Robo-Advisors & Insurance-Linked Securities

Opportunities of combining two thriving business models

Abstract

Robo-advisors and Insurance-Linked Securities – two young business models in two different industries that have seen steep growth during the last decade. Robo-advisors have been successful by automating investment advice, making wealth management more efficient and accessible to a broader client base, while ILS sources new insurance capacity by allowing the financial market to invest in insurance risks largely uncorrelated to other financial instruments.

The first seeks profitable investments on behalf of its growing client base, while the latter seeks investors in uncorrelated risks. It seems obvious that there is potential upside for both business models if they were to converge, but so far there have been little to no touchpoints between robo-advisors and ILS.

This paper presents an analysis based on similar quantitative methods and algorithms used by robo-advisors in combination with historical data to show the significant opportunity to improve the portfolio's risk-return profile. We then discuss some of the practical hurdles to putting this theoretical framework into practice and conclude with some further areas of research.

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Introduction

Opportunities of combining two thriving business models

When we think about financial services and technology, we naturally think about InsurTechs and FinTechs – technological innovations designed to disrupt the traditional insurance and asset management business models. However, we tend to view innovations in each segment in isolation: innovation in the insurance space has opened up a new source of capital through Insurance Linked Securities (ILS) and robo-advisor technology in the asset management is creating more efficient and accessible investment solutions for a broader class of investors.

What would happen if we brought both together? Bringing robo-advisors and ILS together could unlock large volumes of additional capacity for the (re)insurance market with great potential to grow as robo-advisors gain market share. At the same time, ILS has the potential to accelerate the rise of robo-advisors further and generate AUM (Asset Under Management) growth by improving investment results and offering access to better portfolio diversification. This paper investigates the potential benefits of integrating ILS and robo-advisor innovation across the insurance and asset management segments to generate further benefits to both industries.

The rise of ILS

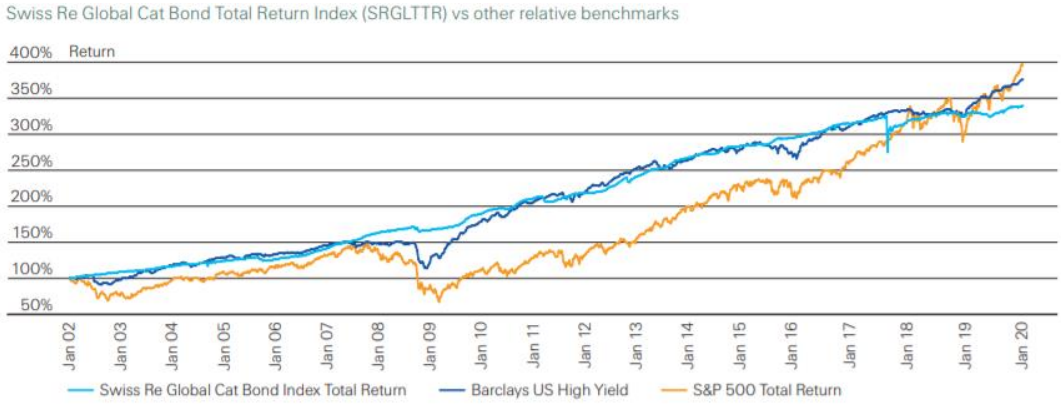
In 1992, Hurricane Andrew made landfall in Florida causing a total insured loss of USD 15.5bn, at the time the World's costliest natural disaster ever. The event had a major impact on the insurance and reinsurance industry, resulting in a shortage of capacity supply, driving significant price increases in the property reinsurance market. Additional capital was needed, and financial markets were able to supply it. In order to access this source of capital, a new method of risk transfer was required, the idea of securitizing catastrophe risk in the form of cat bonds was born.

