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Portfolio perspectives
February 2021

Climate change – Turning investment risk into opportunity

Launching our climate-aware capital market assumptions and strategic portfolios

BlackRock
Investment
Institute

BIIM0321E/M-1552413-1/12

Summary

- Climate change is real and cannot be ignored by investors. Climate risk is investment risk, yet we see it is as a historic investment opportunity. Our capital market assumptions (CMAs) – a core input to building portfolios – for the first time, explicitly reflect the impact of climate change on the investment landscape. This is one of a set of actions we are taking to prepare investors for the global transition to a net zero emissions economy by 2050 or sooner.
- The commonly held notion that tackling climate change has to come at a net cost to the global economy is wrong, in our view. If no action is taken to combat climate change, the considerable physical damages would imply a lower path of economic growth. Our CMAs reflect our view that the green transition to a low-carbon economy, consistent with the Paris Agreement goals, will deliver an improved outlook for growth and risk assets relative to doing nothing.
- Underpinning the climate-aware CMAs is our view of an orderly transition that successfully limits climate-related damage. The tectonic shift toward sustainability has gathered momentum over the past year following a series of major climate change commitments by corporations, governments and investors alike, bolstering our conviction in an orderly transition to a low-carbon world.
- We see climate change and the green transition as persistent drivers of asset returns, and consequently fundamental to making strategic investment decisions. Climate change and policies to combat it flow through our CMAs via three main channels: the macroeconomic impact, the repricing of assets to reflect climate risks and exposures and the impact on corporate fundamentals. Macro variables such as GDP would be different in a world that is transitioning to a low-carbon future, meaning traditional risk premia for *all* asset classes will change. On repricing, we don't believe market prices yet reflect the coming changes, meaning assets poised to benefit from the transition may have a higher return during the transition. Finally, corporate fundamentals – climate change issues impact business models and corporate profitability. We assess the winners and losers at the sector level.
- We focus on the E in ESG. Why? There is now a wide recognition of the importance of climate change for economic and social outcomes and there is consensus on how to measure it - via carbon emissions. There is less consensus on how to define the S (social) and G (governance) dimensions and even less so on how to measure them. Different investors will approach these issues differently underscoring the difficulty in formulating a systematic framework. We see S and G as sources of alpha and so exclude them from our CMAs, which focus on broad market returns, or beta.
- Projections around climate change are highly uncertain due to the complexity of modelling the dynamics between carbon emissions and climate, between climate and economic variables and the myriad dependencies, particularly around mitigation policies. This underscores the importance of explicitly incorporating uncertainty in CMAs.
- Understanding the implications for strategic portfolios warrants taking a more granular view than ever. We now use sectors as the relevant unit of investment analysis. We believe tech and health care are likely to benefit the most from the green transition, whereas energy and utilities may lag. At the broad asset class level, the appeal of developed market equities brightens at the expense of high yield credit and emerging debt due to the higher concentration of carbon intensive sectors that comprise the benchmark indices for the latter.

Authors

Philipp Hildebrand
BlackRock Vice Chairman

Jean Boivin
Head – BlackRock Investment Institute

Jessica Tan
Global Head – Corporate Strategy and Sustainable Investing

Simona Paravani-Mellinghoff
Global CIO of Solutions, Multi-Asset Strategies and Solutions

Ed Fishwick
Global Co-Head of Risk & Quantitative Analysis

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Contributors

Elga Bartsch
Debarshi Basu
Anthony Chan
Carole Crozat
Natalie Gill
Paul Henderson
Eric van Nostrand
Christian Olinger
Vivek Paul
Christopher Polk

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The green transition

Climate change and efforts to curb it will have major economic outcomes, not just far into the future but in the next few decades (Dietz et al., 2020). Economic projections that do not take climate change into account are widely relied upon yet are based on an unrealistic future scenario, in our view. We have updated the long-term macroeconomic framework that underpins our CMAs. The upshot: In our view, a green transition to a low-carbon economy, consistent with the Paris Agreement goals, will deliver an improved outlook for growth and risk assets relative to doing nothing. Such an outlook rejects the commonly held notion that tackling climate change has to come at a net cost to society.

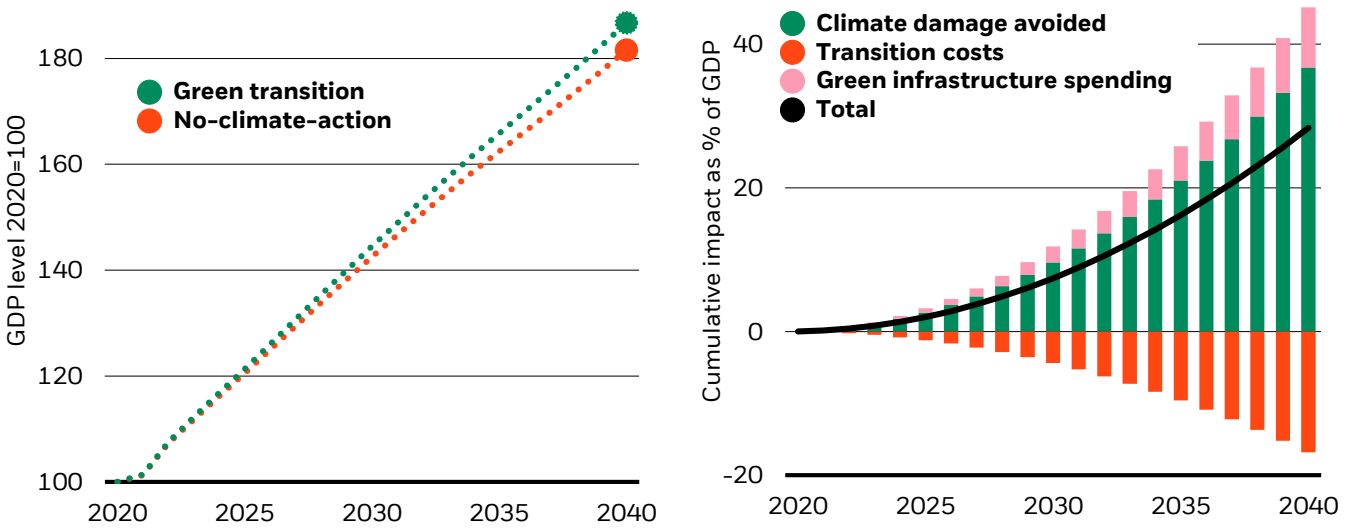
We first incorporate climate damages into our economic projections. The economic losses, associated with rising temperatures, build over time and are more pronounced in some regions than others (Burke et al., 2015). Call this the "no-climate-action" scenario – climate damages occur, but no action is taken to combat it. We then consider a second economic scenario, with policies and innovations that could mitigate climate damages – call this the "green transition" scenario. Specifically, in the green transition we consider the actions needed to ensure the Paris Agreement target of limiting temperature rises to below 2 degrees Celsius is achieved. The green transition is our base case for our updated CMAs and strategic asset class preferences.

