

# Questions & Answers

WEBINAR 'BEYOND TRACKING ERROR'

# How do you optimise for relative iVaR? How to do you backtest the relative iVar objective? What data are used?

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All the portfolios in the backtests were rebalanced on a monthly basis. At each rebalance, we considered all constituents of the index at that historical point in time, and we considered all timeseries until that historical point in time. During the optimisations we construct the portfolio that, given all the relevant constraints, has the lowest possible historical relative iVaR over every subperiod in the past.

# What instruments were used in the InvestSuite iVaR?

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All the backtests and demos included the instruments that were at that point in time present in the corresponding index.

# Can you optimize a multi-asset portfolio across with a fund solution (as opposed to direct equity in today's example)?

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Yes, the InvestSuite Portfolio Optimizer can handle a wide range of instrument types, including stocks, ETFs, Mutual Funds, crypto assets, etc. In order to tilt the portfolio towards a certain ESG aspect or fundamental factor, data on the pertinent field needs to be available. For most ETFs and Mutual Funds, we can do a look-through via Morningstar or Lipper and make use of the actual underlying compositions.

**The level of Tracking Error in the backtest is very high. As a consequence, relative drawdown is also much higher. Isn't this a bit biased?**

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All the portfolios in the backtests were rebalanced on a monthly basis, and with penalized transaction costs. This of course leads to higher tracking error than more frequent rebalancing. Secondly, the ex-ante tracking error was minimised based on historical covariance matrices. Also the relative iVaR backtest was purely based on historical timeseries. This was done to make sure we were comparing apples to apples rather than the result being dependent on the efficiency of fundamental or statistical factor risk models.

# What is the turnover of the relative iVaR strategy? Are transaction costs accounted for?

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Transaction costs are taken into account during every optimisation. The turnover is different for every use-case, and also dependent on the maximum number of instruments that you allow to be in the portfolio (100 in our backtests). Typically, one-way turnover is around 30-40% per year.

**Could you please provide more information on the methodology? It is great to see the backtest but how do you achieve that? What are the elements you look at?**

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All the portfolios in the backtests were rebalanced on a monthly basis. At each rebalance, we considered all constituents of the index at that historical point in time, and we considered all timeseries until that historical point in time. During the optimisations we construct the portfolio that, given all the relevant constraints, has the lowest possible historical relative iVaR over every subperiod in the past.

# The examples show realised Tracking Error and realised iVar. Do you offer forecasts of iVar for portfolios/stocks?

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InvestSuite has built a general Portfolio Optimizer that constructs personalised portfolios based on the investors preferences and the available data. We do not make explicit forecasts ourselves. Out of sample iVaR is heavily dependent on market circumstances (more so than tracking error), and hence can be best used to rank and optimize portfolios cross-sectionally, rather than to calculate an absolute future risk estimate.

# How can one use ex-post risk Tracking Error in conjunction with ex-ante Tracking Error or are these completely independent?

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In the examples shown, the ex-ante tracking error and ex-post tracking error are independent. Our backtests illustrate that minimising for ex-ante tracking error is not always yielding a lower ex-post tracking error compared to minimising relative iVaR.

# Do any ETFs exist yet that utilize iVaR?

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Currently, iVaR is used by asset owners via our (Robo) Advisory products and by pension fund managers. It is not (yet) used for any ETF.

# What type of risk model do you use to calculate ex-ante Tracking Error: e.g. factor-based?

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The current backtests used historical covariance matrices for the minimisation of ex-ante tracking error. Similarly, the backtests on relative iVaR only used historical time series data. In practice, we do use factor models but that would have made the backtests less comparable, as the results would be dependent on the choice of factor risk model.

# On ESG: how do you deal with missing data?

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The portfolios constructed in the backtests only contain instruments for which on the historical point in time ESG data is available. The ESG scores of the benchmark are calculated based on the instruments for which data is available, with industry medians being used for stocks with missing data.

# Is the data, that is shown in the ‘XRay factor’, based on own judgement or does it come from a database?

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The XRay factors are constructed via our in-house quantitative model. These are integrated in our products, but are also offered as a separate service via our value-added APIs. They are comparable to factors used by players such as Axioma and MSCI Barra, but include more underlying data points and are more granular in terms of which data points are being used for which types of stocks.

