Module Risk Management – Tail Risks
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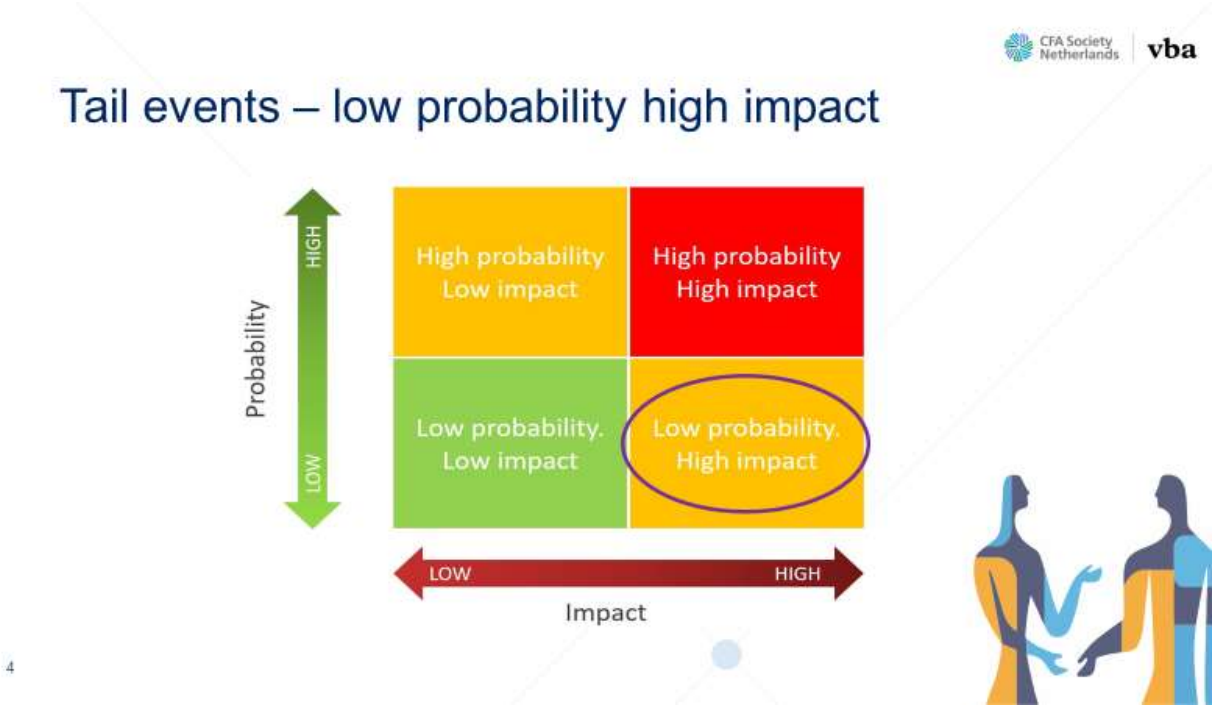
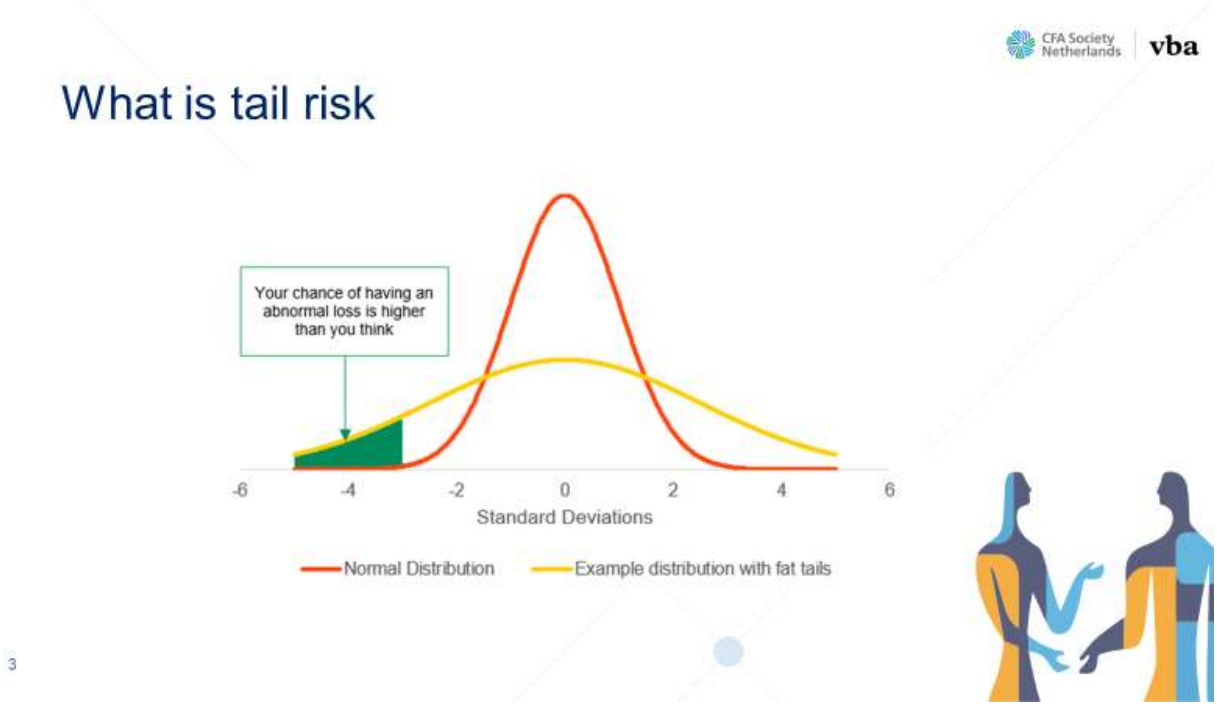
Hello, my name is Anisa Salomons and I work in the Fiduciary Management team of NNIP and I'm board member of CFA Society VBA Netherlands. Today we're going to talk about Tail Risk Management: what is it, how does it affect the investment portfolio and the balance sheet, how can it be mitigated and what could cause a tail event.

