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# Integrating Climate Risk Into Strategic Asset Allocation

Traditional environmental, social and governance (ESG) analysis has tended to focus on fundamental or "bottom-up" factors. However, we believe that the systemic nature of climate risks demands an expanded "top-down" approach that informs broad asset allocation decisions as well as security selection.

In this paper, we provide a framework for integrating climate-related risks into strategic asset allocation (SAA).

In our view, the positive results we find when we integrate climate risks into SAA suggest that investors may be exposed to potential downsides, and missed opportunities, if they fail to take them into account.

## Executive Summary

- We use a Climate Value at Risk ("Climate VaR") model to estimate the potential impact of climate change on the present value of securities, which we then aggregate up to the benchmark index level to use as inputs into the strategic asset allocation (SAA) process.
- *Ex post* Climate VaR adjustment to an SAA optimization lowers the efficient frontier: for a given unit of volatility, estimated return is lower relative to the optimization that does not take climate-related costs (and gains) into account.
- Climate VaR is widely dispersed across different asset classes and sectors—some investments appear to be considerably more at risk than others, suggesting potential opportunities to enhance efficient frontiers by integrating Climate VaR *ex ante* into the SAA optimization process.
- An SAA optimization that fully integrates Climate VaR *ex ante* can raise the efficient frontier, relative to the optimization that receives an *ex post* Climate VaR adjustment to its estimated returns.
- Including low carbon indices into the SAA optimization that fully integrates Climate VaR *ex ante* can additionally reduce a portfolio's financed carbon emissions without impairing its estimated risk-adjusted return.
- Investors can integrate additional climate metrics, such as carbon intensity or carbon footprint, as constraints in the optimization process; the wide variation of financed emissions between asset classes makes it possible to set those constraints within a wide range, and helps to minimize impairment of estimated risk-adjusted return.

In August 2021, the Intergovernmental Panel on Climate Change published *Climate Change 2021: the Physical Science Basis*, which concluded that without dramatic reductions in carbon emissions, it may not be possible to limit global warming to 2.0°C above pre-industrial temperatures. We believe that the impacts of climate change are growing in severity and frequency, and are likely to affect businesses in two major ways: through physical risks to assets, and through business risks associated with the transition toward global net-zero emissions.

Traditional environmental, social and governance (ESG) analyses have tended to focus on fundamental or "bottom-up" factors. The concept of materiality and the advent of sector-specific ESG frameworks such as the Sustainability Accounting Standards Board, now part of the Value Reporting Foundation, have provided needed guidance on how to carry out ESG-integrated fundamental research into individual security issuers.

However, we believe that the systemic and rapidly evolving nature of climate risks demands an expanded approach that informs broad asset allocation decisions as well as security selection.

Investors already incorporate their views on monetary policy and macroeconomic or geopolitical risks into SAA by generating forward-looking capital market assumptions (CMAs). The fundamental difficulty involved in generating those CMAs is amplified by the emergence of novel climate risks, which are much less likely to be reflected in any historical data. This is why a growing portion of the investment industry has begun to question how ESG factors, in particular climate-related inputs, might be integrated into their long-term, "top-down" SAA models.

In April 2021, we published a paper on the "transition to net-zero investing" which leverages the framework developed by the Institutional Investors Group on Climate Change (IIGCC), one of the Founding Partner investor networks of the Net Zero Asset Managers Initiative.[1] The framework outlines a climate-integrated SAA as one key step in the net-zero journey for investment portfolios. In this paper, while acknowledging that climate forecasts are inherently unpredictable in timing and magnitude, we attempt to provide a framework for integrating climate-related risks into SAA.

## A Robust Framework With Some Headline Outcomes

In the traditional "bottom-up" ESG investing process, climate considerations are generally implemented at the sector and company level after the SAA of the portfolio has been set. This may leave climate risk exposure unrecognized at the level of the SAA, and it foregoes the potential to enhance risk-adjusted returns by taking advantage of meaningful variation in climate impact across asset classes and sectors.

[1] See IIGCC, Consultation: Net Zero Investment Framework (August 2020); and "The Transition to Net-Zero Investing" (April 2021) at https://www.nb.com/transfer?URL=insights/white-paper-transitioning-to-net-zero-investing.