In our macro model, we combine our long-term growth framework with a detailed energy component with long-term climate dynamics and the repercussions on economic activity. Our model for a green transition combines the economic costs of physical damages related to climate change (Claire et al., 2020), the benefits and costs of energy transition, and other policy changes such as potential spending on green infrastructure. With these in mind, we find the economic outlook is notably brighter under the green scenario versus the no-climate-action scenario. Why? Economic loss due to climate damages can be largely avoided, in our view, by proactive climate policy action that keeps the global temperature change within the margins of the Paris Agreement through a combination of gradually rising carbon taxes and clean energy subsidies (Burke et al., 2018). In our view, the economic benefit of avoiding climate damages through mitigation policies can outweigh the potential economic costs associated with these policies. This conclusion is at odds with the belief that climate change mitigation is a drag on growth – such an interpretation would only be valid if comparing to an unrealistic scenario that ignores climate change altogether.

Globally, we estimate a cumulative loss in economic output of nearly 25% over the next two decades due to the level of GDP being 2.3% lower in 20 years' time if no climate change mitigation measures were taken. The charts below show our estimates of the impact on China – an increasingly important pillar of the global economy and one where the impact of climate change is likely to be significant. The left chart shows the potential path of GDP and the right, the potential cumulative impact of three factors – avoidance of climate damage, transition costs, and green infrastructure spending – on GDP by 2040. We acknowledge the risks to the downside in our green transition scenario. Delays in implementing climate policies could result in a "disorderly transition". Policy execution will be key: any shortfalls could undermine the policy predictability and credibility, making the energy transition more costly.

The long-term cumulative economic impact

Estimated GDP paths and cumulative impact as a percentage of GDP under two scenarios for China, 2020-40



Forward looking estimates may not come to pass. Sources: BlackRock Investment Institute, Banque de France, International Energy Agency, OECD, January 2021. Notes: The chart on the left shows our estimated path for China's GDP over the next 20 years under the two mentioned scenarios. GDP levels are rebased to 100 as of 2020. The chart on the right shows the cumulative impact on long-term GDP under a green transition relative to a no-climate-action scenario. The bars show the overall estimated impact of three factors – avoidance of climate damages (positive), green infrastructure spending (positive) and costs associated with the transition (negative). The black line shows the estimated net impact. Our estimates of the impact under a climate-aware scenario are based on expected changes in energy consumption including composition, relative carbon and renewables pricing and on potential losses due to global warming. Energy consumption is estimated as a function of GDP and the relative price of energy per the Banque de France's working paper no. 759 titled the Long-term growth impact of climate change and policies. GDP losses from global warming are calibrated on analysis of Impact Assessment Models per W. Nordhaus and A..Moffat (2017). We assume green infrastructure spending programs of 1% of GDP gradually phased out over the next 10 years.

Climate change impacts all assets

When evolving our CMAs to account for sustainability, we focus on the "E" in ESG, in particular, we focus on climate change. Why? First, there is wide recognition of the importance of climate change for economic and social outcomes and second, there is consensus on the measurement of an entity's contribution to climate change - via carbon emissions. Carbon emissions are a widely enough adopted indicator of sustainability for investors to the extent that it can be a driver of repricing at the broad market level. We see insights into S (social) and G (governance) issues as potential sources of alpha impacting security selection, rather than as systematic drivers of returns and so exclude them from our CMAs. If consensus around the S and G dimensions grows and availability of consistent and reliable data improves in coming years we would consider incorporating them into our CMA framework.

Macro variables such as GDP would be different in a world that is transitioning to a low carbon future, meaning traditional risk premia for *all* asset classes will change. Macroeconomic variables, valuations across asset classes – equities, credit, government bonds and foreign exchange – and, ultimately, strategic asset class decisions will be impacted. The chart below shows our updated CMAs for selected asset class – the green dots show the mean expected returns in our base case of a green transition and the red dots indicate the expected returns in a no-climate-action scenario. For U.S. equities, our expected returns in a no-climate-action scenario would fall outside the band of uncertainty around our mean estimate, highlighting the potentially large impact from climate change.