# Questions & Answers

ABOUT PORTFOLIO OPTIMIZER AND IVAR

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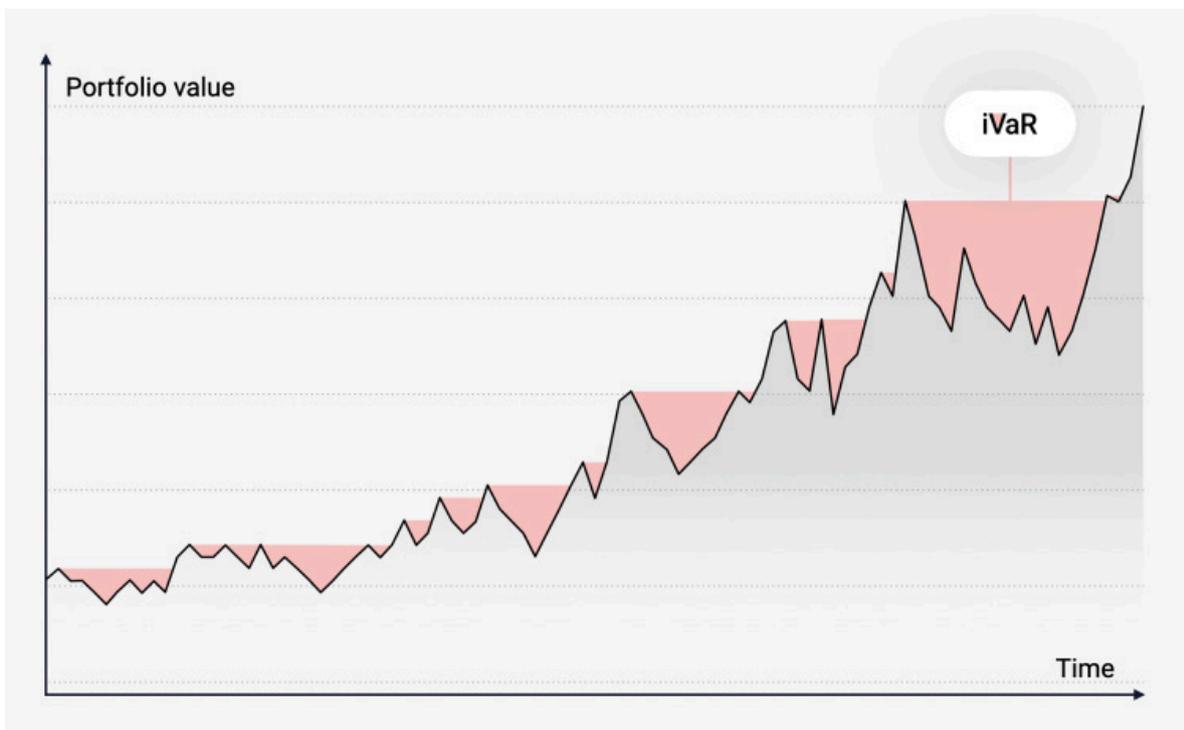
## **GLOSSARY**

# Part one: Portfolio Optimizer & iVaR.

# What is iVaR?

Traditional investment risk measures that are still used today, such as volatility<sup>2</sup>, have historically been chosen because of their simple mathematical properties. They do not work well to describe the risk of real investment portfolios and are not consistent with what end investors perceive as risk.

Following the above observations, we developed a new, innovative risk measure which we call **InvestSuite Value at Risk (iVaR)**. Our basic premise is that any instrument or portfolio providing strict monotonic growth (i.e., no losses) should be riskless, regardless of the speed or consistency of the growth. The reason for this premise is that it matches the behaviour of a savings account, which also increases monotonically in value over time, and is considered riskless by end investors. For instruments or portfolios that do not exhibit monotonic growth (i.e. the vast majority) we calculate the risk (“iVaR”) as the deviation from monotonic growth.

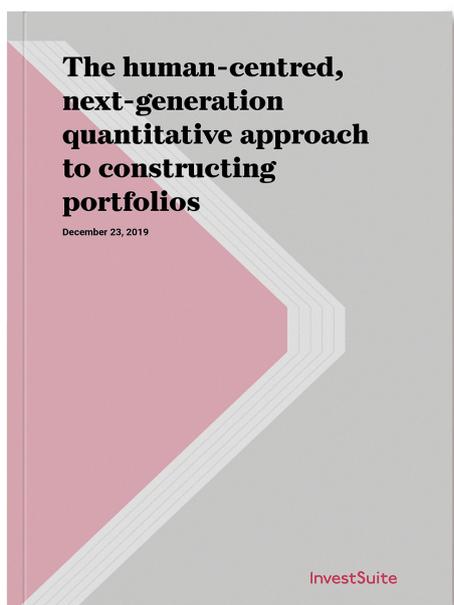


In practice, this deviation is calculated as the difference between the actual value at each point in time and the highest value ever seen up to that point in time. The difference between the two is visualised as the sum of the pink areas (the graph above).