To address this, Neuberger Berman has designed a proprietary approach to SAA that optimizes on client-specific fundamental objectives such as yield, duration and volatility, while integrating various climate-related considerations, which can also be tailored to client needs. These climate considerations can be reactive (such as changes to the estimated returns and volatilities due to climate and climate-policy risks) or proactive (such as making specific portfolio allocation choices to minimize those risks). The structure of our model framework enables these considerations to be implemented alongside an investor's own unique set of objectives and constraints, such as liability and capital considerations for pension plans or insurers.

**FIGURE 1. THE NB CLIMATE-INTEGRATED SAA FRAMEWORK**

| Key NB capabilities | Description | Client considerations |
|---|---|---|
| **Integrate climate-related risks and opportunities** | Corporate debt & equities: Climate-Value-at-Risk model ("Climate VaR")<br><br>Sovereign debt: NB Sovereign Climate-Impact Framework | For climate-aware portfolios |
| **Include financed carbon emission constraint** | Constraint can be applied using carbon intensity or carbon footprint[2] | For portfolios with carbon reduction targets |
| **Integrate both climate-related risks/ opportunities and carbon emission constraint** | For net-zero aligned portfolios | For net-zero aligned portfolios |

Source: Neuberger Berman. For illustrative purposes only.

For the general-case investor, we find that integrating climate considerations at the SAA level leads to the following outcomes:

- A shift away from traditional high yield and emerging markets debt, where issuers have some of the highest environmental costs and exposures
- A shift into U.S. equities from other developed markets
- A broad rotation away from the energy, industrials and basic materials sectors, into technology, communications and non-cyclical consumer sectors
- Enables a modest shift into low-carbon asset classes, which can lower a portfolio's financed carbon emissions without impairing its risk-return profile

## The Impact of *Ex Post* Incorporation of Climate Costs Into SAA

### Climate Value at Risk

As previously mentioned, we believe climate change generally affects businesses in two major ways: First, is the physical impact of climate change itself. Extreme weather events, wildfires, floods and rising sea levels are likely to disrupt some supply chains and threaten the viability of some capital assets. Second, are business and policy risks associated with the transition toward global net-zero emissions. Efforts to slow climate change through carbon taxes, regulation and changing consumer purchasing behavior are likely to create new winners and losers in business as well as new risks and opportunities in investment.

In our climate SAA framework, we integrate these considerations using a forward-looking climate indicator called "Climate Value at Risk" ("Climate VaR"). Developed by Carbon Delta and MSCI and incorporating the latest academic climate science findings and input

[2] Neuberger Berman uses carbon footprint as a key measure of financed absolute emissions. An investment's carbon footprint is defined as the absolute apportioned Scope 1 and 2 emissions divided by the investment amount in millions of dollars. Absolute apportioned emissions are emissions attributed to an investor based on his or her ownership share of a company's total invested capital as defined by EVIC (Enterprise Value Including Cash).

from the financial services industry, Climate VaR is defined as the present value of aggregated future policy risk costs, technology opportunity profits, and extreme weather event costs and profits, expressed as a percentage of a security or portfolio's market value.

We regard Climate VaR as having two primary benefits relative to considering historical or point-in-time climate costs. First, climate effects tend to be long-term in nature, therefore a forward-looking metric best captures the associated risks and opportunities. Second, Climate VaR offers flexibility to carry out climate scenario analysis along various global-warming pathways: it enables investors to estimate VaR given 1.5°C of warming, 2.0°C or warming, or more.

By translating climate impacts into an economic value in present dollars, Climate VaR enables us to integrate them seamlessly into security-level analysis of both equity and corporate fixed income benchmarks. These outputs can then be used, through a proprietary methodology, to adjust the capital market assumptions used in our optimizations.

