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The impact of climate change on the global economy

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Drawing on the comprehensive research done over the past two decades, Keith Wade and Marcus Jennings of the Schroders Economics Team examine how climate change will shape the global economy. In their view, global growth will be hindered by rising operational costs as global temperatures rise, with studies suggesting that a worst-case impact of a 1% reduction in GDP growth per year could be realized. Research also suggests that the impact will be disproportionately damaging to developing economies, and only through a collective effort to enact strict carbon emissions policies can the long-term financial repercussions of climate change potentially be ameliorated.

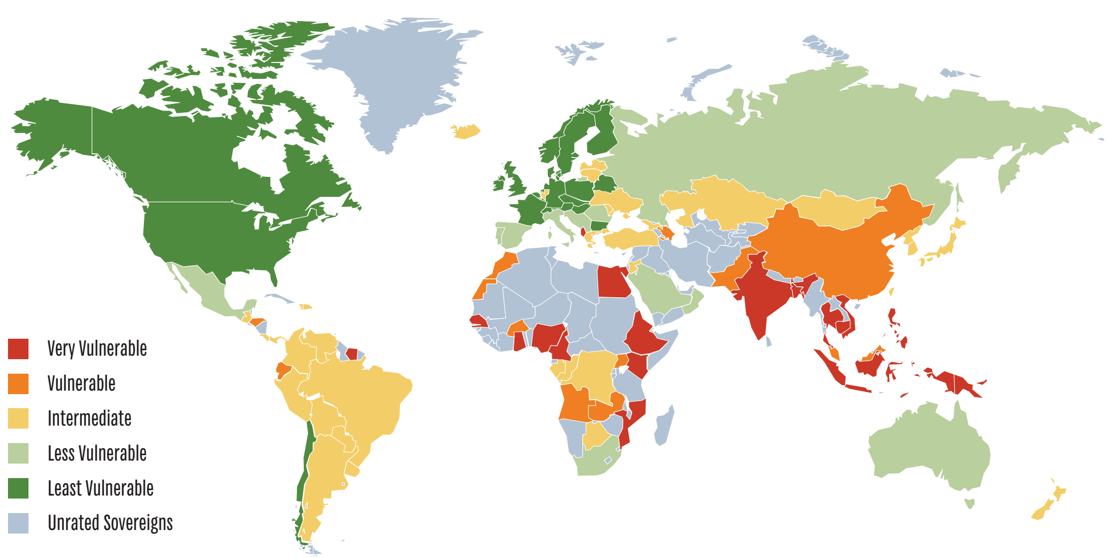
The academic community is leading the way in an attempt to encourage financial market participants and governments alike to change behavior so as to mitigate the costs of global warming. Against this backdrop, we explore how global warming is likely to impact global activity and discuss the need for a collective policy response.

Our main themes are as follows:

Introduction

Assessing the impact of climate change is, at best, an extremely complex exercise with uncertainty about both the degree of future global warming and the subsequent impact on global activity. There are clearly some benefits as well as costs as the planet warms. There is also the unknown of how technological progress will respond and potentially alter the path of global warming. Any assessment also involves taking a very long-run view, well beyond that normally used by financial market participants. However, increasing awareness of the issue means there is a growing demand for a view from shareholders who are either concerned about how the companies they own impact the environment, worried about the effect of climate change on the value chain of those companies, or a combination of both.

Developing economies likely to be most impacted by global warming



Source: Standard and Poor's, 2014

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1. The effect on growth and inflation

Despite there being winners and losers, increasing temperatures will be negative for global activity overall

The overall aggregate effect of climate change on economic growth will most likely be negative in the long run. Although there will be winners and losers from climate change at varying levels of warming, the impact of rising temperatures will be widespread, in part due to the financial, political and economic integration of the world's economies. Global warming will primarily influence economic growth through damage to property and infrastructure, lost productivity, mass migration and security threats. The balance between winners and losers turns increasingly negative as temperatures rise.

Global warming is expected to increase the frequency and severity of extreme weather events, bringing with it property and infrastructure loss. The likes of Hurricane Sandy, which flooded much of New York in 2012, are prime examples of the economic damage such extreme weather events can cause. Rising sea levels will also likely harm economic output as businesses become impaired and people suffer damage to their homes.

While the initial economic response to recover this damage may be positive for GDP (when it is possible to do so), once it is recognized that such events are a permanent feature of the environment, the world economy faces an extreme challenge. Many will find that it is not worth replacing capital stock unless measures can be taken to prevent future damage, or there is an opportunity to move the business to safer ground. At best, this could involve a short period of disruption as businesses relocate; at worst, a permanent loss of capital stock and output. As the temperatures continue to climb, the damage will become increasingly permanent.

