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Davos 2020: We need to talk about (sustainable) growth…

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Economic growth has been a wonderful asset to humankind. For centuries prior to the first Industrial Revolution in the late-1700s, there was little observable economic growth, and standards of living and health were stagnant. The vast majority of the world's population lived in a bleak world. The economic growth that was then kick-started by the first Industrial Revolution provided the necessary conditions for the improvements in sanitation and medicine in the second Industrial Revolution a century later. That was a game changer for health and living standards. Since then, dramatic improvements in child mortality rates, lifespans, education, and personal security have occurred while, more recently, globalisation has helped pull billions out of poverty.

However, in recent years awareness has increasingly surfaced of the negative side effects of economic growth. Debt has exploded and inequality has increased. The most pressing side effect has been the damage to the environment. 21 of the planet's hottest years on record have been seen over the last 23 years. Damage caused by the first two need not be cumulative, whereas many scientists believe that we've passed a tipping point in terms of permanent environmental damage. It also seems that a tipping point has recently been reached in the public awareness of the impact humans are having on the environment, and action is increasingly being sought. However, we think we will soon enter a stage where there will be a realisation of the immense economic and personal trade-offs we will collectively have to make in order to hit climate targets. Such sacrifices may shock citizens and be difficult to administer in democracies. Will human progress be stalled or reversed if we decide that tackling the environment is the priority over growth?

This piece is organised into four sections. First, we explain several different ways in which growth has given humanity great benefits. Second, we examine the negative side effects of growth – particularly debt, inequality, and climate change. Third, we examine the trade-offs involved in taking aggressive action to address climate change. Finally, we look at how progress is being made and how it might continue in the years ahead. The purpose of this exercise is not to promote any specific course of political action. Rather, it is to ensure that when policymakers have these discussions, they do so fully aware of the economic consequences and can plan accordingly.

Ahead of the World Economic Forum's meeting in Davos, this piece summarises the topics we expect to address in conversations with leaders of global organisations, politicians, entrepreneurs, investors, and other experts on the subject of growth and the increasing awareness of its side effects.

Key statistics on a page

- Growth has historically been a game changer for human development. Until the first Industrial Revolution, there was little economic growth. Since then, continuous growth has led to huge improvements in living standards. Over the last century, life expectancy has nearly doubled after centuries of stagnation. Global poverty rates have collapsed, and over the last 40 years, global extreme poverty has fallen from 42% to under 10%. Child mortality has fallen from over 40% in 1800 to c.5% today.
- Economic growth has also coincided with decreasing inequality. From the second Industrial Revolution up until 1984, the share of wealth in the UK owned by the top 1% fell from 70% to 15%. Although global inequality continues to decline, it has stalled (or even reversed) in the developed world since the 1980s, thus helping to encourage populism.
- Over the last 40 years, the total debt (public and private) of G7 countries has doubled relative to GDP.
- Since the first Industrial Revolution, the UK economy has grown 146-fold in real terms, supported by a 42-fold growth in carbon emissions. Over that time, carbon density in the world's atmosphere has risen by over 30%, well above the many, relatively uniform cyclical peaks seen over the last 800,000 years. Furthermore, 21 of the hottest years on record have occurred in the last 23.
- Industrialisation is still associated with pollution. China's overall carbon emissions tripled during the 2000s although they only increased about ten per cent in the 2010s and are unlikely to get close on a per capita basis to the developed world peaks in recent decades. In India, overall emissions have climbed 266% since 2000 and steadily continue to increase.
- The rich overwhelmingly pollute more than the poor. The top 10% of people in the world (by income) generate almost half of carbon emissions. Indeed, the poorest half of the Chinese population (over 600m people) has a total emissions footprint that is still only one-third that of the richest 10% of US citizens (around 30m people).
- As economies orient towards services, emissions fall. The US has reduced its emissions on a per capita basis for several decades, and its total emissions are now similar to what they were in 1970. Similarly, in the UK, carbon emissions have fallen 40% since their peak in 1971, and yet the economy has grown over 2.5 times in real terms.
- Awareness of the trade-offs will now grow. For example, one controversial study calculated that having one fewer child is 24 times better for the environment than the next-best alternative of living without a car. Expected global population growth of c80 million per year and a growing economy will mean that demand offsets energy-efficiency gains.
- To meet 2030 emission targets, the price of an average regular petrol car will rise by nearly €4,000, and a premium car by €7,000.
- The IEA estimate that despite huge investment in renewables, the share of fossil fuels in global primary energy demand will only fall from 81% to 74% by 2040.
- One risk is that if we do nothing to mitigate climate change, the global economic impact could be minimal even with much higher temperatures. Studies suggest that by 2100 global growth might be only 7.2% lower per capita than it would otherwise have been. This may reduce the incentive to act. For context, a historically low 2% pa growth rate would lift global GDP 388% by 2100.

