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Gamechangers

How our nine themes can tackle climate change

Climate change is likely to be the defining topic of this century

We see a transformation of how we consume and produce and how our societies and economies are structured

Our nine themes will play a key role in how the world responds to and evolves alongside climate change

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Impact of HSBC themes

HSBC's nine themes will play a key role in how the world responds to and finances the climate change challenge …

Automation:
Decarbonising industry and improving efficiency

Demographics:
Migration patterns that could be impacted by climate change

Digital Finance:
Broadening out financing of climate adaptation and mitigation investments

Disruptive Technology:
New technologies can improve efficiencies and help to tackle emissions

Energy Transition:
Investment in cleaner forms of energy

Climate change and the economy

Future Cities:
Making cities cleaner and greener will be key to tackling climate change

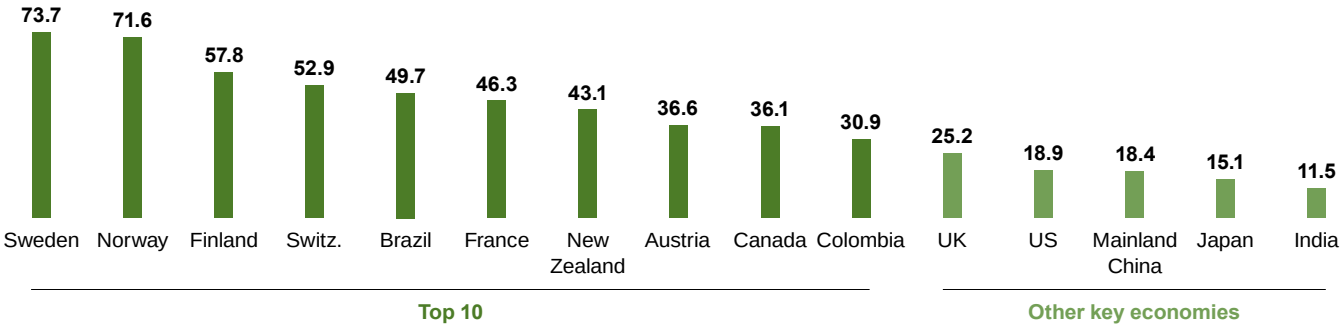
Future Consumer:
The rise of new consumption patterns such as the circular economy

Future Transport:
Investments in new transportation – be it cleaner fuel, public or cycling/walking

Lower for Longer:
Low interest rates may be necessary to fund the investments needed

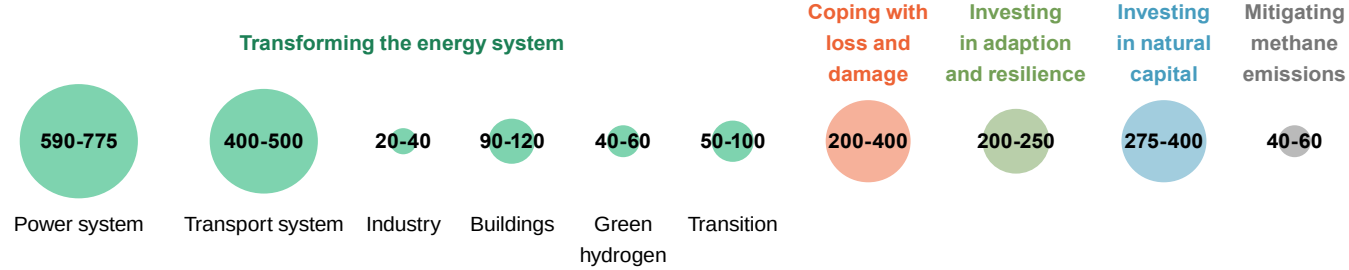
… with some economies leading the way …

Share of primary energy from renewables and nuclear (%, 2022)



… but much more investment is needed to fund the energy transition

Total investment per year by 2030e (USDbn)



Source: HSBC estimates based on data from Energy Institute Statistical Review of World Energy, 2023; Finance for climate action: scaling up investment for climate and development, Grantham Institute, November 2022

Executive Summary

What's happening?
Climate change is highly likely to be the defining topic of this century. The impact of rising global temperatures is already becoming abundantly clear after living through record-breaking global heat in 2023. The increased frequency and severity of extreme weather events, such as heat waves, flooding and wildfires, can have huge social and macroeconomic implications. But while temperature rises to date are already proving disruptive, further temperature rises appear inevitable given current concentrations of greenhouse gasses in the atmosphere and projections for global emissions in coming years.[1]

What could change?
As climate events become more common and severe, the impact that they have on lives and livelihoods, including through disruption to food supply, inflation, and activity, should only get bigger.

But all is not lost. There are many reasons to be optimistic that the world can act in ways that reduce the immense risks from higher global temperatures, in particular, temperature rises over 1.5°C, a level climate scientists say increases the risks of very disruptive and possibly irreversible climate changes. There are many things that can be done now to substantially reduce emissions and the risks of extreme and irreversible climate impacts hitting societies and economies.

What needs to be done?
Some of what the world needs to do involves significantly accelerating mitigation action – trying to increase the pace of emissions reductions – and some will involve adaptation – making the world more resilient in the face of climate changes we are already experiencing and will likely suffer in the future. While international climate change meetings aim to accelerate global action, eg, the upcoming COP28, the low-carbon transition will need to go way beyond commitments made at international meetings. On the ground, the real action will involve a transformation of how we consume and produce; how our societies and economies are structured, and how we live our lives.

In Global Research, we view today's world of disruptive, complex and rapid change through the lens of nine themes. We think these nine themes will play a key role in how the world responds to and evolves amid climate change in the coming years. All nine themes need to be considered together to really understand the transformation that is needed.

Future cities are central to the climate challenge. With the UN projecting that nearly 70% of the global population will live in cities by 2050, these urban areas will both be a hub of innovation and low-carbon activity, central to the mitigation and adaptation response across the world. But, equally, this leaves much of the global population very exposed to the impact of climate change, eg, extreme heat, if cities develop without careful planning to ensure they are sustainable and resilient. As a result, investing in a low-carbon and resilient future requires making sure that cities are well-planned.

Future transport options will be key. This is likely to involve a revolution in mobility, including more mass transit, urban designs that make walking and cycling more viable, and electrification of all forms of road-based transport including cars, vans and trucks.

Demographics will also be impacted, particularly by the risk of much higher rates of migration. We could see some dramatic changes to demographic projections if more people are displaced by extreme weather events or higher temperatures. Cities that are not sustainable and resilient could be a major source of this population displacement.

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[1] The IPCC states that global surface temperatures will continue to increase until at least mid-century under all of the emissions scenarios they consider. IPCC AR6 WGI *Summary for Policy Makers*.

The **future consumer** will likely be one prioritising sustainable products and practices. These forms of consumption are going to be needed, creating fertile ground for a greater role of re-use, second-hand products and the circular economy. Indeed, consumer preferences could shift to demand sustainable consumption, with risks for producers that are not prepared.

Energy transition is the most obvious theme linked to climate change mitigation as underpinning all of this will be the need for clean, reliable and low-cost energy, while ensuring energy security. The need to accelerate the development of cleaner forms of energy will be key in limiting the degree of global warming. While there is much work to do, there are reasons to be optimistic here, with the transition to low-carbon electricity generation in many economies arguably passing a tipping point where deployment is likely to continue to accelerate. The world now needs to ensure this transition spills over into more emerging markets and developing economies. And concerted efforts are needed to accelerate decarbonisation of other forms of energy and sectors that use fossil fuels. The electrification of passenger transport is leading this charge.

But it is a mistake to look at the low-carbon transition as only being about decarbonisation of energy in isolation. This is a transition to a low-carbon economy across industries and society and decarbonisation is inextricably linked to other secular changes.

Automation and robotics, in industry, could play a key role in decarbonising the economy. The efficiency of both capital and labour are likely to be transformed, with production having a far less damaging impact on the environment, climate and biodiversity.

Disruptive technologies that allow us to use less water, tackle transportation issues or create more virtual environments that lower the need for air travel could be key.

Digital finance could be key in terms of allowing more people access to funding in some of the most climate vulnerable parts of the emerging world. It is part of the question about financing the mitigation and adaptation action that will drive emissions lower and increase resilience. With a huge share of future emissions reductions having to come from emerging markets and developing economies, the role of mobile money and new forms of lending could play a key role in building resilience. On a broader macro level, however, much of this means more investment. This may be in the energy transition, public transport or adapting to a period of higher temperatures. The increased risks from climate shocks may mean a role for new types of insurance products, too.

Lower for longer: If de-carbonisation is mainly debt financed, it adds to the already large debt burden for many sovereigns. If the causality remains the same as the last three decades, it will likely have an impact through the debt servicing channel, weighing on future Gross Domestic Product (GDP) and neutral rates.

The upfront costs of achieving the mitigation and adaptation outcomes we need to keep global temperature rises to 1.5°C are immense. It is important how we assess these costs as many of these investments have attractive returns. It is the net dynamic economic cost that matters. Most of the cost estimates available today refer to upfront investment costs. For example, it costs around USD1bn to construct an offshore wind farm, a cost that needs to be financed. These investment needs are large, potentially 3-4% of global GDP, but they are achievable with strong government policy.

A full assessment of these investments needs to consider the full range of costs and benefits to arrive at a net dynamic economic cost of the investment. Making these investment returns even more attractive is the climate impacts they avoid. The latest modelling from forecasters such as Oxford Economics suggests climate impacts on GDP from unmanaged climate change and higher temperatures will be much higher than previously thought, increasing the costs of delaying these investments.

The rationale to act to drive mitigation and adaptation investments is clear and HSBC's nine themes are inextricably linked to making these investments happen and driving the changes

needed as described above. The world is in a precarious place with global emissions and temperatures still rising and scientists warning of immense risks and impacts. But we are also on the precipice of the greatest economic transformation the world has ever seen. A strong policy push could accelerate action and see the world pass more clean technological tipping points (rather than climate tipping points) that accelerate a transition to a more sustainable world.

