Nordea

How climate change affects return on your investments

- How is climate relevant to my investments?
- What are the costs of climate change?
- Are regions and countries affected differently?

#3

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Climate change has become a significant risk factor to consider for the global economy, with links to global growth potential having been established. This is important to consider as long-term growth of the economy is a key driver behind of expected returns in several financial asset classes.

To understand the potential impact of climate change on future returns for stocks and bonds, this analysis considers a realistic scenario over the next three decades. In this scenario, the global economy is already affected by increased temperatures from historical emissions of carbon dioxide (hereafter, CO2), but also faces the costs of maintaining future temperatures at 1.5–2 °C above the pre-industrial level, as pledged in the Paris Agreement.

At the overall level, the analysis suggests ***that the physical costs of climate change and the mitigating actions to tackle it before the middle of the century might come at a net cost to the global economy.*** This makes it highly likely that asset performance (including for stocks and bonds) will also be adversely affected.

This conclusion is based on the evaluation of two distinct challenges to the global economy, which both appear to cause a net cost:

1. ***Temperature has already increased***. This could potentially have an adverse impact on global growth.

2. Although the long-term potential for the global economy will improve after the middle of the century by mitigating actions, ***the costs of avoiding further climate change by transitioning to a low-carbon economy could be significant.***

That said, the exact costs of transforming the economy will largely depend on the timing and the means chosen by governments to reduce future emissions of CO2. For instance, if a carbon tax is chosen, then its size and how generated revenues are spent will be crucial to transition costs.

Although the analysis suggests that tackling the climate challenges could come at a net cost to the global economy (0.31 percentage-point lower GDP growth p.a.), this should always be viewed in light of a scenario in which no mitigating actions are taken. In that scenario, with temperatures rising to around 4°C above the pre-industrial level by the end of the 21st century, global GDP is estimated to be permanently 3.5% lower.

Another aspect that requires special attention from investors is how climate change affects countries and regions differently. The analysis suggests that some regions might almost inevitably be more severely impacted. This includes emerging economies and those with a substantial carbon exposure. For other regions, focus is on understanding how vulnerable they are to climate change. This includes two of the largest global economies – the US and China. The analysis suggests both could be adversely affected.

Structure

This publication first outlines the climate challenge for the global economy. The physical and transition costs are then investigated more closely, and the link between economic growth and return on financial assets is explained. Using independent expected return estimates for the Danish financial sector, we illustrate how investors could adjust any expected return estimates in light of the costs of climate change.

The aim of this edition of ESG Investing is to inspire investors to develop their own approach to integrating climate change into their long-term investment decisions.

