suggests a model of informational equilibrium, wherein markets are efficient in general but still accommodate active management. Investors who are skilled in information gathering and analysis, incurring lower marginal costs, can pursue active management and potentially achieve abnormal returns. Conversely, investors with higher information acquisition costs or less expertise are more likely to choose passive strategies or invest with skilled active managers who possess superior information-processing capabilities (Wermers, 2020).

In the GS-EMH framework, advanced technology further reinforces the advantages of skilled active managers. Fund managers who invest in costly information-gathering technologies gain a competitive edge by lowering the marginal cost of acquiring and processing information, thus securing a dominant position in the market for actively managed funds. These managers can deter competition from new entrants, who face higher costs for similar insights, and passive investors, who do not incur such fixed costs. Consequently, active managers with advanced technology can charge premium fees, recouping their fixed-cost investments and benefiting from the informational asymmetry they maintain (Wermers, 2020). This concept of varying costs and access to technology

Under GS-EMH underscores the coexistence of active and passive management, where each has its role based on investors' information-gathering costs and skills, which will be discussed in more detail below.

In the context of this study, the GS-EMH provides a compelling framework for understanding the potential role of ChatGPT as a low-cost, accessible tool that can assist investors with limited resources in gathering and analysing value-relevant information. Unlike proprietary technologies accessible only to select fund managers with significant capital investments,

ChatGPT represents a democratised approach to financial insights. By providing cost-effective access to advanced data processing and trend analysis, ChatGPT aligns with the GS-EMH notion that market inefficiencies can still be exploited by those equipped with superior information. This study explores whether ChatGPT, by lowering barriers to sophisticated analysis, can offer similar informational advantages to individual investors, allowing them to make more informed decisions without incurring the high costs associated with traditional active management.

While GS-EMH suggests that only the most skilled, technology-equipped managers can achieve above-market returns by efficiently processing information, ChatGPT may introduce an alternative pathway by enabling self-directed investors to access valuable insights at a reduced cost. In this sense, ChatGPT has the potential to shift the dynamics of information accessibility in financial markets. It empowers a broader group of investors, those without access to proprietary technology or extensive financial expertise, to make data-driven decisions, thereby challenging the traditional information asymmetries posited by both EMH and GS-EMH.

2.1.10. Investment strategies

The most prominent reason for investing in the investment world is to earn a return on investment, Rani (2012), however, selecting investments based on returns alone is not enough (Rani, 2012). Most investors invest their funds in more than one security which suggests that there are other factors, besides return, that must be considered. Investors not only like returns but also dislike risk, which is the central theme of this research report. Rani (2012) states that the financial market is a complex and volatile industry which requires critical analysis to adequately evaluate risks relative to returns to assist decisions as regards participation in the industry. Based on this, this research report posits that not all investors have the necessary critical analysis tools to evaluate risks relative to returns. As a result, these investors may turn to other tools that may aid them in this process, tools that have lower fees than those of fund managers. One such tool that investors may turn to is ChatGPT due to its perceived quality of response (Dowling & Lucey, 2023).

Edwin J. Elton and Gruber (1997) stated that one of the critical issues facing an individual is how to allocate wealth among alternative assets, and this essentially forms the basis of portfolio theory. Investment portfolio theories guide how investors or financial planners allocate money and assets within a portfolio, focusing on long-term goals rather than daily market fluctuations (Rani, 2012). These theories provide tools to estimate the expected risk and return of investments and will be discussed briefly below.

Passive portfolio theories emphasize minimal investor input, relying on diversification and market data to match the performance of a market index. Active portfolio theories are categorized into three types: Patient portfolios, aggressive portfolios, and conservative portfolios. Patient portfolios invest in stable, dividend-paying companies. Aggressive portfolios target riskier, high-growth stocks, resulting in higher turnover. Conservative portfolios focus on yield and long-term stability (Rani, 2012). Active portfolio theories can also be discussed broadly in terms of growth and value strategies which is discussed in detail below.

This study focuses on portfolio creation, specifically regarding whether ChatGPT can assist an investor in selecting stocks for a portfolio. ChatGPT was prompted to decide on whether to invest in a wide range of stocks on the JSE, comprising large, mid, and small-cap stocks. These ChatGPT-created portfolios will be compared to existing fund-managed portfolios, namely portfolios from Ninety One, Stanlib, Coronation, Sanlam Investment Management, and Allan Gray, the 5 largest asset management companies in South Africa (Investor, 2024). The fund-managed portfolios have a variety of active equity investment strategies, which in broad terms are classified into value and growth investment strategies and investing in varying stocks, from large to small-cap stocks across the 18 portfolios to which then ChatGPT-created portfolios were compared. Depending on the returns of the ChatGPT portfolios and the returns of the existing asset managers portfolio, this study aimed to conclude whether ChatGPT can outperform the fund managers in generating returns but also in minimising the portfolio risk and conclude which types of investment strategies ChatGPT excels at.

In any financial market analysis, if the objective of the analysis involves the determination of

stocks to buy and at what price, there are two basic methodologies, namely, Fundamental analysis and Technical analysis. Fundamental analysis posits that markets may misprice a security in the short run but that the "correct" price will eventually be reached. Profits can be made by trading the mispriced security and then waiting for the market to recognise its "mistake" and re-price the security. Technical analysis maintains that all information is reflected already in the stock price. Trends 'are your friend' and sentiment changes predate and predict trend changes. Investors' emotional responses to price movements lead to recognisable price chart patterns. Technical analysis does not care what the 'value' of a stock is. Their price predictions are only extrapolations from historical price patterns (Rani, 2012). Based on the information that ChatGPT will be provided with, this study utilised a type of fundamental analysis but did not focus on what price to buy the assets but rather focused on which stocks to invest in.

2.1.11. The Active vs. Passive Debate in Emerging Markets (South Africa)

The debate over active versus passive investment strategies has particular relevance in emerging markets, where market inefficiencies may offer opportunities for active managers to add value. Wessels and Krige (2005) evaluated South African equity funds and found that, although actively managed funds often outperform the index pre-cost, the ALSI index generally outperforms after costs are factored in. This finding aligns with Sharpe's Arithmetic of Active Management, which suggests that high costs lead to underperformance for active funds in the long term, even in less efficient markets.

Wessels and Krige (2005) further highlight that while active funds can occasionally offer downside protection during bear markets, they tend to underperform index funds in bull markets due to dilution from cash holdings. This study's focus on ChatGPT as an alternative low-cost analysis tool directly addresses the concerns raised by Wessels and Krige. Specifically, if ChatGPT can provide cost-effective insights comparable to active management, it may democratise access to quality analysis in a way that mitigates the high costs traditionally associated with active management in emerging markets.

2.1.12. Value vs. Growth Investment Strategies

Value and growth investing strategies represent two prominent approaches within portfolio management, each offering unique insights into stock selection. Chan and Lakonishok (2004) discuss the fundamental differences. Value investing relies on identifying undervalued stocks, often characterised by high book-to-market or earnings-to-price ratios, while growth investing focuses on companies expected to experience substantial future earnings growth. Value stocks tend to outperform growth stocks in the long term, which the authors attribute not to higher risk but rather to market inefficiencies and cognitive biases. Specifically, value stocks are often underpriced due to excessive investor pessimism, while growth stocks may be overvalued due to overly optimistic projections, which are frequently amplified by behavioural biases and agency costs in fund management (Chan & Lakonishok, 2004).

These dynamics are particularly relevant to this study, which investigates whether ChatGPT can replicate or support decision-making processes traditionally associated with active fund managers. ChatGPT's analytical capabilities suggest it may be well-suited to either value or growth strategies, as it can process and evaluate vast quantities of data, identifying potential investment opportunities based on financial metrics. The data-driven nature of value investing, characterised by metrics like price-to-earnings ratios and book-to-market ratios, aligns naturally with ChatGPT's ability to parse financial data for undervalued stocks. However, ChatGPT's forecasting abilities may also apply to growth investing, where it could analyse historical performance and relevant qualitative data (such as earnings announcements or market sentiment) to identify high-growth potential companies.

Furthermore, the implications of the findings of Chan and Lakonishok (2004) regarding market inefficiencies and investor biases are relevant to the exploration of ChatGPT's role in reducing cognitive biases associated with human investment decisions. This aligns with the Grossman-Stiglitz Efficient Market Hypothesis (GS-EMH), which acknowledges that skilled information processing can yield abnormal returns in otherwise efficient markets. ChatGPT could serve as an accessible, low-cost tool for individual investors, enabling them to capitalise on information traditionally leveraged by professional fund managers and thereby reduce barriers to high-quality, data-informed investment strategies.

Given that the study compares ChatGPT-generated portfolios to those actively managed by professional fund managers, an investigation into whether ChatGPT is more aligned with value or growth investing principles remains open. By assessing the relative performance of these portfolios, the results section will explore whether ChatGPT tends to one strategy over the other, contributing to the broader understanding of how generative AI models fare with value-focused versus growth-based investment approaches.

3. Method

Chapter 3 covers the method that was used in this study. Firstly, the research questions are restated followed by an overview of the method that was undertaken in this study. Next the population and sample size are defined, followed by a discussion on how the data was collected and the data analysis. Next the ethical considerations are discussed followed by a discussion on the assumptions and limitations of the study. Finally, this section concludes with a discussion of how the validity as well as the reliability of the results were maintained in the study.

Research Questions:

Research Question 1: How do the average quarterly returns of portfolios created using ChatGPT, compare to those of professional fund managers in South Africa, based on the fund managers' investment strategies?

Research Question 2: How does the standard deviation of quarterly returns, as a proxy for risk, differ between ChatGPT-generated portfolios and professional fund manager portfolios in South Africa?

Research Question 3: How do the average quarterly portfolio returns based on ChatGPT's weightings differ to the average quarterly portfolio returns of equally weighted portfolios?

3.1. Method Overview

ChatGPT 4. O's ability to assist investors in making investment decisions was evaluated and this study was a quantitative study. The reason for using ChatGPT 4.O is that it is the most advanced model of ChatGPT, being the paid version of ChatGPT, and research has indicated that ChatGPT has become financially literate with ChatGPT 4 having outperformed ChatGPT 3,5 on basic financial literacy tests obtaining a 99% score on financial literacy tests (Niszczota & Abbas, 2023) . This version of ChatGPT was also used in this study to reduce misinformation produced by the large language model since this is the premium version of ChatGPT and is prone to less hallucinations. This study used prompt engineering, a

technique that focuses on creating prompts to generate the most accurate responses using generative artificial intelligence (AI) (Mungoli, 2023). This was performed by comparing the returns as well as the risk for existing portfolios managed by fund managers at the 5 largest institutional investors in South Africa, with those for a portfolio created based on the investment advice provided by ChatGPT to invest or not to invest in the stocks. The differences between groups statistical tests were performed to determine whether the ChatGPT-created portfolios outperformed the fund-managed portfolios in generating returns and reducing risk (standard deviation) and whether these results are statistically significant to conclude whether ChatGPT can outperform a fund manager in generating returns but also reducing risk.

ChatGPT was prompted to assume the role of a fund manager based on research that providing a role to ChatGPT improves the accuracy of the responses from the large language model (Nyakundi, 2023), (Mungoli, 2023) and (Barrett, 2023). ChatGPT was then prompted with the investment strategies of the 18 funds to which the portfolios created based on ChatGPT's advice would be compared. The financial information of the company under evaluation as well as the industry that the company operated in was then provided to ChatGPT with the large language model then prompted as to whether the user should invest or not invest in the company based on the investment strategy of each of the 18 portfolios to which the ChatGPT created portfolios would be compared.

The evaluation of each company was done on a company-by-company basis and all the companies on The JSE were evaluated using the advice of ChatGPT to determine whether to invest or not to invest in the companies for the purposes of each portfolio. ChatGPT was prompted to conclude on the level of profitability, the level of risk as well and the past dividend information at that company as well as by considering the industry in which the company operates, and any risks and opportunities associated with that industry. On the basis that accounting information is value-relevant for investors as noted in the literature review section, ChatGPT was prompted with accounting financial information and asked to decide on whether to invest in each company based on whether investing in that stock would meet the investment strategies of those portfolios. If ChatGPT advised the user to invest in the company, the company was included in the portfolio. The prompts were carefully crafted

using the principles of prompt engineering as discussed in section 2 of this document. An example of the prompts used in the study has been included in Appendix 1 to enhance the replicability of the study.

The financial information that was included in the prompts provided to ChatGPT were the statement of comprehensive income, statement of financial position, the statement of cash flows, the financial ratios of the company pertaining to financial risk, liquidity, management efficiency, operating efficiency, operating profitability as well as valuation ratios as well as the consensus estimates from financial analysts for that company as well as a summary of the financials of the company which included metrics such as the market capitalisation of the company and summarised all the other statements.

Once all the companies were included in all 18 portfolios, the individual company returns were obtained from the EquityRT database using an EquityRT plug-in, in Microsoft Excel. The returns were based on the closing share price which included the effects of dividends. This is because the returns for the fund-managed portfolios were obtained from the Citywire database and this is the method used for reporting the total returns for the portfolios and, as a result of this, this study followed the same approach to ensure that the returns of the ChatGPT created portfolios and the existing fund managed portfolios were comparable.

Once all the companies were added to each portfolio created based on the advice of ChatGPT a final prompt was provided to ChatGPT asking it to determine the optimal weighting of the stocks in each portfolio that will maximise returns but result in the lowest risk (as measured by the standard deviation of the portfolio returns). A limit was placed on the number of funds in which ChatGPT could invest, this limit was the fund size of the corresponding existing fund-managed portfolio to which the ChatGPT-created portfolio was compared. Essentially ChatGPT was asked to solve a portfolio optimisation problem, in line with the principles of Modern Portfolio Theory. ChatGPT had to be provided with and "reminded" of all the companies that it had selected for each portfolio because the large language model did not have sufficient memory to "remember" and store all the companies that it had evaluated and included in each portfolio. The companies in each portfolio as well as the share prices for these companies at the start of each quarter were provided to ChatGPT

so that ChatGPT could assign the optimal weightings to the stocks for the 2023 year. Once the weightings were provided the ChatGPT portfolio returns were computed, and the standard deviations were then also computed from the portfolio returns.

The monthly returns for the existing fund-managed portfolios were obtained from the Citywire database. These returns were then converted to quarterly returns and the standard deviation of each of these portfolios was then computed as the standard deviation provided on the Citywire database is an annual standard deviation. The returns and the standard deviation of each of the portfolios created were then compared to the corresponding portfolio whose investment strategy the ChatGPT-created portfolio was based on, and the differences between groups statistical tests were performed using SPSS as discussed below in section 3.4., data analysis.

3.1.1. Development of the standardised prompts for the study based on the literature

ChatGPT was tasked to evaluate the financial information as well as the industry relating to companies listed on the JSE to decide whether the researcher should invest in the company or not based on whether it thinks that the company would be a good fit for the portfolio. The investment strategies of the existing asset manager's portfolio were provided to ChatGPT to achieve this. ChatGPT had to evaluate each company first and later also provided the optimal weightings for each company within the portfolio based on its evaluation of all the companies, which it "thinks" will help achieve the highest returns while minimising the risk of the portfolio, in line with the objectives of Modern Portfolio Theory as the underpinning theoretical framework for this study.

Prompt 1(overall prompt for the project as a whole): ChatGPT will first be asked to assume the role of an investment professional. This is based on the evidence of prompt engineering techniques where it's been found that providing a role and context to large language models improves the output from the models (Mungoli, 2023).

"I need you to assume the role of a fund manager"

Prompt 2 (overall prompt for the portfolio): The researcher then indicated the tasks that ChatGPT must perform after providing the large language model with context.

“I need you to construct portfolios for me. I am going to provide you with the investment strategy of the portfolios. Once I have given you the objectives of the portfolios, I will provide you with historical financial information related to the company under evaluation. I will also tell you what industry this company is in for you to analyse the industry and discuss the industry-specific risks for this company for you to evaluate.” The reason for prompting ChatGPT with this information is because prior research has found that financial information from financial statements is value-relevant and has an effect on share prices and consequently investors' decisions (Ighosewe, 2022). Ighosewe (2022) found that there was a higher value relevance of accounting information in post-IFRS periods than in the pre-IFRS periods in Nigeria and South African firms. Obaidat (2016) investigated the accounting information that is considered more value-relevant for individual investors in the Amman Stock Exchange, emphasizing earnings and cash flow information. Their findings indicated that investors perceived all accounting information to be value-relevant and considered it to be complementary to each other, where the most value-relevant information was the financial risk followed by previous earnings, liquidity, expected earnings, and market stock price. Their results indicated that the value relevance of earning information is superior to the value relevance of cash flow information (Obaidat, 2016).

“I need you to conclude on the profitability of the company, and the level of risk of this stock and based on all the information conclude on whether investing in the company will meet the objectives of the portfolios and whether to invest in the company or not for each portfolio.” This Prompt ensured the fact that investors like to generate returns while they do not like risk as discussed by Rani (2012) was incorporated into the prompt as well as research indicating that providing explicit instructions improves ChatGPT’s responses (Mungoli, 2023).

“Do not access the internet and only use the information that I provide you with to make an investment decision on this company.” This prompt was based on the fact that using the internet and accessing other information could lead to ChatGPT using data that it had been trained on in training data and prior research has found that ChatGPT has biases in its training

data and may reproduce those biases by using information that it has been trained on. (Rane, 2023). ChatGPT's ability to evaluate given data and select stocks is what was under evaluation in this study.

Prompt 3: "Here is the financial information relating to company 1 'insert company name' for you to analyse which operates in the 'insert industry'. 'Insert documents relating to the income statement, balance sheet, cash flows, financial ratios, consensus estimates, and dividend payments. You may now perform the analysis as required above"

The instructions that ChatGPT was provided with were saved and stored in its memory so that the user did not have to keep repeating the prompt, however, at the start of each session the user would start each session with the following prompt "Please access your memory. We are going to continue with the portfolio construction project. Please tell me what your instructions are so that I can review them before we continue". This was based on the large body of research that indicates that ChatGPT "hallucinates" and that it is important to verify the outputs as discussed by (Pisaneschi, 2024).

The final prompt, once all the companies had been selected for each of the 18 ChatGPT portfolios was as follows: "These are the companies that you have included in this portfolio. I need you to provide the optimal weightings that will maximise the returns while minimising the risk of the portfolio. The closing share prices at the start of quarter 1 have been provided for you to use in your asset allocation calculations. The fund size is as follows 'insert fund size' " This prompt incorporated the use of Modern Portfolio Theory in maximising the returns and minimising the risk of the portfolio as a whole (Beyhaghi & Hawley, 2013). Furthermore, one of the assumptions of this study as detailed in the method section of this document is the fact that the funds to invest were not unlimited but rather ChatGPT would be constrained by the size of the corresponding existing fund-managed portfolio.

3.2. Population

The population for this study is the portfolios of the asset managers at the 5 largest asset management companies in South Africa. The 5 largest asset management companies in South Africa are Ninety One, Stanlib AM, Coronation, Allan Gray, and Sanlam Investment Management (Investor, 2024). The study used all the actively managed portfolios of these companies as the researcher, with the assistance of ChatGPT, actively managed the ChatGPT portfolios through selecting the stocks via analysis of the company's financial information to generate returns and minimise risk for comparison to the existing fund-managed portfolios returns and risk. This study created portfolios based on whether ChatGPT advised the researcher to invest in the companies based on whether investing in those companies will meet the trading strategies of the abovementioned portfolios. The returns as well as the risk of the ChatGPT-created portfolios were then compared to these asset managers' portfolios.

3.3. Sample

The asset managers portfolios that this study made comparisons to, were the South African equity portfolios of Ninety-One, Stanlib AM, Coronation, Allan Gray, and Sanlam Investment Management. In determining which funds to include in the analysis, any funds that had invested in overseas listed entities that are not listed on the JSE were excluded. The result of this is that the funds selected had an investable universe of JSE-listed stocks only. The funds selected also had to be equity instrument focused to ensure comparability between the portfolios created based on ChatGPT's portfolio selection advice and the existing portfolios. The sample because of the aforementioned information, consisted of 18 portfolios as listed below in Appendix 3. Any fund of funds and exchange-traded funds of the abovementioned asset management companies were excluded from the sample.

3.4. Data collection

All the financial information as well as the industry classifications relating to all the companies listed on the Johannesburg Stock Exchange were obtained manually from the EquityRT database accessed through the University of the Witwatersrand. The closing share prices as at the start of each of the quarters for 2023 as well as the change in closing share

prices (including dividends) were obtained through an EquityRT plugin in Microsoft Excel for the calculation of the individual company returns and subsequently the portfolio returns. The share price data was obtained for the following periods, Quarter 1, 03 January 2023-31 March 2023, Quarter 2,03 April 2023-30 June 2023, Quarter 3 03 July 2023- 29 September 2023, and Quarter 4, 02 October- 29 December 2023 (for the calculation of returns for the back testing to be performed). The portfolio returns were computed using Microsoft Excel as the change in closing share prices over the closing share prices at the start of each quarter expressed as a percentage. All the fund-managed portfolios were accessed and obtained from the Citywire website which has information on funds available in numerous countries globally, including South Africa (Citywire, 2024a). All the information relating to the portfolios created based on ChatGPT's investment advice as well as the corresponding portfolio of the fund managers were tracked using Microsoft Excel and these decisions were then subsequently used to create the ChatGPT-created portfolios.

The investment strategies of the existing fund-managed portfolios were obtained from the minimum disclosure documents that each of these funds is required to produce which are available on each of these asset management companies' websites. The fund size in Rands for each existing fund-managed portfolio was obtained from the Citywire database to ensure that the ChatGPT portfolios and the existing fund managers portfolios were comparable in size.

Despite using ChatGPT 4.0 the premium (paid) version of ChatGPT, challenges were encountered using the large language model. Only 10 companies could be evaluated per 3-hour session due to the rate limits imposed by OpenAI. With the large volume of documents provided for each company, this reduced the number of companies that could be evaluated every 3 hours which is when the limit would reset. Furthermore, challenges were encountered in that even though the instructions that ChatGPT had to follow were saved in its memory, the tool would not perform the analysis in the same manner in each session and as a result, at the start of each session, ChatGPT was prompted to repeat its instructions which would then be evaluated by the researcher and any amendments made as required before the companies could be evaluated in the manner required in that session.

3.5. Data analysis

Research Question 1: To answer this research question and test the related hypothesis as set out in section 1 of this document, a difference between groups' methodology was utilised. The independent variables for this research question were the groups that were being compared, namely the portfolios created based on the investment advice provided by ChatGPT and the corresponding existing fund-managed portfolios on which the ChatGPT created portfolio's investment strategies were based. The dependent variable for this research question was the average quarterly returns generated by each of the portfolios, both the ChatGPT-created portfolios as well as the existing fund-managed portfolios.

An equally weighted ChatGPT-created portfolio was added to the study to determine how the ChatGPT-created portfolios would fare without the weightings assigned by ChatGPT. The equally weighted portfolios were weighted by using the number of stocks within the portfolio. The weight that was assigned to each stock within the portfolio was the proportion of each stock in the portfolio calculated as 100/n, where n was the number of stocks in the portfolio. A difference between groups methodology was also followed to compare the equally weighted ChatGPT-created portfolios and the corresponding existing fund-managed portfolios to determine what effect the ChatGPT weightings had on the returns of the portfolios.

Once the portfolios were constructed based on the investment advice provided by ChatGPT, i.e. the companies to be included in the portfolios were obtained, the closing share prices, which were adjusted for dividends were extracted from the EquityRT database using an EquityRT plug-in in Microsoft Excel, for each company. The returns were then computed in Microsoft Excel using this data, calculated as the capital appreciation of the closing share prices over the respective quarters, over the share price at the beginning of each quarterly period expressed as a percentage. After ChatGPT was prompted to provide the optimal weightings for each stock within the ChatGPT-created portfolio, the average quarterly returns were then calculated in accordance with the formula below.

For the equally weighted portfolios, ChatGPT was not prompted to provide the optimal weightings, and the weightings were manually assigned to each stock within the portfolio, and the average quarterly return was calculated in accordance with the formula below.

the mean of the return of the portfolios was calculated per the following formula (MIT, 2024)

$rp = \Sigma rp = \Sigma(Xiri)$ $where\ rp\ represents\ the\ returns\ of\ the\ portfolio$

Where: Xi- Represented the weight of the individual stock within the portfolio; ri- represented the return of the individual stock within the portfolio.

Returns are commonly referred to as the mean or average. Return can be seen as the historic average of a stock's return over a given period (Mangram, 2013). Calculations for a portfolio of securities involve calculating the weighted average of the individual returns (Mangram, 2013).

"Unless otherwise stated the performance of investment trusts and equities is considered on the basis of closing price to closing price (close-to-close) for all periods. Analysis is considered with net income reinvested at the dividend payment date, except in cases where investment trust net asset values are concerned when the performance figures are quoted with income withdrawn."(Citywire, 2024b). This is an extract from the Citywire database where the returns relating to the asset manager's portfolios were obtained. To ensure comparability of the ChatGPT portfolios and the asset manger's portfolio, share prices were treated cum dividend based on closing share prices in order to calculate the returns. I.e. The Capital appreciation and the dividends made up the total return for the ChatGPT portfolios to compare to the asset manager's portfolio returns.

The returns were first tested to determine whether the returns were normally distributed. This was performed to determine whether the independent samples t-test or the Mann-Whitney U test was the appropriate statistical test to perform on the returns to determine whether the differences between the existing fund-managed portfolios and the ChatGPT-created portfolios were statistically significant. The key differentiator in whether to perform the

independent samples t-test or the Mann-Whitney U test is whether the returns are normally distributed or not. Normally distributed returns would have meant that an independent samples t-test would be performed. A Mann-Whitney U, a non-parametric test would be performed if the returns were not normally distributed.

The Shapiro-Wilk test was performed to determine whether the returns were normally distributed or not. The null hypothesis of the Shapiro-Wilk test posits that the data are normally distributed, while the alternative hypothesis suggests a deviation from normality. If $P>0.05$, the returns are consistent with a normal distribution, supporting the use of a parametric test, in this case, the independent samples t-test and the Null hypothesis would be retained. If $P\leq0.05$, the returns deviate significantly from normality, necessitating the use of a non-parametric test, in this case, the Mann-Whitney U test would be performed, and the null hypothesis would be rejected. The results of the Shapiro-Wilk test indicated that the returns were not normally distributed, and that the Mann-Whitney U test would need to be performed to determine whether the differences between the returns of the ChatGPT portfolios and their corresponding fund manged portfolios were statistically significant. The results have been included and discussed in section 4, the results section of this paper.

The Mann-Whitney U Test was performed to determine whether the differences between the returns of the abovementioned portfolios were statistically significant and to determine whether the study could conclude that ChatGPT is able or is unable to outperform fund managers in generating portfolio returns. If the p-value is less than the significance level (e.g., $\alpha=0.05$\alpha = 0.05$\alpha=0.05$), you reject the null hypothesis. This means there is a statistically significant difference between the two groups. If the p-value is greater than the significance level of 0.05, you fail to reject the null hypothesis. This means the observed difference is not statistically significant. The results of the Mann-Whitney U test have been included in section 4, the results section of this document.

Research question 2: Once the total returns were computed for the portfolios (the ChatGPT-created portfolios and the existing fund-managed portfolios) descriptive statistics were then computed using SPSS to obtain the standard deviations (a measure of risk) of the average returns of the portfolios created based on ChatGPT's investment advice.