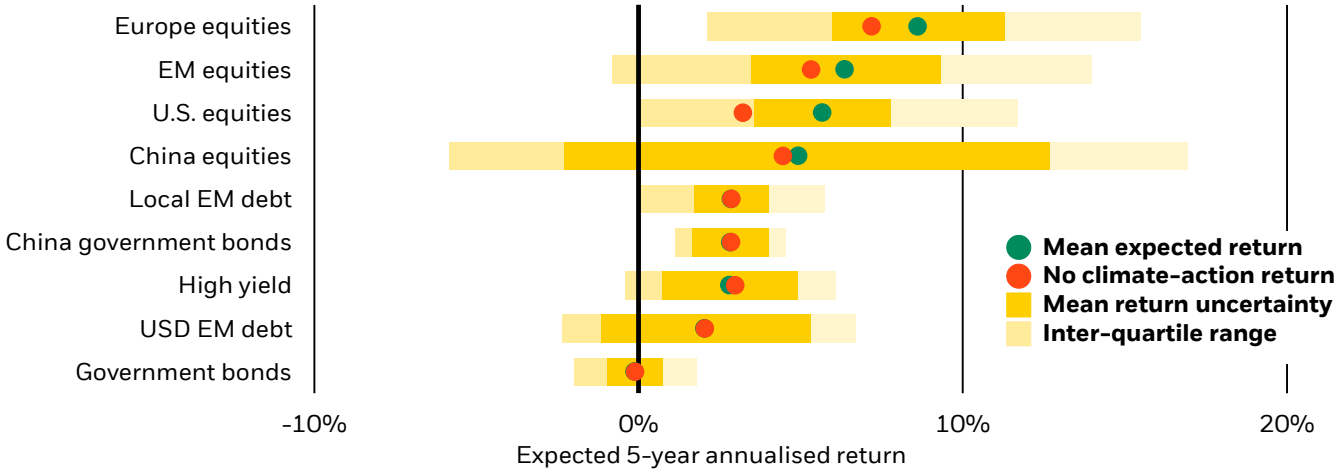
Beyond the macro impact, we see the effects playing out through two more channels:

- **Repricing**: One consequence of shifting societal preferences is that the price investors are willing to pay for assets perceived to be sustainable is changing, driving differentiated returns. This shift means the discount rate we use to value these securities is also changing. Capital flows toward sustainable assets are a symptom of this phenomenon. Our CMAs now directly reflect our estimates of such a premium.
- **Fundamentals**: This channel could be seen as an extension of the macro one. Some companies and sectors are better positioned than others for a transition to a low carbon economy. Corporate behavior will likely respond by adapting to policy and regulatory changes brought about to combat climate change. Profitability across sectors will be impacted with knock on effects for other variables such as credit default and downgrade assumptions. There will be sectoral winners and losers – underpinning why we believe a sectoral approach to sustainable investing is additive to a regional one.

Uncertainty is a key element of our framework and is built into our CMAs. No one yet knows what a low-carbon world looks like. The transition may play out over several years, if not decades. We will monitor key trends such as capital flows, policy developments and technological advancements – and the way asset prices respond to them – and look to evolve our framework as new information becomes available. Our portfolio construction approach that explicitly accounts for uncertainty and provides a term structure of returns to capture the time varying impact of climate change lends itself well to the structural transformation we see playing out.

A meaningful impact

BlackRock capital market assumptions for selected assets, February 2021



This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise - or even estimate - of future performance.
Source: BlackRock Investment Institute, February 2021. Data as of 31 December 2020. Notes: Return assumptions are total nominal returns. U.S. dollar return expectations for all asset classes are shown in unhedged terms,. Our CMAs generate market, or beta, geometric return expectations. Asset return expectations are gross of fees. For representative indices used, see the *Assumptions at a glance table*. For a full of asset classes we cover, visit our Capital Market Assumptions website at blackrock.com/institutions/en-us/insights/portfolio-design/capital-market-assumptions. There are two sets of bands around our mean return expectation. The darker bands show our estimates of uncertainty in our mean return estimates. The lighter bands are based on the 25th and 75th percentile of expected return outcomes – the interquartile range for more detail read Portfolio perspectives.

The tectonic shift

The past year has seen a seismic shift in society's resolve to tackle climate change. President Xi Jinping outlined a plan at last year's United Nations General Assembly to make China carbon neutral by 2060 – a significant milestone given the country's growing role in the global economy. U.S. President Joe Biden returned the country to the Paris climate accord on the first day of his presidency. Investments made under the European Recovery Fund to aid the post-Covid economic revival will have to respect emissions thresholds laid out under European Union regulations.

Investors are just starting to respond to the structural shift – suggesting it is not yet fully in the price of assets. The BlackRock 2020 Global Sustainability Survey found that respondents plan to double their sustainable assets under management (AUM) in the next five years – rising from 18% of AUM on average today to 37% on average by 2025. Climate change is the most prominent sustainability issue. In our view, changing investor preferences will spur a climate change-led repricing in the cost of capital attached to various assets. We expect changing preferences to drive flows into assets perceived to be more aligned with a low-carbon future, spurring a repricing higher for such assets relative to those that are not. The ability to systematically measure carbon emissions, and the broad consensus that carbon footprint matters means it is this measure of E that is likely to drive repricing, in our view. Carbon emissions also indicate the exposure of companies to changing carbon prices, likely a primary policy tool employed to tackle climate change.