Using a production function (Figure 1), we can demonstrate the likely effect climate change will have on output. If we assume less capital stock is available due to the damage inflicted from climate change, we would see a fall in the productive capacity of the world economy. This would translate into a downward shift in the world production function as each unit of labor produces less output. Lower labor productivity may not just occur due to a lower level of capital stock, however. Higher global temperatures may affect food security, promote the spread of infectious diseases and impair those working outdoors. Such factors are likely to cause greater incapacity and social unrest and as a result will reduce both the effectiveness (productivity) and the amount of labor available to produce output.

This effect can also be expressed as a supply shock through a supply and demand framework (Figure 2). Global warming is likely to contract supply at any given price and result in a backward shift of the supply curve (from S1 to S2). As the diagram demonstrates, this will result in a lower level of output (Y2) and, as we discuss in the next section, a higher price (P2).

Figure 1: Global production function

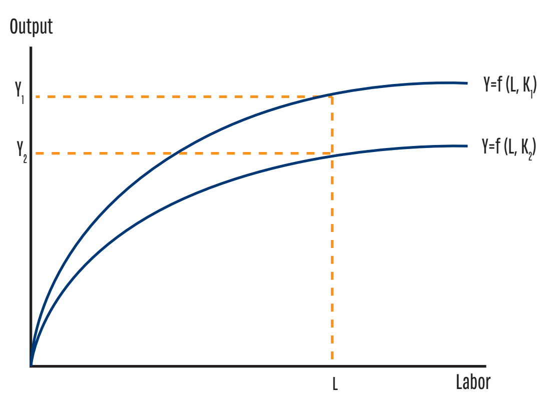
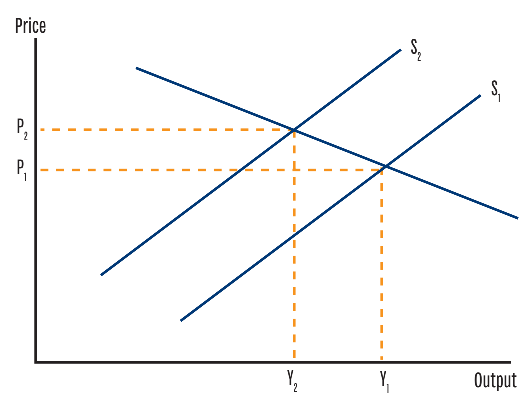


Figure 2: Supply and demand effects



Source: Schroders Economics Team. For illustrative purposes only.

There is also an opportunity cost to be considered. The above analysis is based on a *ceteris paribus*[1] argument whereby the world's population is seen not to respond to climate change. It is probable that over time, preventative measures such as flood defenses are put in place in order to avoid the costs of climate change. While this may reduce the long-term economic consequences, there is likely to be a short-term economic cost to this action as resources are directed away from more productive uses.

According to Mendelsohn (2013), the biggest threat climate change poses to economic growth is from immediate, aggressive and inefficient mitigation policies. The process of adaptation and mitigation will require a temporary economic transition from consumption to investment, with the argument being that the transitional costs are small relative to the cost of inaction. Stern (2006) estimates the costs of mitigation to be in the region of 1% of global GDP per annum by 2050. However, we would argue that as the costs of mitigation rise, budget constraints are likely to become increasingly important. Governments may be unable to raise the capital necessary to build adequate defenses, for example.

Inflation is likely to rise as shortages emerge, particularly in agriculture

The above supply and demand diagram not only shows a reduction in output, but an increase in the general price level as a result of global warming. This leads us onto the possible inflationary effects of global warming on the world economy.

Agricultural yields are sensitive to weather conditions and as our climate becomes ever more extreme, more frequent droughts may reduce crop yields in areas where food production is vital. Higher global food prices will likely thus squeeze consumers' income in the process. We must acknowledge that these effects will be partially offset as other regions becoming more suitable for crop production and new drought resistant crops are developed. However, in aggregate, and as the level of warming becomes even greater, food price inflation should rise.

Rising inflation may also materialize through reduced land availability. The surge in global temperatures may eventually cause some areas of the world to become uninhabitable and with this will come mass migration. Alongside the political and socioeconomic implications of these moves will be higher demand for an ever decreasing amount of land. In essence, the world's population will be forced to live in an increasingly concentrated space. In similar fashion to food inflation however, this effect will also be moderated by some areas of land becoming more habitable.

