THE FUTURE OF FINANCE IS DIGITAL – ROBO-ADVISING AND ARTIFICIAL INTELLIGENCE – A CRITICAL APPRAISAL

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ABSTRACT

After the two revolutions in finance over the last century – the efficient market mathematical finance revolution in the 1950s and the behavioral finance revolution in the 1970s now the third finance revolution with "machine finance" began. Robo-advising combines AI and financial expertise to offer accessible and personalized financial guidance. It analyzes data, optimizes portfolios, and provides lower-cost investment strategies. Robo-advisors automate tasks like portfolio rebalancing and offer efficiency and rational decision-making. However, concerns regarding data privacy, algorithmic bias, and regulations need attention. This article explores the benefits, challenges, and regulatory landscape of robo-advising. It emphasizes the support robo-advisory services provide in minimizing risk, generating returns, and maintaining portfolios. They offer an efficient alternative to traditional advisors, using technology and expertise for personalized investment guidance. Further on the fee structure of robo-advisors and the benefits they offer to financial advisors are described. It explains that traditional financial advisors typically charge fees ranging from 1% to 1.5% of total assets managed, while robo-advisors charge between 0% and 0.25% for basic services. The abstract also explores the impact of fees on investment performance and introduces the concept of robo-advisors using index ETFs to minimize fees. It further explains the two main types of robo-advisors: hybrid robo-advisors and pure robo-advisors. Additionally, the article provides examples of prominent robo-advisor providers and their assets under management. It concludes by highlighting the potential influence of artificial intelligence on robo-advising, including data analysis, personalized recommendations, and improved communication with investors.

Keywords: Digital finance, Robo-advising, AI - *'machine'* finance

JEL Number: F65, G15, G40.

INTRODUCTION

Robo-advising, also known as automated investment or digital advising is revolutionizing the way people approach investing and financial planning. By leveraging technology and algorithms, robo-advisors provide personalized investment advice and portfolio management services to clients, making investing more accessible and convenient. In the rapidly evolving landscape of financial services, technology continues to redefine the way we approach investing. Among the notable advancements is the rise of robo-advising, a revolutionary approach to wealth management that combines artificial intelligence (AI) and financial expertise. With its promise of accessible and personalized financial guidance, robo-advising has swiftly gained traction, transforming the investment landscape for both novice and seasoned investors alike. Robo-advising refers to automated platform-driven investment advisory services that leverage AI algorithms to provide tailored investment strategies and portfolio management. These digital advisors offer an alternative to traditional financial advisors, intending to democratize access to professional investment expertise and lowering

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costs. By utilizing cutting-edge technology, robo-advisors analyze vast amounts of data, assess risk profiles, and optimize investment portfolios, all while maintaining a user-friendly and intuitive interface.

The fundamental concept driving robo-advising is the marriage of human financial expertise with the computational power of AI. By removing the need for face-to-face interactions, robo-advisors offer investors the convenience of instant access to financial insights and recommendations at any time and from anywhere. Whether an individual is planning for retirement, investing in stocks and bonds, or saving for a specific goal, robo-advisors provide customized strategies tailored to their unique financial circumstances, risk tolerance, and investment objectives. In addition to personalized recommendations, robo-advisors boast several distinct advantages. With lower management fees compared to traditional financial advisors, they enable investors with smaller portfolios to access professional-level guidance that was previously out of reach. Furthermore, robo-advisors employ sophisticated algorithms that continuously monitor market trends, automatically rebalance portfolios, and adjust investment strategies as needed, all with minimal human intervention. This automation ensures that investments stay aligned with the investor's goals and risk appetite, saving time and effort for individuals who prefer a hands-off approach. However, while robo-advising has gained popularity and disrupted the financial services industry, it is not without its considerations. As with any technology-driven solution, concerns such as data privacy, algorithmic bias, and potential system vulnerabilities need to be addressed to ensure investor trust and regulatory compliance. Striking the right balance between automation and human oversight is crucial to maintain the integrity and reliability of these AI-driven platforms.

In this article, we delve deeper into the world of robot advising, exploring the underlying technology, benefits and challenges it presents. We examine how robo-advisors construct investment portfolios, the factors they consider, and the strategies they employ to optimize returns while managing risk. We also discuss the evolving regulatory landscape surrounding robo-advising and the steps taken to protect investors. As the financial industry continues its digital transformation, robo-advising stands as a testament to the power of AI in democratizing access to quality financial advice. By combining human expertise with the efficiency of automation, these digital advisors offer investors an opportunity to make informed decisions and build robust investment portfolios. Join us on this exploration of robo-advising and the impact it has on reshaping the way we invest and plan for the future.