It could also change the way we see the world. How we measure economic activity, how we think about progress, and what the aims are of policymakers. Climate change and the battle against it are set to reshape the economic landscape in the years to come.

The full report begins by assessing the potential impacts of climate change on the global economy, as new evidence suggests GDP impacts could be much larger than thought. It then examines what can be done by looking at the response in terms of the scale, type and distribution of investment needed to reduce emissions and transform the global economy, and the impact this could have on the world. Finally, with the help of the Theme Coordinators, we set out each of HSBC's nine themes and how they interact with climate change; together, they will all make an important contribution to the low-carbon economic change and transformation that is already underway across the world.

1. How HSBC's nine themes relate to the climate challenge

	Sub theme	What needs to be done?	What's the economic impact?
Automation	Decarbonising industry and improving efficiency	More investment in more efficient processes, machines and systems, that allows goods and services to be produced with fewer resources being used.	Investment could lift growth and broader economic activity, but this could help to lower costs for businesses (and potentially bring down inflation), with a clear potential impact in terms of employment needs.
Demographics	Migration patterns that could be impacted by climate change	Policy needs to be ready for the potential for large numbers of people needing to move within or between countries due to displacement. This could be on an international level or a within economies to be ready for arrivals.	Potentially big shocks to estimated demographic projections – which could see revisions to potential GDP growth and fiscal assumptions depending on how well integrated migrants are.
Digital Finance	Broadening out financing of climate adaptation and mitigation investments	Greater access for more people and businesses to funding for green upgrades. This could be via more people having access to borrowing tools and new platforms becoming available.	Possibly more borrowing and investment as barriers to funding come down.
Disruptive Technology	New technologies can improve efficiencies and help to tackle emissions	Breakthroughs in new technologies – be it fuels, batteries, materials or processes could help the world become greener, cleaner and combat climate change.	Big changes could alter the way the world works – if breakthroughs pulled down clean energy costs dramatically, for example.
Energy Transition	Investment in cleaner forms of energy	Much more investment in green energy across the world, as well as within electricity grids and battery storage.	A potential investment boom, that could lift material costs and lift inflation, too.
Future Cities	Making cities cleaner and greener will be key to tackling climate change	More urban policies designed to minimise emissions within cities. This could mean more investment in public transportation, cleaner buildings, cycle lanes and open spaces.	More capital investment may be needed, which could support growth, but also stoke inflation.
Future Consumer	The rise of new consumption patterns such as the circular economy	Firms will need to adapt to new models – with more sharing, recycling and reusing of products.	This could reduce GDP as it is measured – as fewer things are produced for the same level of consumption.
Future Transport	Investments in new transportation, be it cleaner fuelled, public transport or walking/cycling	A shift towards electric and hydrogen vehicles, as well as more usage of public transportation.	Impacts in terms of which markets are producers of vehicles, materials that are needed and investment needed for charging infrastructure.
Lower for Longer	If de-carbonisation is mainly debt financed, it adds to the already large debt burden for many sovereigns. If the causality remains the same as the last three decades, it will likely have an impact through the debt servicing channel, weighing on future GDP and neutral rates.	Investors should start to factor in how financing the net zero transition could affect bond valuations.	Debt financed climate spending could weigh on future GDP and neutral rates via the debt servicing channel. EM nations could see a rise in credit risk premia that offsets the fall in risk-free rates.

Source: HSBC

Climate change and the economy

- Climate change could completely alter the economic landscape…
- …affecting economic activity, livelihoods and migration patterns…
- …with some economies more vulnerable than others

The damage set to come

Global average surface temperatures have increased by 1.1-1.2°C since the pre-industrial period. Climate Action Tracker estimates, on current government policies and actions, that global temperatures will rise to around 2.7°C above pre-industrial levels by 2100. This is outside the range of human experience, with significant risks of immense climate impacts.

Climate change looks set to have a big impact on the global economy

The impact of climate change on the global economy in the years to come has scope to be enormous. We have seen all too clearly in 2023 the impact of higher temperatures and more frequent natural disasters on society – with record heat levels, wildfires and flooding becoming all too common in the news.

The impact of climate change and physical climate impacts on the economy is much harder to ascertain. We can look at the numerous channels by which these issues need to be incorporated into growth forecasts, such as the impact on labour productivity, the inability to do certain tasks or for industries to operate and the damages that come from these natural disasters. As human welfare is likely to significantly decline as a result of warming by several degrees, we would expect that the global impact is likely to be negative in terms of the implications for GDP growth. Real GDP growth is driven by investment in innovation, infrastructure and labour and resource productivity. Climate impacts will impact these key drivers.

That said, it is extremely hard to assess the exact costs or impact to the economy from climate change now and in the future because of a range of uncertainties – for example, our ability to adapt and increase resilience. However, the more global temperatures rise, the higher the likelihood that the economic cost of climate change will be sizeable and unequally distributed, impacting both growth and inflation.

What could the growth impact be?

There are multiple case studies as to how much GDP will be impacted. Early estimates, including a meta study by Andrew Moffat and William Nordhaus, reported that on a global scale, the impact of climate change would amount to a permanent reduction of global GDP by 2%[2]. This fitted with work from the IPCC, suggesting that it is reasonable to expect losses of 1-5% of global GDP with an increase of global average temperatures of 4°C (IPCC, 2007).

[2] Nordhaus, W., and A. Moffat, 2017. A survey of global impacts if climate change: Replications, survey methods and a statistical analysis. NBER Working Paper 23646 and ECB: The climate and the economy, March 2023

However, critics of these studies point out limitations of the models used to arrive at these estimates and the sensitivity of estimates to key assumptions used. For example, these models show GDP impacts against a counterfactual. These counterfactuals assume global growth rates of 2-3% pa over many decades. A 2% reduction in GDP against a counterfactual assuming an economy that is many magnitudes bigger than today is insignificant and implies it is not worth responding to climate change; we can easily cope with a 2% reduction in GDP.

More recent studies of GDP costs of climate change impacts arrive at very different conclusions. They show much more substantial impacts, largely through improving on some of the limitations of past modelling – these updates include making damage functions in the models more realistic and using more sensible discount rates.

The impact on growth could be substantial

Recent modelling by Oxford Economics shows substantially larger GDP impacts than early studies[3]. Their older modelling, using a damage function based on average temperature levels, found that if global warming increased from 1.1°C today (compared to the pre-industrial level) to 2.2°C by 2050, this would reduce GDP levels in 2050 by only 1% (compared to baseline). In an updated study, the authors changed the damage function to consider temperature trends, volatility and likelihood of extreme climate impacts. Their new damage function shows that the world is already at an economic tipping point, with labour productivity growth falling rapidly as temperatures rise beyond current levels of warming. They now find that a 2.2°C temperature rise by 2050 could reduce global GDP by up to 20% (compared to baseline), not 1%. It shows that the world appears far more vulnerable to climate impacts than most governments, corporates and investors realise.

Second, it is also clear that the costs will not be distributed evenly and they will hit certain regions particularly hard. For example, Burke et al[4] show that in year 2100 with unmitigated climate change GDP per capita in Sub-Saharan Africa will be 80% lower.

Different regions will be affected differently

The effect of climate change on GDP appears to be non-negligible and will likely hit poorer regions of the world particularly hard. Dell et al[5] use historical fluctuations in temperature within countries to identify their effects on aggregate outcomes. As a ready-reckoner, they find that a 1°C rise in the temperature reduces the economic growth rate in that year by 1.3ppts in lower-income economies. In rich countries, however, changes in temperature are not found to have a robust discernible effect on growth. However, Colacito et al[6] find a contrasting result – with a negative effect on the growth rate from higher temperatures for the United States.

The nature of shocks could be extremely damaging in some regions

Analysis from the Swiss Re Institute suggests that under a severe scenario (temperature rise by 3.2°C by 2050), global GDP losses can go as high as 18%. However, under scenarios of smaller increases in temperatures, losses would likely be smaller, although still 4% of GDP even if the Paris Agreement targets are met. Asian economies are likely to be more impacted, with a greater impact for ASEAN economies, with the region being more susceptible to adverse weather events, leading to land and infrastructure loss. Mainland China is at risk of losing nearly 24% of its GDP in a severe scenario, compared to forecast losses of 10% for the US, Canada and the UK, and 11% for Europe.

The biggest challenge, however, is that these impacts are non-linear. When we hit various tipping points in terms of CO_2 concentrations in the air, temperature rises or a certain frequency of natural disasters, the impact on economic activity can become very large, very quickly. The accepted wisdom from economist-led studies appears to be that, while the total cost to the economy from climate change is highly uncertain, it has the potential to be very large.

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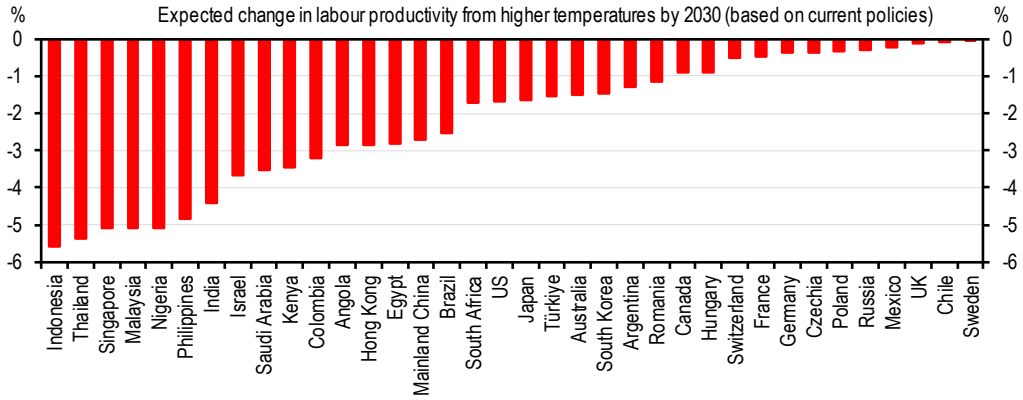
[3] Winter, D. and Kiehl, M. (2022) Temperature volatility comes at a price to worldwide growth. Research Briefing, Global. Oxford Economics, December.
[4] Burke, M., Hsiang, S., and E. Miguel, 2015. Global non-linear effect of temperature on economic production. Nature 527(7577), 235–239.
[5] Dell, M., Jones, B., and B. Olken, 2012. Temperature shocks and economic growth: Evidence from the last half century. American Economic Journal: Macroeconomics 4, 66–95.
[6] Colacito, R., Hoffman, B., and T. Phan, 2019. Temperatures and growth: A panel analysis of the United States. Journal of Money, Credit and Banking 51, 313–368.

