Robo-advice – a true innovation in asset management

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Robo-advice is a fast-growing application of financial technology (FinTech) solutions to asset and wealth management. Thanks to their user-friendly and automated processes, low-cost portfolio management and solid performance, robo-advisors are posing a challenge to traditional financial advisory services.

Digital client onboarding is probably the most crucial step in robo-advice, and it is also extremely convenient and efficient. However, it could become overly simplistic in certain cases. To improve its accuracy, hybrid services that combine the features of both robo-advice and traditional financial advice could be beneficial.

To provide diversified and low-cost investment solutions, robo-advisors mainly invest in ETFs. They take a relatively conservative approach in ETF selection, and the final set of available ETFs comes down to ~3-6% of all investable ETFs.

Robo-advisors create client portfolios using algorithms based on mean-variance optimisation. In addition, they automatically rebalance portfolios to maintain targeted asset allocations and provide tax-efficient solutions through tax-loss-harvesting. Too-frequent rebalancing or tax-loss-harvesting, however, can be detrimental to long-term investment goals.

In the US, robo-advisor start-ups' AuM saw an 8-fold increase in recent years on the back of some retirement savings shifting to robo-advisor accounts. European robo-advisors' AuM is only some 5-6% of that in the US. They might benefit from greater interest from institutional investors, though. The market is becoming a tough place for business-to-consumer robo-advisory start-ups. As a result, there will probably be partnerships and takeovers by established asset management firms or banks in the coming years.

Millennials were among the first robo-advisory clients. Recently, wealthier and more educated clients in their 40s and 50s also seem to have been entrusting robo-advisors with part of their portfolios.

Cost advantages have been creating significant momentum for robo-advice. Yet European robo-advisors on average charge substantially higher fees (0.8%) than those in the US (0.4%). The success of passive investment strategies in recent years together with resilient robo-advisor performance during market volatility might provide further impetus for their services. Still, robo-advisors' performance needs to be tested over a longer period.

Robo-advice is likely to contribute to financial inclusion and helps financially less literate households to invest in capital markets. If robo-advisors and their regulators can guarantee a high degree of accuracy and suitability for clients, robo-advice has great potential to complement, rather than displace, traditional financial advisors in the future.

Introduction
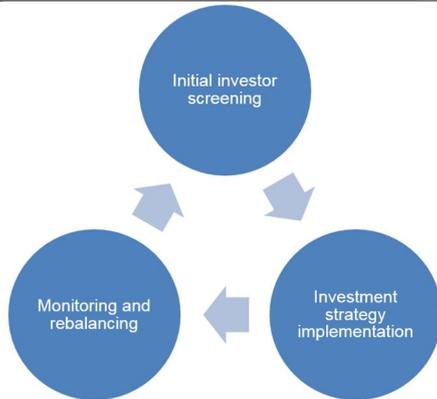
In recent years, robo-advice has become one of the hottest buzzwords in financial technology and asset management. It refers to a fast-growing new breed of digital offering that gives investors access to a basket of investment advisory services at attractive prices. In the eyes of many observers, robo-advice poses a significant challenge to existing traditional financial advisory and asset management services and has the potential to profoundly change the way financial advice is delivered. Against this background, the actual and anticipated growth of robo-advice has attracted considerable attention and requires a closer look.

In this paper, we shed some light on robo-advisory business models, investment strategies and clients, as well as the performance and supervision of robo-advisory services. Section 1 outlines the steps of robo-advice, such as client onboarding and asset selection. Section 2 focuses on asset allocation and rebalancing practices. Section 3 delves deeper into robo-advisors' assets under management, their client characteristics and performance. Section 4 lays out the potential contribution robo-advice could make to financial inclusion and discusses robo-advisory supervision.

Robo-advice steps 1

Source: Deutsche Bank Research

1. Client onboarding and investment strategies

Robo-advice in short

In a nutshell, robo-advice refers to online investment guidance and portfolio management services that are based on algorithms and models. The overarching principle is to minimise or completely eliminate human intervention and to solely utilise computer programmes to find optimal investment strategies for clients. Robo-advisors are fully automated online platforms that provide clients with digital financial advice and portfolio allocation. A typical robo-advisory process involves three steps: 1) initial investor screening; 2) implementation of investment strategies; and 3) monitoring and evaluation of these strategies (see chart 1).

Robo-advice platforms provide clients with prompt access to their accounts on user-friendly smartphone applications and websites. Clients can make adjustments to their portfolios anytime they wish to and recalibrate their investments flexibly. For example, if at some point they would like to adjust their portfolio contributions or cash out their investments, they can easily enter new information into the robo-advice platform. Clients can even recalibrate their stated preferences and thereby targeted asset allocation if needed.

Simple or overly simplified client onboarding?

The clear identification of clients' individual investment preferences is at the heart of robo-advisory (as it is for human advisors). For client screening, robo-advisors use responses to online questionnaires. These questionnaires are designed to identify clients' financial goals, investment horizons and risk tolerance (see table 2 for an example questionnaire). They are set up in the form of a decision tree. Clients answer a sequence of questions and their responses generate specific recommendations. Questionnaires are conducted upon initiation of a robo-portfolio and are not repeated regularly.