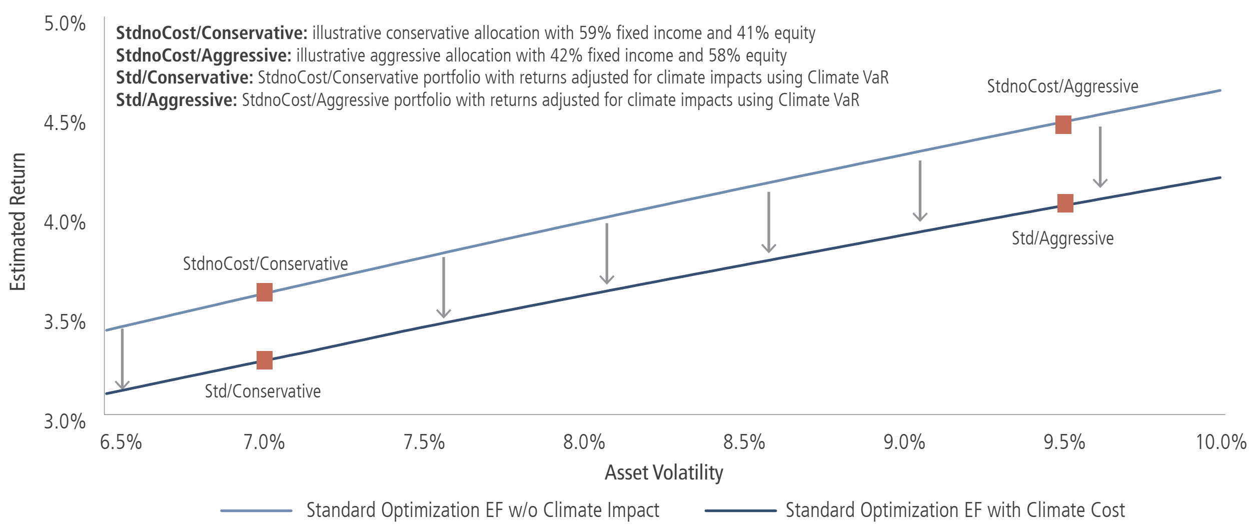
For sovereigns, we use a proprietary framework that deploys similar climate scenarios as those informing Climate VaR to estimate potential changes to macro-economic variables and capital market assumptions by geography.

**Quantifying the Impact of Climate Costs on Portfolio Returns**

To quantify the potential impact of climate costs, we first run an optimization using Neuberger Berman's intermediate capital market assumptions, without integrating climate costs derived from the Climate VaR analysis.

Under this optimization, we create an efficient frontier that represents a range of strategic investment allocations that an investor would make if they did not allow any consideration for climate change—shown as the blue line in Figure 2. On this frontier, we choose two illustrative portfolios—a roughly 40% equity, 60% fixed income portfolio and a roughly 60/40 portfolio—to represent a conservative and more aggressive investor allocation, respectively.

**FIGURE 2. EFFICIENT FRONTIERS: WITH AND WITHOUT ESTIMATED CLIMATE COSTS**




Source: Neuberger Berman, Bloomberg, JP Morgan, MSCI. Data as of December 31, 2021. Indices used: Bloomberg Barclays Indices for U.S. Treasuries, U.S. Corporate bonds, U.S. Large-Cap Equities and Small-Cap Equities; MSCI Indices for EAFE and Emerging Markets Equities; JPM EMBI for Emerging Markets Sovereign Debt; JPM CEMBI for Emerging Markets Corporate Bonds. **Past performance is no guarantee of future results.** Please note that estimated returns data is based on NB's capital markets assumptions and are provided for information purposes only. There is no guarantee that estimated returns will be realized or achieved nor that an investment strategy will be successful, and may be significantly different than shown here. Investors should keep in mind that the securities markets are volatile and unpredictable. There are no guarantees that historical performance of an investment, portfolio, or asset class will have a direct correlation with its future performance. Net returns will be lower.

We then use our proprietary process to convert the Climate VaR costs into return differentials for fixed income and equity asset classes. Based on our process, we estimate that climate costs can shift overall portfolio estimated returns down by up to 45 basis points, which is represented as the downward shift from the light blue efficient frontier to the dark blue efficient frontier.

Essentially, a conservative or aggressive investor that believes they would earn an annualized return of 3.6% or 4.5%, respectively, over the next several years, could instead earn only 3.3% or 4.0% due to projected climate costs under a 2°C warming scenario.

## Opportunity for Further Optimization Based on Climate VaR Dispersion

### Climate VaR Dispersion

So far, we have considered the impact of passively incorporating climate costs into the SAA process, *ex post*. However, by drilling a little deeper into our high-level asset classes, we can see that Climate VaR can vary significantly across asset classes and sectors.

In Figure 3, we segment the Climate VaR values by sector and asset class. We further break down the fixed income indices by credit rating and maturity. Climate VaR tends to be greater for equities versus bonds—the methodology assumes that equity bears the initial cost impact given its lower position in a capital structure. We also notice greater Climate VaR among the most carbon-intensive industries such as those in the energy, utilities and basic materials sectors, as well as in certain consumer discretionary businesses, such as airlines. Within some of these sectors, however, there are pockets of positive Climate VaR, reflecting that some issuers may have a significant portfolio of renewable technology patents. Overall, the indices with the greatest exposure to higher carbon-emitting sectors tend to face greater physical and transition climate risks over time.