What is tail risk

A tail risk is what is called in risk management terms a low probability high impact event. It has a small chance of occurring, but when it does occur the impact is very big. In this graph we use a very simple definition of risk as risk = probability times impact. Probability on the vertical axis and impact on the horizontal axis. The boxes marked yellow have the same "risk", the green box is low probability, low impact, marked green because you can disregard these events. They do not occur frequently and when they occur the impact is limited. In red the high probability high impact events, they occur frequently and they have a high impact so of course you must address these. But also because they occur frequently it is easier for us a persons to assess the risk, and determine mitigating measures. The bottom right box, that we're are talking about today might be more difficult, they occur infrequently, but when they do the impact is very big. Like in our personal life the chance of our house burning down is low, but the impact is big emotional as well as financial. And then the question becomes do you want to mitigate this risk. From perspective of the insurance company or bank that has lend you the money for the house this is different. They look at their portfolio and in their portfolio this event occurs more frequently and the impact is more limited, for them it falls in the other yellow box of a high probability, low impact event. And their mitigating action is that it is often mandatory to have fire insurance in order for them to lend you money. So from a risk perspective tail risk can be summarized as a low probability high impact event.



In financial risk management terms tail risk is formalized by linking it to probability distributions. And tail events occur in the tail of the distribution which means that the frequency of the events is low. Often a definition is used that a tail event is more than 3 standard deviations away from the most frequently occurring event, the median. If you remember your high school statistics well, then a tail event has a probability of less than .3% of occurring.



However this .3% is under the assumption of a normal distribution, as you see in the red line of this graph. If the events do not follow a normal distribution but follow a distribution that have fatter tails (higher kurtosis), as you see in the yellow line, or are skewed with more undesirable events occurring than desirable events, then the probability of the event occurring could actually be much higher. Normal distributions are often used as they are easy in calculations and because it is difficult to estimate the actual distribution due to limited data and the adaptability of financial markets. Financial markets are not physical processes that repeat itself indefinitely in the same way.

Often cited examples of tail events are big market crashes like the Great Financial Crisis of 2007, or the bursting of the dot-com-bubble in the 90s. Although some people, for example, Nassim Nicholas Taleb, do not agree that these are really tail events. Because they fall well within the normal patterns that we see in the financial markets.

In summary a tail event is defined as an event that is three standard deviations away from the median, and normal distribution often underestimates the chance of a tail event happening.

So how does tail risk affect an investment portfolio and what is the effect on the balance sheet of a pension fund

For an investment portfolio risk can be defined as the uncertainty of meeting the investment objective. Investment objectives differ depending on the purpose and can be determined by formal liabilities, or a purpose like to keep an endowment intact and thus having a cash plus inflation target. For investment funds there can be absolute return targets like cash + 3%, but often the target is to meet or outperform a benchmark within a certain risk budget.

