POZNAŃ UNIVERSITY
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Robo-advisory: An Asset Management Perspective

Robo doradztwo: Perspektywa zarządzania aktywami

Bachelor's thesis

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Introduction

People with little or no financial knowledge may not feel confident in creating a structured investment portfolio. Hiring financial expertise from an advisor is highly recommended, but they are expensive and challenging to manage according to your personal needs. Robo-advisors are automatic platforms of investment that deliver investment guidance without the interference of a mortal mentor and have appeared as an alternative to outdated form of investment guidance. This thesis analyses the existing robo-advisors and predicts the future of this innovative technology.

This thesis inspects the model of robo-advisory from various perspectives. The first chapter introduces the basic concept of financial advisory. This chapter strengthens the distinction between various forms of advisory. Furthermore, financial concepts of Modern Portfolio Theory and the Efficient Market Hypothesis are discussed to better understand the concepts ahead.

In the second chapter, the thesis describes the various forms of robo-advisory and how they work, emphasising areas on deliberating the foundation for asset allocation and passive indexing, which is the policy that most robo-advisors have accepted. An in-depth inspection of four foremost robo-advisors deliberates how robo-advisors differ from one another.

In the last chapter, a SWOT analysis has been done to investigate the strengths and weakness of existing robo-advisors. Theoretically, robo-advisors can become infinitely adaptable, as the development of increasingly complex algorithms allows them to tailor their portfolios to people in the most unfavourable economic conditions.

Chapter 1: Basic investment concepts

1.1 Active vs passive investment

Investors have two main investment strategies that can be used to generate a return on their investment accounts: active portfolio management and passive portfolio management. Passive investment is a long-term investment strategy aimed at monitoring a specific market or market segment, using a predetermined policy to simulate the underlying index. This method does not require prediction using market synchronisation or stock selection technology. People can invest in products such as mutual funds or investment funds. Passive investing eliminates the emotional factors that affect the underlying market.

Passive investing involves little to no research on individual companies; instead, the investor tries to diversify money across many stocks. The investor waits for the stock success and emerges as the owner of thousands of stocks funds in leading major indices, such as S&P 500 and Dow Jones. There are so many strategies of passive investing, but index investing is the most common form: depositors use a "buy-and-hold approach" to duplicate the presentation of a precise index, by acquiring the constituent refuges of the index (Graham, 2006).

Active investment is an approach that involves monitoring the stock prices of your positions to find the buying and selling opportunities. Active investment managers achieve this by choosing investments that they believe will stand out, often with the help of analysts and traders. Active managers usually have higher costs than passive managers do. The main goal of the portfolio is often to outperform a certain benchmark. A benchmark can be an index or certain type of indices that offer some gauge of how the overall market or certain segment of the market has performed. The amount an investor earns by outperforming their benchmark is referred to as an alpha return: active investors are looking for alpha on their investment. There are several Active investment strategies to outperform the benchmark (Pedersen, 2019).

Active investment managers aim to review the relevant benchmark with their investment style and stock selection skills. They use a variety of qualitative and quantitative tools, including conceptualisation, partial collection, analysis reports, and frequent communication

with company leaders. Managers also use various risk management techniques to reduce the risk. However, an active investor is confident in putting his money on stake, based on qualitative and quantitative analysis to determine when to buy and sell stocks. The active investor is usually a speculator rather than a “traditional” investor (Graham, 2006).

1.2 Fundamental vs technical analysis

Fundamental analysis is a method of determining the actual or "fair market value" of items. In addition, an enterprise needs to consider some key ratios to estimate the net asset value of the enterprise that has been invested in an inventory of several significant ratios calculated in the enterprise's analysis, in particular:

- Earnings per share (EPS): expressed by the formula (earnings per selected shares) / number of shares outstanding. This ratio shows the extent to which the value of a share has increased or decreased during the period.
- Price/Earnings (P/E) ratio: expressed by the formula (market price per share) / EPS. This ratio shows exactly how much the share price increases earnings per share. If the price between incomes is high, it means that market participants expect stock prices to continue to rise. If the price-to-earnings ratio starts to fall, it means that the share price will soon fall.
- Return on assets (ROA): derived from the formula (net income + interest expense) / total assets. This ratio indicates the extent to which the enterprise uses property, plant and equipment. The high return on assets shows that assets are used efficiently, and operations are strong. The decline in return on equity indicates that the transaction is unprofitable, and its share prices will eventually fall.
- Return on equity (ROE): calculated according to the formula (after-tax wages) / stakeholders’ equity. The ratio shows the use of shareholders' money and the return on the fund's contribution. The low return on equity indicates that shareholders' funds were not used correctly.
- Debt/equity ratio: This can be done with the help of formula [(total liabilities) / stakeholders’ equity]. This is a measure of the advantage between available and used

capital. The low level of this ratio indicates that the existing credit rating has not been fully utilised.

- Market capitalisation: expressed by the formula [(number of shares) x (share price)]. This is a measure of the number of shares traded on the market.
- Price/Sales ratio: expressed by the formula (stock exchange price) / (income over 12 months). This measure indicates whether the exchange rate of the letter indicates the value of the work.
- Price/Book ratio: expressed by the formula (share price) / (total assets - intangible assets and liabilities). This measure compares share prices and the real value of shares. This measure indicates that the strain is undervalued or undervalued.

1.3 Technical Analysis

Technical analysis is performed only the on the price and quantity of stocks. The basic premise is that all known underlying factors are included in the price, so companies don't have to be investigated any further. Technical analysis is mainly based on stock market volatility and is used both by long- and short-term investors. Investors that use technical analysis believe that many economic, industrial and commercial variables do not need to be examined to assess future value, as they believe that fluctuations in price and volume are accompanied by fluctuations in the market in the past (Avramov, 2015).

