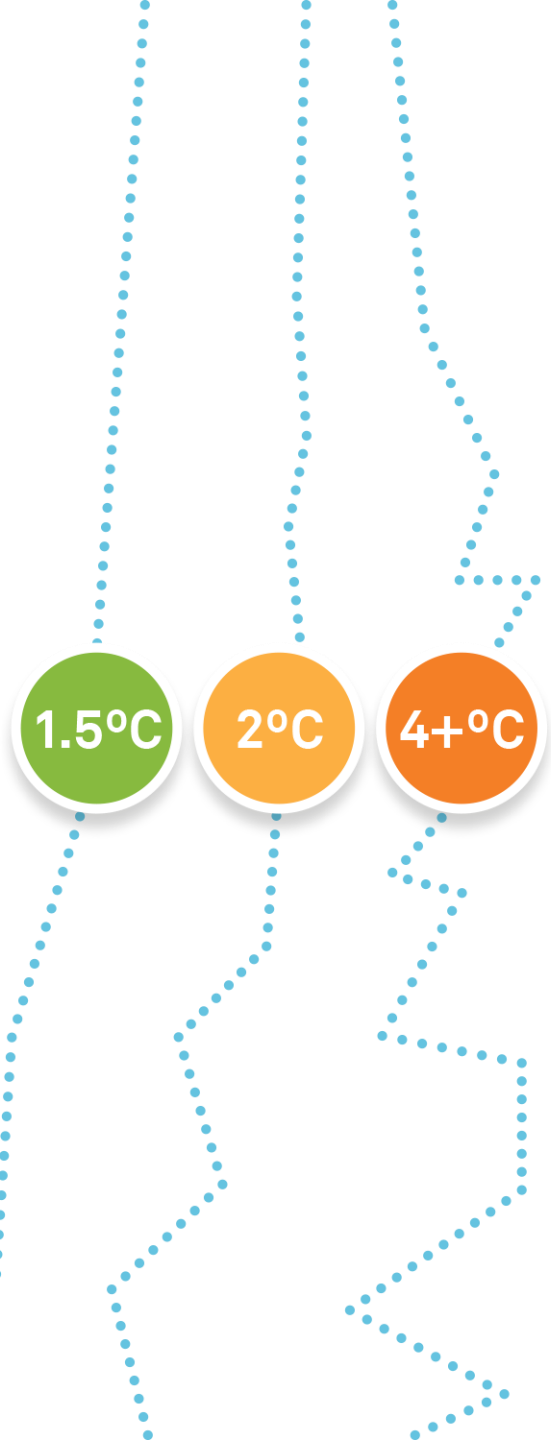
CLIMATE MAPS

Oregon Treasury

Climate Scan Report

October 2021



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Climate risk exposure | OPERF investment portfolio

The view from 10,000 feet

1. Lower return expectations across all assets due to negative climate impact over time.

Over the next 20 years, **all three climate scenarios see lower growth expectations** compared to a baseline. This poses a material risk to both scheme balance sheets and future contribution/funding needs.

2. Worst outcomes come in a Failed Transition due to physical risks.

Globally, the **physical risks** experienced when **transition to a greener economy fails, have the most significant impacts** (63% lower US GDP by 2100). **Notably, by 2037 OPERF's portfolio value in the Failed Transition scenario is significantly down compared to an orderly low-carbon transition.** In a Failed Transition, by 2060 your asset portfolio value is expected to c.20% lower than baseline.

3. Transition risk impacts may occur sooner than most expect.

On the other hand, a **transition scenario** – even a disorderly one – **enables global economies to stabilize** once the transition has been completed. There is hope, and this demonstrates the need for investors to engage with companies and sovereigns on the transition whilst also positioning their portfolios well in the interim.

In the near future, transition impacts are generally positive in Europe. In contrast, the US is more negatively impacted than many other countries due to fossil fuels exports and other high-emitting activity currently being a significant contributor to GDP. Relative to the baseline, in a disorderly transition scenario, high exposure to the US economy contributes to OPERF's portfolio reducing in value by roughly 8% over the next 5 years.

4. Climate risk changes the Strategic Asset Allocation (SAA) landscape as climate impacts affect long-term expectations.

Risk-adjusted returns vary across assets, pathways and time horizons. In general, **cash & corporate bonds are more resilient whereas the least resilient asset classes are listed/private equities and properties** due to their sensitivity to pricing-in shocks and market over-reaction.

Compared to a typical globally-exposed pension scheme, **your portfolio's current climate risk exposure is relatively more vulnerable** due to a exposure to sensitive regions, sectors, and asset classes.

Climate change is likely to see strongly differentiated risk/return at a sector level. As such, future SAA/ALM decisions may benefit from sector-level differences being captured in the analysis.

Key Takeaways | Both short-term and long-term risk is material

Outlook

In the near future, the portfolio could suffer in particular from losses if a disorderly climate transition transpires.

The longer it takes for coordinated policy action on climate, the more radical and disruptive it is likely to be for markets.

The pricing-in of physical risk is likely to come many years or decades ahead of direct impacts. The Failed Transition scenario shows **your current portfolio experiences significant impacts from a failed transition by the middle of the 2030's** as inevitable future physical damage is priced-in.

US

The US represents c.70% of OPERF's allocation exposure (using data received and proxies agreed with you and noting that allocation exposure is not the same as economic exposure). **The US economy is negatively exposed to both physical and transition-related climate risks under all pathways**. The country's position as a net fossil fuel exporter, with low energy efficiency, low carbon pricing and high sensitivity to market sentiment shocks make it highly exposed to transition risks. At the same time it is already experiencing severe extreme weather challenges (both "wet" and "dry") which will only worsen with increasing temperatures, even under the transition scenarios.

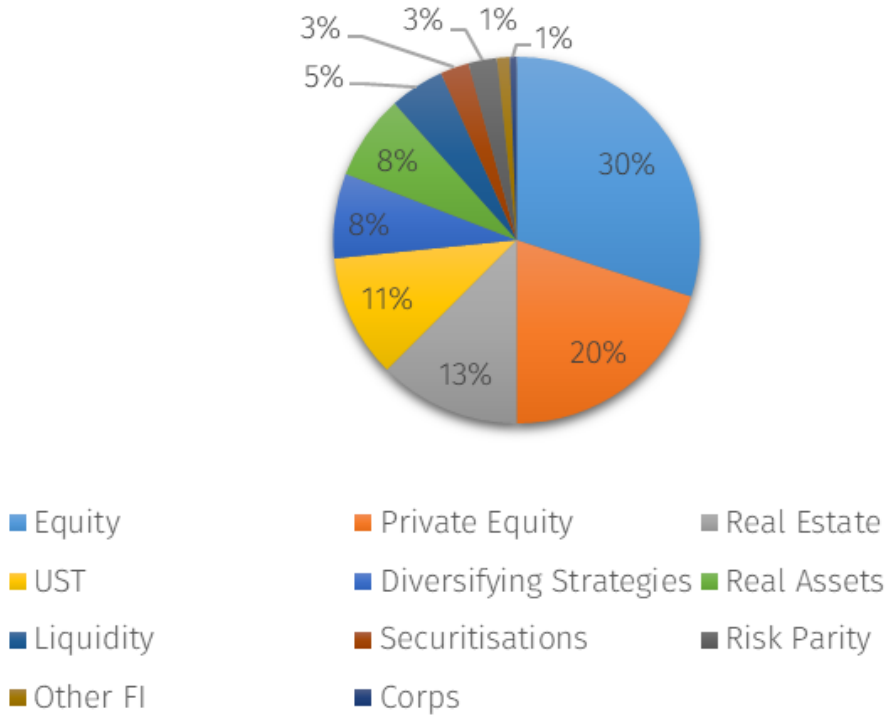
So what?

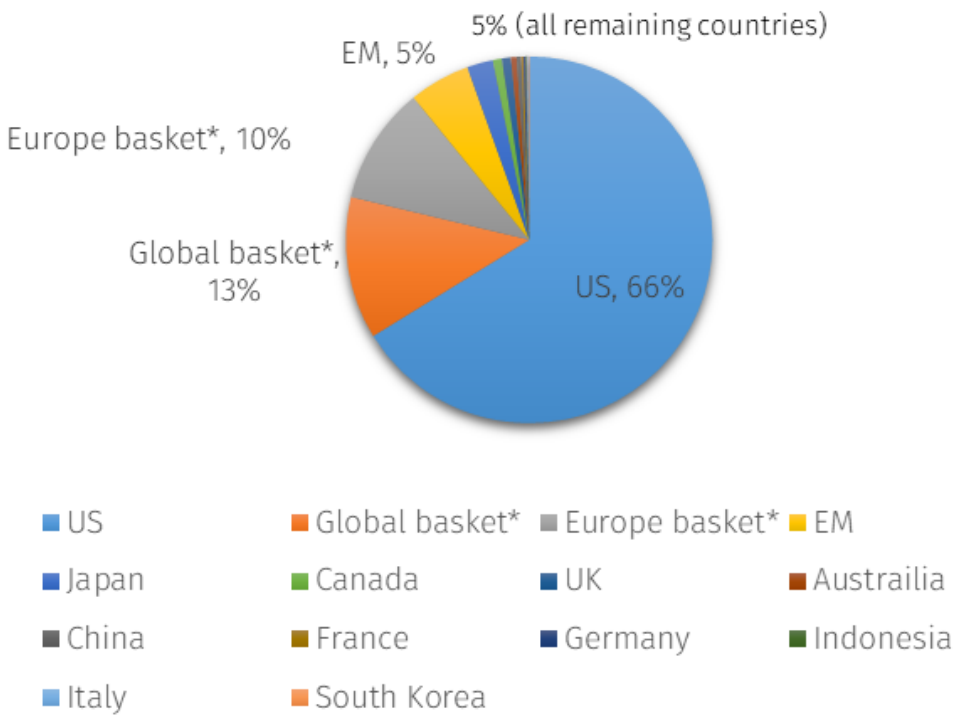
Across all pathways, there is significant differentiation between the likely experiences of different countries, sectors and asset classes. We recommend that using this analysis, you could work with your fund managers and advisors further integrating climate into your investment process. For example:

- Identify the "**hotspots**" of risk, for closer inspection by risk- and asset-managers
- **Consider SAA/ALM actions** to balance de-risking, scheme investment objectives and budgetary considerations
  - For example a "climate-informed" SAA exercise
    - Consider rotation away from transition-sensitive sectors/geographies whilst resilience testing asset de-risking in mitigating climate risk
    - Careful, climate-risk informed choice of longer term, illiquid assets
- Consider if fund benchmarks are **incentivizing fund managers to align their funds with your objectives**/risk appetites in the light of this study?
- Where segregated mandates are a used, then **careful mandate design** will be crucial to appropriately managing climate risk and **taking risk-conscious advantage of the coming economic shifts**. For example maturity caps on debt issued by climate-exposed sectors and climate-aware KPIs for total return funds.
- Potential next steps are expanded upon later in this report with suggestions for different elements of the investment process.

The fund's asset allocation

- Below are asset class and geographic summaries of the allocations we modelled. These were based on data provided by OST and then mapped to our model. Where proxies were required these were agreed with the team.
- In many ways the allocations are typical of other large pension funds open to members and accruing benefits. The significant domestic bias is also typical of pension funds around the world.





Climate scenarios at a glance

We consider **three plausible climate pathways** that explore potential future climate policies, interventions, and consequences of the world failing to mitigate climate change.

Scenarios cannot cover all possible outcomes, and are not mutually exclusive. There is no meaningful or practically useful way to give a probability of a scenario coming to fruition. These scenarios were selected to identify portfolio weak spots that aid decision making to respond to climate risk.

These "what if" climate change scenarios focus on two interdependent climate risk drivers:

- **Transition risk** focuses on the impacts (risks/opportunities) of *policy / technology uptake* towards a low-carbon economy
- **Physical risk** focuses on changes in the natural system attributable to global warming, i.e. sea level rise, frequency and severity of extreme weather events.

Paris Orderly Pathway

- **Large transition impact** due to policy measures & technology drivers
- Transition is assumed to occur as smoothly as possible
- **Market pricing-in** dynamics occur smoothed out over the 2020-2025 period
- **Physical impacts** occur up to 1.5/2°C which are greater than today but still much less than under a Failed Transition

In line with: Emissions ≈ IPCC **RCP 2.6**

Average temp increase of 1.6°C by 2100.

97% probability of limiting warming to 2°C and c.29% probability of limiting to 1.5°C.

Tests exposure to the risks/opportunities from the systemic drivers of an orderly transition and locked-in physical risk

Paris Disorderly Pathway

- **Large transition impact** due to policy measures & technology drivers
- Transition has disruptive effects on financial markets with **repricing** followed by a sudden **sentiment shock** and stranded assets in 2024 / 2025
- **Physical impacts** occur up to 1.5/2°C which are greater than today but still much less than under a failed transition

In line with: Emissions ≈ IPCC **RCP 2.6**

Average temp increase of 1.6°C by 2100.

97% probability of limiting warming to 2°C and c.29% probability of limiting to 1.5°C.

Shows resilience of the portfolio to sudden transition triggering a market dislocation centred on high emitting stocks

Failed Transition Pathway

- **Limited transition impact -** economies follow the business-as-usual track without **additional** new policy measures
- **Severe physical impacts** occur and continues to increase over time – both **gradual physical** changes, as well as more frequent and severe **extreme weather events**
- **Markets price-in physical risks** up to 2050 by end of this decade, and price-in post-2050 physical risks from the mid-2030s onwards

In line with: Emissions ≈ IPCC **RCP 6.0**

Expected global warming by 2100 **3.8°C**

The main focus of this scenario is physical risk, results show the exposure to plausible, severe climate change impacts

Some guiding principles for using these results

The modeling was performed using benchmarks, tailored to reflect the asset allocation of the OPERF portfolio.

Unless stated otherwise, results are shown relative to a baseline that does not make an explicit allowance for the paradigm-shifting changes that our scenarios consider. Instead the baseline is conditioned on historic relationships and long-term views based on current market conditions.

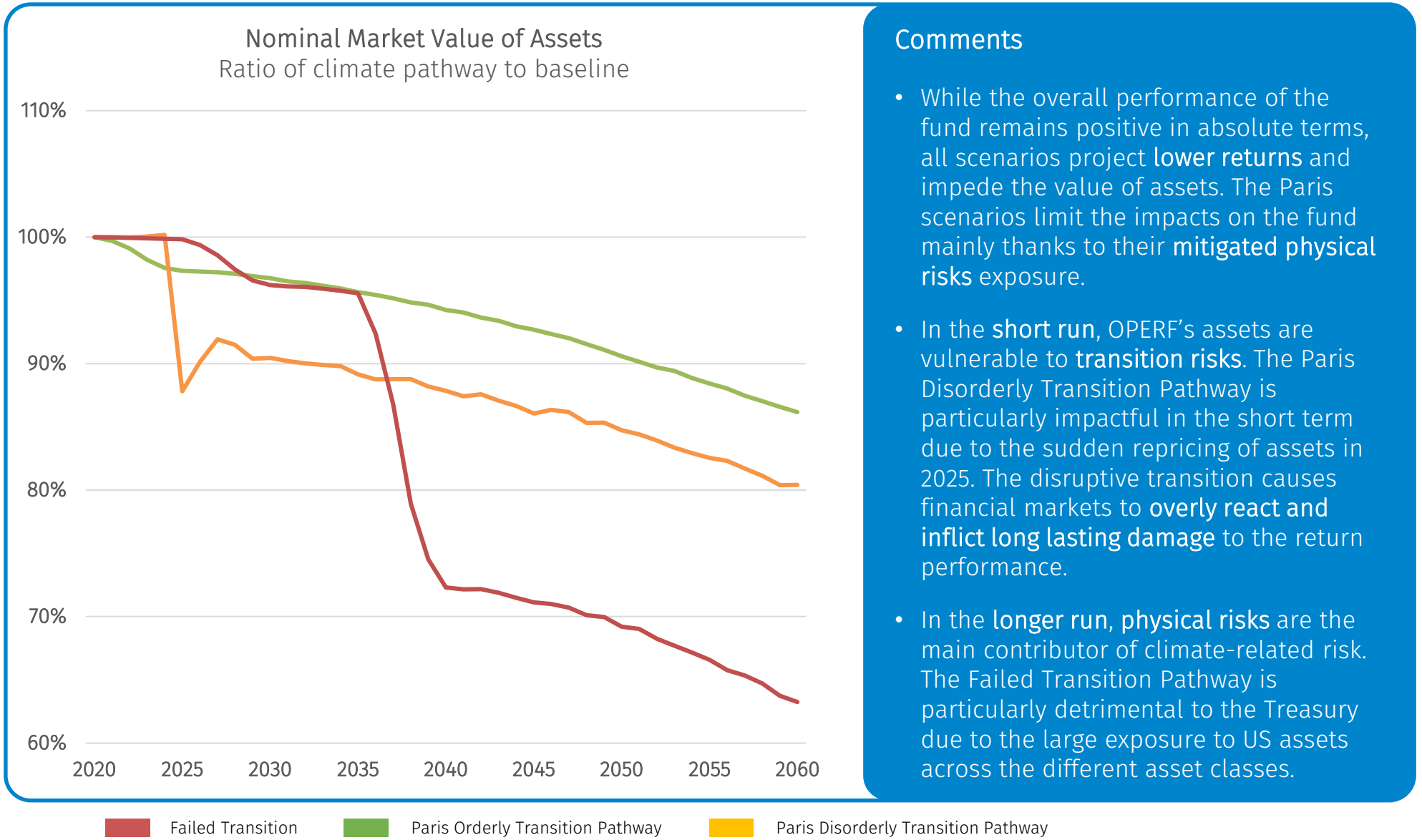
The scenarios have been constructed as diligently as possible. However, climate science is intrinsically subject to significant uncertainties. So scenarios are best viewed as a pressure test for the portfolio, probing for climate-risk weak spots.

Interpretation notes

- Focus on direction and magnitude vs exact numbers
  - Overlay these results on your views/knowledge of individual holdings
  - Results are shown relative to the baseline
- Many climate-financial relationships are non-linear
- Physical risk impacts are likely underestimated
- Climate change scenarios focus on two interdependent climate risk drivers:
  - Transition risk focuses on the impacts (opportunities/risks) of policy/technology uptake towards a low-carbon economy
  - Physical risk focuses on changes in the natural system and impacts on natural catastrophe severity/frequency and resource availability
  - It is entirely plausible that the future holds a mixture of the effects that we model

OPERF investment portfolio performance

The figure below shows the **ratio of cumulative impacts** relative to baseline over the next 40 years.



Comments

- While the overall performance of the fund remains positive in absolute terms, all scenarios project **lower returns** and impede the value of assets. The Paris scenarios limit the impacts on the fund mainly thanks to their **mitigated physical risks** exposure.
- In the **short run**, OPERF's assets are vulnerable to **transition risks**. The Paris Disorderly Transition Pathway is particularly impactful in the short term due to the sudden repricing of assets in 2025. The disruptive transition causes financial markets to **overly react and inflict long lasting damage** to the return performance.
- In the **longer run, physical risks** are the main contributor of climate-related risk. The Failed Transition Pathway is particularly detrimental to the Treasury due to the large exposure to US assets across the different asset classes.