Abstract

Ahead of the World Economic Forum's meeting in Davos, this piece summarises our presentations and debate points for the conversations we will have with leaders of global organisations, politicians, entrepreneurs, investors, and other experts. The topic – growth – is one of the broadest and thorniest facing the world, so we do not pretend to have all the answers. But we have views on a different narrative of growth that we are keen to present for the conversation at Davos.

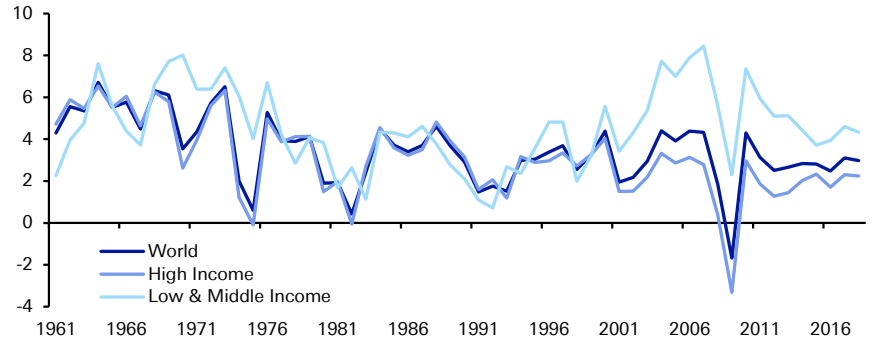
Economic growth has been a wonderful asset to humankind. For centuries prior to the first Industrial Revolution in the late-1700s, there was little observable economic growth and standards of living and health were stagnant. In many ways, the vast majority of the world's population lived in a bleak world. The economic growth that was then kick-started by the first Industrial Revolution provided the necessary conditions for the improvements in sanitation and medicine in the second Industrial Revolution a century later. That was a game changer for health and living standards.

Since then, dramatic improvements in child mortality rates, lifespans, education, and personal security have occurred while, more recently, globalisation has helped pull billions out of poverty. In 1980, those living in extreme poverty amounted to 42% of the global population. As we start 2020 that number has collapsed to 7.7% and has been almost eradicated in China as the country has embraced growth and globalisation.

However, in recent years awareness has increasingly surfaced of the negative side effects of economic growth. Over the last four decades global debt has exploded relative to growth. That suggests that maintaining current levels of activity is not sustainable. Also, one of the contradictions of our age is that although the poorest parts of the world have prospered over this period, wealth inequality has increased in developed countries due to the elite benefiting from globalisation and outsized asset price gains. In contrast, the 'left behinds' have suffered from being exposed to globalisation (cheap labour in emerging markets and declining industries in developed ones). In addition, they have had less opportunity to benefit from soaring asset prices. Populism is at the highest levels since the 1930s and poses many risks to growth and society.