In practice, this deviation is calculated as the difference between the actual value at each point in time and the highest value ever seen up to that point in time. The difference between the two is visualised as the sum of the pink areas (the graph above).

The difference between the two, the sum of the pink areas, is our measure for investment risk, called iVaR (InvestSuite Value at Risk). It is a combination of the size of losses (the height of the pink areas) and the time it takes to make up for those losses (the width of the pink areas). This 4th generation human centric measure of risk can also be used to define relative risk versus a benchmark<sup>4</sup>, similar to how volatility<sup>2</sup> can be used to define relative risk via tracking error<sup>3</sup>.

Using this risk measure in portfolio construction should lead to portfolios that suffer lower losses (versus a benchmark<sup>4</sup>) and make up those losses more quickly, compared to traditional risk measures.



# What is the difference between iVaR and other traditional measures of risk?

Our white paper: [“The human-centred, next-generation quantitative approach to constructing portfolios”](#) explains the differences between iVaR, conditional Value-at-Risk, Value at Risk and volatility<sup>2</sup> in depth. On the graph below we indicate the major differences between those measures of risk. A key feature of iVaR is that it takes into account the total joint return distribution of all assets in the investment universe.

## 4th GENERATION RISK MEASURE - iVaR ADDRESSES THE SHORTCOMINGS OF VOLATILITY<sup>2</sup>, VAR AND CVAR

	Appreciates investment returns are non-normally distributed	Penalizes only losses, not gains	Diversification can only decrease - not increase - risk	Considers entire return distribution (i.e. all possible losses)	Takes into account the time it takes to make up for losses
<b>INVESTSUITE VAR (iVaR)</b>	✓	✓	✓	✓	✓
CONDITIONAL VAR (cVaR)	✓	✓	✓	✓	
VALUE AT RISK (VaR)	✓	✓			
VOLATILITY <sup>2</sup>			✓		



# Harry Markowitz: “A lot has happened since I published that article in 1952.”



Over the last decades, Markowitz has repeatedly admitted that the assumptions behind MPT & CAPM are flawed and that the conclusions of MPT/CAPM do not hold empirically. Below are a few quotes from Harry Markowitz that come from his 2017 interview with Andrew Lo from MIT and his 2005 paper “Market Efficiency: A Theoretical Distinction and so What?”

- *“A lot has happened since I published that article in 1952. Now there’s infrastructure, we have data that goes back to 1926 at least. [...] Now we have optimisers, we didn’t have an optimiser in 1952.”*
- *“I don’t know about you, but I can’t borrow all I want at the risk free rate. Due to investors not being able to borrow at the risk free rate, I don’t believe that the market portfolio even is an efficient portfolio. And it is certainly not an efficient portfolio for everybody”*
- *“It is true that there is no linear relationship between expected return and beta (market sensitivity)”*

- *“The correct portfolio for the individual depends on risk preferences. There are constraints on the choice of portfolio which varies from individual to individual, they have shorter or longer horizons, they are willing to invest in certain asset classes or not, they have different tax situations etc. There is no perfect portfolio, but there is a right portfolio for a specific individual, but it’s a lot of work to find them. Part of the process is always to involve the investor.”*

Nevertheless, a lot of robo advisors proudly claim to be based on Markowitz’s Nobel prize winning technology and ignore the insights that Markowitz himself gained over the last 65 years. Using iVaR within the Portfolio Optimizer is consistent with Markowitz’s 2017 views on how to construct an investment portfolio, not his 1952 views.

# What is so different about the InvestSuite approach in comparison with traditional investment managers?

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The philosophy behind what we do is very different from that of most investment managers. In managing risk, they generally look at tracking error<sup>3</sup> compared to a reference benchmark<sup>4</sup>. Their performance is usually evaluated based on the Information ratio<sup>5</sup> versus this benchmark<sup>4</sup>. We think our iVaR philosophy is more consistent with what end investors actually care about. Portfolio Optimizer is a portfolio construction framework that allows traditional investment managers to combine their views on the markets and restrictions with a 4th generation human centric risk framework.

# How much do you give up on return by minimizing the risk?

Fundamentally, risk and return are different concepts. It is therefore not possible to fully minimize one while simultaneously fully maximizing the other: there has to be a trade-off between risk and return. When only focussing on minimizing risk, some return needs to be given up.

Classic financial theory predicts that risk and excess return<sup>6</sup> should be proportional to each other and taking higher risk should therefore result in a proportionally higher return. This is a strong statement because it means that minimizing risk implies a simultaneous decrease of the returns.