The first cat bond transactions were completed in the mid-1990's and the ILS market has grown rapidly since. Today's size is estimated at USD 90.5bn, which makes up ca. 15% of the total non-life reinsurance market.[1]

Growth was accelerated by good returns due to years of benign loss experience in the property cat market for many of its early years. ILS investors generated annual returns of ca. 7% between 2002 and 2019. Cat bonds outperformed other financial market products such as equities or high yield bonds over many years.[2] However, rather than the comparably high returns, the main attraction for investing in catastrophe insurance risk is the very low degree of correlation with other financial markets. A financial market crisis has no influence on the occurrence of a natural catastrophe that could trigger a cat bond and cause it to lose its value. This resistance to market risk is the greatest advantage of ILS and was proven valuable to investors during the financial crisis of 2007/2008. In

[1] *Willis Re Reinsurance Market Report, April 2020*
[2] *Based on performance on Swiss Re Global Cat Bond Index*

view of the current financial crisis, caused by the Covid-19 pandemic, we are now in another market phase that reiterates the importance of diversification in investment portfolios.



Source: Swiss Re Capital Markets, as of December 31, 2019

The rise of robo-advisors

Not only did the 2007/2008 financial crisis increase the demand for asset diversification, but also for firms to find cheaper and more efficient ways to do business. New business models, based on technological innovations, have disrupted various segments of the financial industry, wealth management services being one of them. Automated financial advisors, so called Robo-advisors, have been successfully challenging traditional business models by automatically building and managing clients' investment portfolios.

Robo-advisors are online platforms, which, by utilizing question-based algorithms, identify a client's risk appetite, investment goals and liquidity. This information is then translated into a portfolio allocation tailored to individual preference. Sophisticated robo-advisors not only build these investment portfolios automatically but also continuously manage and rebalance them accordingly.

This technology has made wealth management more accessible to a broader target group. The ease of accessing the advisor anytime from anywhere appeals especially to the younger generation. Additionally, thanks to savings on fixed costs, robo-advisors can charge lower fees and reduce minimum investment requirements for their clients. Robo-advisor's increasing popularity has resulted in USD 1.4tn of total assets under management (AuM) as of today and is predicted to be at USD 2.5tn by 2023.[3]

[3] *https://www.statista.com/outlook/337/100/robo-advisors/worldwide#market-revenue*

A robo-advisor's business model and how cat bonds can be integrated

Robo-advisors implicitly work through a two-step process to determine the optimal portfolio for an individual investor: Step 1 is to determine the risk appetite of the investor and, in step 2, to build an optimally diversified portfolio matching that risk appetite. Both steps are described below and illustrated with a concrete numerical example using historical data to illustrate the benefits of merging ILS and robo-advisor innovations.

Step 1: Defining investment goals & risk tolerance: A question-based algorithm

In order to automatically advise clients on their investment decisions robo-advisors use question-based algorithms to understand a client's risk profile and investment goals. The questionnaire typically targets two areas, the objective financial ability and the subjective willingness to take risk. For example, Schwab's robo-advisor calls these two categories 'Risk Capacity' and 'Risk Willingness'. 'Risk Capacity' questions ask for specific information such as an individual's investment goals and planned investment period, whereas 'Risk Willingness' questions quantify an investor's subjective risk tolerance by asking questions related to their behavioural tendencies in case of negative developments[4].

By assigning numerical values to each answer of the questionnaire, independent risk scores for objective and subjective risk tolerance are derived. Robo-advisors use different weighting approaches for objective and subjective risk tolerance scores, with some, e.g. Wealthfront, giving a heavier weighting to whichever component is more risk averse[5]. The resulting risk score is associated with the maximum annual level of risk acceptable for the investor.

Answers to subjective risk tolerance questions showing a tendency towards risk adverse behaviour and/or little knowledge of investments receive a lower risk score, while experienced investors with a willingness to accept more risk to maximize returns receive a higher score.