As Figure 1 shows, global growth has held relatively steady over the last few decades but only via a large outpacing of emerging markets versus developed ones. This in itself is creating sustainability issues with just one symptom being the trade war between the US and China.

Figure 1: Real Global GDP Growth (year-on-year, %)



Source : World Bank, Deutsche Bank

Growth in emerging markets has generally been generated via a rapid industrialisation of their economies. That brings us to the most pressing sustainability issue of our generation – the environment. Although on a relative basis emerging market emissions are increasing relative to those in developed markets, more advanced countries are still, in aggregate, the biggest polluters. They have spent nearly two centuries going through heavy industrialisation in an era when the environmental consequences were not as readily understood. As such, this is a global problem that is coming to a head now, as 21 of the planet's hottest years on record have been seen over the last 23 years.

Bringing all this together, debt, inequality and environmental damage are major issues for growth sustainability. However, one could argue that the first two are cyclical whereas the third is potentially structural. Debt problems should eventually self-correct as every debt is an asset to someone else. As such the debt problem is arguably a distribution one and will be solved via default, inflation or growth. The same can be said about domestic inequality. Eventually all high-valuation assets will need to be owned by subsequent generations. Unless their incomes rise, asset prices will have to cheapen. Either way domestic debt and inequality are largely cyclical – albeit working in very long cycles – even if they can cause major economic imbalances for a prolonged period. In the shorter term these imbalances could correct more quickly via financial crises, but whilst history tells us that they can be very damaging, this is not necessarily permanent over the longer term. Economies can bounce back.

However, it is unlikely that the same can be said about the environment, with many scientists believing that we've passed a tipping point in terms of permanent damage. It also seems that a tipping point has recently been reached in the public awareness of the impact humans are having on the environment, and action is increasingly being sought. We think we will soon enter a stage where there will be a realisation of the immense economic and personal trade-offs we will collectively have to make in order to hit domestic and globally agreed climate targets. Such sacrifices may shock citizens and be difficult to administer in democracies.

The problem for the environmental lobby is that a world without economic growth may create a damaging backlash against such climate policies. Nevertheless, the problem with the status quo is that the irreversible damage to our planet will increase. Growth along the lines of the last few decades could lead to environmental catastrophes that forever change the world and humankind.

We therefore need to find a way to create sustainable growth (and even boost it) to balance the simultaneous need for human progress whilst dealing with debt and inequality and protecting the planet. We think this requires game-changing levels of investment in green technologies and technology (as a source of future growth over industrial 'dirty' means) overall. With debt levels already so high, this will likely have to come from freshly printed money. If we do have a climate emergency, any side effects of such policies would likely be a small price to pay to make growth more sustainable for the planet.

So as the skies become more polluted by humans, expect to see more and more green helicopters dropping money from above to encourage investments to tackle this great challenge of our generation.

This piece is organised into four sections. First, we explain several different ways in which growth has given humanity great benefits. Second, we examine the negative side effects of growth – particularly debt, inequality, and climate change. Third, we examine the trade-offs involved in taking aggressive action to address climate change. Finally, we look at how progress is being made and how it might continue in the years ahead. The purpose of this exercise is not to promote any specific course of political action. Rather, it is to ensure that when policymakers have these discussions, they do so fully aware of the economic consequences and can plan accordingly.

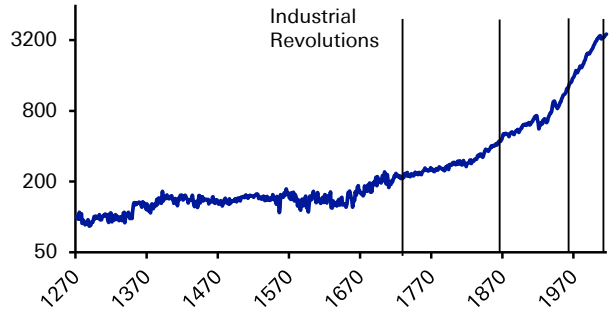
Growth has transformed our lives relative to our forefathers

Our modern era of economic growth is historically exceptional. There is simply no other period in history that has seen sustained growth at the rates seen since the first Industrial Revolution. This has enabled unparalleled technological advances, and standards of living across the world have never been higher than they are today.