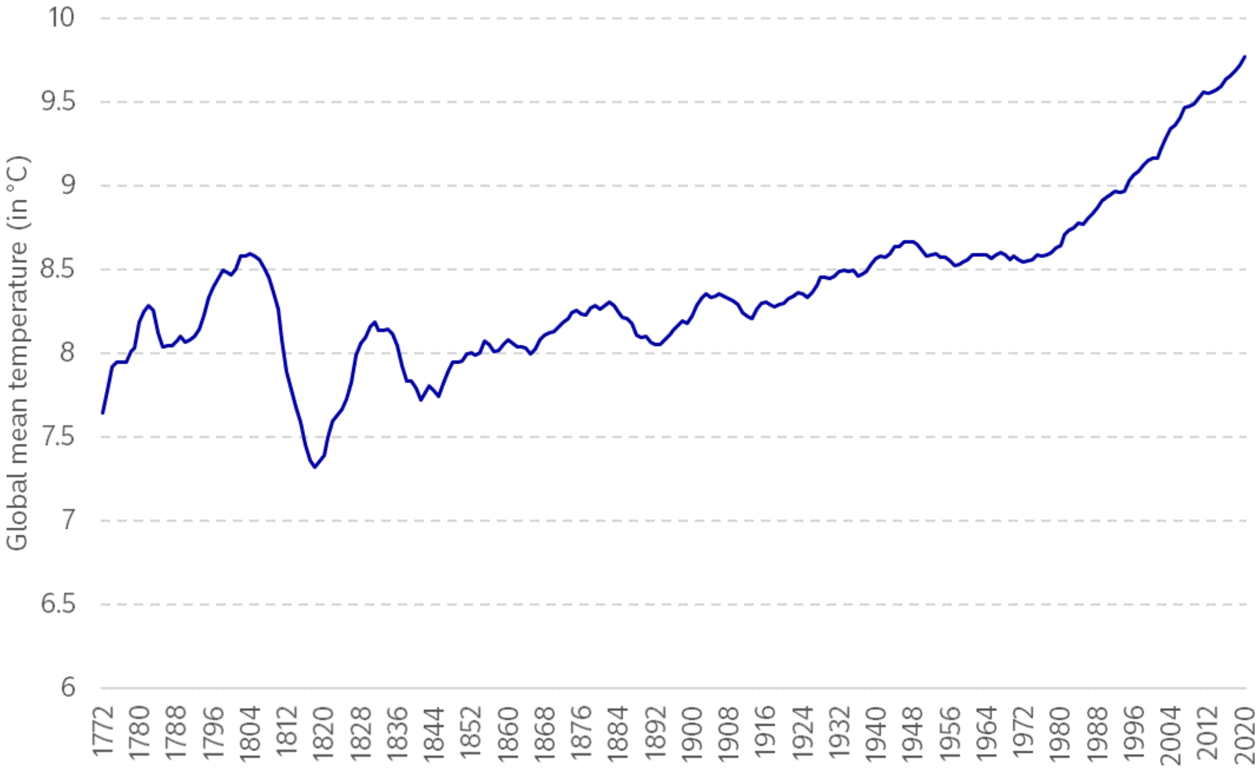
The big picture

Over the past 80 years, the global average land temperature has increased significantly. By 2020 it had increased well above 1°C compared with pre-industrial levels (see Figure 1). According to the leading inter-governmental agency for studying climate change – IPCC, it is likely to rise 2–5°C above the pre-industrial level over the remainder of this century depending on the mitigating actions that countries agree upon (IPCC, 2018).

In the Paris Agreement, (ratified in 2016 and currently signed by 195 countries), the main objective is to limit the global average temperature increase to 1.5°–2°C above the pre-industrial level[1]. To achieve this long-term temperature goal, countries pledged to reduce their emissions of greenhouse gasses (hereafter GHG), and CO2 in particular, to achieve a climate-neutral world. The physical costs for the global economy from increasing global temperatures and the mitigation costs that arise in the transition to a low-carbon economy in line with the Paris Agreement are likely to have a material impact on the expected returns and risks of financial assets, including stocks and bonds.

Quantifying the impact on financial returns for stocks and bonds is complex and encompasses a number of parameters that are unknown to any investor. However, even with incomplete information and a series of simplified assumptions needed to perform calculations, some key findings clearly begin to emerge that the long-term investor should consider.

Figure 1: Global mean temperature over more than two centuries.



Source: Berkeley Earth database and Nordea calculations.

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[1] See UNFCCC (2018) for the contribution of each country made in the Paris Agreement.

Physical costs of climate change

The global economy is likely to be adversely affected by climate and temperature changes. As documented by Stern (2007) and Nordhaus (2008)[2], activities such as global consumption and production cause carbon emissions. As global production is increasing, carbon emissions are rising as well, which then causes higher global temperatures.

Climate change happens with a considerable lag in time but, ultimately, environmental aspects feed back into the global economy and affect it through a number of channels. Labour supply, productivity, crime, human capital as well as political (in)stability are often emphasised.

Global average surface temperature is often chosen to measure climate change, since temperature itself affects economic activity. Another reason is that temperature is a useful index for other important elements of climate change such as changes in precipitation, extreme droughts, floods and freezes.[3]

Loss of productivity following increased temperatures

Temperature increases can affect the global economy through productivity (measured here as real GDP per capita) in several ways. In general, the labour force tends to become less productive in a warmer environment unless additional – but also more expensive – cooling is installed at production facilities. Also, at an aggregated level, a higher mean temperature causes extreme droughts, floods etc., which will more frequently disrupt aggregated production and infrastructure, in turn curbing productivity. Whereas this might make sense intuitively, it is a highly nuanced situation.

A more precise understanding of the exact relationship between changes in temperature and productivity can be gained from a recent study by Burke and Tanutama (2019). Using longitudinal data on economic output from over 11,000 districts across 37 countries, the impact on productivity (i.e. growth in GDP per capita) from increasing global temperatures above pre-industrial levels is evaluated and presented in Table 1. Other studies confirm the adverse relationship between temperature and GDP (Bansal et al, 2012).

Table 1: Temperature effect on productivity growth, conditional upon current mean temperature

CHANGE IN GROWTH RATE PER DEGREE CELCSIUS TEMPERATURE INCREASE			
Temperature (Celsius)	0 Year Lag	1 Year Lag	5 Year Lag
5	0.00033	0.00369	0.02074***
10	-0.00269	-0.00142	0.00822
15	-0.0057***	-0.00652**	0.0043
20	-0.00871***	-0.01163***	-0.01682**
25	-0.01172***	-0.01674***	- 0.02934***
30	-0.01474***	-0.02184***	-0.04186***
35	-0.01775***	-0.02695***	-0.05438***

Notes: Asterisks indicate the level of statistical significance: *p<0,1; **p<0.05; ***p<0.01 95% confidence level.
Source: Burke and Tanutama (2019).

