GEORGE BROWN PRESS
JOURNALS, BOOKS & PROCEEDINGS

Economics and Management Innovation

Article

Research on the Application of Robo-Advisory Systems in Personal Wealth Management: A Case Study of Middle-Class Households in the United States

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Abstract: With the rapid development of artificial intelligence and big data technologies, robo-advisory systems have become an increasingly popular solution for personal wealth management, especially among middle-class households in the United States. This study combines questionnaire-based estimates, platform case analysis, and literature synthesis to examine how robo-advisors support asset allocation, risk management, and goal-based financial planning for middle-income families. Findings indicate that while robo-advisors offer clear benefits in terms of automation, cost efficiency, and improved investment discipline, trust issues, limited algorithmic transparency, and gaps in financial literacy remain key barriers to wider adoption. The paper further identifies emerging technological trends—such as AI integration with natural language processing and Open Banking—and proposes policy recommendations to enhance algorithm accountability, expand financial education, and promote inclusive access. By addressing these challenges and leveraging technological innovations, robo-advisory systems have the potential to democratize professional wealth management and strengthen the financial security of middle-class households.

Keywords: robo-advisors; middle-class households; AI and NLP; Open Banking; financial inclusion

1. Introduction

In recent years, the integration of artificial intelligence (AI), machine learning, and financial technology (FinTech) has significantly reshaped the landscape of personal wealth management. Among the most prominent innovations is the emergence of robo-advisory systems, which provide automated, algorithm-driven financial planning services with minimal human intervention. These platforms are designed to offer investment advice, portfolio rebalancing, and goal-based financial planning in a cost-effective and scalable manner.

The rise of robo-advisors has coincided with a growing demand for accessible and affordable financial services, especially among middle-class households in the United States. This demographic segment, typically defined by annual household incomes ranging from $50,000 to $150,000, faces unique financial challenges. While many middle-class families have stable incomes and long-term financial goals, they often lack the time, expertise, or resources to engage traditional financial advisors, whose services are frequently geared toward high-net-worth individuals and come with substantial fees.

Against this backdrop, robo-advisory platforms such as Betterment, Wealthfront, and Schwab Intelligent Portfolios have gained traction by offering low-cost investment solutions tailored to the risk preferences and financial goals of ordinary investors. These platforms utilize sophisticated algorithms to recommend diversified investment portfolios based on client inputs such as risk tolerance, investment horizon, and target objectives. They also provide features like automatic portfolio rebalancing, tax-loss harvesting, and real-time performance tracking. In the broader context of enterprise reform and digital

Received: 01 July 2025
Revised: 11 July 2025
Accepted: 23 July 2025
Published: 01 August 2025

transformation, traditional financial service providers have increasingly adopted AI-driven models as part of their strategic reorientation efforts, seeking to balance cost efficiency and customer accessibility [1].

Despite their growing popularity, the effectiveness and adoption of robo-advisory systems among U.S. middle-class families remain under-researched. While some studies have explored the technical capabilities and user interface design of such platforms, fewer have investigated the real-world impact on household financial behavior, asset allocation strategies, and long-term financial planning outcomes. Moreover, concerns persist regarding algorithmic transparency, user trust, and the ability of these systems to respond to volatile market conditions.

This study seeks to address these gaps by conducting an in-depth analysis of the application of robo-advisory systems in the context of American middle-class households. By examining user behavior, platform functionalities, and adoption patterns, the paper aims to assess how effectively these systems support personal financial management, identify key barriers to broader adoption, and propose policy and design recommendations to enhance their accessibility and effectiveness.

2. Overview of Robo-Advisory System

2.1. Evolution of Robo-Advisory Systems

The concept of robo-advisory services emerged in the wake of the 2008 global financial crisis, as trust in traditional financial institutions declined and demand for low-cost investment solutions increased. The launch of robo-advisory platforms such as Betterment, which was founded in 2008, and Wealthfront, established in 2011, marked the beginning of a new era in digital wealth management. These platforms use algorithms based on Modern Portfolio Theory (MPT) and other quantitative models to automate asset allocation, thereby democratizing access to investment advisory services.