Inflation could be lifted by supply challenges

On the inflation front, climate change creates many more supply risks. Starting with the impact of higher temperatures, a dataset from Climate Analytics, a non-profit think tank, outlines the impact on productivity across a wide range of economies – as highlighted in chart 1 – based on current temperature expectations. The impact on labour productivity from businesses being unable to fully function or workers having to limit working hours could be sizeable in those economies where temperatures are most likely to keep rising based on current climate policies. As our ESG team cited in *Heat stress: More heat, more stress, more workplace regulation*, 23 June 2022, the ILO projects that, by 2030 (and assuming a global temperature increase of 1.3°C), the equivalent of more than 2% of total working hours worldwide will be lost every year, either because it is too hot to work outside or because workers have to work at a slower pace. In Southern Asia and Western Africa, the figure could reach 5% and, overall, vulnerable workers in developing countries will be most affected.

1. Productivity losses from higher temperatures could be significant

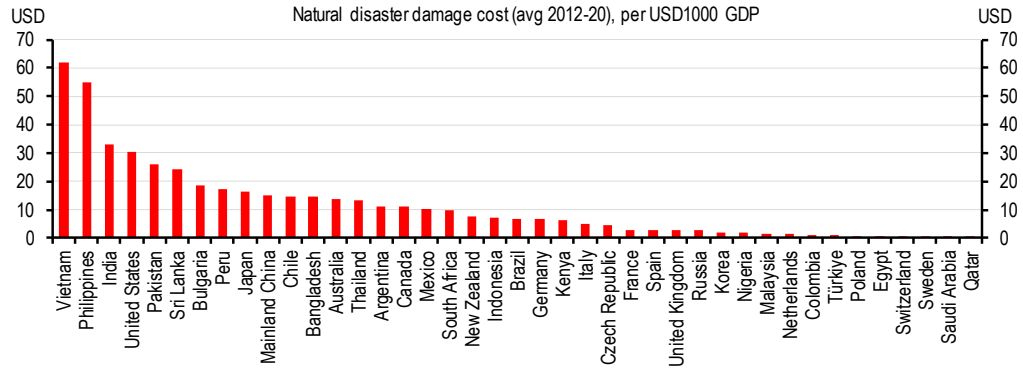


Source: Climate Analytics: Climate Impact Explorer. Note: Based on the baseline scenario used by the Network for Greening the Financial System which sees temperatures rising by 1.5°C by 2035.

Given the impact that drops in productivity can have on the growth-inflation trade-off, this is a key risk for the global economy on both sides of that ledger. The impact is likely to spread beyond productivity, though – with climate change likely to have more wide-reaching supply impacts.

Some of this may be through a greater prevalence of supply shocks that come from natural disasters – which are likely to see an even greater cost in much of the world in the years to come. This could be that we see one-off shocks that disrupt supply chains, either in the short term, or mean that supply chains need to be rejigged. Given the risks being concentrated in many key markets for global supplies of goods (chart 2), this risk could be substantial.

2. Natural disasters already have a notable impact on GDP in many parts of the world

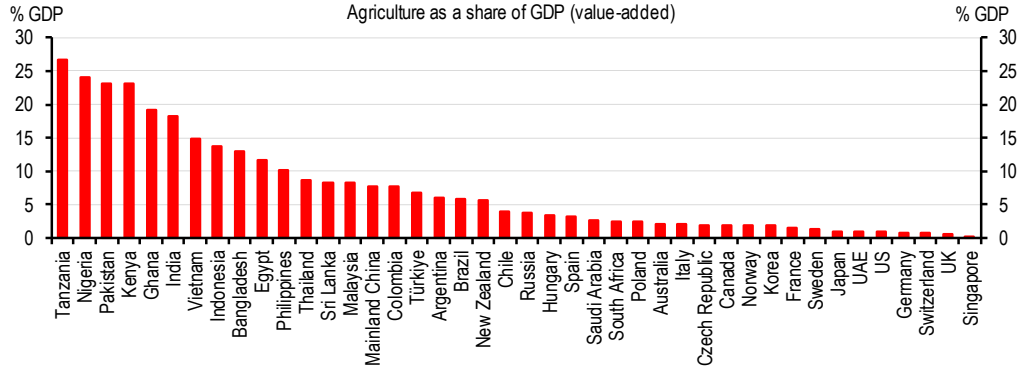


Source: EMDAT (Emergency Disasters Database), United Nations

The impact of climate change on food prices could be notable

On top of this, agricultural yields are sensitive to extreme weather conditions. During the last six decades, we have seen three periods of significantly high food prices (1970s; 2007-08; and 2010-14) triggered by adverse weather shocks. Rising food prices may come through reduced land availability from rising water levels, with the UN Agricultural Outlook 2023-2032 report[7] highlighting that climate change and environmental policies are expected to cause more uncertainty over food prices and could well mean higher prices in the years to come. For more, see *The Future of Food*, 12 November 2023.

3. Some economies, typically in areas more vulnerable to climate shocks, are very reliant on agriculture



Source: World Bank

Shocks can be even more severe than economic ones

The risks extend beyond these simple macroeconomic shocks, too. Examples of what really matters include loss of lives and livelihoods, mental and physical stress, injury and trauma, forced migration, and so on. Direct and cascading climate impacts are also hard to capture on a spatial scale useful for decision making, for example, flash flooding that leads to destruction of agricultural land, that triggers food shortages, inflation and famine. These impacts are difficult or impossible to capture in an economic model that involves forecasting many decades ahead with extreme uncertainty. We could see many people displaced, having to move from one area to another – possibly across borders – due to the impact of climate change, as we outlined in *Climate Change and Migration: A potential shock to demographic projections*, 25 May 2023.

Clearly, the path we're on is likely to mean a more challenging global economic backdrop in the years to come – but things can change, and that's what we look at next.

[7] OECD-FAO Agricultural Outlook 2023-2032, 6 July 2023

What needs to be done?

- Much investment is needed to alter the path of temperature rises
- This could prove to be out of reach, but, if delivered, could support the global economy…
- …with investments in energy, automation and efficiency key

As things stand, the impact of climate change on the global economy is likely to be substantial, even if precise numbers are hard to compute. But, there could be some reasons for hope, at least on the economics front, thanks to structural changes – which is where our nine themes come in.

What needs to be done

In simple terms…

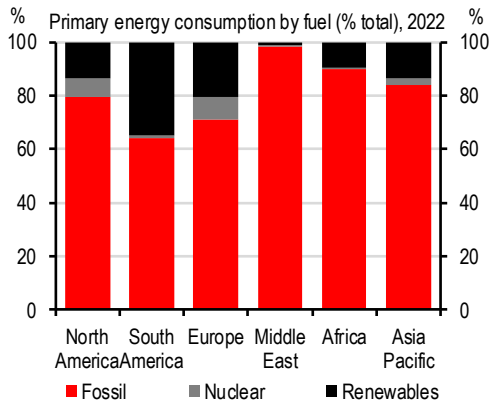
We need to see more spending. The world needs to fight the climate challenge – and that's going to need a sea-change in the economy in terms of investment across sectors.

A lot of power investment is needed

Some of these needs are obvious – the energy transition is at the heart of this. We need to see more investment in grid power generation on a macro level, but at a micro level, investment in local forms of energy production or more efficient systems will be key – think solar, wind and heat pumps.

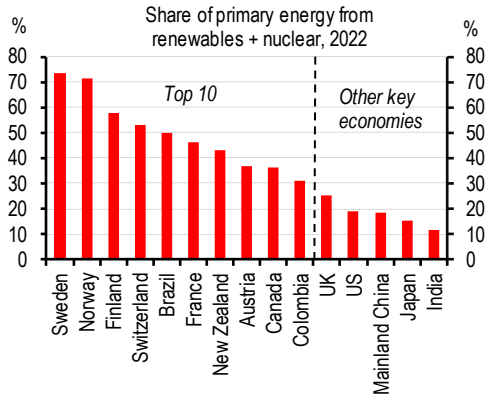
Looking at energy, we can see how the world relies on fossil fuels still, based on data from the latest Energy Institute Statistical Review of World Energy. In 2022, roughly 82% of world primary energy came from oil, natural gas and coal, with a bit of geographical split, as shown in chart 4. In Latin America, the widespread usage of hydroelectric power is key to the good scores, and the same is true in Scandinavia, where renewable energy makes up the largest share of total energy usage.

4. The world still relies on fossil fuels…



Source: HSBC based on data from Energy Institute Statistical Review of World Energy, 2023

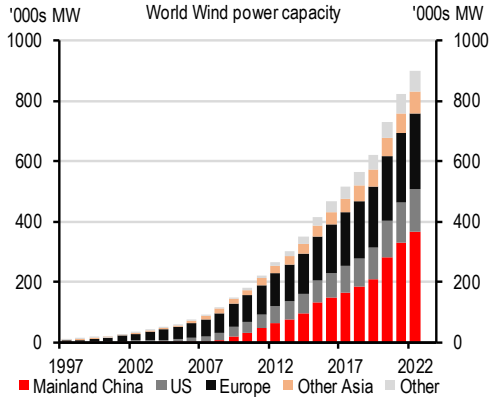
5. …but some economies are leading the way



Source: HSBC based on data from Energy Institute Statistical Review of World Energy, 2023

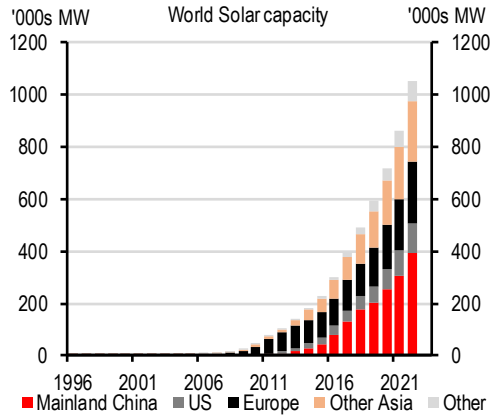
So, globally, while the share of renewables is still too low, progress is being made. The amount of wind energy capacity globally grew by 10.6% in 2022, and solar grew by 22.2%, with the fastest growth rates coming in mainland China, India and parts of Africa and the middle east. This has carried on in 2023 – with an astonishing pace of solar rollout in mainland China, estimated to be up 43% in the first seven months of the year, based on data from the National Energy Administration. Even if capacity in the rest of the world doesn't change, the amount of global solar capacity would rise by 9% just on the investment by China alone in these first few months of the year.