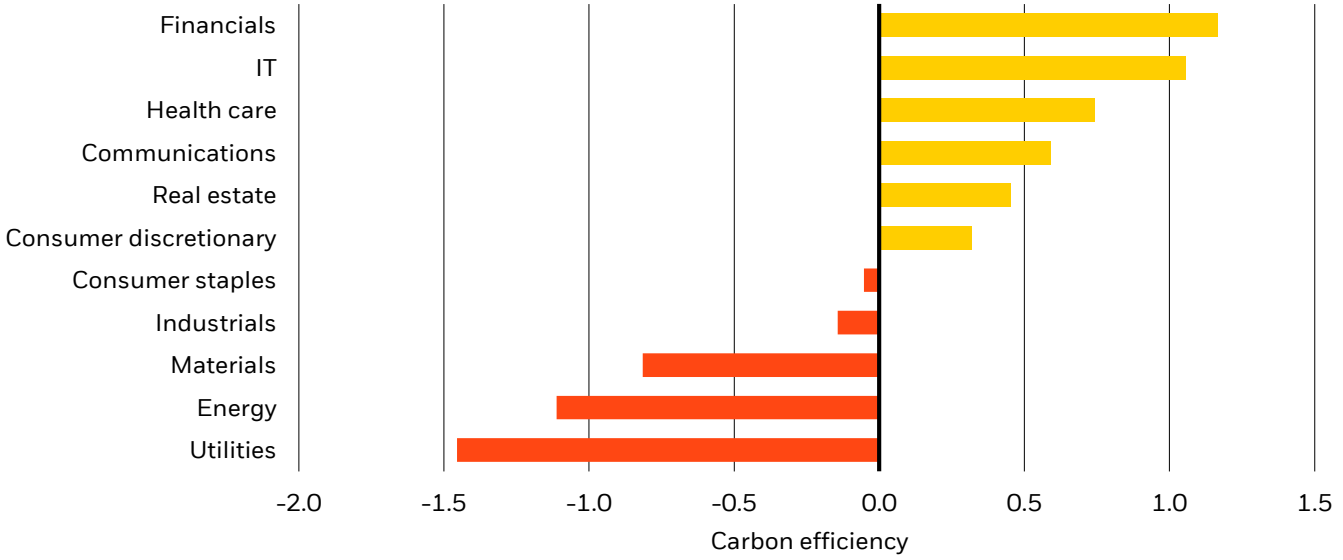
We estimate an expected carbon emission intensity by company and then aggregate up the data at the sector and country level to rank markets according to their carbon footprint. The chart below shows the results for U.S. sectors. This analysis drives our estimates for a sector's change in cost of capital that could occur due to climate-driven repricing. We expect more carbon efficient sectors to have falling cost of capital, all else equal, which drives positive returns during the transition. See the Appendix for more detail on the methodology.

There is no precise answer when estimating the change in cost of capital that could occur. We use the carbon efficiency of each sector to estimate the cost of capital (see Appendix for methodology). For the most carbon efficient sector, financials, could fall by 0.4%, all else equal, and the least efficient, utilities, could rise by 0.5% over five years. We look to a range of sources, including work from the Cambridge Institute for Sustainability Leadership that showed retail investors would be prepared to sacrifice up to 2.5% in returns to invest in greener funds. Recent pricing of green bonds – such as the difference in spreads between green and non-green bonds issued by sovereigns – help inform our estimates for credit.

How long before the transition is priced in? Maybe ser than previously thought given the momentum of global commitments toward carbon neutrality seen just in the past year. The new U.S. administration under President Joe Biden is likely to make climate a major policy focus – potentially hastening the transition. We assume a five-year window for the repricing. This chimes with results from academic research that studies how markets price in predictable but slow-moving shifts in profitability – such as demographics (DellaVigna et al., 2007). Once the repricing phase has passed, this channel is no longer a boon for returns for 'greener' assets. In fact, all else equal, greener assets will have a lower cost of capital, meaning a lower expected return.

The sectoral view

Estimated carbon efficiency for U.S. sectors, February 2021



Indexes are unmanaged and do not account for fees. It is not possible to invest directly in an index. This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise - or even estimate - of future performance. Sources: BlackRock Investment Institute with data from Refinitiv Datastream and MSCI, February 2021, Notes: The chart shows the carbon efficiency measured as total carbon emissions relative to the aggregate firm value for the sectors of the MSCI USA index. The carbon efficiency measure is shown in Z-score terms – or in relation to the mean across sectors. Both Scope 1 (direct emissions from owned or controlled sources) and Scope 2 (indirect emissions from electricity purchased) are considered. These can help gauge the exposure of companies to carbon pricing initiatives as part of climate change mitigation policies.

Impact on corporate fundamentals

Climate change and the efforts to address it will impact the profitability and growth prospects of companies. This needs to be analyzed beyond the impact on headline GDP growth. First, the transition to a low carbon economy will present opportunities for some industries and challenges for others - through environmental regulation and energy policies, carbon pricing mechanisms and changing consumption patterns. Earnings at the industry or sector level could be meaningfully impacted over the coming decade or as the transition occurs – depending on the speed at which the green transition is achieved.