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[2] William Nordhaus won the Nobel Prize in Economic Science in 2018 for this seminal work within this area.

[3] This follows Nordhaus (2008) where global mean temperature serves as a sufficient statistic for measuring climate changes. This analysis uses data on temperature collected from the Berkeley Earth database unless otherwise stated; see http://berkeleyearth.org/data/. The database contains historical observations for temperature since 1790 on a global and regional level.

Two conclusions can be derived from Table 1 that are important in a country-by-country evaluation:

1. **Current temperature matters:** The impact from climate change depends heavily on the *current* mean temperature in the specific geographic region. The productivity of countries with a current mean temperature *above* 15°C is *adversely* affected by an increasing mean temperature. This can be seen in Table 1, column 1 from the negative values for current temperatures of 15–35°C, and that the effects are statistically significant (marked with ***). For example, a country with a current mean temperature of 15°C that experiences a 1°C temperature increase will sustain 0.57 percentage-point lower annual productivity growth. Countries *below* 15°C are either *insignificantly* or *positively* affected by the increase in the mean temperature.

2. **Some countries can mitigate the effect:** It takes time (several years) for climate change to have full impact on the productivity level. In particular, for countries *below 15°C* in current mean temperature, the adverse effects of a rising temperature *may be mitigated* over some years to either become *insignificant* or *positive.* Hence, these countries may be able to mitigate the initial adverse effects from temperature on productivity by innovations. This does not seem possible for countries already *above* 15°C.

For the sake of simplicity in what follows, only the estimates in Table 1, column 1 (with no lagged time effects) are used.

Since the current mean temperature is of particular importance to the effect on productivity, Table 2 provides the mean temperature for a selected set of countries using the most recent ten-year average of land temperature from the Berkeley Earth database. In addition to this, Table 2 uses the information in Table 1 and provides, for each country, an estimate of how a 1°C increase in temperature will affect productivity over the next 30 years[4]. Since the global temperature has already risen 1°C above pre-industrial levels, Table 2 assumes an additional 1°C increase by 2100, which is consistent with the Paris Agreement[5] pledge.

Table 2: The effect of increasing temperature on productivity growth

THE EFFECT OF A 1°C INCREASE ON PRODUCTIVITY GROWTH		
Country	10-year avg. temperature	Avg. chg. in productivity (in ppts)
Australia	22.8	-0.23
Brazil	26.0	-0.23
China	15.9	-0.11
Denmark	9.3	0.00
Finland	3.0	0.00
India	24.9	-0.23
Japan	13.2	-0.11
Norway	1.3	0.00
Sweden	3.7	0.00
United States	14.7	-0.11
Europe	9.6	0.00
North America	3.4	0.00
Global	9.7	0.00
South America	22.8	-0.23
Africa	25.1	-0.23
Oceania	22.5	-0.17
Asia	8.9	0.00

Source: Burke and Tanutama (2019), Berkeley Earth database and Nordea calculations.

It is clear from Table 2, that productivity in primarily European countries is essentially unaffected by the temperature changes, whereas other countries and regions appear to be more negatively affected. A reduction in GDP per capita growth of 0.1–0.3 percentage points is not unreasonable to expect.[6]

Finally, Table 2 suggests that the productivity in emerging economies is likely to be more adversely affected than that in developed economies. This closely mirrors the fact that emerging economies tend to have higher mean temperatures.

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[4] Note that a "0.00" for a country in Table 2 indicates that the temperature effect in Table 1 was insignificant.

[5] In the calculation it is assumed that the 1-degree increase occurs in equally sized steps from 2020–2100 (since 2100 was the year agreed by the Paris Agreement for measuring temperature change) – a period of eighty years. However, the analysis only considers the years until 2050, which will therefore curb the physical effects/costs on increasing temperature.

[6] The numbers for China and the United States have been adjusted from their mean temperature levels of 7.9°C and 12.3°C to 15.9°C and 14.7°C, respectively. This is because a country's mean temperature estimate for large countries tends to be an inaccurate measure because it can easily mask the fact that different parts of the country might be affected differently by temperature. To adjust for this, temperature data for subregions within China (and the United States respectively) are weighted together with the subregion's relative contribution to GDP. See Online Appendix I.

From changes in productivity to financial returns

There is not only a relationship between climate change and productivity growth for countries. There is also a close relationship between productivity growth and financial returns; both for stocks and bonds.[7]

For bond returns, a simplified assumption is made whereby climate change can *only* affect bond returns through the real interest rate. Since this component affects total return for *all* bond asset classes, it is implicitly assumed in this analysis that the *excess premiums* (term, credit etc.) are *not* affected by climate change. Moreover, it is assumed that the changes in productivity equal the changes in the real interest rate. This is not an entirely unrealistic assumption: In neo-classical growth theory, see for instance Solow (1956), the real interest rate equals growth in productivity (plus population growth).