Redacted

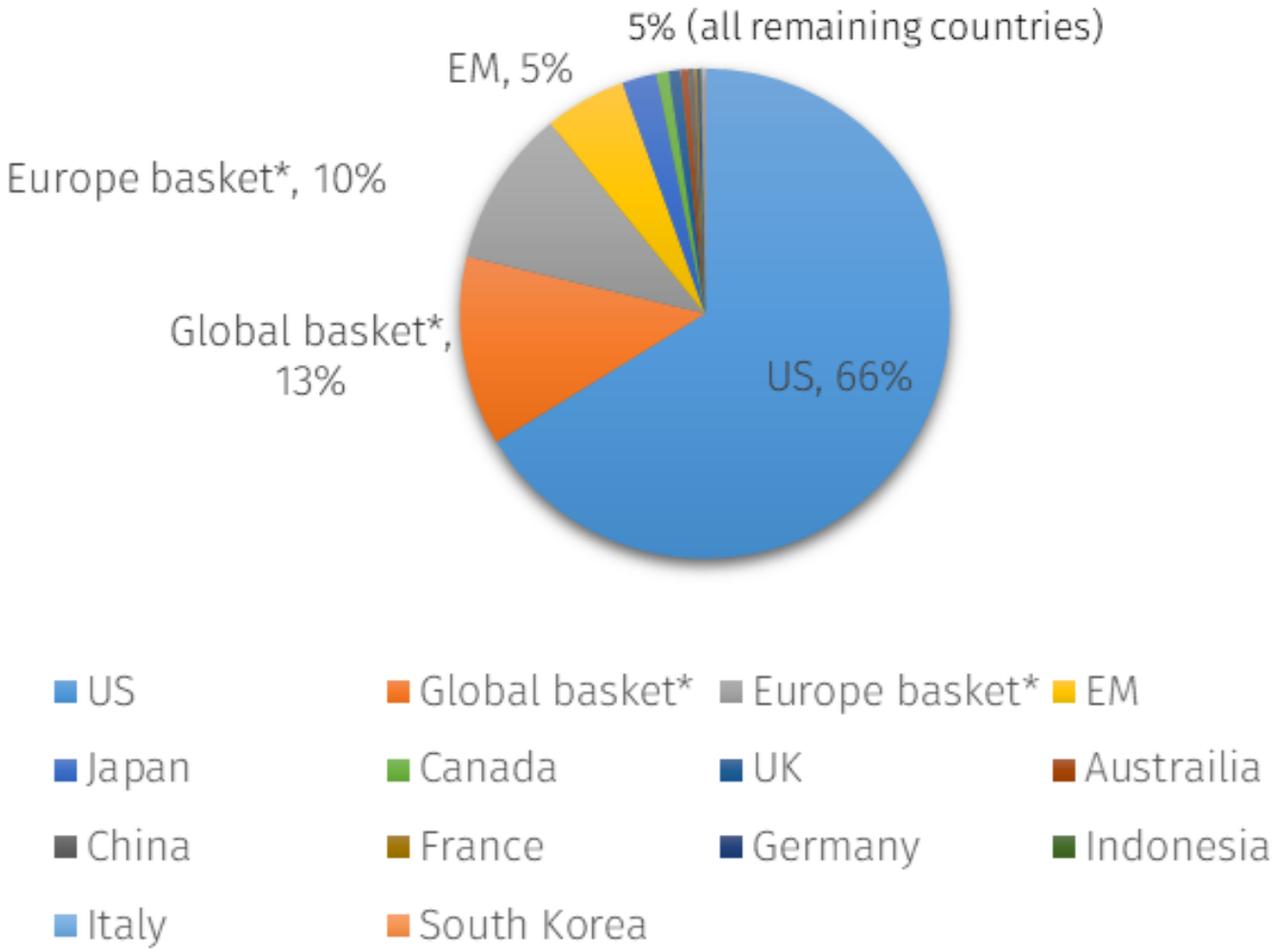
Geographic exposure – country rankings

To help us make sense of the drivers for country exposure this section considers the main levers of regional differences before examining our “rankings” of countries by

- Scenario
- Key economic variables
- Equity performance

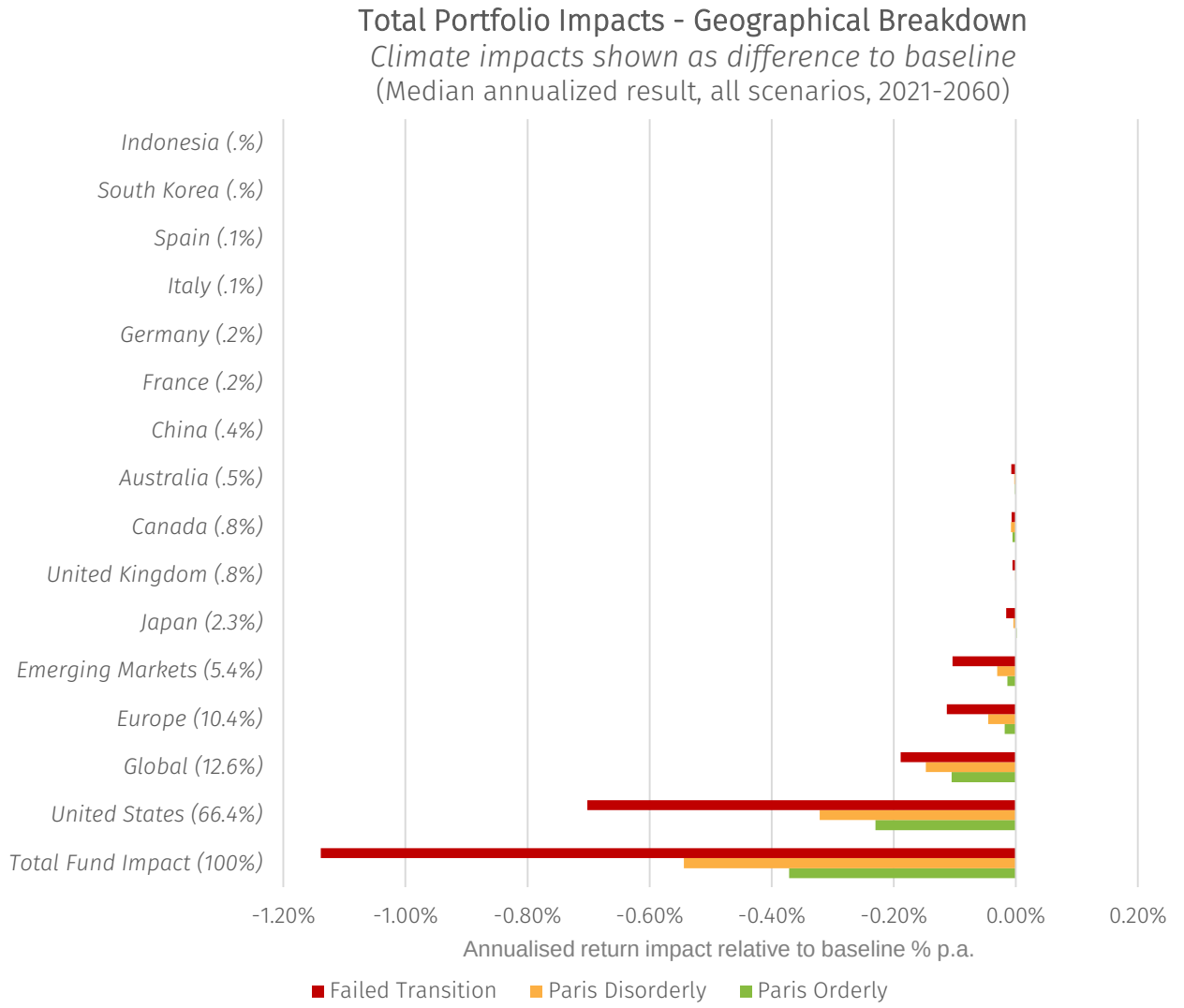
Portfolio exposure – geographic lens

Whilst a strong domestic bias is typical of many pension funds, at a systemic level the US is more exposed to climate risk than many other countries.



Country attribution of total climate risk impacts – all assets

Across all asset classes, US and EM exposures drive total impacts slightly larger than justified by allocations

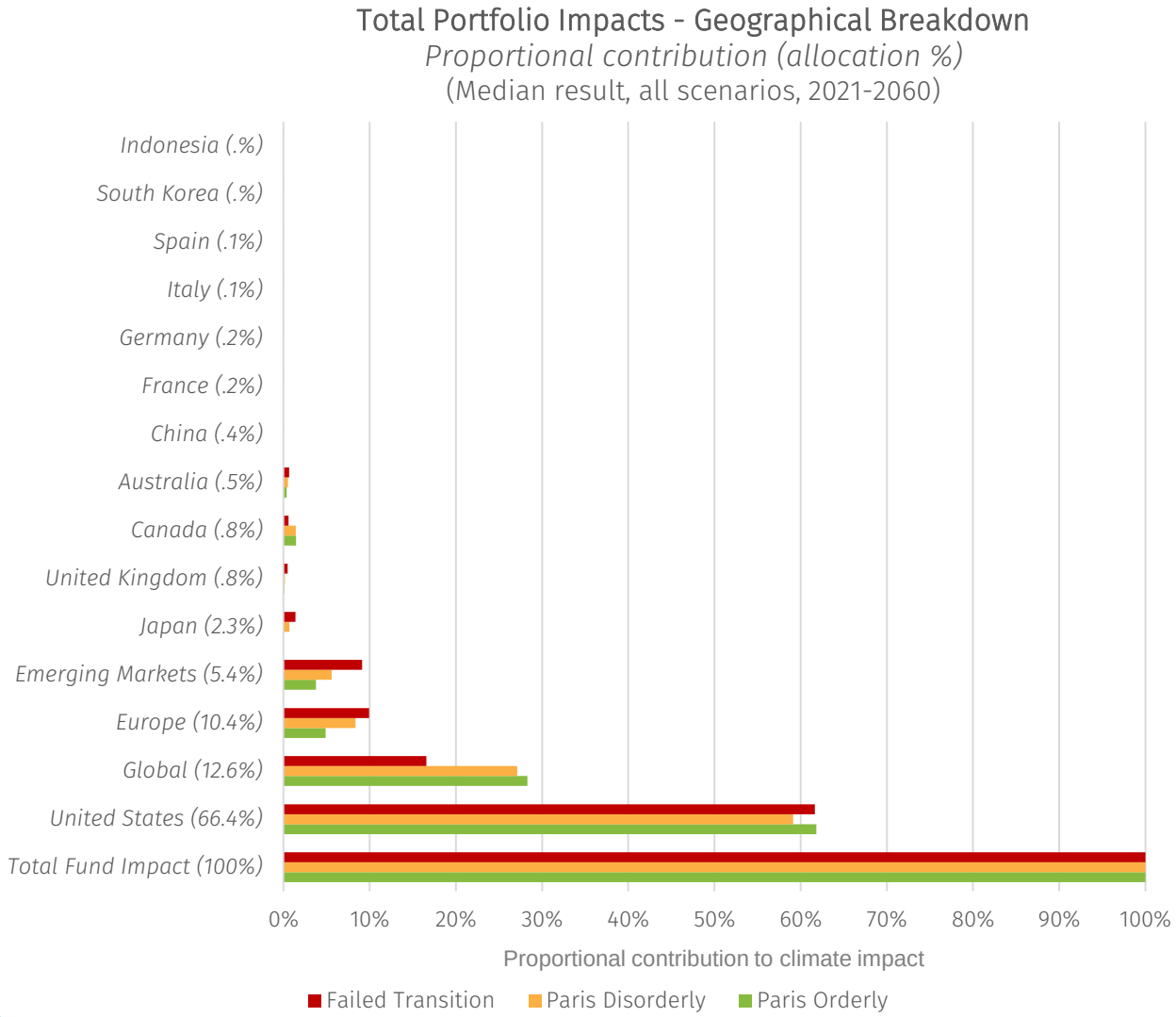


Comments

- Main source of risk comes from the large exposure to US assets.
- The top 3 regions (US, EU, EM) account for most of the risks in the fund across all scenarios.
- Given its unique geographical situation, and allowing for the relative benefits of USTs the US contributes it's fair share of climate risk in the Failed Transition and Disorderly scenario. However, without USTs the picture is very different.
- Despite its much lower allocation, EM is a large contributor of physical risks under a Failed Transition in particular.

Proportional country attribution – all assets

Across all asset classes, US and EM exposures drive total impacts disproportionate to their allocations



Comments

- By re-framing the contributions as a % of total and comparing to allocated capital, we can see which regions produce more climate risk than their fair share.
- The most striking here are US (all scenarios), Global basket (transition) and EM (physical risk – failed transition).
- Note that if we removed the dampening effect of USTs from the US bucket, it would be contributing c.70%-80% of the risk – somewhat in excess of the proportional capital allocated.

Key transition risk drivers explaining regional performance differences

Key Transition Risk Drivers	Impact Narrative	Example Countries
Level of carbon price	The higher it is, the more the region benefits from investments in low-carbon technologies.	Europe
Net importer/exporter of (high marginal production cost) fossil fuels	Exporters tend to be worse off, importers tend to be better off.	Brazil/Malaysia vs. Canada/US/Saudi Arabia/Norway
Weight of energy sector in local stock market	The higher the weight, the more negatively impacted.	Canada, Norway
Relative energy efficiency of the economy	If energy efficient, then investments in energy efficiency (driven by carbon price) boost economic performance.	Europe
Carbon revenue recycling	The higher the carbon price, the more scope for a lowering of VAT / income tax which boosts household incomes. Households are buffered from increasing energy prices.	Europe
Sensitivity to sentiment shock	Some countries are historically more sensitive than others to market shocks.	USA
Investment stimulus	Positive GDP impact in those countries where transition investments are taking place.	China, Netherlands, Finland, Sweden, Turkey
Consumer spending stimulus	Positive GDP impact in those countries where consumer spending in transition activities is taking place.	UK, Europe, New Zealand
Stimulus combined with debt repayment	Initial positive GDP impacts; then decrease in GDP in later years.	Italy, Switzerland

Key physical risk drivers explaining regional performance differences

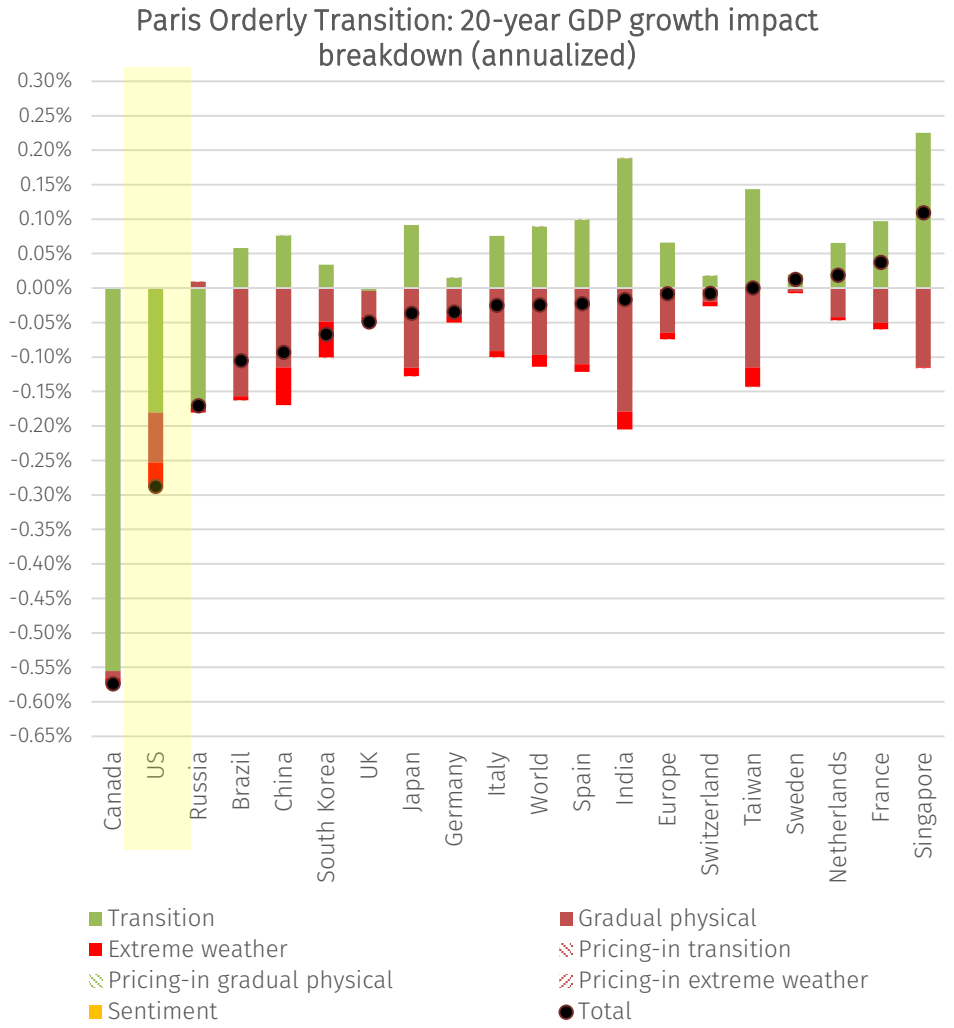
Physical Risk Drivers

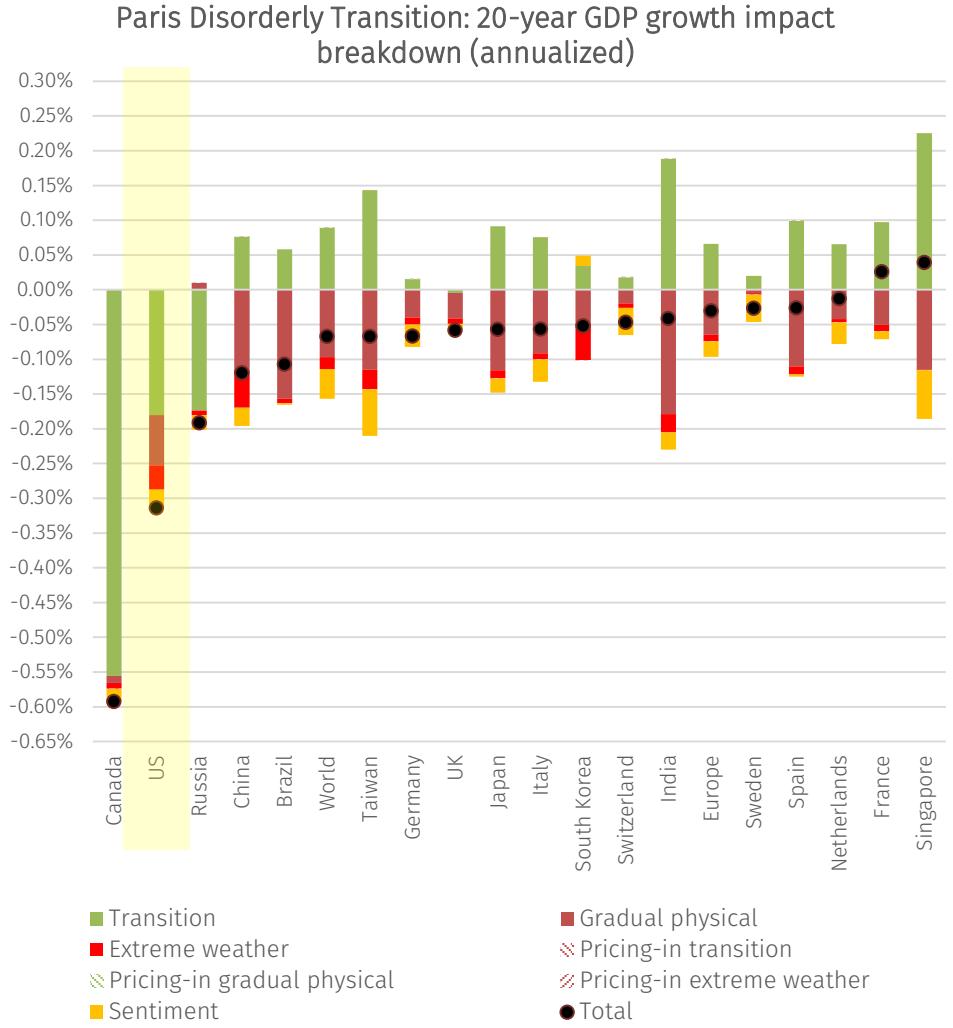
Latitude effect	Countries closer to the poles are currently still less exposed, but warming at faster rates. Countries closer to the equator are already more exposed, with temperature having non-linear impact on productivity.
Current temperature	Countries with current average temperatures below ~5°C (such as Finland and Russia) experience initial positive GDP growth impacts from warming, while countries with high average temperatures experience large negative impacts on GDP growth (e.g. India and Saudi Arabia).
Sensitivity to physical impacts	Decreasing land, labor and industrial productivity in regions that are relatively more exposed to physical impacts.
Sensitivity to economic amplification	Countries with a lower economic coping capacity to buffer extreme weather losses (if they start to occur more frequently)

How do other countries rank in terms of climate impacts?

GDP shocks: Transition scenarios expose countries to risks and opportunities.

- After Canada, the US is the most **negatively** impacted country under both transition pathways.
- Singapore, France, the Netherlands, Sweden and Spain are most **positively** impacted under a transition scenario.

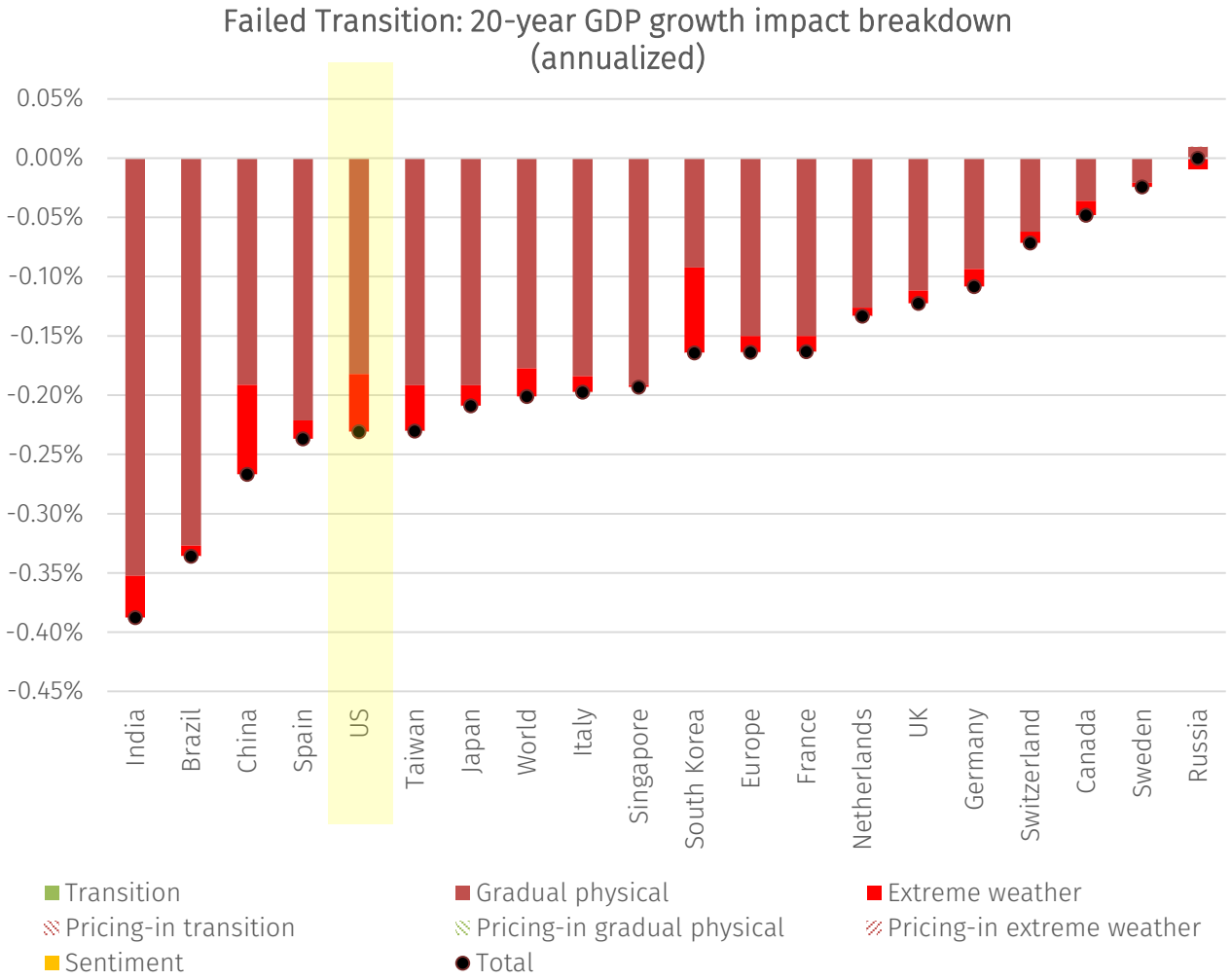




How do other countries rank in terms of climate impacts?