LITERATURE REVIEW

There is much literature available on robo-advising. The field is continuously evolving, and researchers are exploring various aspects, including technology advancements, investor behavior, regulatory implications, and the impact on traditional financial services. There are different definitions for robo-advising: Betterment CEO Jon Stein (CNBC) defines it: *"Robo-advisors have opened up investing to a wider audience, making it more accessible and affordable for everyday investors*." According to Tania Carlone, Managing Director at Accenture Wealth and Asset Management. [Source: Forbes] "*Robo-advisors are particularly appealing to young investors who are comfortable with technology and want a digital solution for their investment needs."*

According to Agarwal et al. (2009), younger investors lack investment knowledge, and many older investors suffer from diminishing cognitive ability. Lam (2016) found that robo-advisors, automated investment platforms that provide investment advice without the intervention of a human advisor, have emerged as an alternative to traditional sources. Phoon

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& Koh (2017) describe how robo-advisors' assets under management (AUM) have risen manyfold through competitiveness in pricing, transparency, and services. Blanche, Casaló, and Flavián, analyze data from a web survey of 765 North American, British, and Portuguese potential users of robo-advisory and propose a research framework to better understand robo-advisor adoption. Fisch et al. (2019) describe the growth of the robo-advisor industry and the services that robo-advisors offer. In his paper "*CAN SLIM Method V.s Robo Advising Stock Market Simulation*" Ambalangodage (2019) also introduces the newest technologies for robo-advising. Cheng et al. (2019) investigate the trust-influencing mechanism of robo-advisors by a mixed-method approach. Rühr (2020) investigates user preferences with robo-advising and the performance-control dilemma. Wang & Yu (2021) proposed a full-cycle, data-driven (model-free) investment robo-advising framework that leverages both inverse optimization and deep reinforcement learning techniques. Alsabah et al. (2021) introduced a reinforcement learning framework for retail robo-advising. Capponi et al. (2022) describe how automated investment managers, or robo-advisors, have emerged as an alternative to traditional financial advisors. In a very interesting study by Hao et al. (2022) they prove that robo-advising improves financial sophistication. Investors have more diversified portfolios and exhibit fewer behavioral biases in portfolio management. Later many special analyses were performed. Anshari et al. (2022) examine the concept of a robo-advisor with digital twin capabilities for personal financial management. Kunschke et al. (2022) give new details what technical innovations and how FinTech is changing the traditional banking sector based on adapted regulation.

There is a huge literature on robo-advising and how it is adapted in different countries, e.g in their paper Integrating the 'Troublemakers': A Taxonomy for Cooperation between Banks and Fintechs" Drasch et al. (2018) describe how robo-advisory improves the customers' investment opportunities in China.

On artificial intelligence, we also find dozens of books. In their book Artificial Financial Intelligence in China by Zhang & Zhao (2021) they prove that artificial intelligence technologies in the form of facial, speech, and semantic recognition have great advantages. In their book Artificial Intelligence for Financial Markets Barrau & Douady (2022) introduces the artificial intelligence technique of polymodels and applies it to the prediction of stock returns.

In their book '*Digitalisierung im Asset Management*' (Soldatos & Kyriazis, 2022) demonstrate that digital finance increases trust and personalization using AI. Artificial intelligence applications like search and recommendation engines, and artificial intelligence platforms such as Google Maps, Chat GPT, BloombergGPT, and Stable Diffusion can be perceived as early manifestations of the ongoing transformation according to (Seppälä et al., 2023).

There are two very interesting modern papers on open AIs chatbot:

Biswas et al. (2023) in their paper ChatGPT in Investment Decision Making found out that chatgpt has different red flags to consider: dependency on the quality of input, transparency, data security, dynamic markets, and changing regulatory framework. Hariri (2023) provides a comprehensive overview of ChatGPT, its applications, advantages, and limitation.

The Characteristics of Robo-Advising

In the ever-evolving world of finance, robo-advising has emerged as a game-changing approach to investment management. Combining the power of automation and advanced algorithms, robo-advisors provide investors with a seamless and cost-effective way to navigate the complexities of asset allocation, portfolio management, and financial planning

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please refer to (Nathmann, 2019). At the heart of robo-advising lies the ability to optimize asset allocation by leveraging key financial data. By analyzing expected returns, deviations, and correlations among various asset classes, robo-advisors can identify portfolio compositions that offer the optimal risk-to-return ratio. Gone are the days of relying solely on rule-of-thumb strategies; robo-advisors utilize sophisticated models and historical trends to make data-driven investment decisions. Robo-advising represents a significant advancement in the financial services industry, aligning itself with the broader fintech revolution. These automated investment management platforms harness technology to provide investors with personalized advice and tailored portfolios. Through user-friendly interfaces and online questionnaires, robo-advisors gather crucial information about investors' risk tolerance, financial goals, and time horizons, enabling them to construct portfolios that align with individual needs and preferences.