Energy costs to increase in the transition to renewables

Higher energy costs are also likely to boost inflation. As our climate becomes more extreme we are likely to demand greater energy to both cool our working and living environments during the summer, and heat them when we experience harsher winters. Not only will energy demand change, but supply may shrink as the efficiency of existing power stations is compromised due to higher temperatures. Policy actions by governments to encourage a transition to green energy may further contribute to energy inflation in the short- to medium-term whereby taxes are placed on fossil fuel-derived electricity. Given that energy forms the basis of most of the world's production, the secondary effects of higher energy prices on inflation will be felt throughout the global economy. Conversely, depending on the pace of change, the greater prominence of renewable energy could limit the cost of energy increases going forward.

Climate change risks are already pushing insurance costs higher

The insurance industry recognizes that it is likely to bear much of the risk of global warming. Companies have already felt the force of extreme weather events on profits; from unseasonal floods in the UK to Hurricane Katrina in the US, extreme weather-related damage to properties has seen insurance companies pay out to cover these costs. It is believed that 2011 was the most expensive year on record for natural disasters, with insured losses costing the industry more than $126 billion. The Governor of the Bank of England, Mark Carney, commenting on the research the Bank has conducted recently, stated that climate change is one of the top risks faced by the insurance industry.

[1] Ceteris paribus is Latin for "all else equal"

The industry has been at the forefront of assessing climate risk, and as a consequence, the costs of global warming could be felt earlier than expected in the form of higher premiums. We are already seeing a curtailment of available cover in areas such as Florida and many Gulf coast states for example. The cost of flood insurance has risen significantly in the UK. Rising insurance costs add to inflation and will deter firms and households from locating in areas at risk. From this perspective, the costs of climate change are already being incorporated into business decisions and in this way are already affecting global activity. Insurance companies may go as far as to refuse to provide insurance cover, posing a challenge for governments who may either have to underwrite, and/or mitigate the risk of damage.

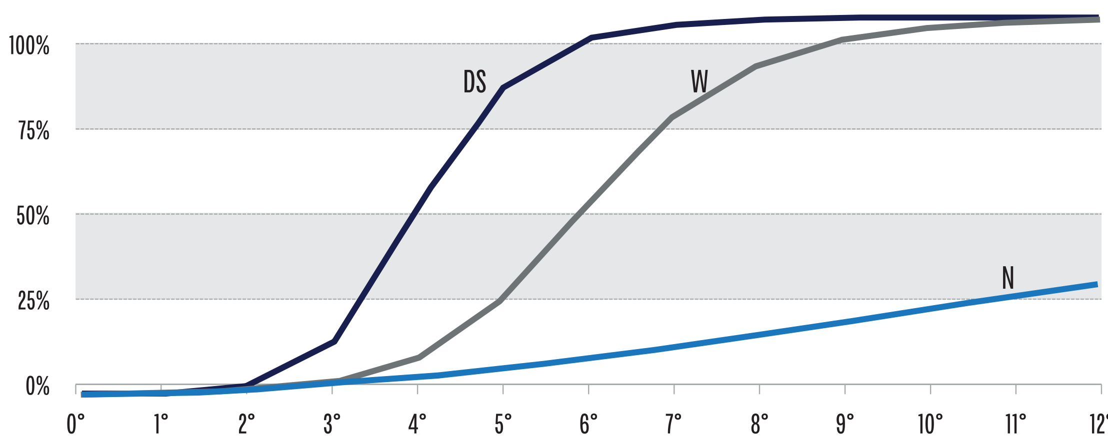
2. Climate damage functions: quantifying the impact on activity

Early estimates of the cost of global warming on world GDP emerged in the early 1990s and since then there have been a number of studies that have both agreed with and contradicted the initial assessments.

Covington and Thamotheram (2015) base their analysis on so called "climate damage functions" that quantify the risk the economy faces as a result of climate change. Economic climate damage is defined as the fractional loss in annual economic output at a given level of warming compared to output in the same economy with no warming. Climate damage functions plot the level of output lost over a range of warming estimates, with all functions predicting a greater loss in annual economic output as the level of warming rises. However, among the estimated climate damage functions there is a lack of consensus as to how damages evolve as warming gradually increases. The following figure and table summarize a number of estimated economic damage functions, named after their respective originators. We briefly discuss each climate damage function below, focusing on the 4°C mark given that the World Bank estimates there is a 40% chance of exceeding this level by 2100, assuming emissions follow a "medium business-as-usual pathway".

Figure 3: Climate damage functions

Climate damage forecasts at a given level of warming based on estimates by Dietz and Stern (2014), Weitzman (2012) and Nordhaus (2013).



Source: Covington and Thamotheram (2015)

Table 1: Climate change functions

Estimates of climate damage at varying degrees of warming. Climate damage is defined as the fractional loss in annual economic output at a given level of warming compared to output in the same economy with no warming.