GDP shocks: A Failed Transition has negative impacts on all countries, but to varying degrees.

- The US, together with India, Brazil and China are the most impacted by a Failed Transition.
- Canada and the Nordic countries are least impacted by the Failed Transition thanks to their demographic and geographic situation.

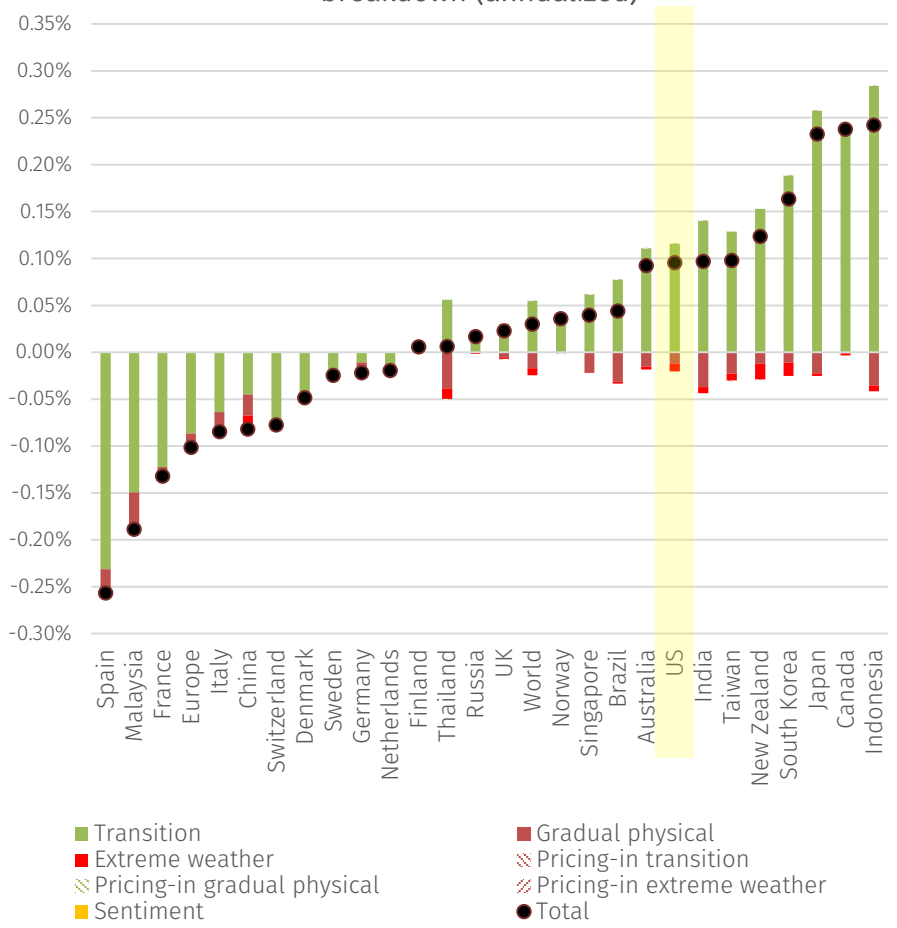


How do other countries rank in terms of climate impacts?

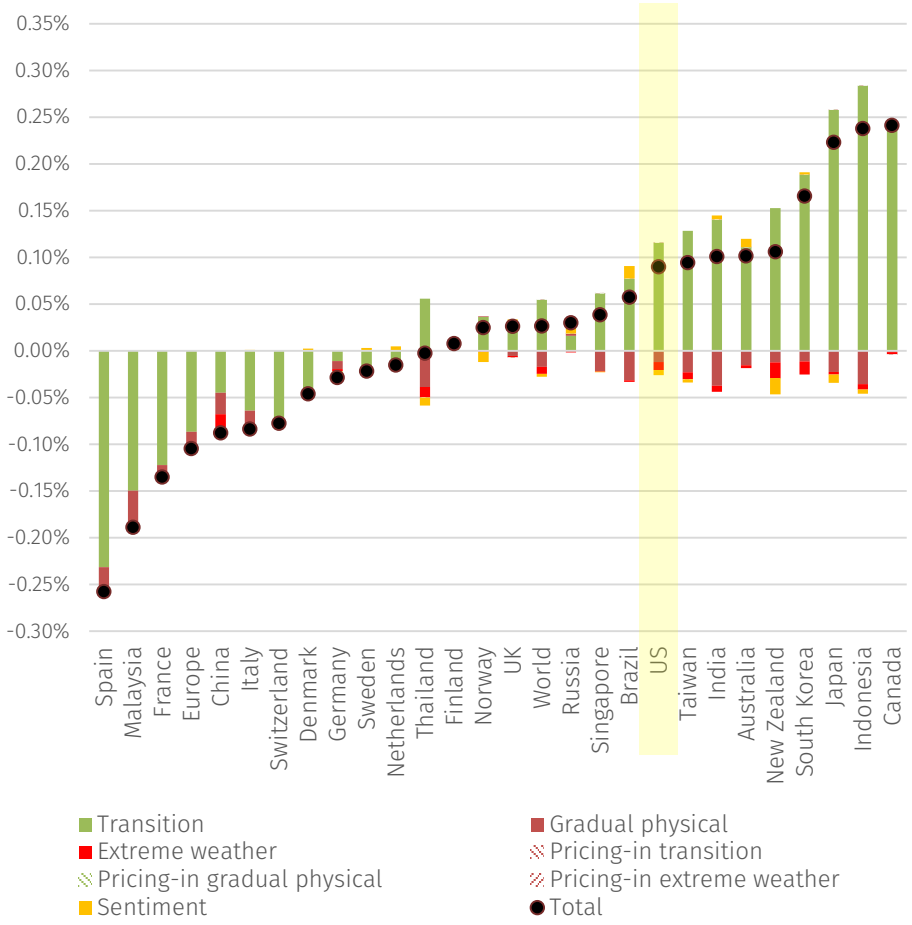
Inflation shocks vary across countries and under each pathway.

- While for some countries, inflation is relatively unaffected by climate change, others experience either a net positive or a net negative inflation impact under the transition scenarios.
- The US experiences high net positive inflation impacts. This is largely driven by demand-pull inflation from higher fuel and carbon taxes.

Paris Orderly Transition: 20-year inflation impact breakdown (annualized)



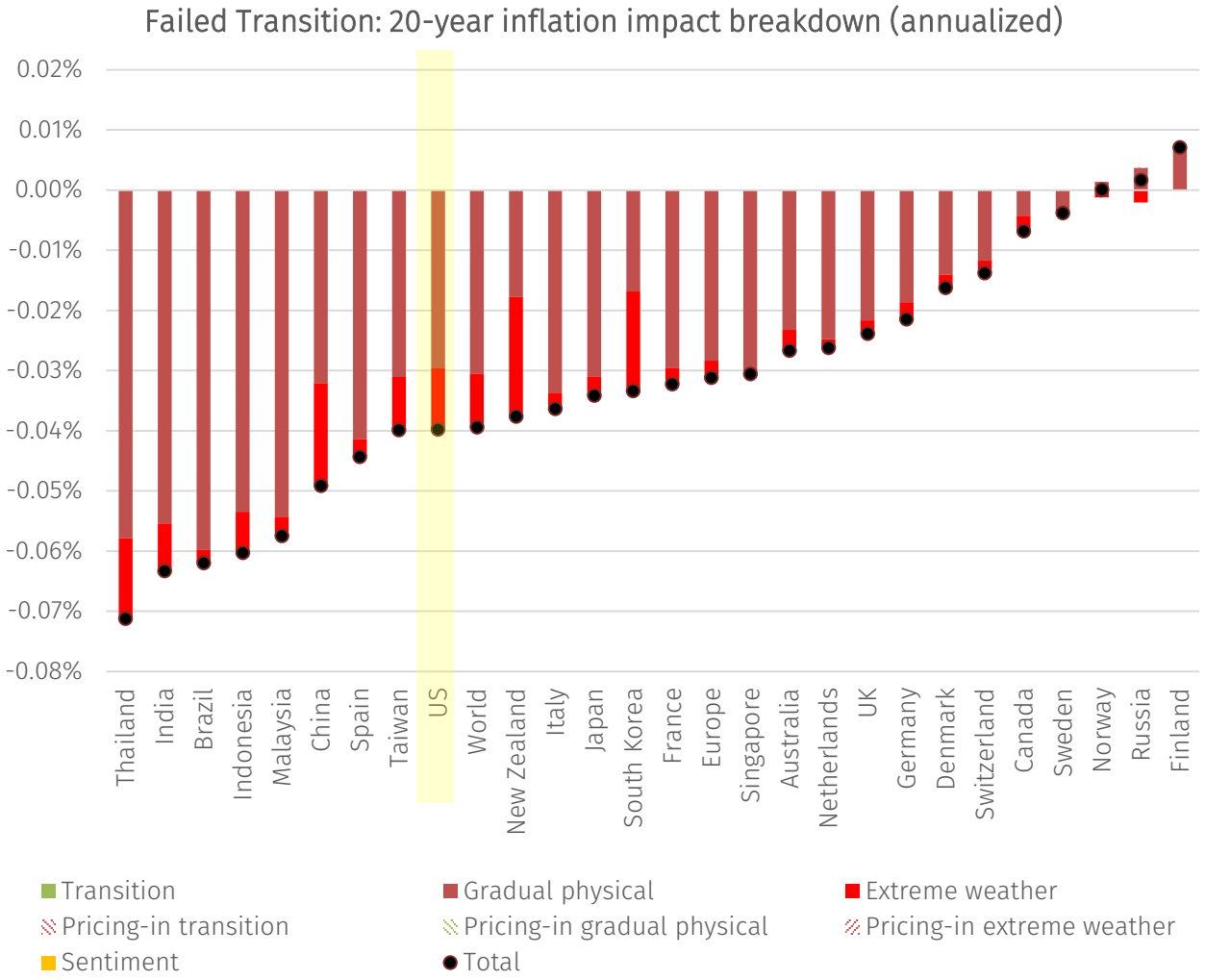
Paris Disorderly Transition: 20-year inflation impact breakdown (annualized)



How do other countries rank in terms of climate impacts?

Inflation shocks: almost all countries experience negative shock under a Failed Transition.

- Under a Failed Transition scenario pretty much all countries experience a negative inflation impact.
- The US is relatively heavily impacted compared to Europe or Canada.

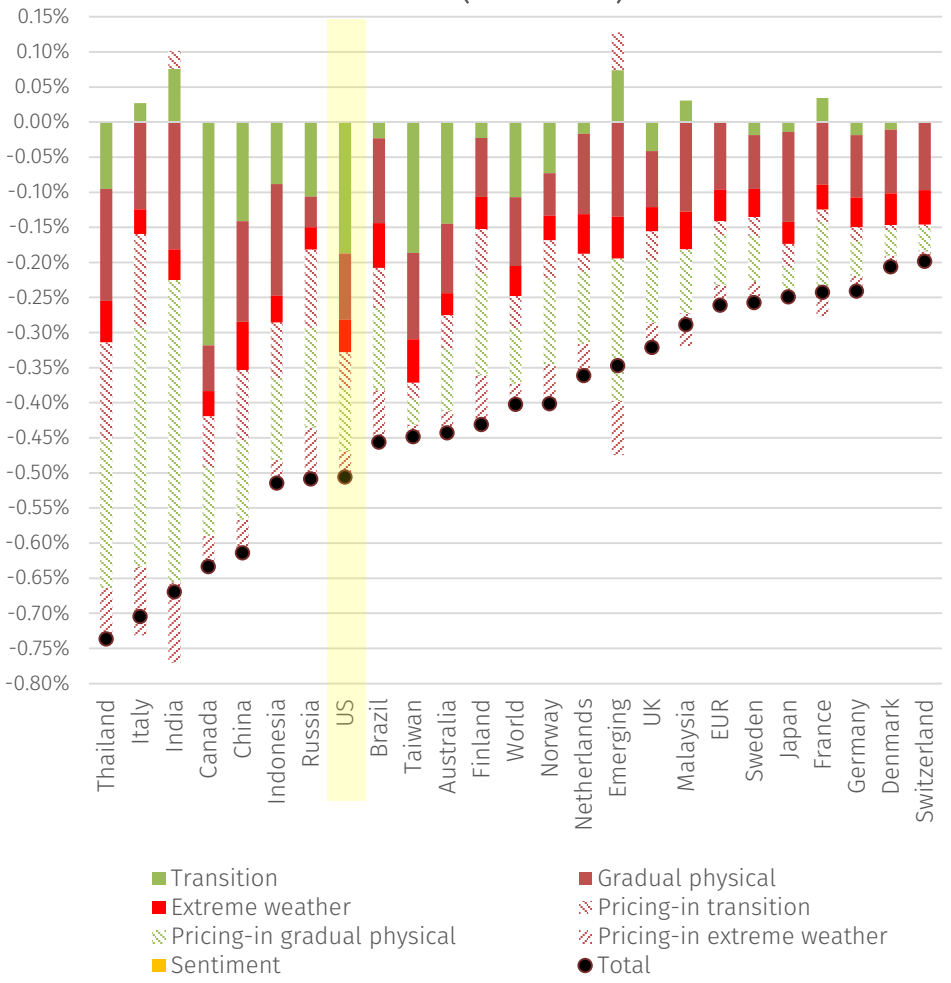


How do other countries rank in terms of climate impacts?

Equity returns are one of the least resilient asset classes and suffer both from transition and physical risk drivers.

- Transition impacts on equity returns are significantly more severe if the transition happens in a disorderly manner.
- Under both transition scenarios, the US ranks among the most impacted regions although not as much as Canada.

Paris Orderly Transition: 20-year global equities impact breakdown (annualized)



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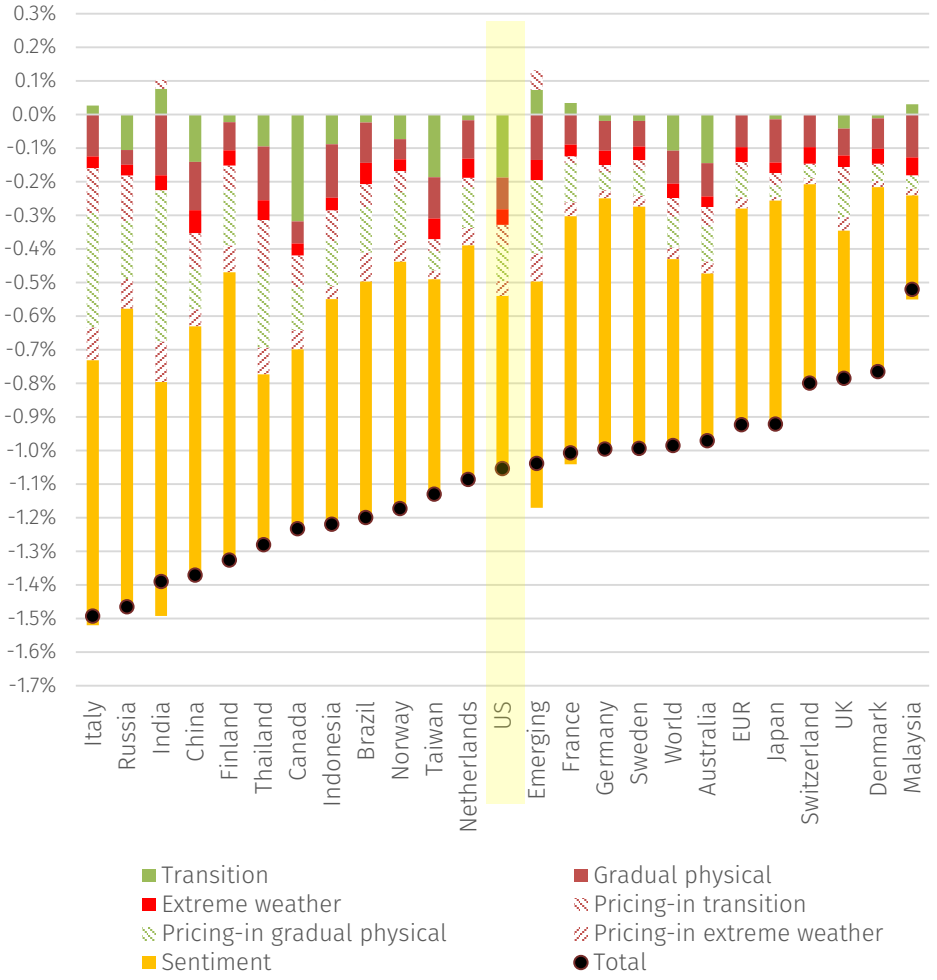
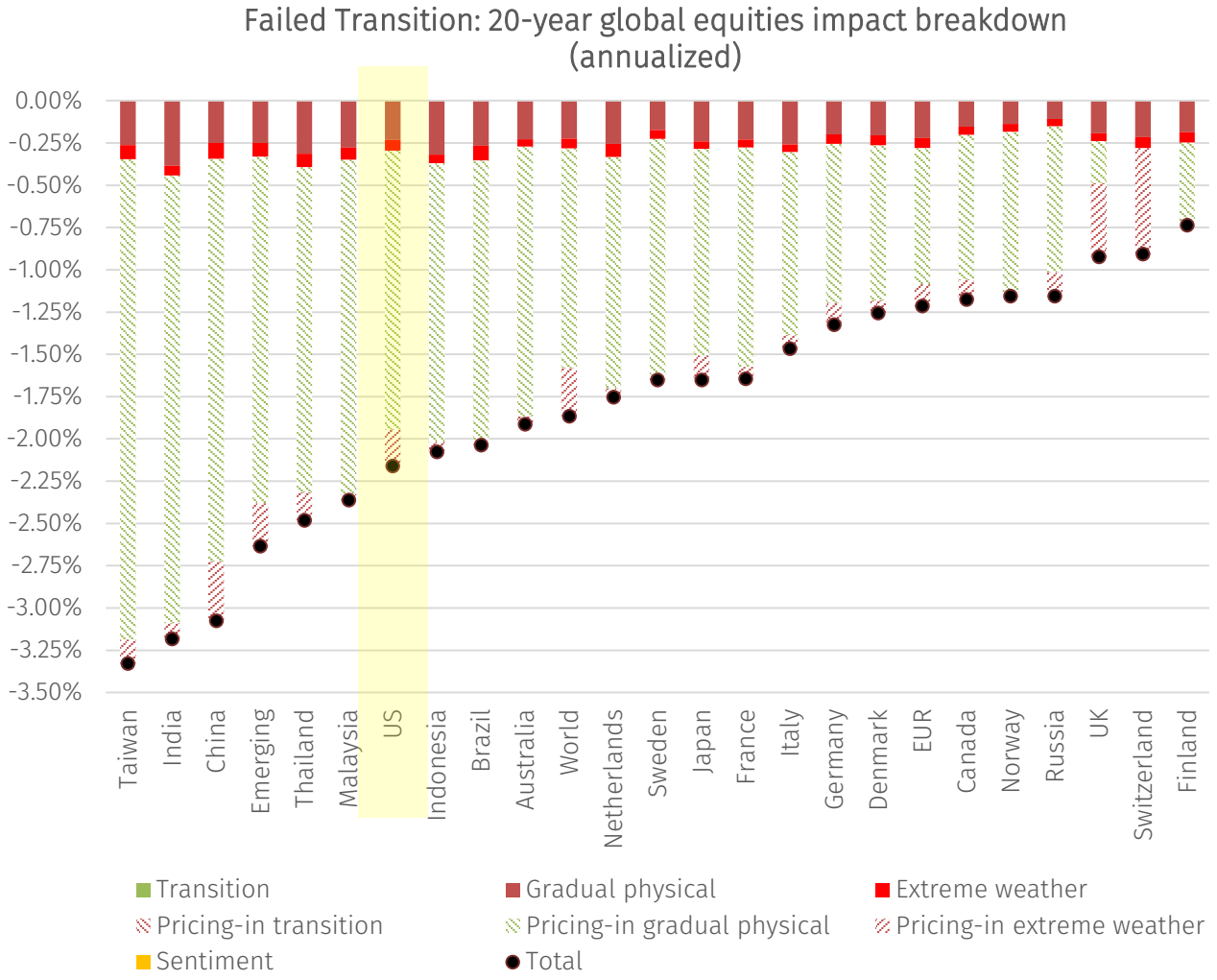


How do other countries rank in terms of climate impacts?

Equity returns vary across countries and under each pathway.