6. Wind energy installations have accelerated…



Source: Energy Institute Statistical Review of World Energy, 2023

7. …and solar, too



Source: Energy Institute Statistical Review of World Energy, 2023

Roughly 2% of global GDP per year

The degree of investment needed for this energy transition is likely to be sizeable, and varies depending on the targets that economies have in terms of how renewable energy mixes need to look in the future. As a benchmark, the International Renewable Energy Agency (IRENA) estimates that the global economy will need to invest around 2.0% of its GDP per year in decarbonisation solutions to achieve a full energy transition by 2050.

Our Asian Economics team looked at how these costs could range across the region, and we have used a similar method to give a back of the envelope estimate of the degree of investment needed to get the level of global spending on renewable energy between now and 2035. If we assume that electricity will need to provide 45% of energy demand by then, according to BP and IEA estimates of what is needed to achieve net-zero targets, we can look at how much investment is needed in different economies to be able to lift renewable output enough to provide a given share of total energy[8].

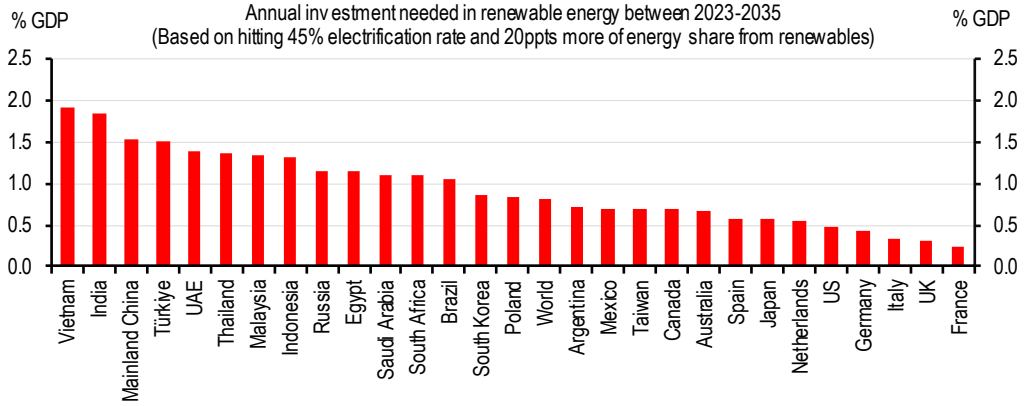
How much investment by economy?

While there are many scenarios we could model, we have put a very simple indicative one below to show the rough rankings of where most investment will be needed. We could have looked at lifting the energy that comes from renewables share to a given percentage, but to make it more equal across economies we have looked at the costs associated with the required extra renewables power to get 20ppts more of total electricity from renewables and electricity providing 45% of power in the economy. Those with a relatively large share of electrification in the economy already (such as in Europe) face lower costs, while the assumption of the same installation cost in each economy will help out richer ones here, and they may see higher costs than indicated.

[8] We also use costs of installation from the International Renewable Energy Agency's (IRENA) 2022 Renewable Power Generation Costs report.

In reality, this scenario is not enough: more needs to be done – and most models look for the world to become much more electrified and with a larger share of that electricity coming from renewables, as we outline below.

8. Investment needs are substantial, even in very mild scenarios



Source: HSBC estimates based on data from Energy Institute Statistical Review of World Energy, 2023. Note: This only estimates upfront installation costs of power generation.

Grid investment needs are vast, too

As well as investments in energy generation, the result of electrification is higher power demand, and a consequence of more variable wind and solar power is rising imbalances on production and consumption of energy. Hence, there is a rising urgency to accelerate investment in power grids to handle greater levels of variable power flow and to accommodate higher power consumption. Grid expansion is also necessary to transport energy generated in decentralised locations over sometimes long distances. According to Bloomberg New Energy Finance (BNEF), some USD21trn of global investment is required in power grids to 2050, from a base of USD300bn in 2022.

However, this vast amount of money – roughly 2% of global GDP per year – is not the sort of amount that can be easily found down the back of the sofa. While at least some of this investment will come from the private sector, governments with already stretched fiscal situations will have to think carefully about the funding of some of this investment.

Huge fiscal costs, potentially

For example, estimates from the OBR in the UK (chart 9) show the fiscal cost of the net zero transition between 2020 and 2050. While the impact is relatively small in the short term, the cost builds in the years to come, estimated to add 20ppts of GDP in public debt. However, only 6ppts of this is in terms of investment needs – on buildings and other public spending – and is a tiny share of the broader likely increase in public debt in the years to come, mostly due to substantial demographic change.

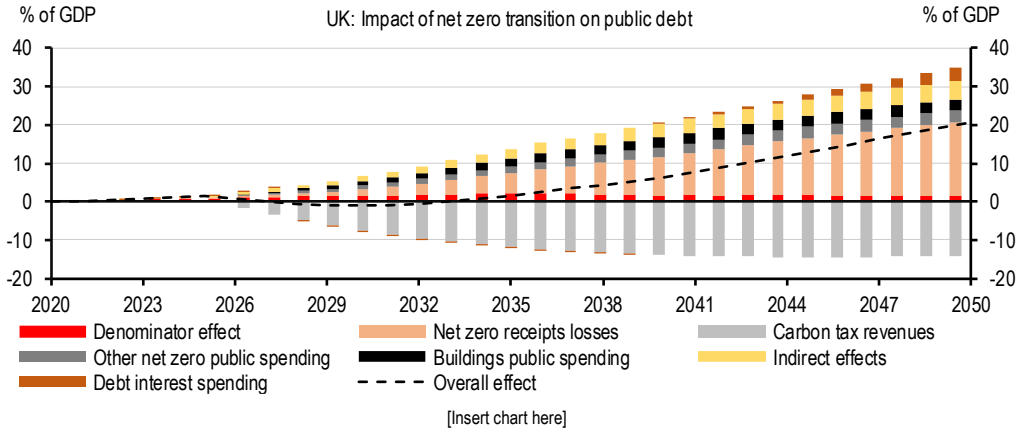
But, it needs to happen. Global investment needs to be increased and sustained above pre-pandemic levels by around this roughly 2% of GDP pa over this decade if the world is going to make substantial progress on the energy transition. For G7 countries, this would amount to an additional investment of around USD1trn per year from now until 2030.

Some of this may be part of the replacement cycle

It is also important to consider the full net dynamic economic costs of these investments. Most of the figures reported refer to upfront investment costs. While these are large, they are not too far off the global depreciation cycle, meaning we would have to make similar levels of investment anyway to modernise and replace existing assets as they age and deteriorate. There will be a “green premium” for many of the necessary green investments, compared to high carbon equivalents, however, this is declining over time as innovation and learning-by-doing drives upfront costs down. Against these upfront costs, we also need to consider other factors such as fuel savings from moving away from fossil fuels and other public goods such as

benefits from reduced air pollution, which leads to around 40,000 premature deaths in the UK alone each year and many millions around the world. We also need to consider costs of delaying climate action, given the impacts we describe above are likely to be substantial. As famously stated by Ottmar Edenhofer, a leading climate change economist, when discussing this calculus, climate change is not a free lunch but it's a lunch worth paying for.

9. Estimates suggest that the need to spend could lift government debt levels substantially



Source: OBR

Urban areas will be key

It's not just about energy. Cities will be at the heart of the fight against climate change – with urban areas absolutely key in the battle. Cities are typically more exposed to the impacts of climate change than rural areas, with most cities being close to bodies of water and vulnerable to rising sea levels, or exposed to more heat stress due to the microclimates that exist in urban areas.

Cities and new urban designs could play an important role

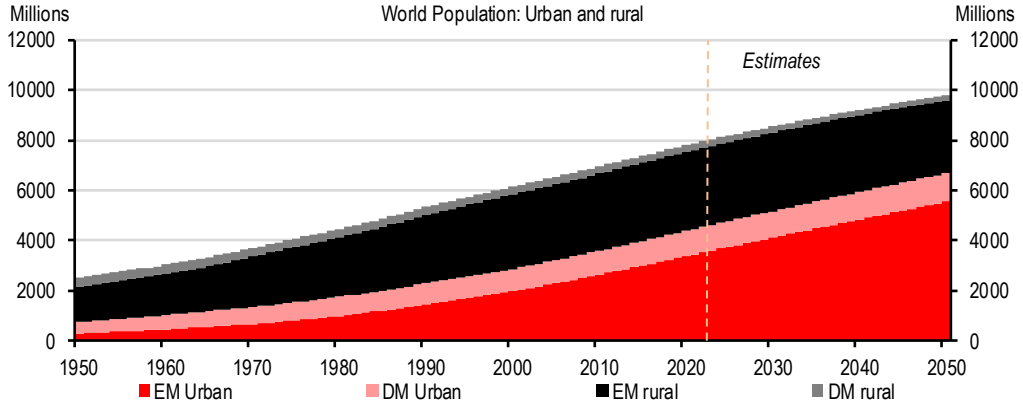
Investment here will take multiple forms – making cities easier to travel around, reducing car journeys, improving public transit and investing in liveable cities that have more open space. Estimates suggest this investment alone could require more than USD2.7trn per year, globally, to enable this transition. An estimate from the C40 cities initiative suggests that the just-shy of 100 cities in its scheme would need USD208bn of investment per year to move towards zero-emission public transport. The future of transport is going to be absolutely crucial in the fight towards net-zero.