Security and Regulation

Robo-advisors prioritize the protection of sensitive personal and financial information. They employ robust data encryption, secure storage practices, and strict access controls to prevent unauthorized access or breaches of user data. As digital platforms, robo-advisors are aware of the potential risks of cyberattacks. To mitigate these risks, they implement measures such as firewalls, intrusion detection systems, regular security audits, and comprehensive employee training to ensure the security of their systems and defend against potential threats. Robo-advisors implement identity verification procedures to ensure the authenticity of their users. This may involve thorough identity document checks, verification through trusted third-party services, or other authentication methods to prevent fraudulent activities.

Robo-advisors operate within the framework of financial regulations and compliance requirements specific to the jurisdictions they serve. These regulations may include registration, licensing, and ongoing reporting obligations to regulatory bodies such as financial authorities or securities commissions. Regulations aim to protect investors by requiring robo-advisors to adhere to certain standards. This includes disclosing relevant information, ensuring transparency of charges, providing clear details about investment strategies and risks, and addressing any potential conflicts of interest. Robo-advisors are typically required to assess the suitability of investment recommendations based on investors' profiles, risk tolerance, and investment objectives. They must ensure that the recommended portfolios align with investors' financial situations and preferences. Robo-advisors have established compliance frameworks and procedures to ensure adherence to relevant regulations. This may involve monitoring and reporting transactions, conducting periodic audits, and implementing internal controls to maintain compliance standards.

Depending on the jurisdiction, robo-advisors may have a fiduciary duty to act in the best interests of their clients. This duty entails providing suitable investment advice, managing conflicts of interest, and prioritizing clients' financial well-being. It is important to note that regulatory requirements for robo-advisors may vary across jurisdictions. Regulations continue to evolve to adapt to technological advancements and the unique challenges posed by digital investment platforms. Robo-advisors must stay updated on the regulatory landscape and ensure compliance with applicable laws and guidelines to maintain the trust and confidence of their clients. Security is of utmost importance in financial investments, particularly for robo-advisors, as they are often young and innovative companies in Germany. Ensuring transparent handling of all security-related matters is crucial. Rest assured that there are legal frameworks in place for the business operations of robo-advisors in Germany, offering maximum security.

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These digital platforms collaborate with banks that keep deposits in accounts as special assets, ensuring the safety of funds even in the event of the robo-advisor or the cooperating bank facing bankruptcy. Additionally, statutory deposit guarantees protect investment amounts, with up to EUR 100,000 per bank and customer. Robo-advisor investment amounts are treated as special assets, and statutory deposit protection also applies to credit balances in clearing accounts. However, it is important to note that regulation and supervision may vary, and risks are limited to price fluctuations. Data protection and encrypted transmissions remain fundamental aspects of ensuring security.

How Can Robo-Advisory Support?

Robo-advisory services play a pivotal role in supporting investors by effectively addressing three crucial objectives. Firstly, they strive to minimize risk, ensuring the safety and security of investors' portfolios. Secondly, they aim to generate returns that align with the investors' savings goals, enabling them to meet specific financial thresholds they have set. Lastly, robo-advisory services seek to maintain a portfolio that is in line with the investors' risk tolerance. Traditionally, financial advisors have been responsible for assisting investors in achieving these objectives, and the industry of such advisors is widespread across the country. These professionals assess investors' risk tolerance by utilizing questionnaires that delve into various aspects of their financial situations and their willingness to undertake risks. Based on the evaluation, financial advisors suggest suitable asset classes and recommend specific allocations that can help investors achieve their financial goals. Additionally, they may assist with tax planning and rebalancing, taking into account the tax advantages of the investment account and ensuring that the portfolio maintains the desired allocation over time.

Robo-advisory services step in by automating and streamlining this process. By leveraging advanced algorithms and data analysis, robo-advisors gather information about investors' risk profiles and financial objectives and then construct optimized portfolios accordingly. These digital platforms can also assist with tax planning strategies and periodic rebalancing, dynamically adjusting the portfolio's allocations as different asset classes perform divergently over time and as investors' circumstances change. Overall, robo-advisory services act as efficient and accessible alternatives to traditional financial advisors. They provide investors with comprehensive support in creating and managing investment portfolios that align with their risk tolerance, savings goals, and evolving market conditions. By combining technology and financial expertise, robo-advisory services offer a seamless and convenient experience for investors seeking robust and personalized investment guidance.