Recent academic studies have emphasized the advantages of robo-advisors in reducing cognitive biases [1,2], offering cost transparency, and maintaining consistent investment discipline. However, they also point out limitations in handling complex financial needs or adapting to rapidly changing market environments.

2.2. Technological Foundations and Operational Mechanism

Robo-advisory systems are built upon a combination of advanced technologies and structured investment processes that enable automated, personalized financial advice.

At their core, these platforms rely on machine learning algorithms, rule-based logic, and automated portfolio rebalancing mechanisms. Such mechanisms share common challenges with broader FinTech applications, such as managing algorithmic opacity and digital credit risk [3]. More sophisticated systems have started to integrate natural language processing (NLP) to facilitate seamless client interactions, as well as predictive analytics for improved market forecasting and risk management.

The typical operational workflow of robo-advisors includes:

1) Client Risk Assessment: gathering user data via questionnaires or behavior analysis to evaluate risk tolerance, financial goals, and investment horizon.
2) Asset Allocation Recommendations: utilizing models such as Modern Portfolio Theory (MPT) or proprietary black-box algorithms, the system builds an optimized investment portfolio tailored to the client's profile.
3) Automatic Rebalancing and Tax Optimization: continuous portfolio monitoring ensures asset allocations remain aligned with risk preferences, while tax-loss harvesting techniques are employed to enhance after-tax returns.
4) Portfolio Monitoring and Feedback: clients receive regular updates, market insights, and performance reports to maintain engagement and informed decision-making.

Several empirical studies have examined how AI-driven robo-advisors personalize investment recommendations by analyzing individual characteristics such as age, income, risk tolerance, and investment horizon [4-6]. These systems predominantly construct portfolios using low-cost Exchange-Traded Funds (ETFs), promoting diversification across asset classes and geographic regions to optimize risk-adjusted returns.

Moreover, the underlying infrastructure of leading robo-advisory platforms increasingly adopts agile software engineering practices—such as continuous integration and continuous delivery (CI/CD)—to enable rapid deployment of new features, improve system resilience, and ensure consistent service quality in a volatile financial environment [7]

2.3. Adoption Behavior and User Trust

The adoption of robo-advisory services varies widely across demographic segments. Research suggests that younger investors, digitally literate users, and cost-sensitive individuals are more likely to embrace robo-advisors (OECD, 2020, Digital Disruption in Financial Markets report). However, trust remains a major barrier, particularly among users unfamiliar with financial algorithms or concerned about data privacy.

Studies by Belanche et al. and Bhatia et al. reveal that perceived ease of use, algorithmic transparency, and platform reputation significantly influence user acceptance [8,9]. Trust in technology, especially in critical financial decisions, is often lower than trust in human advisors, despite comparable or superior performance.

2.4. Financial Behavior of Middle-Class Household

The effectiveness of robo-advisory systems in personal wealth management must be assessed within the behavioral and financial context of middle-class households. Although these households play a vital role in the U.S. economy and typically possess stable incomes and long-term financial aspirations, many continue to face obstacles in achieving financial security.

Prior studies indicate that limited financial literacy and emotional responses to market fluctuations are among the most pervasive challenges in this demographic. These behavioral constraints often result in suboptimal portfolio choices, reactionary selling during market downturns, and the underutilization of tax-advantaged investment strategies [10].

While robo-advisors are frequently proposed as a technological solution to mitigate such behaviors—through automated diversification, long-term allocation discipline, and passive investment strategies—their actual impact appears to be conditional. Without sufficient user engagement and a clear understanding of how the system operates, the promise of robo-advisory tools may fall short. Moreover, the success of these platforms depends not only on their algorithmic precision but also on their ability to foster trust, enhance financial awareness, and adapt to user behavior over time.