In technical analysis, it is assumed that the development of market prices is not just random but follows a certain pattern and development. These trends and tendencies recur over time, and historical developments recur frequently. Below are a few instruments used by investors:

- Simple moving average: This technical indicator is used to predict stock price and turnaround time. Moving averages of both short and long-time horizons can be determined. The line policy shows the current policy. A simple moving average is above the price level. If the simple moving average is below the stock price line (above), it indicates that stock prices are rising (falling).
- Practical average moving average: this technical indicator is similar to a simple average, The longer the time period for the moving average, the greater the lag. So, a

200-day moving average will have a much greater degree of lag than a 20-day MA because it contains prices for the past 200 days.

- Proportional Strength Index: This index is calculated using the formula 100 - (100 / (1 + (average closing price per day / average closing price per day)).) The calculated value of RSI is between 0 and 100.

- Moving Average Convergence/Divergence (MACD): This tool is a pulse indicator. The MACD line was determined by subtracting the 26-day mean from the 12-day moving average. The second line, called the tag line, is the 9-day average. If the MACD line crosses the label line (below the label line), it marks the beginning of the upward (downward) trend.

1.4 Portfolio construction

Portfolio theory assumes that an investor is risk averse: it means given a set of two assets with an equal rate of return, the investor will choose the one with a lower level of risk. (Brown, 2012). A portfolio is simply a set of assets: from stocks, bonds and government bonds to real estate and investment funds. Investors construct portfolios to achieve their goals, and not to rely on a single asset. The composition of the investment portfolio depends on many factors, but the most important are the investor's risk tolerance, the investment period, and much capital he or she has to invest. Diversification is the main reason for constructing portfolios: diversification decreases one’s exposure to risk it spreads the risk impacts on many securities. Markowitz derived a formula for calculating portfolio variance, showing the importance of diversification to mitigate risk and the effective diversification of investments (Markowitz, 1952).

1.6 Portfolio risk

Volatility and beta both are the means to measure the risk. The market beta is 1.0, while the beta of stocks that fluctuate more (less) than the market are greater (lower) than 1.0. Higher beta stocks are expected to be riskier but should provide higher returns. Low beta stocks have less risk, but in turn should prove lower returns.

Beta is the percentage change in an asset's return, given a 1% change in the market portfolio. It is the measure of the sensitivity of an asset's return to the return of the market

portfolio. Beta is a measure to calculate the systematic risk involved in owning any particular asset. The unsystematic risk can be diversified with a large portfolio (Tofallis, 2006).

1.12 Market efficiency

An efficient financial market is a market where securities prices improve rapidly as new information becomes available. Therefore, the current price of securities reflects all information about the securities. According to this, shares are always traded at a fair value, and it is impossible to beat the whole market (Markowitz, 1952).

Chapter 2: How robo-advisors work and differ from each other

2.1 Robo-advisors

The first robo-advisor came into light after the 2008 financial crisis, when investors preferred low-risk portfolios and were fearful of financial shocks. This post-crisis environment translated into low-interest rates and thin returns on active investment. This drove investors to shift from active investment to passive investment and shaped request for a more automated and inexpensive method to assortment organisation. One important innovation to the industry took the shape of robo-advisors, such as Wealthfront and Betterment. These were mostly inactive automatic advantage distribution and portfolio management using ETF's (Schwinn, 2018). Figure 1 analyses the emergence and maturing of robo-advisors and review these along with the traditional human-advisor-based firms and their adoption of technology advances. The incumbent firms are exploring and investing in sophisticated tools and technologies such as advanced analytics and AI to provide a richer toolkit for the advisor and enabling a more insightful experience for the customer.

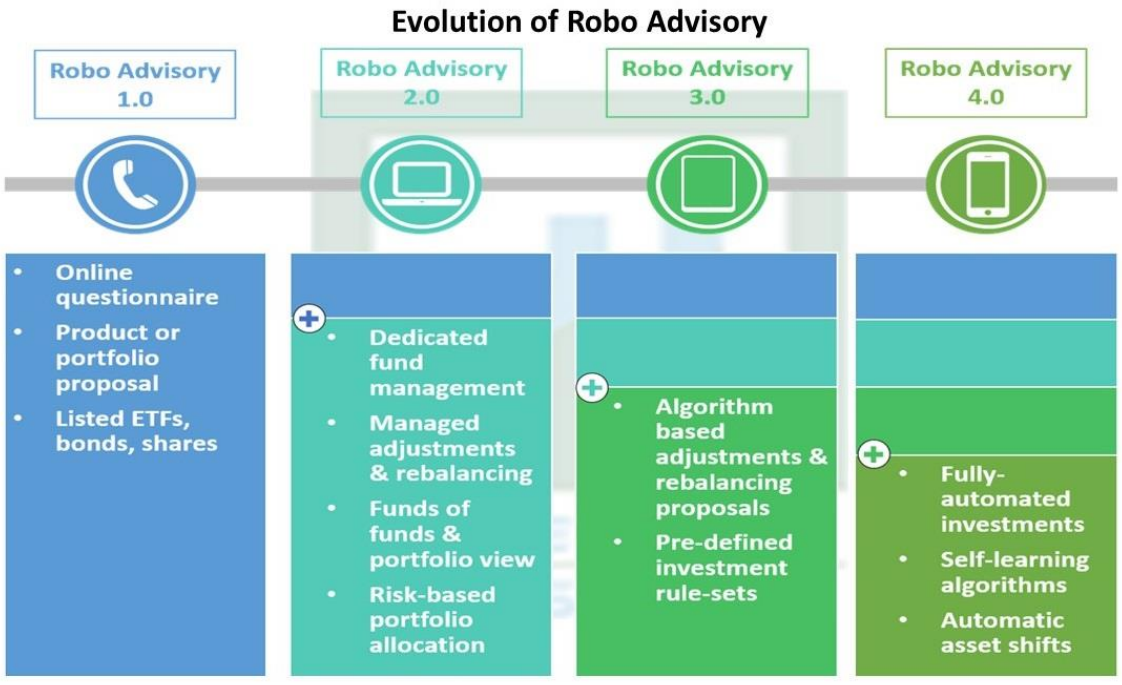

Figure 1. Evolution of Robo-advisory

Source: (Deloitte, 2016).