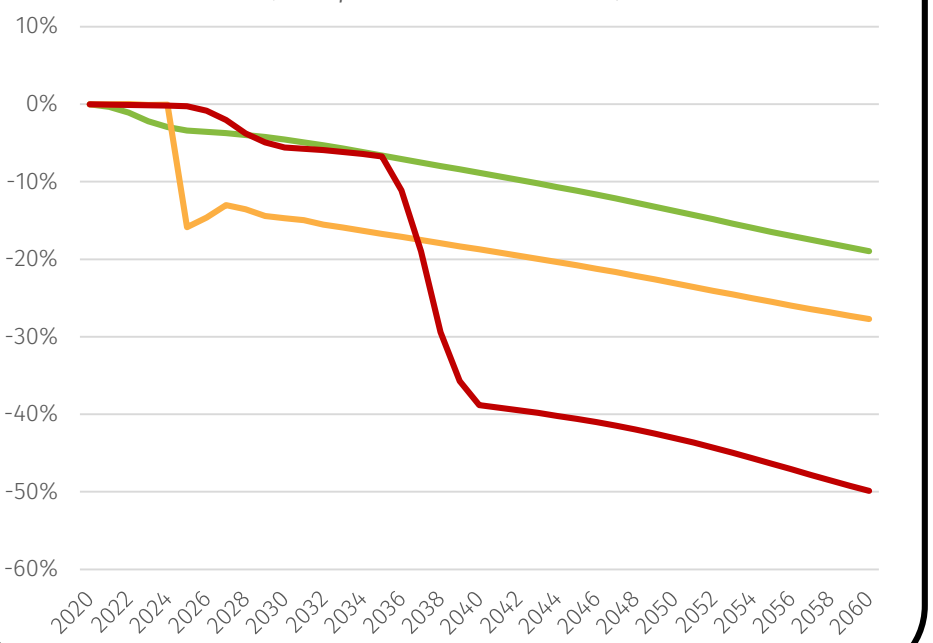
- A Failed Transition impacts equity returns most severely via the markets pricing-in of gradual physical risks.
- While Taiwan, India, China, and other emerging markets are the most negatively impacted nations, the US still leads the way in terms of developed nation facing physical risks (-2.16% in annual losses)



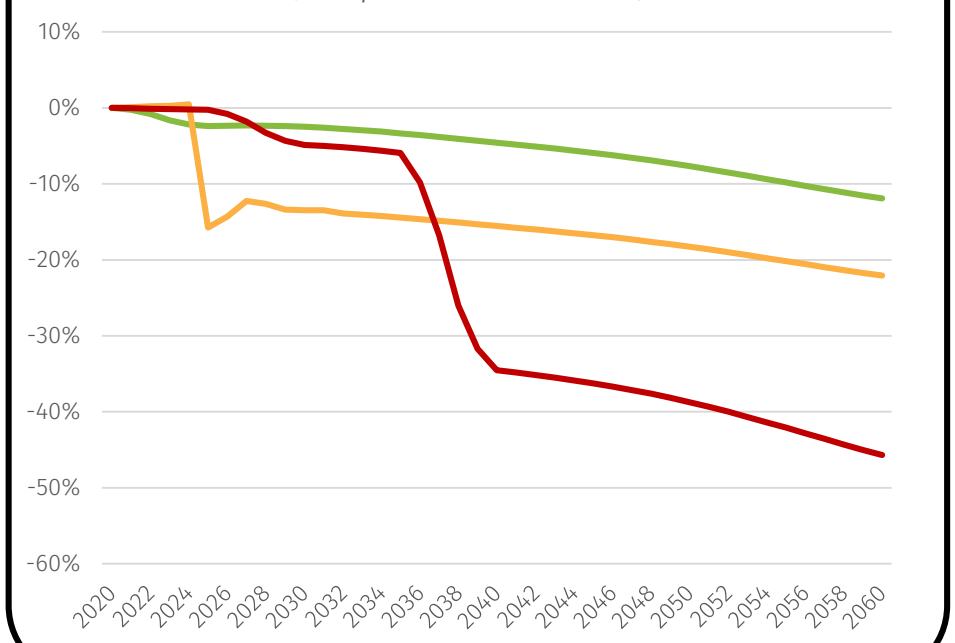
Climate impacts on US Equities vs. the World

US equities face higher transition risk, and seem less resilient to physical risk exposure

MSCI US



MSCI World



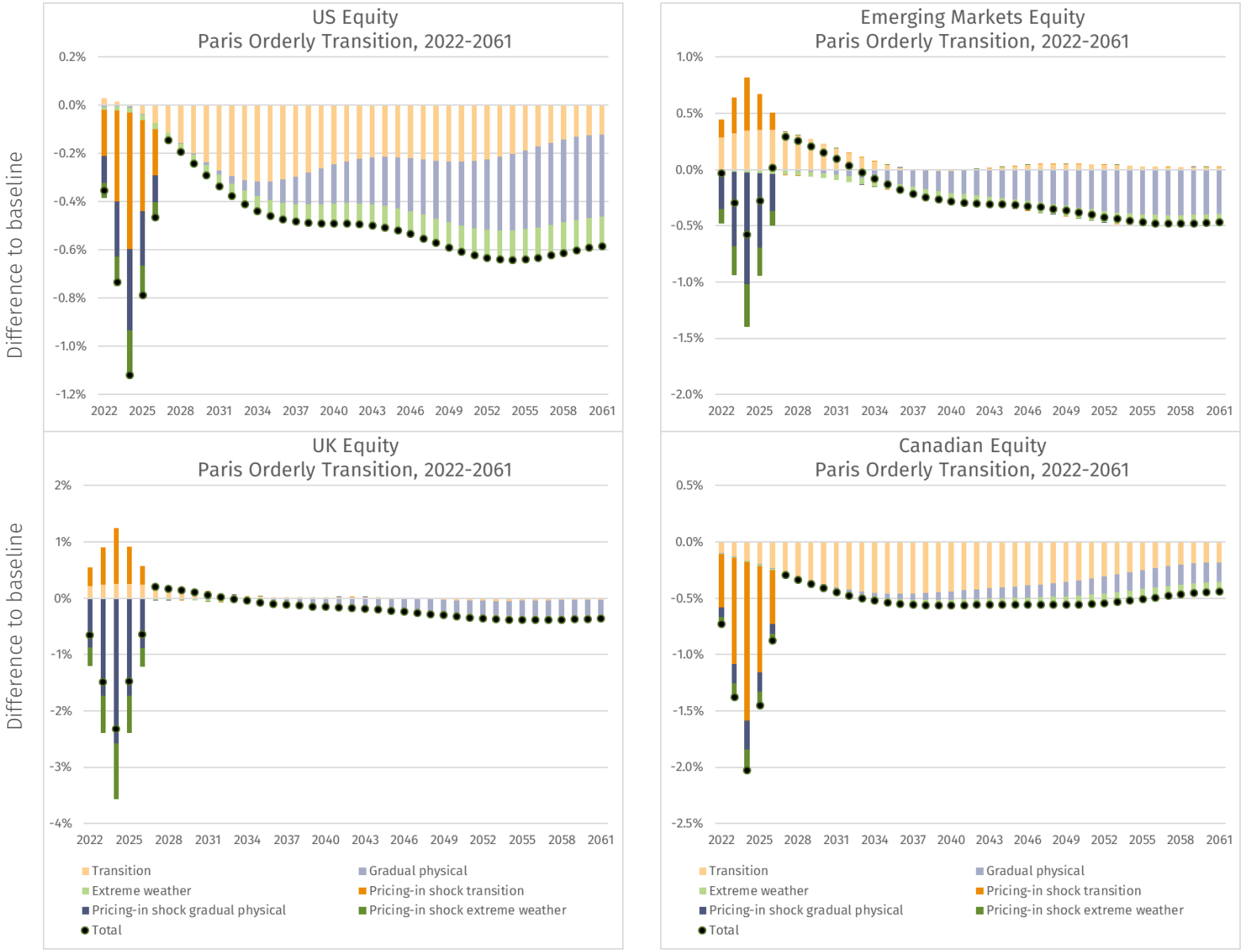
Comments

The Paris Orderly and Disorderly Transition Pathways have a large impact on the US economy, due in part by reduced income from oil and gas exports and high emitting sectors. This is reflected in the impacts on US equity. Compared to the rest of the world, transition impacts are expected to be 50% larger under an orderly transition and 20% larger under a disorderly transition by 2060. Unlike its northern neighbor, the US exposure to physical risks renders the country more vulnerable than most countries. Compared to World equities (of which US is c.60% - MSCI ACWI), US equities are expected to be 40% more exposed to physical risks.

Failed Transition Paris Orderly Transition Pathway Paris Disorderly Transition Pathway

Contribution Analysis: What Types of Risk Affect Your Assets?

A closer look at climate impacts on equities in various markets – Paris Orderly Scenario



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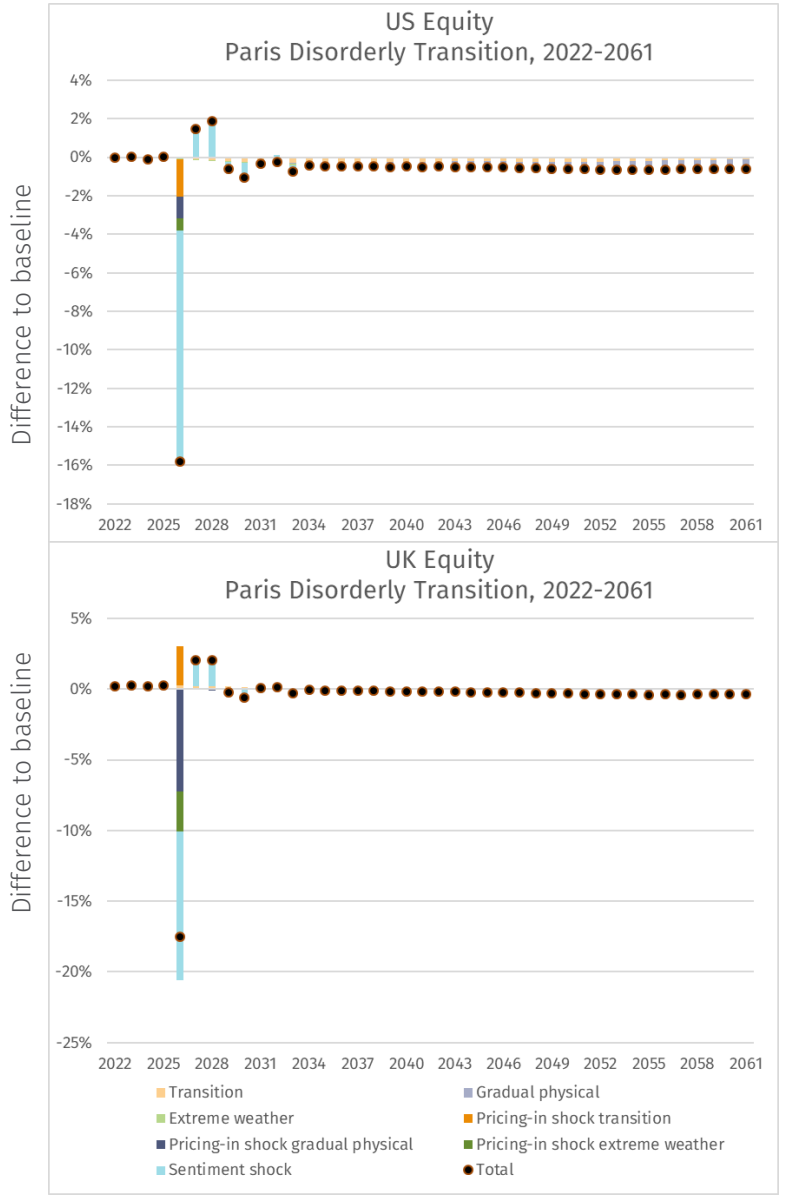
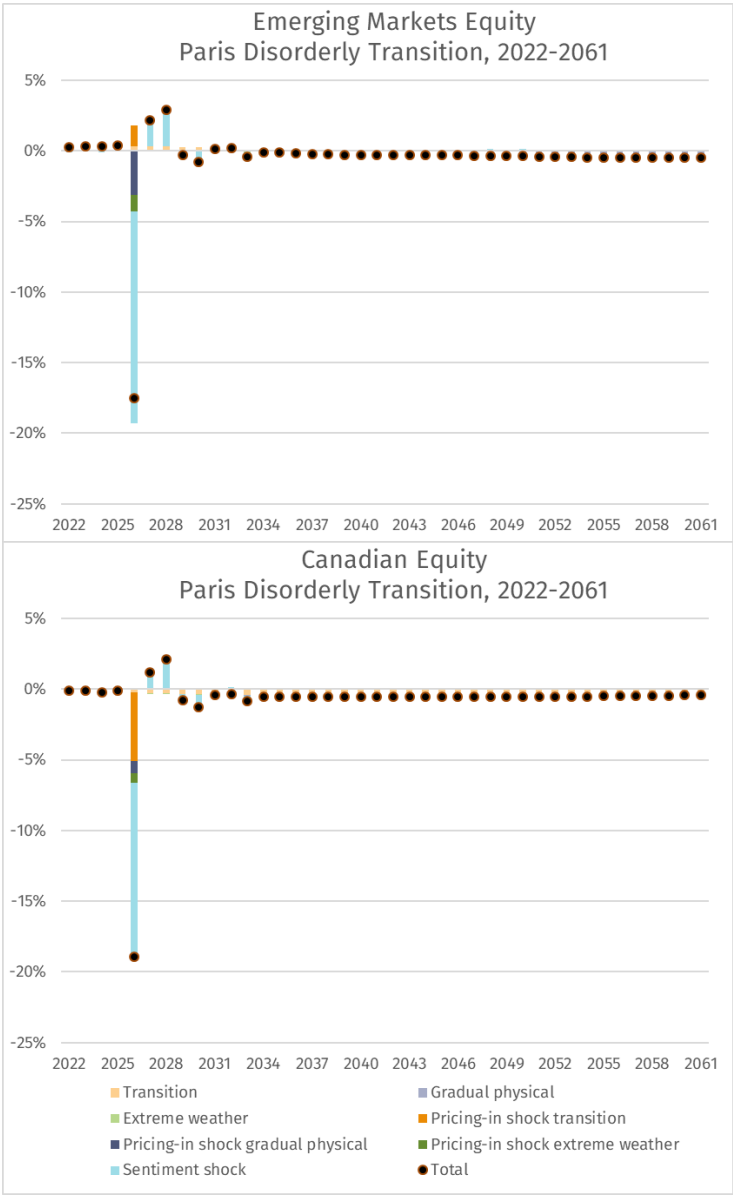
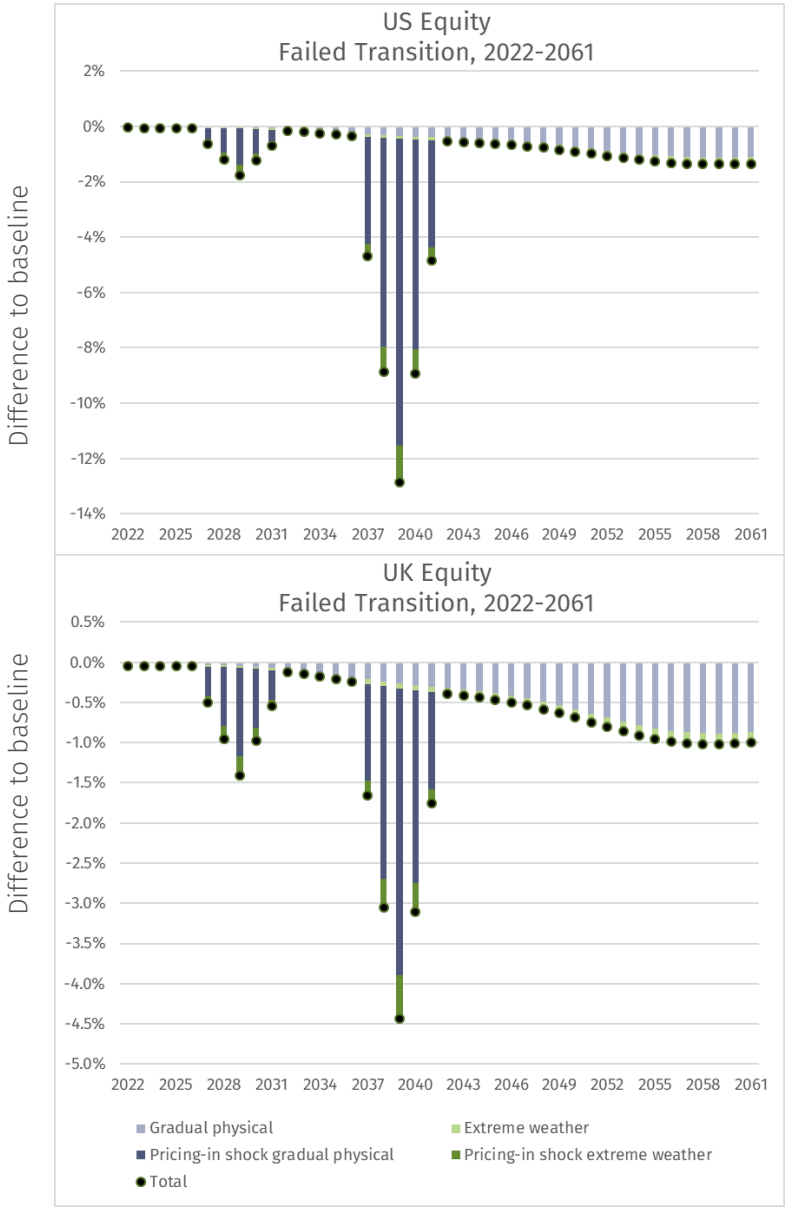
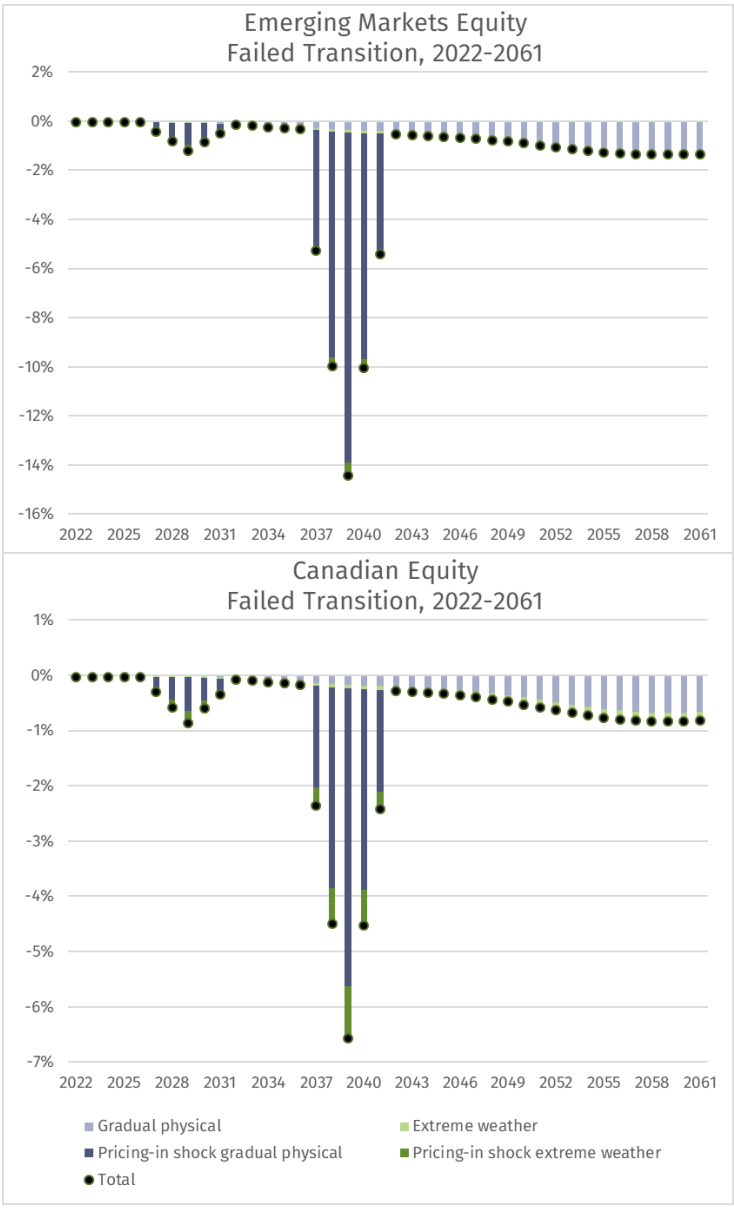




Contribution Analysis: What Types of Risk Affect Your Assets?

A closer look at climate impacts on equities in various markets – Failed Transition





Asset class insights

Having considered regional differences, this section focuses in on the asset classes currently forming the portfolio.

Results are presented in time buckets, showing the median return and the downside 5th percentile.

We show median return for each scenario as a delta to the baseline, so as to give a “climate shock” for that scenario.

For the risk measure, we show the difference in return between the scenario median and the scenario 5% CVaR. This is intended to give you a sense of the downside dispersion of the distribution in that scenario.

By color-coding the tables we can see the hot and cool spots in the portfolio, where it could be most efficient to make deeper investigations into risks and opportunities.

Further granularity is provided in the annex.