The following graphs show that until we entered the Industrial Revolution era, for much of human history, there was frequent or continuous economic stagnation. [1]

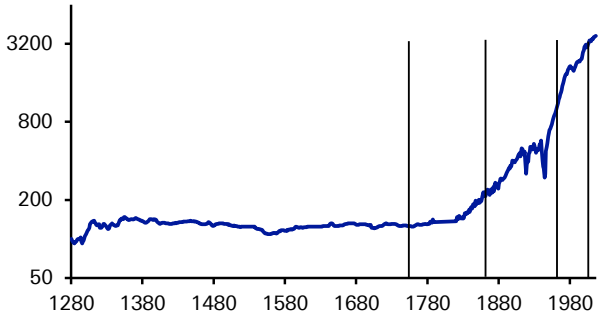
1 For UK, Thomas R and Dimsdale, N (2017) "A Millennium of UK Data", Bank of England OBRA dataset, http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx . For France, Maddison Project Database, version 2018. Bolt, Jutta, Robert Inklaar, Herman de Jong and Jan Luiten van Zanden (2018), "Rebasing 'Maddison': new income comparisons and the shape of long-run economic development", Madison Project Working Paper 10.

Figure 2: English Real GDP per capita (log scale, 1270 = 100), 1270-2016



Source : Bank of England: A millennium of macroeconomic data for the UK, Deutsche Bank

Figure 3: French Real GDP per capita (log scale, 1280 = 100), 1280-2016

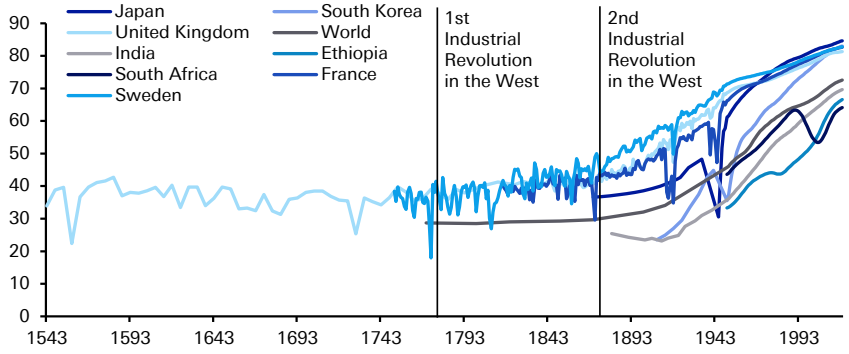


Source : Maddison Project Database, Deutsche Bank
Note: French Revolution data (1790-1819) interpolated as unavailable.

Human health

Before the first Industrial Revolution, generation after generation of people could expect to live a life very similar to that of their predecessors – in terms of their standard of living as well as their lifespan. Figure 4 shows long-term life expectancy over time. In particular, it shows that longevity grew considerably after the second Industrial Revolution – when improvements in sanitation and medicine began to eliminate basic diseases. Of course, these developments would not have been possible without the advancements made during the first Industrial Revolution.