**FIGURE 3. CLIMATE VAR DISPERSION WITHIN ASSET CLASSES**

Weighted average Climate VaR under a 2°C warming scenario (%)

| Climate VaR | U.S. IG A/ above 1-5 yrs | U.S. IG A/ above 5-10 yrs | U.S. IG A/ above 10-20 yrs | U.S. IG A/ above 20+ yrs | U.S. IG BBB 1-5 yrs | U.S. IG BBB 5-10 yrs | U.S. IG BBB 10-20 yrs | U.S. IG BBB 20+ yrs |
|---|---|---|---|---|---|---|---|---|
| **Basic Materials** | 0.0 | -2.2 | -7.8 | -1.4 | -1.5 | -2.0 | -6.0 | -4.8 |
| **Communications** | 0.0 | 0.0 | -0.1 | -0.3 | -0.1 | -0.7 | -0.8 | -1.7 |
| **Consumer, Cyclical** | 0.0 | -0.2 | 0.0 | -0.1 | -3.0 | -2.1 | -1.7 | -3.8 |
| **Consumer, Non-cyclical** | 0.0 | 0.0 | -0.1 | -0.4 | -0.6 | -1.0 | -1.1 | -2.2 |
| **Energy** | -0.3 | -1.5 | -3.4 | -5.6 | -1.9 | -2.9 | -4.9 | -4.5 |
| **Financial** | 0.0 | -0.2 | -0.2 | -0.2 | -0.9 | -0.4 | -0.4 | -0.8 |
| **Industrial** | 0.0 | 0.0 | -0.2 | -0.5 | -0.1 | -0.2 | -1.0 | -1.3 |
| **Technology** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -0.1 | -0.3 |
| **Utilities** | -0.2 | -0.9 | -2.1 | -3.5 | -1.5 | -2.4 | -2.4 | -2.2 |

| Climate VaR | U.S. HY BB & B | EMD Corp | U.S. Large Cap | U.S. Small Cap | Developed Equity Ex U.S. | EM Equity |
|---|---|---|---|---|---|---|
| **Basic Materials** | -8.1 | -15.2 | -17.4 | -18.3 | -26.1 | -31.9 |
| **Communications** | -1.6 | -5.9 | -5.2 | -5.4 | -23.4 | -8.6 |
| **Consumer, Cyclical** | -8.4 | -22.4 | -10.4 | -14.8 | -11.4 | -12.6 |
| **Consumer, Non-cyclical** | -1.4 | -6.0 | -7.3 | -7.2 | -12.2 | -13.1 |
| **Energy** | -9.8 | -20.5 | -34.6 | -34.1 | -41.7 | -63.1 |
| **Financial** | -0.8 | -2.3 | -6.4 | -7.4 | -20.6 | -18.9 |
| **Industrial** | -3.5 | -7.0 | -5.6 | -9.5 | -5.4 | -29.4 |
| **Technology** | -0.3 | -1.3 | -1.3 | -1.6 | -2.0 | -9.1 |
| **Utilities** | -16.4 | -36.0 | -45.9 | -23.3 | -43.3 | -54.7 |

0 to -1.0 | -1.0 to -5.0 | -5.0 to -20.0 | -20.0 to -50.0 | -50.0 or lower

Source: Neuberger Berman, Bloomberg, JP Morgan, MSCI. Data as of December 31, 2021. Indices used: Bloomberg Barclays Indices for U.S. Treasuries, U.S. Corporate bonds, U.S. Large-Cap Equities and Small-Cap Equities; MSCI Indices for EAFE and Emerging Markets Equities; JPM EMBI for Emerging Markets Sovereign Debt; JPM CEMBI for Emerging Markets Corporate Bonds; MSCI ACWI Low Carbon Target Index; MSCI USD Investment Grade Climate Change Corporate Bond Index; MSCI USD High Yield Climate Change Corporate Bond Index. For illustrative purposes only.