The scoring of objective risk tolerance questions is often based on the theory of time diversification, the concept that investments in stocks are less risky over longer periods. An analysis of 210 years of historical data by Jeremy Siegel in his book "Stocks for the Long Run" shows that the minimum risk on the efficient frontier is a function of the holding period, with an increasing allocation to stocks and decreasing allocation to bonds the longer this period is.[6] As a result, most robo-advisors define the portfolio risk an investor is able to assume as a positive function of time horizon. Investors stating a plan to hold their investment for more than 15 years or responding to their investment goal with an answer that implies a long-term investment, such as saving for retirement, can therefore assume a higher portfolio risk in the short run, as this will be offset by the length of the investment period. At the same time, investors whose investment goal is to generate a regular income or save for an event in the near future, are assigned a low risk score to minimize the chance of loss.

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[4] *Schwab Investor Profile Questionnaire Whitepaper*
https://intelligent.schwab.com/public/intelligent/insights/whitepapers/investor-profile-questionnaire.html
[5] *Wealthfront Investment Methodology Whitepaper*
https://research.wealthfront.com/whitepapers/investment-methodology/#9-portfolio-construction
[6] *Jeremy J. Siegel. 1994. Stocks for the Long Run*

Instead of communicating the suggested annual level of risk, robo-advisors translate this information into more intuitive portfolio categories. These are commonly split into “Income”, “Balanced” and “Growth” with increasing tolerance of annual risk levels from the former to the latter. From the results of the questionnaire, investors are provided with a suggested portfolio mix together with a brief description of their portfolio category which reflects their investment goals. In the example of Vanguard the following definitions are used[7]:

- ***Income:*** *An income-oriented investor seeks current income with minimal risk to principal, is comfortable with only modest long-term growth of principal, and has a short- to mid-range investment time horizon.*
- ***Balanced:*** *A balanced-oriented investor seeks to reduce potential volatility by including income-generating investments in his or her portfolio and accepting moderate growth of principal, is willing to tolerate short-term price fluctuations, and has a mid- to long-range investment time horizon.*
- ***Growth:*** *A growth-oriented investor seeks to maximize the long-term potential for growth of principal, is willing to tolerate potentially large short-term price fluctuations, and has a long-term investment time horizon. Generating current income is not a primary goal.*

Based on the above we are assuming the risk scoring to result in the following simplified Portfolio Category matrix:

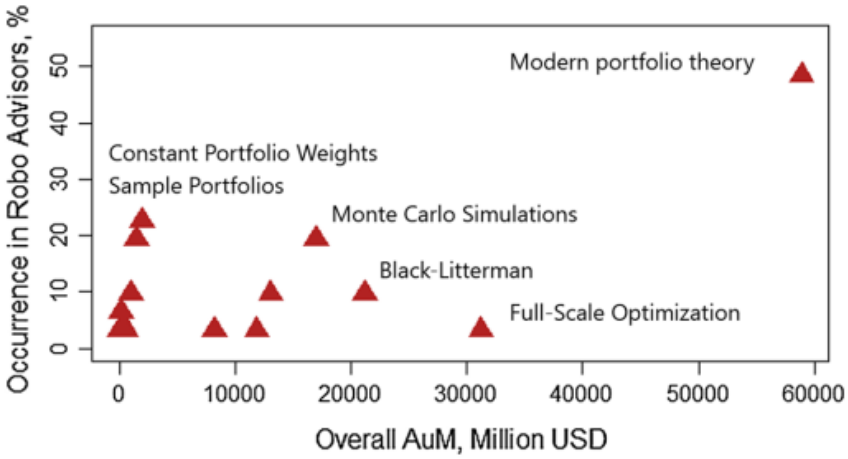
Portfolio Category		**Objective Risk Tolerance Score**		
		Below average	Average	Above average
Subjective Risk Tolerance Score	Below average	Income	Income	Balanced
	Average	Income	Balanced	Balanced
	Above average	Balanced	Balanced	Growth

Step 2: Quantitative methods of robo-advisors – which performance measures matter?

The second step is to define the “optimal” portfolio based on the individual’s implied risk appetite. When evaluating whether incorporating insurance risk into investment portfolios makes sense, it is key to understand on what basis investment portfolios are constructed. An analysis on quantitative methods of robo-advisors from 2018 showed that the most frequently applied framework for robo-

[7] *Vanguard Portfolio Allocation Models*
https://personal.vanguard.com/us/insights/saving-investing/model-portfolio-allocations

advisors' asset selection/allocation, as well as the one with the highest AuM volume, is Modern Portfolio Theory[8].