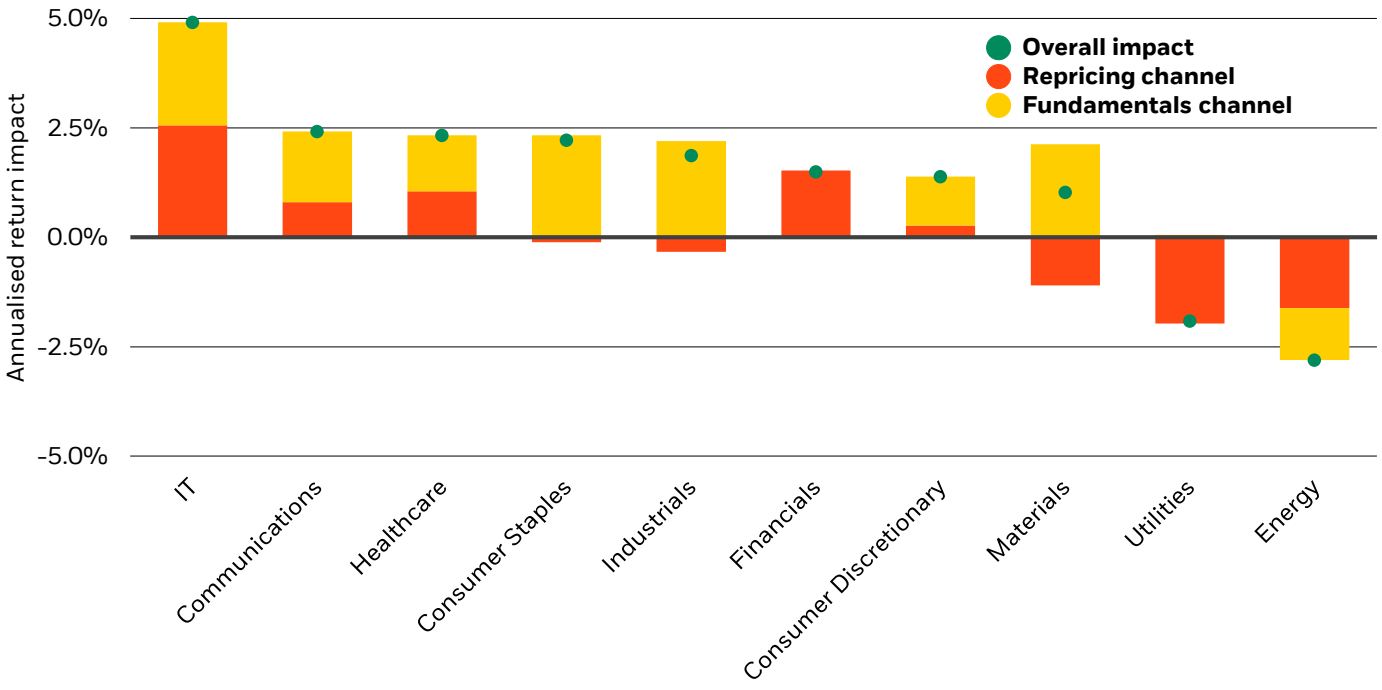
We estimate corporate earnings consistent with our green transition macroeconomic scenario. To arrive at our estimates, we first assess the sensitivity of earnings to carbon pricing initiatives. We expect carbon pricing initiatives – phasing in materially higher carbon prices – to be a core tenet of climate mitigation policies aimed at achieving the Paris climate goals. The estimated sensitivity of earnings depends on current direct and indirect carbon emissions, expected emission abatement, and the ability of companies to pass through costs. Across sectors, carbon pricing initiatives represent a negative earnings impact of varying size.

The corporate fundamental channel goes beyond this carbon cost – we assess the impact of both transition risks and physical risks for 34 industries. We score these industries on two dimensions – how exposed they are to climate change themes and whether the exposure represents a risk or opportunity. This scoring can differ from the carbon price sensitivity – a company could be a high carbon emitter currently, and so could have high carbon price sensitivity, yet could also be positioned to benefit from the green transition through growing demand for its products. A prime example of such opportunities are chemical companies that manufacture materials for electric vehicle batteries and could potentially be big beneficiaries of a green transition. Conversely, consider an insurance company that has low carbon emissions but whose profits are increasingly at risk from physical climate damages.

The chart below shows the estimated return impact across sectors from both the repricing and fundamental channels. We estimate an annualized 7-8 percentage point return differential over five years between the energy and technology sectors – a significant difference in a world of low expected returns across asset classes. The energy sector is, unsurprisingly, most heavily impacted: it is a high carbon emitter and is poised for a structural decline in demand, in our view, as adoption of greener energy sources becomes more mainstream. We consider the energy sector as the most negatively impacted sector and a benchmark to measure other sectors against. We acknowledge the high uncertainty around how corporates will respond to the green transition and what the precise impact of changing business models might be for their profitability. Monitoring the sectoral impact will be a key theme in our ongoing research.

Total return impact

Estimated 5-year expected return differential for U.S. sectors in green transition vs. no action, February 2021



This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise - or even estimate - of future performance. Sources: BlackRock Investment Institute, with data from Refinitiv Datastream and Bloomberg, February 2021. Notes: The chart shows the difference in five-year U.S. dollar expected returns for the highest sub-category of MSCI USA sectors under two economic scenarios - a green transition and a no-climate-action scenario. The difference in expected return is attributable to repricing – the return impact of changing cost of capital - and fundamentals – or the return impact of changing earnings per share growth.

Portfolio implications

Tactical, or shorter-term, investment decisions will not be sufficient, in our view, to position for the fundamental reshaping of the global economy we see playing out. Positioning portfolios appropriately requires expressing views at the strategic asset level. Like any investment view, the ultimate implementation and sizing of climate change-led views in portfolios will vary depending on an investor's risk appetite, objectives and eligible universe. Some investors may have to reallocate as much as 10-20% of existing assets. For others, it will be less. See our investor-specific asset allocation breakdowns for more. Our strategic asset preferences for a hypothetical unconstrained, U.S. dollar investor with a 10-year horizon are shown on the chart below and put our asset class views in a portfolio context. They reflect our views on all drivers of long-term asset returns, from the monetary and fiscal policy revolution to structural trends, such as the U.S.-China rivalry and the polarization of global growth. The impact of introducing climate change as an additional driver of returns on asset class views is shown on the right.