Robo-advice questionnaire example 2

1) Reason for investment
a) General savings
b) Precautionary savings
c) Retirement
d) Other
2) You need this investment starting in _____ (year) for ---- years
3) You have _____understanding of ETFs
a) good
b) some
c) no
4) When deciding on your investments, you
a) maximize gains
b) minimize losses
5) Have you ever lost 25% or more of your investments in one year?
a) Yes
b) No
6) If you ever were to lose 25% or more of your investments in one year, you would
a. sell everything
b. sell part of your investment
c. do nothing
d. reallocate your investments
e. buy more
7) Personal information about
Age, Gender, Income, Mortgage Debt, Other Assets

Sources: Lam (2016), Deutsche Bank Research

Deutsche Bank Research

Online questionnaires have a number of favourable features. First and foremost, online client onboarding is relatively straightforward and less time consuming than face-to-face interviews. Indeed, traditional client onboarding methods can be overly administrative, involving repetitive data entries and extensive paperwork. In contrast, setting up a robo-portfolio is a simple process that usually takes less than 15 minutes. Investors can upload relevant documents online and provide their bank account details for transfers so they can start investing immediately. Secondly, in an online setting, clients are able to assess and modify their investment priorities more flexibly. They do not need to call or visit their advisor to make changes to their portfolios. They can adjust the amount that they deposit, pause contributions or cash out their investments fairly easily. They can even update some of the questionnaire responses such as their risk tolerance and return expectations. That said, for long-term investors, changing investment preferences too often as a reaction to short-term market movements could be detrimental.[1] Thirdly, it is easier for robo-advisors to keep records of client communication. These records can be used to keep track of client preferences, recommendations and other necessary records. This not only improves the efficiency and transparency of client onboarding but also is beneficial for regulatory purposes.

A number of shortcomings exist in robo-advice questionnaires though. To start with, multiple-choice questionnaires usually elicit basic information about clients without a complete overview of a user's financial situation. For example, other potential sources of wealth and detailed monthly expenses could easily be overlooked in a fully automated questionnaire, but financial planning obviously still needs to take into account the investor's overall financial situation. Clients may need a complete assessment of their finances before they make a decision about their savings objectives. Secondly, the focus of one-size-fits-all questionnaires might be too narrow or the questionnaires could be overly simple. For example, if two investors want to take out precautionary savings ("saving for a rainy day"), one could have a potential labour income shock in mind while the other wants to save for health-related risks and unavoidable expenditures. Putting both in one basket may lead to the same portfolio allocation with potentially different saving targets. Thirdly, questionnaires assume ex-ante that investors with similar underlying characteristics will respond to subjective questions similarly. However, the subjective responses of individuals may involve what is referred to as "response bias", which could be misleading for machines. For example, if there are two investors with objectively similar understandings of ETFs, one might think that she has "some" understanding of ETFs" while the other characterises that same understanding as "good" due to overconfidence. Incorrect assumptions or incomplete information, which cannot be recalibrated by robo-advisors per-se, could lead to inadequate recommendations. Of course, these shortcomings can be minimised by employing much longer and more detailed questionnaires. But this could lead to a fourth shortcoming: the potential inaccuracy of responses in an online questionnaire due to respondents losing concentration or attention. It is very difficult to control whether a prospective client is being careless or is too impatient to answer a lengthy online questionnaire.

There are different ways to partially reduce the above shortcomings. To inform investors about financial planning in more detail, explanatory videos could prove helpful. For example, videos that explain the cornerstones of modern financial theories or certain risk concepts could familiarise robo-advisory clients with investment principles and thereby improve the accuracy of online questionnaires. A *vignette question*, a widely used methodology in the social sciences, could reduce the response bias problem (see box 3 for a definition

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Vignette technique | 3

A vignette is a short description of a hypothetical financial situation or decision designed to simulate key features of a real-world scenario. Usually, vignette respondents are asked to evaluate hypothetical people on the same scale that they would assess their own situation. Respondents thus provide an anchor that fixes their own assessment of a predetermined financial situation or decision. These anchors can then be used to make subjective assessments comparable across respondents.

Some examples are:

¾ Patricia is a single mother and has a child. Her net income is EUR 1,300 per month.

How satisfied do you think Patricia is with her income?

Answers on scale from 1 (very satisfied) – 5 (very dissatisfied)

¾ Oliver has been unemployed for five years. He has difficulty making ends meet and would like to start working as soon as he can.

How happy do you think Oliver is with his employment situation?

Answers on scale from 1 (very happy) – 5 (very unhappy)

¾ Alice likes extreme sports so much that sometimes she risks her health.

How reasonable do you think Alice's behaviour is?

Answers on scale from 1 (very reasonable) – 5 (not reasonable at all)

Sources: MEA (2011), Deutsche Bank Research

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[1] In some cases, clients need to liquidate their investment if their risk tolerance has changed and thereby face the associated costs of selling and re-investing.

and some examples). With vignettes, individual investor responses to subjective questions can be re-scaled and profiles can be set up accordingly.

Even though it is possible to overcome some of the shortcomings of digital onboarding, full automation would still entail gaps and weak spots. To improve digital client onboarding in general, hybrid services that combine the features of robo-advice with traditional financial advice could prove beneficial. Such a hybrid solution – combining the strengths of both algorithms and human advisors – is called bionic advice. A bionic advisor that interacts with the client over an online portal to discuss investment needs in detail would probably take more time than a fully automated setting, but could ultimately provide a more accurate, customised assessment.

Robo-advisors invest in ETFs
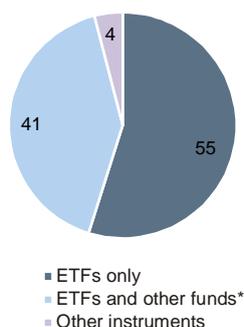
Implementation of investment strategies follows client profile identification. In this step, robo-advisors choose specific assets that are commensurate with investors' individual preferences. Among the spectrum of investable assets, exchange-traded funds (ETFs), which have become increasingly popular in recent years, have lucrative features for automated trading strategies. In short, ETFs are financial assets that are set up to track and match the returns of reference entities. However, unlike mutual funds that may also track indices and are actively managed, ETFs take a passive investment approach and are therefore considerably less expensive to run. ETFs are diversified and mitigate the risk of single-security price changes. Thanks to their low cost and operational efficiency, ETFs are robo-advisors' key investment instruments. Chart 4 sheds some light on the use of ETFs in robo-advice in Europe. Almost all robo-advisory firms choose ETFs as their main investment instruments. Moreover, roughly 6 in 10 base their investment approach exclusively on ETFs. The picture is very similar in the US, with almost all robo-advisors using ETFs for investing.