For equity returns, it is natural to base this on the literature concerning the possible link between equity returns and productivity, in which "supply side" models[8] predict a *positive* relationship between return on capital and growth in GDP per capita. Over the long run, equity returns should be close to what companies produce in the aggregated real economy. That is, in the long run the cash flows generated by companies must be the ultimate drivers of equity returns.

For this relationship to hold in the long run, (real) GDP growth must transmit into shareholders' returns in three steps, as illustrated in Figure 2.

Empirically, Ibbotson and Straehl (2016) find that the total pay-out per share, after appropriately adjusting for share buybacks, has historically grown in line with productivity. Although Bernstein and Arnott (2003) find evidence for some degree of dilution between productivity growth and total pay-out growth, the analysis will work on the assumption that changes in productivity growth (for instance caused by temperature changes) are fully transmitted into a change in pay-out growth[9].

Table 2 therefore *also* provides an estimate for how the physical costs of climate change contribute to financial performance of individual countries for stocks and bonds.

To support this conclusion in an informal way, an empirical deep-dive is made in Fact box 1 to test how climate change affects return on asset classes. In this deep-dive, the potential climate effects for the US economy are estimates based directly on temperature changes.

Figure 2: Transmitting GDP growth into shareholders' returns.

Source: Nordea.

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[7] Again, changes in population and labour force growth are ignored for the sake of simplicity.

[8] Supply side models usually build on the neoclassical growth model of Solow (1956) and extensions thereto.

[9] Another, and perhaps more intuitive, way to understand this is to consider the classical Gordon Growth Model, which implies the expected return, r, equals the current dividend-price ratio, D/P, plus the growth rate of the dividends, g. (i.e. $r=D/P+g$). If the valuation part is constant (i.e. D/P), then a change in productivity causes the dividend growth to change (via earnings growth) and transmit into the expected returns.

FACT BOX 1: Return dynamics for the US economy with climate change

A Vector-Auto-Regressive model (hereafter VAR Model) has been used to explain the return dynamics of stocks and government bonds. Temperature has been included as a state variable, to see if it provides any explanatory power in addition to other state variables and primary assets. Using monthly data from March 1953 to June 2020, the VAR Model analysis confirms the conclusions for the US economy and that it seems to have been *adversely impacted by climate change* over the past seventy years. As seen in Table 3, the coefficient on temperature for explaining the real interest rate is -0.39% and statistically significant[10]. This is fairly similar to the estimated impact of -0.11% that was calculated for the US economy above and presented in Tables 1–2. It is tempting to interpret this as evidence that temperature has adversely affected productivity growth and hence causes the real interest rate to be slightly lower.

The analysis also indicates that the increased temperature has had no significant effect on the excess premiums for bonds and stocks including yield and credit spreads. Because return on the real interest rate is part of the total return of both stocks and bonds, *total return on both assets is adversely affected by temperature changes.*[11]

Table 3: Temperature effects on asset classes for the US economy

TEMPERATURE EFFECTS ON THE US ECONOMY – VAR MODEL USING DATA FROM 1953–2020.

Dependent variable	Constant	Real rate, t	Dividend-price, t	Nominal rate, t	Yield spread, t
Real rate, t+1	-0.002 **	0.433 **	-0.001 *	0.275 **	0.355 **
Stocks, t+1	0.007	0.325	0.000	-1.041 *	2.533 *
Bonds, t+1	-0.011	0.614 **	-0.003	0.185	2.918 **

Dependent variable	Credit spread, t	Temperature, t	Stocks, t	Bonds, t
Real rate, t+1	-0.382 **	-0.004 *	0.004 *	0.013 **
Stocks, t+1	-2.793	-0.012	0.225 **	0.140
Bonds, t+1	-1.550	-0.016	-0.078 **	0.275 **

Notes: Asterisks indicate the level of statistical significance: *p<0,1; **p<0.05; ***p<0.01 95% confidence level.
Source: See the Online Appendix II for details on data sources and Nordea calculations.

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[10] Online Appendix II contains the details on data sources, how to construct the variables as well as how to estimate this type of VAR model. The appendix is also an extended version of Table 3 containing all the coefficients for the VAR model.

[11] The exact effect of on the real interest rate depends on the specific countries in question, where Central banks may have to keep interest rates (a bit) low(er) to offset the adverse impact on growth caused by the costs of climate change.

Mitigation costs of climate change

In the previous sections, the adverse impact of physical costs on financial returns was discussed. This may, however, not be the only potential drag on performance that the long-term investor is likely to experience in the years to come.