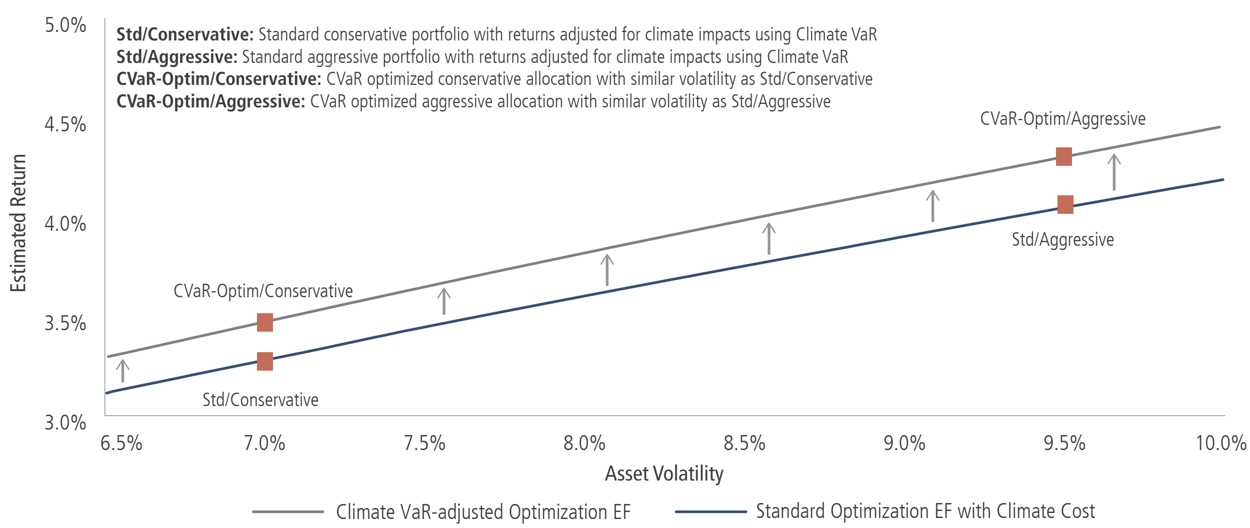
The wide dispersion in Climate VaR suggests an opportunity to enhance estimated risk-adjusted returns by integrating climate costs *ex ante* and re-optimizing to minimize negative Climate VaR and maximize positive Climate VaR in the portfolio. Our optimization allows the relative weight of a sector within an asset class to vary within a specified range.

Let us re-optimize to climate cost-adjusted estimated returns, as suggested, to create a new efficient frontier that we can compare with the standard optimization.

**Climate VaR-integrated Optimization**

In Figure 4, we show the differences between an optimization that integrates Climate VaR *ex ante* (the gray efficient frontier) and the standard optimization that incorporates climate costs *ex post* (the dark blue efficient frontier, which is the same as the dark blue frontier in Figure 2). The gray efficient frontier optimizes based on climate cost-adjusted capital market assumptions and captures the relative value of climate costs when selecting the optimal asset allocation. Comparing the vertical distance between the two efficient frontiers, we find that integrating climate change considerations *ex ante* in the optimization process can improve estimated risk-adjusted returns by up to 30 basis points.

**FIGURE 4. EFFICIENT FRONTIERS: WITH AND WITHOUT CLIMATE-ADJUSTED OPTIMIZATION**




Source: Bloomberg, JP Morgan, MSCI. Data as of December 31, 2021. Allocations and changes in allocations are rounded to whole numbers. Carbon Intensity and Carbon Footprint data are calculated on Scope 1 and 2 emissions. Indices used: Bloomberg Barclays Indices for U.S. Government/Agency Debt, U.S. Corporate bonds, U.S. Large-Cap Equities and Small-Cap Equities; MSCI Indices for EAFE and Emerging Markets Equities; JPM EMBI for Emerging Markets Sovereign Debt; JPM CEMBI for Emerging Markets Corporate Bonds; MSCI ACWI Low Carbon Target Index; MSCI USD Investment Grade Climate Change Corporate Bond Index; MSCI USD High Yield Climate Change Corporate Bond Index. **Past performance is no guarantee of future results.** Please note that estimated returns data is based on NB's capital markets assumptions and are provided for information purposes only. There is no guarantee that estimated returns will be realized or achieved nor that an investment strategy will be successful, and may be significantly different than shown here. Investors should keep in mind that the securities markets are volatile and unpredictable. There are no guarantees that historical performance of an investment, portfolio, or asset class will have a direct correlation with its future performance. Net returns will be lower.