To answer this research question a difference between groups' methodology was utilised. The independent variables for this research question were the groups that were compared, namely the ChatGPT-created portfolios and the corresponding fund-managed portfolios which the ChatGPT portfolios were being compared to. This is because the stocks included in the portfolios determined the volatility of the returns as measured by the standard deviation of the returns (a measure of risk). The dependent variable for this research question was the volatility of the returns (standard deviation) for the groups (the ChatGPT-created portfolios and fund-managed portfolios). An equally weighted ChatGPT portfolio for each of the investment strategies was also constructed as a comparison point and a difference between groups' methodology was also performed between these portfolios ChatGPT equally weighted portfolios and the fund-managed portfolios' risk levels (standard deviations).

The standard deviations (risk) of the portfolios were first tested to determine if they were normally distributed to determine which statistical test, an independent samples t-test or a Mann-Whitney U test would be more appropriate to compare the risk levels of the ChatGPT-created portfolio and the fund-managed portfolios. The Shapiro-Wilk test was performed on the standard deviations as was performed above for the portfolio returns with the same interpretation of the P-Values (significance level) and the same decisions to reject or fail to reject the null hypothesis. This test indicated that the standard deviations were not normally distributed and therefore a Mann-Whitney U test was performed on the portfolio standard deviations to determine whether the difference in standard deviations (risk levels) was statistically significant. The results of the Shapiro Wilk Tests have been discussed in more detail in section 4 of this document, the results section.

The interpretation of the Mann-Whitney U test and the P-values (significance level) remains the same as for the discussion above in the data analysis section for research question 1. The only difference is that in this case, a positive result would be the ChatGPT-created portfolios generating lower standard deviations than the fund-managed portfolios and a statistically significant difference, rather than returns that are statistically significantly higher as was the case above.

Should the standard deviations for the ChatGPT-created portfolios yield a lower standard deviation and the difference is found to be statistically significant after performing the Mann-Whitney U test (assumptions to be discussed below) then the study would conclude that the null hypothesis was rejected which would provide evidence that ChatGPT may generate portfolios with lower risk than that of existing fund managed portfolios.

The total risk of a portfolio is defined as the standard deviation of the returns of a portfolio and can be computed using:

$\sigma_p = \sqrt{(\sum_{i=1}^{n} (w_i^2 \sigma_i^2) + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} w_i w_j \sigma_{ij})}$ (Bradfield & Munro, 2017)

Where: σp= Portfolio Standard Deviation- The square root of the portfolio variance. This gives the overall risk or volatility of the portfolio in the same units as the asset returns. Standard deviation is one of the most commonly used metrics for measuring portfolio risk. A higher standard deviation indicates greater volatility and risk in the portfolio (Biglova et al., 2004).; Wi and Wj= Weight of Asset I and j. The proportion of the portfolio invested in each of the assets in the portfolio. These weights must sum to 1 across all assets in the portfolio (Biglova et al., 2004). σij =Covariance between Asset i and Asset j. The covariance between the returns of asset i and asset j. Covariance measures how the returns of the two assets move together (Mangram, 2013).

Meeting the assumptions to perform the Mann-Whitney U test

To compare the returns as well as the risk (measured by the standard deviation) of the abovementioned groups, a difference between-groups test needed to be performed. Each portfolio created based on ChatGPT's investment advice was compared directly to the corresponding fund-managed portfolio as ChatGPT used the investment strategy of that fund-managed portfolio to create the portfolio to ensure that the portfolios were comparable. In determining which statistical tests will be performed to compare the ChatGPT portfolio and the fund-managed portfolio the following was considered:

The independent variables are made up of categorical independent groups, the groups being compared, the ChatGPT-created portfolios and the existing fund-managed portfolios. The portfolios that are were being compared i.e. the fund-managed portfolios and the ChatGPT portfolios were constructed independently. The fund-managed portfolios had already been constructed by their respective fund managers, and the ChatGPT-created portfolios were constructed by the researcher based on the investment advice of ChatGPT, because of this, there was independence of observations between the groups (the portfolios). The dependent variables in the study for research questions 1 and 2, the average returns of the portfolios (RQ 1) as well as the standard deviation of the portfolios (research question 2) were continuous. Prior research has found that stock returns are not normally distributed (Beyhaghi & Hawley, 2013). In comparing the two groups, the independent samples t-test could not be performed because the average returns of the portfolios and standard deviations of the portfolios were non-parametric (confirmed by the results of the Shapiro Wilk tests performed on both the portfolio returns as well as the portfolio standard deviations). As a result of the abovementioned assumptions for the Mann-Whitney U tests were met, and the Mann-Whitney U test was performed to compare the ChatGPT-created portfolios as well as the fund-managed portfolio's risk and returns.

3.6. Ethics

An ethics waiver was obtained for this study. All the data to be obtained and utilised in this study is publicly available and there was no risk relating to the study, as a result of this, no ethics clearance was necessary to conduct this study.

3.7. Assumptions

The portfolios to be created are for the 2023 quarterly periods (January–March, April–June, July–September, and October–December). The companies listed on the Johannesburg Stock Exchange have different year ends. To ensure that the portfolios created based on the investment advice provided by ChatGPT were comparable to the existing fund-managed portfolios, for the instances where ChatGPT advised the user to invest, the company was included in the ChatGPT created portfolio from the beginning of the 2023 year.

The assumptions of Modern Portfolio Theory were utilised for the study. The assumptions of Modern Portfolio Theory are as follows: (1) Markets are efficient (based on efficient market hypothesis). This assumption applies as the Johannesburg Stock Exchange has been found to be weak form efficient (ğiĠan, 2015). ; (2) investors are rational. This study attempted to maximise returns for the least amount of risk which is consistent with the actions of rational investors (Rani, 2012). (3) A market index can be used as a proxy for the market portfolio. Each of the portfolios that the ChatGPT created portfolios were compared to have a benchmark index. The ChatGPT portfolios were assumed to have the same indices although this study did not explicitly make comparisons to those indices. (4) Investors are price takers and cannot affect security prices, which in the case of this study was also the case as the user nor the asset managers could affect security prices. (5) There is unlimited liquidity and unlimited capital. This study will assume that there are unlimited funds available to invest in the shares to ensure that funds are not a limitation when selecting stocks to invest in to create the portfolio. Modern Portfolio Theory is also based on several critical assumptions one of which is the fact there is unlimited liquidity and unlimited capital (Beyhaghi & Hawley, 2013). Despite the study assuming that there are unlimited funds to invest, the size limit in terms of funds for the ChatGPT portfolios was limited to the same fund size as the corresponding existing asset managers portfolios to ensure comparability of the results.

Due to the fact the information relating to the funds was obtained from the Citywire database, this study ensured that the funds were created based on the same assumptions as those used on the Citywire website. “Unless otherwise stated the performance of investment trusts and equities is considered on the basis of closing price to closing price (close-to-close) for all periods. Analysis is considered with net income reinvested at the dividend payment date, except in cases where investment trust net asset values are concerned when the performance figures are quoted with income withdrawn.” (Citywire, 2024b). This is an extract from the Citywire database where the returns relating to the asset manager’s portfolios were obtained. To ensure comparability of the ChatGPT portfolios and the asset manger’s portfolio, share prices were treated cum dividend based on closing share prices to calculate the returns. I.e. The Capital appreciation and the dividends made up the total return for the ChatGPT portfolios to compare to the asset manager’s returns. The returns on the Citywire

website do not include the effects of the annual management fee and this was therefore not considered when computing the portfolio returns for the ChatGPT portfolios.

3.8. Limitations

ChatGPT can provide misinformation in its current state (Khan & Umer, 2024). It was assumed that any misinformation that it may provide would translate into poor returns and higher risk for the portfolio and would present itself in the output. The study is based on ChatGPT's responses to prompts that it is provided. The quality of the responses is based on the quality of the prompts (Pelster & Val, 2024b). ChatGPT is also subject to "hallucinations" where it may provide incorrect information if the quality of the prompt is poor. To overcome this limitation of "hallucinations", this study has carefully incorporated the use of prompt engineering to get the most accurate responses from ChatGPT as discussed in the literature review under the section "prompt engineering". By using the paid (premium) version of ChatGPT, ChatGPT 4, this study mitigated against misinformation from the model by using a more advanced model.

Despite the measures taken to mitigate the "hallucinations of ChatGPT", the large language model did still "hallucinate". ChatGPT would often try to access the internet and would not solely use the information that was provided it with, which is problematic as it would utilise different sources which would reduce the reliability of the study. The prompts would then have to be repeated with more explicit instructions not to access the internet. Furthermore, ChatGPT would sometimes use financial data that it was prompted with from another company rather than the company under evaluation, and as a result, the researcher would then have to verify all the analysis and restart the analysis.

To overcome the limitation of ChatGPT reproducing biases in its training data as discussed in section 2 of this document the study ensured that it provided the financial information to ChatGPT in the prompt to ensure that the large language model has not been trained on the data which may contain biases so as to not influence the results. The prompt has been modified in the delimitations section of this document to overcome this limitation.

This study involved constructing portfolios based on historical financial information as well as historical returns, with a look-back period between January to December 2023 and back testing performed over this period for the portfolio returns as well as the portfolio standard deviation for the ChatGPT-created portfolios. This is a limitation as the results cannot be used to conclude whether ChatGPT will be able to construct a portfolio and generate returns and risk that outperform a fund manager in the future, however, the results can be used as an early indication of ChatGPT's ability to select stocks for portfolio and potentially outperform fund managers for future returns and risk. The use of a lookback period and creating portfolios based on historical returns using back-testing has been undertaken in previous studies. Moodley et al. (2016) used historical returns to create portfolios based on director dealings. Ko and Lee (2024a) used 1-year return data from January 1, 2021, to December 31, 2021, for the in-sample period to estimate the expected return and covariance of the portfolios in their study. They considered a total of 13 months from January 1, 2022, to January 31, 2023, as the out-of-sample period but followed a similar approach that this study will use by creating portfolios using ChatGPT's investment advice using historical returns.

Most of the existing funds have long-term investment horizons. This study only considered ChatGPT's ability to assist in making investment decisions in the short term to evaluate the large language model's ability to select stocks and generate high returns while minimising risk. This study did not focus on the long-term horizon in the same way that the asset managers would, and this has been included as an area for future research.

3.9. Validity

ChatGPT was prompted to ensure that it did not use the information from the World Wide Web or information already in its training data but rather, to utilise only the information that it was provided within the prompts to evaluate each company and decide on whether to include the company in each of the portfolios or not. This overcomes the limitation of having ChatGPT trained on the data to reduce any bias in its responses based on biases already incorporated within its database which is a similar approach taken in a study by Pelster and Val (2024a).

Pelster and Val (2024a) also found that ChatGPT does not always deliver complete factual accuracy but rather the factual accuracy increases over time. This study was not focused on ChatGPT's ability to provide factual accuracy but rather on its ability to provide advice based on the financial information of the company under evaluation and any misinformation would be incorporated in the returns and risk of the ChatGPT created portfolios (outputs). Despite this, it was important that even though the study was not focused on ChatGPT's ability to provide factual information, that ChatGPT used the correct information that it was provided with in performing its analysis. The responses from ChatGPT were evaluated to ensure that the large language model performed the analysis on the correct financial information. There were instances of the ChatGPT being subject to "hallucinations" where it used financial data of a different company from the company that it was evaluating at that moment in time and as a result that analysis would not be used in constructing the portfolio, and the analysis would then have to be reperformed. This would often occur near the end of each session where the rate limit for the 3-hour session was nearly exceeded.

The incorrect portfolio recommendations provided by ChatGPT were tracked although the portfolios themselves were not adjusted for this fact. This is because the objective of the study was to determine ChatGPT's ability to select stocks and in selecting the incorrect stock for a particular investment strategy, this would add to the findings of the study. For example, there were instances where ChatGPT advised the user to invest in a particular stock even though the investment strategy of that portfolio was focused on small to mid-cap stocks and the stock under evaluation was a large-cap stock. This has been included and discussed in the results section.

The study has also made use of transparent standardised prompts and included all the prompts which were utilised in the study in an appendix. Using standardised prompts improves the validity in several ways. Firstly, ChatGPT's responses can vary based on how the prompt is structured as detailed in the literature review of this document (Pisaneschi, 2024). Standardising the prompts across all the companies and funds ensured that there were more consistent outputs from the large language model and reduced the variability in ChatGPT's responses (Barrett, 2023). Including the prompts that were used in the study, also ensures the replicability of the study which relates to the reliability of the study and is undertaken in

many of the finance studies relating to ChatGPT such as those of (Ko & Lee, 2024a; Pelster & Val, 2024b; Romanko et al., 2023).

3.10. Reliability

O'Leary (2023) found that ChatGPT provided an original essay the first time asking with a 0% score on Turnitin. When ChatGPT was prompted with the same question the Turnitin score increased with each subsequent prompt however the essays were similar but not identical. When prompting ChatGPT with the same prompt from different devices, ChatGPT will provide a different response. The researcher in this case has undertaken this task on multiple devices and accounts to evaluate what responses ChatGPT provides. When using the same prompt ChatGPT provides the same overall answer e.g. when prompted to advise on the level of risk, the level of financial performance as well as the final investment decision, the reasons do differ slightly, but the final investment decision does not change. This demonstrates that anyone could follow the same method and get the same results and ensures the repeatability of the study (Leedy & Ormrod, 2015).

The fact that ChatGPT was prompted with specific financial information and the industries of each company and not information within its training data or from the internet as well as specific asset managers' investment strategies and not just using its judgement to include companies in each portfolio ensures the replicability of the study. When extracting data from the World Wide Web, ChatGPT uses different sources and as a result, this would introduce issues with the reliability of the responses from ChatGPT. Furthermore, providing ChatGPT with the specific investment strategy of each portfolio improves the reliability of the study as each company is evaluated based on the same criteria to either be included or excluded from each portfolio. To ensure the replicability of the study, the investment strategies for each of the fund-managed portfolios to which the ChatGPT created portfolios were compared have been included below in Appendix 3.

Ko and Lee (2024a), Romanko et al. (2023) and Oehler and Horn (2024) in their studies, all repeated the prompts or the process they used to create portfolios based on ChatGPT's advice on numerous occasions as a robustness test. This study followed a similar approach by asking ChatGPT to repeat the analysis, however, there were few instances where the

investment decision of ChatGPT changed which indicates an anchoring bias in the way that ChatGPT functions. This is consistent with the results of Nguyen (2024) who found the presence of anchoring bias in 4 Large language Models (LLMs), including ChatGPT 3 and 4 in their randomised control trials where they used AI in predicting finance values. This combined with prompt engineering techniques as discussed in the literature review section of this document as well as the prompts which were utilised in the study having been included in Appendix 1, improves the reliability of the study. Leedy and Ormrod (2015) State that for quantitative research, replication of the process used in a study in a different context can improve its reliability. Leedy and Ormrod (2015) also state that a representative sample can add to the reliability of the results for quantitative research. Evaluating all the companies on the JSE, constructing portfolios, and comparing them to numerous (18) portfolios also improved the reliability of the results for this study.

4. Results

The research results will be presented and discussed for the purposes of answering the research questions of the study. Section 4.1 discusses the results of the return performance of the ChatGPT portfolios compared to those of the corresponding existing asset managers portfolios for Research Question 1. Section 4.2 discusses the results of the risk performance of the ChatGPT portfolios compared to those of the corresponding existing asset managers portfolios for Research Question 2, with research question 3 and the related hypothesis having been discussed as a controlled variable.

4.1. A comparison of the return performance of the ChatGPT portfolios and the existing asset managers portfolios.

To answer research question 1, the average returns were computed for the ChatGPT portfolios and the corresponding existing asset managers portfolios. This was performed using descriptive statistics, namely the mean of the quarterly returns were computed for each portfolio for the quarterly periods in 2023. Next the Mann-Whitney U test was performed to determine whether the differences in the average quarterly returns for the ChatGPT portfolios and the corresponding ChatGPT portfolios were statistically significant.

To determine whether the Mann-Whitney U test was the appropriate statistical test to perform, the average quarterly returns had to be tested to determine whether they were normally distributed, in which case an independent samples t-test would be performed or not normally distributed in which case, the Mann-Whitney U test (the non-parametric equivalent) would be performed.

4.1.1. Testing the average quarterly returns for the normality of the data

To test the normality of the data, the Shapiro Wilk test was performed over the average quarterly returns for each portfolio. The Shapiro Wilk test is normally performed when the sample size is less than 50 (Mishra et al., 2019). For this study, 18 ChatGPT portfolios were constructed and compared to existing corresponding asset managers portfolios and thus the 18 ChatGPT portfolios make up the sample size of 18 as set out in the method, section 3.2. sample.

The null hypothesis of this test is that the data is normally distributed (Mishra et al., 2019). The results of the Shapiro-Wilk test indicate that the data is not normally distributed as seen below. The p-values from the standard deviations are greater than 0.05 which means that the null hypothesis can be rejected for the ChatGPT portfolios and that the portfolio returns are not normally distributed. The results of the Shapiro-Wilk test have been reported in Table 1.

The results of this test revealed significant deviations from normality in both groups. For the Existing Fund Managed Portfolios and ChatGPT created portfolios the Shapiro-Wilk test returned a statistic where the P-values were above the threshold of 0.05, indicating that the distribution of portfolio standard deviations significantly deviates from normality. These results confirm that the portfolio returns of the ChatGPT-Created Portfolios do not conform to a normal distribution.

The findings suggest that neither the Existing Fund Managed Portfolios nor the ChatGPT-Created Portfolios exhibit normality in their standard deviations. However, the ChatGPT portfolios demonstrated a greater departure from normality, as reflected in their higher Kolmogorov-Smirnov statistic and larger P-values for both tests.

4.1.2. Discussion

A Comparison of the ChatGPT and the corresponding fund-managed portfolios return performance.

ChatGPT demonstrates some ability to outperform fund managers in generating portfolio returns although the results are mixed. Of the comparison groups i.e. the existing fund-managed portfolios and the ChatGPT-created portfolios, 9 of the ChatGPT-created portfolios generated higher average quarterly returns than those of the corresponding existing fund-managers indicating some ability of ChatGPT to select stocks and assign weights to stocks to generate returns. Each of the quarterly returns, as well as the average quarterly returns, have been included in Table 2 above. Table 2 represents the average of the quarterly returns for the ChatGPT and existing fund managed portfolios. The bold average returns represent the portfolio that generated higher average returns for the comparison groups i.e. the ChatGPT portfolios and the corresponding existing fund managed portfolios.

Despite 50% of the ChatGPT portfolios having outperformed the fund managed portfolios, after performing the Mann Whitney U test on the returns generated by the ChatGPT portfolios and the corresponding existing fund-managed portfolios, the P-Value obtained was P = 0.957 (as indicated in Table 3 above) which is greater than the significance level of 0.05. This indicates that the null hypothesis stating that the distributions of the returns is the same across the portfolios, could not be rejected. The returns of the portfolios (ChatGPT and fund-managed) do not show a statistically significant difference in this case. This indicates that overall, this study cannot conclude that ChatGPT outperforms fund managers in generating quarterly portfolio returns.

Figure 2 above illustrates the average returns generated by each of the existing fund-managed portfolios, as well as the ChatGPT-created portfolios. The graph illustrates that apart from a few portfolios the ChatGPT-created portfolios either performed particularly well or particularly poorly with returns that were much higher than those of the fund-managed portfolios or much lower than those of the fund-managed portfolios. This could be a result of the fact that ChatGPT was prompted to select the stocks and then prompted to assign weights to the stocks based on the fund limit and the share prices as of quarter 1 of 2023

without rebalancing the portfolio throughout the year (as a practical expedient). Referring to Figure 2 above, which illustrates the actual quarterly returns of the ChatGPT-created portfolios, this may support this idea as in quarter 1 the ChatGPT-created portfolios were relatively stable with the ChatGPT returns performing similarly to the existing fund-managed portfolios as illustrated in Figure 3 above, which illustrates the actual quarterly returns of the existing fund managed portfolios.

Another possible reason that the ChatGPT-created portfolios follow a similar pattern could be due to actual movements that occurred in the markets due to the back testing methodology used. For example, when comparing the line graphs in Figures 2 and 3, the ChatGPT portfolio returns as well as the existing fund-managed portfolios follow a similar pattern, with a downturn in returns in quarter 2 of 2023 followed by a recovery in quarter 3 and another downturn, although less pronounced, in the 4th quarter of 2023. The returns of the existing fund-managed portfolios, however, appear to be a lot more stable indicating more consistent returns which investors would prefer because investors, as much as they strive for maximum returns, dislike risk (Rani, 2012). This is consistent with the findings for research question 2 of this study, which indicates that ChatGPT is unable to construct a portfolio that generates less risk than that of a fund manager. This is discussed below in detail but illustrated in Figure 5 below which shows the difference between the risk levels of the portfolios as measured by the standard deviations of the portfolios. This illustrates that the ChatGPT portfolios had much larger standard deviations and more associated risk associated with them.

During quarter 2 and 3 ChatGPT-created portfolios performed particularly poorly, with returns below -400%. Conversely, in quarter 3 there were numerous ChatGPT-created portfolios which generated returns in excess of 40%. A possible reason for these large differences is that ChatGPT appears to have firstly selected numerous highly volatile stocks and assigned higher weightings to these stocks based purely on the large return potential of these stocks without considering the downside risk. An example of this is ChatGPT having assigned a 44% weighting to a stock with a return of -1111% which resulted in a return of -488 for the ChatGPT created SIM general equity. This indicates that ChatGPT may struggle to assign weightings to stocks which was also found by Romanko et al. (2023) who found that

the ChatGPT strategies, both "equally weighted" and "GPT weighted demonstrated less optimal outcomes suggesting that while the AI has capabilities in selecting profitable stocks, its ability to optimally distribute portfolio weights could benefit from further refinement. This ties in with the fact that ChatGPT appears to struggle in mitigating portfolio risk as illustrated by the fact that on average the ChatGPT-created portfolios obtained much higher standard deviations than the existing fund-managed portfolios as illustrated in Figure 5 below.

Despite ChatGPT's inability to assign weights to stocks, the fact that ChatGPT-created portfolios outperformed 9 of the existing fund-managed portfolios in generating returns ties in with the fact that ChatGPT has some ability to select profitable stocks and generate returns as illustrated by Romanko et al. (2023).

Figure 5 illustrates the quarterly return data for the equally weighted ChatGPT portfolios. This figure indicates the same pattern of returns as the ChatGPT as well as the fund managed portfolio, however when compared to figure 2, the returns for the equally weighted ChatGPT portfolios are much lower than those of the ChatGPT portfolios where ChatGPT assigned the weights, indicating some ability of ChatGPT to assign optimal weightings to portfolios.
this general performance of the ChatGPT created portfolios which excludes outliers still shows a high level of return volatility indicating the riskiness of the ChatGPT created portfolios compared to the corresponding fund managed portfolios in Figure 4 which illustrate more stable return performance. This is in line with the findings of this research report that ChatGPT cannot outperform fund managers in generating portfolio returns and that ChatGPT produces a much risker portfolio than a fund manager.

4.1.3. Comparison of the equally weighted ChatGPT portfolios and the corresponding fund managed portfolio

An equally weighted portfolio was also computed to determine whether ChatGPT's ability to assign optimal weightings to stocks i.e. weights that will maximise the portfolio's returns while minimising the portfolio's risk.

Equally weighted ChatGPT portfolios were also constructed, and the returns of these portfolios were also compared to those of the corresponding existing fund-managed

portfolios to determine whether the inability of the ChatGPT portfolios to generate returns that were statistically significantly higher than those of the fund-managed portfolio was due to ChatGPT's inability to assign optimal weights to stocks. The results indicate that the equally weighted ChatGPT portfolios significantly underperform in generating portfolio returns when compared to the existing fund-managed portfolios.

Only one out of the 18 equally weighted ChatGPT portfolios were able to generate average quarterly returns higher than those of the corresponding fund-managed portfolios. After performing the Mann-Whitney U test between these two groups (portfolios), a P-value of less than 0,001 was obtained indicating that the difference between the two groups is statistically significant as this is less than the significance level of 0.05. The null hypothesis, stating that the distributions of the returns are the same across the portfolios, is rejected. The equally weighted ChatGPT portfolios significantly underperformed compared to the existing fund managed portfolios (and implicitly the ChatGPT portfolios where ChatGPT was asked to assign weighting to the stocks). This indicates that the ChatGPT portfolios where ChatGPT was prompted to assign the optimal weightings to the stocks, were able to generate higher returns than most of the equally weighted portfolios as well as half of the fund-managed portfolios may indicate some ability of ChatGPT to assign optimal weightings.

Figure 5 indicates the equally weighted ChatGPT portfolio returns. The general movement of the portfolio returns is similar to those of the ChatGPT-created portfolios, with stable performance in quarter 1, a downturn in the 2nd quarter, and a recovery in the 3rd quarter followed by another less prominent downturn in quarter 4. Despite a similar movement in the portfolio returns the returns generated by the equally weighted portfolios are much lower as illustrated in Figure 1, and figure 4 indicating that an investor who was to rely on ChatGPT may be better served relying on both ChatGPT's stock selection recommendations and its weightings rather than equally weighting the stocks in the portfolio.

Overall, the portfolio returns results indicate ChatGPT's ability to process large datasets and identify profitable stocks aligns with the structured investment strategies provided to it. When GPT is explicitly prompted with detailed financial data and investment objectives, it can utilise some aspects of professional decision-making to generate returns although the

large language model does not do well with all types of investment strategies. In this case, ChatGPT's lack of contextual awareness about market trends by not allowing the tool to access the internet (e.g., economic shocks or geopolitical events) may have led to suboptimal weightings and the inclusion of certain stocks that may not have been performing well. The fact that ChatGPT was still able to generate returns that outperformed half of the fund managers' portfolios indicates that with sources of information such as being able to access the internet, ChatGPT may be able to outperform fund managers in the future, but for now, the tool may be better served as a supporting tool rather than as a main stock selection decision maker.

4.1.4. Best and worst performing ChatGPT portfolios. Growth vs Value investing, which is ChatGPT better suited for?

The top performing ChatGPT-created portfolios were the following portfolios (from highest returns to lowest returns): GPT SIM small cap, GPT Coronation Top 20, GPT Standard STANLIB, GPT Coronation SA equity, GPT Stanlib Enhanced Multi fund, indicating the types of investment strategies ChatGPT excels at. The following paragraph summarizes the key features of the investment strategies that ChatGPT appears to excel at.

The SIM small cap is an aggressive Small to Mid-Cap Growth Fund that focuses on small and mid-cap companies with above-average growth potential. The portfolio is actively managed and aimed for maximum capital appreciation. The Coronation Top 20 is a concentrated large-cap growth fund that actively invests in a maximum of 20 large-cap companies listed on the JSE, seeking attractively valued shares with strong long-term growth potential and is invested in shares with no foreign market exposure. These two investment strategies differ significantly but were the strategies that ChatGPT benefitted the most from with high returns in excess of 30%. Interestingly the ChatGPT created Coronation Top 20 fund contained 113 different stocks, much more than the requisite 20 stocks as per the investment strategy. The portfolio included stocks of all sizes as recommended by ChatGPT, large, mid, small, and micro-cap stocks indicating that even while ChatGPT did not adhere to the investment strategy completely it was still able to generate higher returns and outperform the existing fund managed portfolio. The reason for not adjusting the portfolios when ChatGPT made these

errors was to determine ChatGPT's ability to select stocks. The finding that ChatGPT can misclassify stocks is in line with prior research which states that ChatGPT can hallucinate and make mistakes and as result users should be cautious when using the tool (Pisaneschi, 2024). This was also the case for the ChatGPT-created SIM small-cap portfolio in which ChatGPT recommended investing in 8 stocks that are classified as large and mid-cap stocks rather than small-cap stocks, further providing evidence of the abovementioned findings.