Possible Fee Structure of a Robo-Advisor

What benefits do financial advisors derive from this arrangement? They offer their services in exchange for a fee, typically ranging from 1% to 1.5% of the total assets they manage. For instance, if an investor has $1 million under the management of a financial advisor, the advisor would charge approximately $10,000 per year as a fee. Additionally, the funds in which these managers invest also impose their fees. Most mutual funds, especially those actively managed, have fees associated with managing investors' funds. For actively managed funds, these fees typically fall between 0.75% and 1%. Therefore, when entrusting your money to a financial advisor, you might end up paying fees ranging from 1.75% to 2.5% for the management of your investments. The question arises: How do these fees impact your wealth? This inquiry is what prompts us to consider robo-advisors as an alternative. Robo-advisors are known for their relatively low fees. In the context of human advisors, who traditionally operated from physical offices, the general rule of thumb was charging

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approximately 1% of the assets under management. Thus, if you had a portfolio worth $1 million, the fee for managing your investments would amount to $10,000 per year. In contrast, robo-advisors charge between 0% and 0.25% for basic services, representing about a quarter of what a typical human advisor would charge for investment management services.

Example:

You save $1,000 per month and earn a return of 10% per year on your investment. The financial advisor with whom the investor has placed their money charges a fee of 1%.

If you have a manager who charges a higher fee, or you are invested in assets that charge additional fees because of management expenses, such that the total fee runs to 2%, we wind up with only about for example $3 million. Half of our investment is potentially eaten up by fees on investment management over our life of savings. Because of these fees, robo-advising has been born. These robo-advisors help to gauge risk tolerance. They use index ETFs to minimize fees. ETFs attempt to take active positions in a particular market and wind up having much lower management fees than actively-managed mutual funds. These advisors then automatically rebalance your portfolio to maintain an asset allocation.

If the value of different assets in your allocation change, they will rebalance the portfolio. And they also rebalance the portfolio as you age and your goals change. There are two main types of these advisors. Hybrid robo-advisors are services that are mostly automated. So by and large you will not come into contact with a human being when using a hybrid robo-advisor. But there are situations where if you have enough money or you pay a certain fee, you can speak to a human advisor to get further advice on your asset allocation.

To speak to a human being, one usually has to maintain a higher minimum balance or pay some sort of fee. An example of these types of services is those offered by Vanguard, which will provide us with hybrid robo-advising services (on robo-advising with Vanguard (Marszk & Lehmann, 2015). The other type of automated advisor is a pure robo-advisor. Here the asset allocation is purely automated. There's no human contact, everything is performed online. These robo-advisors have very low minimum balances and fees which accomplish two things. First, low fees allow you to keep as much of your money as possible. And the low-minimum balances allow those investors without a lot of wealth in the first place to start investing as early as possible. Two prime examples of these robo-advisors, the two that have the most assets under management, are Wealthfront and Betterment. And in what follows, I use Wealthfront as an example of how a robo-advisor achieves its goals.

How does a peer advisor work? First, there's an online questionnaire that gauges risk tolerance. There are two types of data that the robo-advisor considers when thinking about how tolerant you are towards risk. The first is a set of objective data such as your current age, your income, and your assets. Again, generally, older investors as being less intolerant, investors with more income as being more risk-tolerant, and investors that have more assets as being more risk-tolerant. These are things that can be objectively quantified and aren't based on some subjective belief of how risk tolerant you are. The second set of questions captures subjective data questions like, what would you do in a market downturn?

What the robo-advisor will do is wait for the objective and the subjective number to determine overall risk tolerance. The reason that the robo-advisor weights these two quantities is that behavioral finance tells us that people tend to overestimate their risk tolerance. This happens to be especially prevalent in men and men with post-secondary education in particular, where these investors think they are much more risk tolerant and they show themselves to be in practice. The robo-advisor will then use this information captured in the risk tolerance questionnaire to choose a portfolio on the efficient frontier. Just to refresh, what we've talked about in past videos is that the efficient frontier is the set of asset allocations that have the highest expected return given a level of risk and therefore a level of risk tolerance.