We then select two portfolios on the gray efficient frontier that have the same estimated asset volatilities as the conservative and aggressive portfolios on the standard optimization frontier—7.0% and 9.5%, respectively. Comparing the *ex ante* Climate VaR-integrated optimization portfolios with these estimated volatility levels to their standard counterparts, we can see a meaningful improvement in estimated risk-adjusted returns.

**How Does Climate VaR-Optimization Change Portfolio Allocations?**

Digging into the differences between the Climate VaR-integrated and standard SAAs, we find some interesting trends. Figure 5 shows a detailed breakdown.

**FIGURE 5. HOW CLIMATE VAR-ADJUSTED OPTIMIZATION CHANGES THE SAA OUTPUT PORTFOLIO WEIGHTS**

| | Standard Optimization | | Climate VaR-adjusted Optimization | | Δ Climate VaR-adjusted Optimization | |
|---|---|---|---|---|---|---|
| | Std/ Conservative | Std/Aggressive | CVaR-Optim/ Conservative | CVaR-Optim/ Aggressive | Conservative | Aggressive |
| U.S. Gov/Agency | 25% | 18% | 21% | 14% | -4% | -4% |
| U.S. Corp A/above | 17% | 12% | 17% | 11% | 0% | -1% |
| U.S. Corp BBB | 8% | 6% | 7% | 5% | -1% | -1% |
| **Core Fixed Income** | **50%** | **36%** | **45%** | **30%** | **-5%** | **-6%** |
| U.S. HY BB&B | 3% | 2% | 2% | 1% | -1% | -1% |
| EM Sovereign | 1% | 1% | 1% | 2% | 0% | 1% |
| EM Corp | 4% | 3% | 4% | 2% | -1% | -1% |
| **Extended Fixed Income** | **9%** | **6%** | **7%** | **5%** | **-2%** | **-2%** |
| U.S. Large Cap | 19% | 26% | 19% | 28% | 1% | 2% |
| U.S. Small Cap | 2% | 3% | 2% | 3% | 0% | 0% |
| Developed Equity ex US | 14% | 20% | 13% | 19% | -1% | -2% |
| EM Equity | 6% | 9% | 6% | 9% | 0% | 1% |
| **Equity** | **41%** | **58%** | **40%** | **59%** | **-1%** | **1%** |
| Low Carbon IG | 0% | 0% | 5% | 3% | 5% | 3% |
| Low Carbon HY | 0% | 0% | 1% | 1% | 1% | 1% |
| Low Carbon Equity | 0% | 0% | 2% | 3% | 2% | 3% |
| **Low Carbon Indices** | **0%** | **0%** | **8%** | **7%** | **8%** | **7%** |
| Estimated Return (%) | 3.26 | 4.03 | 3.46 | 4.30 | 0.20 | 0.27 |
| Volatility (%) | 6.98 | 9.46 | 6.99 | 9.50 | 0.01 | 0.04 |
| Climate VaR (%) | -7.7 | -9.4 | -6.1 | -7.4 | 1.6 | 2.0 |
| Carbon Intensity (tons/$mm revenue) | 212 | 196 | 149 | 130 | -63 | -66 |
| Carbon Footprint (tons/$mm invested) | 70 | 69 | 44 | 42 | -26 | -28 |

Source: Bloomberg, JP Morgan, MSCI. Data as of December 31, 2021. Allocations and changes in allocations are rounded to whole numbers. Carbon Intensity and Carbon Footprint data are calculated on Scope 1 and 2 emissions. Indices used: Bloomberg Barclays Indices for U.S. Government/Agency Debt, U.S. Corporate bonds, U.S. Large-Cap Equities and Small-Cap Equities; MSCI Indices for EAFE and Emerging Markets Equities; JPM EMBI for Emerging Markets Sovereign Debt; JPM CEMBI for Emerging Markets Corporate Bonds; MSCI ACWI Low Carbon Target Index; MSCI USD Investment Grade Climate Change Corporate Bond Index; MSCI USD High Yield Climate Change Corporate Bond Index. **Past performance is no guarantee of future results.** Please note that estimated returns data is based on NB's capital markets assumptions and are provided for information purposes only. There is no guarantee that estimated returns will be realized or achieved nor that an investment strategy will be successful, and may be significantly different than shown here. Investors should keep in mind that the securities markets are volatile and unpredictable. There are no guarantees that historical performance of an investment, portfolio, or asset class will have a direct correlation with its future performance. Net returns will be lower.