	Climate damage		
Warming	**DS-damages**	**W-damages**	**N-damages**
1°	0%	0%	0%
2°	2%	1%	1%
3°	14%	3%	2%
4°	50%	9%	4%
5°	81%	25%	7%

Source: Covington and Thamotheram (2015)

Estimates of climate change damage vary according to whether there is a tipping point at which damage accelerates

The "N-damages" climate damage function, named after its originator Nordhaus (2013), is widely used by economists and is the least concerning of the three climate damage functions. Climate damage under this function would be progressive whereby no tipping point is reached and the world's population has the greatest amount of time to offset any negative effects of global warming. It can be seen that by the year in which the world is 4°C warmer, annual economic output will be just 4% lower than a base case with no warming. The baseline case in Nordhaus's study is for warming of around 3.8% by 2100. Nordhaus believes the economic impact of climate change is likely to be small over the next couple of decades and that agriculture is the most exposed sector to global warming. Although the cumulative effects are reasonable at the point at which 4°C is reached, the loss in terms of average annual growth would be extremely small and difficult to distinguish given that it will take many decades to reach 4°C of warming based on current estimates.

The "W-damages" function was produced by Weitzman (2012) and estimates that by the time 4°C of warming is reached, 9% of annual economic output will be lost relative to the base with no warming effect. Under this scenario, those industries that are largely predisposed to climate change risk globally are likely to be affected, for example insurance, agriculture and forestry. However, Pearce et al (1996) believe that only a fraction of the market economy is vulnerable to global warming, namely agriculture, coastal resources, energy, forestry, tourism, and water. These sectors contribute just 5% of global GDP to which their share is expected to shrink overtime (Mendelsohn, 2013).

This can be seen when we translate the damage function into the effect on economic growth. If we assume a base case of 3% annual economic growth and that 4°C warming is reached by 2080, we find that annual growth will be pared back to 2.85%. This is based on an economy that is 9% smaller due to climate damage in 2080 relative to an economy with no warming. An effective loss of 0.15% per annum could be seen to warrant some attention from policymakers and the government alike, but is unlikely to be sufficiently powerful to prompt a significant response to climate change.

In the most severe case, global GDP growth would be some 1% lower per annum

The final climate damage function, "DS-damages", named after Dietz and Stern (2014) is the most extreme scenario in which the global economy would suffer considerable loss as a result of climate change. Under this scenario, as and when warming extends to 4°C, annual economic output will be 50% lower compared to a scenario where no warming occurs. To put this into perspective, Dietz and Stern estimate warming of approximately 3.5°C by 2100. If we take a stricter approach however, using the same assumptions as the W-damages function above but assuming 4°C is reached in 2080, the base case 3% annual economic growth rate falls to just 1.9% a year. At this rate, climate change is set to have a noticeable impact on future growth and living standards. Reaching a tipping point at 2-3°C, as Dietz and Stern predict, could therefore be seen as a crucial stage of warming for the global economy whereby the costs of insufficient action significantly weigh on growth. Christine Lagarde, head of the International Monetary Fund (IMF), believes the planet is "perilously close" to a climate change tipping point to the extent that climate change poses the greatest economic challenge of the 21st century.

In table 2 we summarize some additional benchmark studies in the literature aiming to address the economic impacts of climate change. Similar to the damage functions described above and aside from the Stern review and upper estimates from the Intergovernmental Panel on Climate Change (IPCC), the consensus is that the economic costs of marginal warming will be small up to 2°C but begin to gather pace if we move toward 4°C.

This analysis indicates that output losses accelerate once warming exceeds 2°C, but that these effects are not likely to be felt for another 30 years. It is this threshold which is apparent in investment studies such as that recently published by Mercer which finds negative returns to diversified portfolios once warming breaches 2°C.

However, let us not forget that warming unfolds over time and that actions today have implications for the future. Since the process is largely irreversible over the medium term, the global economy can be seen to have committed to a certain degree of future warming already. A 2014 World Bank study titled "Turn Down the Heat. Confronting the New Climate Normal" estimates that warming of close to 1.5°C above pre-industrial times is locked into the earth's atmospheric system and is thus unavoidable. According to the same study, without reasonable action to reduce emissions, the earth is on track for 2°C warming by mid-century and 4°C or more by the end of the century. Stern (2006) also estimates that without action to reduce emissions, the concentration of greenhouse gases could double their pre-industrial levels as early as 2035, almost committing the world to temperature increases of over 2°C.