The Stanlib general Equity portfolio is a Diversified General Equity Fund that offers a diversified portfolio of JSE-listed shares and includes exposure to both South African and foreign investment markets within ASISA guidelines. This portfolio targets reasonable long-term capital growth. The Coronation South African Equity Growth Fund invests in South African equities without foreign market exposure. The fund focuses on companies listed on the Johannesburg Stock Exchange and is fully invested in shares at all times, with no sector restrictions. The Stanlib Multi-Style Active Equity Fund combines quantitative and fundamental analysis, focusing on companies with high returns on capital and earnings growth at attractive valuations and employing portfolio construction and risk management for diversification. The key feature of the aforementioned investment strategies that ChatGPT appears to excel at using, is the fact that these investment strategies are all growth investment strategies in some form, indicating that ChatGPT performs well when given a growth investment strategy, given the superior returns generated from these investment strategies which all outperformed their comparative existing fund managed portfolios.

The following portfolios were the worst performing ChatGPT-created portfolios: The GPT SIM General Equity, GPT Allan Gray Equity, GPT Ninety-One Value Fund, GPT Sanlam Select Thematic Equity, and GPT Ninety-One Emerging Companies Fund. These portfolios indicate the investment strategies that ChatGPT is not well suited for. The following paragraph summarizes the key features of these investment strategies.

The GPT SIM General Equity targets long-term capital growth by investing across all industry sectors of the Johannesburg Stock Exchange (JSE). It employs an active stock selection strategy aiming to outperform the FTSE/JSE Capped SWIX Index. The fund focuses on

investments across all market capitalizations and may hold up to 45% of its portfolio in offshore assets and is suitable for investors who can tolerate capital volatility in the short term. The GPT Allan Gray Equity fund primarily invests in JSE-listed equities, with up to 45% allowed in offshore investments managed by Orbis Investment Management Limited. The portfolio is fully invested in equities and aims to outperform the average return of South African General Equity Funds over the long term. It follows a value-oriented approach, targeting undervalued shares based on intrinsic value assessments. The fund aims to create long-term wealth while enduring periods of short-term underperformance relative to peers.

The GPT Ninety-One Value Fund focuses on investing in out-of-favour, undervalued stocks trading below historical valuation metrics or at a discount to net asset value. The portfolio is highly concentrated, with significant exposure to specific sectors or industries. It targets long-term capital growth but may experience extended periods of underperformance. It also includes a foreign equity allocation ranging from 10% to 30%. GPT Sanlam Select Thematic Equity fund seeks long-term capital growth above the FTSE/JSE Shareholder Weighted Index by investing in high-quality companies with robust fundamentals. It uses a thematic investment approach to identify sectors likely to benefit from medium- to long-term market trends. The fund is diversified across JSE sectors, focusing on companies with strong cash flow and quality management. Offshore equity investments and financial instruments are permitted to achieve the fund's objectives. The GPT Ninety-One Emerging Companies Fund invests in small and medium-sized South African companies with above-average growth potential. It provides exposure to diverse industries, including mining, financial, and industrial sectors, as well as established companies with recovery potential. The fund is more volatile than general equity funds, reflecting its focus on higher growth opportunities. Other investments include derivatives and non-listed eligible securities.

All five of the worst-performing ChatGPT portfolios aim to deliver significant capital growth over the medium to long term, emphasizing sustained performance rather than short-term returns. Most of the ChatGPT-created portfolios involve investment strategies that are diversified across multiple sectors or the entire JSE, allowing broad market exposure. Investors in these portfolios are expected to withstand potential short-term volatility in exchange for long-term gains and the poor returns generated in the short term for the

purposes of this study could be an effect of the investment strategies themselves, indicating that ChatGPT is best suited for assisting investors with a tolerance for volatility. Furthermore, the fact that two of the worst-performing investment strategies involve value-orientated investment strategies and none of the best-performing ChatGPT-created portfolios involve value-orientated strategies may indicate that ChatGPT struggles when prompted to construct portfolios for return maximisation based on Value-based investment strategies.

4.1.5. Tables and Graphs for research question 1

Table 1

4.1.6. Table 1

Table 1 illustrates the results of the Shapiro-Wilk test. The results indicate the portfolio returns are not normally distributed.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Ninety One Active Quants	,190	4	.	,970	4	,842
GPT Ninety One Active Quants	,211	4	.	,945	4	,684
Sanlam Private Wealth	,287	4	.	,909	4	,479
GPT Sanlam Private Wealth	,230	4	.	,915	4	,507
Coronation Smaller companies	,295	4	.	,930	4	,592
GPT coronontion smaller companies	,335	4	.	,849	4	,223
Ninety One Value fund	,169	4	.	,997	4	,989
GPT Ninety one Value Fund	,416	4	.	,707	4	,014
Ninety One emerging companies fund	,315	4	.	,809	4	,120
GPT Ninety One emerging companies fund	,258	4	.	,886	4	,366
Stanlib Enhanced Multi equity fund	,216	4	.	,981	4	,907
GPT Stanlib Enhanced Multi equity fund	,227	4	.	,976	4	,880
Coronation SA equity fund	,174	4	.	,982	4	,916
GPT Coronation SA equity	,228	4	.	,976	4	,877
Coronation Top 20	,258	4	.	,954	4	,741
GPT Coronation Top 20	,419	4	.	,678	4	,006
Standard Stanlib Equity	,227	4	.	,943	4	,670
GPT Standard Stanlib equity	,334	4	.	,883	4	,351
SIM Small Cap	,262	4	.	,888	4	,372
GPT SIM small cap	,344	4	.	,872	4	,306
SIM Top Choice Equity	,254	4	.	,869	4	,294
GPT SIM TOP Choice Equity	,221	4	.	,979	4	,896
Allan Gray Sa Equity	,328	4	.	,876	4	,320
GPT Allan Gray Sa Equity	,209	4	.	,985	4	,928
Allan Gray Equity	,238	4	.	,920	4	,536
GPT Allan Gray Equity	,430	4	.	,661	4	,004
Sanlam Select Thematic equity	,239	4	.	,966	4	,814
GPT Sanlam Select Thematic equity	,256	4	.	,896	4	,413
Ninety One Equity Fund	,225	4	.	,938	4	,643
GPT Ninety One equity Fund	,249	4	.	,880	4	,340
Ninety One Sa Equity	,215	4	.	,980	4	,903
GPT Ninety One Sa equity	,208	4	.	,985	4	,928
Sim General Equity	,275	4	.	,945	4	,683
GPT SIM General equity	,424	4	.	,670	4	,005
Coronation equity fund	,256	4	.	,958	4	,766
GPT Coronation equity fund	,207	4	.	,985	4	,929

a. Lilliefors Significance Correction

4.1.7. Table 2

Table 2 Illustrates the comparison between the average percentage returns generated by the ChatGPT and existing asset manager's portfolios returns for 2023.Table 2 and Figure 1 illustrate the comparison between the average quarterly returns for existing fund manager's portfolio returns and the corresponding ChatGPT portfolio. ChatGPT was able to generate portfolio returns that exceed those of the existing fund managers portfolios for 9 of the 18

portfolios indicating some ability for ChatGPT to select stocks and generate portfolios returns. However, it is clear from Table 2 and figure 1 that there was a lot of volatility in the ChatGPT portfolio returns either performing very well or very poorly compared to those of the existing fund managers which were much more stable. A detailed discussion has been included in the discussion section below.

***Bold indicates that this was the better performing portfolio**	Existing asset manager's portfolio returns (%)	ChatGPT created portfolio (%)
Ninety-One Active Quants	**7.79**	1.94
Sanlam Private Wealth	**15.20**	1.19
Coronation Smaller companies	**3.51**	0.41
Ninety-One Value fund	**7.93**	(90.74)
Ninety-One emerging companies fund	**2.03**	0.39
Stanlib Enhanced Multi equity fund	9.00	**21.06**
Coronation SA equity fund	8.52	**21.09**
Coronation Top 20	10.53	**33.63**

Standard Stanlib Equity	12.78	**29.53**
SIM Small Cap	1.43	**35.77**
SIM Top Choice Equity	6.80	**14.60**
Allan Gray Sa Equity	7.93	**13.40**
Allan Gray Equity	**13.40**	(100.68)
Sanlam Select Thematic equity	**10.00**	0.07
Ninety-One Equity Fund	10.11	**19.55**
Ninety-One Sa Equity	9.64	**12.72**
Sim General Equity	**8.53**	(111.07)
Coronation equity fund	11.98	**12.70**

4.1.8. Figure 1

Figure 1 illustrates the differences in average quarterly returns for the ChatGPT and the corresponding asset manager's portfolios for 2023. A comparison of the average quarterly returns of the ChatGPT-created portfolios against the average quarterly returns of the existing asset manager's average quarterly returns based on the asset manager's investment strategy

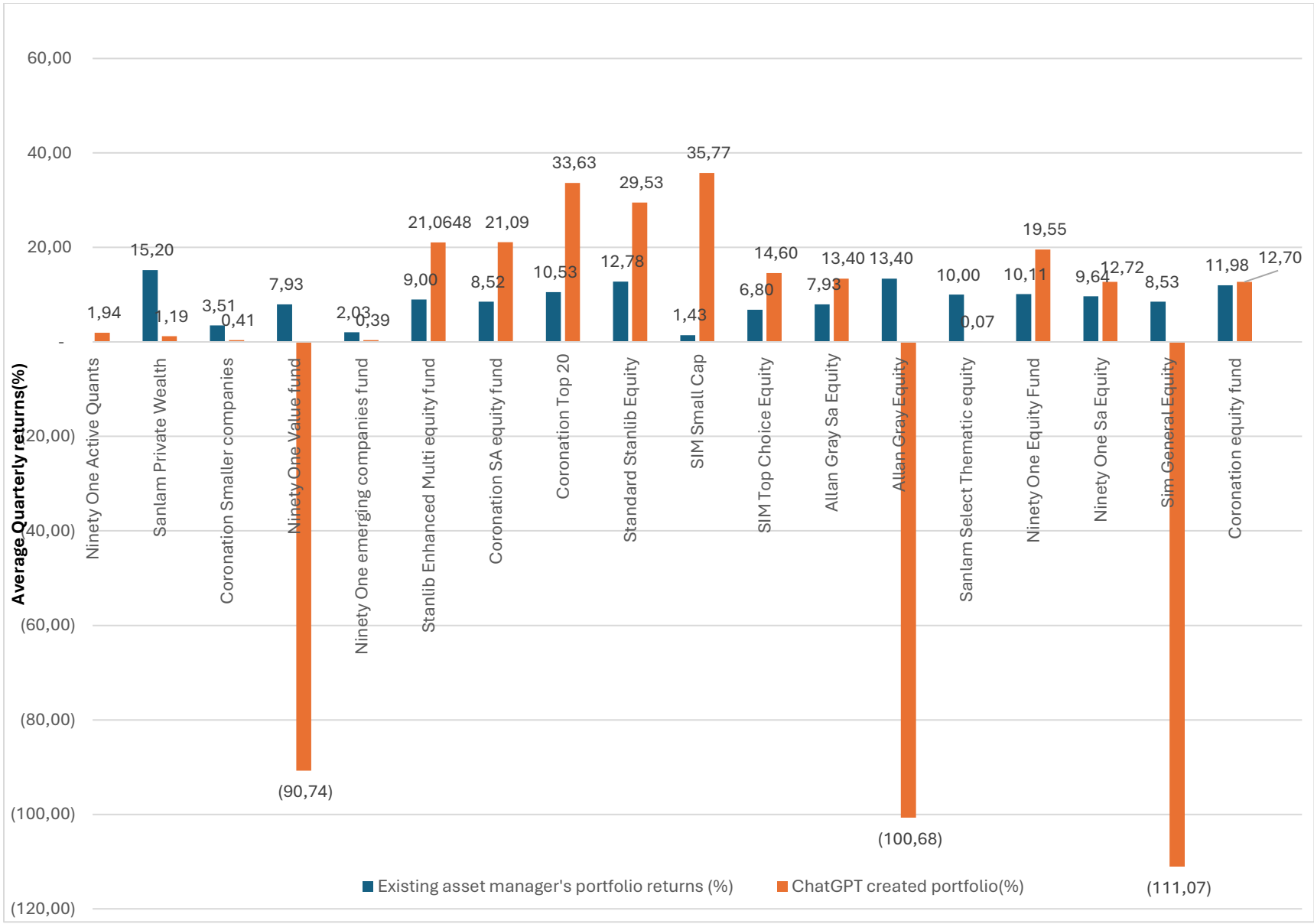

60,00
40,00
20,00
-
(20,00)
(40,00)
(60,00)
(80,00)
(100,00)
(120,00)
Average Quarterly returns(%)
1,94
15,20
1,19
3,51
0,41
7,93
(90,74)
2,03
0,39
9,00
21,0648
8,52
21,09
10,53
33,63
12,78
29,53
1,43
35,77
6,80
14,60
7,93
13,40
13,40
(100,68)
10,00
0,07
10,11
19,55
9,64
12,72
8,53
(111,07)
11,98
12,70
Ninety One Active Quants
Sanlam Private Wealth
Coronation Smaller companies
Ninety One Value fund
Ninety One emerging companies fund
Stanlib Enhanced Multi equity fund
Coronation SA equity fund
Coronation Top 20
Standard Stanlib Equity
SIM Small Cap
SIM Top Choice Equity
Allan Gray Sa Equity
Allan Gray Equity
Sanlam Select Thematic equity
Ninety One Equity Fund
Ninety One Sa Equity
Sim General Equity
Coronation equity fund
Existing asset manager's portfolio returns (%)
ChatGPT created portfolio(%)

Table 3

4.1.9. Table 3

Table 3 indicates the results of the Mann Whitney U test testing the differences between the ChatGPT portfolios and the existing corresponding fund manged portfolios. The results indicate that the differences between the ChatGPT portfolios and the existing fund managed portfolios are not statistically significant.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.a, b	Decision
1	The distribution of returns is the same across categories of Portfolios.	Independent-Samples Mann-Whitney U Test	,957	Retain the null hypothesis.

a. The significance level is ,050.

b. Asymptotic significance is displayed.

Table 4

4.1.10. Table 4

Table 4 illustrates the comparison between the average percentage returns generated by the equally weighted ChatGPT and existing asset manager's portfolios returns for 2023. The results indicate that the equally weighted portfolios were overall unable to generate returns that exceed those of the existing fund managers portfolios. 17 of the 18 existing fund manager's portfolios outperformed the equally weighted ChatGPT portfolios.

***Bold indicates that this was the better**	Existing fund managed portfolio returns (%)	GPT Equally weighted *GPT refers to the ChatGPT portfolios. (%)

performing portfolio		
Ninety-One Active Quants	**7.79**	**1.16**
Sanlam Private Wealth	**15.20**	0.98
Coronation Smaller companies	**3.51**	1.07
Ninety-One Value fund	**7.93**	-0.67
Ninety-One emerging companies fund	**2.03**	-2.44
Stanlib Enhanced Multi equity fund	**9.00**	1.00
Coronation SA equity fund	**8.52**	1.00
Coronation Top 20	**10.53**	1.23
Standard Stanlib Equity	**12.78**	-0.47
SIM Small Cap	**1.43**	-1.35
SIM Top Choice Equity	**6.80**	1.01
Allan Gray Sa Equity	**7.93**	0.85
Allan Gray Equity	**13.40**	-0.64
Sanlam Select Thematic equity	**10.00**	0.00

Ninety-One Equity Fund	**10.11**	1.26
Ninety-One Sa Equity	**9.64**	0.88
SIM General Equity	**8.53**	-0.57
Coronation equity fund	**11.98**	0.85

Table 5

4.1.11. Table 5

Table 5 indicates the results of the Mann-Whitney U test between the equally weighted ChatGPT portfolios and the corresponding existing fund managed portfolios. The results in Table 5 indicate that the differences between these portfolios are statistically significant. When these results are read in conjunction with table 4 above, the results indicate that an equally weighted ChatGPT portfolio cannot outperform an existing fund managed portfolio.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.a, b	Decision
1	The distribution of returns is the same across categories of Portfolios.	Independent-Samples Mann-Whitney U Test	<,001	Reject the null hypothesis.

a. The significance level is ,050.

Figure 2

4.1.12. Figure 2

The graph in figure 2 illustrates quarterly return data for the ChatGPT-created portfolios in 2023. The fact that despite having different investment objectives the ChatGPT portfolios followed the same pattern despite varying levels of returns. This indicates that the returns for the ChatGPT portfolios were influenced not only by ChatGPT's ability to select stocks and assign optimal weights, but also movements in the market.

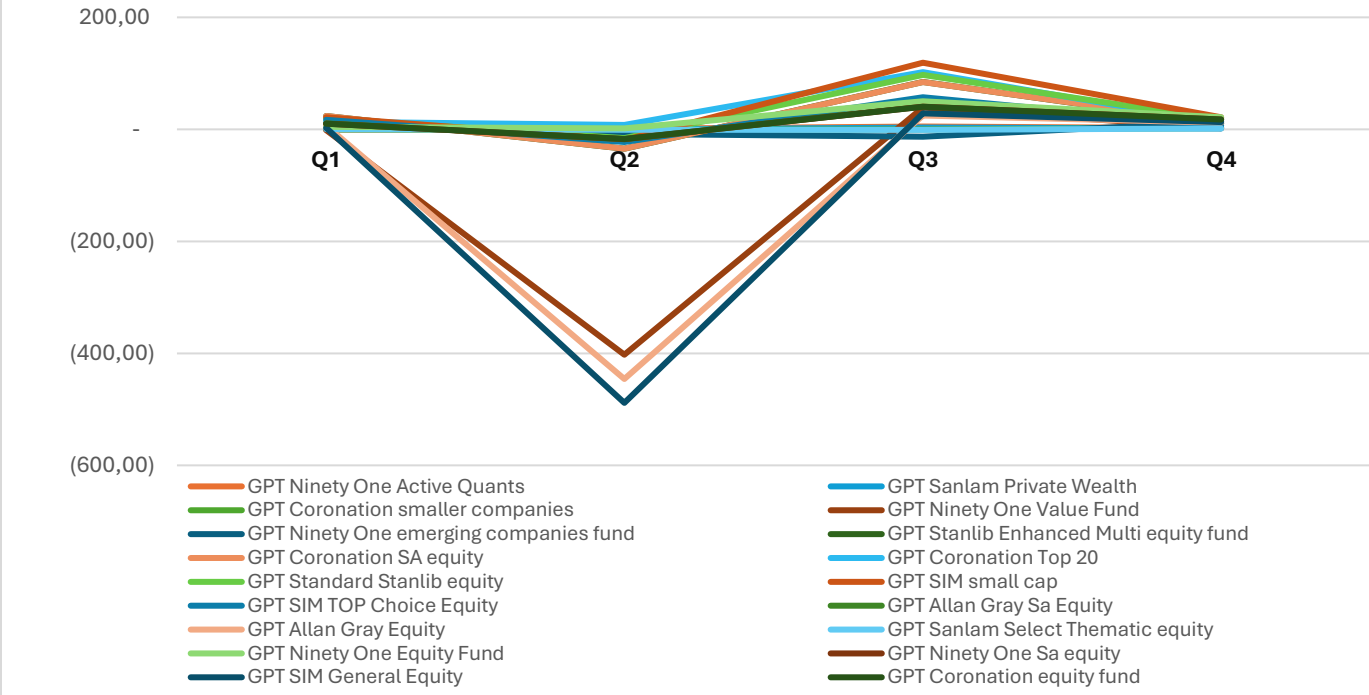


Figure 3

4.1.13. Figure 3

Figure 3 illustrates the ChatGPT Quarterly returns for 2023 excluding outliers. The graph indicates that despite the removal of outliers there is still high levels of volatility in the ChatGPT returns indicating the riskiness of ChatGPT based portfolios.

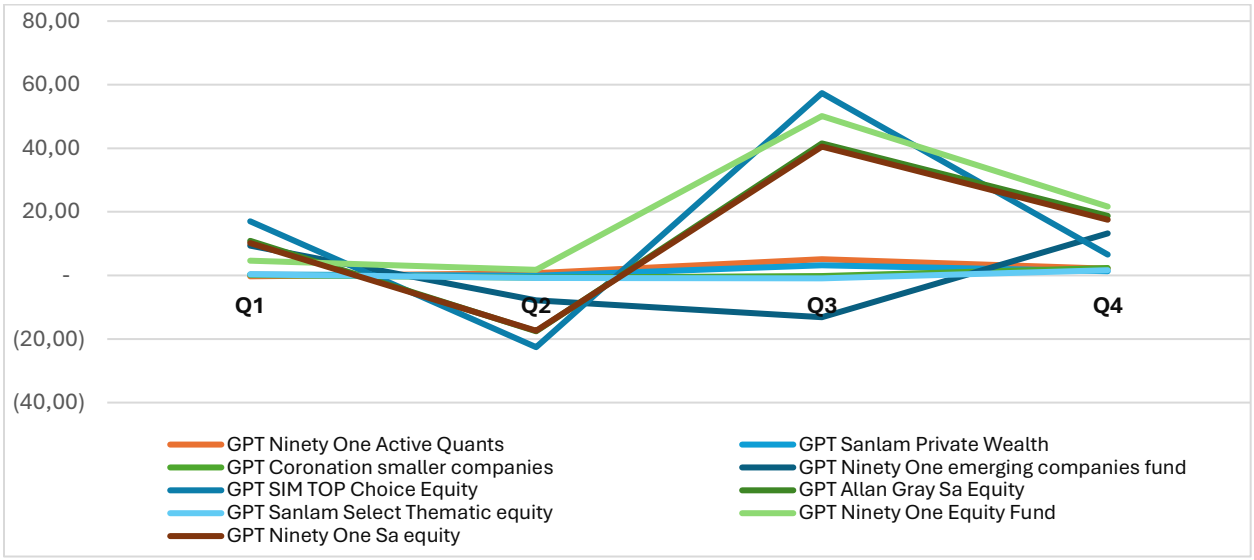
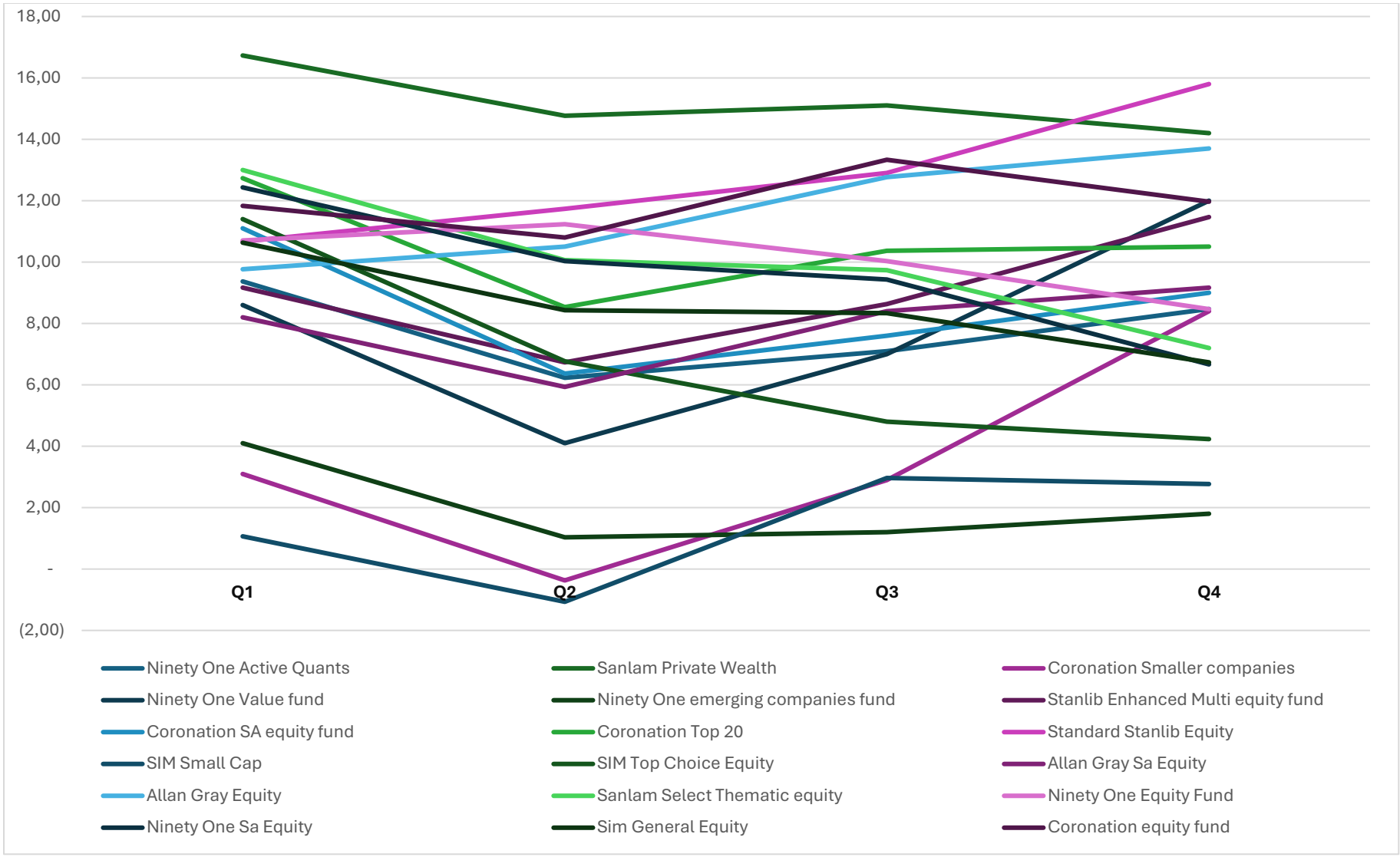


Figure 4

4.1.14. Figure 4

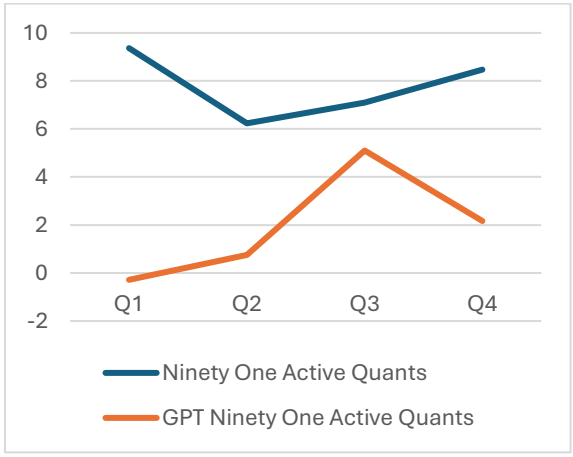
Figure 4 illustrates the quarterly return data for the existing fund-managed portfolios. The graph indicates that the existing fund managed portfolio returns are more stable with less large fluctuations which would indicate more volatility. The returns on the existing fund managed portfolios still follow the same pattern as that of the ChatGPT portfolios which reinforces the fact that some of the changes relate to market conditions however these portfolios were more stable despite prevailing market conditions.