Urban design will be key, too, in order to make cities work efficiently and reduce their climate impact. Fifteen-minute cities, which allow more journeys to be taken by foot, bike, or public transit, helping to cut urban congestion, could gain more prominence in much of the world. This style of urban design simply means that many fewer journeys are needed to be taken by cars, and can be replaced by foot or bicycle, improving quality of life and local air quality. Despite some opposition to the idea of the concept, it's likely to become embedded into city planning in the years to come.

Much more need in EM

Importantly, however, with the evolving shape of global urbanisation, with more of the world's population living in cities in emerging economies, typically with less-developed public transit, the investment needs are only going to grow and grow. Estimates from the UN suggest that more than half of the world's population will live in EM cities in 2035, up by 5ppts from today and from 30% at the turn of the century (and 70% by 2050). This part of the world is where much of the future investment needs are going to be concentrated.

10. The world's population is set to become more urban, particularly in the emerging world



Source: UN Urbanisation Prospects

A number of fast-growing cities will need even more investment

As the world's population shifts even further towards these urban areas, the need to make sure that they can function well is key, and with that comes a huge role in tackling climate change. Some of the world's mega cities are chronically underinvested when it comes to infrastructure, with Dhaka and Lagos having skeleton metro networks and none at all in Kinshasa and Karachi. Four of the world's biggest 12 cities by 2035 currently don't have widespread networks of trains to get around them.

11. The world's largest cities will need more infrastructure investment

World's largest cities in (population in millions):

	2022			2035		
1	Tokyo	Japan	37.3m	Delhi	India	43.3m
2	Delhi	India	32.1	Tokyo	Japan	36.0
3	Shanghai	Mainland China	28.5	Shanghai	Mainland China	34.3
4	Dhaka	Bangladesh	22.5	Dhaka	Bangladesh	31.2
5	São Paulo	Brazil	22.4	Cairo	Egypt	28.5
6	Mexico City	Mexico	22.1	Mumbai	India	27.3
7	Cairo	Egypt	21.8	Kinshasa	D. R. Congo	26.7
8	Beijing	Mainland China	21.3	Mexico City	Mexico	25.4
9	Mumbai	India	21.0	Beijing	Mainland China	25.4
10	Osaka	Japan	19.1	São Paulo	Brazil	24.5
11	New York	US	18.9	Lagos	Nigeria	24.4
12	Chongqing	Mainland China	16.9	Karachi	Pakistan	23.1
13	Karachi	Pakistan	16.8	New York-	US	20.8
14	Istanbul	Türkiye	15.6	Chongqing	Mainland China	20.5
15	Kinshasa	D. R. Congo	15.6	Kolkata	India	19.6
16	Lagos	Nigeria	15.4	Lahore	Pakistan	19.1
17	Buenos Aires	Argentina	15.4	Manila	Philippines	18.6
18	Kolkata	India	15.1	Osaka	Japan	18.3
19	Manila	Philippines	14.4	Bangalore	India	18.1
20	Tianjin	Mainland China	14.0	Istanbul	Türkiye	18.0
21	Guangzhou, Guangdong	Mainland China	14.0	Buenos Aires	Argentina	17.1
22	Rio de Janeiro	Brazil	13.6	Guangzhou, Guangdong	Mainland China	16.7
23	Lahore	Pakistan	13.5	Tianjin	Mainland China	16.4
24	Bangalore	India	13.2	Chennai	India	15.4
25	Shenzhen	Mainland China	12.8	Shenzhen	Mainland China	15.2
26	Moscow	Russia	12.6	Rio de Janeiro	Brazil	14.8
27	Los Angeles	US	12.5	Luanda	Angola	14.5
28	Chennai	India	11.5	Hyderabad	India	14.2
29	Bogotá	Colombia	11.3	Los Angeles	US	13.8
30	Paris	France	11.1	Jakarta	Indonesia	13.7

Source: UN Urbanisation Prospects

And this highlights how much of the global investment needs are likely to be in the emerging world. These are the regions, typically, with more ground to make up in terms of their energy mix, too, and so investment needs are likely to be greater as a share of GDP than in the developed world.

Investment needs across the emerging world could be massive

A report from the Grantham Research Institute on Climate Change and the Environment in May 2022 estimated that, given the need for continued improvements in human and physical capital, the aggregate investment and development spending in EM economies (excluding mainland China) would need to increase from 11.3% of GDP in 2019 to 15.1% in 2025 and 18.2% in 2030. This increase is equal to USD1.3trn by 2025 and USD3.5trn by 2030. The authors acknowledge that this scaling up of spending is unprecedented but suggest that it could be feasible with contributions from both private and public sources.

12. Investment will have to ramp up in the emerging world, too

Investment needs per year for sustainable development and climate action for EMDCs (other than China)

	2019		2030		Gap (2030-2019)	
	USDbn	% of GDP	USDbn	% of GDP	USDbn	% of GDP
SGD related investment	2385	11.3	5880	18.2	3500	6.9
of which climate and related investment	450	2.1	2250	6.9	1800	4.8

Source: Financing a big investment push in emerging markets and developing economies for sustainable, resilient and inclusive recovery and growth, Grantham Institute, May 2022

Investment spreads beyond energy

Investment spending goes beyond transport and energy, though; another report from the Grantham Research Institute on Climate Change and the Environment[9] highlights water and sanitation and telecoms as other areas of investment to allow the transition to net zero to be possible. The paper highlights various historical estimates of the global investment needed, with the estimate produced equal to USD7.4-7.9trn, equal to roughly 7% of global GDP as of 2023.

13. Estimates of global physical investment capital needs

USDtrn, per year by 2030	SYSTEMIQ (2021)	NCE (2016)	Battacharya (2016)	OECD (2017)
Energy	2.8-3.3	3.3	3.9	2.1
Transport	2.7	1.0	2.0	2.7
Water and Sanitation	0.9	1.5	0.9	0.9
Telecoms	1.0	0.5	1.0	0.6
Total	**7.4-7.9**	**6.3**	**7.8**	**6.3**

Source: Grantham Research Institute on Climate Change and the Environment, Investments for Green Recovery and Transformational Growth 2020–30, June 2021

For emerging markets and developing countries other than China, those spending needs are huge. Based on estimates from the Independent High-Level Expert Group on Climate Finance, spending will need to reach around USD1trn per year by 2025 (4.1% of GDP compared with 2.2% in 2019) and around USD2.4trn per year by 2030 (6.5% of GDP), on the specific investment and spending priorities outlined in table 14 below. There's a lot of investment that needs to happen. Mobilising that investment is a major topic in itself – see below in the section "How do we pay for it" for more discussion.

[9] Grantham Research Institute on Climate Change and the Environment, Investments for Green Recovery and Transformational Growth 2020–30, June 2021

14. Investment needs by 2030 (annual spending as of 2030)

Categories of investment			Needs by 2030 (USDbn)
Transforming the energy system	Power system	Zero carbon generation	300-400
		Transmission and distribution	200-250
		Storage and back-up capacity	50-75
		Early phase out of coal	40-50
	Transport system	Low emission transport infrastructure	400-500
		Fleet electrification/hydrogen	100-150
	Industry	Energy efficiency	10-20
		Industrial process	10-20
	Buildings	Electrification	20-40
		Energy efficiency and GHG abatement	70-80
	Green hydrogen	Production	20-30
		Transport and storage	20-30
	Just transition	Targeted programs and safety nets	50-100
Coping with loss and damage			200-400
Investing in adaptation and resilience			200-250
Investing in natural capital		Sustainable agriculture	100-150
		Afforestation and conservation	100-150
		Biodiversity	75-100
Mitigating methane emissions from fossil fuels and waste			40-60
Total investment needs per year by 2030			USD 2-2.8trn

Source: Finance for climate action: scaling up investment for climate and development, Grantham Institute, November 2022

Businesses doing the right thing

Some of this will come from the private sector

Some of the huge investment needs will fall on the private sector, in particular, industry, as they transition to low-carbon and more efficient production processes. Here there is hope, driven by the need to satisfy various emissions and resource use targets and to incorporate digitisation and automation in production. Business also needs to appeal to investors and consumers as their preferences shift towards low-carbon options. We could see a huge amount of investment from businesses as they green their operations.

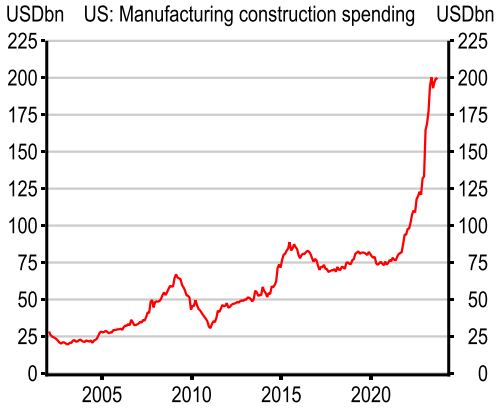
Some of this may go unnoticed, with business investment that may have been spent on typical upgrades to machinery or new plants being swapped to more efficient equipment that can help with progress towards net zero. In the US, business fixed investment in equipment is roughly USD1.2trn per year, and so some of this being diverted to green investments across the world could help to bridge the gap.

More investment will be pushed to be green

New regulations, including green taxonomies, will improve transparency and credibility around green investment by business, helping stakeholders make more informed investment and purchasing decisions. The EU taxonomy, for example, is now in force and companies are reporting their share of turnover, capex and opex that is “green” and aligned with taxonomy activities for the first time (the EU taxonomy lists activities that are “green” and contribute to Europe’s net zero 2050 goal).