Automation and passive investment strategies have an important value-added function in the eyes of observers: the elimination of internal agency conflicts that can arise between financial advisors and their customers. Indeed, the remuneration structures of financial advisory services (both commission-based and fee-based models) have been criticised for triggering conflicts of interest and creating false incentives. Moreover, financial firms that, on the one hand, sell financial products and, on the other, recommend these to their clients are a source of criticism for policymakers.[2] Of course, conflicts of interest can arise in any setting where there are information asymmetries, including robo-advice. Thanks to full automation though, robo-advisory services benefit from improved compliance and record keeping.[3] Moreover, robo-advisors' commission remuneration is largely standardised. The fact that they receive the standard remuneration for every product they sell, irrespective of its type, is thought to lower the possibility that robo-advisors will favour one product over another.[4]

Selecting from the entire ETF universe

Even though robo-advisors mainly use ETFs, not all ETFs are equally suitable for robo-portfolios. Indeed, the ETF market is very diverse and is also growing sharply. For example, in the US alone, ETFs' total assets under management rose to around USD 2,500 bn in 2016, up from USD 423 bn in 2006. There were more than 1,700 ETFs listed on US exchanges in 2016, up from around 120 in

ETFs: Robo-advisors' key investment instruments   4

%

- ETFs only
- ETFs and other funds*
- Other instruments

* Other actively managed funds.

Source: Deutsche Bank Research

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[2] See Inderst and Ottaviani (2009) for a detailed discussion.
[3] See Medcraft (2015).
[4] See Ahlswede (2012) for a detailed discussion.

2003. Within this spectrum, ETFs that track local stock market indices are most common. Specialised ETFs exist to provide exposure to specific industries or commodity markets. Some ETFs consist of exchange-traded derivatives such as futures, forwards and options. Bond ETFs invest in sovereign and corporate bonds. Investors who have a short investment horizon and are ready to accept more risk for higher returns may turn to leveraged ETFs, which magnify returns by providing exposure to derivative instruments. There are even hybrid products that combine the features of mutual funds and traditional ETFs ("actively managed ETFs") as well as ETFs of ETFs.[5]

When selecting from the large universe of investable ETFs, robo-advisors usually follow a top-down approach (see box 5). Firstly, they exclude ETFs that are leveraged, that are not diversified enough or that provide niche coverage (e.g. by focussing on a single emerging country only). ETFs that have a short history and insufficient market liquidity are also dropped – it is difficult to calculate volatilities and correlations accurately enough to apply optimisation procedures. Moreover, for an ETF with low liquidity, bid-ask spreads might be too wide to allow for low-cost rebalancing. Finally, ETFs that have performed persistently poorly relative to the market are also discarded from the investable sample.

Top-down approach to ETF selection 5

Universe of all investable ETFs

EXCLUDE ETFs that are/have

Leveraged, not diversified, niche coverage

Short history

Insufficient market liquidity

Poor performance

FINAL SET

3-6% of investable ETFs
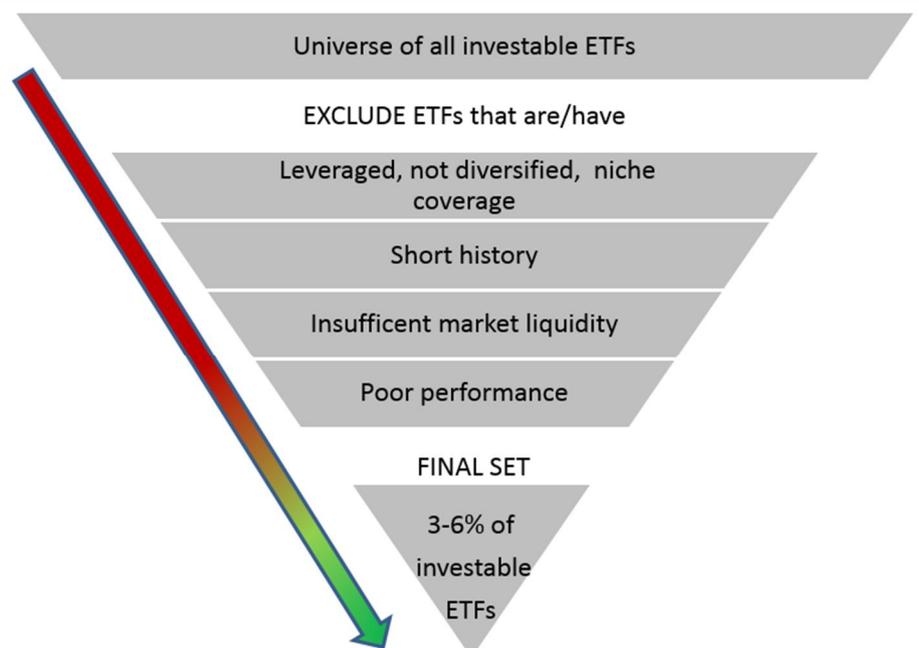
Sources: Company reports, Deutsche Bank Research

On the whole, robo-advisors take a relatively conservative approach towards ETF investments. The final set of ETFs available for robo-advisory purposes usually comes down to ~3-6% of all investable ETFs. These are strongly diversified ETFs with wide coverage. Moreover, they are very liquid and have low bid-ask spreads. They usually have a long history that reduces potential data-related problems. However, although this exclusive circle of ETFs is most suited to robo-advisory services, the small set may turn out to be somewhat restrictive in the later stages of robo-advice, which we discuss in the coming sections.