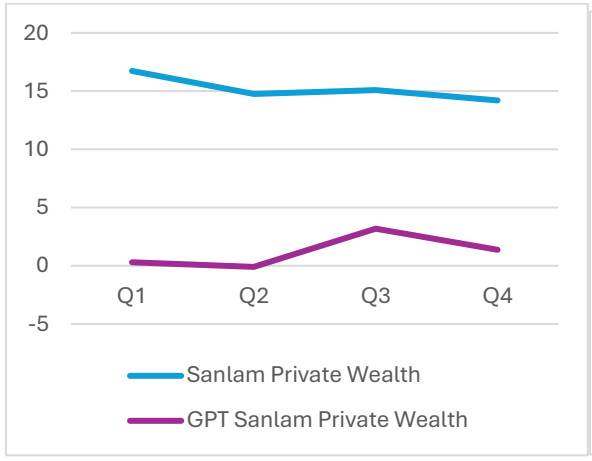

18,00
16,00
14,00
12,00
10,00
8,00
6,00
4,00
2,00
-
(2,00)
Q1
Q2
Q3
Q4
Ninety One Active Quants
Sanlam Private Wealth
Coronation Smaller companies
Ninety One Value fund
Ninety One emerging companies fund
Stanlib Enhanced Multi equity fund
Coronation SA equity fund
Coronation Top 20
Standard Stanlib Equity
SIM Small Cap
SIM Top Choice Equity
Allan Gray Sa Equity
Allan Gray Equity
Sanlam Select Thematic equity
Ninety One Equity Fund
Ninety One Sa Equity
Sim General Equity
Coronation equity fund

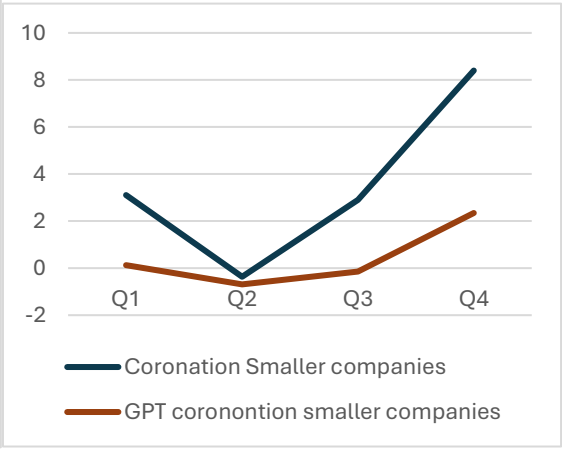
Figures 4.1-4.18

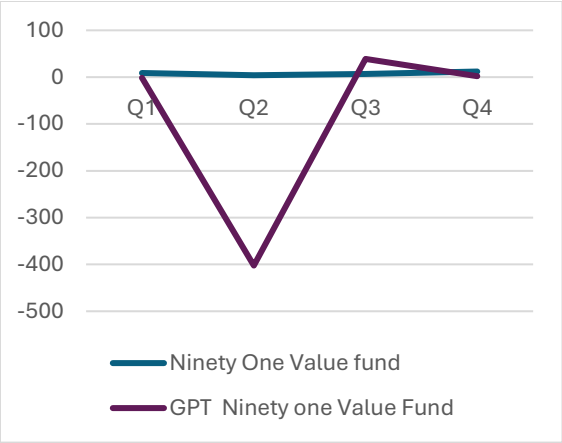
4.1.15. Figures 4.1-4.18

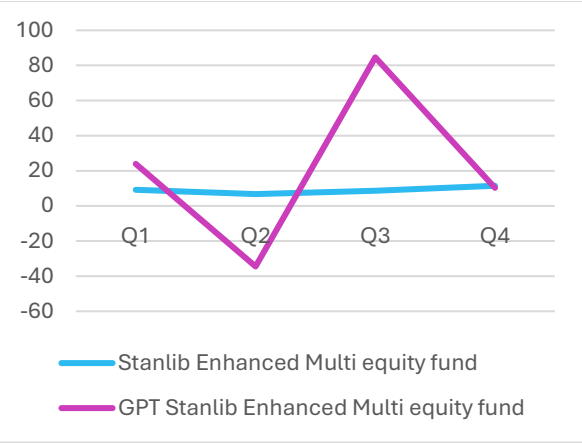
Figures 4.11-4.18 illustrate the direct comparisions between the existing fund managed portfolios and the corresponding ChatGPT portfolios. These figures illustarte the fact the half the ChatGPT portfolios outperformed the existing fund managed portfolios, however on a general basis showed more violatility.

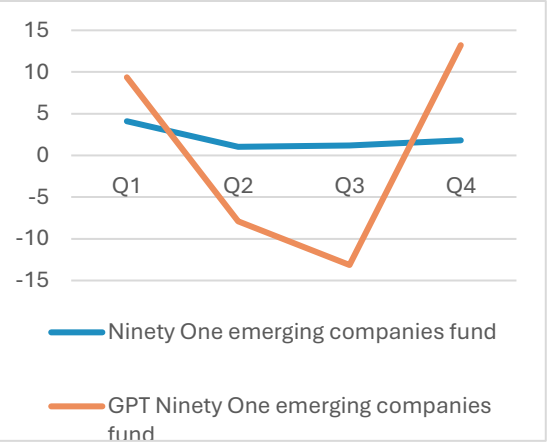


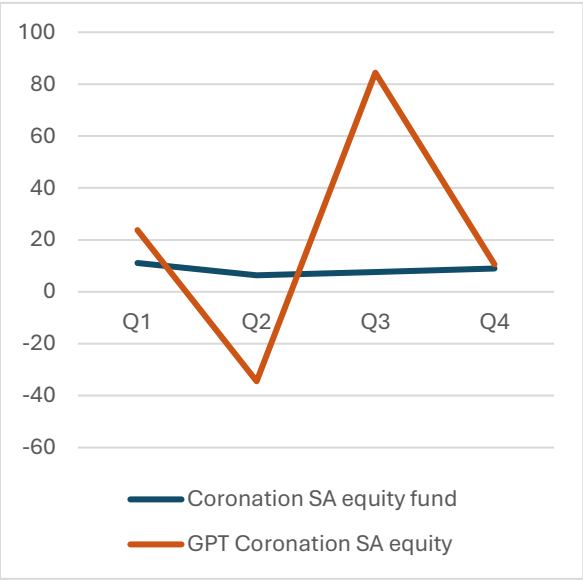


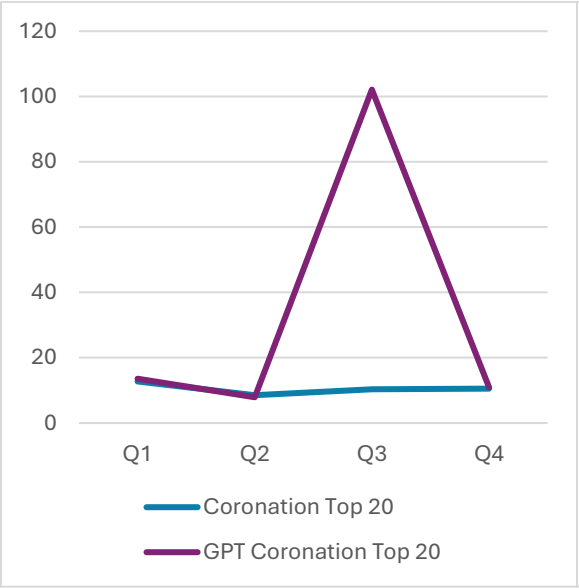


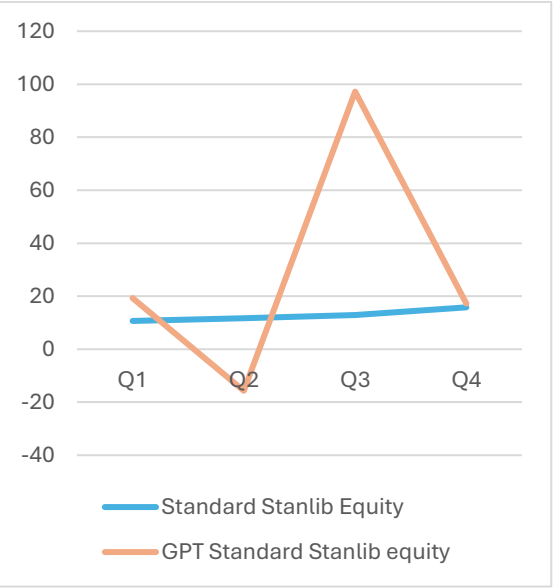

100
0
-100
-200
-300
-400
-500
Q1
Q2
Q3
Q4
Ninety One Value fund
GPT Ninety one Value Fund

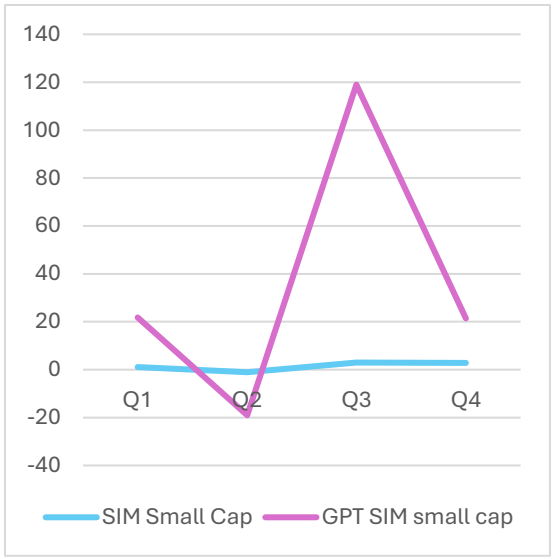

100
80
60
40
20
0
-20
-40
-60
Q1
Q2
Q3
Q4
Stanlib Enhanced Multi equity fund
GPT Stanlib Enhanced Multi equity fund

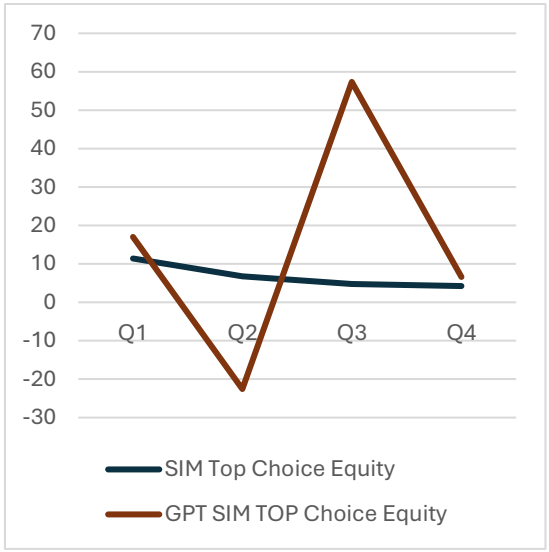

15
10
5
0
-5
-10
-15
Q1
Q2
Q3
Q4
Ninety One emerging companies fund
GPT Ninety One emerging companies fund


100
80
60
40
20
0
-20
-40
-60
Q1
Q2
Q3
Q4
Coronation SA equity fund
GPT Coronation SA equity

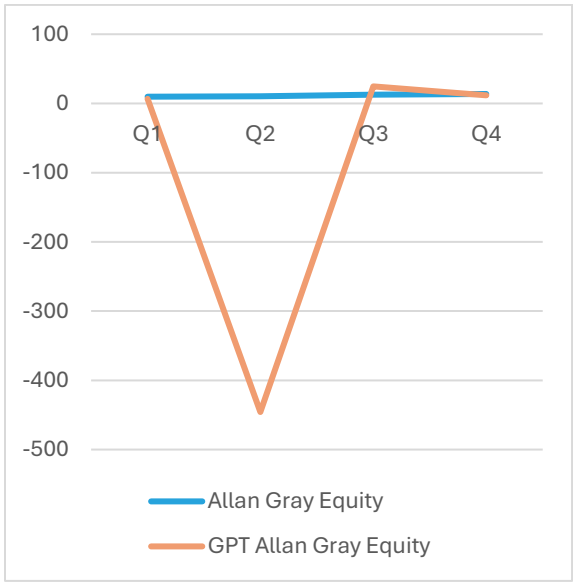

120
100
80
60
40
20
0
Q1
Q2
Q3
Q4
Coronation Top 20
GPT Coronation Top 20

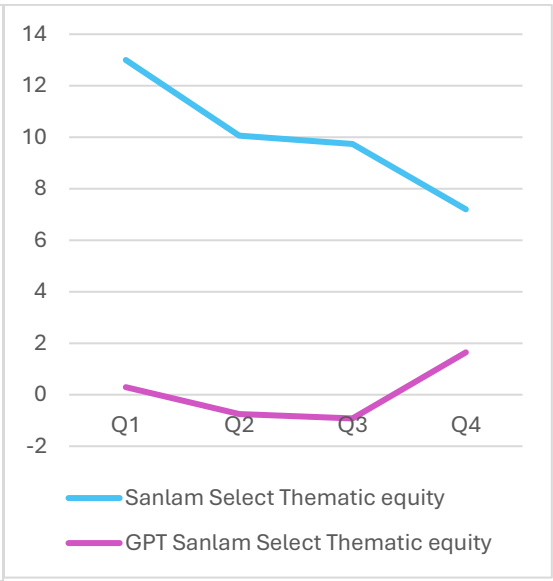

120
100
80
60
40
20
0
-20
-40
Q1
Q2
Q3
Q4
Standard Stanlib Equity
GPT Standard Stanlib equity

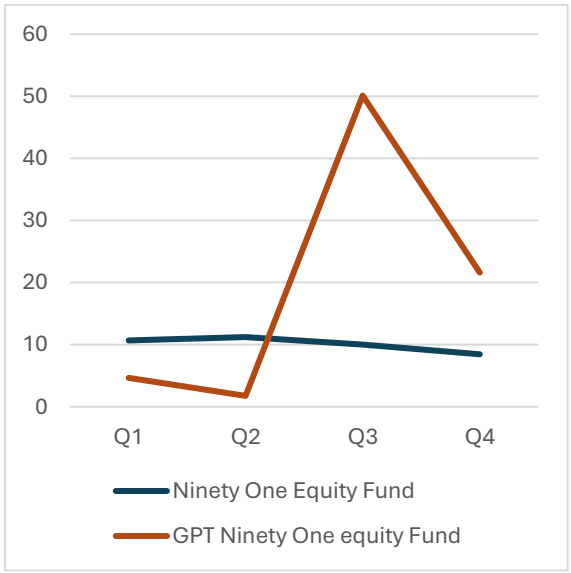

140
120
100
80
60
40
20
0
-20
-40
Q1
Q2
Q3
Q4
SIM Small Cap
GPT SIM small cap

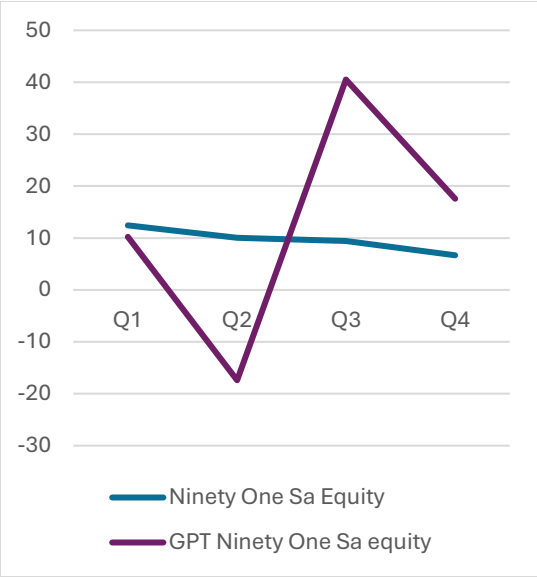

70
60
50
40
30
20
10
0
-10
-20
-30
Q1
Q2
Q3
Q4
SIM Top Choice Equity
GPT SIM TOP Choice Equity

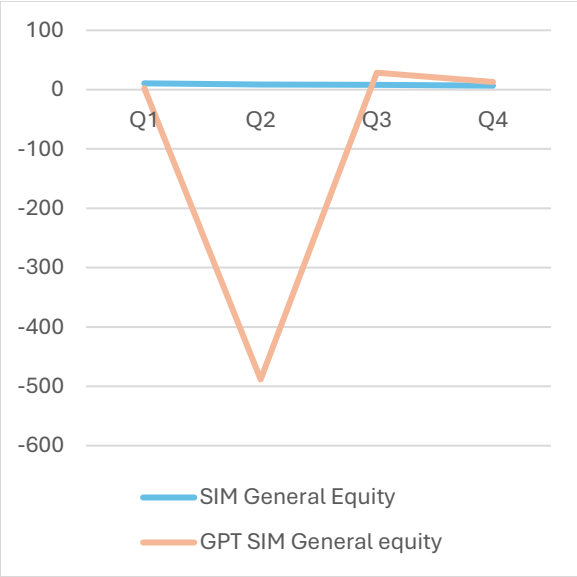

50
40
30
20
10
0
-10
-20
-30
Q1
Q2
Q3
Q4
Allan Gray Sa Equity
GPT Allan Gray Sa Equity

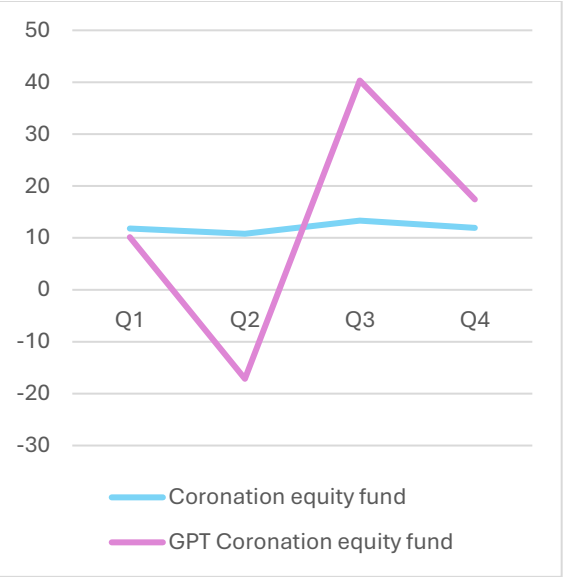

100
0
-100
-200
-300
-400
-500
Q1
Q2
Q3
Q4
Allan Gray Equity
GPT Allan Gray Equity


14
12
10
8
6
4
2
0
-2
Q1
Q2
Q3
Q4
Sanlam Select Thematic equity
GPT Sanlam Select Thematic equity


60
50
40
30
20
10
0
Q1
Q2
Q3
Q4
Ninety One Equity Fund
GPT Ninety One equity Fund

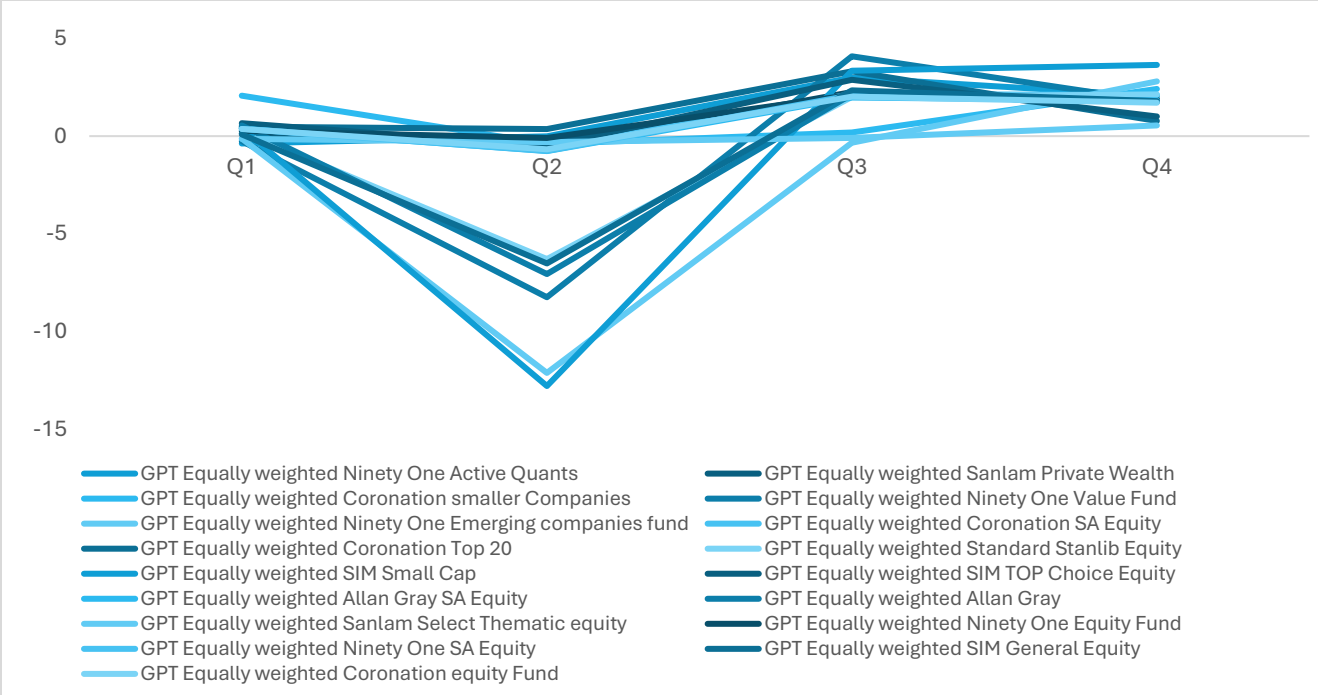

50
40
30
20
10
0
-10
-20
-30
Q1
Q2
Q3
Q4
Ninety One Sa Equity
GPT Ninety One Sa equity


100
0
-100
-200
-300
-400
-500
-600
Q1
Q2
Q3
Q4
SIM General Equity
GPT SIM General equity


50
40
30
20
10
0
-10
-20
-30
Q1
Q2
Q3
Q4
Coronation equity fund
GPT Coronation equity fund

4.1.16. Figure 5

Figure 5 illustrates the quarterly return data for the equally weighted ChatGPT portfolios. This figure indicates the same pattern of returns as the portfolios above, however when compared to figure 2, the returns for the equally weighted ChatGPT portfolios are much lower than those of the ChatGPT portfolios where ChatGPT assigned the weights, indicating some ability of ChatGPT to assign optimal weightings to portfolios


5
0
-5
-10
-15
Q1
Q2
Q3
Q4
GPT Equally weighted Ninety One Active Quants
GPT Equally weighted Coronation smaller Companies
GPT Equally weighted Ninety One Emerging companies fund
GPT Equally weighted Coronation Top 20
GPT Equally weighted SIM Small Cap
GPT Equally weighted Allan Gray SA Equity
GPT Equally weighted Sanlam Select Thematic equity
GPT Equally weighted Ninety One SA Equity
GPT Equally weighted Coronation equity Fund
GPT Equally weighted Sanlam Private Wealth
GPT Equally weighted Ninety One Value Fund
GPT Equally weighted Coronation SA Equity
GPT Equally weighted Standard Stanlib Equity
GPT Equally weighted SIM TOP Choice Equity
GPT Equally weighted Allan Gray
GPT Equally weighted Ninety One Equity Fund
GPT Equally weighted SIM General Equity

4.2. Research Question 2 Results

Research question 2 focused on risk levels. The results of this research question are presented below:

To answer research question 2, the standard deviations were computed from the average quarterly returns for each of the ChatGPT and the corresponding existing asset managers portfolios. Next the differences in the standard deviations were compared to determine whether the ChatGPT can produce standard deviations (risk) that are lower than that of the corresponding existing fund managed portfolios. The Mann-Whitney U test was then performed to determine whether the differences in the standard deviations for the ChatGPT portfolios and the corresponding ChatGPT portfolios were statistically significant.

To determine whether the Mann-Whitney U test was the appropriate statistical test to perform, the standard deviations for each portfolio had to be tested to determine whether they were normally distributed, in which case an independent samples t-test would be performed or not normally distributed in which case, the Mann-Whitney U test (the non-parametric equivalent) would be performed.

Testing the average standard deviations for the normality of the data

To test the normality of the data, the Shapiro Wilk test was performed over the average quarterly returns for each portfolio. The Shapiro Wilk test is normally performed when the sample size is less than 50 (Mishra et al., 2019). For this study, 18 ChatGPT portfolios were constructed and compared to existing corresponding asset managers portfolios and thus the 18 ChatGPT portfolios make up the sample size of 18 as set out in the method, section 3.2. sample.

The null hypothesis of this test is that the data is normally distributed (Mishra et al., 2019). The results of the Shapiro-Wilk test indicate that the data is not normally distributed as seen below. The p-values from the standard deviations are greater than 0.05 which means that the null hypothesis can be rejected for the ChatGPT portfolios and that the standard deviations are not normally distributed. The results of the Shapiro-Wilk test have been reported in Table 5 below.

The results of this test revealed significant deviations from normality in both groups. For the Existing Fund Managed Portfolios, the Shapiro-Wilk test returned a statistic of P value of 0.811 and a significance level of 0.002. Both P-values are above the threshold of 0.05, indicating that the distribution of portfolio standard deviations significantly deviates from normality. Similarly, the ChatGPT-Created Portfolios exhibited even stronger deviations. The Shapiro-Wilk test returned a P-Value of 0.698 with a P-value at a significance level of less than 0.001. These results confirm that the standard deviations of the ChatGPT-Created Portfolios also do not conform to a normal distribution.

The findings suggest that neither the Existing Fund Managed Portfolios nor the ChatGPT-Created Portfolios exhibit normality in their standard deviations. However, the ChatGPT portfolios demonstrated a greater departure from normality, as reflected in their higher Kolmogorov-Smirnov statistic and smaller P-values for both tests.

4.2.1. Tables and Graphs for research question 2

Table 6

4.2.2. Table 6

Table 6 indicates the results of the tests for normality for the standard deviations of the ChatGPT and the corresponding fund managed portfolios.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Portfolios	Statistic	df	Sig.	Statistic	df	Sig.
PortfolioSD	Existing Fund managed portfolios	,216	18	,026	,811	18	,002
	ChatGPT created portfolios	,267	18	,001	,698	18	<,001

a. Lilliefors Significance Correction

Table 7

4.2.3. Table 7

Table 7 illustrates the level of risk of all the portfolios as measured by the standard deviation of the ChatGPT portfolios and the corresponding existing fund managed portfolios

***Bold indicates that this was the better performing portfolio**	Existing Fund managed portfolios Standard Deviation		ChatGPT created portfolios Standard Deviation *GPT- refers to the fact that this portfolio was created using the advice of ChatGPT
Ninety-One Active Quants	**1,40**	GPT Ninety-One Active Quants	2,34
Sanlam Private Wealth	**1,09**	GPT Sanlam Private Wealth	1,47
Coronation Smaller companies	3,63	GPT coronation smaller companies	**1,33**
Ninety-One Value fund	**3,29**	GPT Ninety-one Value Fund	7,93
Ninety-One emerging companies fund	**1,42**	GPT Ninety-One emerging companies fund	12,87
Stanlib Enhanced Multi equity fund	**1,95**	GPT Stanlib Enhanced Multi equity fund	49,16
Coronation SA equity fund	**2,03**	GPT Coronation SA equity	49,04

Coronation Top 20	**0,86**	GPT Coronation Top 20	22,86
Standard Stanlib Equity	**1,11**	GPT Standard Stanlib equity	23,95
SIM Small Cap	**0,94**	GPT SIM small cap	29,35
SIM Top Choice Equity	**1,63**	GPT SIM TOP Choice Equity	16,53
Allan Gray Sa Equity	**0,70**	GPT Allan Gray Sa Equity	12,20
Allan Gray Equity	**0,93**	GPT Allan Gray Equity	115,08
Sanlam Select Thematic equity	1,19	GPT Sanlam Select Thematic equity	0,59
Ninety-One Equity Fund	**0,60**	GPT Ninety-One equity Fund	11,09
Ninety-One Sa Equity	**1,18**	GPT Ninety-One Sa equity	11,94
Sim General Equity	**0,80**	GPT SIM General equity	125,91
Coronation equity fund	**0,52**	GPT Coronation equity fund	11,84

Table 8

4.2.4. Table 8

Table 8 illustrates the level of risk of all the portfolios as measured by the standard deviation of the Equally weighted ChatGPT portfolios and the corresponding existing fund managed portfolios.