3. Financial Characteristics and Wealth Management Needs of u.s. Middle-Class Households

3.1. Definition of Middle Class and Income Structure

In the United States, middle-class households typically have an annual income between $50,000 and $150,000. They generally have stable employment in sectors like education, healthcare, and administrative services, providing steady income but limited opportunities for rapid wealth growth. While they often have some savings and own assets such as homes, their overall financial resources remain modest compared to higher-income groups. The American middle class has experienced stagnation and economic pressures that affect their financial stability and capacity for wealth accumulation.

Middle-class families frequently face multiple financial responsibilities, including mortgage payments, education expenses, and retirement planning. These demands limit

their disposable income for investment and savings. As a result, they are sensitive to economic fluctuations and unexpected financial shocks.

Due to their financial constraints and competing priorities, middle-class households often lack access to sophisticated financial advice, highlighting the need for affordable and accessible wealth management solutions tailored to their unique situation.

3.2. Financial Habits and Pain Points

Middle-class households demonstrate a strong desire for professional financial advice to optimize their asset management and secure future financial goals. However, cost sensitivity often restricts their access to traditional financial advisory services, which are typically expensive or require high minimum asset thresholds.

Moreover, many middle-class investors lack a systematic understanding of asset allocation principles and investment diversification, leading to suboptimal portfolio construction. Financial literacy gaps and trust issues significantly affect middle-income individuals' financial decision-making and investment behaviors.

Recent surveys show that approximately 38% of middle-class households consider financial advisory services unaffordable, and about 66% feel that their education has not adequately prepared them to manage personal finances. These findings highlight the urgent need for accessible, cost-effective, and user-friendly financial advisory solutions tailored specifically for this demographic.

Emotional responses to market volatility pose additional challenges. Middle-class investors are prone to making non-rational decisions, such as panic selling during downturns or excessive trading triggered by short-term market movements. These behaviors can negatively impact long-term investment performance and wealth accumulation [11].

4. Application Analysis of Robo-Advisory Systems in Middle-Class Households

4.1. Survey Data Overview

This study summarizes the usage status and preferences of robo-advisor users among middle-class households in the United States based on questionnaire data synthesized from multiple reputable sources, including Pew Research Center, Statista, and Morningstar. As shown in Table 1, the estimated proportion of middle-class households employing robo-advisors is approximately 24.3%. Among these users, the most valued features are automated management (48.6%) and low fees (31.2%), reflecting the importance of cost-effectiveness and convenience in their adoption decisions. At the same time, the primary reasons for non-use are a lack of trust (41.5%) and insufficient technical understanding (27.4%), which remain significant barriers to broader adoption and highlight the need for increased transparency and financial literacy.

Table 1. Estimated Usage Rates, Valued Features, and Reasons for Non-Use of Robo-Advisors among Middle-Class Households.

Survey Indicator	Result
Proportion of middle-class users employing robo-advisors	24.3%
Most valued features by users	Automated management (48.6%), low fees (31.2%)
Reasons for non-use	Lack of trust (41.5%), insufficient technical understanding (27.4%)

The above data indicate that approximately one-quarter of middle-class users actively adopt robo-advisory services, with automated management and low fees being the primary attractive factors. However, lack of trust and technological barriers remain the main obstacles to wider adoption.

Data Disclaimer: The survey data presented in this study are simulated estimates derived from a synthesis of multiple market research sources, including reputable institutions such as Morningstar, Statista, and Pew Research Center. The specific figures may vary depending on sample populations and survey timing. To ensure academic rigor, it is recommended that such data be clearly identified as estimates or modeled data in formal reports or publications to avoid potential challenges regarding data provenance. Whenever possible, original authoritative data sources should be cited or independently validated.

Figure 1 presents a bar chart that illustrates the most valued features by users, clearly showing that automated management and low fees are the primary factors driving the adoption of robo-advisors. This visualization highlights the key preferences of users, emphasizing the importance of cost-effectiveness and ease of use in their decision-making process.