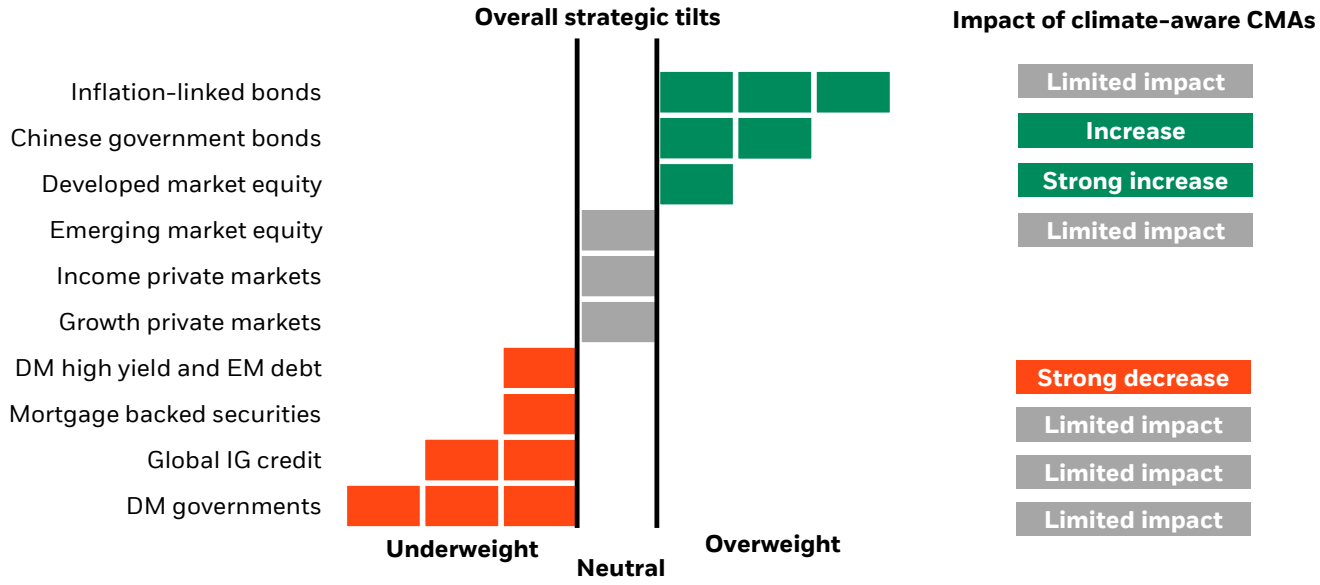
The most significant impact is a stronger preference for developed market equities at the expense of high yield and emerging market debt. The composition of developed market equity indices better aligns with the climate transition and equities have more ability to capture the upside opportunities from the climate transition. The higher carbon intensity of companies that typically make up high yield and emerging market debt benchmark indices detracts from their expected returns, diminishing their appeal within our overall preferred strategic allocation. Another impact of incorporating climate change in our CMAs - granular investing becomes more prominent in portfolio construction. We believe climate change will drive greater dispersion of returns at a sector level than at the asset class level. We see sectors as the relevant unit of investment analysis and if we allow sector granularity in our portfolio construction, buying assets at the sector level rather than at an index-based regional level, the impacts on strategic asset preferences can be material.

We have a strategic preference for inflation–linked government bonds over nominal government bonds. We see the policy revolution driving higher inflation over the medium-term but don't expect rising inflation expectations to be reflected through higher nominal yields as much as was historically the case. Yet we see a diminished ability of nominal bonds to act as ballast and expect high public debt levels to push yields higher over the strategic horizon. We are strategically underweight credit as we see valuations as expensive on a relative basis relative to equities.

Our preference for a strategic overweight to Chinese assets overall is not diminished – and is, in fact, enhanced for Chinese government bonds given the relatively poorer outlook for comparable assets. The sector composition of mainland Chinese equity indexes differs from the makeup of the broad economy with low exposure to sectors at risk from the green transition such as energy, utilities and materials. More broadly, China's commitment to a net zero economy by 2060 reinforces our views around potential improvements in carbon emission intensity for its companies.

Tilting toward sustainability

Hypothetical U.S. dollar 10-year strategic allocation vs. our equilibrium view, February 2021



This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise - or even estimate - of future performance. Sources: BlackRock Investment Institute, with data from Refinitiv Datastream and Bloomberg, February 2021. Notes: The chart shows our asset views on a 10-year view from an unconstrained US dollar perspective against a long-term equilibrium allocation described on our capital market assumptions website. The portfolio is illustrative and the allocation above does not represent any existing portfolio and, as such, is not an investible product. The construction of the hypothetical asset allocation is based on criteria applied with the benefit of hindsight and knowledge of factors that may have positively affected its performance and cannot account for risk factors that may affect the actual portfolio's performance. The actual performance may vary significantly from our modelled CMAs due to transaction costs, liquidity or other market factors. Indexes are unmanaged, do not account for management fees and one cannot invest directly in an index. See appendix for full list of index proxies.

Appendix

Macroeconomic model methodology

We use a long-run model of climate change that allows us to account for the physical damages, energy transition and the impact of public policies and their impact on macro variables, such as level of GDP, in a single, transparent framework. We combine our long-term growth framework with a detailed energy component with long term climate dynamics and the repercussions on economic activity.