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The Future of Robo-Advice: Practical Examples

In their working paper "Who uses robo-advising and how?" Baulkaran1 and Jain (2023) show from India data that users of robo-advisory services are relatively young, predominantly male, married, small investors, and professionals. There may be no such thing as a "pure" robo-advisors. Two of the largest independent robots are Wealthfront and Betterment. Both have client service representatives and expanding business models. From the industry viewpoint, the robot model is useful because it makes clients with relatively modest investable assets more economically viable to service. In this section, we describe some financial institutions which use robo-advising to manage their portfolios.

Royal bank of Scotland

Royal Bank of Scotland together with IBM is piloting a robot that will answer customer questions and pass requests on to the right agents (Davradakis et al., 2019)

SEB bank

Sweden's SEB bank became the first bank to use IPsoft's cognitive technology for customer services. (Davradakis et al., 2019)

Sberbank

Sberbank invested about USD 1 billion toward this aim, e.g. via its research labs dealing, among other things, with robotics, blockchain, and artificial intelligence (AI) (Allinger et al., 2022).

Vanguard personal advisor - around $32 billion in assets

One example which has grown dramatically recently is the Vanguard personal advisor services which were re-branded after being around for a long time, a couple of years ago as a robot. By June of 2015, it had $21 billion of assets, as of the first quarter of 2019 it had almost 116 billion. By all accounts, it's the largest financial Robo. Vanguard Personal Advisor Services rebranded as a robot in May 2015. By June it had $21.2 billion AUM1, and $115 billion as of 1st quarter of 20192, and is likely the largest robot. Wealthfront has $11 billion AUM as of 1st quarter of 2019. (Betterment overtook Wealth Front's AUM in July 20153, and has $16 billion as of 1st quarter of 2019) 90% of Wealthfront AUM is in Vanguard funds 3. Betterment caught up with Wealthfront by pivoting its business model to emphasize DC plan sales to small companies. Over the last three years, various large brokerages or asset managers have acquired or built robots or robot-like offerings (e.g., Schwab, Merrill Lynch); and Fidelity controls much of Betterment's order flow and earns referral fees

Betterment - around $6 billion in assets

Betterment, in some sense, is viewed to have caught up with Wealthfront by pivoting its business model to emphasize defined contribution plan sales in smaller companies, which historically has not been the bailiwick of Wealthfront.

Over the last several years, certain large brokerages and asset managers have acquired, built, or develop robo-like offerings. Firms like Blackrock, Schwab, Merrill. Fidelity controls much of the Betterment order flow, and of course, also earns referral fees in doing so

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Wealthfront - around $5 billion

Wealthfront, which is another top 10 firm, has about $11 billion of assets as of the first quarter of 2019. Betterment overtook Wealthfront AUM back in 2015, and we'll discuss that in a second, having about $16 billion as of the same mark to market. 90 percent of Wealthfront assets have been placed in Vanguard funds as part of the underlying strategy across asset allocation categories. Wealthfront in particular uses a model that is called the Black-Litterman model for thinking about expected returns. The model uses the capital asset pricing model, as an anchor. The capital asset pricing model tells us something about how expected returns are determined. Although this particular equation may look like a little bit of math, it has a relatively simple interpretation. What this particular expression is saying is that the expected return on an asset ought to be equal to the risk-free rate, plus a measure of risk that's given by the ratio of the covariance of the return on the asset with a return on a market portfolio, divided by the variance, multiplied by a risk premium, the risk premium on the market portfolio. People often see this written as the expected return is the risk-free rate plus the Beta times the market risk premium. The concept behind the CAPM is relatively simple and it says that any investor can invest in a broad market portfolio. So if the investor can invest in a broad market portfolio, the amount of risk that we're taking on by investing in an individual asset is quantified by how much that asset co-moves with the return on the market portfolio.

If it comoves more, that means when the market portfolio does well, the asset goes up by more in value, but when the market does poorly, the asset goes down more in value. We usually think of times when market returns are low or when asset prices fall as being bad times. So by investing in an asset that has a high Beta, we're going to have very low returns at exactly the time when we would like to have relatively high returns, that is to say, bad times or recessions. As a result, we think we get a higher expected return for investing in these more risky assets. What I'm showing you on this particular slide is a set of numbers from a wealth-front white paper as to what they expect the returns on different asset classes to be. US stocks, which are typical US equities, and foreign developed stocks, which are equities in developed markets such as Germany, the United Kingdom, Japan, etc. Emerging market stocks are the stocks of economies that are not quite as developed such as those of Mexico, Argentina, or say Thailand, or the Philippines. Dividend stocks are stocks that pay high dividends, and then the remaining asset classes are different areas of the economy outside of stocks. Natural Resources refer to areas of the economy such as oil and minerals. Real estate encompasses both residential and corporate real estate. US government bonds are those bonds issued by the US treasury, tips are bonds issued by the treasury that have inflation protection.