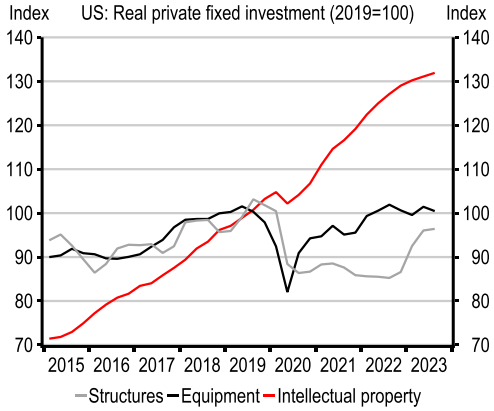
As well as this type of shifting to green investments in existing industry, the green transition will require a huge amount of investment in new industries. Some of that investment is clear in the recent data – with the most striking being the impact of the Inflation Reduction Act and CHIPS Act in the US on driving manufacturing investment (chart 15). While this manufacturing will be broad-based to a degree, the subsidies on electric vehicles and batteries will mean much of this investment increase is likely to be concentrated in these sectors over the coming few years.

15. The Inflation Reduction Act has stoked manufacturing spending…



Source: Macrobond

16. …and more investment has been coming in equipment and IP



Source: Macrobond. Note: Intellectual property includes software and research and development (R&D).

Technological progress can make industry greener

Technological investments can help, too – with software and Research & Development (R&D) key parts of the recent investment story and inextricably linked to decarbonisation; this is particularly evident in the US (chart 16). Looking at disruptive technologies, there are a number of channels where technological investment by firms can make a difference. For example, a 2021 report by Vodafone found the UK could cut its overall emissions by up to 4% per year by adopting Internet of Things (IoT) technology in manufacturing, transport and agriculture, while smarter factories can boost energy efficiency of manufacturing process, leading to 3.3m tonnes of CO_2 being saved per year[10]. This technology can also enable smart buildings, and British design and engineering company Arup has a product called Neuron, which uses IoT sensors and 5G to analyse a building's energy usage data in real-time to optimise heating systems[11] – it's estimated the product could save between 10-30% of energy used in a typical commercial building[12].

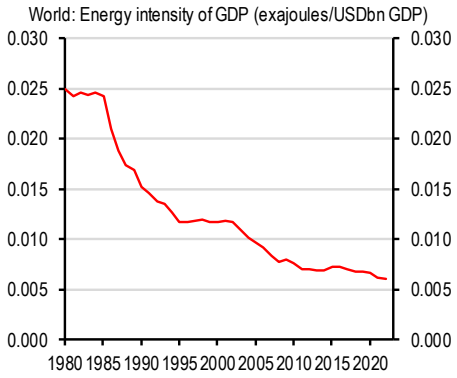
AI can also be used to design energy efficient buildings, transport networks, and infrastructure projects. For instance, a study by Microsoft showed that AI applications across agriculture, water, energy, and transport could lead to a 4% cut in GHG (greenhouse gas) emissions by 2030[13].

Automation and efficiency gains will play a role

This could lead us towards a more energy efficient economy – so we tackle the climate challenge from both sides – using less energy and making sure that what we produce is from greener sources. If we can improve the productivity of how we produce goods, the energy intensity of the economy can drop further, helping to reduce emissions. Over an extended period of time, economic growth has become less energy intensive and, if these technological developments can help on that front going forwards, net-zero targets may be more in reach than we may have previously thought. Indeed, as GDP growth is achieved by reducing inputs per unit of output, significant improvements in resource efficiency could enable the world to achieve deep decarbonisation and a more sustainable future and keep growing.

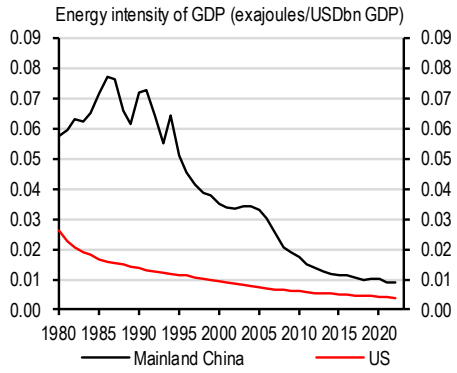
[10] Tech could significantly cut emissions and be a driving force behind the UK achieving its net zero targets, Vodafone, 14 September 2021
[11] How AI can help the environment, DW, 19 April 2023
[12] Climate Change and AI, Global Partnership on AI, November 2021
[13] How AI can help the environment, DW, 19 April 2023

17. The world is able to do more with less energy…



Source: Energy Institute Statistical Review of World Energy, 2023, IMF, HSBC

18. …with some convergence happening across the world



Source: Energy Institute Statistical Review of World Energy, 2023, IMF, HSBC

But what about a re-think?

What is success?

One solution for the world is to change how it understands growth. Traditionally, the focus has been on GDP growth, levels of industrial output and relentless consumption of goods and services. By supplementing GDP growth with a broader set of welfare indicators that incorporate physical, natural and social capital, this could enable the world to achieve a much more sustainable path that boosts welfare (and possibly also a narrower traditional measure of GDP growth, as described above).

Within a new and expanded definition of welfare and growth, the circular economy is going to play a key role – with more products being reused, recycled and shared – lowering the amount that we consumer in terms of natural resources and the number of units that come off production lines.

This creates some huge challenges for businesses, though, as this does not imply change around the margins. It threatens a radical re-think of how the economy works. Take cars, for example. Today, the average passenger car in the UK is only used 4% of the time[14] – the rest of the time it is sat idle. In a world where cars are shared, rather than owned, we could see the size of the global car fleet drop by a third based on some studies[15].

New ways of living and consuming could bring social benefits

That brings with it several spillovers – fewer cars being produced, less demand for the materials involved, less space needed for car parking and potentially a re-design of how we think about homes (possibly without driveways or car parking), roads and urban areas. On the flip side, that frees up considerable resources for new growth areas of the economy as they emerge in coming years, if they are low-carbon growth areas.

Progress on the circular economy has been disappointing

A future model of consumption looks almost certain to involve more circularity across these various channels. The circular economy has substantial room to grow within a number of processes. However, in recent years, the numbers have gone into reverse: Rising material extraction has shrunk global circularity: from 9.1% in 2018, to 8.6% 2020, and now 7.2% in 2023, according to The Circularity Gap Report 2023[16], despite more recycling and reusing processes becoming available.

[14] RAC, Cars parked 23 hours a day, 8 July 2021
[15] Three Revolutions in Urban Transportation, UC Davis, May 2017
[16] Circle Economy, The Circularity Gap Report 2023

New consumer patterns could emerge

The report highlights several ways in which the way we use manufactured goods can change to enable more circularity, such as:

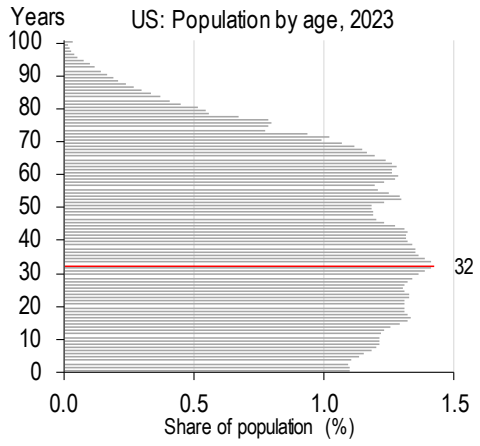
- Swapping fast fashion for sustainable textiles and ensuring that all used clothing should be reused or recycled. Second-hand clothing reselling is a great example of the circular economy in action.
- Shifts towards buying what we need – so moving to service-based business models like sharing or pay-per-use are recommended. This is part of the economy that could be ripe for growth, and may prove to be popular with younger generations, particularly those that live in densely-populated urban areas living in closer proximity to other people.
- Extending the lifetime of machinery, equipment and goods. This may include regulations over the minimum guarantee of products, which can lessen the costs of repairing, remanufacturing, upgrading and reusing goods. Items being repaired and refurbished more commonly seems likely.

How possible is this?

Such shifts in the growth model may be possible, but it needs changes in the mindsets of consumers. We believe this may be more plausible than many may think at first, and it comes down to demographics. In aggregate, people aren't fans of paying more for more sustainable products – for example, our latest *UK: Anatomy of the consumer 2023* report (23 March 2023) showed 48% of respondents were unwilling to pay more for sustainable fashion and 44% with no interest in the idea of rental clothing models.

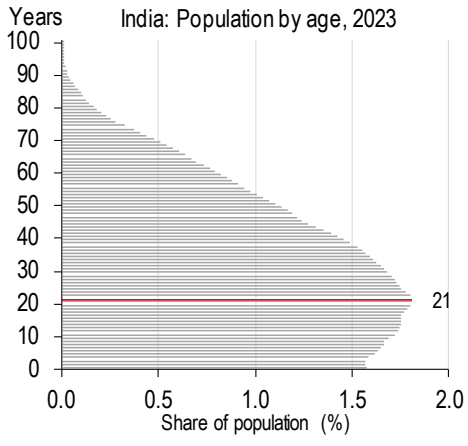
But, many surveys show a generational difference. A wide-ranging survey from First Insight and the Baker Retailing Center at The Wharton School of the University of Pennsylvania[17] in 2022 showed growing momentum for sustainable purchases, with Generation Z influencing other generations towards sustainability. If this demographic transition accelerates the shift in consumers' focus towards more sustainable consumption patterns, these new models could become more widespread more quickly.

19. The US modal consumer is at a key age to drive taste changes…



Source: UN Population Division

20. …and the world's most populous economy may see big changes in coming years



Source: UN Population Division

[17] The state of consumer spending: Gen z influencing all generations to make sustainability-first purchasing decisions, First Insight and the Baker Retailing Center at The Wharton School of the University of Pennsylvania, 2022

On top of this demographic shift possibly accelerating the shift towards more sustainable products, there is a high chance that it also leads to more digital adoption – such as virtual reality and the metaverse. While momentum may have appeared to have softened for the metaverse concept, it could allow more people to work remotely, travel virtually, and learn from home – all of which can cut transport emissions. If adopted by more than 90% of the US population by 2050, as on some estimates, researchers at Cornell University[18] suggest this could reduce GHG emissions by 10 gigatons via alleviating air pollution, reducing transport and commercial airline usage, and shifting energy demand from offices to residences.