The low volatility anomaly<sup>7</sup> shows, however, that in practice the trade-off between risk and return is not as bad as the above relationship. On the contrary: in most markets, low volatility stocks have historically achieved higher returns than high volatility<sup>2</sup> stocks.

A second effect is called volatility drag<sup>8</sup>. A higher compounded portfolio return over time can be achieved by lowering volatility<sup>2</sup> by itself. So it is not necessary to achieve a higher median or even arithmetic mean average return to be able to provide compounded outperformance.



The result is that, at least historically, it has been perfectly possible to decrease risk without necessarily decreasing returns. There is, of course, no guarantee that the low risk anomaly will hold in the future.

# How do you make sure to be protected against drawdowns in the future, when markets may behave totally differently from today?

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The iVaR approach is dynamic and takes into account current market circumstances. This means that, if markets start behaving totally differently over time (as they often do), the iVaR methodology will pick up on this changing behaviour and reallocate the portfolio accordingly. In short, when minimizing for iVaR the proposed portfolio will shift out of assets with a high sensitivity to systemic risk at that point in time. As an example, in 2005 financial stocks did not behave yet as being very sensitive to risk on/off sentiment, but by end 2006 they started to, and the non-relative iVaR methodology therefore shifted out of financials long before the actual 2008 financial crisis.

# How far back in time does the data set need to go to allow the algorithm to calculate iVaR. Is there a minimum and/or an ideal length of time?

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The Portfolio Optimizer needs at least 3 years of historical data for all instruments. This doesn't mean that all instruments have to exist for 3 years. InvestSuite has built methodologies to create proxies (i.e. underlying index of a fund/etf) and to model historical returns based on factor models. More data is always useful, e.g. in the benefit of conducting a backtest for the strategy.

# What is the time horizon for which the iVaR based optimization is best suited?

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The iVaR based optimization is calibrated to minimise the risk (as defined by iVaR) in the near future. There is no real point in trying to minimise the risk further in the future, as InvestSuites methodology is inherently dynamic and can rebalance as time goes on and market circumstances change. This constitutes a major difference in comparison to classical risk management applications that try to predict longer term risks when holding illiquid instruments.

# How can clients differentiate if the same product is sold to different competitors?

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InvestSuites Portfolio Optimizer is a cloud based portfolio construction tool that is built to allow customisation at scale. Among others, our clients can

- Select a custom investment universe.
- Define a customised objective consisting of among others minimising risk, minimising relative risk, maximising ESG scores etc.
- Implement a custom investment policy that can include in-house views on asset class, sector, region, bond type, etc.
- Set minima/maxima on the exposure to certain parts of the market (asset classes, regions, sectors, bond types, etc.). Those limits can also be set relative to a benchmark<sup>4</sup>.
- Optionally define expected returns for each investment. The Portfolio Optimizer can minimise portfolio risk subject to achieving at least a certain level of expected return (or vice versa, maximizing expected return subject to a maximum risk level).
- Use a custom rebalancing logic/frequency.
- Use a custom client user interface.

In general, InvestSuite aims at having bank level parametrisation possibilities that are very exhaustive.

# Which quality measures or macro data does the algorithm take into account during the portfolio construction?

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Portfolio Optimizer does not explicitly take into account quality<sup>11</sup> or macro-economic data. Nevertheless, they are taken into account implicitly since:

- Lower quality investments will tend to exhibit more drawdowns<sup>1</sup> and volatility<sup>2</sup>, leading our portfolio construction algorithm to avoid them
- Macro data is also immediately reflected in the price of investments and therefore taken into account in the portfolio construction. InvestSuite does not believe in predicting macro variables (research has repeatedly shown this is near impossible), but research is being performed on modelling probabilities of where we are in the business cycle. The pertinent probabilities can be taken into account during the portfolio construction.

# How is currency risk handled for non EUR/USD investors?

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InvestSuite prefers to handle risk in the currency of the investor. Risk can, of course, differ depending on in which currency the risk is calculated<sup>9</sup>. E.g., if USD drops 10% compared to the Euro, this will not impact a USD investor, but it will of course impact an Euro investor that invests in securities that have exposure to USD. Since our portfolio construction method minimizes risk in the investor's currency, it will for example complement USD-based investments with others so that the EUR-denominated value has minimal risk (for a EUR based investor).

The built-in currency hedging<sup>10</sup> of the previous point, however, does not work well for fixed income ETFs. For currencies such as GBP/CHF/JPY there are sufficient ETFs that invest in local currency fixed income ETFs, such that currency risk<sup>9</sup> can be avoided.