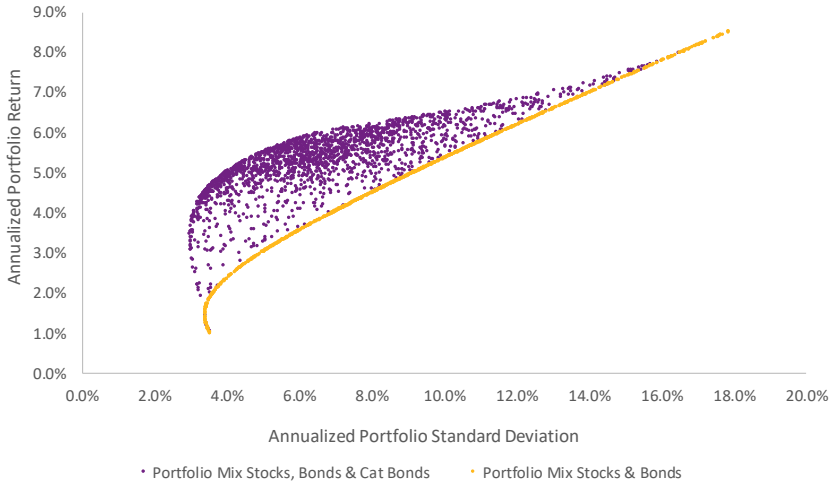
Modern Portfolio Theory or Mean-Variance Analysis is a theory first presented by Harry Markowitz in 1952, which intends to maximise the expected portfolio return for a given level of risk, measured by the portfolio standard deviation. This is based on the main concept of diversification, i.e. a portfolio's risk can be reduced by holding combinations of securities that are not perfectly positively correlated.

The diversification benefits of insurance risks: A concrete example

The optimal portfolio recommended by robo-advisors achieves the highest expected return given the client's personal risk tolerance through diversification. The question is, can diversification be further improved by incorporating insurance risk?

For this we are comparing a simplified "traditional" robo-advisor portfolio – i.e. a mixed portfolio of stock and bond exchange traded funds (ETFs), which for the purpose of this analysis contains two ETFs, one for US stocks and another one for US bonds – with a robo-advisor portfolio mix of stocks, bonds and cat bonds over the past 10 years. The product palette of ILS will be limited to cat bonds as the only liquidly traded form of ILS, for which the performance will be measured by the Swiss Re Global Cat Bond Index.

[8] *Beketov, M., Lehmann, K. and Wittlke, M. 2018. Robo Advisors: quantitative methods inside the robots https://link.springer.com/article/10.1057/s41260-018-0092-9#Bib1*