2.2 Pure vs Hybrid Advisors

Financial technology (FinTech) has revolutionised numerous harvests offerings in the monetary service industry. One of the various interests of this technology is providing investment recommendation through online platforms. These are the human-assisted computer programs conducting automated research analysis called robo-advisors (Coleman, 2020). “Robo-advisors” are a class of monetary consultants that deliver monetary information or organisation online with negligible human interference. Robo-investing is one such way to invest online. A “robo-advisor” is a website or app set up by a company to help manage investors’ money. It is a low-cost, simplified way of investing, where a computer does much of the work for investors, matching their risk profile. These online advisors use algorithms and device cookies from the behaviour millions of users to generate a single set of advice for an investor. Robo-advisors can also make decisions keeping in mind certain techniques used to predict future trends.

Research indicates that robo advisors’ recommendations differ from the traditional human investment advisor significantly over several dimensions. Portfolios shaped on the buy, hold and sell endorsements of robo-advisors seem to overtake those of human forecasters, hence are more profitable (Britannica, 2020). Firstly, robo-advisors cooperatively harvest a more composed delivery of buy and sell recommendation with being less subject to behavioural prejudices and conflict of interest than a human advisor. Robo-advisors are programmed to follow strict rules with limited human review; their models and recommendations tend to be more consistent, less susceptible to behavioural biases, random errors and faceless conflict of interest. Robo-analyst firms issue recommendations that are substantially more negative than traditional analysts’ recommendations. For a given stock, robo-analyst firms are 14% less likely to have an outstanding buy recommendation and 16% more likely to have an outstanding sell recommendation than are traditional analysts (Coleman, 2020).

Secondly, a robo advisor is better equipped to perform greater in-depth research, and revise their recommendation more frequently than a human advisor. Their recommendation relies less on earning declarations and more on large volume data unconfined in firms' annual reports. Though robo-advisors are less likely to include subjective or non-financial information into their examination such media reports, press conferences or information with no subjective source of information. However, robo-advisors possess the potential to analyse

a large amount of data and generate more objective-based recommendations than traditional advisors at low cost. Robo-analysts gather and analyse enormous capacities of monetary intelligence and integrate details into their representations more speedily and totally than outdated analysts, who face intellectual restraints such as incomplete courtesy, exhaustion, and other prejudices (Coleman, 2020). However, Robo-Advisor reports in the short run market reaction may be less prominent than traditional analysts. Due to this, the investor may suffer from a bias known as algorithm aversion.

A pure robo advisor is the concept of the future, with no direct human involvement. A pure robo advisor will work on pre-defined algorithms - machine learning and Artificial Intelligence - based on widely accepted investment theories. This concept of robo-advisory is still hypothetical, and much efforts and time are needed for it to become a reality. In the future, when robo will be able to read and analyse the trends to decide on their own to make a financial gain, and can thus set long-term and short-term objectives (Coleman, 2020). Hybrid consultants combine digital algorithms and human investment advisors. In hybrid scenarios, the financial advisor can interview the client and decide which robo advisor is right for them. Some automate the investment process, the cost of hybrids is lower than that of traditional advisors, but they still offer the opportunity to discuss with a financial advisor.

2.3 How does robo-advisory work?

The existing robo-advisors offer customised portfolio composition for wealth building and retirement plan. The customer assortment arrangement is originally founded on limits like age, superannuation timeline, risk appetite, available assets, annual income and investments goals (Schwinn, 2018). Portfolios are reweighted mechanically on an on-going basis—different robo-advisors target different advisors based on their algorithms. Depending on the information given, robo-advisors can decide to reinvest the dividends and yields accordingly. The investment methodology of all investment advisors can be abridged as including three separate steps: Asset allocation, Implementation, and Leadership and balance, presented in Figure 2:

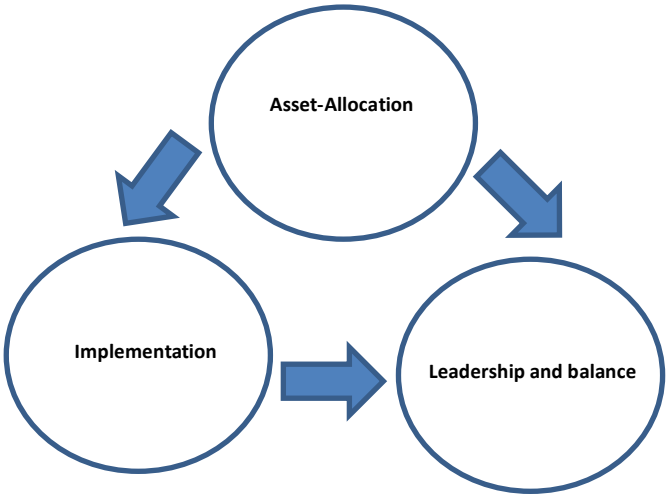

Figure 2. Investment Methodology

Source: own elaboration.

These are discussed below:

1. Asset Allocation

Asset allocation is the process of deciding how to share investor convenience for investing between different countries and asset classes. Asset categories include securities with similar characteristics, features and risk/return ratios. Large asset classes, such as “bonds”, can be divided into smaller asset classes, such as government bonds, corporate bonds, and high-yield bonds (Brown, 2012). Most allocation methods are based on the investor's policy evidence (investor goals or objectives, investment wishes and guidelines). Robo consultants typically use mean or variance analysis for variance analysis of average assets. The average error detection curve is a method of balancing risk and benefit. Robo-advisors' customers can withdraw money at any time, depending on the circumstances, which limits robos’ investments to liquid assets. Thus, mechanical asset management excludes asset classes such as real estate and private equity, as they block funds for a long time and are not easy to trade.