We project the impact on GDP level in a macroeconomic climate model for 30 countries/regions using our long-term growth model based on the three factors of production: labor, capital and energy and assume a constant elasticity of substitution – in other words, there is no change in estimated impact if one factor is substituted for the other. We use the Advanced Climate Change Long-term (ACCL) assumptions set out in Banque de France's 2020 paper (Claire et al., 2020) as a starting point for estimates of the impact from climate change. These assumptions use a set of widely accepted calibrations regarding climate sensitivity, carbon emission factors, energy substitutability and efficiency, carbon storage and sequestration and regional attributions of damages in modelling different carbon pricing policies. We further augment these estimates to reflect more recent developments in energy technology based on research from Rhodium Group and Goldman Sachs. The GDP losses from global warming are calibrated on an analysis of Impact Assessment Models by Nordhaus at al (2017). Country-specific energy consumption is estimated as a function of GDP and changes in the relative price of energy (per the Banque de France estimates), while the relative price of energy is computed using the International Energy Agency's (IEA) energy prices (including taxes) and OECD GDP deflators, and projected forward using user-defined carbon and renewables pricing assumptions. Energy consumption is converted into CO2 emissions using IEA data and default emission factors collected from the Covenant of Mayors for Climate and Energy Report. The global stock of CO2 in the atmosphere is converted into a global temperature increase using the greenhouse gas trajectory adopted by the UN Intergovernmental Panel on Climate Change in 2014. The table below shows our assumptions for our two main scenarios: a green transition (our base case) and no-climate-action.

The positive effect of a green transition relative to the no climate action scenario rests on the gradual phasing in of carbon pricing consistent with the Paris Agreement, green infrastructure spending programmes (gradually phased out over ten years) and subsidies on renewable energy. We estimate the net impact of a green transition over the next 20 years to be positive at the global level but with regional divergences. The tables shows the specific assumptions we make for each scenario.

Green transition vs no-climate-action scenario assumptions

	Green transition	No-climate-action scenario
Global temperature by 2100	Broadly within that of Paris Agreement at a global temperature increase of 1.9 degrees Celsius in 2100	Materially higher increase in global temperatures of 5.8 degrees Celsius, a more sensitive economic damage function and release of 2 Gigatons from natural carbon sinks to get to climate damages of 27% by 2100 (consistent with the upper end of the range considered by the Network for Greening the Financial System).
Climate policies assumed within the our adjusted ACCL model	Gradual increase in carbon pricing of 3% per year and in renewables subsidies of 1% per year	None
Fiscal policy assumptions beyond the ACCL model	Green infrastructure spending of 5% of GDP over 10 years, using country specific IMF multipliers, adjusting for historical implementation gaps	None
Updated carbon abatement costs since ACCL model was calibrated	Adding the 20% reduction in carbon abatement costs as estimated by Goldman Sachs	None

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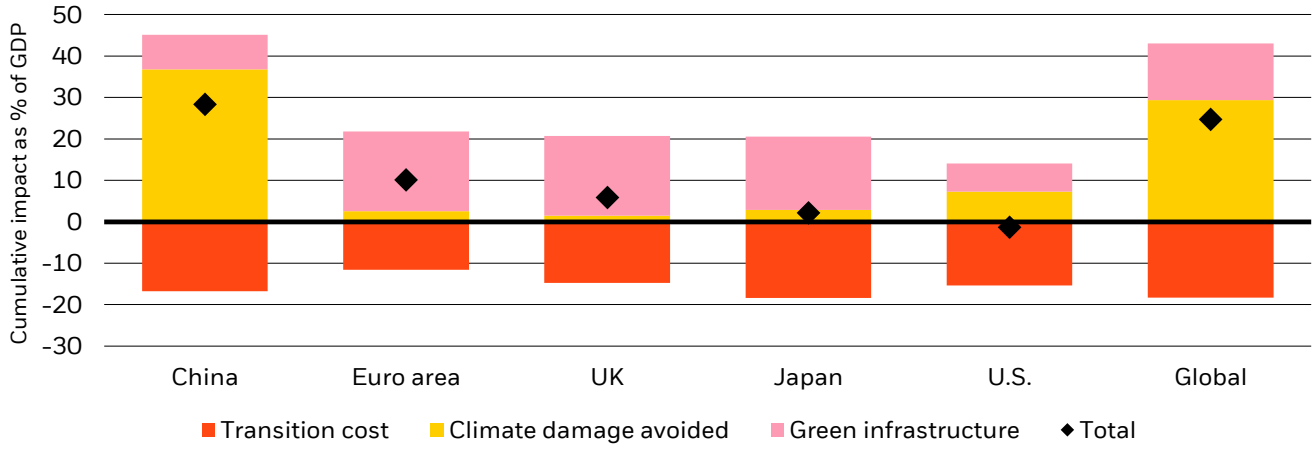
Appendix

Macroeconomic model methodology (continued)

The impact of a green transition over the next years will likely be positive at the global level, in our view, but with regional differences as shown in the chart below.

The long term economic impact

Estimated cumulative GDP impact under green vs no-climate-action scenarios by 2040