For other currency investors, currency hedging<sup>10</sup> could be an option. Next to this, the investment universe can easily incorporate mutual funds, which more often exist in local market or currency hedged versions.

Currency risk<sup>9</sup> is less relevant for equity investments since it is generally much smaller than equity risk. Moreover, due to the fact that local equity market returns and currency returns tend to be negatively correlated, having some currency exposure is often risk reducing.

# Which instrument types can be used in the portfolio construction?

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The universe can consist of a broad range of instrument types, e.g. stocks, bonds, ETFs, Mutual Funds, cryptocurrencies, etc. In case iVaR or cVaR is selected as the measure of risk, instrument types with highly skewed distributions such as structured products can be supported as well. In the latter case the only requirement for an instrument to be incorporated in the universe, is to have sufficient (reconstructed) historical time series data.

# How many instruments should be in the investment universe and how diverse (uncorrelated) do the underlying instruments have to be?

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Irrespective from the risk measure that is used within the portfolio construction, it is important for the Portfolio Optimizer to have sufficient diversification options. This is, however, very hard to quantify. For any hypothetical investment universe, InvestSuite can check the “diversification ratio”, i.e. comparing the risk of the portfolio to the weighted average of the risks of the individual investments. This can give a good indication of whether the investment universe is diversified enough.

# How many times a year does the portfolio construction methodology propose a rebalance?

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Portfolio optimizations can be performed at any point in time and the proposed portfolio can be implemented accordingly. Next to this, rebalances can be proposed automatically by the optimization algorithm. InvestSuites Portfolio Optimizer offers a high degree of customisation. A lot of those parameters also have an influence on the proposed rebalancing frequency and turnover.

In general, when focussing on limiting risk through iVaR, the proposed strategy will be low turnover. On average, 1 or 2 rebalances per year are sufficient to keep the risk of the portfolio limited. Doing more rebalancings would lead to excessive and unnecessary costs. It is important to bear in mind that these are long-term averages. Due to the way the algorithm works, there will be more rebalancings when markets are very volatile and/or markets dynamics are changing.

# Does Portfolio Optimizer involve AI or Machine Learning?

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This all depends on what is considered to be AI/Machine Learning. Yes, Portfolio Optimizer does learn from past investment price data to find the optimal portfolio that limits future investment risk within the given constraints. Yes, InvestSuite is developing GARCH/DCC models that are able to learn from historical data how market dynamics tend to behave and turn that into realistic simulation of scenarios that describes how the future could look like.

No, Portfolio Optimizer does not use “generic” AI such as neural networks. The simple reason for this is that there is not enough independent data to train these generic algorithms on, and the market dynamics change so quickly over time that a model trained to a specific period would break down in the next period. Therefore in investment analysis, these generic models are not often used.

To give an example comparison: it is straightforward to find millions of pictures of cats. Hence, it is relatively easy to train a neural network to recognize a cat. In the last 20 years, however, there have only been a couple of independent recessions, so there is very little data to train a neural network on what a recession looks like. Furthermore, the world is in a totally different place than 20 years ago, so the things that may have caused a recession then may have become irrelevant today. On the other hand, a cat of 20 years ago still looks like a cat.

Because of this lack of “unlimited” data, models that work well in investment management usually have some structural form that is imposed, such that the number of parameters that need to be learned by the model is not too excessive and can be trained with a more limited data set without risking too much overfitting.

# Did InvestSuite backtest the Portfolio Optimizer?

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Portfolio Optimizer is a highly configurable portfolio construction tool that offers customization at scale. It is, of course, not possible to backtest all possible combinations of risk measures, objectives, investment universes and other settings.

InvestSuite did perform a broad range of backtests to assess the relevance of the proprietary measure of risk, iVaR. When running the backtest, at the end of each month data that are available up to that point are fed to the portfolio construction algorithm (using iVaR), the portfolio is rebalanced, and the portfolio is held as a buy-and-hold portfolio until the end of the next month.

Not only do the backtests show that Portfolio Optimizer would have achieved the key objective (minimising deviation from expected monotonic growth) very well in practice, they also show that the approach of limiting that risk would not have resulted in a lower return - actually quite on the contrary. Of course it is important to note that past performance may not be indicative of future performance.

# What is the pricing model of Portfolio Optimizer?

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The general pricing structure of Portfolio Optimizer consists of an annual variable license fee, based on the assets under management. The license fee is floored and the variable part follows a tiered structure, i.e. the possible AUMs are divided into bands and the fee tiers down for the next AUM band.

# Which data are used within Portfolio Optimizer?

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When Portfolio Optimizer is only used to minimize the risk in the portfolio, it solely requires historical time series data. When additional restrictions, e.g. sectoral or regional limits, are applied, additional data is of course needed. InvestSuite has data contracts with some of the main data providers. Alternatively, the Portfolio Optimizer can be run with custom data from our clients.