If the global temperature is to be maintained at around 2°C above pre-industrial levels by the end of this century, mitigating – but also costly – actions must be taken to transform the global economy into a low-carbon economy. If no mitigating actions are taken, countries *may* save the costs from the mitigating actions over the next thirty years, but they will eventually experience *higher* costs in terms of GDP that is permanently 3.5 percentage points lower, as the temperature will continue to rise to about 4°C above pre-industrial levels by the end of 2100.

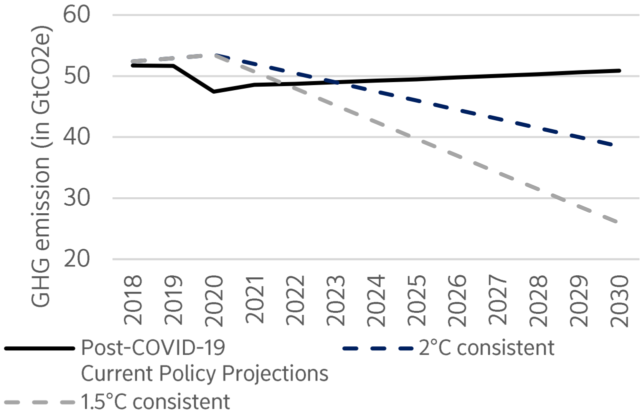
Although it may be difficult for elected governments, this analysis assumes that governments will implement the necessary mitigating actions to maintain global temperatures at 2°C above the pre-industrial level, as pledged in the Paris Agreement. Figure 3 illustrates what this will require in terms of reductions in CO2 emissions. To meet the targets of the Paris Agreement of 2°C, and with an aspirational level of 1.5°C, there must be a reduction of 12 GtCO2e and 25GtCO2e, respectively, in GHG emissions[12] before 2030 and (at least) a similar amount after 2030. This is because the current commitments are insufficient to reach the level of ambition from the Paris Agreement. Currently, these commitments will "only" imply a mean temperature of 3 °C above pre-industrial levels.

In order to achieve these reductions after 2030, the focal point of discussions has mainly been a carbon tax, which is a tax on the supply of fossil fuels in proportion to their carbon content. A carbon tax is often suggested, because it seems to be the most efficient way to obtain the reductions since it:

(i) Incentivises energy conservation and the shift to cleaner fuels.
(ii) Has the ability to generate government revenues.
(iii) Provides substantial domestic environmental gains; see IMF (2019a).

However, carbon taxes also add to the cost of living for households through increasing energy prices; see IMF (2019b), and may affect inflation.[13]

Figure 3: Current and needed trajectories for emissions to reach the targets



Source: CAT (2018).

Assuming a carbon tax will be implemented globally, the obvious question is how sizeable it has to be to yield the targeted reductions in CO2 and maintain temperatures at 2°C above the pre-industrial level by the end of the century. Most proposed carbon tax rates are in the range of USD 50–100 per tonne CO2 (Stern and Stiglitz, 2017). The International Energy Agency (2018) proposes around USD 100 per tonne and the IMF (2019a) has a similar proposal with an optimal carbon tax of USD 70–75 per tonne, although USD 50 is more likely to be politically feasible. In the following analysis, a carbon tax of USD 70 per tonne is assumed as it is consistent with reaching the temperature targets of the Paris Agreement.

Imposing a carbon tax is, however, not without costs for the global economy until the middle of the century, although in the long run the climate and the economy will clearly benefit from it. The *efficiency costs* come from two distinct sources:

1. The costs of transforming aggregated production into low-carbon technology.
2. The decline in overall economic activity due for instance to higher energy prices.

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[12] As of 2016, carbon dioxide (CO2) from fossil fuels is approx. 63% of all GHG. Note that 1Gt is 1 billion tonne.

[13] Changes in energy prices are likely to have an effect on aggregated demand and tend to be inflationary. However, the supply side of the economy is also affected because lower productivity growth reduces production capacity, which tends to be deflationary. At this point, it is unclear which effects will be predominant; see Bolton *et al.* (2020).

Costs of transitioning to low-carbon technology

Imposing a carbon tax gives firms and household an incentive for shifting to cleaner, but more costly, technology than they would otherwise have preferred. This type of distortion could lower GDP and eventually burden financial performance. Countries with relatively high carbon-intensive aggregated production are likely to face highest transition costs.

Table 5: The costs of shifting to low-carbon technology

Countries	Costs (ppts)
Australia	0.2
Brazil	0.1
China	0.6
Denmark	0.1
Finland	0.1
India	2.4
Japan	0.2
Norway	0.2
Russia	0.4
Sweden	0.0
United States	0.2

Notes: For China, Russia and India the costs are only two thirds of those in IMF (2019a) to allow for some of the welfare gains.
Source: IMF (2019a) and Nordea calculations.