Because robo-advisors negotiates with many investors to develop portfolios for different purposes, it can develop different sets of asset classes for taxable and deferred tax accounts. The asset class can be selected according to the role of the asset class in the investment portfolio. For example, they may be added to the portfolio due to U.S. share capital growth,

long-term inflation protection and tax efficiency. Index-linked bonds can be selected due to high yields, historically low volatility, and diversification and inflation protection. In each asset class used to create the asset portfolio, the robo advisor evaluates the expected return, variance, and correlation.

2. Implementation

Once robotic advisors have chosen an active margin portfolio, they choose a swap fund to represent each asset class, focusing on how ETFs contribute to cleaner after-tax offers and risk-adjusted portfolio. Many robo consultants use algorithms to collect tax losses daily. Tax collection is a method of selling marketable securities and using the proceeds to buy highly relevant investments. By realising capital losses and exploiting the differences between short-term and long-term capital gains taxes, the portfolio receives additional profits through the relationship between tax savings (including tax claims) and the tax rate arbitration.

3. Leadership and Balance

Wealthy advisors monitor the portfolio and can use a variety of long-term and short-term policies. To maintain investment economics, robo consultants typically use a refinancing-based threshold (as opposed to temporary refinancing). This means that if the weight of the asset class differs from the allotment of limits by a certain amount, the algorithm performs the transactions necessary to automatically, return the asset allocation to the destination. For example, if there is no inflow of funds into the fund and no cash outflows from the investment accounts, the sale of excess asset classes reduces the purchase of asset classes from the total volume of the low-portfolio asset portfolio. The distribution of the investor's goals may also change over time. For example, a portfolio that investors can take on plays a positive role in the calendar. Over time, the length of investors decreases and forces robot advisors to adjust portfolio risk. The risk tolerance and objectives of an investor's investments may also change over time (Kaya, 2017). Investors can usually report these changes via the robo-advisor web platform and adjust the target distribution accordingly.

2.4 Open Issues in Robo Advising

Robo-advisory is still a new concept and is under development. It has both positive and negative properties. However, the unprecedented and rapid development of algorithmic

advisors has also raised a number of issues that are still open to researchers, practitioners and regulators (Facundo Abraham, 2019). These problems need to be addressed and need the attention of researchers in the fields of finance, economics, law, social psychology and philosophy.

1. Specific areas of international robo advisory

Cost-effective use, cost, and investment studies have, from the outset, proving the accuracy of asset allocation over a lifetime. Integrity consists of two aspects: (i) the optimal allocation of resources in different areas, such as the allocation of assets for the payment of mortgages, student loans and pension savings throughout life; (ii) human and educational resources best installation. Designing an international robo consultant is a challenge. For the most part, there are still no personal procedures for individuals. Most current robo consultants divide users into broad categories related to risk aversion, age, and other demographics. Users in the same category receive the same advice, although their preferences may differ. The purpose of identifying the most important actions can reduce the scale of this problem. In addition, machine-learning methods can be useful for gaining access to individual functions, which explains further differences in investors' return on investment.

If the investor's financial situation is poor and economic preferences and opinions cannot be communicated consistently, further research should provide additional support to robotic advisers for any function. Most current robo consultants focus on only one or a few limited areas, which can be catastrophic. Another experience is the design of methods for analysing data mining in machines to simultaneously, analyse multilateral information covering multiple aspects of a person's financial performance. Multiple integrated data analysis systems can produce a single proposal.

2. Algorithmic Aversion

People use Google Maps to drive their cars, but will people trust algorithms to make investments? Compared to older consumers, the younger generation is more likely to receive digital advice, and one of the reasons is that the younger generation is more protected from technology. So convincing the older generation with the most assets to use robo consultants is a challenge (Huang, 2018).

2.5 What are Legal and Ethical Morals for robo-advisors?

U.S. lawmakers require robo advisors to register under the Investment Advisers Act 1940. Registration indicates that the robo consultant is a trustee. However, most robo consultants do not provide comprehensive financial advice, but are based on self-assessment questions that make people doubt whether robo consultants are able to perform the due diligence required to perform their nursing duties. Moreover, robo-advisors at the time of investing require some sensitive personal data and information. Robo-advisors are entrusted with the personal information, which may end up in wrong hands that investor is unaware of the importance of this information.

2.6 Existing leading robo-advisors

Although most robo-advisors work on the same overall speculation approach discussed in the preceding chapter, important alterations still occur. This section will cover a detailed analysis of existing robo-advisors based on investment frameworks of asset allocation and implementation.

1. Vanguard Personal advisor

Vanguard's largest robo as of September 30, 2018, Pioneer Robot Advisors managed $112 billion in global assets, and served more than one million investors worldwide. To use Vanguard's personal advisor service, investors must start with at least $50,000. Personal advisory services select funds from more than 100 Vanguard investment funds and ETFs based on clients' personal investment goals. Fees collected by Pioneer Personal Advisory Service account for 0.30% of asset management. These fees are at least $ 150 per year (Utkus, September 2019).

2. Charles Schwab

"Charles Schwab Corporation" is the 14th major investment foundation in the U.S. with over US$3.3 trillion in customer properties. Schwab's robo-advisor amassed $41 billion in assets under management (AUM) as of June 30, 2019 and earned a second-place to Vanguard's $115 billion AUM, in the competitive robo-advisor field. The Schwab Intelligent Portfolio requires a $5,000 account minimum. Schwab Intelligent Portfolios Premium fee is based on a subscription model. After a $300 set up fee, the cost is $30 per month, regardless

of the size of the portfolio. Schwab robo-advisor platforms invest money in exchange-traded funds from a pool of 53 choices, representing 20 asset classes. Every investment portfolio has from 6% to 29% in the cash asset class, depending upon the asset allocation (Mercadante, 2020).