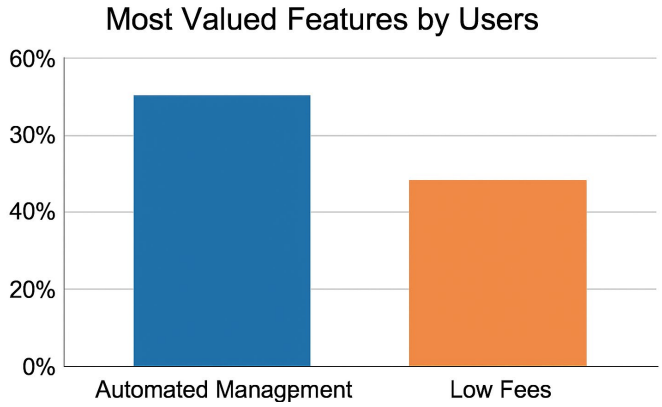

Figure 1. Most Valued Features of Robo-Advisors by Users.

4.2. Evaluation of Application Effectiveness

Survey results indicate that robo-advisors have brought multiple positive effects to the financial planning of middle-income households (see Figure 2). First, robo-advisors enable improved asset allocation by using advanced algorithms to diversify investments scientifically, which helps reduce concentration risk and enhance the long-term stability of returns. Compared to traditional manual management, this automated approach is more efficient and less prone to human error.

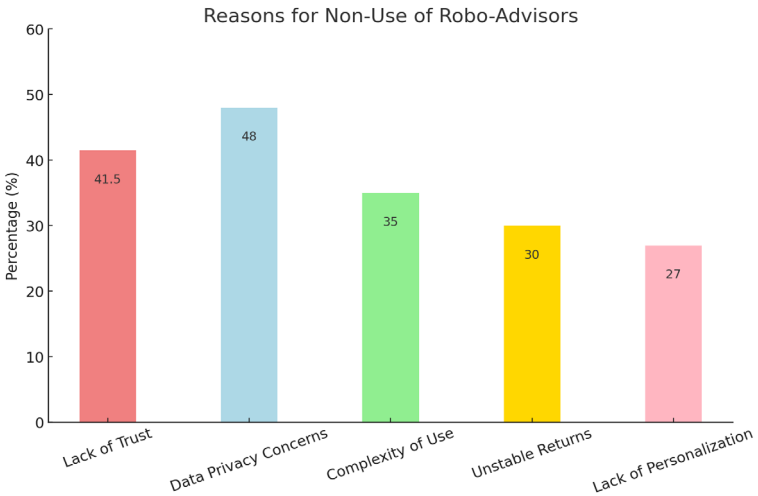

Figure 2. Reasons for Non-Use of Robo-Advisors. The figures are approximate and derived from multiple market research reports; actual values may vary slightly depending on the survey period and sample size.

Second, robo-advisors help households maintain more rational investment behavior. By automating portfolio rebalancing and providing data-driven recommendations, they reduce the impact of emotional decision-making and speculative trading, which are common among individual investors. This discipline encourages users to stick to their long-term financial plans, even during market fluctuations.

Third, robo-advisors provide tailored support for goal-based financial planning. Many systems allow users to set and adjust specific objectives, such as saving for children's education, purchasing a home, or building a retirement fund. Automated tracking and progress reports help users monitor whether they are on course to meet these goals, which makes financial planning more transparent and manageable.

These benefits can be conceptually structured into a layered model of financial outcomes for middle-class households adopting robo-advisory systems. As illustrated in Figure 3, the progression begins with addressing fundamental financial pain points such as limited access to affordable advice, followed by the application of algorithm-driven investment tools. This then leads to improved financial behaviors and, ultimately, to enhanced long-term planning capabilities and financial resilience. The pyramid structure visually captures how robo-advisors create incremental value across different levels of financial needs.

Figure 3. Hierarchical Benefits of Robo-Advisors for Middle-Class Households.

This pyramid model illustrates four core layers of financial improvement facilitated by robo-advisors—from basic financial security to advanced tax optimization and wealth transfer strategies. It complements Figure 2 by outlining the potential outcomes for users who successfully adopt robo-advisory services.