How do we measure economic success?

Is GDP the best number to look at?

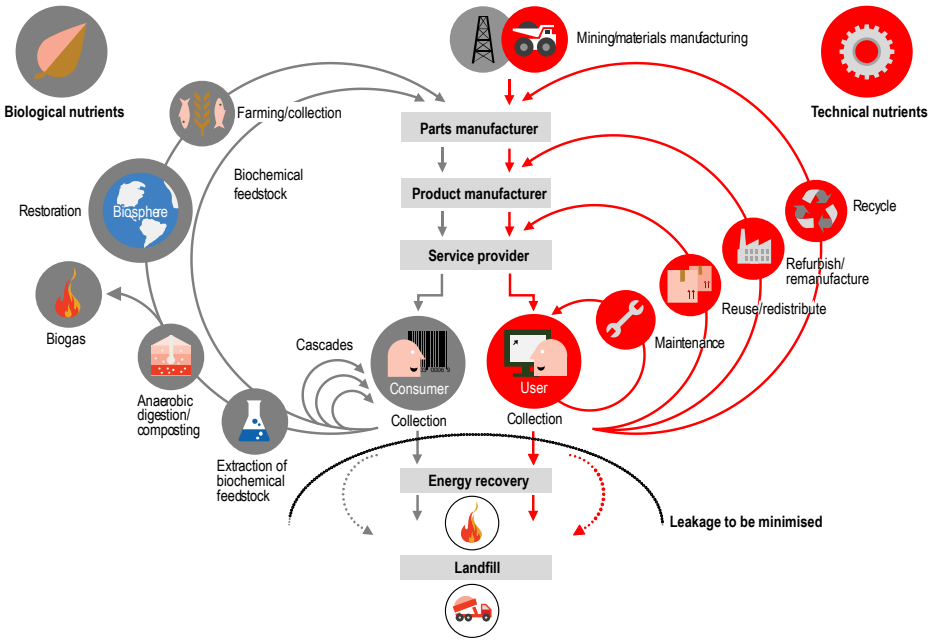
This could bring with it a wide range of questions of what economic success entails. A world focused on GDP, with relentless consumer spending, production of goods and extraction of materials is not consistent with meeting climate goals. A world with less of a focus on these things may be one where economists stop focusing on GDP alone as a measure of economic success.

There is also a good chance that some of these necessary changes in the way the world works could render many of our 'most-loved' economic indicators meaningless. Using the aforementioned car example – shifting from ownership to access would dramatically pull down the number of cars produced each year, actively weighing on global manufacturing production, trade data and GDP. Using any of these metrics as a proxy for economic progress may be unwise in the years to come if they become more distorted with changing growth models.

Maybe a greater focus on living within our planet's means

We could well see climate implications make up more of the focus in measurements instead. Kate Raworth's book and continued work on the concept of 'Doughnut Economics' has gained traction in many international circles – with the concept being that we ensure that no one falls short on life's essentials (from food and housing to healthcare and political voice), while ensuring that collectively we do not overshoot the capacity of our planet's systems – such as climate, water availability and fertile soils.

21. The circular economy would mean more products being re-used – potentially changing how we measure activity



Source: World Economic Forum & Ellen MacArthur Foundation circular economy team drawing from Braungart & McDonough and Cradle to Cradle

[18] Metaverse could put a dent in global warming, Cornell Chronicle, 14 June 2023

Is de-growth possible?

While the above discussion focused on changing how we measure growth and welfare, there is also a growing movement towards the concept of 'de-growth'[19], or various similar concepts. Such ideas believe that the world is living beyond its means, and we need to cut back on consumption of natural resources to preserve our planet. Such a notion is starting to become more mainstream, with a wider discussion among policymaker circles in recent years[20]. There is a chance that some advances in medical science make such a world more relevant today than we might think – with Walmart suggesting that people taking the weight-loss drug Ozempic are cutting back on their food shopping[21].

While such a move may be some way off, such discussions could well continue to influence political discourse. Of course, the alternative is to work out how to grow and improve quality of life without pushing our planet any further to its limits – which is where these new consumption models may come more into play.

Can we just do things better?

Many economists push back against the concept of de-growth. The key mistake de-growthers make, which some say invalidates their arguments, is to confuse output growth with growth in material inputs (fuels, minerals, natural capital, capital equipment…). This is a similar mistake the Club of Rome made in the 1970s.

What matters for growth is not final consumption, but productivity, eg, reducing intermediate consumption of primary resource inputs. That is, decoupling materials (and labour) from output.

What reduces this intermediate consumption? Investment in innovation in all its multiple forms, including ideas and knowledge, to increase resource and materials efficiency. Some call this the light-weighting of GDP. In contrast, de-growth would stunt investment and resource efficiency, slowing action on climate. Very few countries that are in decline are making advances in protecting the climate and their environments. Declining economies are typically seeing more emissions and less productive outputs[22].

How do we pay for it?

As previously discussed, the upfront investment needed to fight climate change is likely to be huge. In this report, we've largely focused on the upfront investment costs for mitigation, not adaptation – these are likely to be just as important in the years to come. This means huge amounts of investment that will need to be funded from somewhere. Here we are talking largely about substantial low-carbon infrastructure projects with large public good components (rather than corporate investment discussed above).

The costs of investment need to come from somewhere

While some of this funding will come from government sources, finding enough available cash with already stretched balance sheets may not be easy. These high levels of government indebtedness are one of the reasons why interest rates may need to be lower over the longer term – to make this level of debt manageable, one of the structural drivers behind our lower-for-longer theme.

In addition, how governments use their scarce resources will be critical. Governments will need to ensure the cost of capital is kept low through various finance instruments that can de-risk projects, eg, grants, concessional finance, and leverage private sector finance, in particular, in the early stages of projects. Once a project is operational and revenue streams are more secure, governments can securitise those revenue streams and recycle the funding for new projects.

[19] 'Degrowth' — Marxism is back for the modern age, FT, 6 November 2022
[20] 'Degrowth' starts to move in from Europe's policy fringes, FT, 30 May 2023
[21] Ozempic Is Making People Buy Less Food, Walmart Says, Bloomberg, 5 October 2023
[22] Zenghelis, D., (2020) Can we be green and grow?, Lombard Odier.

In terms of funding EM investment needs, developed countries committed to a USD100bn a year by 2020 to support developing countries on climate action. While there has been progress in both bilateral and multilateral public finance flows since 2013, the commitment[23] to deliver USD100bn a year by 2020 was not met. However, this will probably be achieved by 2023, helped by financing from the multilateral development banks. Still, this amount is largely symbolic, with investment needs many orders of magnitude higher.

Green lending to emerging markets is a clear area for growth

It is important to note here that crucial discussions are currently underway among shareholders of the Bretton Woods Institutions, including the World Bank, to reform their operations to increase green lending to emerging and developing economies, enabling these governments to increase investment and leverage more private capital. Many think that the actions of the multilateral development banks, often viewed with suspicion by developing countries, will not be sufficient. One option discussed recently is that the International Monetary Fund (IMF) could radically increase Special Drawing Rights (SDRs), which is a type of international reserve asset created by the IMF to supplement the official reserves of its member countries.

In the private sector, labelled bonds may help to shift capital to green investments. We estimate that around 60% of net zero investments would be funded by debt[24], most of which would come from the private sector. The growing size of the labelled bond market (green and sustainability linked bonds) reflects this trend. What will be key is to ensure the credibility of green and other types of sustainable bonds, eg, Sustainability-Linked Bonds (SLBs). These bonds could continue to attract a significant discount in the cost of capital if seen as credible and delivering outcomes aligned with the low-carbon transition. On top of the fiscal side, new forms of finance will be key to getting credit to the parts of the world where more investment may be needed.

Having more people digitally connected may broaden out access to funding

Financial inclusion is positioned prominently as an enabler of eight of the seventeen United Nations' 2030 Sustainable Development Goals (SDGs) – from eradicating poverty, to increasing diversity. GSMA, the mobile network organisation, argues that it could also build resilience to climate change by enabling services such as savings, credit, insurance, remittances and government transfers that can provide vital support for those managing climate extremities. Mobile money and other forms of digital transfers would allow marginalised populations to receive cash transfers after disasters and provides a fast, targeted and cost-efficient channel for supporting affected communities.

As well as enabling communities to react to extreme events, financial inclusion could help them plan better for shifting weather patterns. Mobile money-enabled insurance services can address the lack of financial protection that smallholder farmers need to deal with unpredictable weather patterns. One example is Kilimo Salama in Kenya, which collects insurance premiums using mobile phone-based money transfer system M-Pesa when farmers purchase seeds and fertilisers, and in the event of adverse weather makes pay-outs directly into the M-Pesa mobile phone accounts of the farmers.

Mobile money may also support climate change mitigation efforts by providing finance for clean and affordable energy. For example, the mobile money-pay-as-you-go (PAYG) model is helping households replace dirty, non-renewable energy sources, such as kerosene, charcoal and wood, and enabling low-income consumers to access energy-powered assets by giving access to funds for these investments more easily.

Financing these changes won't be easy – but with technology making it easier to join the world's capital to important projects, there is reason for hope that this may be possible. This technology may also be able to overcome some of the limitations of governments in developing countries, where their capacity to act on climate change at the national level is limited due to weaknesses in institutions that prevent clear and credible policy to mobilise the needed investments.

[23] Made at the 15th Conference of Parties (COP15) of the UNFCCC in Copenhagen in 2009
[24] Global Landscape of Climate Finance, Climate Policy Initiative, December 2021

What does it all mean?

- Climate change is set to heavily affect the global economy…
- …and tackling it could impact growth and inflation…
- …as well as posing substantial fiscal challenges for governments

Macroeconomic implications

Climate change creates additional uncertainty for the global economy, unwelcome at a time when the growth-inflation trade-off appears to have worsened.

Growth

On the growth front, as described above, we could see huge impacts from higher temperatures across the world, pulling down potential growth rates and adding uncertainty to the path of growth, particularly in those economies and regions that are most exposed to climate risks.