For selected countries, Table 5 gives an estimate of the transition costs measured relative to annual GDP.[14] *Most countries will face costs in the range of 0.1–0.2 percentage points of GDP growth annually.* This is mainly countries with a relatively large service sector, such as European countries. For other countries, the effect is more pronounced. Russia and China are likely to experience a drop in GDP of 0.4 and 0.6 percentage points, respectively, whereas it is even worse for India with a drop of 2.4 percentage points in GDP growth. This is not surprising since all these countries have relatively high carbon-intensive production. However, unlike the physical costs, *all* countries appear to be negatively affected.[15]

The change in GDP will, all else equal, transmit directly into a similar change in GDP per capita growth (i.e. productivity) compared to a situation without a shift to low-carbon technology[16]. As argued above, productivity growth is essential to understanding financial performance in the long run. Lower productivity growth will affect both return on both equities and bonds through a lower real interest rate.

It must be emphasised that these considerations also require countries to meet a considerable private and public investment challenge for the energy sector. Globally, around 2% of additional GDP must be invested every year, but with clear regional differences. The United States and Europe must invest around 1% of GDP whereas for China and India the figure is around 2–3.5% of GDP. To compare, GDP dropped around 3% in Q12020 as a consequence of the covid-19 pandemic. Investing in the energy sector may, however, not necessarily be a further burden on performance.

Decline in economic activity

The other source of efficiency cost, when imposing a carbon tax, is the distortional effect on economic activity. The size of this distortional effect on the economy is somewhat tricky to estimate because each part of the calculation involves elements which are highly uncertain at this point in time. Apart from uncertainty concerning the size of the carbon tax (and also whether developed countries should pay the same tax per tonne as emerging economies[17]), uncertainty mainly centres around how the revenue generated by the carbon tax will be redistributed (i.e. "recycled") back into the economy.

The size of the distortional effects from the carbon tax will depend on how the generated revenues are used and potentially, if this will offset some of the distortions created by other taxes (e.g. in the personal income tax).

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[14] Note that the costs are estimated on the basis of USD 70, as elsewhere in this analysis. However, a USD 70 carbon tax is likely to overstate the costs of implementing new technology because this is likely to diminish over the next thirty years. To adjust for this, only five-sevenths of the cost estimate are used.

[15] It should be noted from Table 6 that countries are also likely to experience some welfare gains from reducing cardon emissions, in most cases in the long term (i.e. beyond the next thirty years), the costs on GDP from shifting to a low-carbon economy might be offset. These benefits are pronounced for China, India and Russia.

[16] See Online Appendix III for a detailed outline of this argument.

[17] Emerging countries have not contributed historically to much of the existing issues with CO2 and global warming. In that sense it could be argued that emerging economies should pay a lower carbon tax than developed economies.

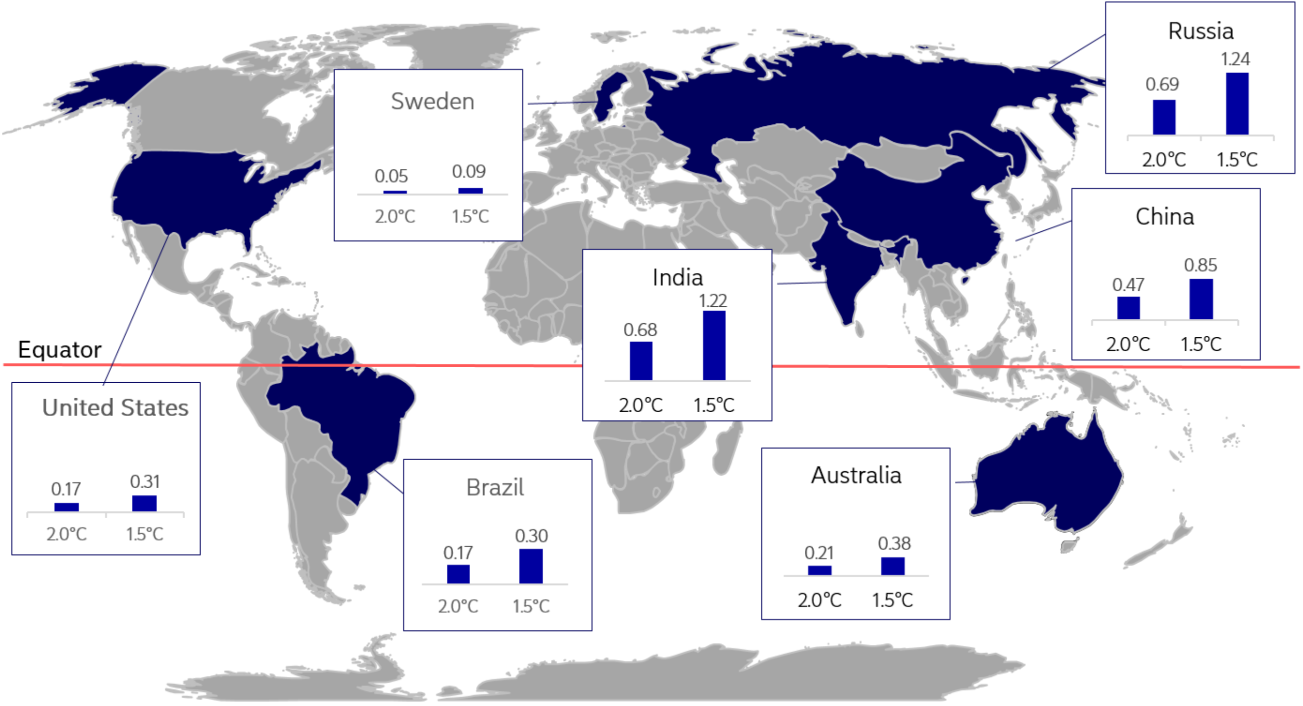
Some simplified assumptions are needed to make calculations more feasible. As discussed above, a carbon tax of USD 70 is assumed because it is consistent with the Paris Agreement.
Following the work of the IMF (2019b), it seems reasonable that tax revenues can be redistributed back into the economy such that (at least) one third of the distortional effect is mitigated; i.e. in the calculations of the potential efficiency loss on economic activity, an effective tax rate equal to two-thirds of USD 70 is used.