Municipal bonds are issued by states and local entities and usually have some tax advantage associated with them, US corporate bonds are issued by US corporations, and emerging market bonds are generally the bonds of emerging market governments, so similar to treasury bonds but being issued by the government of Mexico for example, and then risk parody. Wealthfront e.g. is going to solve your particular risk tolerance. As we discussed previously, the second major input to an asset allocation problem is the risk involved in a particular asset class. Wealthfront estimates for the risk involved in each of the individual asset classes has captured by their return volatility. The main thing to see from this particular slide is that there is a lot of variation in the risk of the different asset classes. At the lowest end of the spectrum, US government bonds have an annual volatility of only about four percent, municipal bonds of five percent, tips of six percent, and US corporate bonds of seven percent. At the higher end of the spectrum are typically equities. Our stocks have a volatility of 15 percent. At the highest end, emerging market stocks have a volatility of 23 percent.

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So the trade-off between these different asset classes is going to depend on the individual investor's risk tolerance, A higher risk tolerance will tend to shift more of the portfolio allocation to the US in emerging market stocks and away from the bond investments.

What this allocation is showing is that the vast majority of money is being invested in stocks, US stocks, foreign stocks, emerging markets, and dividend stocks. A fairly small fraction of my money is being invested in bonds, corporate bonds, and emerging market bonds. Finally, 90 percent of this portfolio was invested in US stocks and real estate, and about 10 percent was invested in corporate and emerging market bonds. Wealthfront is doing in this particular situation is taking the risk tolerance reflecting how willing you are to take on the standard deviation of a portfolio and allocating my assets among these different portfolios to achieve a target standard deviation with as high of an expected return as possible.

The asset allocations vary across the entire spectrum. The risk score can go from 0-10. This corresponds to an amount of volatility that one is willing to take on, which is commensurate with his utility function. One example is an investor who has a risk score of zero will take on a volatility of five percent in her portfolio, whereas an investor who has a risk score of 10 will take on a volatility of 15 percent in her portfolio. Each score or each unit of score represents an additional one percent per year of volatility. Again, the key thing to notice here is that as we go to the left end of the risk aversion scale, for those investors who have a relatively low-risk tolerance, there is relatively little allocation placed in orange, yellow, and brown securities, which are relatively risky, and much more are placed in light blue and dark blue securities which are relatively safe. For risk-averse investors, what we wind up seeing is that there is a fairly small allocation that's going to stocks, emerging markets, and other similar securities in the neighborhood of around 25-30 percent, whereas for our more risk-tolerant investors, about 90 percent of the allocation is going to these riskier asset classes. In 2019, it was reported that Wahed, a US-based investment fund company, had become the first globally accessible halal robo-advisor for Islamic value-based investing (Sahabuddin et al., 2023).

How Artificial Intelligence will Affect Robo-Advising

Artificial intelligence (AI) is expected to have a significant impact on robo-advising. Grennan & Michaely (2021) observed 290 FinTechs and 57% use artificial intelligence (AI) to generate investment signals. By using artificial intelligence, banks can offer chatbots, virtual assistants, and Robo-advisors that establish a direct connection with clients and enable the delivery of multiple services (Pal & Singh, 2019). AI can analyze vast amounts of data and extract valuable insights to inform investment strategies. By leveraging machine learning algorithms, robo-advisors can continuously learn and adapt to changing market conditions, allowing for more accurate predictions and better-informed investment decisions. AI can help robo-advisors provide more personalized recommendations and tailored investment strategies. By analyzing individual preferences, risk tolerance, financial goals, and other relevant factors, AI algorithms can create customized portfolios that align with each investor's specific needs. AI-powered robo-advisors can utilize natural language processing capabilities to communicate with investors more effectively. They can understand and respond to investors' queries, provide explanations, and conversationally offer guidance, making the overall user experience more intuitive and engaging.

AI can enhance risk management techniques used by robo-advisors. By continuously monitoring market trends, news, and economic indicators, AI algorithms can identify potential risks and adjust investment strategies accordingly. This real-time risk assessment can help mitigate losses and maximize returns. AI can incorporate insights from behavioral finance into robo-advising. By analyzing investor behavior, sentiment, and biases, AI

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algorithms can account for emotional factors that may influence investment decisions. This can lead to more effective strategies that align with investors' psychological tendencies and promote better long-term outcomes. AI-driven automation can streamline various aspects of robot advising, including portfolio rebalancing, tax optimization, and trade execution.