***Bold indicates that this was the better performing portfolio**	Existing Fund managed portfolios SD		ChatGPT Equally weighted Portfolios SD
Ninety-One Active Quants	**1,40**	EW GPT Ninety-One Active Quants	1,62
Sanlam Private Wealth	**1,09**	EW GPT Sanlam Private Wealth	1,17
Coronation Smaller companies	3,63	EW GPT coronation smaller companies	**1,38**
Ninety-One Value fund	**3,29**	EW GPT Ninety-One Value Fund	5,35
Ninety-One emerging companies fund	**1,42**	EW GPT Ninety-One emerging companies fund	6,60
Stanlib Enhanced Multi equity fund	1,95	EW GPT Stanlib Enhanced Multi equity fund	**1,31**
Coronation SA equity fund	2,03	GPT Coronation SA equity	**1,38**
Coronation Top 20	**0,86**	EW GPT Coronation Top 20	1,40
Standard Stanlib Equity	**1,11**	EW GPT Standard Stanlib equity	3,97
SIM Small Cap	**0,94**	EW GPT SIM small cap	7,76
SIM Top Choice Equity	1,63	EW GPT SIM TOP Choice Equity	**1,41**
Allan Gray Sa Equity	**0,70**	EW GPT Allan Gray Sa Equity	1,30
Allan Gray Equity	**0,93**	EW GPT Allan Gray Equity	4,33
Sanlam Select Thematic equity	1,19	EW GPT Sanlam Select Thematic equity	**0,37**

Ninety-One Equity Fund	**0,60**	EW GPT Ninety-One equity Fund	1,09
Ninety-One Sa Equity	**1,18**	EW GPT Ninety-One Sa equity	1,33
Sim General Equity	**0,80**	EW GPT SIM General equity	4,07
Coronation equity fund	**0,52**	EW GPT Coronation equity fund	1,25

Figure 6

4.2.5. Figure 6

Figure 6 illustrates the differences in standard deviations of all the portfolios under evaluation.

Bar Graph illustrating the differences in risk in the Fund managed, ChatGPT created and Equally weighted ChatGPT created portfolio as measured by the standard deviations of the portfolios

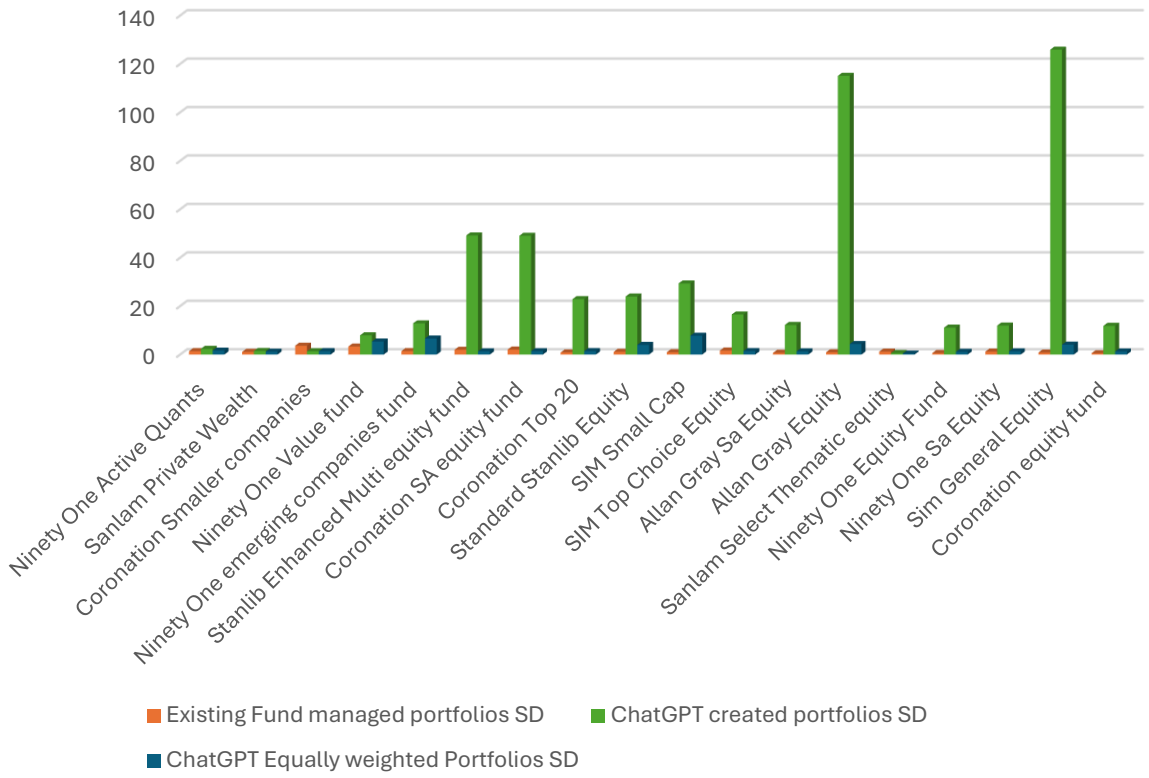


Table 9

4.2.6. Table 9

Table 9 illustrates the fact that the difference between risk levels (measured by the standard deviation of portfolio returns) between the fund-managed and ChatGPT-created portfolios is statistically significant.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.a, b	Decision
	The distribution of portfolio SD is the same across categories of Groups.	Independent-Samples Mann-Whitney U Test	<,001c	Reject the null hypothesis.

a. The significance level is ,050.

Table 10

4.2.7. Table 10

Table 10 illustrates the fact that the difference in risk (SD) between the existing fund-managed portfolios and the EW ChatGPT-created portfolios is statistically significant.

	Null Hypothesis	Test	Sig.a, b	Decision
1	The distribution of Portfolio SD is the same across categories of Groups.	Independent-Samples Mann-Whitney U Test	,040c	Reject the null hypothesis.

a. The significance level is ,050.

4.2.8. Discussion

In constructing the ChatGPT portfolios based on the existing fund-managed portfolios investment strategies, ChatGPT demonstrated some ability to generate returns and outperform existing fund-managed portfolios. However, the results were not statistically significant and therefore this study is unable to conclude that ChatGPT can outperform fund managers in generating returns. Conversely, from a risk mitigation perspective, the results indicate that ChatGPT does not outperform fund managers in reducing portfolio risk as measured by the standard deviations of the portfolio returns.

Table 6 and 7 above with Figure 5 above illustrates the standard deviations of each of the portfolios, which is used as the measure of risk within this study. All but one of the ChatGPT-created portfolios have higher standard deviations than those of the existing fund-managed portfolios and these standard deviations appear to be much higher than those of the ChatGPT-created portfolios. The bolded standard deviations indicate which portfolio between the ChatGPT portfolio, and the existing fund managers portfolio has performed better from a risk minimisation perspective i.e. a lower standard deviation. This is supported by the result of the Mann-Whitney U test indicated in Table 8 and 9 above which illustrates that the standard deviations are significantly higher than those of the existing fund-managed portfolios and the result is statistically significant.

After computing the standard deviations of the existing fund-managed portfolios as well as the ChatGPT-created portfolios from the portfolio returns of these portfolios, the standard deviations were also tested to determine whether the standard deviations of the portfolios are normally distributed. The results of the test for normality have been included below.

The Mann-Whitney U test was performed to determine whether there is a significant difference in the distribution of Portfolio Standard Deviations (Portfolio SD) between two categories: Existing Fund Managed Portfolios and GPT-Created Portfolios. The null hypothesis for this test states that the distribution of Portfolio SD is the same across both categories. The results of the test indicated a significance level (P-value) of less than 0.001, which is well below the threshold for statistical significance ($\alpha=0.05$), consequently, the null

hypothesis is rejected, meaning that there is sufficient evidence to conclude that the distribution of Portfolio Standard Deviations is not the same between the two groups.

Rejecting the null hypothesis implies that a statistically significant difference exists between the variability of standard deviations in the two portfolio categories. This finding suggests that the way standard deviations are distributed in the Existing Fund Managed Portfolios differs from that of the GPT-Created Portfolios. The results indicate that ChatGPT does not perform well in reducing portfolio risk and that ChatGPT does not outperform fund managers in reducing portfolio risk. This has implications for investors who might use the large language model in their portfolio management in that they might then expect higher volatility from a portfolio that has been constructed by ChatGPT. The results could also reflect the investment strategies that ChatGPT was provided with, with several of the investment strategies indicating aggressive equity investment strategies as well as investment strategies that are tailored for investors who do not mind volatility in the short term as a lot of the strategies are growth strategies focused on medium to long term growth.

The results of the portfolio risk indicate that ChatGPT as a tool for stock selection provides a trade-off for higher returns for high portfolio risk. Of the top 5 best performing ChatGPT-created portfolios, 3 of the portfolios, the GPT SIM small cap fund, The GPT Coronation SA Equity, and the GPT Stanlib enhanced Multi-Style Fund, these portfolios are also among the portfolios with the highest standard deviations indicating that despite generating high returns, ChatGPT also constructed higher risk portfolios. The other two of the highest return ChatGPT created portfolios also demonstrated high standard deviations as well, the GPT Standard Stanlib portfolio and the GPT Coronation Top 20 fund further illustrating the trade-off between higher returns and the portfolio risk.

Another observation that emphasises the existence of this trade-off between ChatGPT portfolio returns and risk is the fact that among the worst-performing ChatGPT-created portfolios, some of these portfolios also exhibit the lowest levels of risk as indicated in the table and Figure 4 below. The GPT Ninety-One Value Fund and the GPT Sanlam Select Thematic Equity Fund were amongst the worst performing ChatGPT created portfolios in

generating portfolio returns, however, these portfolios have also generated lower levels of risk indicating the presence of the trade-off relationship as discussed above.

The worst-performing ChatGPT-created portfolios also appear to generate higher risk as well, emphasizing the fact that ChatGPT struggles with those investment strategies as discussed above in the discussion of the returns generated by the portfolios. The GPT Allan Gray Equity and the GPT SIM General Equity were the worst-performing ChatGPT-created portfolios in generating returns and reducing portfolio risk as indicated by extremely high standard deviations.

Figure 6 further illustrates the fact that there is this trade-off between risk and returns and that ChatGPT in selecting and assigning stocks, pursues higher returns at the expense of higher risk. This is because the ChatGPT-created portfolios exhibit extremely high risk, measured by the high standard deviations whereas the equally weighted ChatGPT portfolios are much less volatile but as discussed earlier, significantly underperform the fund-managed portfolios in generating returns.

Both sets of ChatGPT portfolios, both those weighted by ChatGPT and the equally weighted portfolios generated higher levels of risk than those of the existing fund-managed portfolios, as measured by higher standard deviations. To add to the discussion above, the fund-managed portfolios generated standard deviations (risk) that were statistically significantly lower than the ChatGPT portfolios, this was also the case in comparing the existing fund-managed portfolios with the equally weighted ChatGPT portfolios. The P-value in comparing the fund-managed portfolios and the equally weighted ChatGPT portfolios was 0,040 which is less than the significance level of 0,05 indicating the differences are statistically significant, with the fund-managed portfolios exhibiting lower levels of risk as illustrated in Table 5 below. The equally weighted portfolios when compared to the existing fund-managed portfolios generally have higher standard deviations and as a result higher risk levels, significantly underperform in minimising portfolio risk with the Mann-Whitney U test indicating a P-Value of 0,040 which is less than 0,05 indicating a statistically significant result, as illustrated in table 6 below.

Overall, the results for risk indicate that fund managers perform significantly better than ChatGPT in lowering portfolio risk and thus investors seeking stability in their portfolios should not turn to ChatGPT to assist them in selecting stocks. The findings on poor portfolio risk management coupled with certain portfolios generating high returns may indicate that ChatGPT is more aligned with a risk-tolerant investor who does not mind volatility in the short term and is rather focused on future longer-term growth. This aligns with the findings as discussed in the returns section 4.1. of the results discussion that ChatGPT may be better suited to a growth equity investment strategy and the above-mentioned findings that ChatGPT trades off higher risk in pursuing higher returns.

4.3. Other Interesting observations

The ChatGPT-created portfolio returns appear to have followed a similar pattern. The returns generally decreased in the 2nd quarter of 2023 with a large recovery in the 3rd quarter, which typically seems to have been the best-performing quarter for ChatGPT and finally another decrease in 2024. While the quarterly returns of the portfolios differ, because the returns appear to follow such similar patterns indicates that ChatGPT generally created portfolios that were similar in their composition and that the weightings assigned to the stocks were similar. This is illustrated in figures 2 and 4 which shows the movement of each of the ChatGPT portfolios from quarter 1 through to quarter 4 of 2023.

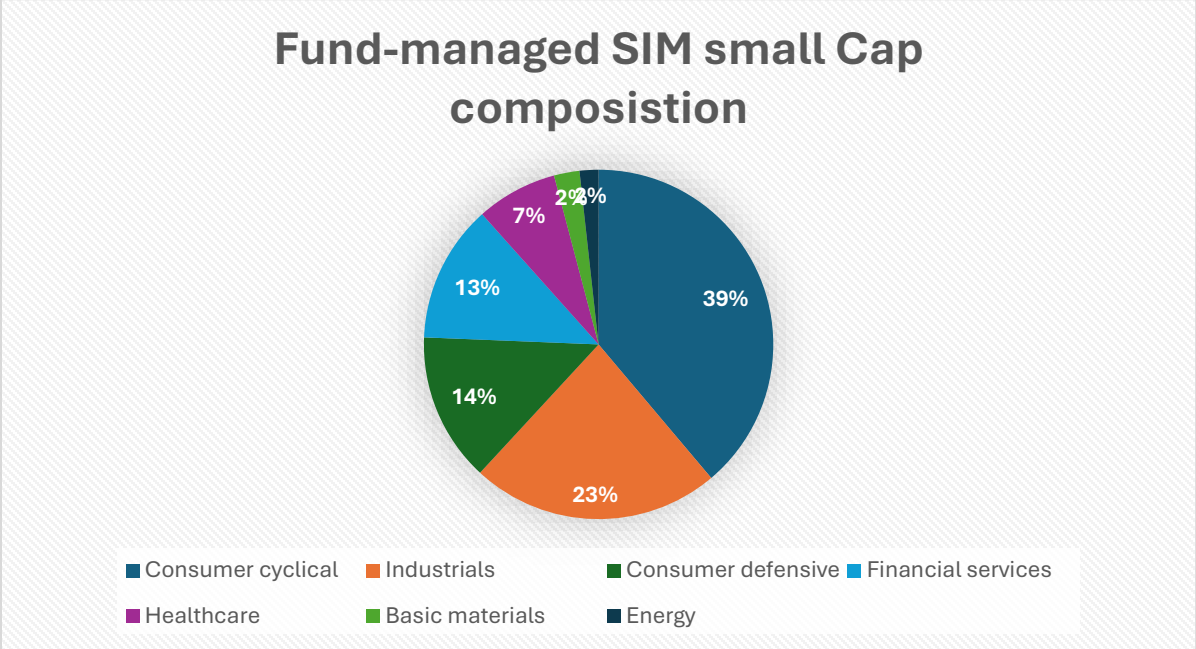
Despite being unable to outperform the fund managers in generating portfolio returns ChatGPT demonstrated an ability to perform financial analyses and an analysis of the industry in which the company operates. As stated in the method, ChatGPT was prompted to conclude on the profitability level, and the level of risk at the company as well as incorporate an analysis of the industry that the company operates in. An example of the analysis performed by ChatGPT on Shoprite has been included in Appendix 10 demonstrating this ability.

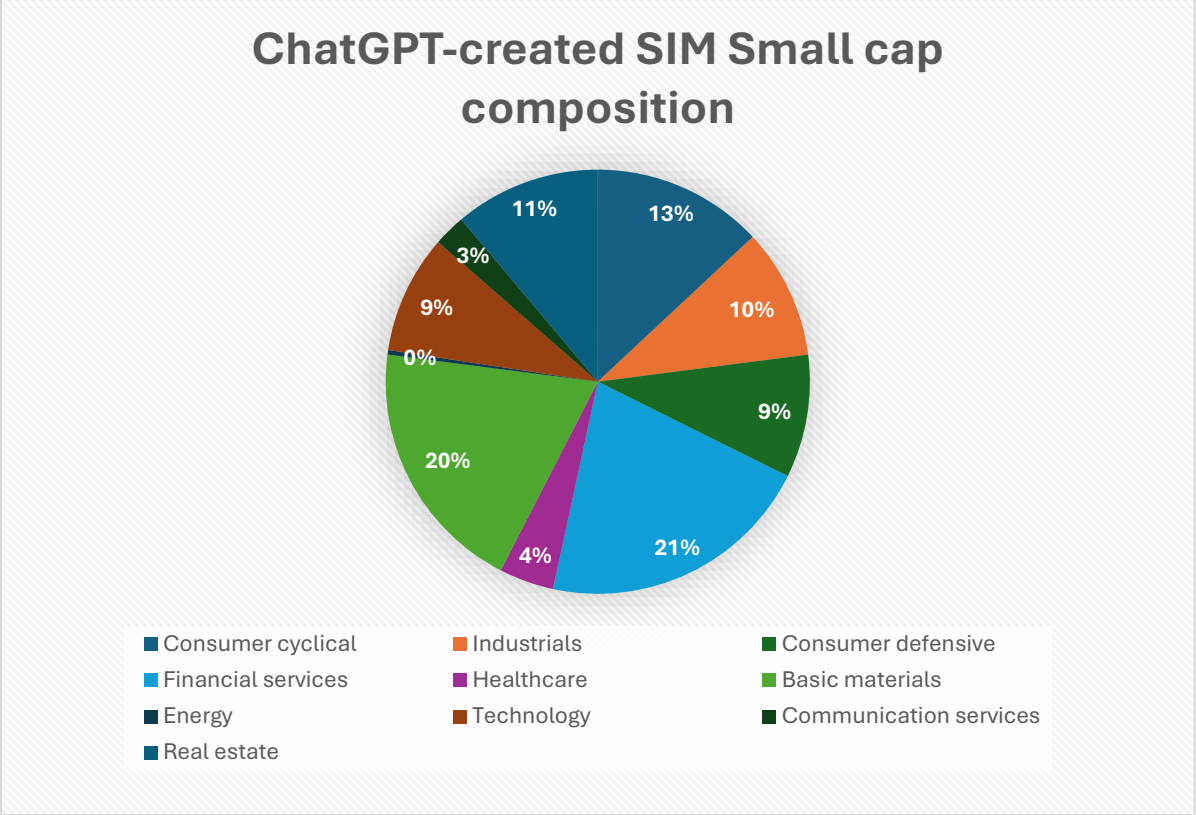
The analysis above illustrates that in evaluating a company, ChatGPT selects particular metrics to evaluate the profitability and risks of the company. This is particularly relevant as for this study, ChatGPT was not prompted with any metrics to concentrate on but was only asked to conclude on the company's profitability and risk level. ChatGPT appeared to use the revenue growth, the EBITDA Margin as well as the net income margin to conclude on the level of profitability. At the beginning of the project, ChatGPT appeared to have utilised all the financial information available in evaluating the company, including the historical financial information as well as the consensus estimates that it was prompted with as illustrated in the output above. Over time ChatGPT seemed to base its conclusions on the profitability of the company i.e. the consensus estimates projections that it was prompted indicating that ChatGPT may have a bias for forward-looking information rather than historical information. This is demonstrated by an example of an evaluation of Sanlam Limited in Appendix 11 which was evaluated much later.

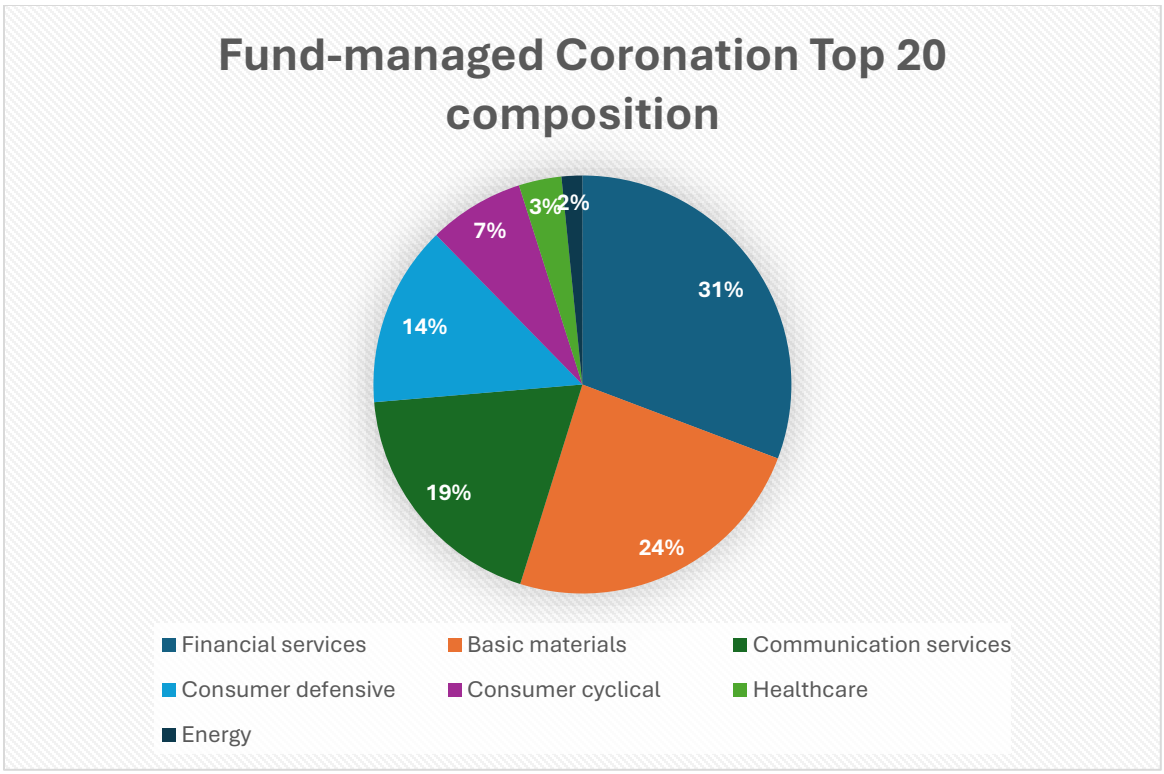
The time when ChatGPT was accessed to perform the analysis also had an impact on the ability of ChatGPT to perform the analysis and the quality of the output received from ChatGPT. During the mornings and the evenings ChatGPT worked well, with few issues encountered regarding hallucinations of the model as well as the time taken by the model to perform the analysis and provide a response. During the day the large language model took significantly longer to generate its responses and had more instances of hallucinations like using the incorrect company data, or the analysis not being completed due to an error occurring. This may be as a result of higher usage during the day which reduced the model's capabilities. This is in line with the research of Ray (2023) who found that ChatGPT can generate text in real-time, but it can sometimes be slow to respond.

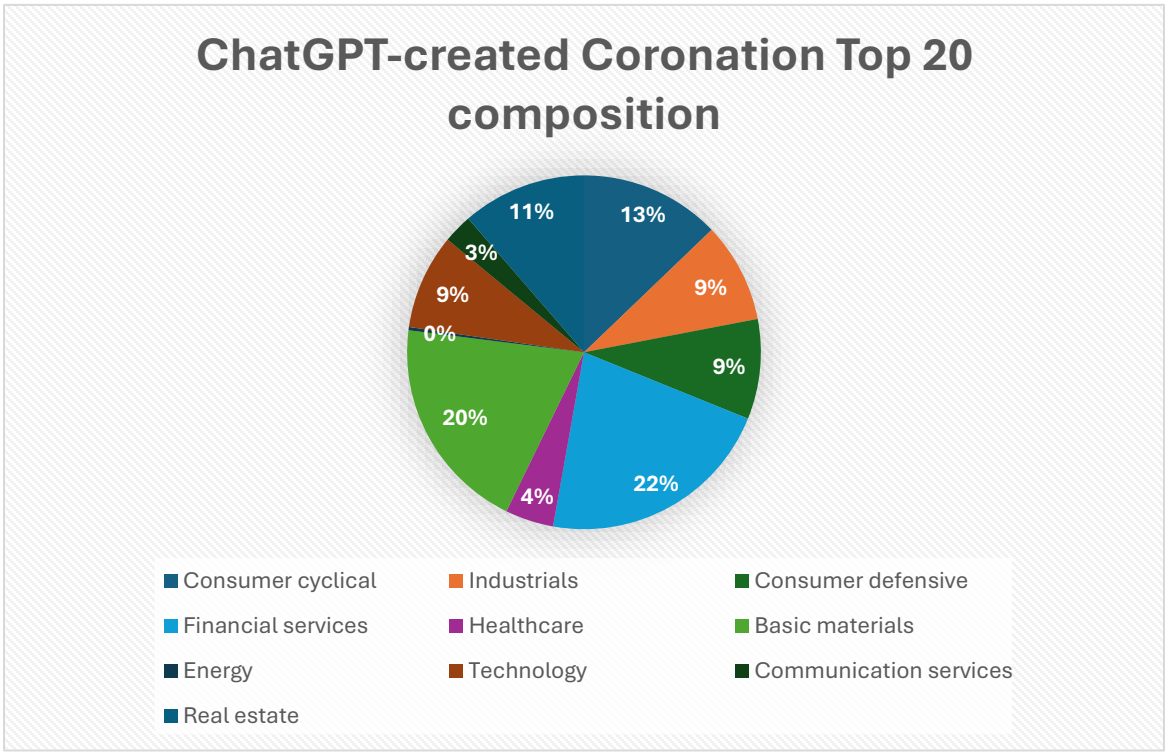
4.3.1. Portfolio construction

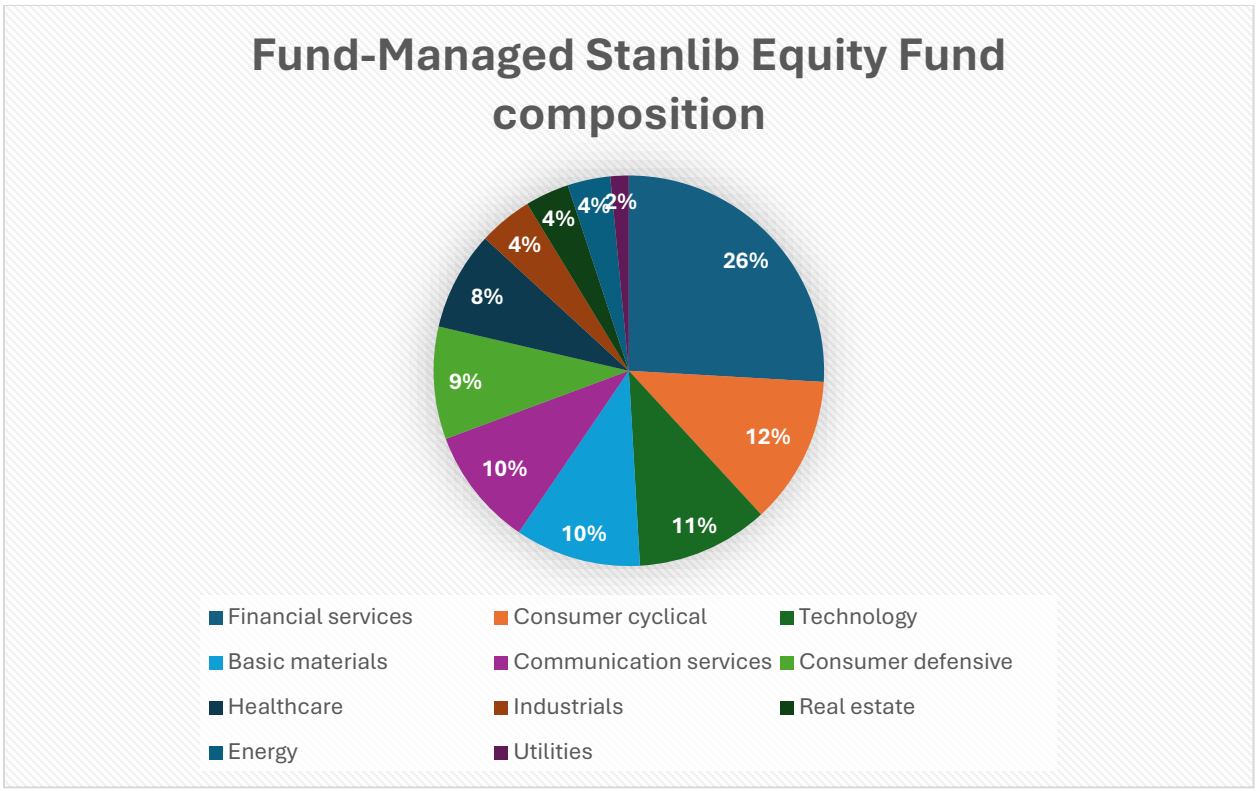
Industry comparisons of the top 5 performing ChatGPT-created portfolios and the corresponding fund-managed portfolios.