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[5] Exchange-traded notes (ETNs), which are issued by major banks as senior debt, are investment instruments similar to ETFs, but involve credit risk.

2. Asset allocation and rebalancing

Mean-variance optimisation for asset allocation
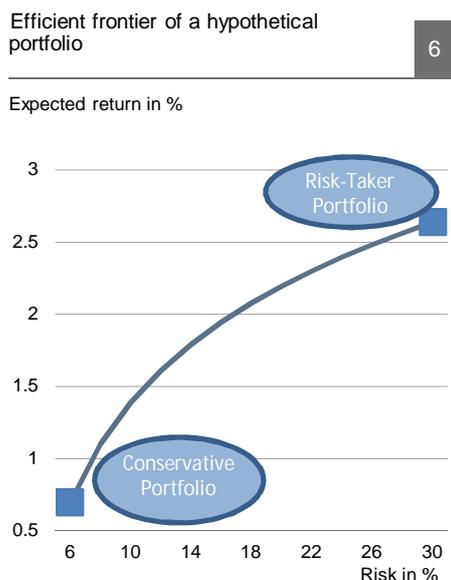
After selecting specific ETFs, robo-advisors usually allocate assets using algorithms based on mean-variance optimisation.[6] Mean-variance optimisation uses volatilities and correlations of a range of asset classes as input parameters and maximises the expected returns for a given level of risk. In line with industry practice, the variance of returns serves as a risk proxy. Historical time series are used to estimate the parameters of mean-variance optimisation and to create "efficient" risk-return portfolios.[7] Robo-advisors then select a portfolio from the efficient frontier, taking investors' risk tolerance into account (see chart 6). A typical conservative portfolio has relatively low expected returns for relatively low risk.

The simplicity of mean-variance optimisation streamlines the investment process and is essential in a fully automated system. But simplicity sometimes creates drawbacks when applied to real data. Among its shortcomings are 1) the model's assumption of normality, which is central to mean-variance optimisation. It fails to incorporate fat tails and skewness of real-time series data. For example, asset returns are not symmetrical in some cases, and the magnitude and frequency of (extreme) negative returns are greater than implied by normal distribution. 2) Mean-variance portfolios can be too sensitive to changes in asset returns,[8] i.e. even with a small increase in the (past) returns of one asset, the portfolio tilts strongly towards that asset while drifting away from the rest.

Of course, the shortcomings of mean-variance optimisation are an issue not just for robo-advisors but also for traditional financial advisors that use these methods. However, in the case of robo-advisors, misallocations in portfolios due to sudden swings in returns on individual assets can happen more frequently as a result of the very nature of full automation.[9] To address these weaknesses and mitigate concerns about a portfolio's robustness in the face of extreme market movements and model parameter selection, robo-advisors could offer stress testing, back testing and other sensitivity analyses.

Threshold-based rebalancing prevails

To both ensure that overall portfolio risk does not increase and potentially take advantage of price changes, a crucial step in robo-advisory services is to regularly monitor and rebalance portfolios. It is indeed the case that significant deviations of portfolio weights from their target values can occur within just a day or a few days' time. To achieve their long-term investment goals, portfolio weights should be monitored continuously and, if needed, brought back to their targeted values. In doing so, time-based or threshold-based portfolio rebalancing strategies (or a combination of the two) are widely used in asset management. Time-based strategies regularly rebalance portfolios, e.g. daily, weekly, monthly, quarterly or annually. Threshold-based strategies rebalance portfolios when they deviate from targeted asset allocations by a predetermined

Efficient frontier of a hypothetical portfolio 6

Expected return in %

Source: Deutsche Bank Research

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[6] Some robo-advisory firms also use Black-Litterman models.
[7] In his seminal 1952 work, Nobel Laureate Harry Markowitz introduced the concept of mean-variance optimisation. Markowitz' framework takes a set of risky assets and calculates portfolios for which the expected return is maximized for a given level of risk measured as the combined variance of the returns on the assets.
[8] Best and Grauer (1991) and Britton-Jones (1999).
[9] High-frequency trading also uses computer algorithms for light-speed trading and thus provides examples of such exacerbated reactions.

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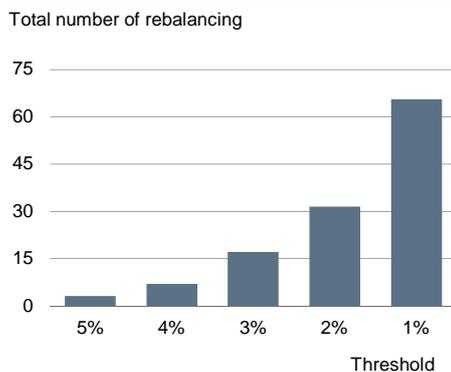
minimum percentage. The caveat for the former is to find an optimal rebalancing frequency, whereas, for the latter, selecting the optimal threshold is complicated.

Robo-advisors monitor and automatically rebalance portfolios on behalf of their clients, predominantly by employing threshold-based strategies. Since drift (i.e. deviation from a target) in the share of one asset leads to the reverse effect for another asset, assets that have an overweight are sold and their proceeds are used to buy assets that have an underweight. Rebalancing is triggered when an asset's drift reaches a certain threshold value. For example, if the share of equity ETFs in a portfolio rises from a target of 60% to 64% with maximum tolerated deviation set at 3%, then the portfolio is rebalanced by selling equity ETFs and investing the proceeds in other assets such as bond ETFs. To shed further light on threshold rebalancing, chart 7 presents the results of an empirical exercise for a hypothetical portfolio. For this exercise, we first assigned a portfolio weight of 60% to risky assets. Using actual time series between 2006 and 2016, we calculated the number of times rebalancing was required to bring the portfolio back to its 60% weight. We differentiated between threshold values ranging from 1% to 5%. We set the maximum threshold value at 5%, as figures above 5% hardly lead to any rebalancing. As seen in the chart, if the threshold value is set very low, i.e. if a small drift from the target portfolio weight suffices, the number of times that the portfolio has to be rebalanced increases significantly. For a 1% deviation from the target, 20 times more rebalancing is required than for a deviation of 5%. It is actually widespread practice among robo-advisors to use 3-5% as the threshold or to rebalance at least once a year.