As illustrated in Figure 3, 12 GtCO2e and 25 GtCO2e of emissions must be reduced to achieve the 2°C/1.5°C targets from the Paris Agreement. To derive how much each country must contribute, and is therefore impacted in terms of costs, each country's share of global CO2 emissions is used. This deviates from the commitments stated in the Paris Agreement, see UNFCCC (2018), but is assumed for two reasons: First, the commitments by countries are so far *not* on track to achieving the 2°C target. Second, GDP for the G-20 countries is going to increase significantly by 2030, which means that CO2 emissions will also *increase* by 26%.

In the long run, it is difficult to see how countries like China, the US and India – with emission shares of 33%, 12% and 9%, respectively, in 2030 – will not, at some point, have to reduce their *absolute emissions* in a way that reflects their share of global emissions. Otherwise global targets for temperatures simply cannot be reached.

Figure 4 illustrates this type of efficiency loss for selected countries. As was the case with efficiency costs for shifting to cleaner technology, the efficiency costs in terms of economic activity are highest for countries with the highest carbon-intensive production; i.e. India, China, Russia etc. For these countries, the costs seem to be well above 0.2% of GDP annually, whereas the costs for countries with less carbon-intensive sectors, such as European countries, appear to be (well) below 0.2% of GDP annually. To reach the 1.5°C target, the costs are obviously higher. Again, efficiency costs seem to be higher for emerging economies.

Figure 4: The efficiency cost from loss of economic activity (% of GDP annually).



Source: IMF (2019a) and Nordea Calculations.

Piecing it all together – adjusting expected returns across regions and asset classes

With estimates for *physical costs* as well as *mitigating costs*, Table 6 presents what could be the total net impact on productivity (and GDP per capita growth) across the countries. The US economy may be adversely affected with a combination of both relatively high physical and mitigating costs. Also, countries either with high CO2-intensive production or that are otherwise exposed to fossil fuel could be significantly impacted.[18] This includes countries such as China, Australia, Brazil and Russia. European countries seem to be less affected with overall costs in the range of 10–20 bps p.a. These countries benefit from low mean temperatures and a sector composition that has a relatively modest exposure to carbon.

In more general terms, Table 6 suggests that emerging economies could be more severely affected. India (and partly also China) deserve considerable attention from investors. They are among the countries that emit the most, and also the current mean temperature is working against these countries.

As an example, the region Guangdong, which contributes 10.9% of GDP in China, has a mean temperature of 22.2°C. It will likely be significantly impacted by climate change. It is, however, also important to emphasise that countries like China and India ought also to be those that would benefit most in terms of welfare gains, such as improved health, from reducing emissions. In the analysis above, these benefits are not included to any great extent because they will likely to be gained after 2050 once emissions have been reduced.

Table 6: Total costs of climate change for individual countries

THE IMPACT OF PHYSICAL AND EFFICIENCY COSTS ON PRODUCTIVITY				
	Change in GDP/capita growth p.a. (in ppts)			
Countries	Physical	Cleaner technology	Less activity	Total net impact
Australia	-0.23	-0.13	-0.14	-0.50
Brazil	-0.23	-0.07	-0.11	-0.40
China	-0.11	-0.60	-0.31	-1.02
Denmark	0.00	-0.07	-0.04	-0.10
Finland	0.00	-0.07	-0.08	-0.15
India	-0.23	-3.11	-0.45	-3.79
Japan	-0.11	-0.13	-0.11	-0.35
Norway	0.00	-0.13	-0.05	-0.18
Russia	0.00	-0.40	-0.46	-0.86
Sweden	0.00	0.00	-0.03	-0.03
United States	-0.11	-0.13	-0.12	-0.36
Global				-0.31
Europe				-0.12
North America				-0.36
Emerging Markets				-1.01
Eastern Europe				-0.86
Latin America				-0.40
Emerging Markets Asia				-0.80

Source: IMF 2019a, IMF 2019b and Nordea calculations.