**Part two: when used  
as framework for  
portfolio construction  
for individual retail  
clients.**

# Can I use the Portfolio Optimizer to construct individual portfolios for every single retail client?

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Portfolio Optimizer is a cloud based optimization tool that is built to allow customization at scale. Therefore, it is extremely well suited to create hyper personalised portfolios for retail clients. InvestSuites B2B clients can, of course, determine the degree of personalisation that is allowed for each end client. Nevertheless, the Portfolio Construction algorithm will take into account all available data up to that point in time. Two similar retail clients with exactly the same setup can have slightly different proposed portfolios depending on the date on which the proposed portfolio is being constructed.

# What about the risk profile of a retail investor? How does InvestSuite use risk profiles such as SRI scores?

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There is no strict regulatory definition of what a risk profile should entail. InvestSuites B2B client can define what they mean with a certain risk profile (e.g. maximum exposure to equity, maximum SRI score in the universe, maximum weighted average SRI score of the portfolio, ...). Nevertheless, InvestSuite has in-house experts that are able to fully support the way the B2B client defines its risk profiles.

For our backtests related to iVaR, InvestSuite used the simplest possible way of defining risk profiles: setting the percentage equity to a fixed value (0/25/50/75/100%).

# How much tilting by the end-user is allowed?

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The Portfolio Optimizer allows as much tilting as the B2B client allows. InvestSuites API supports a hierarchical structure where the B2B client can set the broad lines within which the advisors can set their limits. Next, the advisors can set the lines within which the end users can set their limits. It is a very flexible system and InvestSuite can of course set this up together with the B2B client.

# What is the minimum time horizon for retail clients to be invested?

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In general, there is no real minimum time horizon, as long as the investor realizes he has a higher probability of ending up with a lower amount than the starting amount if he invests for only a short period of time. Usually banks will include the time horizon in the risk profile, giving shorter term investors a more defensive profile.

When iVaR is used as a measure of risk, and the Portfolio Optimizer is used to minimize the risk in the portfolio, then the proposed portfolio is slightly more suited for shorter term investors than an equivalent risk profile in traditional balanced funds. By construction, the optimizer then focuses on limiting risk and having a shorter expected time for recovering from a drawdown<sup>1</sup>.

# What is the minimum amount for retail clients to be invested?

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This heavily depends on 3 factors:

- Settlement costs<sup>12</sup>
- Availability of omnibus custody accounts<sup>13</sup>
- Availability of fractional share trading<sup>14</sup>

# Why does InvestSuite not use classic model portfolios?

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InvestSuite has a couple of reasons for not proposing model portfolios:

- Classic model portfolios are usually simple market cap weighted portfolios. They hold all countries, sectors, stocks, etc. proportional to their size (in terms of market capitalization). The reason for doing this is that they assume market cap weighted portfolio are risk-return efficient, which research has repeatedly shown they are not (see for example Haugen & Baker, Journal of Portfolio Management, 1991: <http://www.efalken.com/LowVolClassics/HaugenBaker991.pdf>).
- Classic model portfolios for different risk profiles usually have the same compositions for their equity and fixed income parts, and equity vs fixed income weight just varies between risk profiles. This is again not risk-return efficient: a more defensive investor should for example hold more defensive equity than a dynamic investor.
- Classic model portfolios assume investors are all identical and have no personal preferences. InvestSuite believes some investors may for example want to invest in a socially responsible way or exclude certain investments (e.g. emerging markets). This more customized approach is not compatible with classic model portfolios.

- Model portfolios cannot be “backtested”: it is not possible to simulate what a model portfolio’s performance would have been before its inception because it is not possible to go back in time and ask what the model portfolio’s investment committee would have proposed to invest in (unless the model portfolio’s investment strategy is simple enough that it can be automated without an investment committee). InvestSuites portfolio construction methodology can be asked what advice it would have produced in the past with the data that was available at that time, and therefore can be backtested.

# Why are hyper personalised portfolios better than model portfolios?

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- Investors have different time horizons, risk tolerances, tax situations, risk exposures (e.g. through their job or holdings in private companies), which should by itself already result in a different investment portfolio for each client. Furthermore, Harry Markowitz makes a great point in a 2017 interview when he says that it is crucial that investors invest in a portfolio that is invested in assets they feel comfortable with. Retail investors massively lose out on performance - about 3% per year(!) - by buying and selling their risky investments at the wrong point in time. If an investor is not fully comfortable with an investment portfolio, the probability of him selling out of it during a time of crisis is much higher. This can be solved with a more personalised portfolio, which is exactly what InvestSuites Portfolio Optimizer aims to achieve. And of course a personalised portfolio provides a much better user experience than forcing investors into a plain vanilla standardised product.
- Individualised portfolios also allow direct clients (the banks/brokers) to incorporate their views into the portfolios. They would not be able to do this if they are forced to use a set of model portfolios that InvestSuite decided on.