Key Findings – Asset Classes

FOCUS ON PARIS DISORDERLY TRANSITION RISKS

Fixed Income:

- Less sensitive to climate risks than other asset classes.
- Corporate and non-investment grade bonds are more sensitive and sector-specific in exposure

Equities and PE:

- Global equities very sensitive
- US especially hard hit
- PE mirrors equity sensitivities

Alternatives, Real Estate, Infrastructure:

- Alternatives can offer climate transition protection due to a lower beta
- Real estate and infrastructure follow similar dynamics as public equity especially if strong links to energy and utilities
- Real assets - holdings slightly more exposed due to exposure to transition-exposed sectors
- Physical risk exposure becomes more critical through time

All of the above should be weighed against the need to meet pension liabilities.

More detailed tables (also for the other climate scenarios), with upside and downside 5% VaR are included in the annex.

Scenario 2: Paris *disorderly* transition pathway	2021-2025		2026-2030		2031-2040	
	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR
Fund	-2.6%	-7.4%	0.6%	-8.0%	-0.3%	-5.0%
Fixed income						
US Investment Grade						
US Government Bonds						
US Index-Linked						
US High Yield						
EM Debt						
Equity						
MSCI World AC						
Small Cap						
Minimum Volatility						
Private Equity						
Venture Capital/Growth						
Buyout						
Emerging Market						
Distressed Debt						
Real Estate						
Direct Real Estate						
REITs						
Real Assets						
Real Asset Portfolio						
Opportunity Portfolio						
Diversifying Strategies						
HF Fund of Funds						
Risk Parity						
Global Sovereign Rates						
Inflation-Linked Bonds						
Corporate Credits						
Listed Equities						
Commodities						

Data Redacted

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Risk/Return Analysis of portfolio constituents* (annualized results)

Scenario 1: Paris *orderly* transition pathway	2021-2025		2026-2030		2031-2040		2041-2050		2051-2060		2021-2060	
	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR
Fund	-0.5%	-7.2%	-0.1%	-7.9%	-0.3%	-5.0%	-0.5%	-5.2%	-0.5%	-5.2%	-0.4%	-2.7%
Fixed income												
US Investment Grade												
US Government Bonds												
US Index-Linked												
US High Yield												
EM Debt												
Equity												
MSCI World AC												
Small Cap												
Minimum Volatility												
Private Equity												
Venture Capital/Growth												
Buyout												
Emerging Market												
Distressed Debt												
Real Estate												
Direct Real Estate												
REITs												
Real Assets												
Real Asset Portfolio												
Opportunity Portfolio												
Diversifying Strategies												
HF Fund of Funds												
Risk Parity												
Global Sovereign Rates												
Inflation-Linked Bonds												
Corporate Credits												
Listed Equities												
Commodities												

Data Redacted

*Additional granularity can be provided upon request

Risk/Return Analysis of portfolio constituents* (annualized results)

Scenario 2: Paris *disorderly* transition pathway

	2021-2025		2026-2030		2031-2040		2041-2050		2051-2060		2021-2060	
	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR
Fund	-2.6%	-7.4%	0.6%	-8.0%	-0.3%	-5.0%	-0.5%	-5.1%	-0.5%	-5.1%	-0.5%	-2.7%
Fixed income												
US Investment Grade												
US Government Bonds												
US Index-Linked												
US High Yield												
EM Debt												
Equity												
MSCI World AC												
Small Cap												
Minimum Volatility												
Private Equity												
Venture Capital/Growth												
Buyout												
Emerging Market												
Distressed Debt												
Real Estate												
Direct Real Estate												
REITs												
Real Assets												
Real Asset Portfolio												
Opportunity Portfolio												
Diversifying Strategies												
HF Fund of Funds												
Risk Parity												
Global Sovereign Rates												
Inflation-Linked Bonds												
Corporate Credits												
Listed Equities												
Commodities												

Data Redacted

*Additional granularity can be provided upon request

Risk/Return Analysis of portfolio constituents* (annualized results)

Scenario 3: Failed transition pathway

	2021-2025		2026-2030		2031-2040		2041-2050		2051-2060		2021-2060	
	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR	Median	Bottom 5% VaR
Fund	0.0%	-7.2%	-0.7%	-7.9%	-2.8%	-4.9%	-0.9%	-5.1%	-0.9%	-5.1%	-1.1%	-2.7%
Fixed income												
US Investment Grade												
US Government Bonds												
US Index-Linked												
US High Yield												
EM Debt												
Equity												
MSCI World AC												
Small Cap												
Minimum Volatility												
Private Equity												
Venture Capital/Growth												
Buyout												
Emerging Market												
Distressed Debt												
Real Estate												
Direct Real Estate												
REITs												
Real Assets												
Real Asset Portfolio												
Opportunity Portfolio												
Diversifying Strategies												
HF Fund of Funds												
Risk Parity												
Global Sovereign Rates												
Inflation-Linked Bonds												
Corporate Credits												
Listed Equities												
Commodities												

Data Redacted

*Additional granularity can be provided upon request

Focus on real assets (1/3)

What drives the climate exposure of your real asset portfolio? Zoom in on the main contributing sectors

The real asset portfolio was analyzed on a bespoke basis in Climate MAPS. We analyzed the sector exposure within the portfolio to create the bespoke climate shock. As the portfolio breakdown slides above illustrate, the asset class is quite exposed to climate risks.

To better understand, we created a bespoke calibration for the real assets portfolios. Working with your teams, we agreed on the following mapping to capture the systemic region/sector exposures. Sector allocations were made on the basis of data provided which was assumed to reflect the dominant economic activity of the individual holding.

As with the rest of our analysis, the outputs should be viewed as an overlay to your knowledge of the underlying holdings.

Also note that what are described here as “sectors” are more accurately “economic activities”, and so a more diversified company could (if more granular data were available) be considered a blend of different region/sector pairs.

Cells circled pink denote the sectors highlighted in the charts on the next slide. Some cells show a 0% due to rounding for clarity of presentation, however they were included in the model.

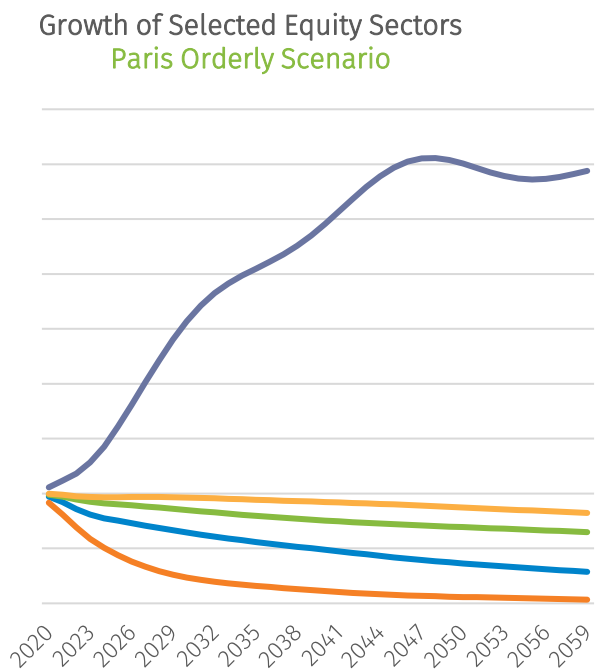
Real asset portfolio allocation %	Fossil fuel utilities	Industrials	Low carbon utility	Energy	IT	Oil & gas	Materials	Forestry	Cons staples
North America	7%	5%	6%	8%	6%	30%	4%	5%	4%
Europe	3%	2%	2%	1%	5%	2%	1%		0%
Asia	1%	1%	1%	0%	1%	1%	3%		

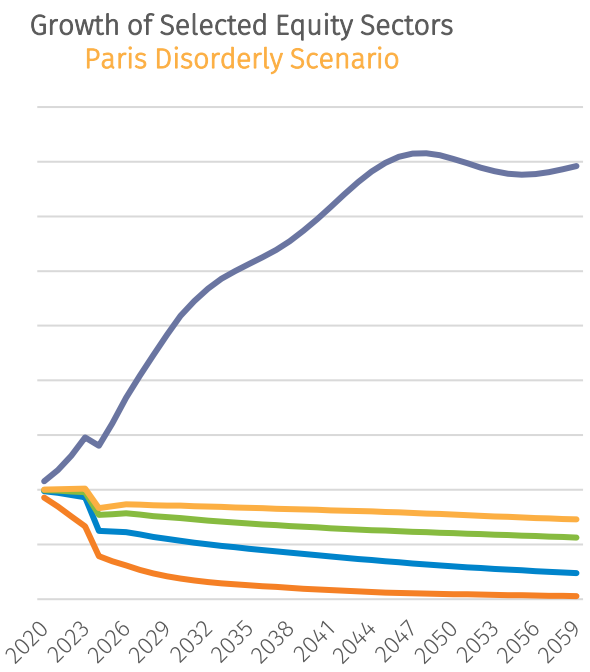
Focus on real assets (2/3)

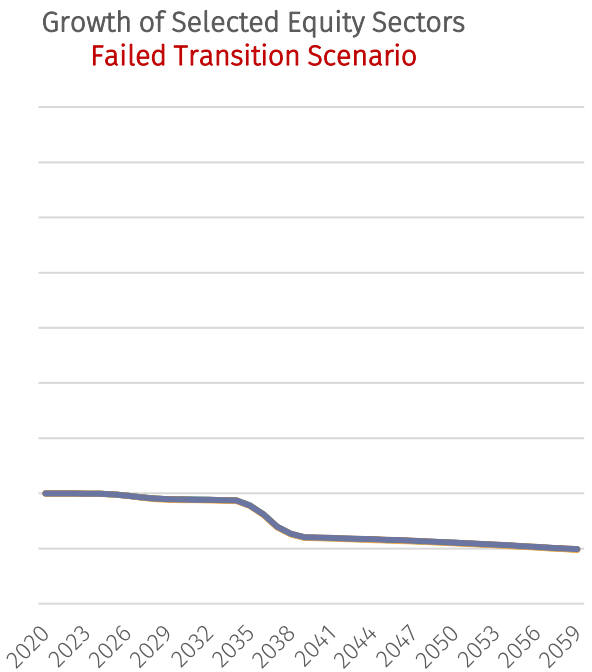
What drives the climate exposure of your real asset portfolio? Zoom in on the main contributing sectors

Below, we show the performance of the top 5 equity sector/region combinations in the real asset portfolio. These 5 sectors represent c.55% of the real asset portfolio. The most notable exposure stems from US Oil & Gas that represents c.30% of the portfolio. This sector is expected to suffer significantly during the transition.

In the Failed Transition scenario, all sectors are impacted equally by physical risks - there are no safe haven when viewed at this level of granularity. At individual holding/project level there will be considerable difference in resilience to physical client risks.





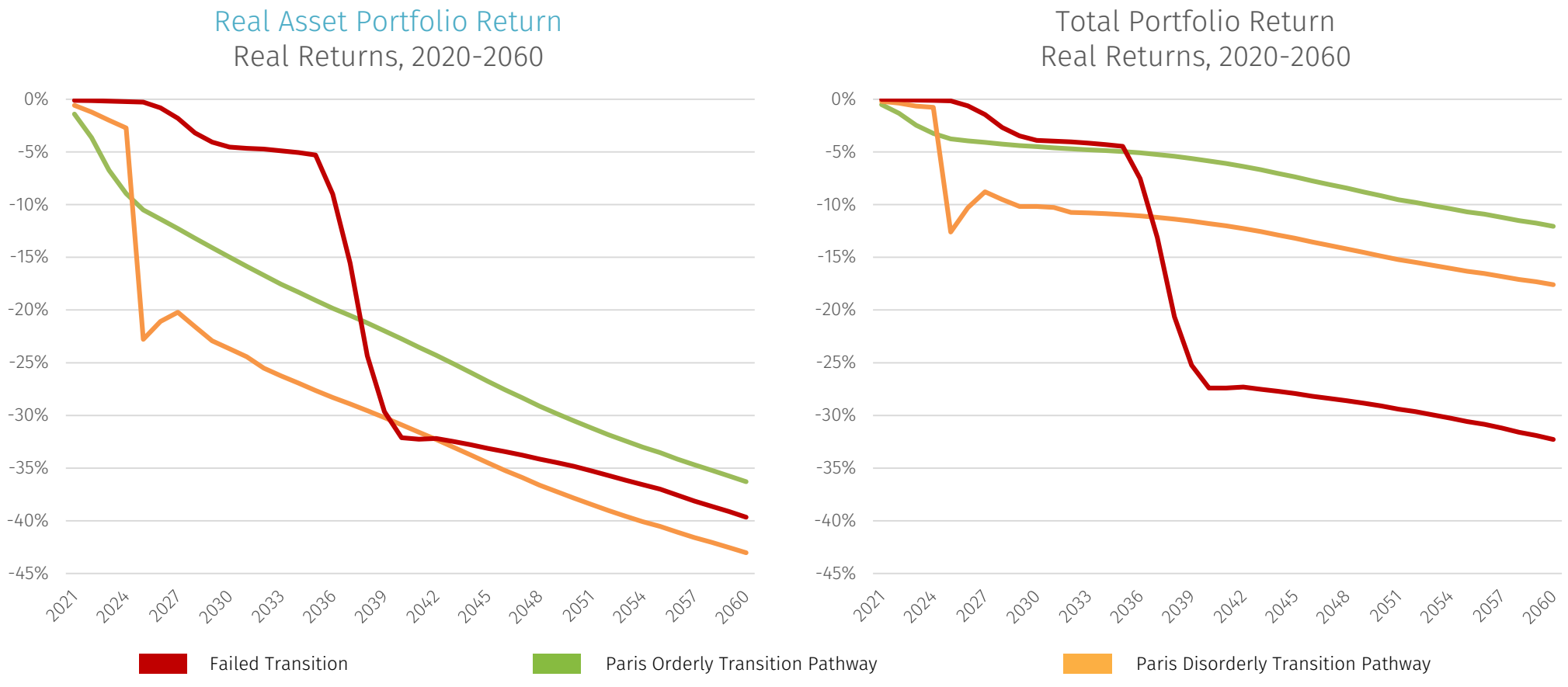


Focus on real assets (3/3)

What drives the climate exposure of your real asset portfolio? Zoom in on the main contributing sectors

The overall impact on your real asset portfolio is a blended average of the performance of the sectors previously shown as well as the smaller exposures not presented on the previous slide. The picture below details further the underperformance of your real asset portfolio illustrated in the previous tables.

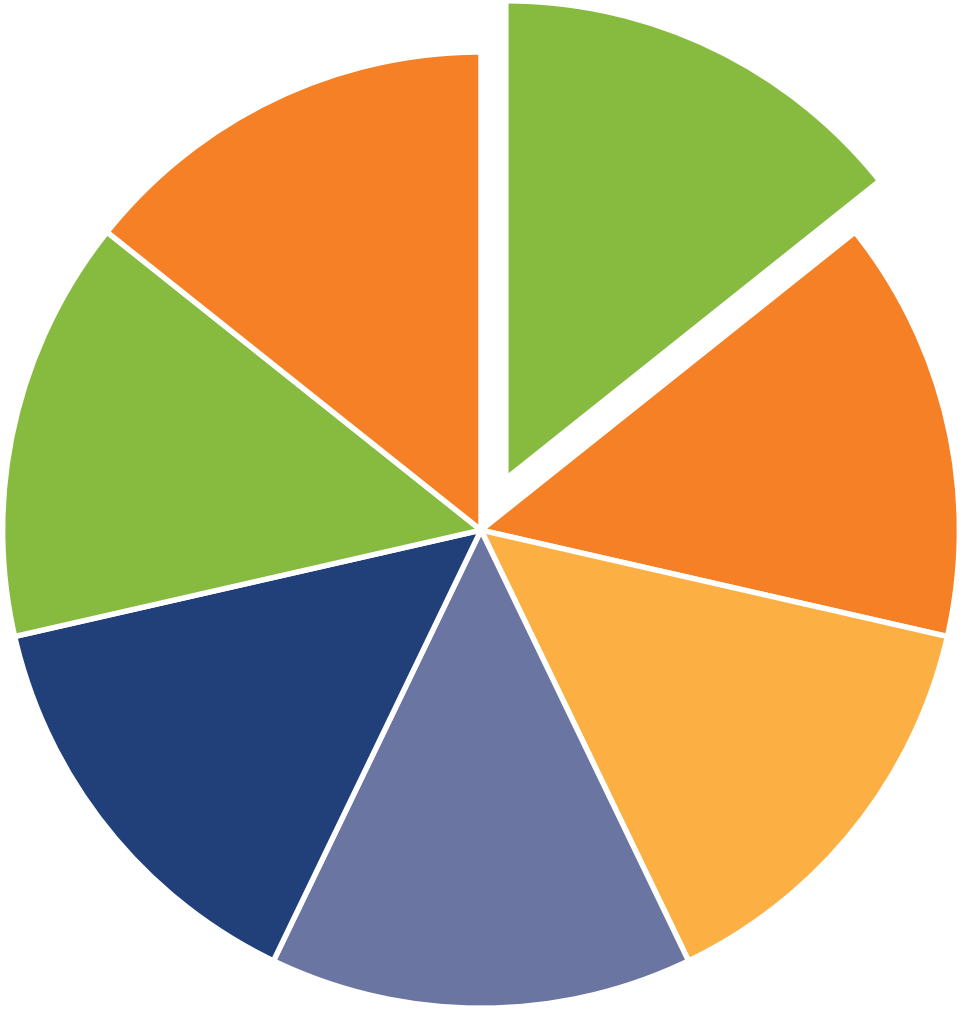
Potential “quick wins” for this portfolio could be to consider carefully exposures to the utility and oil & gas sectors (transition risk) as well as considering diversifying with foreign investments in countries less exposed to climate risk such as in Europe (both physical and transition risks).



Sector insights

The sector-level impact of climate risk is highly differentiated.

By considering the differences between sectors within countries and between countries, we can start to make sense of the landscape of risks and opportunities.



Sector insights – key findings

The sector-level impact of climate risk is highly differentiated. Remembering that the sector heatmaps reflect economic activities, it is likely that any one company has exposure to multiple cells in the heatmap – regardless of the sector that company may been allocated to in a system like GICS.

Paris Orderly

Short term, the orderly pricing-in of the transition sees significant "losers" in fossil-exposed sectors such as fossil-based utilities (which need to be substituted, so utility companies shift activities to low-carbon utilities), Other Energy (coal and oil sands) and O&G. Low-carbon energy sees significant upside from both sector growth and revenues transferring from fossil-based energy generation. Within 20 years fossil-based utilities have essentially disappear.

Paris Disorderly

This disorderly shock, which is modelled in the first 5 years, has an epicenter in the high-emission and fossil-exposed sectors. The subsequent recovery is faster in climate-aligned activity sectors such as low-carbon utilities and to a lesser extent in more neutral activity sectors like consumer.

Failed transition

The physical risk impacts central to this scenario do not start to be priced in until after 2025. But after 10y the impacts are marked and in our current modelling most differentiated by region. However, other factors to consider in assessing physical risk at holding level are the length/complexity of supply chains and the resilience of major facilities to extreme weather.

How to use this in your decisions

One potential way to use these tables is in testing portfolio construction resilience, understanding sector-level "what ifs" and their impact on strategy implementation.

Another application could be for fund managers to overlay these "sector views" over their views on individual holding and how they could respond to this systemic impacts.