There are two ways a rebalancing can be triggered: 1) market movements lead to drift from target asset allocation; or 2) clients update their preferences, which creates new targets. In the first case, rebalancing is a two-edged sword, as investors might have to sell their winning investments with further upside potential. Because this is a process controlled by a rational machine rather than by human intuition, it is only a soft version of a behavioural bias known as the "disposition effect". Investors often overreact to short-term market movements and tend to sell winners while holding on to losers. In the second case, clients' targeted asset allocation could also be subject to changes over time, which would trigger rebalancing. However, as robo-advice relies on identifying long-term investment preferences, these targets should not be recalibrated too often (by repeating the questionnaire). Taken together, while rebalancing is important to maintain targeted asset allocation, it relies on some very sensitive parameters. If performed too often, it may even become detrimental to long-term investment goals.

Tax-loss-harvesting for tax efficiency

Robo-advisors pay extra attention to tax efficiency in portfolio allocation and rebalancing. In particular, they look to maximise investors' after-tax returns by using tax-loss harvesting (TLH). In short, TLH offsets capital gains with capital losses to minimise tax payments. It realises losses and invests the proceeds in assets whose risk-return profile resembles the assets sold (substitution). Because investments are replaced with highly correlated alternatives, the portfolio's risk-return profile remains largely unchanged. Meanwhile, realised losses are used to offset any realised taxable gains.

Even though TLH is a fairly straightforward and beneficial strategy at first glance, it requires certain conditions be met. Firstly, it relies on finding a highly correlated alternative asset to match the asset where the loss has been realised. Considering the relatively small sample of investable ETFs for robo-advisory services, finding an ETF that brings the portfolio back to an investor's risk-return preferences may prove tricky. What's more, policymakers have

If thresholds are set too low, number of potential trades surges sharply* | 7

Total number of rebalancing

*Estimates using monthly absolute S&P 500 returns from 2006-2016, with a portfolio weight of 60% equities and 40% fixed income assets. We assume perfect negative correlation between equities and fixed income assets.

Source: Deutsche Bank Research

Let us assume that an investor buys a share for USD 100. Sometime later, the investor sells the share for USD 75 to realise a loss. The investor buys the same (or almost identical) share back within 30 days for USD 80. In this case, the investor is not allowed to realise the USD 25 loss from the sell trade for tax purposes. However, the loss is accounted for in the cost basis. Put differently, the purchase price of the share for tax purposes is now USD 105 (USD 80 for the last trade plus the USD 25 disallowed loss). If the investor realises a loss in the future from this share, this new cost will be relevant for tax purposes.

Source: Deutsche Bank Research

introduced measures to avoid tax arbitrage. In the US, with the "wash-sale rule", investors who sell a security to realise a loss and then repurchase a security that is substantially identical (with significant holding overlaps or near-perfect correlation) within 30 days cannot realise trade-for-tax purposes (see box 8 for an example). This rule applies to any investment with a security identification number (CUSIP), including ETFs. Therefore, the sample of ETFs to be used in TLH is probably even smaller in the US. Here, we estimate that for each ETF that is sold for TLH, there are only roughly 7-10 investable ETFs that significantly correlate with the primary ETF where the wash-sale rule does not apply. All in all, with the wash-sale rule, the circle of available alternatives is relatively limited and can be consumed by overly frequent TLH in a relatively short period of time.

It is also important to remember that there are transaction costs associated with TLH. Even though the time and labour costs of TLH are very limited due to full automation in robo-advisory services, there are transaction costs associated with ETF trading. For example, the loss is realised at the bid price and the money is reinvested in the correlated asset at the ask price. Although bid-ask spreads are usually very low for liquid ETFs, too much TLH may inflate the transaction costs and outweigh the benefits.

3. Robo-advisory market trends

A growing and changing landscape
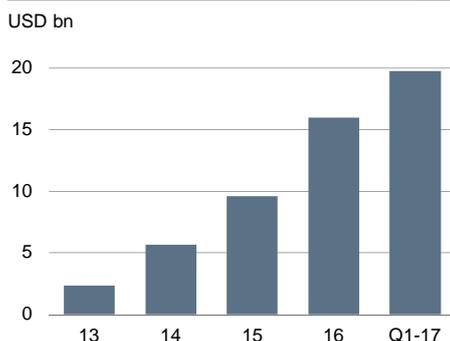
Thanks to their easy and user-friendly processes of client onboarding, portfolio analytics, asset allocation and rebalancing in addition to low costs and solid performance, robo-advisors' assets under management (AuM) have been growing sharply in recent years. In the US, AuM of robo-advisory start-ups (FinTech firms that exclude established asset management providers who offer automated portfolio management) has seen an 8-fold increase from USD 2.3 bn in 2013 to USD 20 bn in Q1 2017. The main impetus behind this has probably been growing retirement savings in robo-advisory accounts. Of course, these are the early years of robo-advisory services and this growth could slow in pace in the years to come.