3. Betterment

John Stein launched a better offer in 2010. Originally thought to be too simple, it has evolved to meet investor expectations and now has more than 400,000 customers and more than $ 16 billion in assets under management (Securities and Exchange-Review.com, 2020). Patches are one of Robo Advisor's largest independent Internet platforms. For digital accounts under $2 million, the fee is only 0.25% of the fees, while the management fees for other assets are zero. The proposed improvement also proposes an advanced plan that requires a minimum investment of $ 100,000 and collects 0.40% of assets under management (Barbara A, 2019). The client's investment portfolio is based on variables such as age, retirement plan, annual income and investment objectives. The second operation is the automatic reinvestment of dividends. Most of its clients have net assets of $ 100,000 (Schwinn, 2018).

4. Wealthfront

Wealthfront Inc. is an investment services company based in Palo Alto, California, founded in 2008 by Andy Rachleff and Dan Carroll. In January 2019, Wealthfront's assets under management exceeded $11.4 billion. The account management fee is 0.25%, although the initial $5,000 investment is managed for free. Wealth front invests 11 results in asset class swaps (portfolio includes 6-8 properties). For customers with a taxable account of at least $100,000, Wealthfront also offers an equity fund called a Wealth Risk Equity Fund. Wealthfront provides daily tax receipts and payments for all taxable accounts (Coombes, 2020).

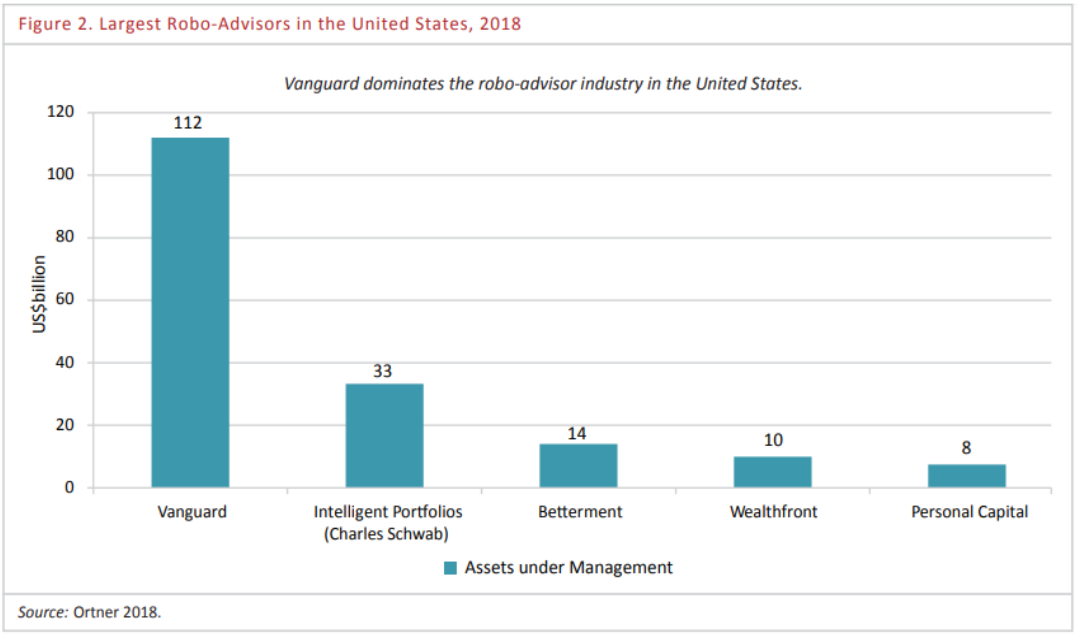

Figure 3. Top Robo-advisors in comparison to Asset under Management

Source: (Abraham, 2019).

2.7 How robo-advisors differ from one another based on investment framework

Investment advisers may have the best investment practices from different perspectives, comply with different regulations and respond differently to incentives and conflicts of interest. These differences range from asset class definitions to investment risk measurement, as well as conflicts of interest between robot advisors and their subsidiaries.

1. Asset Classes

Robot consultants have different ways of defining asset classes based on subsidiaries. Most of the equipment offered by AI invests primarily in equities and bonds, but the level of asset classification in several subgroups. For example, Schwab's smart portfolio divides many U.S. equity asset classes into small and large equities into the United States, reflecting their belief that size is an important distinguishing feature. Charles Schwab's platform selects swaps from 53 options representing 20 asset classes, but Betterment distinguishes between value and interest rate equities due to its presence in domestic and foreign markets. Wealthfront invests money in 11 different asset classes.

Dividing asset classes by these characteristics contradict the analysis of average variants of different asset classes. Each activity increases moving goals based on different key

characteristics. As there are no restrictions on the division of asset classes into asset classes, defining asset classes based on the different characteristics of asset classes can further increase their value. As the number of asset classes increases, the function of maximising errors becomes easier when maximising the average variant. In an analysis of the increase in asset classes, it is probable that some asset classes will have higher positive errors in the estimated return or larger negative errors at the allotment date. Indeed, many asset classes and their inevitable valuation errors under financial market assumptions ensure that maximising average variability without minimum and maximum limits for each asset class results in a meaningless allocation of assets. Without minimum restrictions, some asset classes cannot be divided (PUHLE, 2019).

Robo consultants can invest to some extent in foreign bonds. Advisors may argue that the ability of foreign bonds should improve portfolio diversification (Lam, 2016).

International real estate investment involves brokering between diversity and expected returns. Real estate has special characteristics of income and equity. Fixed income refers to the fixed contractual lease benefits offered by the lessee to the owner, but the equity ratio is deducted from the residual value of the asset. With the current lease, the holiday profit and the loss on the sale are uncertain. Investors who choose to invest in international real estate may reasonably forego a new market, as they often have weaker legal and less stable political systems that could jeopardise the security of their investments. In addition to Schwab, Wealthfront and Betterment, Schwab is the only robo consultant to invest in international real estate.