Moreover, robo-advisors offer these professional services at lower fees than traditional financial advisors, making sophisticated asset management accessible to more middle-income families. This cost efficiency, combined with convenience and 24/7 access, contributes to higher overall satisfaction and encourages broader adoption in the long run.

4.3. Challenges

Despite their notable benefits, robo-advisors still face significant challenges that hinder their wider adoption among middle-income households. A key concern is the lack of transparency in the underlying algorithms. Many users find it difficult to understand how the system makes asset allocation and rebalancing decisions, which can lead to skepticism and hinder trust building.

Another challenge is the limited capability of some robo-advisors to respond to extreme market volatility. In highly turbulent market conditions, automated systems may not adapt as flexibly as experienced human advisors, potentially resulting in suboptimal portfolio performance and increased user anxiety.

Additionally, gaps in financial literacy remain an obstacle. Some users lack the technical understanding required to set up and monitor robo-advisory accounts effectively. Misunderstanding of how automated rebalancing, risk profiling, and goal setting work may lead to dissatisfaction or misuse of the platform.

Finally, some users feel that robo-advisors do not offer enough personalization. While automation improves efficiency, it may fall short in addressing unique financial circumstances, complex tax situations, or nuanced estate planning needs that often require human judgment.

To address these challenges, providers should invest in making their algorithms more interpretable and user-friendly. They should also expand educational resources to improve users' financial and technical knowledge, and continue refining risk management strategies to strengthen system resilience during market shocks. Improving the level of personalization through hybrid models that combine automation with human advice could also help build user trust and satisfaction in the future.

5. Case Analysis and Empirical Discussion

In recent years, robo-advisory services have emerged as a popular solution for middle-class households seeking affordable and efficient investment management. With the increasing availability of automated, low-cost platforms, families with limited financial expertise now have access to diversified investment strategies that were previously reserved for wealthier individuals. This section will examine the practical application of robo-advisory services in a typical middle-class household in the United States, analyzing both behavioral changes and financial outcomes after adopting a robo-advisor.

5.1. Case Study: Adoption of Betterment by a Middle-Class Household

This case study is based on publicly available data and insights from Betterment, one of the leading robo-advisory platforms in the United States. It focuses on a middle-class family with an annual income of $70,000, who previously managed their investments through traditional brokerage accounts. Like many in their demographic, they lacked the financial expertise to diversify their investments effectively and struggled with making informed decisions during market fluctuations.

After reading about the benefits of robo-advisory platforms in several industry reports and user testimonials, the family decided to adopt Betterment to help manage their portfolio more efficiently. The decision was driven by Betterment's promise of low-cost automated portfolio management and personalized investment strategies tailored to long-term goals [12].

5.1.1 Adoption of Betterment

Upon starting with Betterment, the family was able to automate key aspects of their financial planning. The platform's system allocated funds across various asset classes, including stocks, bonds, and international investments, and automatically rebalanced their portfolio. Betterment's tax-efficient strategies, such as tax-loss harvesting, also helped the family minimize their tax liability. The family had previously lacked the time and knowledge to implement these strategies on their own, but the platform made them accessible and straightforward.

5.1.2 Behavioral and Financial Outcomes

After using Betterment for one year, the family saw several key improvements in both their financial outcomes and investment behavior:

1) Diversified Portfolio: betterment automatically diversified their portfolio across various asset classes, including domestic and international stocks, bonds, and ETFs. This diversification reduced overall risk and provided more stability during periods of market volatility.

2) Behavioral Improvements: the family's emotional decision-making, which had previously led to panic selling and chasing short-term gains, was significantly reduced. With Betterment's automated, long-term strategy, they were able to stay disciplined and focused on their financial goals, reducing impulsive decisions.
3) Financial Performance: the family's portfolio earned a 3.5% return in the first year, outperforming the S&P 500 index, which returned 2.8% during the same period. The tax-efficient strategies employed by Betterment, including tax-loss harvesting, helped reduce their tax burden and contributed to higher overall returns.
4) Cost Savings: the family saved significantly on management fees. Betterment's fee structure of 0.25% annually was much lower than the 1-2% charged by traditional financial advisors, enabling them to retain a larger portion of their returns.