For investors assessing the value of a stream of income, these projections are critical and we would suggest using a range of climate damage functions given the uncertainty over each. Expressing future economic losses in today's prices requires discounting the loss in output back to the present day. By its nature, small changes in the discount rate cause large changes in loss estimates given the very long time horizon in which climate change is expected to occur. When attempting to quantify the impact climate change will have on a diversified portfolio, Covington and Thamotheram (2015) use a discount rate of 6.5%. In contrast the Stern

Table 2: Estimates of economic losses from climate change

Study	Warming	Impact (% on GDP)	Comment
Mendelsohn, Schlesinger, Morrison and Andronova (2000)	2.0° by 2060	A cumulative effect of a loss of 0.3% of GDP in 2060	Assuming 2°C of warming is reached by 2060, most damages will come from agriculture. OECD economies will gain from warming while the rest of the world will lose. Damages to individual countries do not always follow continental averages. The Ricardian model predicts much smaller losses and gains than the reduced-form model, predicting a 0.04% net gain to 2060 GDP levels from 2.0°C warming.
Mendelsohn, Schlesinger and Williams (2000)	2.5°C by 2100	Cumulative market impact costs do not exceed 0.1% of GDP in 2100	The market impact costs will vary from country to country across the globe. High-latitude countries are expected to gain and low latitude countries are forecast to be harmed by warming. However, temperature effects beyond 2°C are expected to reduce benefits and increase damages.
Stern (2005)	Baseline scenario of between 2.4°C and 5.8° by 2100	An average loss of 5% of global GDP per annum over the next two centuries	Estimates are based on no action. Costs increase to 20% of GDP or more if a wider range of risks and impacts are considered. Based on simple extrapolations, costs of extreme weather alone could reach 0.5-1% of world GDP per annum by the middle of the century.
Intergovernmental Panel on Climate Change, Fifth Assessment (2014)	Approximately 2.0°C	A loss of 0.2%-2.0% of GDP per annum	There are large differences between countries when damage estimates accelerate beyond 3°C of warming. Delaying mitigation efforts beyond those currently in place to 2030 is estimates to substantially increase the difficulty of transitioning to low long-term emission levels.

Source: Schroders. Please refer to references section for complete sourcing information.

review (2006) uses 1.4% (0.1% above expected consumption growth), so it is unsurprising that Stern's estimates forecast greater costs of climate change than many other studies. Given the decline in long-term interest rates since the Global Financial Crisis, it seems using a rate toward the lower end of recent studies would be reasonable.

3. Regional effects

The burden of climate change will be felt most by the developing world

The effects of climate change will not be uniformly distributed across the globe and there are likely to be winners and losers as the planet warms. Applying a broad brush to climate effects, developing countries are more likely to disproportionately experience the negative effects of global warming. Not only do many developing countries have naturally warmer climates than those in the developed world, they also rely more heavily on climate sensitive sectors such as agriculture, forestry and tourism. As temperatures rise further, regions such as Africa will face declining crop yields and will struggle to produce sufficient food for domestic consumption, while their major exports will likely fall in volume. This effect will be made worse for these regions if developed countries are able to offset the fall in agricultural output with new sources, potentially from their own domestic economies as their land becomes more suitable for growing crops. Developing countries may also be less likely to create drought resistant harvests given the lack of research funding.

The increased frequency and severity of extreme weather will weigh on government budgets. The aftermath of natural disasters often falls on authorities who are forced to spend vast amounts on clear-up operations and healthcare costs that come with experiencing extreme weather. Revenue reductions may also be experienced by countries heavily dependent on tourism or on selling fishing rights, for example (IMF, 2008).

The effects on the developing world are two-fold. Firstly, as developed countries face an increasing strain on domestic budgets, fewer resources in the form of aid and economic development funds will flow to developing countries. Secondly, the governments of these nations will be forced to channel resources away from productive and growth-enhancing projects towards countering the costs of extreme weather. Such effects will damage near-term growth prospects. Furthermore, developing countries are likely to have less capacity to rebuild. The time required to recover from natural disasters will be prolonged and if longer than the frequency with which such disasters occur, many developing economies could remain in a constant state of reconstruction (Hallegatte, Dumas, Hourcade, 2010).