2. Estimated mean square error input

Robo consultants differ significantly from the level of the Black-Litterman model. Schwab's seems to completely ignore the Black-Litterman model, but Betterment relies entirely on maximising market reversal when making its forecast revenue forecast and refuses to confuse its view with indirect market equilibrium returns. Robo consultants who do not rely solely on indirect market returns in a balanced market typically use historical returns, interest rates, credit spreads, dividend yields, growth, and other macroeconomic variables to estimate expected long-term returns (PUHLE, 2019). For equities, robo consultants can use Gordon's growth model to create their own projected earnings forecasts. Gordon's growth model is a

special case of the dividend discount model, which assumes that the value of the company's shares is the present value of all future dividends. Schwab's and Wealthfront's smart portfolios use Gordon's growth model to provide a view of projected stock returns. For example, Schwab first assessed the market risk premium for large U.S. equities. To do this, it calculates the difference between the historical average return on large shares capitalised in the United States and the historical return on risk-free assets.

Schwab's portfolio analysis is based on mean-variance with full optimisation. This approach can combine the investor's choice of loss-making and consider all the features of the income distribution, such as the mean and kurtosis. Full optimisation takes these higher moments into account through historical results. Schwab has taken this approach because research shows that investors experience twice as much psychological pain from a loss than from a gain.

3. Financial risks and targets

Some robo consultants use portfolio-based goals, while others focus on choosing the best portfolio for their overall investment. Schwab and Betterment optimise the portfolio to meet each investor's goals, while Wealthfront optimises more general portfolios. Schwab's investment goals and the Betterment platform are anything from earning retirement income to creating prospects and saving money. Proponents of an objective approach believe that asset allocation can improve psychological accounting and allow investors to identify different levels of risk and different risk factors for each subclass. Systematic investment also allows investors to adjust the distribution of assets. The opposite view is that it is difficult for investors to explain their goals (JungFlorian, 2019).

4. Risk Measurement

Each robo consultant has a different risk measurement method. This includes various measures to gather information from investors according to their objectives. Charles Schwab uses questionnaires to obtain a comprehensive overview of investors' objective opportunities and their subjective willingness to support objective and subjective risk tolerance. By asking specific business questions (concerning retirement and investment goals), they can better gauge investors’ risk tolerance. By asking questions about behavioural habits (such as what investors could do after a major investment loss), the firm better understands the investor's

willingness to take risks. Investors classify results according to the level of risk tolerance and risk appetite and as an average of two points to determine the appropriate levels of risk that individuals should bear. When risk-taking skills are compatible with risk aversion, the task of an investment adviser is the easiest. If the risk aversion is moderate, and the risk aversion is moderate, the adviser must provide investors with relevant information to make this clear. Although Schwab does not ask customers about the total value of their current assets or their annual tax revenue, it does ask when investors intend to use the funds for each purpose.

Pioneer has a stable framework for analysing objective investment opportunities and subjective willingness to analyse objective and subjective risk tolerance. Pioneer asks investors to determine the value of their portfolio. Vanguard examines the financial and emotional value of investor guidance using three sets of values. Monetary value assesses an investor's ability to achieve desired goals, including pension plans, cash flows, debt levels, spending habits and legacy plans, and has no intended emotional value and should not be assessed by quantitative measures alone. It also has subjective or qualitative aspects based on the client's emotional connection, the investor's confidence and the investor's perception of financial success or success. Based on these qualitative and quantitative data, Vanguard analysed the measurement of individual investors' risks. The pioneer robo advisor has setpoints for each problem so that risk-averse clients receive accurate information.

Wealthfront assesses investors' subjective risk tolerance by asking clients whether they focus on maximising returns, minimising losses, or both. It also raises a theoretical question about how investors react to a market downturn. The general wealth risk indicator above is a weighted combination of subjective and objective risk measures, with the component being given a higher weight, indicating increased risk transfer. Although the change does not appear to include subjective risk, tolerance measures in portfolio selection, for each goal, Betterment builds a "track" that determines the recommended asset allocation. In most cases, the proposed allotment is only the investor's maturity limit, except for a decrease in the purpose of the runway.

The key aspects of the major US robo-advisors are summarized in Table 1:

Table 1. Comparison of major robo-advisors

	Vanguard Personal advisor	Charles Schwab	Betterment	Wealthfront
Management fee	0.30%	0%	0.25%	0.25%
Minimum account balance	$50,000	$5,000	$0	$500
Structure of portfolios	"Personal Advisor Services" chooses funds from the over 100 Vanguard mutual funds and ETFs based on the individual investment objectives of the client.	It was built from up to 53 ETFs covering as many as 20 asset classes; larger cash allocation than other services. Income- and domestic-focused portfolios available.	Standard portfolio uses ETFs from about 12 asset classes. Socially responsible investing, smart beta and target income portfolios available. Ability to adjust the percentage of the portfolio in each investment.	ETFs from 11 asset classes (portfolios generally consist of 6 to 8). Individual stocks held in larger accounts.
Tax issues	Assets are allocated strategically among taxable and tax-advantaged accounts to optimise for taxes. Tax-loss harvesting done on a client-by-client basis.	Tax-loss harvesting is free with a $50,000 minimum balance.	Daily tax-loss harvesting on all taxable accounts.	Daily tax-loss harvesting on all taxable accounts.
Rebalancing	The service is available here, but it isn't automatic.	Free automatic rebalancing on all accounts	Free automatic rebalancing on all accounts	Free automatic rebalancing on all accounts
Customer support	Customer service hours are Monday to Friday, from 8 am to 8 pm Eastern time.	Phone and live chat support 24/7	Phone and email support Monday-Friday 9 am-6 pm.	

Source: own elaboration.

Chapter 3: A critical analysis of the robo-advice industry

3.1 SWOT analysis of the robo-advisory industry

In this chapter, I perform a SWOT analysis, which serves as a methodological tool to investigate tactical rudiments of the present robo-advisory marketplace. The purpose of the SWOT analysis is to critically analyse the advantages of robo-advisory and to show how robo-advisory can transform existing financial advisory.

3.1.1 Strengths

I identified three major strengths of robo-advisors, which I discuss below.