For these funds with a target relative to a benchmark, tail risk resulting from very large market movements are not necessarily a problem. The whole market is going down and as long as they keep the losses relative to the benchmark limited or even outperform the benchmark they still fulfill their objective.

But tail risk comes also in other forms, for example. liquidity drying up or being forced to put up additional collateral for your derivative positions due to the large market movements. The Gamestop frenzy at the beginning of the year is an example related to this. On a Reddit forum people organized to bid up the price of the stock of GameStop. Which resulted in big returns for the people who invested at the right moment. While at the same time some hedge funds had large short positions in this stock. With short selling the fund borrows the stock from another investor for a certain time period after which they have to return it. When they borrow the stock they sell it and they expect that at the moment they need to return the stock the price has dropped and they can buy it at a discount and thus making a return. However with Gamestop this went awry. Melvin Capital is an investment fund that had large short positions and needed capital injections in order to close out their short positions and stay afloat. They received a capital injection from hedge fund Citadel, while at the same time market maker Citadel Securities executed the trades for online broker Robinhood. There is a two day lag between the trade and the settlement for which the broker needs to post collateral. Due to the increased volatility of the stock the collateral requirements increased and also caused problems for Robinhood. They decided to halt trading in Gamestop and needed to raise additional capital. This example shows the indirect effects of tail events on investment portfolios.

A pension fund is typically a long term investor. They receive premiums now and need to payout pension benefits in the future when the participant retires. According to pension consultant AON the average duration of the liabilities of a pension fund in the Netherlands is approximately 20 years. Therefore, the liabilities of a pension fund are very sensitive to interest rate movements. They solve this by hedging the interest rate risk with interest rate swaps and bonds. If you look at the balance sheet of a pension fund you see on the right hand side in blue the pension liabilities, which are partially matched as you see in green and yellow. Pension funds in the Netherlands hedge between 30 and 70% of the interest rate risk. Typically industry wide pension schemes are at the lower end of the scale and company pension scheme at the higher end of the scale.

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Pension fund sensitive to equity and interest risk

Assets *(duration x < y)*	Liabilities
Matching Assets • Interest rate derivatives • High quality Government bonds **Assets with dual objective** • Investment Grade Credit bonds • Mortgages **Growth assets** • High yield and Emerging Market debt • Equity and Alternative investments	**Nominal liabilities *(Duration Y)*** • Pension payments

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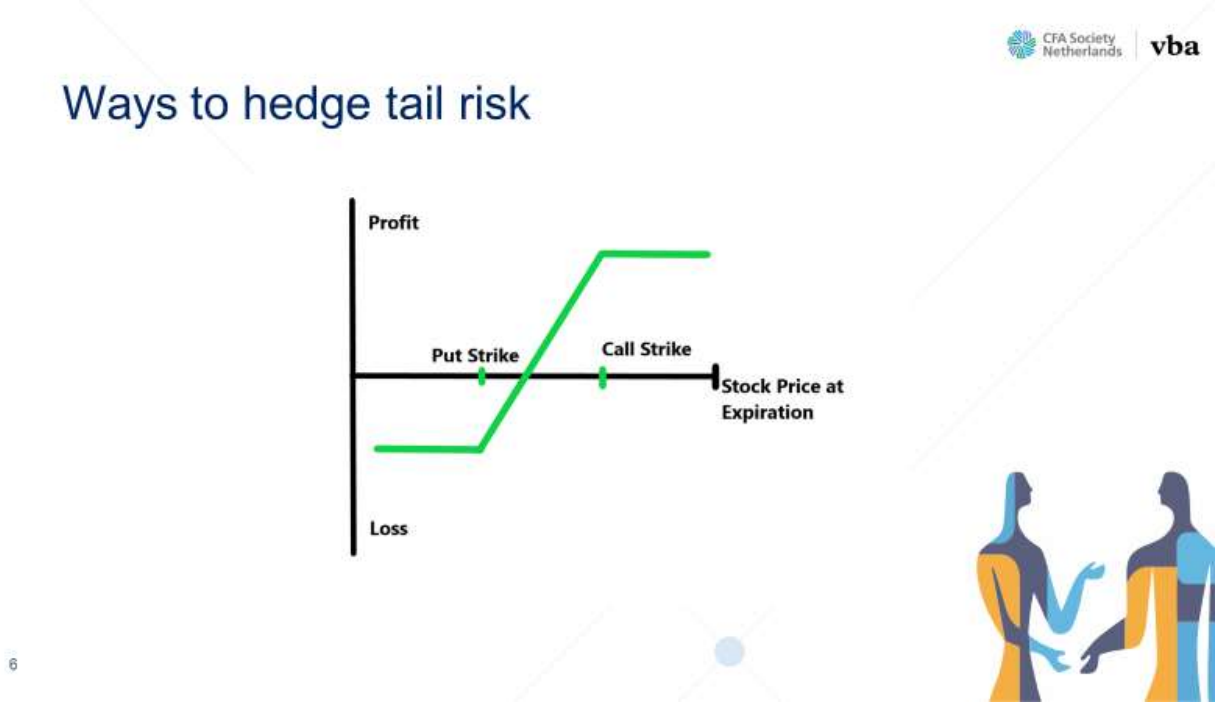
The pension ambition cannot be fulfilled by only investing the pension premiums matching assets, therefore the pension fund needs to generate additional return by investing in growth assets, which you see in red. Examples of these growth asses are equity, high yield, EMD, real estate, infrastructure equity which all correlate with the equity markets.
The pension fund would like to payout inflation indexed pensions, these inflation matching assets are sometimes part of the matching portfolio and sometimes part of the growth portfolio.
In summary, there is a residual interest rate risk from the pension liabilities and equity risk on the asset side.
We have all seen in the Netherlands how the pension funds have been affected by the gradual drop in interest rates to 0%, which was really considered a tail event when I started working in 2007. This was combined with the 2008 crash in the equity markets, luckily followed by a strong recovery. The coverage ratios have severely dropped by these events, below 100% for the large funds, and has accelerated the discussion about a new pension system.