There is growing competition for robo-advisory start-ups as established asset management firms as well as banks enter the business of automated wealth advice. The market is becoming a tough place for FinTech start-ups, especially as they do not yet have large client networks. In the US, defined contributions for retirement savings are largely invested in asset management firms that manage huge funds. A shift in retirement savings towards the robo-advisory subsidiaries of established firms and banks will probably boost AuM in the coming years. Under growing competitive pressure, robo-advisory start-ups are likely to evolve from business-to-consumer into business-to-business services. They may partner with or be absorbed by established asset management firms or banks.

A detailed analysis of independent robo-advisors, i.e. start-ups, in Europe is difficult as hardly any firm publishes data on AuM. Yet available figures suggest that their AuM in the EU is some 5-6% of that in the US. Industry estimates indicate that there are at least five robo-advisory firms that manage more than EUR 100 m each. EU robo-advisors are concentrated in a small number of countries. The UK spearheads, accounting for roughly 75% of the AuM of the entire market. Another 17% comes from Germany. Of the 60-70 robo-advisors in the EU, around one-third are located in the UK and another third in Germany. This implies that robo-advisors in Germany are relatively small and that some

Robo-advisors' AuM grow significantly in the US*   9

USD bn

*Robo-advisor start-ups only.

Sources: Company reports, Deutsche Bank Research

Robo-advice – a true innovation in asset management

UK together with Germany are the robo-advisory hotspots in the EU

10

% of AuM in the EU

- UK
- DE
- Others

Source: Deutsche Bank Research

Demographics of robo-advisors' clients

11

% of individuals that use robo-advisory services in Italy
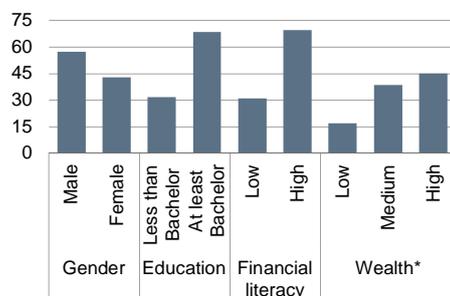
*low wealth up to EUR 10,000, medium EUR 10,000-50,000 and high more than EUR 50,000.

Sources: Consob, Deutsche Bank Research

Average fees for USD 100 k investment

12

% p.a.

Source: Deutsche Bank Research

consolidation or market exits can be expected. At the same time, the German market offers a lot of potential for robo-advisors as many households do not yet participate in capital markets and manage their savings in the form of traditional bank deposits.[10]

In the EU as a whole, the capital market participation of retail investors is suffering from a high degree of risk aversion and a heavy reliance on pay-as-you-go benefit pension systems. As a result, bank deposits (41%) and insurance and pension fund reserves (39%) make up the lion's share of households' financial assets. Expressed differently, even though Europe has a very large asset management industry (AuM: EUR 23 tr in 2016), its typical clients are institutional investors or high net-worth individuals (HNWIs). In this respect, robo-advisors could greatly benefit from heightened interest from institutional or HNWI investors. Indeed, this may be just about to happen as, like in the US, traditional asset managers and banks that manage large funds have begun offering robo-advice services in Europe. Moreover, in the long run, shifts from deposit savings to capital market investments might create additional momentum for robo-advice in the EU.

Clients are not just millennials

Who are the clients of these robo-advisory firms? Millennials between the ages of 24 and 35 are often quick to adopt new technologies, prefer self-service approaches and are therefore logical initial users. Indeed, in the early days of robo-advisory in 2013/14, 50-60% of its clients were millennials. However, this has been changing in recent years. Industry estimates indicate that US robo-advisory clients are on average in their mid-40s with account balances that tilt slightly towards six-digit figures. This points to a broadening client base in the US that is increasingly attracted to automated investing.

There is limited information available about European robo-advisory client demographics. For Germany, there are estimates that clients are on average 40 years old, have a monthly net household income of around EUR 4,000 and are university graduates. Somewhat more detailed figures are available for Italian investors. In Italy, male clients outnumber female clients, which is most likely the case in other countries as well. More educated clients use robo-advice more often than less educated investors. The same holds true for financial literacy. Finally, there is a linear correlation between wealth and the use of robo-advice. In general, however, robo-advice investors probably will not be shifting their entire portfolios to accounts like these, but will be increasingly using these services.
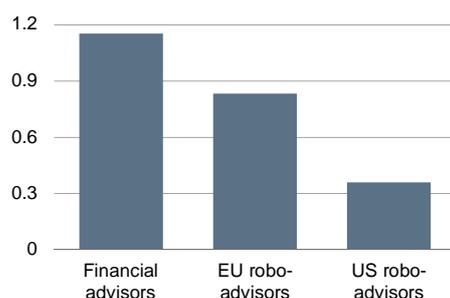
Why do clients value robo-advisory services?

The technological advancements in financial services in the last few decades have driven down costs for end users in general. Robo-advice is a case in point, and the widespread perception is that it is a low-cost alternative to traditional financial advisors who provide active management. Chart 12 compares the fees charged by financial advisors with those of robo-advisors. Financial advisors' average annual fees are typically around 1% for managing a portfolio of up to USD 100,000. For a similar portfolio, US robo-advisors charge around 0.4% on average with a range between 0.15% and 0.67%. Some robo-advisory firms offer free services for investments up to USD 10,000. Unlike many traditional financial advisors, there are usually no minimum volume requirements for opening a robo-advisor account. EU robo-advisors are relatively expensive and

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[10] See Giannetti and Koskinen (2010) for a comparison of stock market participation rates globally.
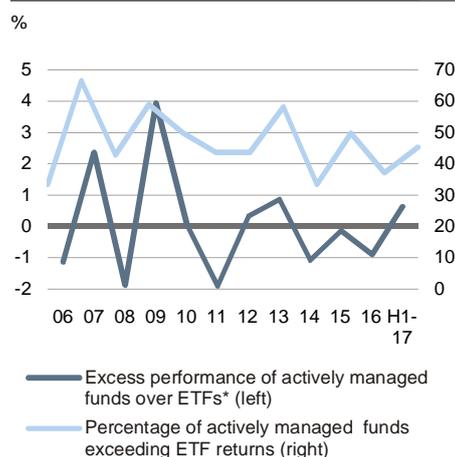
charge annual fees of around 0.8% on average. This can be partly explained by somewhat higher overall asset management fees in Europe compared with the US.[11] Cost is definitely an important factor for clients choosing robo-advisors, and reductions in the average cost of financial advice have no doubt been positive for investors. However, there are also other factors that help to determine the long-term success of a financial plan.