By reducing manual intervention and minimizing human error, AI can enhance operational efficiency, lower costs, and deliver a more seamless and consistent user experience. AI-powered algorithms can help detect fraudulent activities and enhance cybersecurity measures within robo-advisory platforms. By analyzing patterns, anomalies, and historical data, AI can identify potential threats, protect investor information, and ensure the integrity of transactions. Overall, the integration of AI into robo-advising has the potential to improve decision-making, increase personalization, and enhance the overall efficiency and effectiveness of the investment process. However, it is important to ensure that appropriate safeguards are in place to address ethical considerations, data privacy, and transparency, as the reliance on AI algorithms introduces new challenges and responsibilities for both providers and regulators. Robo-advisory, in comparison to humans, may offer superior returns because of the low cost of financial advisory stemming from the use of artificial intelligence (Brenner & Meyll, 2020; Lui & Lamb, 2018).

Critical Appraisal of Robo-Advising

Advantages

Robo-advising offers several major advantages, starting with its structured processes. First and foremost, it provides accessibility and affordability to a broader investor base. Traditional financial advisors often require higher minimum investments and charge substantial fees, making their services inaccessible to many. In contrast, robo-advisors offer low-cost solutions, enabling individuals with smaller portfolios to access professional-grade financial guidance (please refer to (So, 2021)). Also Philippon (2019) on fintech and financial inclusion analyses the cost structure of roboavising. Moreover, robo-advisors deliver automation and efficiency in portfolio management. Through automatic rebalancing, tax loss harvesting, and progress reporting, these platforms ensure that investment strategies remain aligned with investors' goals and adapt to changing market conditions. The systematic and emotion-free nature of robo-advising eliminates biases and impulsive decision-making, promoting a disciplined and rational investment approach. Users do not need in-depth specialist knowledge to answer questions as they are kept clear and simple.

The registration process with a Robo Advisor is straightforward, requiring users to open a clearing account with the provider's partner bank and transfer their investment amount or monthly savings installments. The Robo Advisor then accesses the account and implements the selected investment strategy. Most robo-advisors use investment strategies based on Exchange Traded Funds (ETFs) or index funds, which provide broad diversification by mapping various relevant indices without active fund management. These funds have low costs, resulting in better returns compared to traditional investment funds. Investors benefit from risk diversification, automated transactions, and cost savings (cost reductions of robo-advisory in (Rubini, 2018).

Robo-advisors act as intermediaries between investors and their investment portfolios. Unlike human fund managers, the algorithms used by robo-advisors make objective decisions based on mathematical models for risk management. It is important to note that from a legal standpoint, robo-advisory operates in a gray area, and most providers exclude liability. Conducting a thorough robo-advisor comparison can provide valuable guidance, as conditions, services, and investment strategies may vary between providers. The number of

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investment strategies offered also differs, so it's essential to study the available options carefully. Intelligent tools provided by the robo-advisor should display available funds and offer detailed reporting. Providers approved as intermediaries according to Section 34f of the Commercial Code in Germany can only present standardized portfolios and must work with third parties as brokers. Therefore, investors must initiate recommended adjustments themselves. Conversely, a financial portfolio manager licensed according to Section 32 of the German Banking Act can make and implement all decisions based on an analysis of the investor's specifications, within defined parameters, and under the supervision of German regulator BaFin. In 2016 Faubion (2016) prove that Robo-advisors promise to be the next step in the evolving world of retirement planning.

Many robo-advisors use portfolios with static weightings, such as 40 percent equities and 60 percent bonds, based on the "*modern portfolio theory*" developed by Markowitz in the 1950s. However, technological advancements have surpassed this approach, and modern robo-advisors use technology-driven models that dynamically adjust portfolio weightings based on risk tolerance and expected returns. These adjustments aim to maintain a constant level of risk, made possible by today's computing power. Robo-advising combines the precision and efficiency of technology with the personalized touch of investment advice, making it an art of fintech. It offers a lean and transparent cost structure for capital investment, allowing individuals to invest in relatively small amounts. Automated processes save time and effort, and convenient and risk-minimizing diversification is achieved across different asset classes. However, robo-advising does not provide real advice, and investment strategies are largely standardized, lacking individualization. Providers generally do not offer in-depth inquiries, so investors should possess solid basic knowledge. Costs are still higher compared to self-initiated investments, but lower than those associated with traditional human financial advisors opposing traditional finance (Rossi & Utkus, 2021).