Sectorial Impacts under the Paris Orderly Transition Pathway

Cumulative return (difference to baseline) heat map – Public equities – 5 years

	5Y	Total	Oil & Gas	Other Energy	Low Carbon Electric.	Other Utilities	Water Supply	Forestry	Materials	Public Admin.	Industrials	Consumer Disc.	Consumer Staples	Health	Financials	IT	Telecom	Real Estate
Cumulative climate impact - Paris Orderly	World	-1.8%	-11.7%	-8.5%	10.0%	-54.4%	-1.7%	-1.7%	-1.2%	-3.0%	-0.6%	-2.0%	-1.6%	-1.8%	-1.3%	-1.0%	-1.4%	-1.5%
	DM																	
	Europe																	
DEVELOPED MARKETS	US																	
	Japan																	
	UK																	
	France																	
	Germany																	
	Canada																	
	Sweden																	
	Switzerland																	
	Australia																	
	Netherlands																	
	Spain																	
	Italy																	
	Singapore																	
	Finland																	
	Denmark																	
	Norway																	
	EM																	
EMERGING MARKETS	China																	
	India																	
	South Korea																	
	Brazil																	
	Russia																	
	Malaysia																	
	Thailand																	
	Indonesia																	
	Philippines																	
	Taiwan																	

Data Redacted

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Sectorial Impacts under the Paris Disorderly Transition Pathway

Cumulative return (difference to baseline) heat map – Public equities – 5 years

Cumulative climate impact - Paris Disorderly	5Y	Total	Oil & Gas	Other Energy	Low Carbon Electric.*	Other Utilities	Water Supply	Forestry	Materials	Public Admin.	Industrials	Consumer Disc.	Consumer Staples	Health	Financials	IT	Telecom	Real Estate
	World	-15.9%	-26.8%	-23.3%	-2.7%	-67.8%	-15.8%	-15.8%	-15.4%	-17.2%	-14.7%	-16.1%	-15.6%	-15.9%	-15.4%	-15.2%	-15.5%	-15.6%
	DM																	
	Europe																	
DEVELOPED MARKETS	US																	
	Japan																	
	UK																	
	France																	
	Germany																	
	Canada																	
	Sweden																	
	Switzerland																	
	Australia																	
	Netherlands																	
	Spain																	
	Italy																	
	Singapore																	
	Finland																	
	Denmark																	
	Norway																	
	EM																	
EMERGING MARKETS	China																	
	India																	
	South Korea																	
	Brazil																	
	Russia																	
	Malaysia																	
	Thailand																	
	Indonesia																	
	Philippines																	
	Taiwan																	

Data Redacted

** Note that some region/sector combinations were originally very small which cause the growth rate to appear particularly large*

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Sectoral Impacts under the Failed Transition Pathway

Cumulative returns (difference to baseline) heat map – Public equities – 20 years

Cumulative climate impact - Failed Transition	20Y	Total	Oil & Gas	Other Energy	Low Carbon Electric.	Other Utilities	Water Supply	Forestry	Materials	Public Admin.	Industrials	Consumer Disc.	Consumer Staples	Health	Financials	IT	Telecom	Real Estate
	World	-36.3%	-36.2%	-36.3%	-36.3%	-36.1%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%	-36.3%
	DM																	
	Europe																	
DEVELOPED MARKETS	US																	
	Japan																	
	UK																	
	France																	
	Germany																	
	Canada																	
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	Denmark																	
	Norway																	
	EM																	
EMERGING MARKETS	China																	
	India																	
	South Korea																	
	Brazil																	
	Russia																	
	Malaysia																	
	Thailand																	
	Indonesia																	
	Philippines																	
	Taiwan																	

Data Redacted

*Note that from Dec21 our modelling will better differentiate the imipact to different sectors from physical risk

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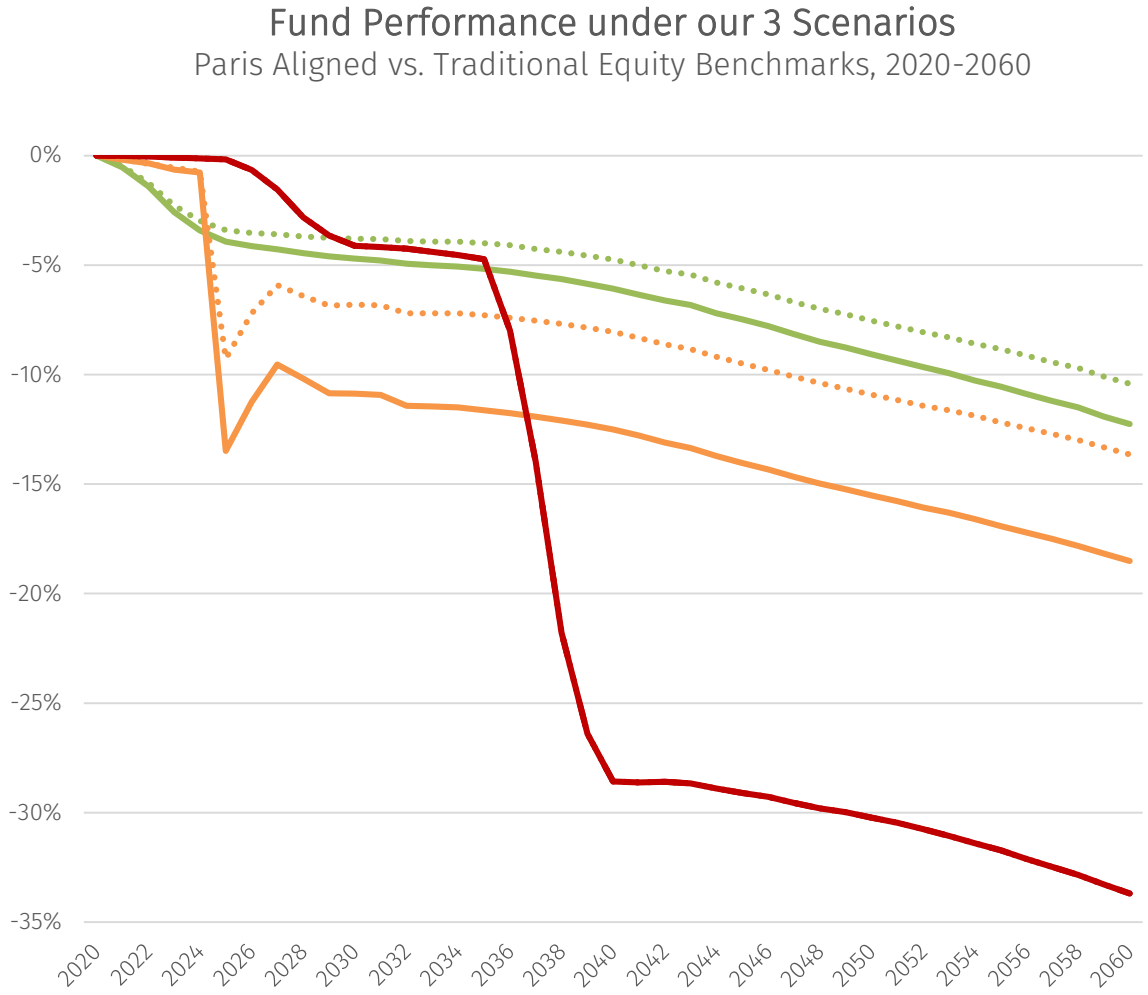
What-if Analysis: Switch all listed equities to “Paris-aligned” companies

This section analyzes the impact of switching all investments in listed equities to a low-carbon (Paris-aligned) benchmark. (100% of companies aligned to a world consistent with the goals of the Paris agreement).

The current equity portfolio was simplified and represented by MSCI World.

Performance of the fund is compared between the base benchmark and a completely aligned benchmark.

Switching to Paris-aligned benchmarks potentially mitigates downside performance if a disorderly transition scenario unfolds



"What happens to OPERF's real returns when equities are allocated to Paris-aligned benchmarks?"

- Started the analysis from the current portfolio and swapped all equities for MSCI World (30% of fund).
- Analyzed two alternatives: standard MSCI World benchmark versus a fully Paris-aligned version of the benchmark
- Switching to an (idealized) 100% Paris aligned benchmark would provide the best hedge from transition risks. However, implementation limitations mean that the real degree of alignment will probably be lower (too few aligned companies to maintain diversification)
- As more companies commit to net-zero, higher degrees of alignment could be achieved.
- It is important to note, however, that Paris alignment does not help for mitigating physical risks.

Failed Transition
Paris Orderly Transition Pathway
Paris Disorderly Transition Pathway
Standard MSCI World
MSCI World Paris Aligned (100%)

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Next steps

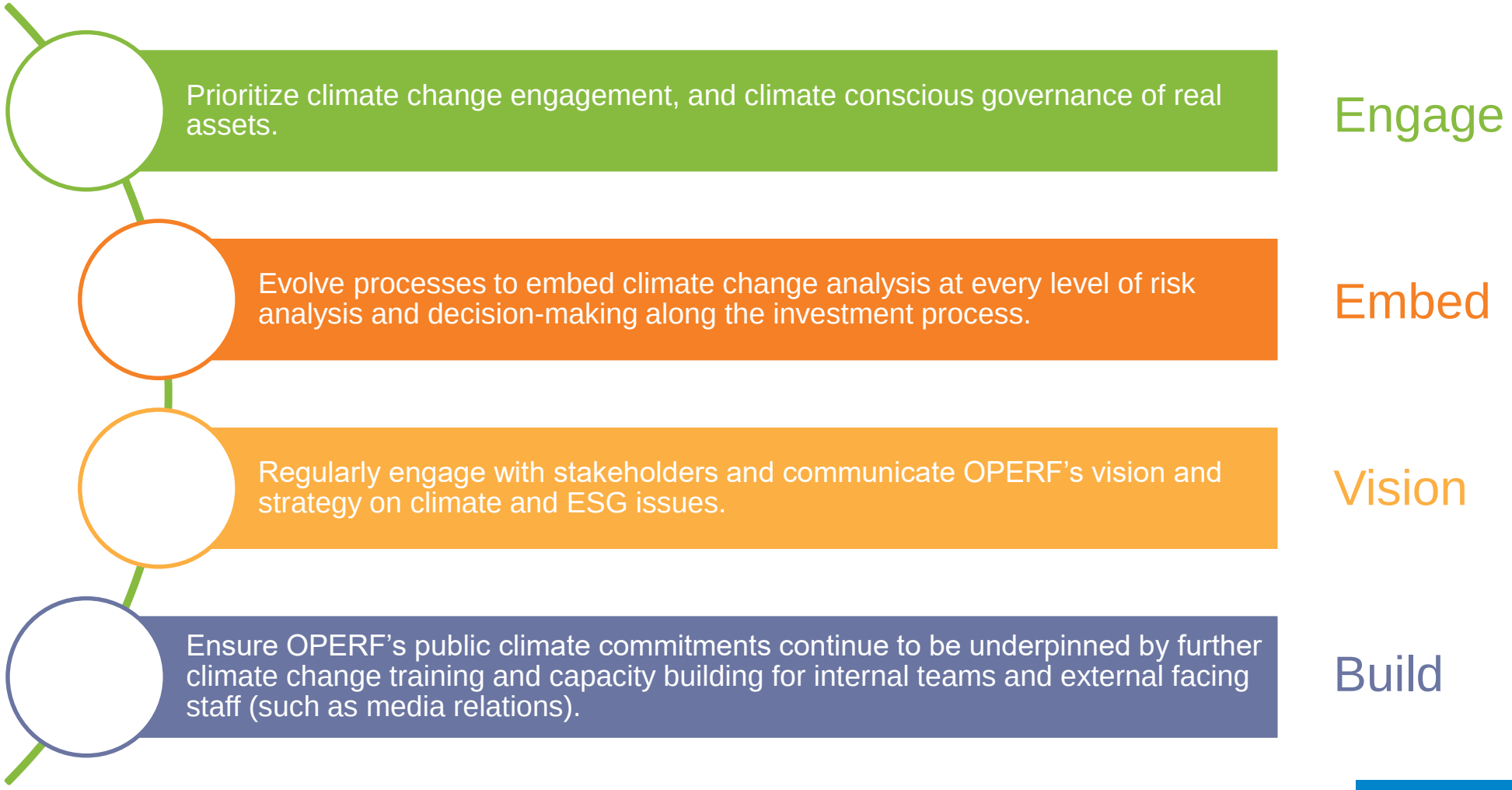
We have drawn on our experience with many pension funds globally to provide a brief set of recommendations for OST to consider as “next steps” following this analysis.

The recommendations are, however, just suggestions not advice and we would naturally expect the Treasury to arrive at its own decisions.

Whilst our analysis has been focused on the asset-allocation aspects, our suggestions cover the full gamut of the investment process since that is typically what is required to fully address this huge topic.

Recommendations – observations on best practice

Climate Strategy



ORTEC FINANCE

Recommendations – observations on best practice

Total Portfolio

ORTEC FINANCE

Recommendations – observations on best practice

Asset Classes

Equities: Tilt equity portfolios to be less exposed to transition risk by using climate-aware benchmarks or sustainable funds aligned to transition scenarios.
Consider aligning fund manager KPIs to your appetite for transition risk in mandate design.

Equity

Prioritize researching climate risks in utilities/energy stocks, bonds and real-assets.

Focus

To support potential future reporting requirements, include capturing climate transition indicators (regulatory, regional, business and technology risk etc.) and analyzing sector specific climate risks.

Metrics

Alternatives: given OPERF's allocation to alternatives, consider new allocations to climate solutions oriented private assets (such as green infrastructure).

Alternatives

Fixed Income: US corporate credits are less sensitive to climate transition risks than equities and could be a good way to maintain US exposure. However, this should be balanced with the need to meet liabilities.

Credit

ORTEC FINANCE

Next steps – Phase 2: Proposals for insightful “what-if” analysis

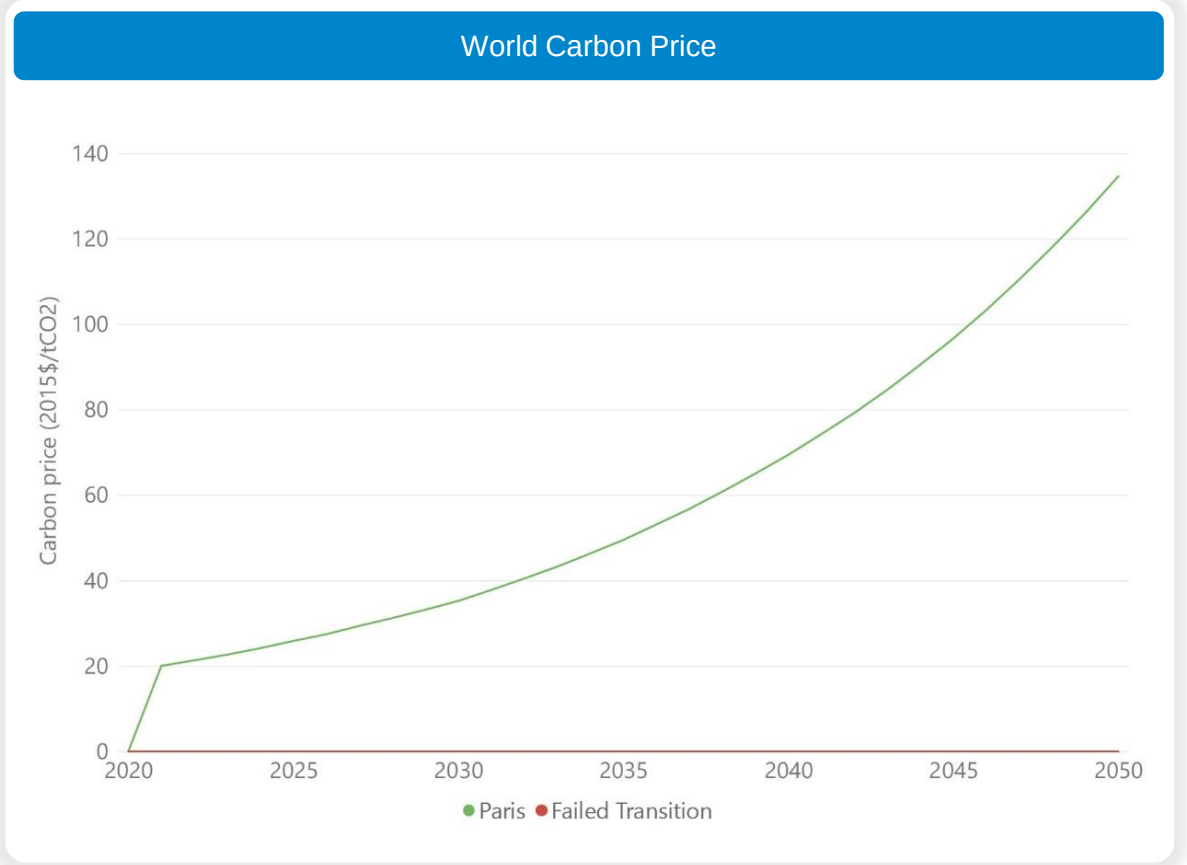
1) Investigate the potential benefit of geographic diversification by halving US equity and real asset exposure and rebalancing to less climate-exposed regions

Chart Redacted

US Policies

cambridge econometrics
camecon.com

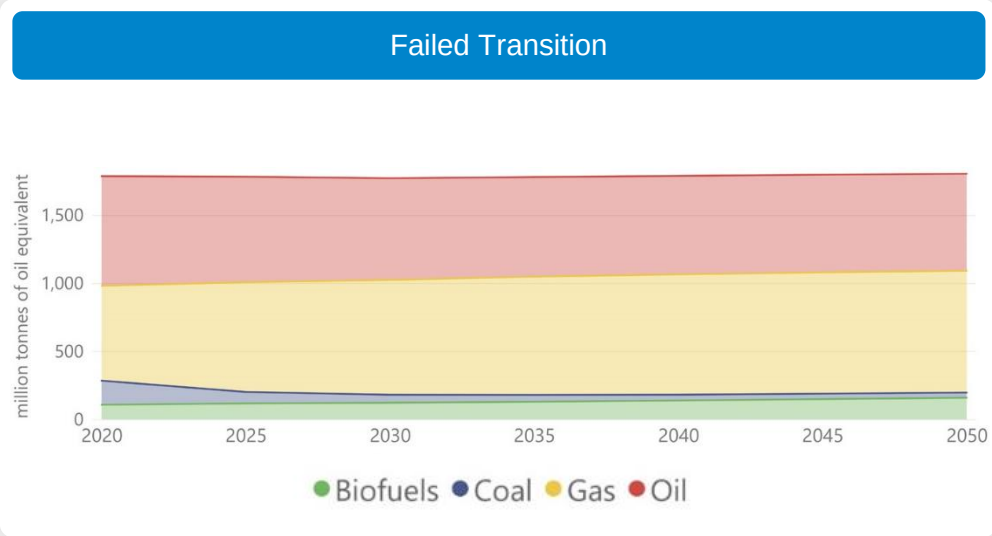
- Carbon tax
- Investment subsidies for CCS
- Feed-in tariffs for renewables
- Coal-fired electricity fully phased out by 2050
- Biofuel blending requirements
- Policies supporting take up of EVs
- Investments in energy efficiency

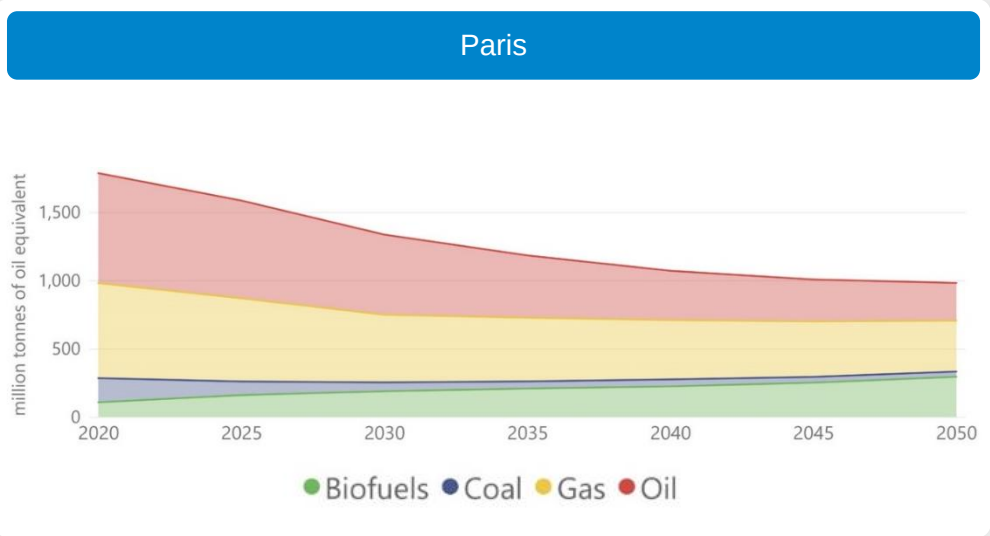


Find out more on our Narratives Dashboard: www.climatemaps.app

US Fuel Demand

cambridge econometrics
camecon.com





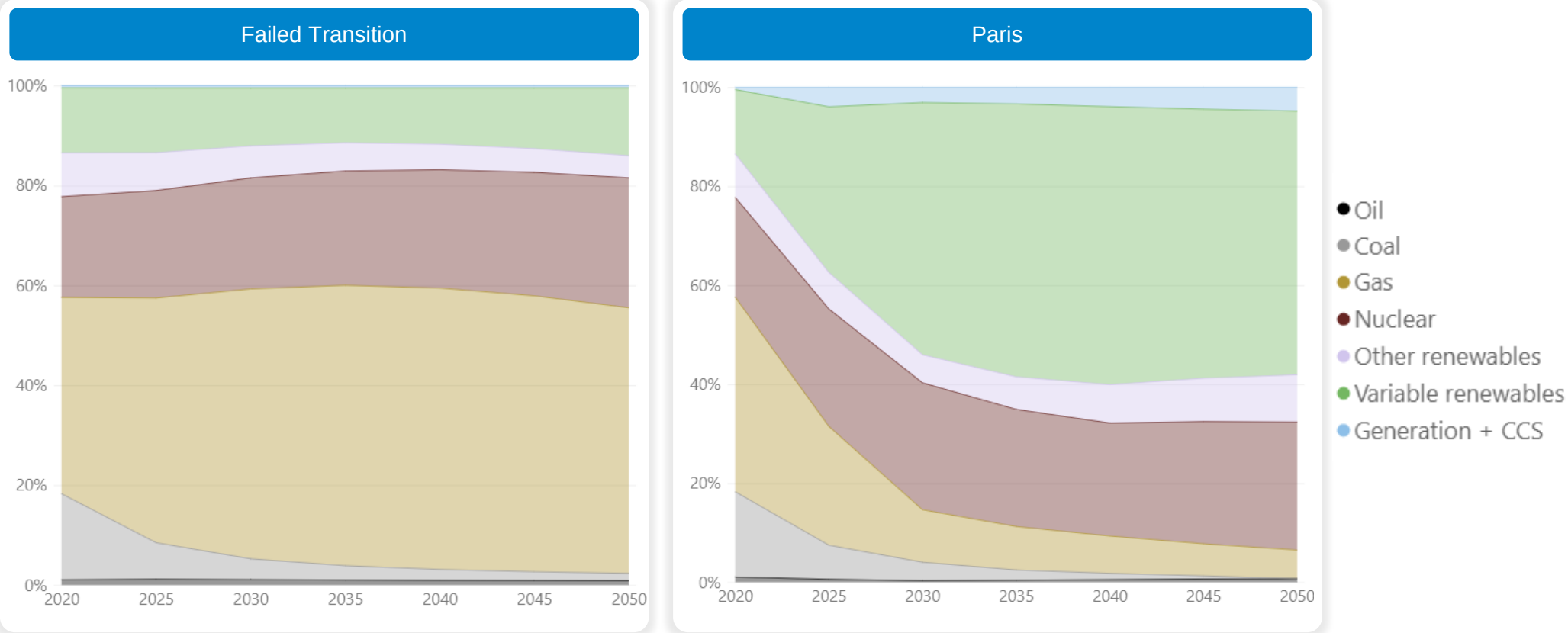
In Paris Transition Pathways:

- Primary fuel demand decreases 45% by 2050 relative to 2020
- Biofuel use grows more than tenfold
- Proportion of gas stays relatively stable
- Share of oil and coal reduces substantially

Find out more on our Narratives Dashboard: www.climatemaps.app

US Electricity Generation

cambridge econometrics
camecon.com



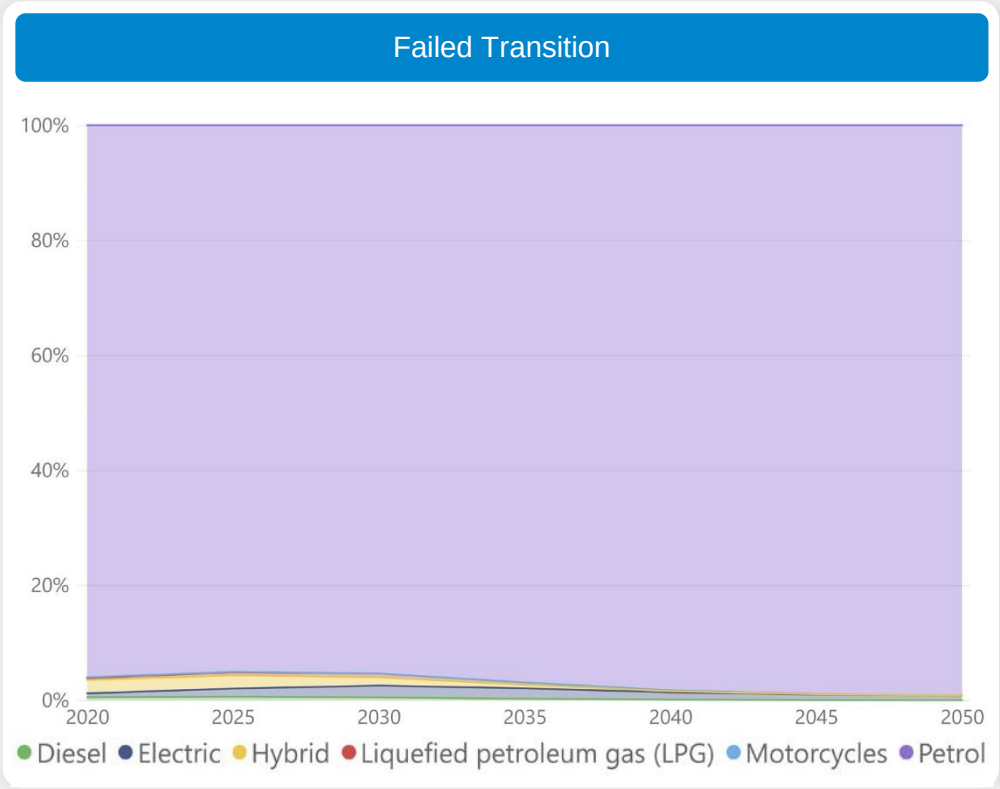
In Paris Transition Pathways:

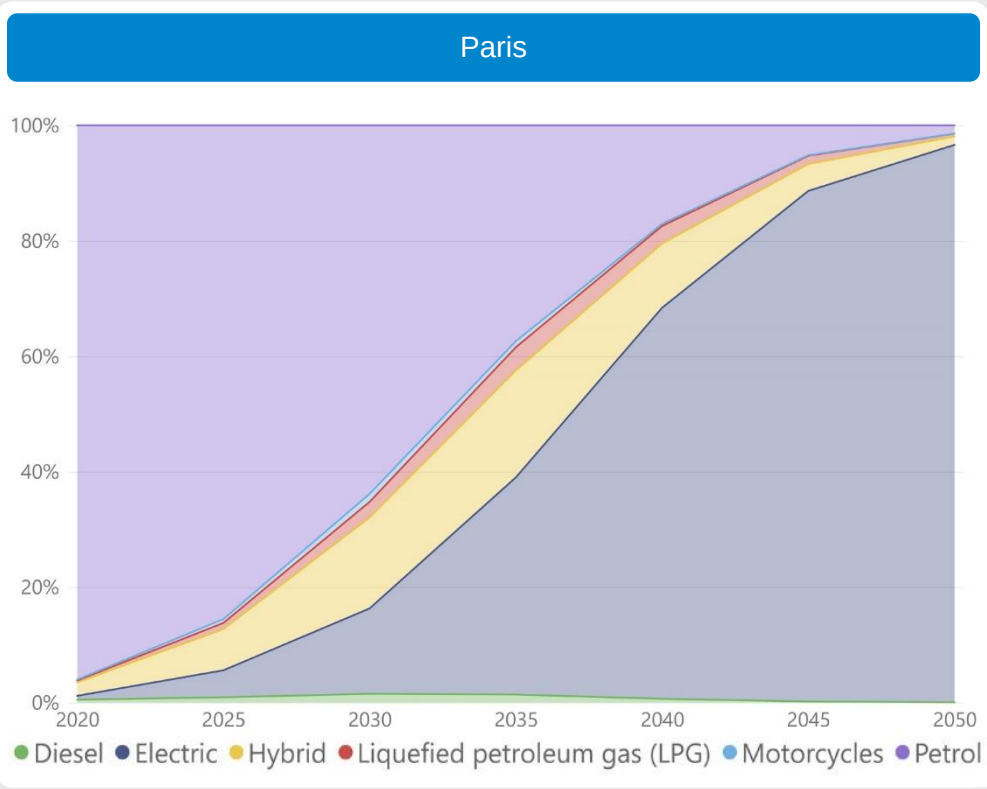
- Renewables and CCS technologies make up over 70% of the US electricity generation mix in 2050
- Fossil fuel phase out rapidly in the short term and gradually in the long term
- Take up of new technology due to investment in low-carbon technology

Find out more on our Narratives Dashboard: www.climatemaps.app

US Passenger Transport

cambridge econometrics
camecon.com





In Paris Transition Pathways:

- By 2050 electric vehicles make up 97% of the US passenger transport mix

Find out more on our Narratives Dashboard: www.climatemaps.app

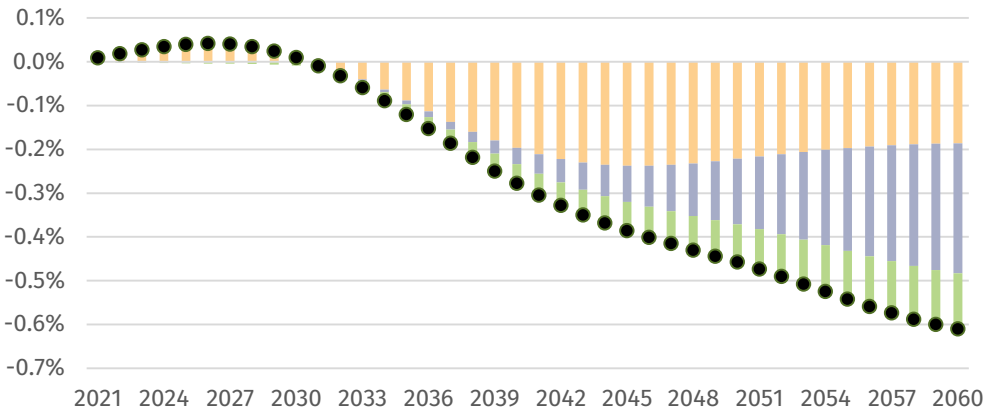
A closer look at the three climate pathways

The impact of orderly climate action

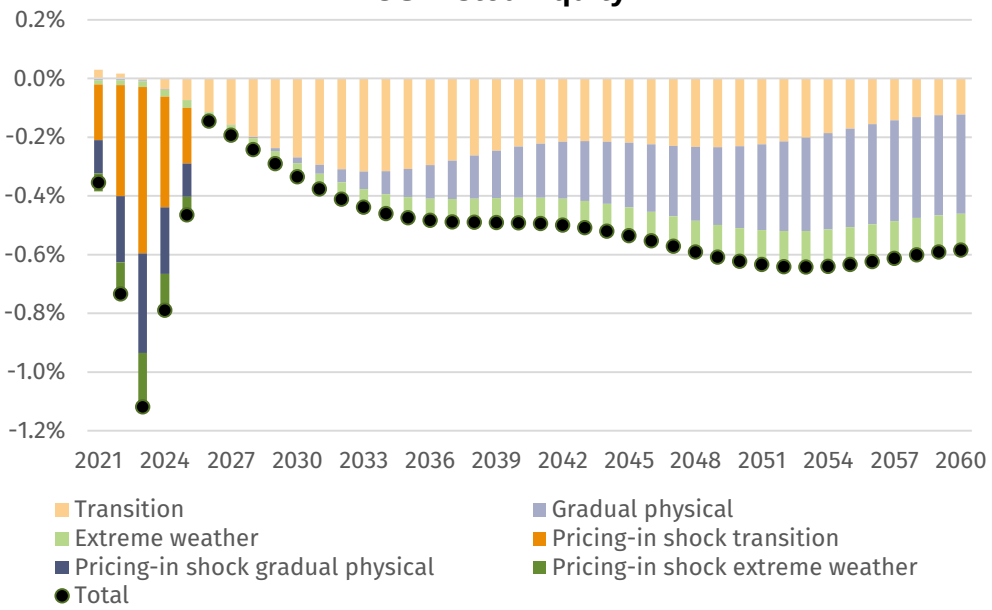
Scenario 1: Paris Orderly Transition Pathway

1. Paris Agreement goals **met**.
2. Rapid and effective climate action, with smooth market reaction.
3. Ambitious low carbon policies – high investment in low carbon technologies.
4. Major change in global fuel / electricity mix.
5. Average global temperature stabilizes at 1.5°C above pre-industrial levels.
6. Transition has limited positive effect on global GDP and is more than offset by negative physical impacts.
7. Moderate physical impacts, with a much lower increase in extreme weather risks between 2020 and 2100 than under a Failed Transition scenario.
8. The US, compared to other regions, is more negatively impacted by this pathway due to the its economy's dependency on fossil fuel exports, its slow progress on energy efficiency and carbon pricing, as well as its high sensitivity to market sentiment.

US Sovereign Bond Yield Levels – 10y



US Listed Equity



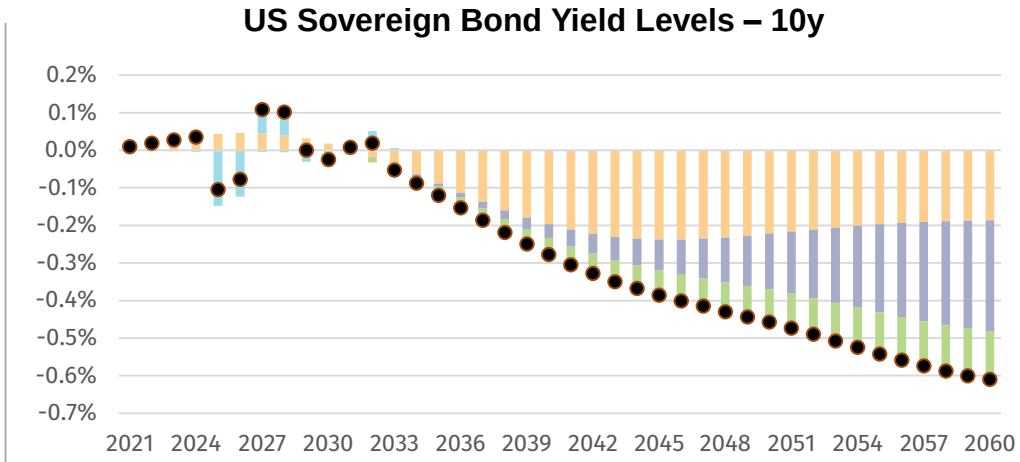
Note: the data presented in the graphs is shown as difference to baseline and are annualized results

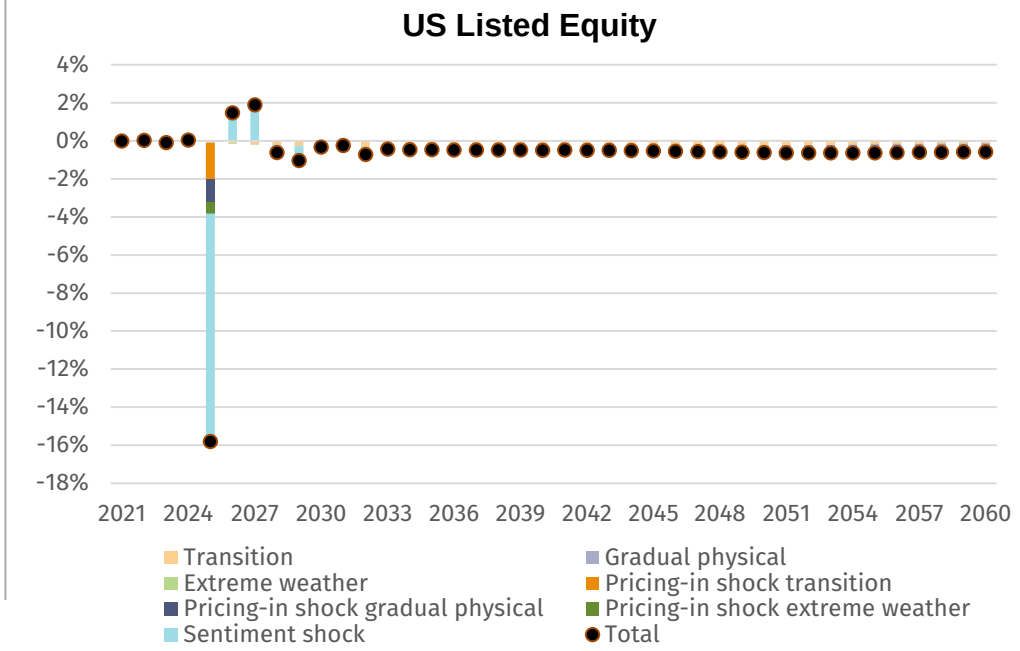
A closer look at the three climate pathways

The impact of a delayed market reaction

Scenario 2: Paris Disorderly Transition Pathway

1. Paris Agreement goals **met**.
2. Rapid & effective climate action, but markets slow to react.
3. Ambitious low carbon policies – high investment in low carbon technologies.
4. Major change in global fuel / electricity mix.
5. Average global warming stabilizes at 1.5°C above pre-industrial levels.
6. Transition has limited positive effect on global GDP and is outweighed by negative physical impacts.
7. Abrupt market reaction in 2025 impacts the real economy, for example causing a fall in all major countries' GDP in 2025. In the long term, GDP is slightly lower than in the Paris Orderly scenario as a result of the disorderly transition.
8. Moderate physical impacts, with a much lower increase in extreme weather risks between 2020 and 2100 than under a Failed Transition scenario.
9. The US, compared to other regions, is more impacted due to its sensitivity to transition risks & how these are priced in.





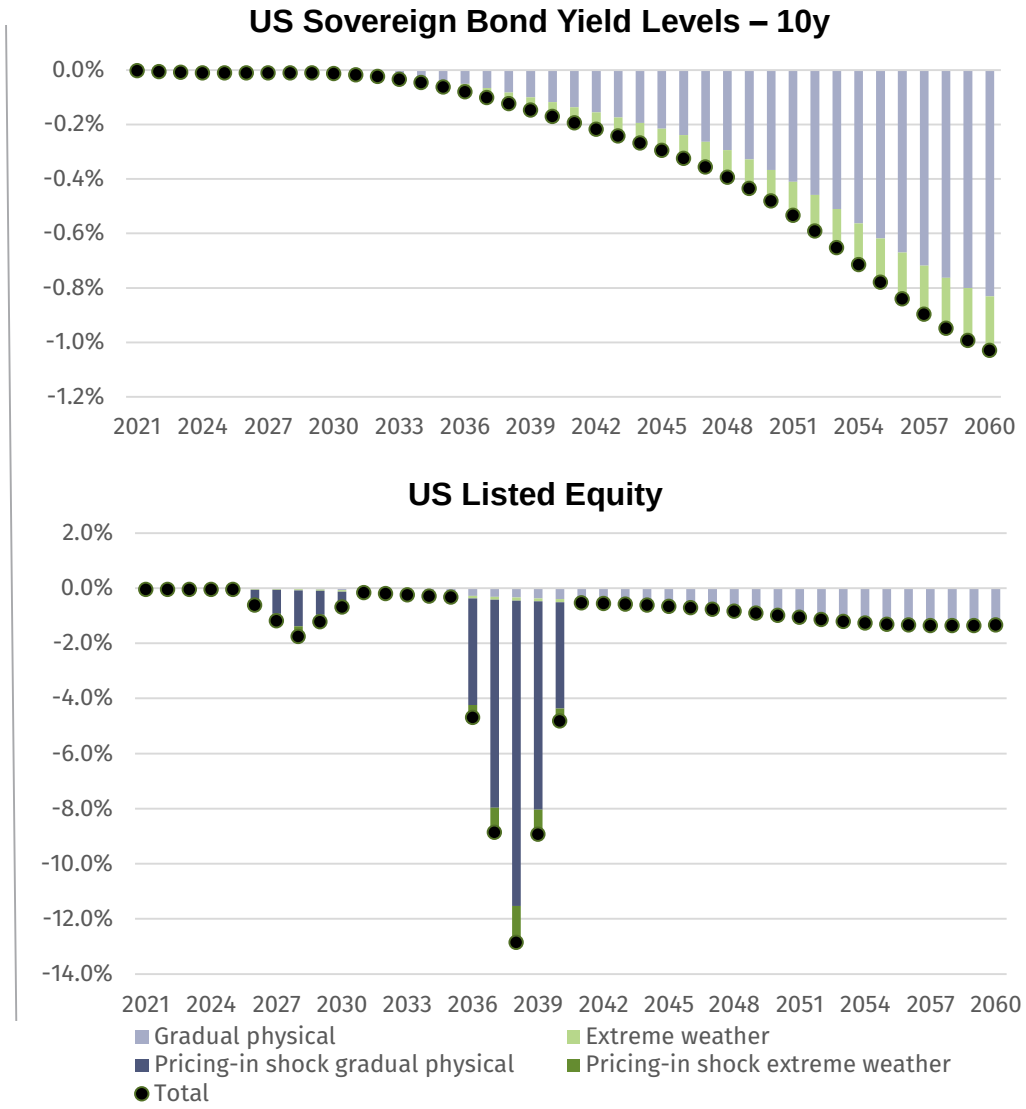
Note: the data presented in the graphs is shown as difference to baseline and are annualized results

A closer look at the three climate pathways

What might happen if Paris goals are not met?

Scenario 3: Failed Transition Pathway

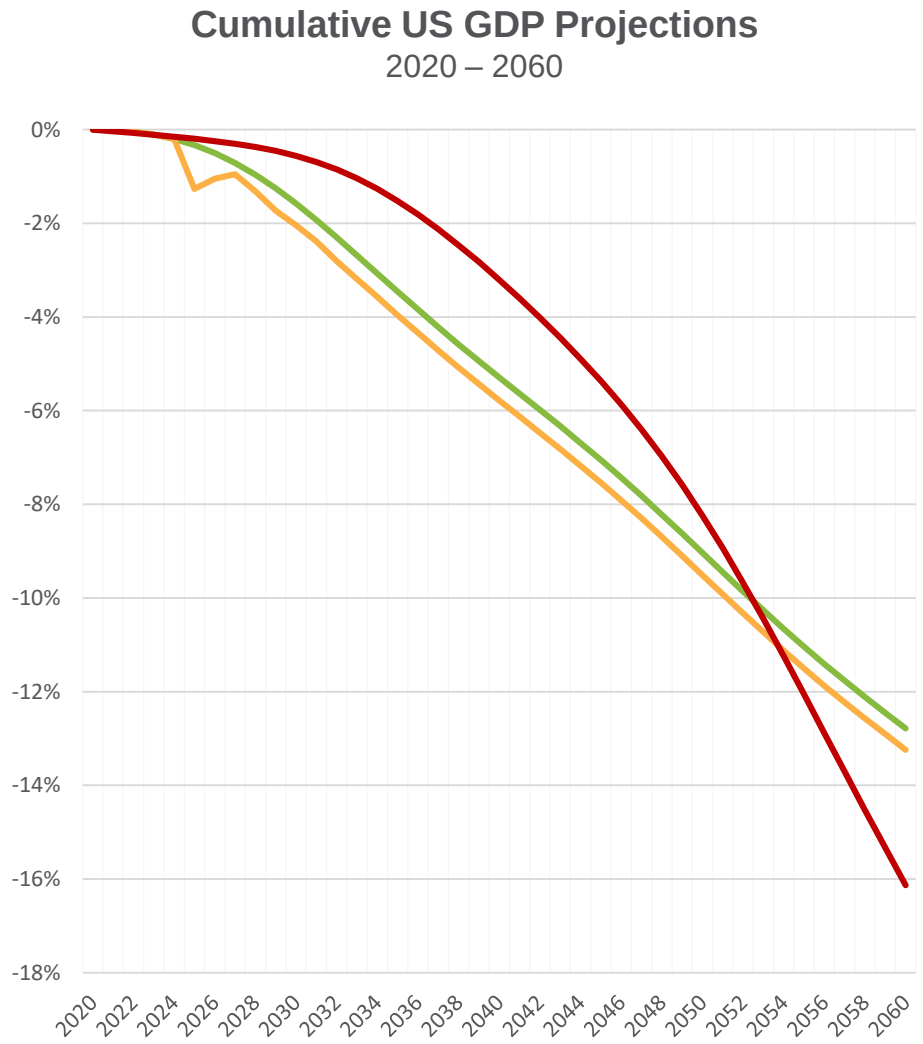
1. Paris agreement goals **not met.**
2. Only existing climate policies are implemented.
3. Limited change in global fuel / electricity mix despite significant falls in renewable energy prices.
4. Average global warming is about 2°C by 2050 and 4°C by 2100, compared to pre-industrial levels.
5. Physical impacts have a significant negative impact on global GDP.
6. Extreme weather risks increase significantly between 2020 and 2100 via a combination of increasing event frequency and severity of losses.
7. The physical risks are comparable to the two Paris scenarios for the first 10 years, then increase substantially and irreversibly. Warming makes agriculture impossible in certain areas around the world. Extreme weather events more than double on a global level.
8. Unfortunately, the US demography and geography plays against its favour and exacerbates the adverse effects of global warming (especially at risk from extreme weather events)



Note: the data presented in the graphs is shown as difference to baseline and are annualized results

Climate impacts on selected macroeconomic variables – United States*

How is the economy impacted by climate change?