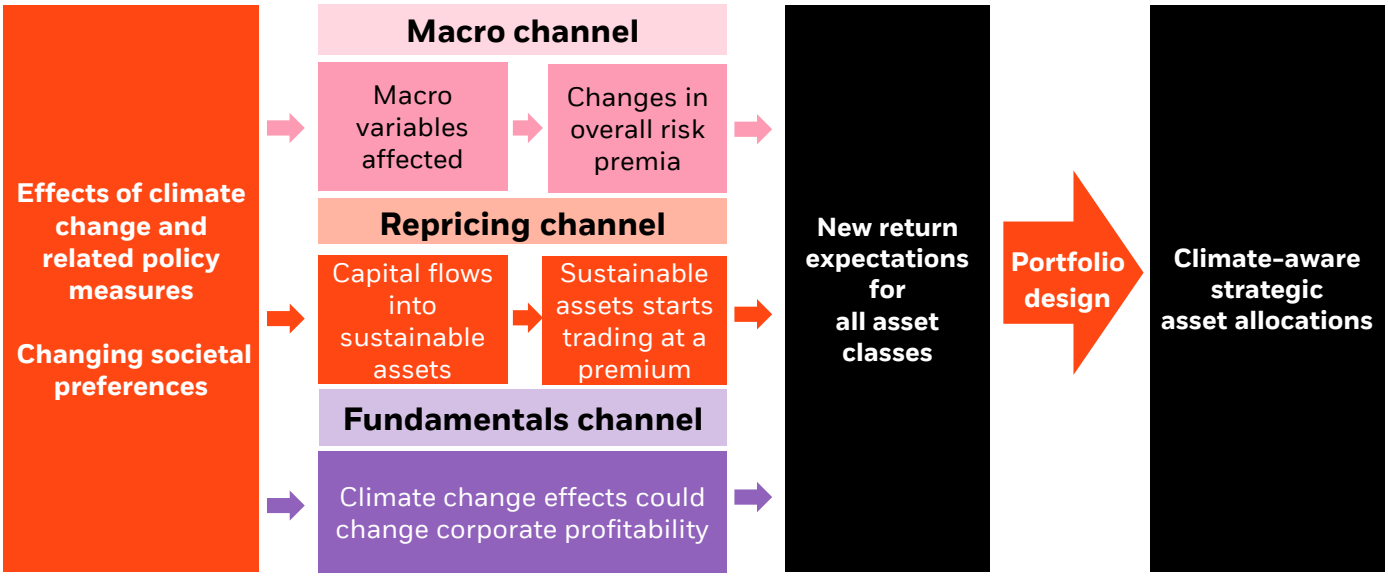


This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise - or even estimate - of future performance. Sources: BlackRock Investment Institute, with data from Refinitiv Datastream and Bloomberg, February 2021. Notes: The chart shows our estimate of the long-term economic impact of climate change over the next 20 years in terms of cumulative change in the GDP level versus a no-climate-action scenario, taking the assumptions referenced on page 8 into account..

Our framework, illustrated in the schematic below, outlines how we approach incorporating the implications of climate change and shifting investor sustainability preferences into expected asset class returns and strategic asset allocation

Three channels drive the climate change impact on assets

BlackRock framework for climate-aware portfolios



Source: BlackRock Investment Institute, February 2021. Notes: For illustrative purposes only. Subject to change without notice.

Appendix

Repricing channel

We believe the structural shift toward sustainable investing is not yet priced in. Over coming years, we expect assets perceived to be more sustainable to command a premium over less green counterparts, assuming all else is equal. We estimate the impact of this repricing in two stages: first, we arrive at a measure of a company or issuer's carbon footprint and second, use this measure to estimate a change in cost of capital.

We use direct and indirect carbon emissions as our preferred proxy for the cost of capital. Carbon emissions are a consistently and widely reported metric. Broad carbon emissions data across companies is lagged by up to two years, so we estimate the emissions today using the most recent observation and the rate of change over time. We find that future carbon emissions can be estimated up to three years using both the level and trend of today's emissions. We further refine the metric by focusing on carbon emissions *intensity* by measuring emissions against a company's enterprise value – the sum of a firm's market capitalization and debt obligations. Focusing purely on the absolute level of emissions would unfairly penalize large firms. Considering enterprise value also brings debt into the equation, allows us to apply the analysis to both equity and credit. We use z-scores to normalize the data sets to be comparable across sectors and assets classes given the highly skewed nature of carbon metrics. We also scale a sector's carbon intensity score with -3 as the least green to +3 the most green to derive a sustainability premium.

We assume those sectors with highest carbon intensity will experience rising cost of capital and those with lowest intensity will experience falling cost of capital. Based on an estimate of the difference in cost of capital between the most and least carbon efficient companies once climate change impacts are fully priced in, we calibrated the change in cost of capital for all regional equity sectors and regional markets.

Our equity expected returns are estimated using an augmented dividend discount model. The change in cost of capital is introduced to the dividend discount model, to estimate the impact of the 'repricing channel'.

Fundamental channel

Climate change and the efforts to address it will impact the profitability and growth prospects of companies. We estimate the impact on corporate earnings at the sector level of a green transition. To arrive at our estimates, we first assess the sensitivity of earnings to carbon pricing initiatives, which we expect to be a core tenet of climate mitigation policies. We assume a carbon tax of $125 in 20 years - consistent with our green transition scenario. The impact on each firm's earnings is calculated based on the expected tax on its own emissions (direct cost), the increase in its own energy costs (indirect cost), the expected passthrough of the tax and the expected abatement of emissions in response to rising carbon cost.

In our fundamental channel, we also take account of the physical and transition risks and opportunities that could impact earnings across 34 industries.

The return estimates are uncertain in nature – quantifying the impact of climate change (through physical and transition risk) is often challenging as there is no historical precedent. We acknowledge certain limitations of our model. We assume that no carbon tax is already priced in and so the introduction of carbon taxes would likely be a drag on prices.

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Appendix

Indexes

European equities: MSCI Europe

EM equities: MSCI Emerging markets index

U.S. equities: MSCI USA

EM debt, local: JPMorgan GBI-EM index

EM debt, USD: JPMorgan EMBI Global Diversified Index

China government bonds: Bloomberg Barclays China Treasury + Policy Bank Total Return Index

Global high yield debt: Bloomberg Barclays Global High Yield Index

Global investment grade credit: Bloomberg Barclays Global investment grade credit

Global government bonds: Bloomberg Barclays Global Aggregate

Private markets: BlackRock proxy. We use BlackRock proxies for selected private markets because of lack of sufficient data. These proxies represent the mix of risk factor exposures that we believe represents the economic sensitivity of the given asset class.

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