The table on the left shows the allocations of the portfolios marked on the efficient frontiers in Figure 4. The table on the right shows the difference in allocations between the Climate VaR-integrated optimization portfolios and the standard optimization portfolios.

Overall, we see a reallocation out of traditional core and extended fixed income asset classes, especially high yield and emerging markets debt. This makes sense in our framework, as high yield and emerging markets debt issuers have some of the highest environmental costs, as reflected in their Climate VaR metrics.

Within equities, we see a pivot away from non-U.S. developed market equities into U.S. large caps since the latter index is more weighted to technology and communications. Given the expected timelines over which environmental policies are likely to be implemented, with faster action anticipated in Europe than in emerging countries, it is not surprising to see comparatively more punitive climate costs for non-U.S. developed market equities.

From a sector perspective, we see rotations away from carbon-intensive sectors across fixed income and equity, such as basic materials, consumer cyclical, energy, industrials and utilities. Our optimization results suggest that portfolio estimated returns can be enhanced by increasing exposure to the communication, non-cyclical consumer and technology sectors.

In the Climate VaR-integrated optimization, we have included some additional asset classes, identified as "Low Carbon Indices." These are the MSCI ACWI Low Carbon Target Index, MSCI USD Investment Grade Climate Change Corporate Bond Index and MSCI USD High Yield Climate Change Corporate Bond Index, and the objective of these indices is to replicate the return and risk profiles of their "parent" indices, but using securities with low reported emissions.

Adding these asset classes into the mix has no material return impact on the efficient frontiers—confirming that a large majority of the improvement in estimated risk-adjusted return over the standard optimization comes from integrating Climate VaR rather than from adding these Low Carbon Indices. The results shown in Figure 5 do suggest that investments based on indices such as these can lower a portfolio's financed emissions without substantially impairing even the improved, Climate VaR-integrated estimated returns and volatility. This is the case for the conservative investor, where there is more of a tilt to fixed income Low Carbon Indices, and for the aggressive investor, where there is more of an equity tilt.

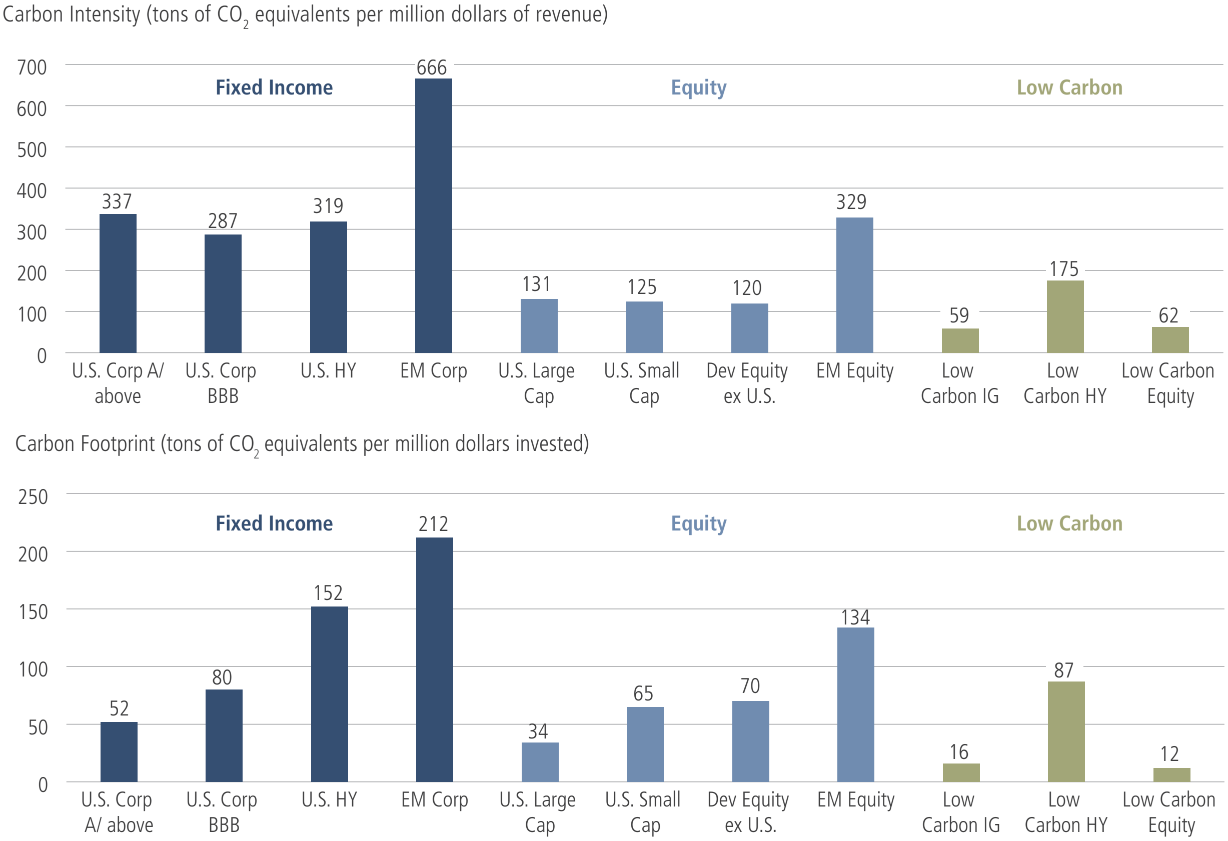
**Integrating Financed Emissions into the SAA Process**