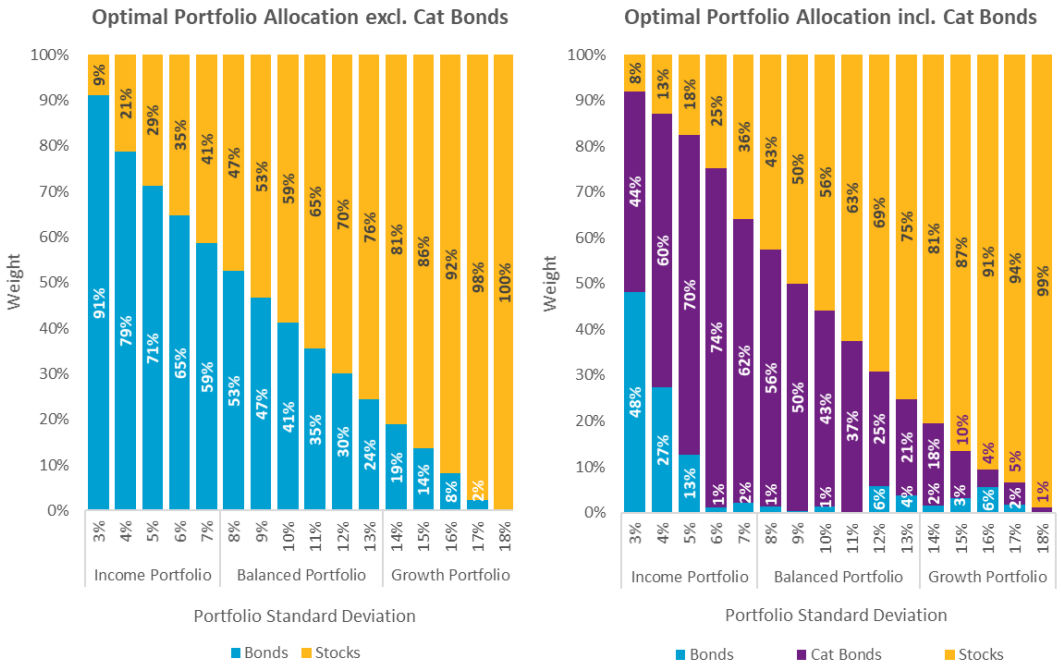
10-year historical analysis (04/2011 – 04/2020) of portfolio combinations of stocks (Vanguard Total Stock Market ETF, which tracks the performance of the CRSP US Total Market Index), bonds (Vanguard Total Bond Market ETF, which tracks the performance of the Bloomberg Barclays Capital Aggregate Bond Index) and cat bonds (Swiss Re Global Cat Bond Performance Index)

This analysis clearly shows that the low degree of correlation of cat bond returns with other asset classes results in a shift of the efficient frontier leftwards: put more simply, including cat bonds in a portfolio reduces the "risk" (as measured by standard deviation), whilst still achieving the same expected return (or, equivalently, increases the expected returns for the same risk). Therefore, most portfolio combinations without cat bonds are inefficient under the mean-variance framework. A robo-advisor operating under this quantitative method would therefore always choose to allocate a portion of the investment to cat bonds. Determining the share of investment allocated depends on the client's risk tolerance and investment goals.

Portfolio generation: Asset allocation and expected returns

For a traditional robo-advisor investing in stock and bond portfolios, this optimization method results in a small share in the stock portfolio and a large share of in the bond portfolio for investors with a low risk tolerance and a larger share of stocks and a smaller share of bonds for a high risk tolerance.

When the same exercise is undertaken with cat bonds offered as an option, cat bonds will largely replace traditional bonds in the portfolio. This is because cat bond index returns have historically shown a low level of risk, like bond portfolios, but offer great diversification for both bond and equity portfolios.