Paris Transition:

- Over the next 20 years, the US is heavily impacted by the transition pathways due to the economy's dependence on fossil fuel exports. Rapidly declining demand will impact also other related sectors, as well as government royalties, spending, and so on.
- Other regions, such as Europe and China, can even benefit from the low-carbon transition, such as renewable energy technology producers.
- In the second half of this century, transition risks will fade out and lower GDP expectations compared to baseline are due to the locked-in physical impacts of half a degree of further warming compared to today.

Failed Transition:

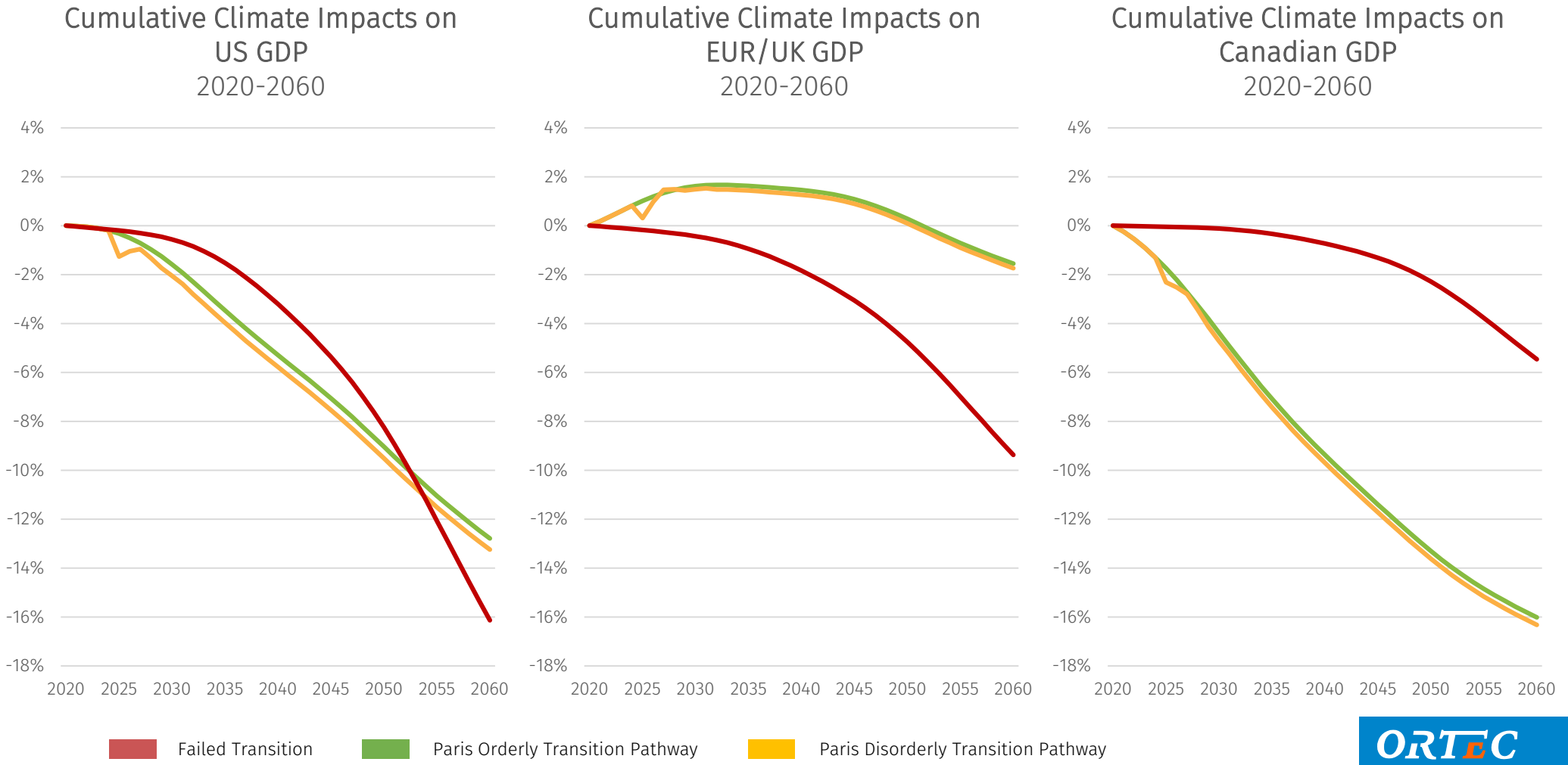
- Physical risks become more significant over time, which gradually affect GDP growth. These physical risks are particularly impactful for the US unlike other countries such as its neighbor, Canada.
- Due to its demographic and geographic situation, the US is more severely affected in the Failed Transition with GDP projections 16% lower by 2060 under a Failed Transition compared to baseline.

Failed Transition Paris Orderly Transition Pathway Paris Disorderly Transition Pathway

*Analyze many more variables using the ClimateMAPS Scenarios Narratives Dashboard.

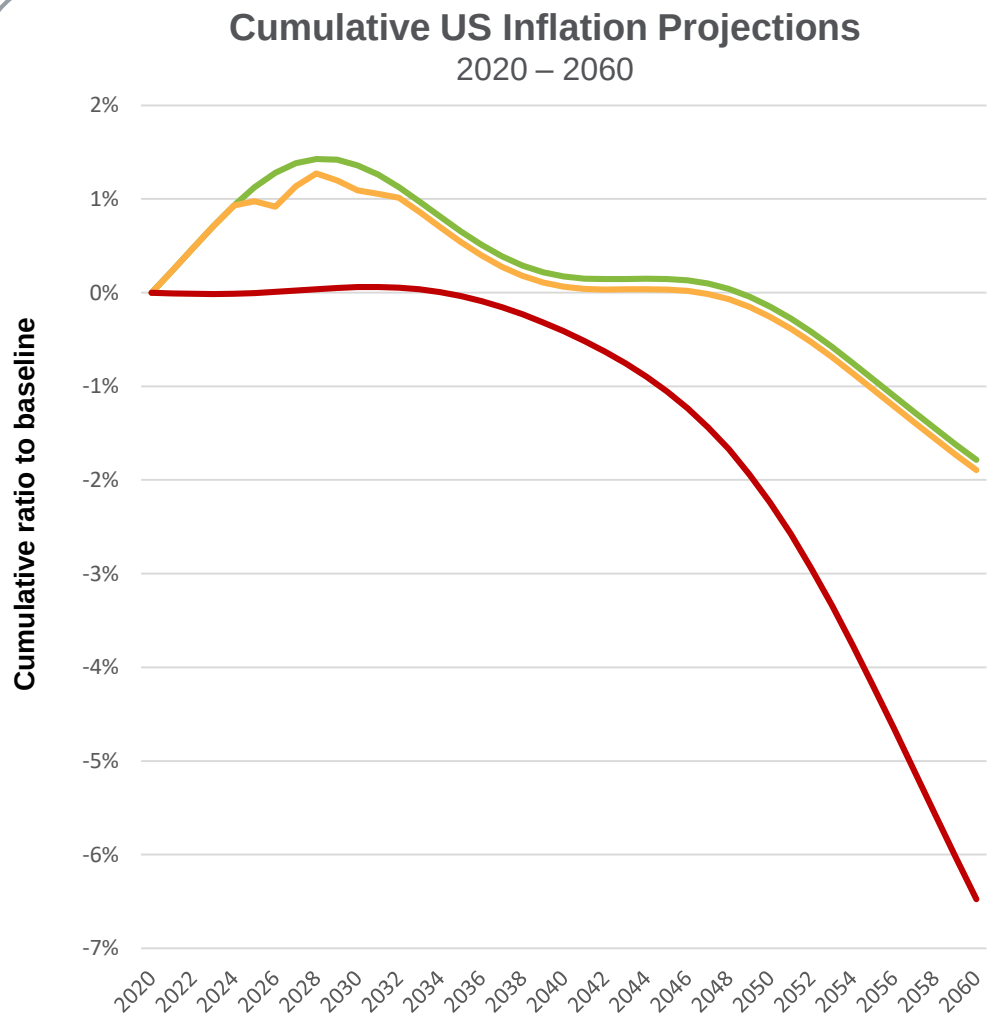
Climate impacts on key economies: GDP considerations

Countries are impacted differently depending on their specific geographic and economic considerations. While the US is severely impacted under our 3 scenarios, Canada for instance suffers particularly from a transition.



Climate impacts on selected macroeconomic variables – United States*

A transition to net zero will increase US inflation



Comments

In the US, under the Paris Orderly and Disorderly Transition Pathways, there is an increase in prices in the upcoming years driven by demand-pull inflation effects: the stimulus effects of low-carbon energy and infrastructure investment drive an initial increase in prices.

In the longer term, with the low-carbon regulation put in place (e.g. phase out of fossil fuels) as well as the effect of learning-by-doing, energy product cost is expected to fall. This then drive down the energy/fuel prices. With subsidies and regulation, the cost of renewable technologies decrease overtime which partly affect the electricity price.

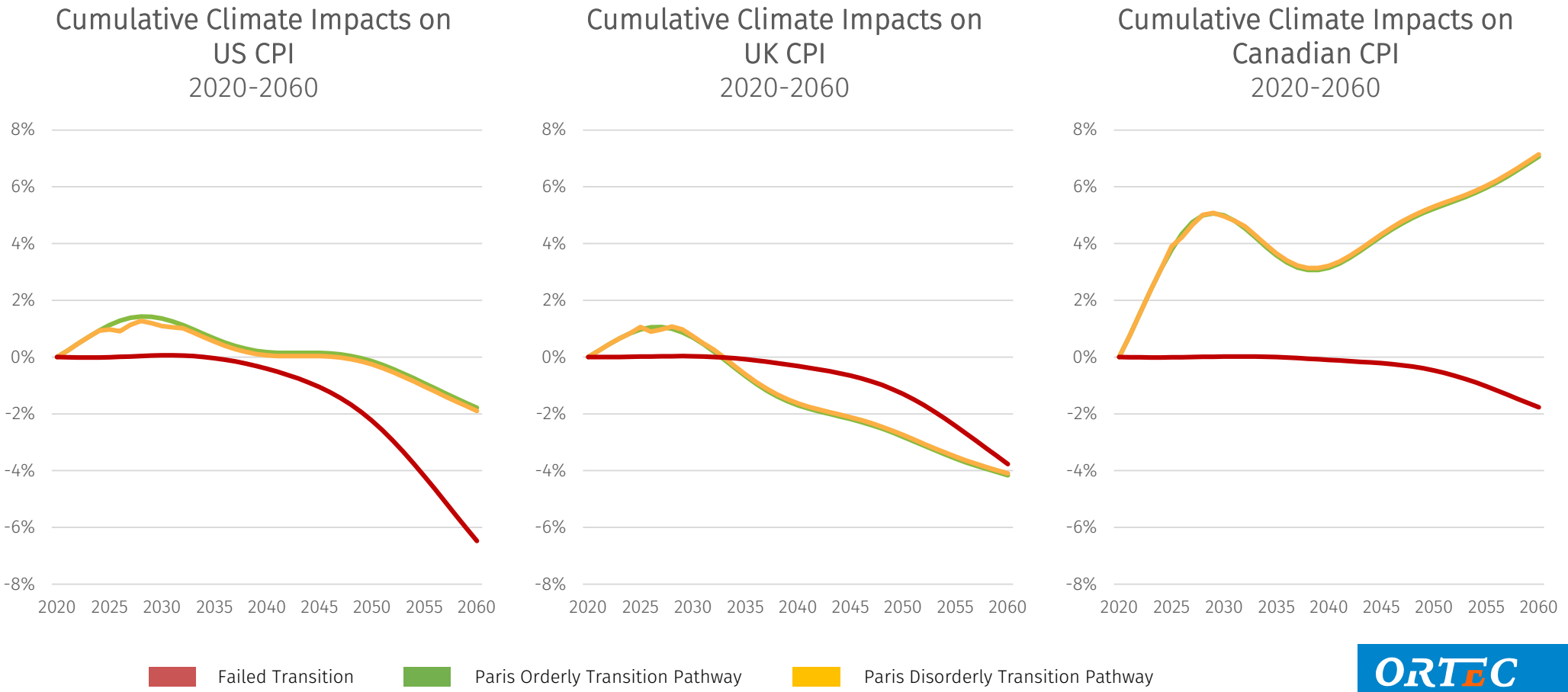
Under a Failed Transition, prices are not influenced by new policy changes in the short-term. However, mounting physical impacts will impact the economy in the medium and long term which will impose deflationary pressure towards the end of the time horizon. These effects are particularly large for the US.

Failed Transition Paris Orderly Transition Pathway Paris Disorderly Transition Pathway

*Analyze many more variables using the ClimateMAPS Scenarios Narratives Dashboard.

Climate impacts on key economies: inflation considerations

In the Paris Orderly and Disorderly Transition Pathways, the transition puts upward pressure on inflation in the US.
The positive transition impact is larger than the (negative) impact of increasing physical risks up to 2030.
In the long run, increasing gradual physical risks lead to a reduction in inflation.
In the Failed Transition Pathway, increasing physical risks decrease inflation from the early 2030s.



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Financial Results

Paris Orderly Transition

The following subsection focuses on the impacts induced by the Paris Orderly Transition pathway on your portfolio.

The key effects to keep in mind in this pathway are the initial transition shock occurring in the short-term as well as the locked-in physical risks that materialize later on. Annualized results are located in the annex.

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Paris Orderly Transition Pathway

Climate impacts summary – Public equities

Public equities:

- The asset class is impacted by pricing-in shocks spread over 2021-2026.

Summary of climate impacts on equities:

- Equities suffer from transition risks in the first years. After 2026, physical risks gradually increase over time. The cumulative relative performance of the equity arm of the portfolio compares to baseline over 40 years is -11% under the Paris Orderly Transition pathway.
- Emerging markets tend to be less sensitive to both climate-related risks.
- Canada & the US suffers the most due to their dependency on fossil fuel exports, lack of energy efficiency and carbon pricing progress and high sensitivity to market sentiment.
- Overall, Japan and Singapore are the winners among the developed markets.
- Low carbon electricity
    - Winners: emerging markets, Australia and Singapore
    - Losers: Europe, the UK
- Other utilities and energy are the most negatively impacted sectors where all regions suffer important losses.

Paris Orderly Transition Pathway

Climate impacts summary – Others

Fixed Income:

- Interest rates in Canada, and most other countries, are not materially impacted in the short-run due to limited climate-related impacts on growth in this pathway.
- In the medium-run most countries experience some negative impacts from the transition, and in the longer term, they suffer more from physical risks.
- The gradual (but generally modest) decline in yields leads to a slight upward pressure on fixed income returns.
- Canadian corporate credits are more significantly impacted with cumulative return of -7% over the next 40 years compared to baseline. Still, these impacts remain much lower than those on equities.

Property:

- Listed and unlisted real estate behave similarly as listed equities. However, differences arise from divergence in regional exposure. It also has some differences in volatility between listed and unlisted benchmarks within a country.

Infrastructure:

- Listed infrastructure assets are expected to perform in a similar fashion as broad equities, albeit with a slightly more negative cumulative performance. OPERF's specific infrastructure exposure is slightly more at risk than our broad benchmark, but remain in line with what's expected on the asset class.

Financial Results

Paris Disorderly Transition

The following subsection focuses on the impacts induced by the Paris Disorderly Transition pathway your portfolio.

The key effects to keep in mind in this pathway are the delayed transition shock that strikes in 2024 as well as the sentiment shock and increased volatility in the following few years. After this initial chaotic transition, this pathway behaves the same way as its orderly counterpart. Annualized results are located in the annex.

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Paris Disorderly Transition Pathway

Climate impacts summary – Public equities

Public equity:

- The asset class is impacted by the pricing-in shock in 2025H2 – 2026H1. This shock is deployed rapidly due to the delay in the implementation of required policies under the Paris transition.
- Both the pricing-in shock and the sentiment shock have a large impact across all regions from 2025H2 – 2026H1 onwards as delayed market pricing-in strikes.
- Under the Paris Disorderly pathway, there is a loss of about 17% on your equity portfolio in the first 5 years compared to the baseline. In 2025H2 – 2026H1, the abrupt sentiment shock also takes place and adds on top of the pricing-in shock.
- After the recovery, equity returns move roughly to baseline levels in both Paris pathways, while towards the end of the time horizon, equity returns are lowered by physical risks.

Summary of climate impacts on equities:

- Because of the delayed pricing-in shock, all the impacts are more significant in this pathway than under the Paris Orderly transition. Furthermore, the sentiment shock materially affects cumulative climate impacts by 2026.
- Emerging markets benefit from the transition to low-carbon technologies but are also more sensitive to negative impacts on high carbon technologies.
- Japan and Singapore are the “winners” among developed markets.
- Low carbon electricity – all regions benefit, however relatively we see the following:
    - Winners are Australia, emerging markets, Japan, the US
    - Losers: Europe and the UK
- Other utilities and Energy are the most negatively impacted sectors where all regions suffer important losses.

Paris Disorderly Transition Pathway

Climate impacts summary – Others

Fixed Income:

- Apart from the sentiment shock as well as different size and timing of the pricing-in shock, the yields are impacted in the same way as under the Paris Orderly Transition pathway. Therefore, in the medium term, interest rates generally go down slightly, with a somewhat larger impact for Canada than the UK for instance.
- This gradual (but generally modest) decline in yields leads to slight upward pressure on fixed income returns.
- The sentiment shock causes some upward short-term movements of sovereign yields, especially for the Canada, which in turns improve fixed income returns.
- For corporate credits, spread tightening movements benefit the portfolio after climate shocks.

Property:

- Similar impacts as under the Paris Orderly Transition pathway.

Infrastructure:

- Similar impacts as under the Paris Orderly Transition pathway.

Financial Results

Failed Transition

The following subsection focuses on the impacts induced by the Failed Transition pathway on your portfolio. The key effects to keep in mind in this pathway are the important physical risks that build up as time goes on. The expected losses associated with the physical risks compound with time and lead to important losses. As noted earlier, by 2038, the Failed Transition pathway is already expected to be the worst pathway of the three. From our experience, your portfolio is moderately impacted due to its exposure to relatively exposed assets classes such as public equities, real estate and infrastructure. The strong emphasis on Canadian assets reduces the exposure of the portfolio due to the smaller physical risks, compared to other, less resilient countries such as the US. All alternative asset mixes increase this exposure due to the reduction in Canadian exposure. Annualized results are located in the annex.

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Failed Transition Pathway

Climate impacts summary – Public equities

Public equities:

- The entire asset class is affected by the delayed pricing in shocks from 2026-2031 and 2036-2041.

Summary of climate impacts on equities:

- In the first 5 year time bucket, impacts on equities are muted when compared to those of the Paris Transition pathways. This is because under the Failed Transition pathway, pricing-in shocks only start in 2026 and no transition shock occurs. A second pricing shock strikes in 2036-2041, intensifying the impact of physical risks on the asset class.
- Unlike under the Paris Transition pathways, the low-carbon electricity sector does not grow under the Failed Transition pathway. Since no additional efforts are made to transition towards renewable energy and no additional “green” technologies are developed, sectors only suffer from physical and extreme weather impacts, without experiencing any transition opportunities.
- There are no winners. The least impacted countries are Switzerland and Canada – due to their geographic location.

Failed Transition Pathway

Climate impacts summary – Others

Fixed income:

- Pricing in physical shocks in 2026-2031 and 2036-2041 hit the asset class during these periods. However, the credit spreads tightening in the subsequent years after both shocks benefit the asset class. From 2040, we see a rebound in credit returns.
- The asset class is not strongly affected by slow onset physical risks over the short and medium term. The influence on interest rates becomes significant in the long term (roughly from 2040 onwards). Significant lower economic growth in the long term drives nominal yields down.
- In the short to medium term, fixed income returns are not significantly impacted. In the long term, expected returns are lower due to the structurally low yields.
- Credits have a positive climate shock over the whole horizon. In comparison to equities, this is partially explained by the shorter term horizon compared to equities while climate impacts, especially under the Failed Transition, are more long-term oriented.

Property:

- Real estate is significantly affected by the pricing in shocks as the asset class is sensitive to physical damages and requires a strong correction in its valuation.
- The asset class is further impacted more significantly towards the end of the period when physical damages start to affect real estate prices.

Infrastructure:

- Infrastructure assets are expected to be affected more than other asset classes, particularly so in the US. The asset class suffers more or less like listed equities.

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