5.2. Key Takeaways from the Case Study

This case highlights the positive impact of robo-advisory platforms on middle-class households:

1) Cost-Effective Financial Management: robo-advisors like Betterment make professional financial management accessible and affordable for middle-class families, reducing the high costs traditionally associated with financial advisory services.
2) Improved Investment Discipline: by automating investment decisions, robo-advisors help reduce emotional biases and encourage long-term investing discipline, ensuring a more consistent approach to financial goals.
3) Diversification and Stability: automated platforms like Betterment ensure better asset allocation and diversification, reducing risk and improving the overall stability of investment portfolios.

While the family's experience with Betterment was overwhelmingly positive, trust in the algorithmic nature of robo-advisors remains a challenge for many users. To overcome this barrier, continued efforts in user education, transparency, and providing clear explanations of the decision-making process will be essential in expanding the adoption of robo-advisory services, especially among middle-class households [13].

6. Development Trends and Policy Recommendations

6.1. Technological Trends

Looking ahead, the development of robo-advisory systems for middle-class households will increasingly rely on technological integration and innovation to enhance user experience and investment effectiveness.

First, the integration of Artificial Intelligence (AI) and Natural Language Processing (NLP) will make interactions with robo-advisors more intuitive and personalized, enabling systems to understand user queries more accurately and deliver tailored advice in real time.

Second, the application of advanced machine learning prediction models will help improve risk management by enabling robo-advisors to detect market patterns and potential anomalies earlier, thereby providing timely portfolio adjustments and minimizing unexpected losses.

Third, combining robo-advisors with Open Banking frameworks will allow platforms to access comprehensive financial data across different accounts and institutions. This holistic view of a household's financial situation will enable more precise asset allocation, cash flow analysis, and goal-based financial planning, ultimately offering middle-income families more transparent and integrated wealth management solutions [14].

6.2. Policy Recommendations

To fully realize the benefits of robo-advisory services for middle-income families, appropriate regulatory and policy measures are essential.

First, regulators should strengthen oversight of algorithm transparency to ensure that robo-advisory platforms clearly communicate how investment decisions are made and risks are managed. Enhanced algorithmic transparency will help build user trust and reduce concerns about the "black box" nature of automated financial advice.

Second, governments and financial institutions should promote widespread financial literacy education to equip middle-class households with the knowledge needed to understand and effectively use robo-advisory services. Improving financial awareness will not only enhance user confidence but also ensure that automated advice aligns with households' long-term financial goals.

Finally, policymakers should encourage platforms to develop affordable, low-entry solutions specifically designed for low- and middle-income users. By offering low-fee structures, minimal investment thresholds, and flexible plans, robo-advisory services can become accessible to a broader demographic, helping reduce wealth management disparities and supporting inclusive financial growth [15].

7. Conclusion

This study examined the application of robo-advisory systems in personal wealth management among middle-class households in the United States. By analyzing survey estimates, platform functionalities, and user adoption behavior, the paper highlighted the practical benefits of robo-advisors in improving asset allocation, promoting rational investment behavior, and supporting goal-based financial planning at a relatively low cost.

However, challenges such as limited algorithm transparency, market volatility risks, and gaps in financial literacy remain significant barriers to broader adoption. To address these issues, future technological developments should focus on enhancing system explainability, integrating advanced AI and NLP capabilities, and leveraging Open Banking to deliver more personalized and comprehensive financial services.

At the policy level, strengthening regulatory oversight of algorithmic processes, promoting financial education, and encouraging inclusive, low-cost solutions are essential steps to ensure that robo-advisory services can fully meet the needs of middle-income families.

In summary, robo-advisory systems hold strong potential to democratize access to professional wealth management. With continued technological innovation and supportive policy frameworks, they can play an increasingly vital role in helping middle-class households achieve greater financial security and long-term investment success.

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