Another significant advantage of robo-advisors is periodic rebalancing. Typical investment portfolios may become unbalanced if one asset class performs exceptionally well, resulting in overexposure to that class. Robo-advisors automatically monitor portfolios and rebalance them to maintain the desired asset allocation. They also consider changes in age, life situations, and risk tolerance to ensure an optimal asset allocation for investors. Robo-advising makes investing more accessible to a wider range of individuals, eliminates the need for large minimum investment amounts, and offers lower fees compared to traditional human financial advisors. It provides a convenient and user-friendly investment experience, with 24/7 accessibility. Robo-advisors employ modern portfolio theory, rely on data-driven decisions, continuously monitor portfolios, and offer transparency. However, it's important to acknowledge that while robo-advising has its advantages, it may not suit everyone, particularly those seeking personalized guidance or facing complex financial situations.

Disadvantages

Robo-advisors, relying on algorithms and automation, may not offer the same level of personalized advice and tailored investment strategies as human financial advisors. They may not fully consider individual circumstances, goals, or risk tolerance. The technology-driven nature of robo-advising can result in a lack of human interaction, which may be preferred by some investors who seek guidance, reassurance, and emotional support during market volatility or major life events. Robo-advisors may not be equipped to handle complex financial situations that require in-depth analysis, customized strategies, or specialized knowledge. They typically focus on simpler investment needs and may not be suitable for individuals with intricate financial situations or unique investment requirements.

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Robo-advisors base their investment decisions on historical data and algorithms, which means they may not fully account for unpredictable market events or sudden changes in economic conditions. They may lack the flexibility to adapt quickly to new circumstances or emerging investment opportunities. While robo-advisors offer diversified portfolios, they often have a limited range of investment options compared to traditional financial advisors. Their focus on ETFs or index funds may not provide access to certain asset classes or specialized investment products that could be beneficial in specific situations. Like any technology-based platform, robo-advisors are vulnerable to technical glitches, system failures, or cybersecurity risks. These issues could disrupt account access, compromise personal information, or lead to financial losses. Robo-advisors do not provide emotional guidance or behavioral coaching, which can be crucial during market volatility when investors may face the temptation to make impulsive decisions based on short-term fluctuations. Human advisors often offer guidance to help investors stay disciplined and focused on long-term goals. Algorithms used by robo-advisors rely on historical data and predefined rules, potentially lacking the same level of human judgment, intuition, or ability to interpret non-quantifiable factors that can impact investment decisions.

The regulatory landscape for robo-advisors is still evolving, resulting in uncertainties or legal gray areas regarding their operations, compliance requirements, and potential liabilities. It is important for investors to carefully review the terms and conditions, as well as the regulatory framework, to ensure their rights and protections are adequately addressed. Robo-advising may not be appropriate if you are knowledgeable about the financial market, prefer to develop and pursue an individual investment strategy and manage your portfolio independently. Opening a suitable custody account and trading with financial instruments that align with your style might be a better option. While processes in robo-advising are largely automated, they still require human intervention. Providers may differ in terms of necessary shifts, employee support, and customer training and education. Some companies use modern technologies exclusively for communication, while others digitally map a significant part of the process. Different authors warn of the risks of robo-advising (please refer to: (Silva, 2019)). However, it's important to recognize that robo-advising may not be suitable for all investors. Those with complex financial needs or a desire for a more hands-on approach may prefer the personalized touch of traditional advisors. Furthermore, concerns such as data privacy, regulatory compliance, and algorithmic transparency warrant careful consideration as the industry continues to evolve.

Summary

Robo-advising combines AI and financial expertise to provide personalized investment strategies. It offers accessibility, affordability, and efficiency with lower fees and automated portfolio management. Concerns about data privacy and regulation exist. Robo-advisors prioritize security and comply with financial regulations. They minimize risk, generate returns, and maintain portfolios aligned with investors' preferences. Overall, robo-advisory services support investors by providing tailored guidance and efficient management of investment portfolios. The fee structure of a robo-advisor typically ranges from 0% to 0.25% for basic services, which is significantly lower than the 1% to 1.5% fee charged by human financial advisors. Robo-advisors use index ETFs with lower management fees and automatically rebalance portfolios to maintain an optimal asset allocation. This low-cost approach helps investors save on fees and allows those with smaller balances to start investing early. However, some robo-advisors may charge higher fees for personalized human advice or require higher minimum balances. The use of artificial intelligence (AI) in robo-advising enables data analysis, personalized recommendations, and effective communication with

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investors. AI can enhance the accuracy and adaptability of investment strategies and improve the overall robo-advising experience.

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