Parts of Africa and Asia most at risk

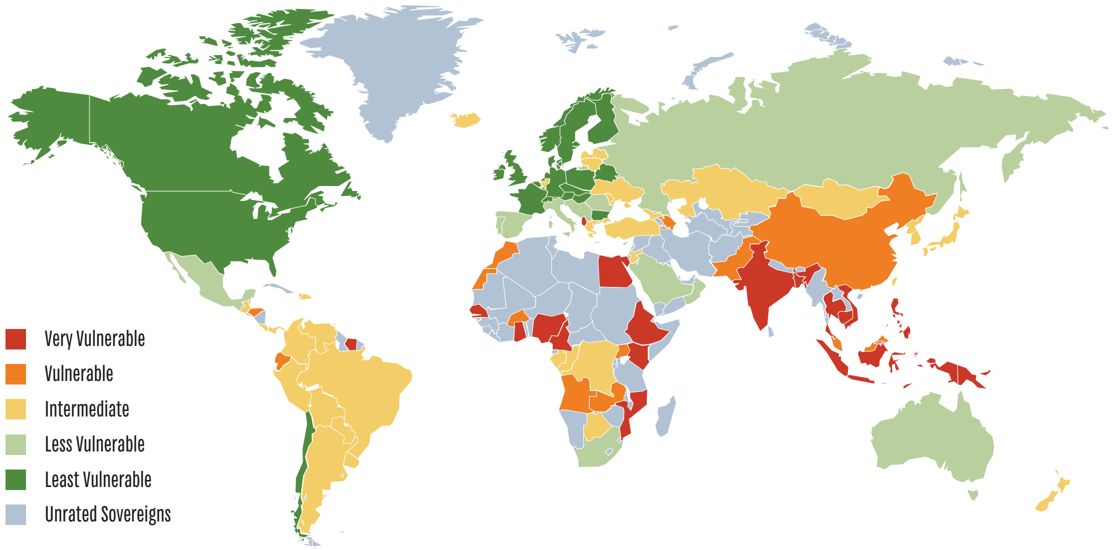
Highly vulnerable regions in the emerging world include Sub-Saharan Africa and South and South East Asia, according to the World Bank. In South Asia, cities such as Kolkata and Mumbai will face increased flooding, warming temperatures and intense cyclones. Loss of snow melt from the Himalayas will also reduce the flow of water into the Indus Ganges and Brahmaputra basins. Meanwhile in South East Asia, Vietnam's Mekong Delta, which produces most of the country's rice, is especially vulnerable to rising sea levels. For Sub-Saharan Africa, food security will be a major challenge due to droughts and shifts in rainfall.

Many developing nations are situated in low latitude countries and it is estimated that 80% of the damages from climate change may be concentrated in these areas (Mendelsohn et al 2006). In contrast, northerly regions such as Canada, Russia and Scandinavia, may enjoy a net benefit from modest levels of warming (Stern, 2006). Higher agricultural yields, lower heating requirements and lower winter mortality rates are a handful of economic benefits climate change may bring, although these benefits may diminish as warming continues.

The prediction that developing countries will be disproportionately affected is reinforced by Standard and Poor's research on the influence climate change will have on sovereign risk. Recognizing that climate change is a global mega-trend impacting sovereign risk through economic, fiscal and external performance, they find that lower-rated sovereigns appear most exposed. They assess sovereign vulnerability on three measures: share of the population living in coastal areas below five meters of altitude, the share of agriculture in national GDP and a country score from the "vulnerability index" compiled by the Notre Dame University Global Adaption Index. Such an index measures the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. Based on these measures we can interpret the results in part as the susceptibility of an economy to climate change. Figure 4 below summarizes the results on a world map. In line with much of the economic literature, many developing nations appear most vulnerable to climate change during the remainder of the current century.

Figure 4: Sovereign risk to climate change

Potential vulnerability to climate change

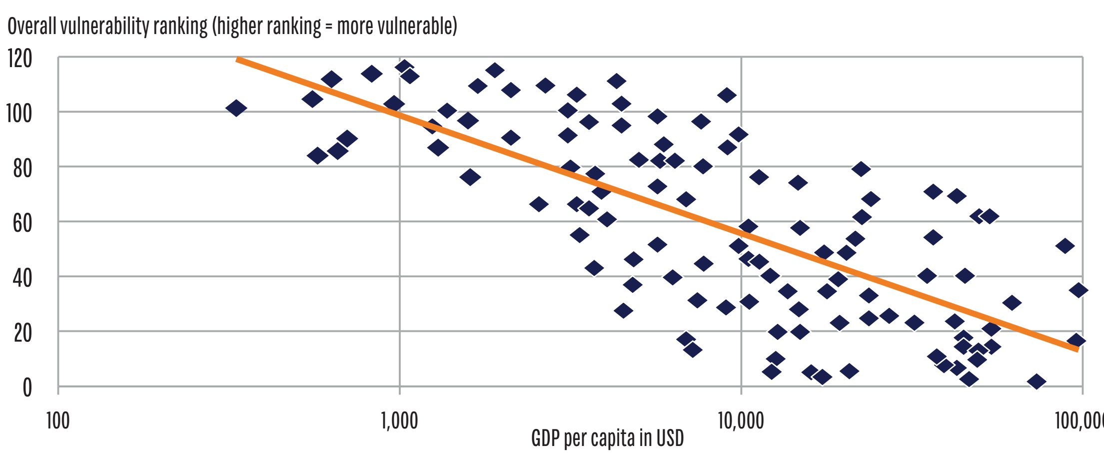


Source: Standard and Poor's, 2014

Alternatively, Figure 5 below expresses this trend of higher vulnerability among poorer countries by plotting the overall vulnerability ranking against GDP per capita for each country.