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[18] With new technology using less or no fossil fuels for production, the financial value of fossil reserves will be significantly reduced; hence "stranded assets". Clearly, this will impact the value of companies holding these stranded assets and therefore also any benchmark indices of which they are part. Stranded assets form a separate analysis that is beyond the scope of the present analysis, but results presented in Schroder (2020) suggest that countries with numerous reserves will be adversely impacted. These countries tend to be the same countries that, in this analysis, emerge as the most adversely affected. In other words, had this analysis taken stranded assets into account, this would likely have underscored the conclusion drawn in this analysis.

It should also be emphasised that these results are highly dependent on investors' assumptions in terms of the exact size of the carbon tax rate, how the revenue it generates is redistributed back into the economy and the time span allowed for temperatures to transmit into productivity changes. Changing any of the above assumptions could materially alter the conclusion.

The estimates in Table 6 can be used directly to calculate the adjusted expected return for both stocks and bond asset classes. To illustrate how this can be done, the information in Table 6 is used to adjust return expectations in the Danish Industry Standards (Samfunds-forudsætningerne). The results are presented in Table 7.

Table 7: Adjusting expected returns for climate effects.

Asset Class	Unadjusted returns	Adjustments (ppts)	Returns adjusted for climate effects
Government & Mortgage Bonds	-0.10 %	-0.10	-0.20 %
Investment Grade Bonds (EU+US)	0.60 %	-0.24	0.36 %
High Yield Bonds (EU+US)	2.90 %	-0.28	2.62 %
Emerging Markets Bonds	3.10 %	-1.01	2.09 %
Global Stocks	6.40 %	-0.31	6.09 %
Emerging Market Stocks	8.10 %	-1.01	7.09 %

Note: Investment Grade is calculated as 50% European and 50% US whereas High Yield is calculated as 66% US and 33% European.
Source: Rådet for Afkastforventninger (H2-2021) and Nordea calculations.

Key points for investors

The global economy is not immune to climate change. As temperatures have already increased above the average pre-industrial level, the physical and mitigation costs involved in preventing further temperature increases are likely to adversely affect asset returns until at least the middle of the century. As climate and temperature changes have already occurred, this is likely to affect asset prices even if mitigating actions are taken now. Because there is still much uncertainty surrounding what the mitigating actions will be, asset pricing will also reflect this. This means potential for repricing. The questions are probably therefore more a case of *which assets, and by how much?* This analysis has not looked at how individual sectors will likely be affected, but clearly this is an aspect that investors should also consider closely. Five aspects deserve to be mentioned:

1. **Decoupling between emerging and developed markets:** Throughout the analysis, a reoccurring theme seems to be the decoupling between emerging and developed economies. Overall, emerging economies seem to be more severely affected by climate change – both in terms of the physical and mitigating costs – which is reflected in significantly reduced expected return. Two important countries in the world economy are China and the United States. Our analysis suggests that they could both be adversely affected by climate change, which also makes it likely that the global economy will also be adversely affected. Importantly, they are affected by both increased physical and transition costs.

2. **Some countries are less affected:** As long as global temperatures are maintained at around two degrees above the pre-industrial level, European countries, and Nordic countries in particular, appear to be relatively less affected. This result is a combination of two factors: the current mean temperature is sufficiently low, such that a mild increase in temperature would actually increase productivity; second, the transition costs to a low-carbon economy are generally lower in these countries. Investors should also recognise and capitalise on the opportunities presented by the transition to a global low-carbon economy in terms of innovations and productivity growth.

3. **Stocks and bonds are both affected:** Generally, the higher costs (both physical and transition costs) cause reduced productivity for the countries. This affects both the expected return of stocks and different types of bonds. It is likely that other asset classes (for instance private equity, hedge funds, commodities, real estate, etc.) will also be affected. Investors should, however, be cautious in viewing asset classes as either “grey” or “green”. Each asset class is more heterogenous and the distinction should be made on the basis of how different types/regional stocks (resp. bonds) are affected. Again, the sector perspective for stocks also seems relevant to bear in mind.

4. **A starting point for further discussions:** It is important to emphasise once again that the conclusions of this analysis are highly dependent on the exact assumptions made to make it feasible. This should not discourage investors, but rather be considered to highlight the importance of continuous reflections on the topic because climate change is likely to have an effect on the long-term investment.

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