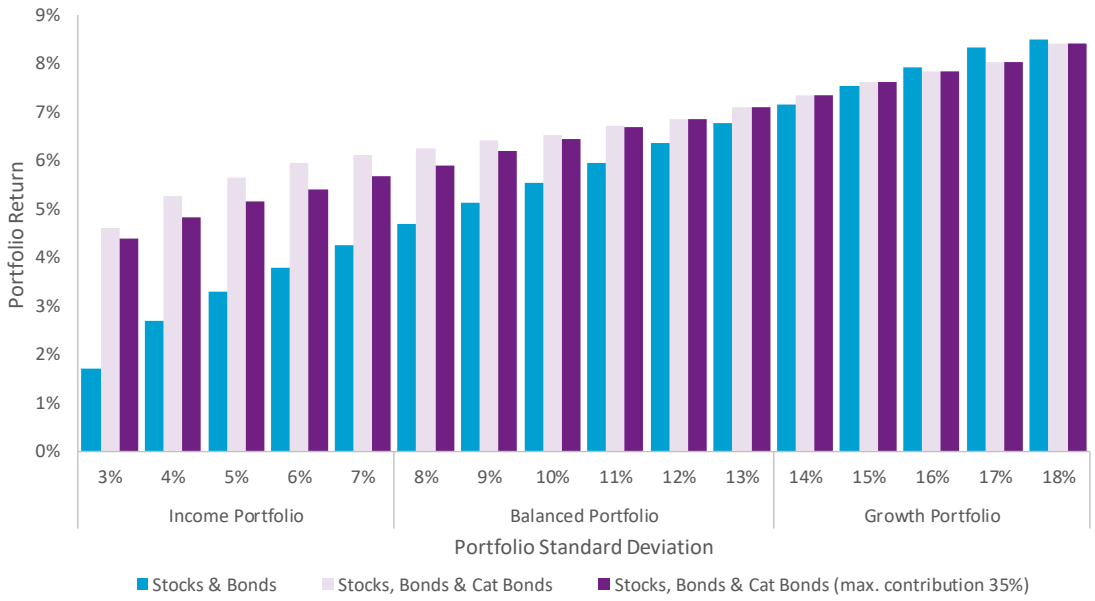


Based on the historical performance of cat bonds (Swiss Re Global Cat Bond Performance Index), stocks (Vanguard Total Stock Market ETF, which tracks the performance of the CRSP US Total Market Index) and bonds (Vanguard Total Bond Market ETF, which tracks the performance of the Bloomberg Barclays Capital Aggregate Bond Index) over the past 10 (04/2011 – 04/2020).

As previously discussed, most robo-advisors rely on mean-variance-optimization based on the assumption of normally distributed returns, which leads to the suggested asset allocation in the previous exhibit. Yet, advising an investor with a low to moderate risk tolerance to allocate 70% of their investment to cat bonds could lead to disastrous results, due to their high probability of default. Most cat bonds are rated in the region of BB or B by Standard & Poor's, categorising them as speculative investments.

There are two approaches possible to make up for the lack of adequate assessment under the mean-variance framework: one is to change the framework to include skewed distributions or tail events (discussed in the last section of this paper) and the other is to enforce maximum allocation constraints for cat bonds during the optimisation process. For this study we follow Wealthfront's approach who choose 35% as the maximum allocation for each asset class.

Under this new condition, the inclusion of cat bonds, even when limited to a maximum share of 35%, still generates higher returns for all of the "Income" and "Balanced" portfolios as well as for two out of three "Growth Portfolios". Only in the case of investors accepting the highest volatility levels expected returns would be diluted by adding a small share cat bonds without substantially diversifying the risk.



Annualized portfolio return based on the historical performance over the past 10 years (04/2011 – 04/2020) for different combinations of cat bonds (Swiss Re Global Cat Bond Performance Index), stocks (Vanguard Total Stock Market ETF, which tracks the performance of the CRSP US Total Market Index) and bonds (Vanguard Total Bond Market ETF, which tracks the performance of the Bloomberg Barclays Capital Aggregate Bond Index).

Outlook – Opportunities & Challenges

Based on this research, in most cases robo-advisors would have been able to improve their clients' investment results over the past 10 years by adding cat bonds to their portfolios. Especially low to moderate risk portfolios would have benefitted from the diversification effect of cat bonds increasing the expected annualized return by up to 3% for the same level of volatility.

At the same time, given the predicted volume of assets robo-advisors will manage by 2023, an average allocation of 4% to cat bonds across all portfolios would already result in doubling the current size of the ILS market and therewith increasing available (re)insurance capital substantially.

Although this might seem like a win-win-situation for both sides, there are some challenges along the way that will need further investigation.

Shortcomings of the mean-variance-model

The assumption made under the mean-variance framework of independent, identically and normally distributed returns falls short in reflecting the true behaviour of cat bond risk. Hence, risk assessment and portfolio optimization methods will have to be adjusted in order to give adequate investment advice going forward.

A potential method to account for the skewed distribution of cat bond returns is to move from a standard mean-variance-optimization to a mean-value at risk or mean-conditional value at risk optimization. Adjusting the measure of risk and the assumed probability distribution could, however,

drastically change the recommended portfolio compositions. An analysis from 2011 of non-insurance linked financial instruments shows the differences in asset allocation between a mean-variance-optimization with the assumption of normally distributed returns and a mean-conditional value at risk optimization for which returns are modelled with negative skewness and fatter tails by the Johnson distribution. The results verify what is intuitively expected, the mean-conditional value at risk optimizer tends to recommend less allocation to asset classes with large negative skewness and excess kurtosis (fat tail), characteristics that are ignored in the mean-variance model.[9] Adapting this method for a mixed portfolio including ILS might therefore lead to significantly reduced allocations to cat bonds due to the heavy tail risk.