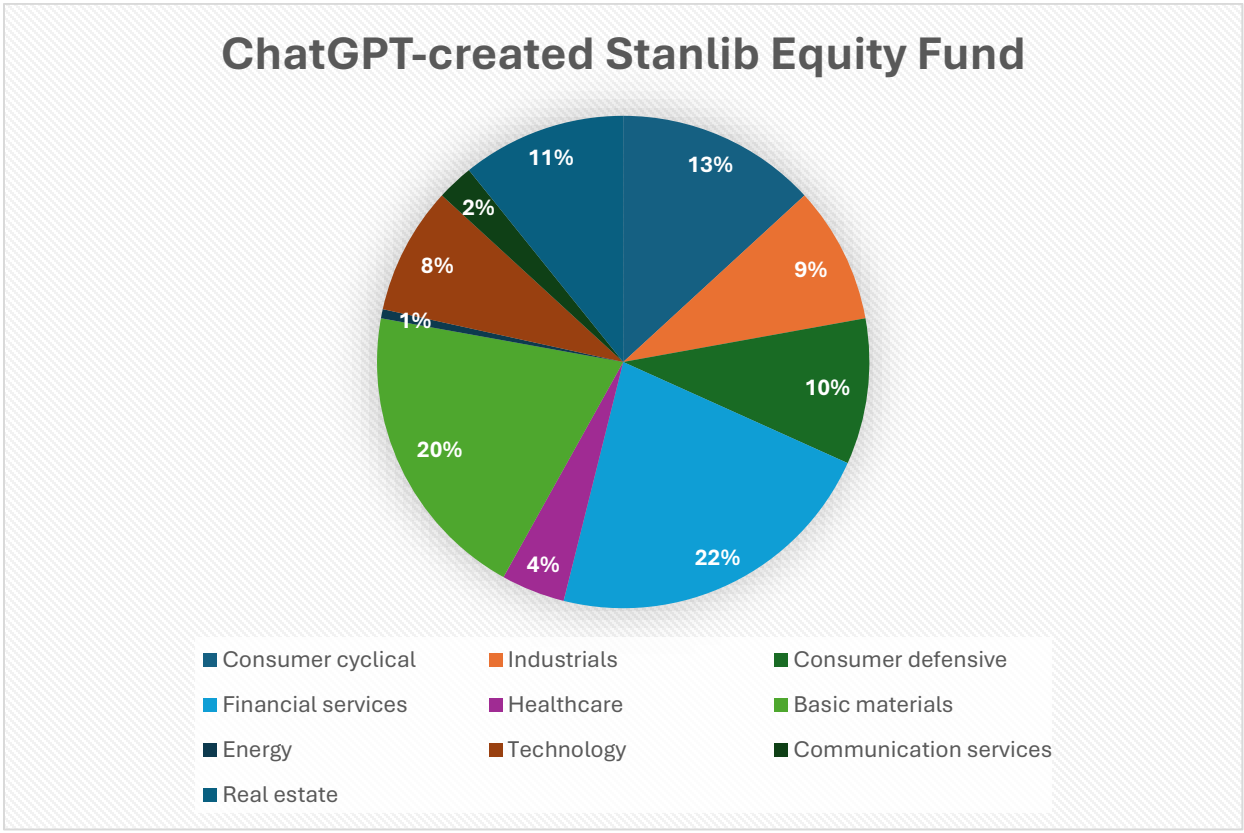




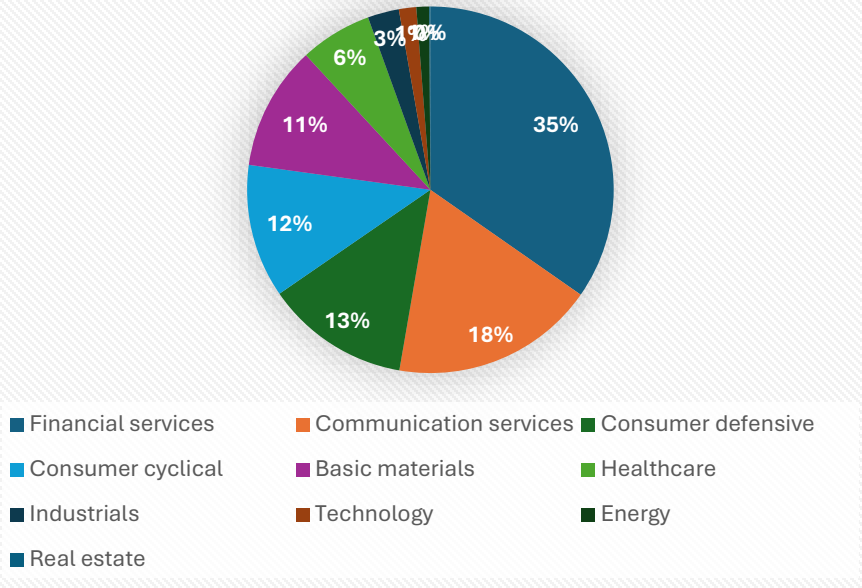

Fund-managed Coronation Top 20 composition
31%
24%
19%
14%
7%
3%
2%
Financial services
Basic materials
Communication services
Consumer defensive
Consumer cyclical
Healthcare
Energy


ChatGPT-created Coronation Top 20 composition
13%
9%
9%
22%
4%
20%
0%
9%
3%
11%
Consumer cyclical
Industrials
Consumer defensive
Financial services
Healthcare
Basic materials
Energy
Technology
Communication services
Real estate

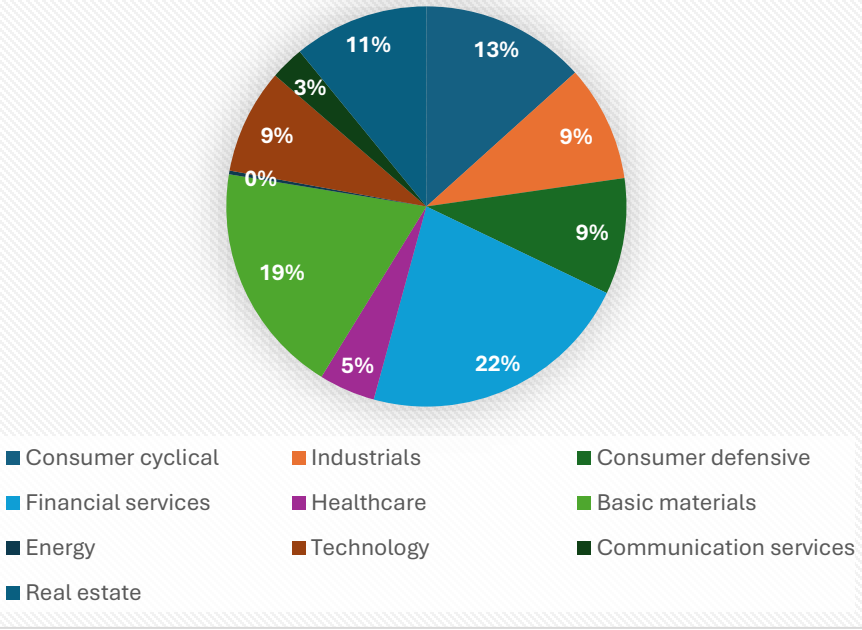

Fund-Managed Stanlib Equity Fund composition
26%
12%
11%
10%
10%
9%
8%
4%
4%
4%
2%
Financial services
Consumer cyclical
Technology
Basic materials
Communication services
Consumer defensive
Healthcare
Industrials
Real estate
Energy
Utilities

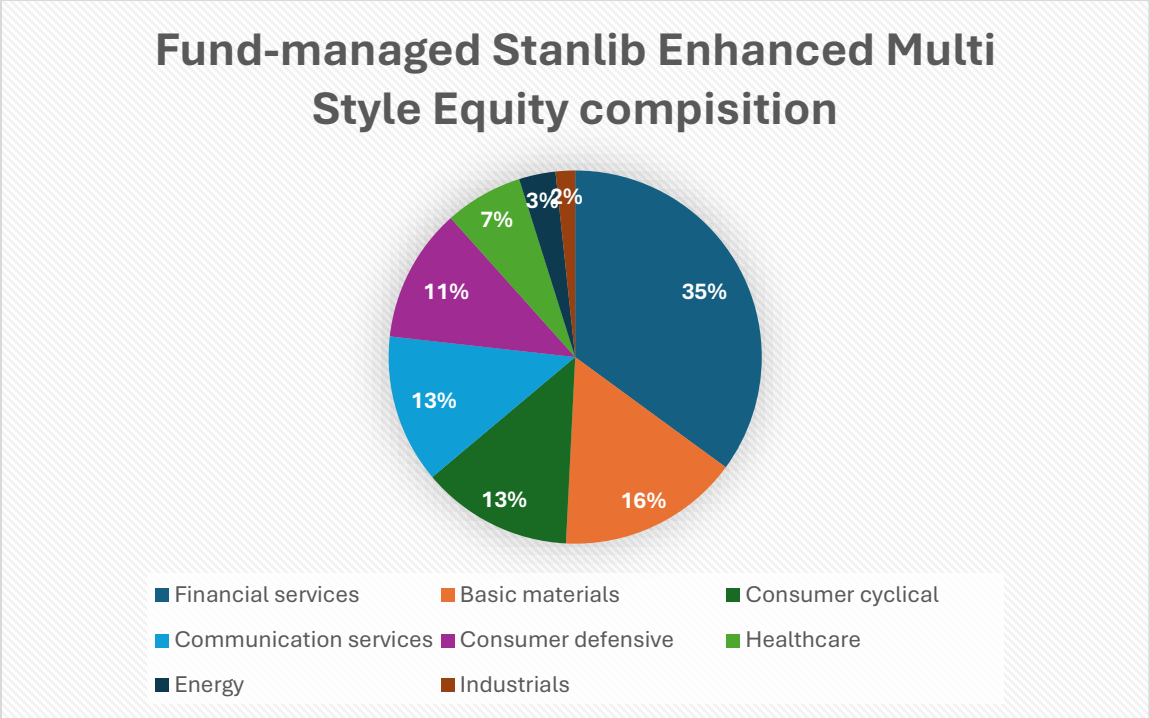

ChatGPT-created Stanlib Equity Fund
13%
9%
10%
22%
4%
20%
1%
8%
2%
11%
Consumer cyclical
Industrials
Consumer defensive
Financial services
Healthcare
Basic materials
Energy
Technology
Communication services
Real estate

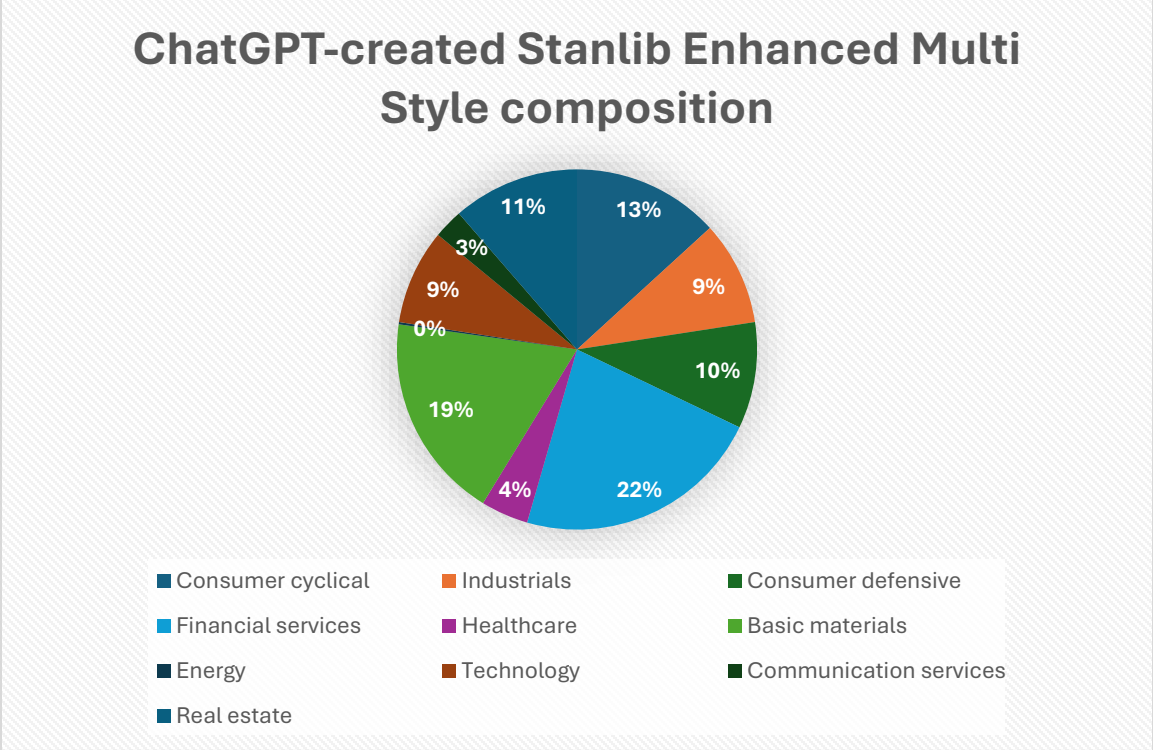
Fund-managed Coronation Sa Equity composition



ChatGPT-created Coronation Sa Equity composition







Figures 6-15 illustrate the differences in industry composition between the top 5 ChatGPT-created portfolios and the corresponding fund-managed portfolios

The pie charts above illustrate ChatGPT's ability to construct a diversified portfolio from an industry diversification perspective. The pie charts above illustrate the differences in industry between the top 5 performing ChatGPT portfolios and their corresponding fund-managed portfolios. A key theme across the ChatGPT-created portfolios is the fact that the portfolios are similar in their industry compositions. While it has been discussed above, that ChatGPT can analyse an industry and identify industry-specific risks the fact that the portfolio industry compositions are generally similar indicates the fact that ChatGPT can be generic in its responses. It could also indicate the fact that ChatGPT has a higher propensity to include stocks within portfolios given particular investment strategies and a result of including a large number of stocks in each portfolio, given the fact there is a limited number of stocks to select from on the JSE the portfolios are bound to be similar.

All the ChatGPT-created portfolios had large numbers of stocks included within the portfolio, which indicates that ChatGPT is inclined to advise an investor to invest in stocks. To illustrate this, the portfolios constructed by ChatGPT contained the following numbers of stocks. Portfolio 1(162), portfolios 2 (182), portfolio 3(91), portfolio 4 (180), portfolio 5 (100), portfolio 6 (174), portfolio 7(174), portfolio 8(107), portfolio 9(177), portfolio 10(98), portfolio 11(156), portfolio 12(185), portfolio 13(177), portfolio 14(150), portfolio 15 (181), portfolio 16(177), portfolio 17(191), portfolio 18(176). Including a large number of stocks may indicate that ChatGPT prioritizes diversification however, despite including a large number of stocks with a wide range of industries in each portfolio, ChatGPT was still unable to minimise portfolio risk and was outperformed by the fund managers in minimising portfolio risk indicating that this is not necessarily the case. Instead, this could indicate that ChatGPT is more inclined to include stocks within its portfolios rather than not and is more partial to investing rather than not investing. Overall ChatGPT advised the researcher to include 65% of all stocks that were under evaluation, which indicates that ChatGPT is more inclined to include rather than exclude stocks.

Traditionally, 10–20 stocks have been found to be sufficient for diversification globally. However, Bradfield and Munro (2017) find that South African portfolios require significantly more stocks due to higher market concentration. Their study employed variance and standard deviation of returns as primary risk measures. Their study found that higher

correlations among stocks in the Johannesburg Stock Exchange (JSE) contribute to elevated risks and that effective diversification requires 33–60 stocks for SWIX-weighted (market-capitalization) portfolios to achieve 90–95% risk reduction while equally weighted portfolios require fewer stocks (15–29). The high number of stocks in ChatGPT's portfolios correlates with increased levels of risk. Including a large number of stocks may dilute the portfolio's focus, increasing the likelihood of exposure to correlated risks within concentrated markets like the JSE (Bradfield & Munro, 2017).

When ChatGPT was prompted to repeat the analysis on each company, ChatGPT did not change its investment decisions on the company. ChatGPT only changed its analysis e.g. change in the level of risk or profitability and the investment decisions if it was prompted on the same company in a different conversation, indicating the fact that ChatGPT is quite confident in its responses. ChatGPT however appears to have grown in confidence over time. Initially, the large language model would advise the user to "proceed with caution" but the more the user utilised ChatGPT, this cautious approach seems to have disappeared over time.

Another interesting finding is that ChatGPT despite concluding on different levels of profitability and risk could still generate the same investment recommendations. This study therefore did not find any evidence of how ChatGPT makes its decisions and whether it gives more weight to the profitability assessment or risk assessment of the companies under evaluation, and this also illustrated a trait of ChatGPT being generic in its responses despite using the paid version of Chat which is the more advanced level of ChatGPT being ChatGPT 4.0 (Ray, 2023). Extracts from the portfolio recommendations have been provided below illustrating the fact that for different levels of profitability and risk, ChatGPT still provided the same investment recommendations, and the responses generated by the large language model were generic for each company. It was found that ChatGPT is a complex and opaque model that can be difficult to understand and explain (Ray, 2023). Ray (2023) further states that it is important to ensure that the model is transparent and explainable, particularly in areas where its decisions can have significant impacts on individuals and society i.e. in this context where an investor may use the large language model and rely on its outputs to make stock selection decisions.

4.3.2. Table: 11

Table illustrating that ChatGPT generalizes and provides the same investment decision for different levels of risk and profitability.

This table provides an example of how ChatGPT generalizes and provides the same investment or do not invest decision but for different levels of risk and profitability.

Company Name	Industry	Level of profitability	Level of risk	Observations	Ninety-One Active Quants
KAL GROUP LIMITED	Specialty Retail	Good	Low	Strong profitability metrics and robust revenue growth align with quantitative selection criteria for long-term capital growth.	Invest
MERAFE RESOURCES LIMITED	Other Metals & Mining	Good	Medium	Strong profitability metrics and stable revenue align with quantitative selection criteria for long-term capital growth.	Invest
SYGNIA LIMITED	Financial Conglomerates	Good	Low	Strong profitability metrics and consistent revenue growth align with quantitative selection criteria for long-term capital growth.	Invest
SPEAR REIT LIMITED	Real Estate Investment Trusts (REITs)	Good	Medium	Spear REIT's stable income and high occupancy rates	Invest

				align with long-term capital growth strategies focused on reliable returns.	
INVICTA HOLDINGS LIMITED	Industrial Distribution	Average	Medium	Invicta's consistent revenue growth and profitability align with long-term capital growth strategies.	Invest
SABVEST CAPITAL LIMITED	Asset Management	Good	Low	Sabvest Capital's robust profitability and diversified portfolio align with long-term capital growth strategies.	Invest

Observations	Sanlam Private Wealth Equity B3	Observations	Coronation Smaller Companies Fund	Observations	Ninety-One Value Fund
Diversified equity portfolio benefits from KAL Group's financial stability and consistent growth trajectory.	Invest	Fits the small to mid-cap focus, offering growth potential and attractive valuation in the specialty retail sector.	Invest	Strong ROE and undervaluation relative to peers align KAL Group with value-driven portfolio objectives.	Invest
Diversified equity portfolio benefits from Merafe Resources' strong financial stability and competitive	Invest	Fits the small to mid-cap focus, offering growth potential and strong fundamentals in the metals & mining sector.	Invest	High ROE and undervaluation relative to peers make Merafe Resources suitable for a value-driven portfolio.	Invest

market positioning.					
Diversified equity portfolio benefits from Sygnia's robust financial health and consistent growth trajectory.	Invest	Fits the small to mid-cap focus, offering growth potential and attractive valuation in the financial conglomerates sector.	Invest	High ROE and undervaluation relative to peers make Sygnia suitable for a value-driven portfolio.	Invest
The company's diversified property portfolio and strong financial performance make it a suitable candidate for a diversified equity portfolio seeking stable income streams.	Invest	Spear REIT's mid-cap status and regional specialization offer growth potential within a focused market, aligning with small to mid-cap investment strategies.	Invest	The company's consistent dividend yield and undervaluation relative to peers make it an attractive option for value-driven portfolios.	Invest
Diversified equity portfolio benefits from Invicta's strong financial health and diversified product offerings.	Invest	Invicta's mid-cap status and growth potential in industrial distribution align with small to mid-cap investment strategies.	Invest	Moderate ROE and undervaluation relative to peers make Invicta suitable for value-driven portfolios.	Invest
Diversified equity portfolio benefits from Sabvest Capital's	Invest	The company's growth potential in asset management aligns with small	Invest	High ROE and undervaluation relative to peers make Sabvest	Invest

financial stability and strong investment income.		to mid-cap investment strategies.		Capital suitable for value-driven portfolios.	
Observations	Ninety-One Emerging Companies Fund	Observations	STANLIB Enhanced Multi Style Equity	Observations	Coronation SA Equity
Suitable for small and medium-sized companies fund due to growth potential and strong fundamentals in a niche market.	Invest	High profitability metrics and sustainable dividend payouts make KAL Group a strong candidate for multi-style equity funds.	Invest	Local equity focus benefits from KAL Group's strong presence in South African specialty retail markets.	Invest
Exposure to metals and mining aligns with the small to medium-sized companies fund objectives, supported by strong profitability.	Invest	High-quality financial metrics and sustainable margins position Merafe Resources as a strong candidate for multi-style equity funds.	Invest	Local equity focus benefits from Merafe Resources' strong presence in the South African mining industry.	Invest
Suitable for small and medium-sized companies fund due to strong fundamentals	Invest	High profitability metrics and sustainable dividends position Sygnia as a strong candidate for	Invest	Local equity focus benefits from Sygnia's leadership in South African financial	Invest

and growth potential in financial services.		multi-style equity funds.		services markets.	
Spear REIT's focus on small to medium-sized properties in the Western Cape aligns with funds targeting this segment, offering stable returns and growth opportunities.	Invest	The company's diversified property sectors and consistent financial performance make it suitable for multi-style equity funds seeking a blend of income and growth.	Invest	Spear REIT's strong presence in the Western Cape makes it a compelling addition to local equity funds focusing on regional investments.	Invest
Exposure to industrial distribution supports inclusion in funds targeting small to medium-sized companies with growth opportunities.	Invest	Invicta's financial stability and diversified operations position it as a suitable candidate for multi-style equity funds.	Invest	Strong local market presence and industrial expertise align Invicta with local equity fund objectives.	Invest
Sabvest Capital's strong fundamentals and diversified holdings make it an appropriate fit for funds targeting small	Invest	The company's financial stability and diverse investment strategies position it well for multi-style equity funds.	Invest	Sabvest Capital's leadership in the asset management sector aligns with local equity fund objectives.	Invest

to medium-sized companies.					
Observations	Coronation Top 20 A	Observations	Standard STANLIB Equity Fund	Observations	Sanlam Investment Management (SIM) Small Cap fund
Excluded due to concentration on large-cap holdings; KAL Group remains a mid-cap company.	Do Not Invest	Diversified growth fund aligns with KAL Group's strong financial performance and market positioning.	Invest	Aggressive small to mid-cap fund benefits from KAL Group's robust growth potential in the specialty retail market.	Invest
Excluded due to concentration on large-cap holdings; Merafe Resources remains a mid-cap company.	Do Not Invest	Diversified growth fund aligns with Merafe Resources' strong operational performance and market positioning.	Invest	Aggressive small to mid-cap fund benefits from Merafe Resources' robust growth potential in the metals & mining market.	Invest
Excluded due to concentration on large-cap holdings; Sygnia remains a mid-cap company.	Do Not Invest	Diversified growth fund aligns with Sygnia's strong operational performance and market positioning.	Invest	Aggressive small to mid-cap fund benefits from Sygnia's growth trajectory and competitive positioning in financial services.	Invest
Given its mid-cap status,	Do Not Invest	The company's redevelopment	Invest	Spear REIT's regional focus	Invest

Spear REIT may not align with concentrated large-cap equity funds.		opportunities and stable income streams position it well within diversified growth equity strategies.		and growth potential in the Western Cape market align with aggressive small to mid-cap fund objectives.	
Invicta's mid-cap status excludes it from large-cap-focused equity funds.	Do Not Invest	Diversified growth strategies align with Invicta's steady operational performance and market positioning.	Invest	Aggressive small to mid-cap funds benefit from Invicta's growth trajectory and industrial market positioning.	Invest
Sabvest Capital's mid-cap status excludes it from concentrated large-cap-focused equity funds.	Do Not Invest	Diversified growth fund aligns with Sabvest Capital's strong operational performance and market positioning.	Invest	Aggressive small to mid-cap funds benefit from Sabvest Capital's diversified portfolio and growth trajectory.	Invest

*Not all the portfolio analyses have been included as this table has only been included for illustrative purposes

5. Conclusion

This study explored the potential of ChatGPT, a generative AI model, in constructing stock investment portfolios and evaluated its performance relative to fund-managed portfolios from South Africa's top 5 leading asset managers. Using Modern Portfolio Theory as the guiding framework and focusing on active equity investment strategies, the research assessed ChatGPT on two primary objectives, maximising returns and minimising risk. The findings offer valuable insights into the capabilities, limitations, and implications of leveraging AI tools like ChatGPT in the financial sector.

ChatGPT demonstrated the ability to construct competitive portfolios, outperforming fund-managed portfolios in 9 out of 18 cases based on the fund managers investment strategies. However, the differences in portfolio returns were not statistically significant, as evidenced by the results of the Mann-Whitney U test. While ChatGPT excelled in growth-oriented strategies, it struggled in value-based and diversified strategies which underperformed. From a risk perspective, ChatGPT-created portfolios exhibited substantially higher standard deviations, indicating that the large language model trades off higher risk in pursuit of higher returns. These findings indicate that ChatGPT may be better suited for risk-tolerant investors seeking long-term growth, rather than those prioritising stability and consistency in returns.

Despite these limitations, the study highlights ChatGPT's strengths in financial analysis and industry evaluation. When prompted, ChatGPT effectively analysed company profitability, risk levels, and industry-specific factors. Notably, ChatGPT was able to identify relevant metrics, such as revenue growth, EBITDA margins, and sector-specific risks, without explicit guidance, demonstrating its potential to democratise financial knowledge. This capability is relevant for less financially literate investors, who could leverage the large language model to make more informed stock selection decisions. However, the study also revealed that ChatGPT's responses tended to be generic across similar prompts, the model is subject to hallucinations and the outputs require constant validation tool (Pisaneschi, 2024; Pelster & Val, 2024a). This was discussed in the method section and its propensity to recommend investments consistently, regardless of varying profitability and risk assessments, suggests limited nuance in its decision-making process.