Should a long term investor hedge their main risks?
For a long term investor who believes in mean reversion, it does not make much sense to hedge the equity risk. A drop in the price of equities will be followed by an increase in the direction of the mean. And thus should not hinder the funds in meeting their investment goals.
However, certainly now but also in the past you could argue *if* they *really* are long term investors. When the coverage ratios drop below the first threshold (the VEV) they are no longer allowed to index the pensions. And if the ratios drop even further below their critical boundary (MVEV), the pension fund is obligated to cut benefits, which participants in the pension funds as well as their board do not like happening. Hence pension funds are not only long term investors but they have also short term constraints. With the transfer to the new pension system they are again short term constraint because under the 'Transitie-FTK, the coverage ratio should be at least 90% with the expectation to increase to 95%.

How can you hedge the risk?
Hedging of the interest rate and/or equity risk is possible with plain vanilla instruments. For the interest rate risk, pension funds already use interest rate swaps. They could combine this with interest rate swaptions in order to protect their downside, without losing the upside of rising rates.
Also for equities it is possible to use put options to protect the downside, in order to reduce costs this is often combined with call options into a collar. However, then you also give away some of the upside.
Caveat is that predicting that a crash will happen is not difficult, predicting *when* it will happen is difficult. With the use of options there are certain costs, but uncertain benefits. So the question becomes what will you regret more in the future, buying the protection that you might not need, or cutting pension benefits while this could have been prevented.



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What can cause a tail event

In general one can say there is a buildup in the financial system, and then a seemingly random event occurs that brings it over the tipping point. That was for example the fear last year with the onset of the covid-19 pandemic, which did cause stress on the financial markets but was not the tipping point. The DNB publishes in their 'Overzicht Financiële Stabiliteit' on what they see as risks that threaten the stability of the financial system. Each of these risks could contribute to a tail event. On the vertical axis you can see the different regions: the Netherlands, Europe to International at the top. On the horizontal axis it ranges from acute risks to slumbering risks.