As well as integrating Climate VaR into the SAA process as an optimization parameter, investors can also apply other climate metrics as constraints—whether carbon intensity, carbon footprint or any other metric. In this way, we can build an SAA process that fully reflects the objectives of a climate-conscious investor that wants to meet certain carbon targets, by putting limits on portfolio-financed emissions while also accounting for climate-related risks in capital market assumptions.

A portfolio's financed emissions are calculated either as "carbon intensity" or "carbon footprint." Carbon intensity is defined as the number of tons of $CO_2$ equivalents emitted for every million dollars of each constituent company's revenue. The carbon footprint of the portfolio is the absolute apportioned emissions financed by the portfolio itself—that is, the emissions attributed to an investor based on their ownership share of an emitter's total invested capital, further normalized by the investment value.

These values, covering Scope 1 and 2 emissions for the full set of headline asset classes used in the optimizations above, are set out in Figure 6. The important thing to note here is the wide variation of financed emissions, and particularly of carbon footprint, between these asset classes. When using metrics such as these as optimization constraints, this variation makes it possible to set those constraints within a relatively wide range, and it also helps to minimize the constraints' impairment to the unconstrained efficient frontier. While we recognize the importance of measuring Scope 3 emissions, we've assessed that data coverage and quality is not yet sufficient to warrant their inclusion in the optimization process.

**FIGURE 6. FINANCED SCOPE 1 AND 2 EMISSIONS ACROSS ASSET CLASSES**




Source: Bloomberg, JP Morgan, MSCI. Data as of December 31, 2021. Indices used: Bloomberg Barclays Indices for U.S. Treasuries, U.S. Corporate bonds, U.S. Large-Cap Equities and Small-Cap Equities; MSCI Indices for EAFE and Emerging Markets Equities; JPM EMBI for Emerging Markets Sovereign Debt; JPM CEMBI for Emerging Markets Corporate Bonds; MSCI ACWI Low Carbon Target Index; MSCI USD Investment Grade Climate Change Corporate Bond Index; MSCI USD High Yield Climate Change Corporate Bond Index. For illustrative purposes only.

The scope for reducing portfolio financed emissions is meaningful but limited, given that the current global investable universe still mostly includes companies that have yet to transition their business models and services to net-zero emissions. The initial 25 – 30% reduction in a portfolio's financed emissions may be relatively easy to achieve, especially with the addition on low carbon asset classes such as those suggested here, but achieving a net-zero goal over time is partly dependent on the development of climate solution technologies which may not yet be viable enterprises at scale today. As an active manager, we also believe that net-zero investing requires assessing and engaging with companies on their climate transition plans, based on the bottom-up qualitative judgment of our research analysts and portfolio managers.

## Conclusion

We believe that the systemic nature of climate risks means that they should inform not only security selection, but also long-term asset allocation decisions.

By estimating the impact of climate change on asset class estimated returns using a Climate VaR model, we believe we can show how that impact changes the efficient frontiers generated by SAA processes—and, by implication, the potential risks of failing to take climate-related costs into account.

But there is potential opportunity here, as well as potential risk. Modeled Climate VaR is widely dispersed across different asset classes and sectors—some investments appear to be considerably more at risk than others. That suggests potential opportunities to enhance efficient frontiers by integrating Climate VaR into the SAA optimization process. We have attempted to show and quantify that potential enhancement in the optimizations in this paper.

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