Figure 4: Life Expectancy (Years)



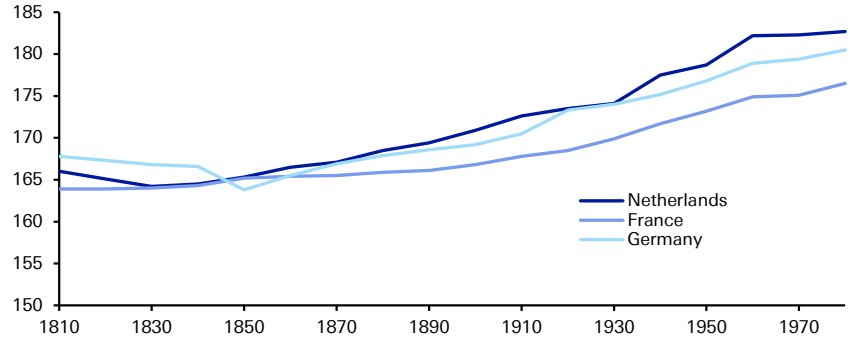
Source : Our World in Data, Deutsche Bank

As the graph shows, UK life expectancy hardly changed between the mid-1500s and the mid- to late 1800s. Some people reading this report likely had grandparents or great grandparents that at birth were expected to live little longer than their forefathers several hundred years before. Yet since then, life expectancy has roughly doubled. There is little doubt that economic growth helped facilitate this.

It is difficult to measure health over the very long run, but a good proxy is to look at average heights through history. Figure 5 shows that over the last 200 years, males have grown 10-15cm. This contrasts with the preceding centuries, with an analysis by Köpke and Baten (2003) finding that heights were broadly constant over the two

thousand years before that.[2] So once the spoils of the first two Industrial Revolutions spread, humans saw huge health and life expectancy benefits.

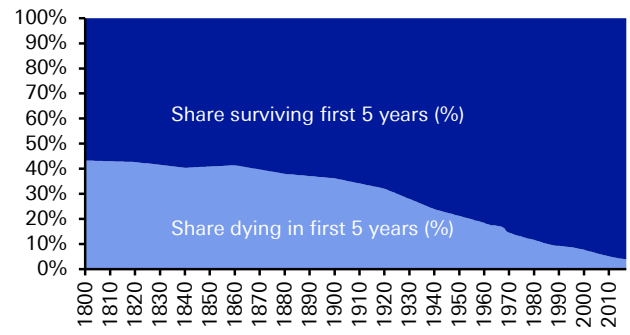
Figure 5: Average height of men by year of birth (cm)



Source : Our World in Data, Deutsche Bank

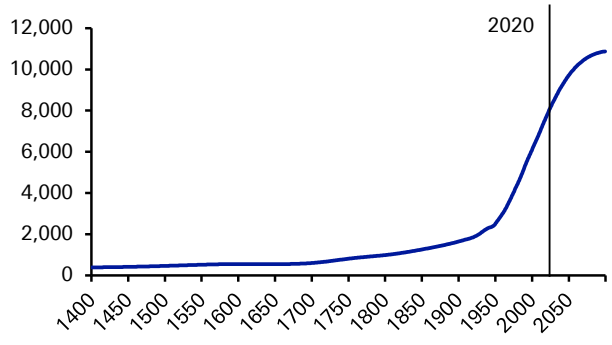
As economic growth boosted quality of life and health, a self-reinforcing cycle was established that boosted economic growth further as populations surged around the globe. Infant mortality collapsed (Figure 6) and the world population (Figure 7) started to increase notably in the nineteenth century relative to the earlier years of the prior millennium. However, the real population explosion was in the twentieth century as these economic and health gains spread around the globe and compounded in an exponential manner.