## Glossary

- <sup>1</sup> Drawdown: A drawdown is the peak-to-trough decline of an investment during a specific recorded period. A drawdown is usually quoted as the percentage between the peak and the subsequent trough.
- <sup>2</sup> Volatility: Mathematically, it is calculated as the standard deviation of the returns of an investable asset. It is therefore a measure for “absolute risk” and indicates how likely the performance of an investment is to significantly deviate from the return of a cash investment. Usually, annualized numbers are used. A tracking error of 16% means that (assuming normality) the annual return of the investment has a 68% probability of staying within the -16% to 16% range around the return of cash.
- <sup>3</sup> Tracking Error: Mathematically, it is calculated as the standard deviation of the excess returns of an investable asset compared to a reference benchmark. It is therefore a measure for “relative risk” and indicates how likely the performance of an investment is to deviate from the performance of the reference benchmark. Usually, annualized numbers are used. A tracking error of 2% means that (assuming normality) the annual excess returns of the investment vs the benchmark has a 68% probability of staying within the -2% to 2% range.
- <sup>4</sup> (Reference) Benchmark: Evaluating investment performance based on absolute returns is hard. The general direction of markets will dominate investment performance and if you are a long-only equity/bond investor, determining whether you did a good job based on absolute returns alone therefore would be unfair. As a consequence, most asset managers and professional investors evaluate performance compared to a reference benchmark that represents the performance of the broad market that the investor is investing in. This way of evaluating performance gives asset managers the incentive to manage performance and risk compared to this reference benchmark rather than in an absolute sense. Since most retail investors actually care about absolute performance and risk, this creates a clear mismatch. Our approach tackles this problem.
- <sup>5</sup> Information Ratio: Mathematically, it is calculated as the ratio of the (annualized) excess return vs the reference benchmark divided by the (annualized) tracking error vs the benchmark. It is therefore a risk-adjusted measure of outperformance. Really good investment managers achieve an information ratio of 1.
- <sup>6</sup> Excess Return is the return of an investment above the risk-free rate. It appears in traditional financial theory, where excess return can only be achieved by taking on risk. In practice it is a bit of a strange concept, as a risk-free rate does not exist in practice.

- <sup>7</sup> The low-volatility anomaly is the empirical observation that portfolios of low-volatility stocks or bonds have higher risk-adjusted returns than portfolios with high-volatility stocks or bonds in most markets studied. The anomaly holds for the last 80 years in the US and for at least the last 20 years in other markets. One of the main explanations is that traditional finance assumes that investors can borrow unlimitedly at the risk-free rate (allowing any anomaly to be arbitrated away by investing in low volatility stocks and bonds in a leveraged way). In case there are limits to borrowing, it can be theoretically shown to lead to the empirically observed low-volatility anomaly (e.g. Jensen, Black, Scholes).
- <sup>8</sup> Volatility drag is a mathematical effect that is the consequence of how returns compound over time. Holding the arithmetic mean of annual returns equal, a security with lower volatility will have higher compound growth. This can be shown quite easily: A security that drops 50%, then rises again by 50% will only have 75% of its original value. A security that drops 10%, then rises again by 10% will have 99% of its original value. Therefore, being able to achieve the same (or even lower) arithmetic mean returns with the same volatility results in larger compounded returns over time.

The below table provides a simple example to illustrate this. The Low Risk portfolio has an annual return that alternates between 0 and 2% and therefore achieves a median (and arithmetic mean) return of 1%/year. The annualised return over the 10 years is roughly equal to 1% as well.

The return of the high risk portfolio alternates between -20% and +24% and therefore has a median return of 2%/year. However, due to the higher return variance, the actual annualised period return is negative at -0.4%/year. This shows that you can have a lower median/arithmetic average return and still outperform.