Could investment lift underlying growth in some areas?

But, on the other hand, we may see this incredible amount of investment coming into the global economy lift underlying potential growth rates, especially if those investments drive productivity. Even without any multipliers, this could dramatically lift the underlying pace of global productivity. However, for now, despite a surplus of global savings, such a pace of investment seems unlikely, or it may be re-purposed investment from other sources – so shifting from fossil fuels to green energy, for example. It will take strong and credible government policy to divert global savings into productive climate change investments.

Overall, the effect of climate change impacts and the transition on economic growth will depend on the trade-off between these two forces and how meaningful they become in the coming years. If we hit tipping points in terms of climate change that makes large parts of the world either largely or entirely uninhabitable, the macroeconomic shock here would clearly outweigh any upside risks from higher levels of investment. On some projections of global temperature rises, that is a plausible scenario for some regions.

The most vulnerable economies here are those already at risk from extreme temperatures and weather events – with those with large coastal populations, high dependence on agriculture or in areas with more extreme weather events looking particularly vulnerable. In these regions, typically South East Asia and much of Africa, the downside risks from climate change are unlikely to be offset by any uplift from investment.

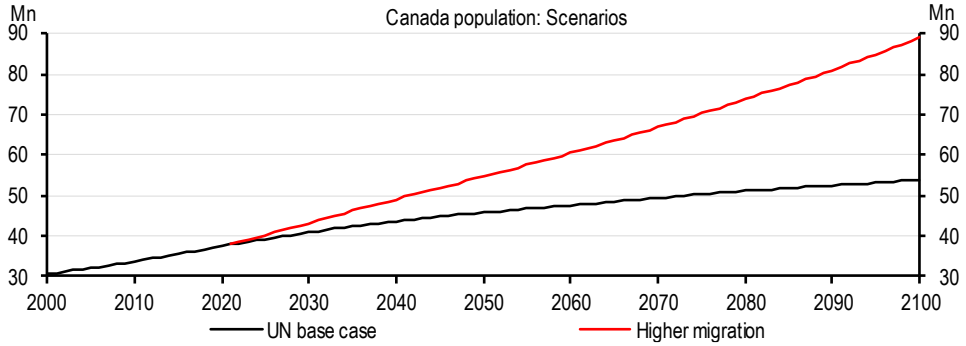
Some positives for some economies?

But while the uninhabitable parts of the world may suffer from higher global temperatures, the opposite could be in economies whose climate could become more temperate. For example, some economies could see faster population growth (which if managed properly could lift potential GDP growth) or more activities could be possible – such as producing new crops or becoming more attractive as tourist destinations.

It could be a story of relative winners and losers

It's not to say this will be positive for these economies, but simply that they could see some relative upsides compared to those economies that are more vulnerable to the impacts of climate change and are unable to see the levels of investment needed for the energy transition and improving productivity.

22. If Canada's inward migration rate is doubled, the population could grow quickly



Source: UN Population Division, HSBC

Inflation

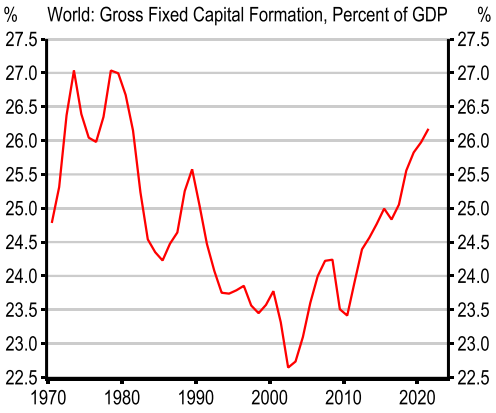
Economic theory says that all of this must be inflationary. First, we have greater uncertainty about global supply that could come from climate impacts: this could be impacts on productivity, food supplies or energy prices as discussed earlier – and means that a period of elevated inflation volatility could be expected as these adverse shocks become more frequent.

A period of stickier inflation from the transition and climate shocks?

Additionally, any degree of additional spending on global investment acts as a demand shock. Even if we do not get to the additional required spend on tackling the climate emergency, the additional impact that this has on demand is likely to be substantial. This could be the increased demand for physical materials or the creation of more jobs that further tightens the labour market. What will be key is the flexibility of economies to adjust, eg, flexibility of labour and capital markets, as investment patterns change.

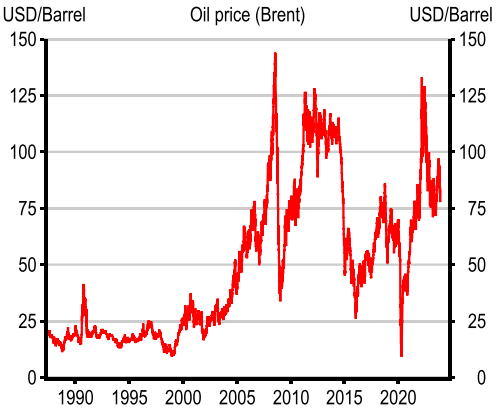
Third, the period of the energy transition means that investment in fossil fuel production is reduced, keeping supply constrained, and prices higher, something that is already playing a role in keeping energy prices elevated. However, with the potential for scaling renewable energy, in particular solar, so strong, this could offset or overcome constrained fossil fuel supply. Timing of the rise of the new with decline of the incumbent will be crucial.

23. Global investment has been rising as a share of GDP



Source: Macrobond, World Bank

24. Oil prices may stay elevated for a while



Source: Macrobond

As an ECB paper[25] highlights, the inflationary effects of climate change may be referred to as "climateflation". The direct inflationary effects of a higher price of carbon energy constitute "fossilflation". The process of adjustment by firms away from carbon energy into non-carbon energy, or green investment, may trigger "greenflation". It's worth keeping in mind, however, as the same paper highlights, that we may see relative price adjustments that keep the costs of other goods and services lower, or we may see some of the investments in clean energy or efficiency gains act as a positive supply shock as well – so the impact on inflation may not be quite so clear cut.

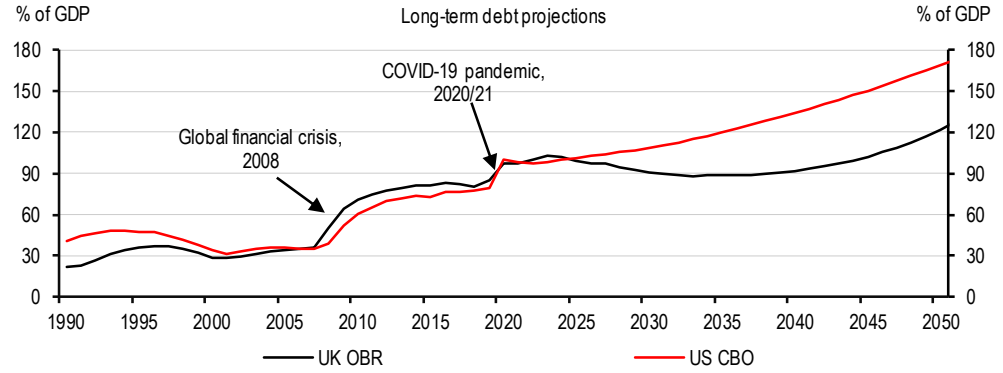
One factor of many

It's worth remembering that these upside risks to inflation are only one of many things likely to lift or lower inflation rates in the medium term, such as technological change, global supply chains and demographics, as we outlined in *Gamechangers: How nine key themes are shaping the future of the global economy*, 2 April 2023.

Policy

Challenges in terms of economic policy will come for both governments and central banks. As outlined earlier, the enormous upfront investments needed in the climate transition will no doubt put strain on already stretched government finances.

25. Government debt levels are already set to rise in key global economies



Source: OBR, CBO

Greater inflation volatility could be a feature of the economy

For central banks, the inflation risks and more inflation volatility mean that inflation expectations could become de-anchored and create a risk of inflation persistently above central banks' targets. The ECB paper argues that, given monetary policy affects inflation with a delay, policy may need to be held tighter for longer to protect against these challenges.

However, given this tighter monetary policy, we could see even greater damage to the real economy than from the impact of climate change alone, and so this may create the need for central banks to weigh up the trade-off between the potential stickiness of inflation against these growth implications.

The trade-off depends on the nature and size of the shock, initial conditions, any fiscal policy response to the same shock, and on projections of the state of the economy over the medium term, but all else being equal, the impact of climate change may mean inflation is stickier and interest rates are held slightly higher.

Policy needs to support the transition

For governments, setting climate policy in such a dynamic setting is a real challenge. Leaving political constraints aside, governments need to make clear and transparent calls on how they will fund the transition. High levels of subsidies are likely to be relatively expensive (per tonne of

[25] The climate and the economy, ECB Working Paper Series, March 2023

GHG reduced), compared to a policy with a clear and credible explicit carbon price and institutions such as green investment banks that can raise capital and leverage private finance and clear policies around research and development of clean technologies.

The latter approach corrects for the market failures holding back more investment and it allows markets to allocate resources in the most efficient way. It also reduces the burden on governments, both in terms of funding the investment directly but also having to make extremely challenging calls around where the economy should allocate resources as it transitions and constantly changes.

Governments will have a key role to play

Governments can then step in when there are bottlenecks or other issues with markets that need intervention. For example, the European Commission proposed a wind energy support package in October 2023 that will help maintain wind power investment in the face of severe, but likely temporary, inflationary pressures on supply chains.

On funding, this approach can also raise significant revenues for governments, in particular, through auctioning of carbon pricing permits or carbon taxes. It is argued that as these taxes are levied on a “bad”, ie, the greenhouse gas externality, they can allow governments to use some of the proceeds to reduce distortionary taxes, including on labour, and also on smoothing the impacts of transition on the less well off in society, which will increase economic efficiency and help to reduce inequality.

In summary…

Climate change looks set to have a dramatic effect on the global economy, both because of the impacts it has directly, as well as the implications of the various investments and changes required to limit temperature increases. We could see more volatility in growth and inflation outcomes, with winners and losers across the world, and another reason to give policymakers headaches.

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