Figure 6: Child mortality has plummeted



Source : Our World in Data, Deutsche Bank

Figure 7: While the world population has soared



Source : Our World in Data, United Nations, Haver Analytics, Deutsche Bank

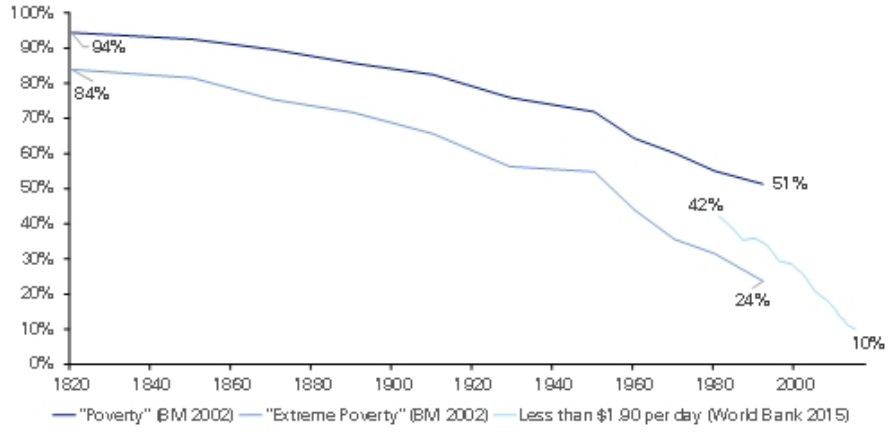
Related to improved health outcomes is the increase in safety. Indeed, countries with stagnant growth are far more likely to have higher homicide rates compared with countries with higher growth. This suggests that people are more likely to try to increase their share of a static pie by taking from others and eliminating their competition for scarce resources.

2 Köpke, Nikola; Baten, Jörg (2003) : The biological standard of living in Europe during the last two millennia, Tübinger Diskussionsbeiträge, No. 265, Eberhard Karls Universität Tübingen, Wirtschaftswissenschaftliche Fakultät, Tübingen

Poverty and inequality

It has not just been since the first Industrial Revolution that a selective proportion of the global population has benefited economically. Figure 8 shows that global poverty measures have declined from almost universal levels 200 years ago to today's relatively low levels.

Figure 8: Extreme poverty reduction



Source : Bourguignon and Morrison (2002), World Bank, Deutsche Bank

If anything, global poverty has collapsed at the fastest pace in history over the last 40 years. It is no coincidence that this was the period during which growth spread most widely across the globe. This globalisation has also been a catalyst for reducing inequality. In fact, in a world with a growing population, growth is a vital way to reduce inequality. That is because if there are more people striving to be successful, they can achieve their goals only if the overall pie is expanding.

Another way to see the benefits of economic growth is to look at what happens without it. Just one recent example is Venezuela. With an economy heavily leveraged to the price of oil, the collapse in the price of crude in 2014 exposed the lack of economic development elsewhere and put the brakes on economic growth. Populist government policies, including price controls and expropriations, disincentivised business growth and worsened the effects of a lack of growth. The result was hyperinflation and widespread social chaos. In 2019, the country experienced its sixth consecutive year of economic contraction – the IMF's World Economic Outlook in October showed a one-third contraction in 2019. The country can expect a further ten per cent contraction in 2020. Tragically, Venezuela also has one of the highest homicide rates in the world, with the UN Office on Drugs and Crime putting the rate in 2016 at 56 per 100,000 people.

The negative side effects of growth over the last 50 years

Although growth has undeniably been a positive force in so many areas over the last 200-plus years, the side effects have often been ignored. In this section we address three key side effects – debt, inequality, and the environment.

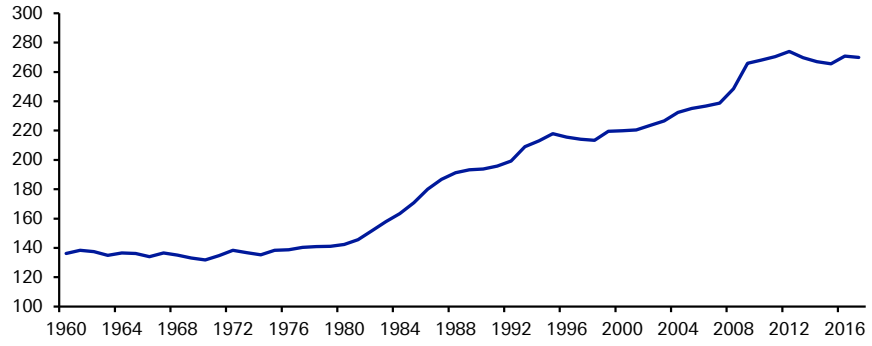
Debt

With debt piles at record levels, and demography suggesting more debt is likely, a

world without growth invites a financial crisis of epic proportions. If we can't grow our way out of the increasing debt burden, our economic system is very vulnerable. Sustainable growth is therefore essential.