An intriguing observation was the uniformity in ChatGPT-created portfolio returns, which followed a similar pattern of decline in the second quarter of 2023, recovery in the third quarter, and decline again in the fourth quarter. This indicates that ChatGPT's stock selection and weighting strategies may lack sufficient variability and adaptability to market dynamics. Furthermore, ChatGPT demonstrated a tendency to include a large number of stocks in its portfolios, with the number of stocks ranging from 91 to 191. While this suggests an emphasis on diversification, the persistently high-risk levels of these portfolios imply that the mere inclusion of many stocks for diversification purposes is insufficient for effective risk management, especially in a South African context. ChatGPT's inclination to recommend investments (having recommended that 65% of all stocks under evaluation should be included in the portfolios) rather than avoid them further highlights its partiality toward inclusion over exclusion.

This study fills a gap in the existing literature by exploring ChatGPT's effectiveness in stock selection and portfolio management, particularly in the context of South African financial markets. The findings suggest that ChatGPT has potential as a complementary tool for individual investors and financial professionals, particularly in growth-oriented strategies. However, its inability to minimize risk and its reliance on generic responses underscore the need for cautious integration into investment practices. The results also emphasize that ChatGPT is not yet equipped to replace professional fund managers due to ChatGPT being unable to minimise portfolio risk and generate stable returns.

In future, advancements in AI, including real-time data integration and more nuanced decision-making algorithms, could significantly enhance ChatGPT's capabilities. Future research could explore its long-term performance, application in international markets, and effectiveness in dynamic portfolio rebalancing. ChatGPT is a valuable tool for democratising financial knowledge and empowering investors who are less financially literate. This paper concludes that investors could benefit from using the tool as supportive rather than standalone tool in portfolio stock selection. The tool could offer insights that complement, rather than replace, professional expertise in the asset management industry. This is similar

to the findings from Romanko et al. (2023) who found that utilising ChatGPT as a "standalone" investment advisor may not be a good idea due to its high number of limitations.

With advancements in AI technology, including the incorporation of real-time data and enhanced contextual processing, ChatGPT's capabilities in financial decision-making could improve significantly. Future research could explore ChatGPT's long-term performance which would include different market conditions, evaluate its application across diverse international markets, and investigate its ability in portfolio rebalancing. Future research could also compare ChatGPT's ability against those of fund managers with a wider variety of assets included in the portfolios. Another recommendation for future research could be to investigate ChatGPT's future market performance rather than using back testing in the methodology. In the context of the JSE, with the JSE not being a highly liquid market a final recommendation for a future area for research would be to consider how ChatGPT can handle liquidity issues. Future research can build on this study and make comparisons of the results of this study to when the study is applied to other exchanges. Fund managers can potentially use ChatGPT and other large language models to perform initial analysis and then make decisions, indicating the potential for ChatGPT to complement fund managers in performing their work.

6. References

Barrett, T. (2023). *Uplevel your prompt craft in ChatGPT with the CREATE framework*. Retrieved 21 May 2024 from https://edte.ch/blog/create-framework/?v=3a1ed7090bfa#:~:text=the%20CREATE%20framework-,Uplevel%20your%20prompt%20craft%20in%20ChatGPT%20with%20the%20CREATE%20framework,best%20practices%20and%20critical%20guidelines.

Beyhaghi, M., & Hawley, J. P. (2013). Modern portfolio theory and risk management: assumptions and unintended consequences. *Journal of Sustainable Finance & Investment*, *3*(1), 17-37.

Biglova, A., Ortobelli, S., Rachev, S. T., & Stoyanov, S. (2004). Different approaches to risk estimation in portfolio theory. *The Journal of Portfolio Management*, *31*(1), 103-112.

Bradfield, D., & Munro, B. (2017). The number of stocks required for effective portfolio diversification: The South African case. *South African Journal of Accounting Research*, *31*(1), 44-59.

Brenner, L., & Meyll, T. (2020). Robo-advisors: A substitute for human financial advice? *Journal of Behavioral and Experimental Finance*.

Chan, L. K., & Lakonishok, J. (2004). Value and growth investing: Review and update. *Financial Analysts Journal*, *60*(1), 71-86.

Cherry, C., Mohamed, W., & Brahmbhatt, Y. (2023). Using FinBERT as a refined approach to measuring impression management in corporate reports during a crisis. *Communicare: Journal for Communication Sciences in Southern Africa*, *42*(1), 64-80.

Citywire. (2024a). https://citywire.com/za/sector/south-africa-funds/i1565?expandedList=true&league=fund

Citywire. (2024b). *Citywire Fund Performance - Limitations And Restriction Of Use*. https://uk.citywire.com/legal/limitationsanduserestrictions.aspx

Dowling, M., & Lucey, B. (2023). ChatGPT for (Finance) research: The Bananarama Conjecture. *Finance Research Letters*.

Edwin J. Elton, & Gruber, M. J. (1997). Modern portfolio theory, 1950 to date. *Journal of Banking & Finance*.

Fabozzi, F. J., Gupta, F., & Markowitz, H. M. (2002). The Legacy of Modern Portfolio Theory. *The journal of investing*, *11*, 7-22.

ğiĠan, A. G. (2015). The Efficient Market Hypothesis: review of specialized literature and empirical research. *Procedia Economics and Finance*(32), 442-449.

Giudic, P. (2018). Fintech Risk Management: A Research Challenge for Artificial Intelligence in Finance. *Frontiers in Artificial Intelligence*.

Heymans, A., & Santana, L. (2018). How efficient is the Johannesburg Stock Exchange really? *South African Journal of Economic and Management Sciences*, *21*(1).

Ighosewe, E. F. (2022). Accounting information and value relevance: a quinquennial comparison of pre-and post-IFRS adoption of listed firms in Nigeria and South Africa. *Modern Economy*, *13*(7), 1006-1023.

Investor, T. D. (2024). *South Africa's largest asset managers*. Retrieved 18 September from https://dailyinvestor.com/investing/48232/south-africas-largest-asset-managers/

Khan, M. S., & Umer, H. (2024). ChatGPT in finance: Applications, challenges, and solutions. *Hitotsubashi Institute for Advanced Study (HIAS), Institute of Economic Research (IER), Hitotsubashi University, Japan*.

Kim, J. H. (2023). What if ChatGPT were a quant asset manager. *Finance Research Letters*, *58*, 104580.

Ko, H., & Lee, J. (2024a). Can ChatGPT improve investment decisions? From a portfolio management perspective. *Finance Research Letters*, *64*, 105433.
Ko, H., & Lee, J. (2024b). Can ChatGPT improve investment decisions? From a portfolio management perspective. *Finance Research Letters*.
Leedy, P. D., & Ormrod, J. E. (2015). *Practical Research*
PLANNING AND DESIGN (11 ed.). Pearson.
Lopez-Lira, A., & Tang, Y. (2023). *Can ChatGPT Forecast Stock Price Movements? Return Predictability and Large Language Models*. University of Florida.
Mangram, M. E. (2013). A SIMPLIFIED PERSPECTIVE OF THE MARKOWITZ PORTFOLIO THEORY. *GLOBAL JOURNAL OF BUSINESS RESEARCH*, *7*(1), 59-70.
Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of cardiac anaesthesia*, *22*(1), 67-72.
Moeini Najafabadi, Z., Bijari, M., & Khashei, M. (2020). Making investment decisions in stock markets using a forecasting-Markowitz based decision-making approaches. *Journal of Modelling in Management*, *15*(2), 647-659.
Moodley, N., Muller, C., & Ward, M. (2016). Director dealings as an investment strategy. *Studies in Economics and Econometrics*, *40*(2), 105-123.
Mungoli, N. (2023). Exploring the Synergy of Prompt Engineering and Reinforcement Learning for Enhanced Control and Responsiveness in Chat GPT. *Journal of Electrical Electronics Engineering*, *2*(3), 201-205.
Nguyen, J. K. (2024). Human bias in AI models? Anchoring effects and mitigation strategies in large language models. *Journal of Behavioral and Experimental Finance*, *43*, 100971.
Niszczota, P., & Abbas, S. (2023). GPT has become financially literate: Insights from financial literacy tests of GPT and a preliminary test of how people use it as a source of advice. *Finance Research Letters*.
Nyakundi, H. (2023). *How to Communicate with ChatGPT – A Guide to Prompt Engineering*. Retrieved 21 May 2024 from https://www.freecodecamp.org/news/how-to-communicate-with-ai-tools-prompt-engineering/
O'Leary, D. E. (2023). An analysis of three chatbots: BlenderBot, ChatGPT and LaMDA. *Intelligent Systems in Accounting, Finance and Management*, *30*, 41-54.
Obaidat, A. N. (2016). Accounting information: Which information attracts investors attention first. *Accounting and Finance Research*, *5*(3), 107-117.
Oehler, A., & Horn, M. (2024). Does ChatGPT provide better advice than robo-advisors? *Finance Research Letters*.
OpenAI. (2024). Retrieved 23 May 2024 from https://platform.openai.com/docs/guides/prompt-engineering
Pelster, M., & Val, J. (2024a). Can ChatGPT assist in picking stocks? *Finance Research Letters*.
Pelster, M., & Val, J. (2024b). Can ChatGPT assist in picking stocks? *Finance Research Letters*, *59*, 104786.
Pisaneschi, B. (2024). *Unstructured Data and AI Fine-Tuning LLMs to Enhance the Investment Process*.
Rane, N. (2023). Role and challenges of ChatGPT and similar generative artificial intelligence in finance and accounting. *Available at SSRN 4603206*.
Rani, A. (2012). THE MODERN PORTFOLIO THEORY AS AN INVESTMENT DECISION TOOL. *INTERNATIONAL JOURNAL OF MANAGEMENT RESEARCH AND REVIEW*, *2*(7).

Ray, P. P. (2023). ChatGPT: A comprehensive review on background, applications, key challenges, bias, ethics, limitations and future scope. *Internet of Things and Cyber-Physical Systems*, *3*, 121-154.

Romanko, O., Narayan, A., & Kwon, R. H. (2023). Chatgpt-based investment portfolio selection. Operations Research Forum,

Technology, M. I. o. *The Major Formulas and Terms For Portfolio Theory, CAPM*. Retrieved 28 April from http://web.mit.edu/15.415ab/www/mid2form_all.pdf

Ullah, R., Ismail, H. B., Khan, M. T. I., & Zeb, A. (2024). Nexus between Chat GPT usage dimensions and investment decisions making in Pakistan: Moderating role of financial literacy. *Technology in Society*, *76*, 102454.

Wermers, R. (2020). Active investing and the efficiency of security markets. *The Journal of Investment Management*.

Wessels, D., & Krige, J. (2005). Active versus passive investing I: The South African experience. *Studies in Economics and Econometrics*, *29*(2), 1-33.

Wu, S., Irsoy, O., Lu, S., Dabravolski, V., Dredze, M., Gehrmann, S., Kambadur, P., Rosenberg, D., & Mann, G. (2023). Bloomberggpt: A large language model for finance. *arXiv preprint arXiv:2303.17564*.

Barrett, T. (2023). Uplevel your prompt craft in ChatGPT with the CREATE framework. Retrieved 21 May 2024 from https://edte.ch/blog/create-framework/?v=3a1ed7090bfa#:~:text=the%20CREATE%20framework-,Uplevel%20your%20prompt%20craft%20in%20ChatGPT%20with%20the%20CREATE%20framework,best%20practices%20and%20critical%20guidelines.

Beyhaghi, M., & Hawley, J. P. (2013). Modern portfolio theory and risk management: assumptions and unintended consequences. Journal of Sustainable Finance & Investment, 3(1), 17-37.

Biglova, A., Ortobelli, S., Rachev, S. T., & Stoyanov, S. (2004). Different approaches to risk estimation in portfolio theory. The Journal of Portfolio Management, 31(1), 103-112.

Bradfield, D., & Munro, B. (2017). The number of stocks required for effective portfolio diversification: The South African case. South African Journal of Accounting Research, 31(1), 44-59.

Brenner, L., & Meyll, T. (2020). Robo-advisors: A substitute for human financial advice? Journal of Behavioral and Experimental Finance.

Chan, L. K., & Lakonishok, J. (2004). Value and growth investing: Review and update. Financial Analysts Journal, 60(1), 71-86.

Cherry, C., Mohamed, W., & Brahmbhatt, Y. (2023). Using FinBERT as a refined approach to measuring impression management in corporate reports during a crisis. Communicare: Journal for Communication Sciences in Southern Africa, 42(1), 64-80.

Citywire. (2024a). https://citywire.com/za/sector/south-africa-funds/i1565?expandedList=true&league=fund

Citywire. (2024b). Citywire Fund Performance - Limitations and Restriction of Use. https://uk.citywire.com/legal/limitationsanduserestrictions.aspx

Dowling, M., & Lucey, B. (2023). ChatGPT for (Finance) research: The Bananarama Conjecture. Finance Research Letters.

Edwin J. Elton, & Gruber, M. J. (1997). Modern portfolio theory, 1950 to date. Journal of Banking & Finance.

Fabozzi, F. J., Gupta, F., & Markowitz, H. M. (2002). The Legacy of Modern Portfolio Theory. The journal of investing, 11, 7-22.

ğiĠan, A. G. (2015). The Efficient Market Hypothesis: review of specialized literature and empirical research. Procedia Economics and Finance (32), 442-449.

Giudic, P. (2018). Fintech Risk Management: A Research Challenge for Artificial Intelligence in Finance. Frontiers in Artificial Intelligence.

Heymans, A., & Santana, L. (2018). How efficient is the Johannesburg Stock Exchange really? South African Journal of Economic and Management Sciences, 21(1).

Ighosewe, E. F. (2022). Accounting information and value relevance: a quinquennial comparison of pre-and post-IFRS adoption of listed firms in Nigeria and South Africa. Modern Economy, 13(7), 1006-1023.

Investor, T. D. (2024). South Africa's largest asset managers. Retrieved 18 September from https://dailyinvestor.com/investing/48232/south-africas-largest-asset-managers/

Khan, M. S., & Umer, H. (2024). ChatGPT in finance: Applications, challenges, and solutions. Hitotsubashi Institute for Advanced Study (HIAS), Institute of Economic Research (IER), Hitotsubashi University, Japan.

Kim, J. H. (2023). What if ChatGPT were a quant asset manager. Finance Research Letters, 58, 104580.

Ko, H., & Lee, J. (2024a). Can ChatGPT improve investment decisions? From a portfolio management perspective. Finance Research Letters.

Ko, H., & Lee, J. (2024b). Can ChatGPT improve investment decisions? From a portfolio management perspective. Finance Research Letters, 64, 105433.

Leedy, P. D., & Ormrod, J. E. (2015). Practical Research

PLANNING AND DESIGN (11 ed.). Pearson.

Lopez-Lira, A., & Tang, Y. (2023). Can ChatGPT Forecast Stock Price Movements? Return Predictability and Large Language Models. University of Florida.

Mangram, M. E. (2013). A SIMPLIFIED PERSPECTIVE OF THE MARKOWITZ PORTFOLIO THEORY. GLOBAL JOURNAL OF BUSINESS RESEARCH, 7(1), 59-70.

Moeini Najafabadi, Z., Bijari, M., & Khashei, M. (2020). Making investment decisions in stock markets using a forecasting-Markowitz based decision-making approaches. Journal of Modelling in Management, 15(2), 647-659.

Moodley, N., Muller, C., & Ward, M. (2016). Director dealings as an investment strategy. Studies in Economics and Econometrics, 40(2), 105-123.

Mungoli, N. (2023). Exploring the Synergy of Prompt Engineering and Reinforcement Learning for Enhanced Control and Responsiveness in Chat GPT. Journal of Electrical Electronics Engineering, 2(3), 201-205.

Niszczota, P., & Abbas, S. (2023). GPT has become financially literate: Insights from financial literacy tests of GPT and a preliminary test of how people use it as a source of advice. Finance Research Letters.

Nyakundi, H. (2023). How to Communicate with ChatGPT – A Guide to Prompt Engineering. Retrieved 21 May 2024 from https://www.freecodecamp.org/news/how-to-communicate-with-ai-tools-prompt-engineering/

O'Leary, D. E. (2023). An analysis of three chatbots: BlenderBot, ChatGPT and LaMDA. Intelligent Systems in Accounting, Finance and Management, 30, 41-54.

Obaidat, A. N. (2016). Accounting information: Which information attracts investors attention first. Accounting and Finance Research, 5(3), 107-117.

Oehler, A., & Horn, M. (2024). Does ChatGPT provide better advice than robo-advisors? Finance Research Letters.

OpenAI. (2024). Retrieved 23 May 2024 from https://platform.openai.com/docs/guides/prompt-engineering

Pelster, M., & Val, J. (2024a). Can ChatGPT assist in picking stocks? Finance Research Letters.

Pelster, M., & Val, J. (2024b). Can ChatGPT assist in picking stocks? Finance Research Letters, 59, 104786.

Pisaneschi, B. (2024). Unstructured Data and AI Fine-Tuning LLMs to Enhance the Investment Process.

Rane, N. (2023). Role and challenges of ChatGPT and similar generative artificial intelligence in finance and accounting. Available at SSRN 4603206.

Rani, A. (2012). THE MODERN PORTFOLIO THEORY AS AN INVESTMENT DECISION TOOL. INTERNATIONAL JOURNAL OF MANAGEMENT RESEARCH AND REVIEW, 2(7).

Romanko, O., Narayan, A., & Kwon, R. H. (2023). Chatgpt-based investment portfolio selection. Operations Research Forum,

Technology, M. I. o. The Major Formulas and Terms for Portfolio Theory, CAPM. Retrieved 28 April from http://web.mit.edu/15.415ab/www/mid2form_all.pdf

Ullah, R., Ismail, H. B., Khan, M. T. I., & Zeb, A. (2024). Nexus between Chat GPT usage dimensions and investment decisions making in Pakistan: Moderating role of financial literacy. Technology in Society, 76, 102454.

Wermers, R. (2020). Active investing and the efficiency of security markets. The Journal of Investment Management.

Wessels, D., & Krige, J. (2005). Active versus passive investing I: The South African experience. Studies in Economics and Econometrics, 29(2), 1-33.

Wu, S., Irsoy, O., Lu, S., Dabravolski, V., Dredze, M., Gehrmann, S., Kambadur, P., Rosenberg, D., & Mann, G. (2023). Bloomberggpt: A large language model for finance. arXiv preprint arXiv:2303.17564.

7. Appendix 1: Example of the prompts provided to ChatGPT, a repeat of the analysis, and the responses from ChatGPT

Researcher: I need you to assume the role of a fund manager. I am going to provide you with the investment strategies of 18 different portfolios. I will then provide you with the financial information of that company as well as the industry. I need you to conclude on whether the level of profitability is good, poor, or average. I also need you to conclude on whether the level of risk at this company is high, medium, or low. I then need you to provide reasons of whether to invest or not to invest in each portfolio along with the recommendation for each portfolio. The invest or do not invest decision must be made based on whether based on the financial performance of this company and the industry, the company will meet the investment strategies of that portfolio. You need to consider the industry that this company operates in as well as the industry-specific risks in the analysis. I need you to provide this in tabular format in the chat. Please do not access the internet. Only use the information that I provide you with to come to an investment decision.

ChatGPT said:

ChatGPT

Understood! Please provide the investment strategies for the 18 portfolios, and once you provide the financial and industry information for a company, I will conduct the analysis. The output will include:

Profitability Analysis: Concluding whether the company's profitability is Good, Average, or Poor, with reasons.

Risk Analysis: Concluding whether the company's risk is High, Medium, or Low, with reasons.

Portfolio Recommendations Table: A detailed table with the decision to Invest or Do Not Invest in each portfolio based on alignment with the strategy, with detailed reasoning.

Investment Recommendation Summary: A concise summary listing all portfolios where investment is recommended (Invest) and those where it is not (Do Not Invest).

Please provide the information, and I'll get started!

You said:

Here are the investment strategies: Portfolio 1 investment strategy

The Fund aims to provide capital growth over the long term by investing primarily in South African equities (e.g. company shares) The Fund uses a quantitative investment strategy (i.e. using a mathematical model to identify investment opportunities) with regards to stock selection and portfolio construction Other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)

Portfolio 2 investment strategy

This is a diversified local equity portfolio. The portfolio aims to outperform the JSE All Share Index on a total return basis, over an investment horizon of three years or more, by investing in high-quality companies that we feel are undervalued. This portfolio is suitable for investors who can withstand potential capital volatility in the short term. The portfolio offers a carefully selected, well diversified basket of shares from all sectors on the JSE. However, it may also provide exposure to unlisted shares. The investments in the portfolio are subject to rigorous, in-depth research and adhere to our pragmatic value investment philosophy.

Portfolio 3 investment strategy

The fund aims to maximise long-term growth from investing in a select group of small to medium-sized JSE-listed companies. It seeks to outperform the combined JSE Mid and Small Cap Indices. The fund invests in companies that form part of the JSE Small or Mid Cap Indices, or in companies that have a market capitalisation smaller than the company with the lowest market capitalisation in the JSE Large Cap Index. *

The fund is mandated to use derivative instruments for efficient portfolio management purposes.

Portfolio 4 investment strategy

Fund Features An equity-only fund where the manager prefers to buy out-of-favor, undervalued stocks which may lag the rest of the market for long periods. This means the

Fund should be considered as a long-term investment to be held through an entire market cycle Takes concentrated positions in stocks, which may lead to significant exposure to a particular sector or industry Relative to the ALSI, periods of outperformance from purist value portfolios tend to be short and sharp, while periods of underperformance can be long. The Fund's long-term track record of meaningful outperformance must be viewed in this context Objectives and investment policy summary The Fund aims to provide capital growth over the long term The Fund invests primarily in equities (e.g. company shares) that are trading below the rating (e.g. share price divided by company earnings) at which they traditionally traded in the past, relative to the market. The Fund also invests in shares trading at a discount to the net asset value of the company. The Fund will invest a minimum of 10% of its value in foreign equities up to a maximum of 30%, other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)

Portfolio 5 investment strategy

Fund Features An equity-only portfolio offering exposure to small and medium-sized companies listed in South Africa Provides diversification from a general equity fund More volatile than a general equity fund Objectives and investment policy summary The Fund aims to provide capital growth The Fund invests primarily in the equities (e.g. shares) of mining, financial and industrial companies and in the equities of smaller companies with above average growth potential as well as established companies with sound recovery prospects Other investments may include derivatives (financial contracts whose value is linked to the price of an underlying asset) and other eligible securities not listed a recognised stock exchange.

Portfolio 6 investment strategy

What is the fund's objective? The STANLIB Enhanced Multi Style Equity Fund is an active equity fund that aims to provide investors with sustainable capital growth over the long term by investing in a broad range of South African equities. The investment team combines our bottom-up fundamental and quantitative insight to invest in quality companies with high returns on capital as well as high potential for earnings growth, at attractive valuations. Portfolio construction and risk management form an integral part of the investment process.

What does the fund invest in? The fund invests in the constituents of the Index. The allocation to the various factors/styles is based on a bottom-up approach in scoring stocks on multiple factors. The multiple investment style scores are then blended for diversification prior to portfolio construction. The portfolio may also hold a small portion in cash instruments and listed derivatives to effect efficient portfolio management.

Portfolio 7 investment strategy

The SA Equity Fund aims to achieve the best possible long-term growth from investing in South African shares. The SA Equity Fund invests in the shares of companies listed on the Johannesburg Stock Exchange. While investments in foreign markets are specifically excluded, the fund can invest in international companies that are listed in South Africa. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will be fully invested in shares at all times. The fund is mandated to use derivative instruments for efficient portfolio management purposes

Portfolio 8 Investment strategy

Top 20 aims to outperform the equity market over the long term. The fund's managers actively seek out attractively valued shares that could offer strong long-term growth. The fund would typically hold shares in a maximum of 20 companies selected from all equities listed on the JSE. Its investments will therefore always be concentrated and limited to shares in large companies listed in South Africa. While investments in foreign markets are specifically excluded, the fund can invest in foreign companies that are listed locally. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will remain fully invested in shares at all times. The fund is mandated to use derivative instruments for efficient portfolio management purposes.

Portfolio 9 Investment strategy

What is the fund's objective? The fund's main objective is to provide a diversified portfolio that delivers a reasonable level of capital growth over the longer term. What does the fund invest in? The fund invests primarily in shares listed on the Johannesburg Stock Exchange

(JSE). The Fund invests in South African and foreign investment markets, up to the limits allowed by the ASISA South African - Equity - General classification.

Portfolio 10 Investment strategy

Fund Objective This is a specialist equity fund which seeks to achieve maximum capital appreciation by investing in companies with small to mid - market capitalisations and who display the potential to deliver above average earnings growth. The fund may invest a maximum of 45% of assets offshore. Fund Strategy This is an aggressive, actively managed fund focusing on small to mid-cap companies with above average growth potential and which have been mispriced by the market. This portfolio may also invest in participatory interests of underlying unit trust portfolios.

Portfolio 11 Investment Strategy

Fund Objective This is a pure equity fund which aims to deliver above average growth of capital over the medium to long-term by taking high conviction bets in a concentrated portfolio of SIMs best equity investment ideas. The equity exposure is limited to a minimum of 75% at all times. This fund may display higher volatility in the short to medium-term and is suitable for the sophisticated investor with an aggressive risk profile. Fund Strategy This actively managed equity portfolio holds approximately 20 stocks listed on the JSE; reflecting the best ideas and most active positions held throughout SIMs equity unit trust range. This portfolio may also invest in participatory interests of underlying unit trust portfolios. The fund may also invest up to 45% offshore and may invest in derivative instruments, however neither of these components have been utilized in the past or are currently in the portfolio.

Portfolio 12 Investment strategy

Fund description and summary of investment policy

The Fund invests in shares listed on the Johannesburg Stock Exchange (JSE). The Fund is typically, fully invested in shares. Returns are likely to be volatile, especially over short- and medium-term periods.

ASISA unit trust category: South African – Equity – General

Fund objective and benchmark

The Fund aims to create long-term wealth for investors. It aims to outperform the South

African equity market over the long term, without taking on greater risk. To pursue its objective the Fund's portfolio may differ materially from its benchmark. This will result in the Fund underperforming its benchmark materially at times. The Fund aims to compensate for these periods of underperformance by delivering outperformance over the long term. The Fund's benchmark is the FTSE/JSE All Share Index including income.

Portfolio 13 Investment strategy

Fund description and summary of investment policy Performance net of all fees and expenses The Fund invests primarily in shares listed on the Johannesburg Stock Exchange (JSE). The Fund can invest a maximum of 45% offshore. The Fund invests the bulk of its foreign allowance in equity funds managed by Orbis Investment Management Limited, our offshore investment partner. The Fund is typically fully invested in shares. Returns are likely to be volatile, especially over short- and medium-term periods. ASISA unit trust category: South African – Equity – General Fund objective and benchmark The Fund aims to create long-term wealth for investors. It aims to outperform the average return of South African General Equity Funds over the long term, without taking on greater risk of loss. To pursue its objective the Fund's portfolio may differ materially from those of its peers. This will result in the Fund underperforming its benchmark materially at times. The Fund aims to compensate for these periods of underperformance by delivering outperformance over the long term. The Fund's benchmark is the market value-weighted average return of funds in the South African – Equity – General category (excluding Allan Gray funds). How we aim to achieve the Fund's objective We seek to buy shares offering the best relative value while maintaining a diversified portfolio. We thoroughly research companies to assess their intrinsic value from a long-term perspective. This long-term perspective enables us to buy shares from sellers who over-react to short-term difficulties or undervalue long-term potential. We invest in a selection of shares across all sectors of the stock market, and across the range of large, mid and smaller cap shares.