Lower commissions and minimum investment

One of the main advantages of robot consultants is the lower fee structure and minimum investment requirements. For example, in the U.S. market, the minimum investment in robo consulting services starts at $0, depending on whether there are caps on mechanical consulting. In addition to the fact that robotic consultants invest mainly in ETFs, which usually involve low costs than the benefits of the organisation, the costs are also significantly reduced. Studies have shown that the cost structure of many robotic consultants is regression and inversely proportional to the size of the investment (i.e., the higher the investment, the lower the cost ratio and vice versa) (Jung et al., 2019). Weak robo consultants and the lowest minimum investment have actually changed the rules for financial advice - the fees charged by a regular consultant are 1 to 3% of the value of their portfolios.

Recovery of tax losses

Another key element of robots' tax advice is an effective tax collection mechanism. The aim is to sell securities at a loss, collect the proceeds and buy other assets with a strong positive correlation. Then you can realise and eliminate capital losses along with other capital gains to achieve tax savings. Investors involved in tax collection benefit from it in two ways. First, tax savings can be reinvested to reach a conclusion that includes tax savings. Second, due to the different tax rates for long-term and short-term financial income, tax rates can be discussed. Most robo advisors use ETF-based tax incentives to buy and sell highly relevant ETFs. Consultants such as Wealthfront are looking for a more effective approach, applying the term

"direct indexation", when buying and selling ETFs, rather than the individual stocks on which they are based, provide higher returns. Long-term investors mostly use tax collection, as tax issues can be purchased without purchase. In addition, profit from tax losses is limited to countries with different tax rates and short-term profits.

Digital investment experience

Robo advisors' digital approach has an advantage over ease of use. In the age of technology, this concept of robo consulting seems promising. It is designed for millennia and people with a strong connection to technology. In addition, due to the transparency and graphical presentation of the consultant's website, users believe that they can understand the offers without any doubt, that they can easily access the platform and are affordable. Minimise emotional decision-making: Robot consultants are guided by emotions rather than algorithms. When the market rises or falls, robo consultants should prevent them from making "bad" choices and help maintain a stable level of risk. According to the Vanguard report, robo advice maybe 3% higher than regular retail investors, in part because professional investors have little emotional motivation.

3.1.2 Weaknesses

Conflicts of interest

"The FINRA report" (FINRA, 2017) calls on clients involved in robot consulting to point out that robot consulting does not necessarily eliminate conflicts of interest in personal financial advice, as robot consultants have relationships with clients. Affiliated securities brokers, cashiers, administrators and other companies provide automated investment services to their clients. There may be conflicts of interest in the investment advice received, which may call into question the objectivity of the investment advisers provided by the robo advisers.

Poor risk tolerance and lack of specialisation

The advisory robot evaluates the investor's risk analysis based on a completed questionnaire. In general, the questionnaires used to determine a personal investment policy do not take into account personal goals and may be based on additional incorrect assumptions, incomplete information or circumstances that are not relevant to investors. The questionnaire may contain prejudices and does not take full account of investors' intentions.

Incorrect assumptions can lead to incorrect data that may not meet personal needs (Jung et al., 2019).

No personal relationship required

One of the main roles of robo-advisors is that personal counselling is no longer required. This has reduced costs and advised a wider range of clients, but some investors are sceptical about the technology. This is especially true for asset management, as rich clients dominate, and personal communication seems to be more important.

3.1.3 Opportunities

Digital services are everywhere

The financial and asset management sector is under constant demographic and technological change. As a result, consumer behaviour is also changing. People can connect extensively anytime, anywhere with smartphones, tablets, laptops and other devices. The younger generation, in particular, is growing up in technology, so they are getting used to technology. Today, the digitalisation of everyday life has laid the foundations for robo consultants to create a good foundation for markets characterised by traditional asset management and asset management organisations. Robot consultants need to open up many new markets and potential customers. Robo advice is not widely available outside the U.S. and Europe. Standardisation and integration: The asset management sector is large and diverse, but currently, robo consultants are only concerned with refinancing assets and allocating assets. It is difficult to standardise complex resource management services. However, there are still opportunities to standardise and integrate more sophisticated services that can be attractive to clients who now rely on traditional personal consultants.

3.1.4 Threats

Competitive environment

In the face of the future threat that all robo consultants face in the market, there is an intense competition that they face. There are about 200 robo consultants in Europe alone (Huang, 2018). Nevertheless, these robo consultants still compete in the internal market, protected by regulations, investment practices and other barriers. Once barriers have been removed and international standards have been set, some advice from small businesses on robo cannot

stand up to large ones. In addition, the relative importance of independent robotic advisory activities is slowly declining as robotic advisors are provided by other financial institutions, such as depositors and brokers. Some traditional financial management companies, such as Vanguard and Schwab, have integrated robo-advisors into their business models. Schwab is the first company to use a mixed approach. Despite increased competition, this development has also strengthened the credibility of robot consultants. Traditional strong consultants join the field of hardware consulting (such as Schwab Intelligence). They can replace smaller robo advisors.

Potential threats from regulators

Many authorities and individuals have recently raised concerns about the regulation of digital investment advice for a number of reasons. Advisory consulting manages wealth based on algorithms, and very sophisticated technology makes it difficult to control. There is still a lot of work to be done in the field of robotic consulting services, so companies need to pay close attention to changes in the law and regulatory environment. In addition, network security issues need to be addressed, as the sensitivity of personal information needed to provide personalised advice automatically is more important than ever.

Network security and data protection

Robot consultants are fully automated platforms that are typically connected to cloud services, which can cause some network security issues. An increasing number of non-governmental robo consultants may be challenged in their network security practices (Levin, 2020). Impact of the recession: Robo consultants have been ubiquitous since the 2008 recession. Many investors are concerned about the work of robotic economic advisers. Some researchers believe that because robot counsellors are not emotionally motivated, they work well, but the problem still exists. For example, following the outcome of the 2016 Brexit referendum, many investors quickly moved forward and sold their positions recklessly, losing the opportunities that followed the recent recovery in stock prices. robo-advisors avoid this situation because they adhere to predetermined risk levels, distribute themselves between specific assets and asset classes, and do not panic in similar situations. This may be an option for robot consultants. The question of the success of robot advisers in the event of a major market downturn (as in the 2008 financial crisis) remains unresolved (Metinkomar, 2017)

3.1.5 Summary

The strengths, weaknesses, opportunities and threats of robo-advisors are summarized in Table 2.