	Low Risk Portfolio	High Risk Portfolio	Low Risk PF Value	High Risk PF Value
			100.0	100.0
<b>Year 1</b>	0%	-20%	100.0	80.0
<b>Year 2</b>	2%	-24%	102.0	99.2
<b>Year 3</b>	0%	-20%	102.0	79.4
<b>Year 4</b>	2%	-24%	104.0	98.4
<b>Year 5</b>	0%	-20%	104.0	78.7
<b>Year 6</b>	2%	-24%	106.1	97.6
<b>Year 7</b>	0%	-20%	106.1	78.7
<b>Year 8</b>	2%	-24%	108.2	96.8
<b>Year 9</b>	0%	-20%	108.2	77.5
<b>Year 10</b>	2%	-24%	110.4	96.1
<b>Median Return</b>	1.0%	2.0%		
<b>Mean Return</b>	1.0%	2.0%		
<b>Annualised Return</b>	1.0%	-0.4%		

- <sup>9</sup> Currency Risk is something that people often get wrong. Currency risk is caused by having an underlying exposure to currencies other than the investor's home currency. For example, the currency risk is exactly the same whether you buy Intel shares on the New York Stock Exchange in USD or on the Frankfurt Exchange in EUR. If the USD drops, that drop will be reflected in the EUR price of Intel (this seems super straight forward, but I have seen multiple private bankers being unable to grasp this). Likewise, from a currency risk perspective it doesn't matter whether a fund is denominated in EUR, USD or any other currency, the currency risk for the investor remains the same. The only advantage of having a fund denominated in the home currency of the investor is that he doesn't need to exchange currency to purchase or sell it. The way to avoid currency risk is by doing Currency Hedging, either within the fund/ETF or directly on the investor's account.
- <sup>10</sup> Currency Hedging is the process of avoiding the currency risk of an investment by short selling the currency of the investment against the investor's base currency. For example, if you buy 1000\$ worth of Intel shares, you can short sell 1000\$ against EUR and this will fully offset a decline of the EUR. A few options are possible, all of which involve derivatives and can therefore be complex from a regulatory point of view.
- Forward FX contracts: involves borrowing dollars with a settlement date in the future, then buying them back later with the same settlement date as the initial transaction. Any losses or gains on the hedge are exchanged on the settlement date. Interactive brokers support automatic FX hedging at the time of purchase of an instrument, making this process relatively straightforward.
  - CfD (contract for difference): A retail-oriented derivative with a not too great reputation (mainly due to speculation being done with them, often incurring large losses). On a daily basis, changes to the currency value are settled on the account of the investor. Therefore simpler than a forward contract but the counterparty may take higher margins.
  - FX Future: Similar to a CFD, but more focused towards institutional investors and therefore has higher unit amounts.
- <sup>11</sup> The quality of a company is a concept that is often a bit ambiguous. Generally, a few metrics fall under the category of quality, but every investor will have its own weighting between them:
- Profitability (measured as return on assets or return on equity): higher quality companies manage to create high profits compared to their allocated capital.

- Leverage & debit servicing: Calculated as a company's debt divided by its total assets. Higher leveraged companies are much more risky as small decreases in assets can lead to insufficient assets to pay back debt and therefore bankruptcy. Also debit servicing (cash flows or profits divided by interest payments) are often used as a quality measure.
- ESG: Environmental, social and governance standards that a company adheres to. Especially governance is often seen as an important measure of quality.
- Stability: Companies with stable revenue, margins and profits are usually seen as higher quality. A more diversified client and product base also leads to higher stability. Also having an "economic moat" (strong market position that makes it difficult for new entrants, allowing a company to keep stable high margins for a long period of time) is seen as a good metric of quality.

<sup>12</sup> Usually, transaction costs are calculated as a percentage of the traded amount with a minimum floor. The minimum is almost never lower than 5€, which makes it expensive to trade smaller amounts. Trading 500€ will in that case incur a cost of 1%, which is of course very high.

<sup>13</sup> An omnibus custody account (as opposed to a segregated custody account) means that the intermediary financial institution only has 1 account on which it holds the investments of all clients. The allocation to individual clients is then done using internal systems. This approach is often used by robo-advisors and other retail brokers, as it allows to split up fixed transaction costs over multiple clients, allowing multiple clients to each trade smaller amounts, which would not be cost efficient otherwise (it's not very efficient to buy 50€ of shares when the minimum transaction cost is 5€...). Omnibus custody accounts also support fractional share trading.

<sup>14</sup> Fractional share trading is a concept that allows retail investors to buy a fraction of a share (or ETF). It is very useful for investment plans where people may want to buy less than 1 share at a time (usually around 100€). Fractional shares cannot be traded on an exchange, so someone else has to take the "rest of the share" on his books, which requires e.g. a broker to function as an intermediary. Apart from regular investment plans, fractional share trading is less necessary as few people will want to invest less than 100€ per security. Fractional share trading is also only useful through an omnibus custody account as otherwise the minimum transaction costs would be prohibitive.