Figure 5: Sovereign vulnerability ranking vs. GDP per capita (USD)

Vulnerability to climate change is inversely related to prosperity



Source: Standard and Poor's, 2014

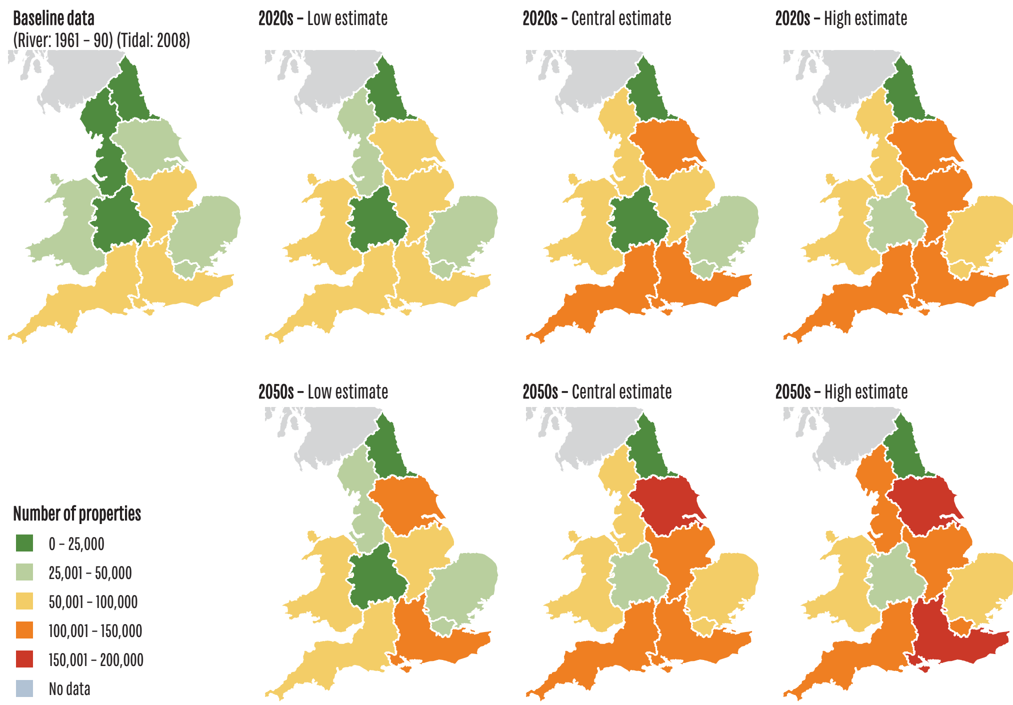
UK should fare better than developed peers

In the UK, the average temperature is now 1°C higher that it was 100 years ago and 0.5°C higher than it was in the 1970s. As a higher latitude country, it is believed that the UK will fare better than many developing nations as global warming progresses. That is not to say the nation will escape the costs of climate change – particularly given its significant coastline where rising sea levels pose an obvious threat. According to Stern (2006), estimates of the cost of floods to the UK economy as a result of 3°C - 4°C of warming are in the region of 0.2% - 0.4% of GDP annually by the middle of the century, if flood management efforts are not strengthened. In England, the south and parts of Yorkshire and Humberside are forecast to experience the greatest impact from flooding by 2050 as shown by Figure 6.

Aside from increased flooding, water availability will become progressively more constrained and droughts more frequent (Stern, 2006). Milder winters and the associated decline in cold-related mortality rates will be countered by a greater prevalence and severity of heat waves, bringing with it a higher number of heat-related mortalities. Finally, with the agricultural sector contributing approximately just 0.6% of GDP, the benefits of longer growing seasons will be marginal to the economy.

Climate change may also indirectly affect the UK economy through global supply chains. The UK may both export to and import from climate-sensitive countries. The subsequent influence of climate change in these economies may feed through to the domestic economy through lower demand for exports or higher prices of imports for example.