Portfolio 14 Investment strategy

This is a pure equity fund diversified across all sectors of the JSE. The fund aims to achieve maximum capital growth above the benchmark, FTSE/JSE Shareholder Weighted Index over the medium to long-term by investing in companies that are of quality and have the right

fundamentals to grow better than the benchmark. This fund is suitable for investors who can withstand potential capital volatility in the shorter term. Fund Objective the Fund applies a thematic approach with a focus on companies with quality management and good cashflow generation capabilities. The top down "thematic" approach means that the manager will attempt to identify the sectors and companies in the market that are likely to benefit over the medium to long term from trends in the investment market. The manager will also focus on more liquid counters. The Fund may hold offshore equity. The investment manager will also be allowed to invest in listed and unlisted financial Instruments as allowed by the Act from time to time in order to achieve its investment objective

Portfolio 15 Investment strategy

Fund Features An equity-only fund for investors seeking capital growth over the long term An investment philosophy focused on investing in companies where expected future profits are being revised upwards at reasonable valuation A disciplined investment process, based on detailed fundamental analysis and an appreciation of the economic cycle Objectives and investment policy summary The Fund aims to provide a total return (the combination of income and capital growth) by investing in equities (e.g. company shares) Other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)

Portfolio 16 Investment strategy

The Fund aims to achieve a total return comprising both capital growth and income by investing primarily in South African securities with no foreign exposure allowed. The Fund will be unrestricted in its choice of companies either by size or industry.

Portfolio 17 Investment strategy

The fund seeks to maximise long-term capital appreciation by investing primarily in a broad spectrum of listed equities. The Equity Fund primarily invests in the shares of companies listed on the Johannesburg Stock Exchange but can also invest in international equities. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will be fully invested in

shares at all times. The fund is mandated to use derivative instruments for efficient portfolio management purposes.

Portfolio 18 Investment strategy

Fund Objective The fund seeks long term capital growth over the long term by investing in selected shares across all industry sectors of the JSE. This fund is suitable for investors who can withstand potential capital volatility in the shorter term. The fund may also invest in participatory interest (units) of collective investment schemes. Fund Strategy This fund aims to outperform the FTSE/JSE Capped SWIX Index through active stock selection across all sectors and market capitalisation on the JSE. The fund may at any time hold a maximum of 45% in offshore assets. - I will now provide you with the company's financial information and industry.

You said:" Please perform the required analysis on FIRSTRAND LIMITED which operates in the COMMERCIAL BANKS industry." (the financial information that was uploaded was contained in numerous EXCEL documents and has been excluded from this example due to the format differences and space considerations)

ChatGPT said:

Profitability Analysis for FirstRand Limited

Conclusion: Good

Revenue Growth: Net sales for 2024 are ZAR 138,833 Mn, representing a growth of 7.83% compared to the previous year, with consistent growth projections (~6.79%-8.42%) in future years. This indicates strong revenue expansion.

Net Interest Margin (NIM): A critical profitability indicator for banks. NIM improved significantly from 324.9bps (2022) to 388.1bps (2024), reflecting enhanced operational efficiency.

Dividends: Historical DPS shows consistent growth, increasing from ZAR 1.89 (2023 interim) to ZAR 2.15 (2024 final), underlining robust profitability and shareholder returns.

Risk Analysis for FirstRand Limited

Conclusion: Medium

Leverage: Adjusted Net Interest Income (NII) increased steadily, with ZAR 92,278 Mn in 2024, indicating efficient management of financial leverage. However, reliance on interest income exposes it to interest rate volatility.

Liquidity Risks: Historical balance sheet data reflects increasing reserves and strong end-of-period assets, though macroeconomic factors like regulatory changes and credit risk remain significant.

Industry Risks: Operating in the commercial banking sector, FirstRand is vulnerable to global economic uncertainty, regulatory challenges, and potential loan defaults.

Portfolio	Reasoning	Decision
Portfolio 1	Quantitative capital growth strategy aligns with strong revenue growth, profitability, and robust dividends.	Invest
Portfolio 2	High-quality and undervalued equity with consistent growth fits diversified equity strategies.	Invest
Portfolio 3	Excluded due to large-cap focus, not aligning with small/mid-cap strategy.	Do Not Invest
Portfolio 4	Undervalued stock with consistent profitability and long-term growth potential fits value strategies.	Invest

Portfolio 5	Excluded as it does not meet the small/medium-sized company criteria.	Do Not Invest
Portfolio 6	High returns on capital and earnings growth make it a fit for multi-style equity portfolios.	Invest
Portfolio 7	Fully South African focus aligns with FirstRand's consistent domestic performance.	Invest
Portfolio 8	Large-cap equity with strong financials aligns with concentrated portfolio strategies.	Invest
Portfolio 9	Consistent historical growth and dividends make it a fit for diversified growth objectives.	Invest
Portfolio 10	Excluded as it does not align with the aggressive small/mid-cap growth focus.	Do Not Invest
Portfolio 11	Fits high-conviction strategies due to strong earnings and historical outperformance.	Invest
Portfolio 12	Long-term wealth creation aligns with FirstRand's strong profitability and growth.	Invest

Portfolio 13	Value creation strategy fits with consistent dividends and growth.	Invest
Portfolio 14	Aligns with thematic focus on quality management and strong cash flow generation.	Invest
Portfolio 15	Historical profit revisions and stable returns align with total return objectives.	Invest
Portfolio 16	Strong dividends and earnings fit the total return focus with no foreign exposure.	Invest
Portfolio 17	Broad-spectrum equity focus aligns with FirstRand's diversified growth potential.	Invest
Portfolio 18	Active stock selection aligns with consistent profitability and strong fundamentals.	Invest

You said: "I need you to perform the analysis above. Please forget the previous analysis and perform the analysis as if you had received the information for the first time." The output of the repeat of the analysis has been excluded as ChatGPT did not provide a significantly different response from the first analysis.

8. An example of the prompt provided to ChatGPT once the Instructions were loaded and saved in its memory

You said: Please access your memory. We are now going to continue with the portfolio construction project. Please will you tell me what your instructions are so that I can verify them before we continue?

ChatGPT said:

ChatGPT

Here are my current instructions for the portfolio construction project. Please review them and let me know if there are any updates or clarifications before we proceed:

Role: I assume the role of a fund manager, analyzing each company and determining its suitability for inclusion in one or more of 18 distinct portfolios based on the provided investment strategies and financial data.

Analysis Objectives:

Assess each company for profitability, dividends, and risk based on historical and estimated financial data.

Categorize profitability as Good, Moderate, or Poor and risk as High, Moderate, or Low.

Align each company with the investment strategies for Portfolios 1–18.

Portfolio Strategies:

Each portfolio has a unique investment objective, such as growth, value, income, or risk focus.

Recommendations must align with the specific strategy and constraints of each portfolio (e.g., small- or mid-cap focus, no foreign exposure, etc.).

Recommendation Format:

Overall, Company Summary: A table summarizing profitability, dividends, and risk.

Portfolio Analysis: A detailed table for all 18 portfolios, with:

Column 1: Portfolio names.

Column 2: Recommendation to invest or not invest.

Column 3: Detailed reasoning tied to the portfolio's strategy.

Data Requirements:

Use all provided financial data, including historical figures, ratios, dividend payouts, and future estimates.

Incorporate all sector-specific risks and analysis.

Include detailed reasoning for each recommendation.

Recommendation Presentation:

Summarize findings in a comprehensive table format.

Ensure every recommendation is backed by robust reasoning that addresses key factors such as growth potential, valuation, and risk.

Documentation:

Save and track all recommendations, ensuring an accurate record for each portfolio.

Once all companies are analyzed, compile an Excel document summarizing investment decisions and reasoning for all 18 portfolios.

Updates and Verification:

Perform detailed re-analyses as needed to ensure no critical details are missed.

Follow exact wording for portfolio recommendations as provided by the user.

Historical and Future Data:

Include all available years of historical and projected financial information in the analyses.

Let me know if these instructions are correct, or if there's anything you'd like to add or modify before we move forward.

9. An example of the prompt provided to ChatGPT to assign the optimal weightings to the stocks within the portfolios.

You said: "I need you to assume the role of a fund manager. Then I will provide you with the companies that you said I must include in this portfolio. I am going to need you assign weights to each of the stocks within the portfolio, that will ensure that the portfolio obtains the highest returns and lowest risk (standard deviation). In the document I provide there is a column for the weighting. Assume that the size of the portfolio is R2,7 billion. Then I need you to use the share prices and assign the optimal weights to maximise portfolio return but minimise portfolio risk. Please ensure that each stock has a weighting of more than 0. Ensure that the weightings you provide are in percentages. Please do this in the columns named "weightings".

10. Appendix 2: Method used by the Citywire website to report on fund performance to be used in this study

“Within the 'Unit Trust Performance' tables all figures are shown on a bid-to-bid basis with all gross dividends paid by the unit trust reinvested into the fund at the ex-dividend date.

Within Citywire stories, unless otherwise stated, unit trust performance is considered on a bid-to-bid basis for periods of less than one year and on an offer-to-bid buying price to selling price) basis, which includes the effects of a fund's initial charges, for periods of one year or more.

Unless otherwise stated the performance of investment trusts and equities is considered based on closing price to closing price (close-to-close) for all periods. The analysis is considered with net income reinvested at the dividend payment date, except in cases where investment trust net asset values are concerned when the performance figures are quoted with income withdrawn.

While these figures will not necessarily reflect the performance an investor would have achieved it puts performance on a standard, consistent basis and allows investors to be more confident about comparable performance figures” (Citywire, 2024b).

11. Appendix 3: A list of the asset managers' portfolios and their trading strategies that the ChatGPT portfolios will be compared to.

Asset manager’s fund	Fund objective/investment strategy
Ninety-One Active Quants R	The Fund aims to provide capital growth over the long term by investing primarily in South African equities (e.g. company shares) The Fund uses a quantitative

	investment strategy (i.e. using a mathematical model to identify investment opportunities) with regards to stock selection and portfolio construction other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)
Sanlam Private Wealth Equity	This is a diversified local equity portfolio. The portfolio aims to outperform the JSE All Share Index on a total return basis, over an investment horizon of three years or more, by investing in high-quality companies that we feel are undervalued. This portfolio is suitable for investors who can withstand potential capital volatility in the short term. The portfolio offers a carefully selected, well diversified basket of shares from all sectors on the JSE. However, it may also provide exposure to unlisted shares. The investments in the portfolio are subject to rigorous, in-depth research and adhere to our pragmatic value investment philosophy
Coronation Smaller Companies Fund	"The fund aims to maximise long-term growth from investing in a select group of small to medium-sized JSE-listed companies. It seeks to outperform the combined JSE Mid and Small Cap Indices. The fund invests in companies that form part of the JSE Small or Mid Cap

	Indices, or in companies that have a market capitalisation smaller than the company with the lowest market capitalisation in the JSE Large Cap Index. * The fund is mandated to use derivative instruments for efficient portfolio management purposes. "
Ninety-One Value Fund R	Fund Features An equity-only fund where the manager prefers to buy out-of-favor, undervalued stocks which may lag the rest of the market for long periods. This means the Fund should be considered as a long-term investment to be held through an entire market cycle Takes concentrated positions in stocks, which may lead to significant exposure to a particular sector or industry Relative to the ALSI, periods of outperformance from purist value portfolios tend to be short and sharp, while periods of underperformance can be long. The Fund's long-term track record of meaningful outperformance must be viewed in this context Objectives and investment policy summary The Fund aims to provide capital growth over the long term The Fund invests primarily in equities (e.g. company shares) that are trading below the rating (e.g. share price divided by company earnings) at which they traditionally traded in the past, relative to the market. The Fund also invests in shares trading at a discount to the net asset value of the company. The Fund will

	invest a minimum of 10% of its value in foreign equities up to a maximum of 30%, other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)
Ninety-One Emerging Companies Fund	Fund Features An equity-only portfolio offering exposure to small and medium-sized companies listed in South Africa Provides diversification from a general equity fund More volatile than a general equity fund Objectives and investment policy summary The Fund aims to provide capital growth The Fund invests primarily in the equities (e.g. shares) of mining, financial and industrial companies and in the equities of smaller companies with above average growth potential as well as established companies with sound recovery prospects Other investments may include derivatives (financial contracts whose value is linked to the price of an underlying asset) and other eligible securities not listed on a recognised stock exchange.
STANLIB Enhanced Multi Style Equity	What is the fund's objective? The STANLIB Enhanced Multi Style Equity Fund is an active equity fund that aims to provide investors with sustainable capital growth over the long term by investing in a broad range of South African equities. The investment team combines our bottom-up

	fundamental and quantitative insight to invest in quality companies with high returns on capital as well as high potential for earnings growth, at attractive valuations. Portfolio construction and risk management form an integral part of the investment process. What does the fund invest in? The fund invests in the constituents of the Index. The allocation to the various factors/styles is based on a bottom-up approach in scoring stocks on multiple factors. The multiple investment style scores are then blended for diversification prior to portfolio construction. The portfolio may also hold a small portion in cash instruments and listed derivatives to effect efficient portfolio management.
Coronation SA Equity	The SA Equity Fund aims to achieve the best possible long-term growth from investing in South African shares. The SA Equity Fund invests in the shares of companies listed on the Johannesburg Stock Exchange. While investments in foreign markets are specifically excluded, the fund can invest in international companies that are listed in South Africa. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will be fully invested in shares at all times. The fund is mandated to use derivative

	instruments for efficient portfolio management purposes
Coronation Top 20	Top 20 aims to outperform the equity market over the long term. The fund's managers actively seek out attractively valued shares that could offer strong long-term growth. The fund would typically hold shares in a maximum of 20 companies selected from all equities listed on the JSE. Its investments will therefore always be concentrated and limited to shares in large companies listed in South Africa. While investments in foreign markets are specifically excluded, the fund can invest in foreign companies that are listed locally. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will remain fully invested in shares at all times. The fund is mandated to use derivative instruments for efficient portfolio management purposes.
Standard STANLIB Equity Fund	What is the fund's objective? The fund's main objective is to provide a diversified portfolio that delivers a reasonable level of capital growth over the longer term. What does the fund invest in? The fund invests primarily in shares listed on the Johannesburg Stock Exchange (JSE). The Fund invests in South African and foreign investment markets, up to the limits

	allowed by the ASISA South African - Equity - General classification.
Sanlam Investment Management (SIM) Small Cap fund	Fund Objective This is a specialist equity fund which seeks to achieve maximum capital appreciation by investing in companies with small to mid - market capitalisations and who display the potential to deliver above average earnings growth. The fund may invest a maximum of 45% of assets offshore. Fund Strategy This is an aggressive, actively managed fund focusing on small to mid-cap companies with above average growth potential and which have been mispriced by the market. This portfolio may also invest in participatory interests of underlying unit trust portfolios.
SIM Top Choice Equity	Fund Objective This is a pure equity fund which aims to deliver above average growth of capital over the medium to long-term by taking high conviction bets in a concentrated portfolio of SIM`s best equity investment ideas. The equity exposure is limited to a minimum of 75% at all times. This fund may display higher volatility in the short to medium-term and is suitable for the sophisticated investor with an aggressive risk profile. Fund Strategy This actively managed equity portfolio holds approximately 20 stocks listed on the JSE; reflecting the best ideas and most active positions held throughout SIM`s equity unit

	trust range. This portfolio may also invest in participatory interests of underlying unit trust portfolios. The fund may also invest up to 45% offshore and may invest in derivative instruments, however neither of these components have been utilized in the past or are currently in the portfolio.
Allan Gray SA Equity	"Fund description and summary of investment policy. The Fund invests in shares listed on the Johannesburg Stock Exchange (JSE). The Fund is typically fully invested in shares. Returns are likely to be volatile, especially over short- and medium-term periods. ASISA unit trust category: South African – Equity – General Fund objective and benchmark- The Fund aims to create long-term wealth for investors. It aims to outperform the South African equity market over the long term, without taking on greater risk. To pursue its objective. The Fund's portfolio may differ materially from its benchmark. This will result in the Fund underperforming its benchmark materially at times. The Fund aims to compensate for these periods of underperformance by delivering outperformance over the long term. The Fund's benchmark is the FTSE/JSE All Share Index including income"

Allan Gray Equity	Fund description and summary of investment policy Performance net of all fees and expenses The Fund invests primarily in shares listed on the Johannesburg Stock Exchange (JSE). The Fund can invest a maximum of 45% offshore. The Fund invests the bulk of its foreign allowance in equity funds managed by Orbis Investment Management Limited, our offshore investment partner. The Fund is typically fully invested in shares. Returns are likely to be volatile, especially over short- and medium-term periods. ASISA unit trust category: South African – Equity – General Fund objective and benchmark The Fund aims to create long-term wealth for investors. It aims to outperform the average return of South African General Equity Funds over the long term, without taking on greater risk of loss. To pursue its objective the Fund's portfolio may differ materially from those of its peers. This will result in the Fund underperforming its benchmark materially at times. The Fund aims to compensate for these periods of underperformance by delivering outperformance over the long term. The Fund's benchmark is the market value-weighted average return of funds in the South African – Equity – General category (excluding Allan Gray funds). How we aim to achieve the Fund's objective We seek to buy

	shares offering the best relative value while maintaining a diversified portfolio. We thoroughly research companies to assess their intrinsic value from a long-term perspective. This long-term perspective enables us to buy shares from sellers who over-react to short-term difficulties or undervalue long-term potential. We invest in a selection of shares across all sectors of the stock market, and across the range of large, mid and smaller cap shares.
Sanlam Select Thematic Equity	This is a pure equity fund diversified across all sectors of the JSE. The fund aims to achieve maximum capital growth above the benchmark, FTSE/JSE Shareholder Weighted Index over the medium to long-term by investing in companies that are of quality and have the right fundamentals to grow better than the benchmark. This fund is suitable for investors who can withstand potential capital volatility in the shorter term. Fund Objective- The Fund applies a thematic approach with a focus on companies with quality management and good cashflow generation capabilities. The top down "thematic" approach means that the manager will attempt to identify the sectors and companies in the market that are likely to benefit over the medium to long term from trends in the investment market. The manager will also focus on more liquid counters. The Fund may hold offshore

	equity. The investment manager will also be allowed to invest in listed and unlisted financial Instruments as allowed by the Act from time to time in order to achieve its investment objective
Ninety-One Equity Fund	The Fund aims to provide investors with capital growth over the long term. The objective is to achieve returns well in excess of the benchmark, measured over three-year periods. The fund is actively managed and invests in South African equities. The mandate is not restricted to any specific investment style. The investment strategy is underpinned by extensive research focusing on three sector groupings: resources, industrials and financials. The focus is predominantly on individual stock selection. However, macro-economic considerations such as interest rates and the performance of the rand also play an integral part in constructing the portfolio. Fund Features An equity-only fund for investors seeking capital growth over the long term An investment philosophy focused on investing in companies where expected future profits are being revised upwards at reasonable valuation A disciplined investment process, based on detailed fundamental analysis and an appreciation of the economic cycle Objectives and investment policy summary The Fund aims to provide a total return (the

	combination of income and capital growth) by investing in equities (e.g. company shares) Other investments may include the units of other funds (including foreign funds) and derivatives (financial contracts whose value is linked to the price of an underlying asset)
Ninety-One SA Equity	The Fund aims to achieve a total return comprising both capital growth and income by investing primarily in South African securities with no foreign exposure allowed. The Fund will be unrestricted in its choice of companies either by size or industry.
Coronation Equity	The fund seeks to maximise long-term capital appreciation by investing primarily in a broad spectrum of listed equities. The Equity Fund primarily invests in the shares of companies listed on the Johannesburg Stock Exchange but can also invest in international equities. There are no restrictions on how much exposure the fund can have to different sectors (for example, to mining, financial or industrial companies). The fund will be fully invested in shares at all times. The fund is mandated to use derivative instruments for efficient portfolio management purposes.
Sanlam Investment Management General Equity Fund	Fund Objective The fund seeks long term capital growth over the long term by investing in selected shares across all industry sectors of the JSE. This fund is suitable for investors who can withstand

	potential capital volatility in the shorter term. The fund may also invest in participatory interest (units) of collective investment schemes. Fund Strategy This fund aims to outperform the FTSE/JSE Capped SWIX Index through active stock selection across all sectors and market capitalisation on the JSE. The fund may at any time hold a maximum of 45% in offshore assets

12. Appendix 4: An Example of an analysis performed by ChatGPT on Shoprite Limited

“Shoprite holdings

Comprehensive Analysis for SHOPRITE HOLDINGS LIMITED

1. Profitability Analysis

Historical Performance (2020-2023)

Revenue Growth:

2020: ZAR 150,100 Mn

2021: ZAR 165,900 Mn (+10.53%)

2022: ZAR 180,300 Mn (+8.70%)

2023: ZAR 240,718 Mn (+33.53%)

The company demonstrated robust growth, with revenue surging in 2023 due to market share gains and strong consumer demand.

Net Income Trends:

2020: ZAR 3,800 Mn

2021: ZAR 4,300 Mn (+13.16%)

2022: ZAR 5,800 Mn (+34.88%)

2023: ZAR 6,248 Mn (+7.73%)

Net income increased steadily over the years, reflecting operational efficiency and disciplined cost management despite inflationary pressures.

EBITDA Margins:

2023 EBITDA Margin: 8.84%

Margins have remained stable, indicating effective cost controls. Projections show gradual improvement to 9.04% by 2027, suggesting enhanced operational efficiency.

Future Growth Projections (2024-2027)

Revenue Projections:

2024: ZAR 262,672.50 Mn (+9.12%)

2025: ZAR 285,440.38 Mn (+8.67%)

2026: ZAR 304,733 Mn (+6.76%)

Revenue is expected to grow steadily, supported by organic store expansion and increased customer base.

Net Income Projections:

2024: ZAR 8,314 Mn (+33.06%)

2025: ZAR 9,298.80 Mn (+11.83%)

2026: ZAR 10,448.95 Mn (+12.38%)

Profitability Conclusion:

Historical: Good, with steady growth in revenue and earnings over the years.

Future Outlook: Good, driven by projected revenue expansion, cost management, and operational efficiencies.

2. Risk Analysis

Balance Sheet Strength (2023)

Total Assets: ZAR 78,300 Mn

Total Liabilities: ZAR 54,100 Mn

Adequate asset-to-liability coverage indicates financial stability.

Net Debt/EBITDA: 1.81, reflecting manageable leverage.

Cash Flow and Liquidity

Operating Cash Flow:

Consistently positive, supported by robust revenue generation and disciplined financial management.

Cash/Assets Ratio:

2023: 12.88%

Indicates sufficient liquidity to meet short-term obligations.

Sector-Specific Risks

Consumer Spending Trends:

Inflationary pressures could impact customer purchasing power, affecting revenue.

Geopolitical Risks:

Exposure to regulatory and political challenges across Africa may pose risks.

Risk Conclusion:

Risk Level: Medium. While the financial position is strong, risks from inflation and geopolitical factors slightly elevate the risk profile.

3. Dividends

Historical Dividend Performance (2020-2023)

2020: ZAR 4.00 per share (Dividend Yield: 2.67%)

2021: ZAR 5.00 per share (+25.00%)

2022: ZAR 6.15 per share (+23.00%)

2023: ZAR 6.63 per share (+7.80%)

Dividend payments have grown consistently, reflecting management's commitment to shareholder returns.

Future Dividend Projections

2024: ZAR 7.12 per share (+7.39%)

Yield: 1.45% (slightly below historical levels due to share price appreciation).

Dividend Conclusion:

2023: Good, with consistent growth and competitive yields.

2024: Good, with projected increases aligning with profitability growth.

4. Summary of Financial Metrics

Metric	2020	2023	2024 Projection
Revenue (ZAR Mn)	150,100	240,718	262,672.50
Net Income (ZAR Mn)	3,800	6,248	8,314
EBITDA Margin (%)	7.80%	8.84%	8.62%
Dividend Yield (%)	2.67	1.71	1.45
Risk Level	Medium	Medium	Medium
Profitability	Good	Good	Good

Final Investment Decision

Profitability: Good, reflecting consistent growth in revenue and earnings.

Risk: Medium, with manageable financial leverage but exposure to inflation and geopolitical risks.

Dividends: Good, with consistent and growing payouts aligned with profitability.

Final Decision: Invest

Shoprite Holdings Limited aligns well with portfolio objectives for growth and income. Its consistent profitability and dividend growth, coupled with manageable risks, make it a strong addition to the portfolio."

13. Appendix 5: An example of an evaluation performed by ChatGPT on Sanlam Limited

"Financial Analysis for SANLAM LIMITED

Historical Financial Performance

Net Sales:

Grew steadily from ZAR 80,441 million in 2022 to ZAR 87,840 million in 2023(A), reflecting a 9.20% increase.

Projected growth to ZAR 102,177.96 million in 2024(E) (+16.32%) and ZAR 106,989.15 million in 2025(E) (+4.71%).

Net Income:

Improved from ZAR 14,478 million in 2023(A) to a projected ZAR 17,496.48 million in 2024(E), demonstrating strong earnings growth.

EBITDA Margin:

Margin is expected to remain stable around 20.52% in 2024(E), reflecting consistent operational efficiency.

Dividends

Historical Dividends:

DPS increased from ZAR 3.00 in 2021 to ZAR 4.00 in 2024(E), representing steady shareholder returns.

Dividend Yield: Ranged from 4.71% to 6.32%, highlighting its income attractiveness.

Liquidity and Risk

Leverage:

Total Debt/Equity ratio remains elevated at 9.49 in 2024/6M but is consistent with industry norms for life insurers.

Liquidity:

Adequate cash flow and asset management ensure stability.

Regulatory Risk:

Compliance with South African insurance regulations mitigates systemic risks.

Sector-Specific Risks

Regulatory Pressure: The insurance industry faces stringent regulatory oversight, impacting profitability and operations.

Interest Rate Sensitivity: Higher interest rates could affect investment portfolios and reserve valuations.

Macroeconomic Dependence: Earnings are tied to the economic health of the regions in which it operates.

Competitive Market: Intense competition in the life insurance sector could pressure pricing and margins."

In both examples of the analyses performed by ChatGPT above, ChatGPT was able to successfully evaluate the industries and industry-specific risks associated with the industries that the companies operate in. Shoprite operates in the department stores industry as classified by the EquityRT database. ChatGPT was able to incorporate the industry-specific factors into the profitability and analysis as well assessing the industry-specific industries as illustrated in the following extracts from the conversation with ChatGPT. "Revenue is expected to grow steadily, supported by organic store expansion and

increased customer base.” Sector-Specific Risks- Consumer Spending Trends: Inflationary pressures could impact customer purchasing power, affecting revenue. Geopolitical Risks: Exposure to regulatory and political challenges across Africa may pose risks.” Sanlam Limited operates in the insurance industry a much different industry and ChatGPT was still able to incorporate industry-specific factors into the analysis as illustrated in the following extract “Regulatory Risk: Compliance with South African insurance regulations mitigate systemic risks. Sector-Specific Risks Regulatory Pressure: The insurance industry faces stringent regulatory oversight, impacting profitability and operations. Interest Rate Sensitivity: Higher interest rates could affect investment portfolios and reserve valuations. Macroeconomic Dependence: Earnings are tied to the economic health of the regions in which it operates. Competitive Market: Intense competition in the life insurance sector could pressure pricing and margins.”