Portfolio performance is another important factor for clients deciding where to invest. If traditional financial advisors were able to offer higher excess returns than their robo-counterparts, the higher fees would be justified. Chart 13 compares the performance of actively managed funds and passive investment alternatives in the US.[12] Our sample includes all long-term mutual funds and ETFs. All returns are post-fees. Over the last decade, actively managed funds performed notably stronger than ETFs only in 2007 and 2009. By contrast, they significantly underperformed in 2008 and 2011. Since 2012, they have slightly underperformed compared with ETFs on average. Of course, some actively managed small-cap and mid-cap funds in particular have also performed significantly better than ETFs in recent years. But their returns can be quite volatile and their performance does not represent the overall market. Indeed, the percentage of actively managed funds that outperform has been declining in recent years. For example, on average only 40% of actively managed funds were able to beat ETF returns between 2014 and 2016. In light of this, it is probably difficult for retail investors to pick the "right" actively managed fund that sustainably outperforms a comparable ETF. This implies that higher fees are not necessarily linked to higher returns, and some robo-advisors might even provide higher returns for lower fees. Still, it is important to note that recent years witnessed extraordinary monetary policies and favourable liquidity conditions on all fronts. The performance of robo-advisors needs to be tested over a longer period to make a comprehensive assessment.

Robo-portfolio performance under volatility

In the eyes of some observers, the emergence of robo-advisory services has coincided with bull markets, and their business models have not yet been tested in volatile conditions. These critics argue that robo-advisors will underperform during heightened volatility in financial markets and that their investment strategies will prove inadequate. On the other hand, proponents of robo-portfolios argue that robo-advisors are not day traders and paying too much attention to market movements leads to detrimental trading decisions for long-term investors anyway. If a buy-and-hold approach beats a market-timing approach as some argue, robo-advisors should perform well even in times of volatility.

There is little data available to quantify the performance of robo-advisors versus human advisors in times of volatility. However, it can be argued that robo-advisors engage in relatively conservative investment practices to manage volatility and to reduce investment risks in general. To be specific, they usually have a policy of entering the market 30 minutes after it opens and to leave it before it closes. Moreover, some robo-advisors suspend trading for a few hours before and after market-moving events such as central bank announcements about interest rates. These are precautionary measures designed to reduce the algorithm's potential overreaction to market movements that could otherwise lead to unnecessary losses for clients.

Actively managed funds struggling to outperform ETFs   13

——— Excess performance of actively managed funds over ETFs* (left)

——— Percentage of actively managed funds exceeding ETF returns (right)

*Asset-weighted returns of active mutual funds and ETFs that are both net of fees.

Source: Deutsche Bank Research

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[11] See FSUG (2014) for a detailed analysis.
[12] See Del Guercio and Reuter (2014) and Berk and van Binsbergen (2015) on the debate about the performance of active management.

Extreme volatility around Brexit `14`
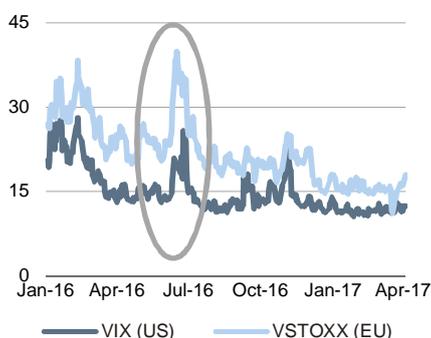
Sources: Bloomberg, Deutsche Bank Research

The Brexit referendum was an important test for the performance of robo-advisors and their trading practices. Indeed, it was one of the most significant shocks to the financial markets in recent years and led to severe volatility. For example, the benchmark European stock market volatility index surged 60% in the weeks around voting and calmed a couple of weeks later (see chart 14). US markets experienced a similar surge in volatility. Because this period was an exogenous test of robo-advisors' performance, their trading practices received particular attention. Interestingly, some of the largest robo-advisors halted trading for several hours on 24 June 2016 to prevent investor overreaction. They informed investors through social media to prevent panicking and fire sales. As the markets calmed fairly quickly, it was revealed that robo-portfolios had weathered the Brexit storm relatively well. Yet critics view the trade freeze as an extreme measure and argue that investors should be the only ones to decide when and how much to trade. Again, more data and longer time series are required to make a comprehensive assessment of robo-advisors' portfolio performance during market upheavals.

4. Future role of robo-advice and its supervision

Can robo-advisors contribute to financial inclusion?

Even though the clients of robo-advisory firms are more likely to be financially literate, relatively wealthy individuals for now, less wealthy investors and investors with little financial knowledge would benefit to a larger extent from the advancement of robo-advisory services. By and large, for less wealthy investors, the affordability of financial advice is central. For example, in 2016, around half of the financial advisors in the UK turned away clients due to the small size of their investments. Moreover, an estimated 30-50% of consumers would pay for financial advice if it were more affordable.[13] There is widespread agreement that robo-advisory services can reduce the cost of advice and thus convince these types of consumers to embrace them.