Figure 6: Numbers of residential properties at significant likelihood of flooding (rival and tidal) in England and Wales



Source: the UK Climate Change Risk Assessment, 2012

4. Policy responses

Climate change calls for a collective effort from governments, firms, shareholders and individuals to both adapt and implement measures to mitigate its effects. As carbon dioxide emissions are the main culprit for global warming, any policy response must effectively target reduced emissions. Since free markets fail to incorporate and price the negative externality[2] of global warming, government intervention is required to realign resource allocation. Without public policy looking to change private sector behavior, economies run the risk of continuing to pollute to a point where it is too late and the economic costs are catastrophic. Intergovernmental agreements that encompass all major economies will be the most effective in tackling climate change. Without a collective policy response, the efforts of only a handful of countries looking to reduce carbon dioxide emissions will fall short of what is needed to make a material impact on a global level. We touch upon some popular policy responses below.

Decarbonizing the world's energy supply through a rapid energy transition will reduce the risks of climate change. The use of biofuels, hydrogen and clean energy can speed up decarbonization alongside reducing demand through energy efficiency measures. Governments may offer subsidies to green energy providers to promote innovation and reduce the cost of energy from these sectors.

[2]A negative externality is a cost that is suffered by a third party as a result of an economic transaction that they were not directly involved in. Similarly, a positive externality is a benefit enjoyed by a third party who did not partake in the economic transaction from which they derive this benefit.

The Bank of England has recently committed to researching the risks to the financial system if climate regulation were to limit global temperature increases. It follows on from comments made by Mark Carney during the 2014 World Bank seminar that referenced the possibility that the majority of proven coal, oil and gas reserves could be considered "unburnable" if regulation limited temperature increases to 2°C. Among economists, it is recognized that to effectively stem the production of carbon dioxide, a globally recognized market-based approach is required. One of the most widely proposed measures is carbon pricing. Placing a price on each tonne of carbon dioxide emitted, or distributing tradable permits that license a stated level of carbon dioxide emissions, is believed to be an effective measure to combat global warming. Economically speaking, this internalizes the negative externality (in other words, ensures that the company/entity that is emitting the carbon dioxide pays for the social costs) associated with burning fossil fuels. Nevertheless, this method brings with it a host of questions primarily focused on determining appropriate emission levels, pricing and implementation measures. To work successfully it also requires global recognition. Since an estimated carbon price of $100 per tonne is believed to be needed by 2030, few countries are willing to make their economies internationally uncompetitive by introducing carbon pricing.

In their second paper, Covington and Thamotheram (2015) propose an alternative method that places the responsibility on shareholders to initiate change. Recognising that directors of fossil fuel companies are assessed, and remunerated, on short-term goals to create value, shareholders are able to use voting rights to place a greater emphasis on meeting long-term goals. One such goal would be reducing carbon dioxide emissions. By setting goals consistent with a reduction in the level of emissions, directors would be measured and remunerated on meeting these goals. Such a plan could redirect capital expenditure away from fossil fuel exploration to the development of clean energy projects. For this concept to work, Covington and Thamotheram (2015) rightly highlight that it relies on sufficiently high carbon pricing (or low emission ceilings) to make the transition economically viable. Meanwhile, investors concerned about the impact of climate change and the potential for carbon-based assets to be written down, will vote with their feet.

Monetary policy dilemma

Finally, let us briefly consider the monetary policy implications of climate change. Climate change will reduce economic growth and create higher inflation. From a monetary policy standpoint, such a stagflationary environment will place the world's central banks in a dilemma: weaker growth will bring calls to stimulate the economy, but such efforts are only likely to aggravate inflation. Monetary policy is not able to offset the shift in the supply curve and policy action will have to focus on the measures described above. The long-time horizon means that we are unlikely to see much in the way of a visible effect until much later in the century.

Conclusion

Climate change will have an impact on the global economy. Attempting to understand, let alone quantify, these impacts is, however, a particularly difficult exercise subject to great error. Despite this, from what we know today, we are able to make inferences about how global warming will influence various economic factors.

More extreme weather has the potential to weaken economic growth through damage to the capital stock and labor supply, and labor productivity will weaken as the world economy adjusts to higher temperatures. Inflation will rise through the growing cost of food, energy and insurance. Monetary policy will be limited as it attempts to combat the stagflationary pressures of climate change.

The general consensus, which is supported by a growing amount of evidence, suggests we should act sooner rather than later to avoid potential future costs. Successful mitigation policies will necessitate actions from all parties. The insurance industry is already moving to incorporate some of these costs, but without a broader co-ordinated correct policy response, the world economy is unlikely to factor in one of the greatest negative externalities ever faced.

Recognizing that quantifying the impact of climate change on shareholder's investments is critical in creating an incentive to act, we will be looking to incorporate climate change effects into an extended long-run return forecast for different asset classes.

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