Not only the assumption of normally distributed returns is problematic with regards to cat bonds, but also assuming serial independence can lead to significant underestimation of risk. Since global warming is and will be influencing the frequency and severity of weather-related natural catastrophes, long-term trends and time-dependencies should be considered when assessing investments in products linked to this risk.

Adapting robo-advisor questions to include ILS

The asset allocation decision for stocks and bonds in a robo-advisor portfolio are purely made based on the outcome of the questionnaire and the assigned risk level categorisation. This can also be done for deriving the adequate cat bond allocation, however, adding questions to evaluate an investor's appetite for alternative investments is necessary as some of the characteristics of the portfolio will change. One of the main aspects is the tail risk implied by ILS; a second is the lower level of liquidity cat bonds offer compared to stocks and bonds. A robo-advisor will therefore have to make sure that the investor is happy to sacrifice some degree of flexibility for a better diversified and performing portfolio.

Replicating the performance of the Swiss Re Global Cat Bond Performance Index

While our analysis is based on existing ETFs for stocks and bonds, the performance of cat bonds has been measured via the Swiss Re Global Cat Bond Performance Index, a non-investable index. The index tracks the aggregate performance of all catastrophe bonds issued globally and offered under Rule 144A[10]. As there is currently no investable cat bond ETF which tracks this index, a Robo-advisor attempting to include cat bonds in their portfolios in the same manner as done in this study would have to invest in all cat bonds available on the market according to their current weighting in the index. This is obviously a showstopper for a business model trying to automate and maximize efficiency in portfolio management.

An alternative could be a cooperation with an ILS fund who will manage the investments allocated to cat bonds. However, this will add an additional administrative layer to the distribution chain as well as create additional costs and could severely impact two of robo-advisors' unique selling points, cost

[9] *Cindy Sin-Yi Tsai, 2011. The Real World is Not Normal. Introducing the new frontier: an alternative to the mean-variance optimizer.*
http://morningstardirect.morningstar.com/clientcomm/iss/Tsai_Real_World_Not_Normal.pdf
[10] *Swiss Re Cat Bond Indices Methodology*
https://catbond.com/wp-content/uploads/2019/08/201408_ILS_Cat_Bond_Indices_Methodology.pdf

effectiveness and instant flexibility. Whether these downsides could be outweighed by the achievable diversification benefit in portfolios, will have to be examined on a case by case basis.

The ideal solution to this problem for the financial and insurance industry, however, would be to establish an ETF for cat bonds, which replicates the performance of the Swiss Re index. There are some obvious advantages for investors, such as instant peril diversification and tax efficiency, which would preserve a robo-advisor's low maintenance and cost-efficient portfolio strategy. In addition to that, robo-advisors will not need to build their own (re)insurance expertise but can rely on the diversification and market dynamic represented by the ETF instead, which will again save cost and increase the attractiveness of including ILS. A further evaluation of whether and how a cat bond ETF can be implemented would be essential to fully exploit the potential of ILS in robo-advisor portfolios.

Conclusion

So far ILS capacity only makes up a small share of the reinsurance market, although the diversification benefits of ILS in investment portfolios and the limited correlation with other financial instruments are indisputable. There is large potential for growth, which could be unlocked if investing in ILS was made simpler and more broadly accessible. Robo-advisors offering cat bonds as part of their asset selection could be a way of reaching a broader investor group.

From a performance point of view, we've shown that this would have been beneficial for robo-advisors and their clients, but there are some practical hurdles that could jeopardise the efficiency and flexibility of their business model. If those can be overcome, ILS can truly change the dynamics of the (re)insurance and asset management industries.