Indicators of financial literacy `15`

% of correct survey responses

Sources: Lusardi and Mitchell (2013), Deutsche Bank Research

Affordability is only one side of inclusion. Research suggests that investors with lower cognitive abilities and less financial knowledge suffer the most from investment mistakes and biases. These investors are more likely to realise losses during market upheavals.[14] They also face lower returns in the long run if they do not participate in market recovery. And many people struggle with basic financial concepts such as calculating compound interest rates and understanding the benefits of diversification. Survey responses can provide insights into financial literacy and cognitive abilities. For example, in some countries, up to two-thirds of individuals are not able to calculate compound interest. Moreover, only around 50-60% of individuals are aware of the benefits of diversification when investing in stock markets. Taken together, many individuals face significant difficulties in financial decision-making.

Of course, the availability of robo-advice does not change the need for financial literacy. Nevertheless, if households were to delegate some of their investment decisions to robo-advisors, it could be an alternative way to enhance the quality of their financial decisions in light of markets characterised by growing complexity. Indeed, academic literature suggests that taking financial advice is a key determinant of households' willingness to invest in risky assets.[15] This line of literature also shows that financial advice matters most for households with low financial capabilities. All in all, robo-advisors will not be a substitute for

[13] See FCA (2016).
[14] See Bucher-Koenen and Ziegelmeyer (2011).
[15] See Georgarakos and Inderst (2011).

financial education, but will complement financial planning. A likely precondition for this is that robo-advisors guarantee a high degree of accuracy, suitability and consistency to satisfy clients' goals. This, on the other hand, requires sufficient regulation and supervision.

Supervision of robo-advisors

The same conduct standards for advisory services apply to robo-advisors and traditional financial advisors alike. Robo-advisors must be transparent in terms of costs, potential risks and limitations of their services. They have a duty to fully and fairly disclose all information so that clients can clearly understand their investment practices and potential conflicts of interest. Such information should be easily accessible and understandable. Secondly, robo-advisors need to explain how they handle operational and market risk both in normal times and in distressed market conditions. Investors must be informed about operational aspects of their services, i.e. regarding the assumptions and limitations of the optimisation algorithm for portfolio allocation and rebalancing. Thirdly, robo-advisors should ensure that their recommendations and strategies are suitable for their clients. Suitability should be based on the client's financial situation and investment objectives. For this, robo-advisors depend on the information provided by clients in online questionnaires. As previously mentioned, client screening is in many respects at the core of robo-advisory. Last but not least, cybersecurity and the protection of sensitive customer information is a very important issue when it comes to automated online advice. Thus, robo-advisors must establish controls to protect client data and to maintain the public website/the client's log-in functionality.[16]

Still, the fast-growing robo-advisory landscape has not gone unnoticed by policymakers, as unique business models and limited or no human interaction require some clarification in certain cases. In the US, to inform robo-advisory clients, the Securities and Exchange Commission (SEC) recently published a guidance report.[17] The SEC emphasises that, as registered investment advisors, robo-advisors are subject to the requirements of the Advisers Act of 1940. Likewise, the joint committee of the three European Supervisory Authorities (ESA) launched an assessment of robo-advice, aimed at gauging whether any action was required to harness its potential benefits and mitigate its risks. At the end of 2016, the ESA committee decided to continue monitoring robo-advisory services, but not to take any cross-sectoral regulatory or supervisory action. As previously mentioned, digital advice services are subject to the same regulatory requirements as traditional financial advisors and are therefore supervised by the same authorities as traditional financial advisors, i.e. the SEC and FINRA in the US, the FCA in the UK, BaFin in Germany and AMF in France. In a late-2016 survey by the IOSCO, supervisors in the US, the UK and Germany reported that existing rules appear to be sufficient, for now at least, to cover automated advice tools.[18] Supervisors in France and the Netherlands reported they are still assessing whether additional rules or safeguards are needed.

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[16] See IOSCO (2016b).
[17] See SEC (2017).
[18] See IOSCO (2016a).

Summary

In this paper, we have taken a closer look at the fast-growing robo-advisory landscape. One of the most important steps in the robo-advisory process is client-onboarding. To improve its accuracy, it may prove beneficial to introduce vignettes and some human touch in the form of bionic advice. Robo-advisors mainly invest in ETFs, but they are relatively selective, and only ~3-6% of all ETFs fit in with their investment practices. Robo-advisors largely use algorithms based on mean-variance optimisation to allocate assets. Rebalancing is an integral part of modern portfolio management and robo-advisors predominantly use threshold strategies to do so. If performed too often, rebalancing may be detrimental to long-term investment goals. Meanwhile, too frequent tax-loss-harvesting may quickly consume the set of investable ETFs and become costly.

Robo-advisors' AuM has been growing significantly in the US, mainly due to a partial shift of retirement savings to robo-advisory accounts. The market is now becoming a tough place for business-to-consumer robo-advisory start-ups. Partnerships and takeovers by established asset management firms or banks will probably take place in the coming years. European robo-advisors' AuM is only some 5-6% of that in the US. Here, the industry could benefit from greater interest from institutional or HNWI investors. Millennials were among robo-advisors' first clients. Recently though, wealthier and more educated clients in their 40s and 50s have also seemed to be entrusting them with part of their portfolios. The cost advantage of robo-advisors has been creating significant momentum for their services. That said, regional differences exist with higher fees in Europe than in the US. The outperformance of passive investment strategies in recent years in general and robo-advisors' resilience during market volatility in particular might provide a further impetus for their services.

As an affordable alternative, robo-advice also has a lot of potential to contribute to financial inclusion. It is not a substitute for financial education in a society, but it can work as a complement to financial planning. This is especially important for households with low financial capabilities. If robo-advisors and their regulators guarantee a high degree of accuracy and suitability for clients, robo-advice has great potential to complement rather than displace traditional financial advisors in the future.

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