Table 2. SWOT analysis

	Strengths • Lower commissions and minimum investment • Recovery of tax losses • Digital investment experience	**Weaknesses** • Conflicts of interest • Poor risk tolerance and lack of specialisation • No personal relationship required
	Opportunities • Digital services are everywhere	**Threats** • Competitive environment • Potential threats from regulators • Network security and data protection

Source: own elaboration.

3.2 What is the future of robo-advisory?

The robo-advice industry is still in its infancy, so few studies have reported its different effects on the financial system (including asset markets). Due to low cost and easy access, robo advisors can contribute to more complex human investment practices. Robo consultants may attract low-income or younger people because they have low volatility and may not invest. The most important effects on the industry, however, will come from capabilities which have not yet been released to the market, but which are logical extensions of existing Robo-advice capabilities. In addition to cognitive computing, these include the addition of investments other than ETFs, such as fixed income, hedge funds and real estate. Proper management and monitoring are significant keys to the success of robot researchers. Policymakers will benefit from the establishment of good practices that ensure the objectivity

and transparency of robotic advisors according to the needs of each client. Tutors have begun to develop guidelines.

Robo-advisors have already had a significant impact on the wealth management industry. The most important effect will come from capabilities, which have not yet been released to the market but are the logical extension of robot-capabilities. Estimates for the future of robo-advisory market by several well-known institutes predicts between $4.2 trillion and $5.5 trillion in assets to be managed with the support of robo-advisory services in 2022. By the year 2025, this figure is expected to rise to over $16 trillion in assets under management. Future proposals will be made digitally, and 40% of respondents will agree to use automated counselling services. This relationship can be expected to increase in the future as the new generation is more likely to adopt automated counselling services. The future of robo-advisors will be affected by the following aspects, as described by Brown (Brown, 2012):

- **Scalability and geographic distribution**: Most of the U.S. robo-advisors limit their services to the domestic market. This is because of differences in the regulatory environment, investor protection, compliance requirement and taxation rules. Terms of service must be analysed, as there are both differences in terms of taxation and services offered. Although the U.S. is the largest consumer market with huge growth potential, limiting to a single market does not lead to economies of scale.

- **Product mix:** In the U.S. and Europe, the increase of cost-efficient crops like, ETFs have resulted in wide investor acceptance. In the future, we might see further diversification into other asset classes like ETCs (exchange-traded commodities), foreign exchange products and real estate investment trust.

- **Customer demography**: Robo consultants still seem to be struggling to attract wealthy investors, including the wealthy (those with more assets). Despite the strong attractiveness of mobile services and automation for millennia, there is still a tendency to need highly qualified personal consultants. Robo consultants need to offer attractive service products to attract investors that are more affluent.

The Customer demography of Robo advisors according to different criteria is elaborated in Figure 4. There is very limited information about the European Clients: Figure 4 analyses information about Italian clients, broken down according to gender, education, financial literacy and wealth.

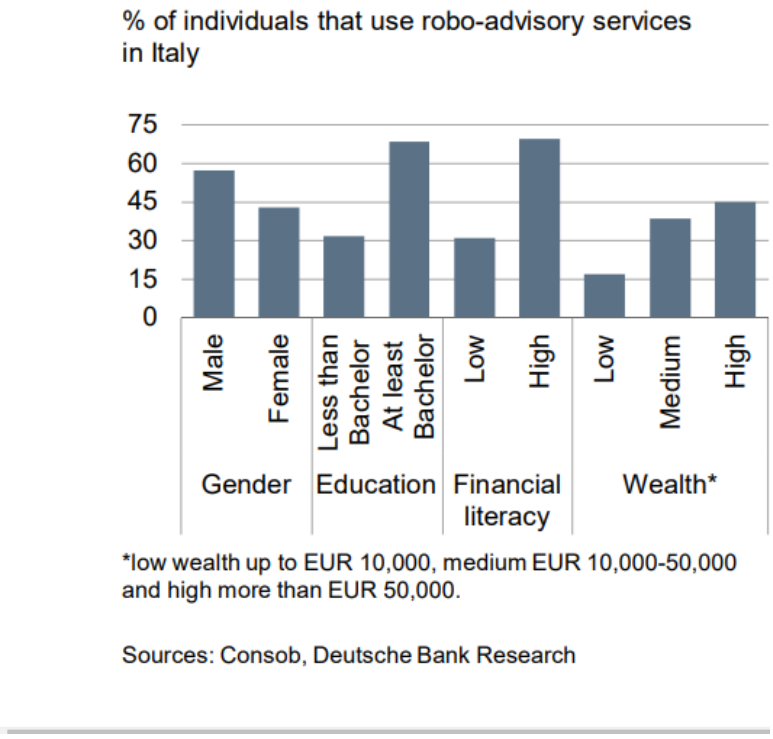

Figure 4. Demographics of robo-advisor's clients

Source: (Kaya, 2017).

Conclusion

Robo-advisors are still in the development stage. Their emergence does not mark the end of traditional investment advisors, as the two may work together. The cost of a robo-advisor is relatively low, as is the minimum balance of an investment account, which means that they can meet the needs of people who cannot afford the usual advisory fees. The development of artificial intelligence shows that the integration of these services with traditional full-service banks, securities firms and asset management companies should happen soon. In the future, robo-advisors are expected to be better in identifying individual differences in risk-taking, the advice provided and other aspects of financial management. As younger investors age so will the importance of the robo investment industry. However, before that happens, many aspects of robo counselling still need to be addressed. For example, it will take some time for government agencies to properly regulate this industry.

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