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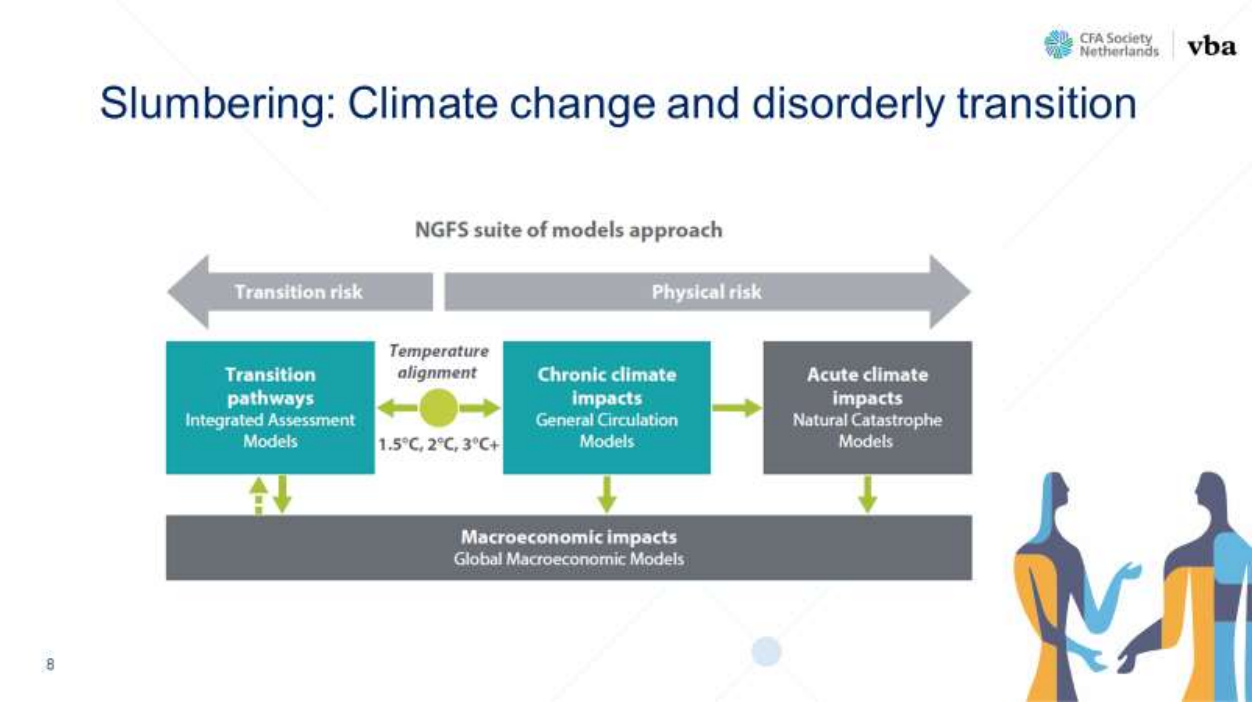
You can recognize some of these as themes that are part of the MiFID II program. The continuing low yields that has an effect on the real estate market, makes it easier for sovereigns to stimulate the economy by increasing debt levels and has an effect on business models. A rising inflation could force central banks to increase rates, which could set off taper tantrums. A delay of the post-covid-19 recovery or a heterogenous rise out of the covid pandemic could also affect the financial stability.
One of the slumbering risks they identify is climate change and the energy transition needed to fulfill the Paris agreement. A slumbering risk indeed as we can all see climate change and loss of biodiversity happening around us, but we don't know how effective we all will be as governments, companies and consumers in keeping our promises, changing behavior, making the necessary investments and creating technological break throughs. The modelling is very complex. The Network for Greening the Financial System proposes the following schematic model to study the effects of climate change on the economy. They first separate physical risk and transition risk. The physical risks are for example rising sea levels, but also droughts that decrease agriculture output. Transition risk is about the ability and the pathway in transitioning to a low carbon economy. Both the physical and transition risk are of course impacted by how effective we are in keeping temperature increases between the 1.5-3 degree pathway. If we don't get rising temperatures under control, governments may be required to quickly increase carbon pricing which then will have an effect on the economy. So this is a slumbering risk indeed that is currently still difficult to quantify with much certainty.



To summarize

Tail risks are low probability high impact events. Typically we think of large market movements, but also the related increase in volatility has its effect on derivative pricing and collateral requirements. Another related risk is loss of liquidity. Investment funds with an absolute return target or that use derivatives are vulnerable to tail events. Pension funds typically have the most exposure to interest rate risk and equity risk. As a long term investor without short term constraints it would not make much sense to hedge equity risk.

However with the current low coverage ratios and the transition to the new pension system, the Dutch pension funds do have short term constraints and could consider hedging these risks. Instruments that could be used to hedge the risk are interest rate swaptions and equity puts or collars. But of course hedging the risk has a certain cost but uncertain pay off.

Tail events could be set off by a myriad of possibilities. What is of concern to the DNB at the moment is the low rate environment which has triggered the search for yield and thus inflated prices and has caused high government debt levels which are increasing further by the Covid-19 stimulus. A slow and/or unequal path out of the pandemic could also cause instability in the financial system. Finally they see climate change and the energy transition as a slumbering risk.