A look at recent history shows that to achieve the living standards people have collectively demanded, governments and individuals have accumulated more and more debt. This has particularly been the case over the last half century.

Figure 9: G7 GDP-weighted total (public and private) debt (% of GDP)



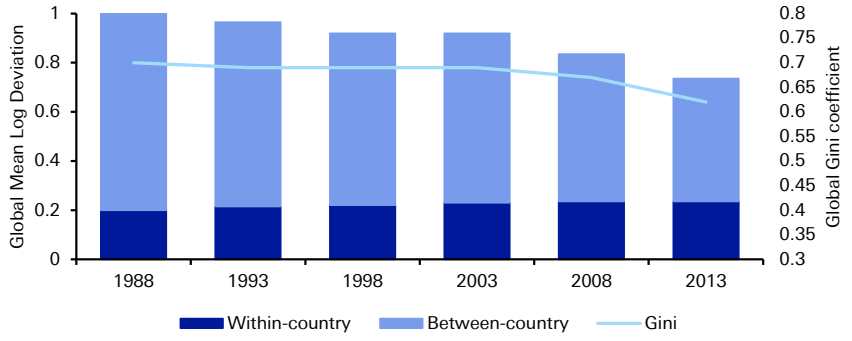
Source : Deutsche Bank, IMF

After the financial crisis, this debt began to look more unsustainable in free markets, and central banks embarked on policies of very low interest rates, aggressive money printing, and debt purchases that continue to this day. While that has had the effect of making high debt loads more sustainable today, it is setting the conditions for a debt crisis in the future, especially if we downplay the importance of economic growth. The reality is that many places around the globe have already passed the point at which debt can be sustainable without regular central bank money printing.

Inequality as a negative side effect of growth – an increase after centuries of decline

As Figure 10 shows, at a global level income inequality has actually narrowed in recent decades, which chimes with our earlier analysis on the recent big reduction in poverty during the globalisation era. So in that respect we should celebrate this era of global growth. However, there is evidence that inequality has increased in some countries, especially in the developed world and particularly in terms of wealth, as we'll see below.

Figure 10:Global Income Inequality, 1988-2013



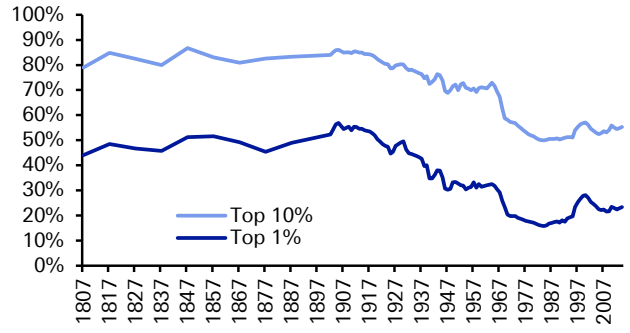
Source : Shared Prosperity: Taking on Inequality, World Bank (2016)

While there are flaws, it appears that the combination of capitalism and globalisation is the best way to build an economic system that fosters growth and wealth for all. However, over the last four decades, societies have not ensured redistribution to those left behind by globalisation. This has led to extreme inequality in many areas but is perhaps more acute in terms of wealth over incomes. Not only is this dangerous for society, but it risks fuelling more populist movements.

In the end, these populist movements may eventually support anti-capitalist and anti-globalisation policies. Not only would this risk curtailing growth, but it may also have more impact on those with lower incomes. That is because while everyone would be made poorer, the poor would be less able to afford to absorb their losses.

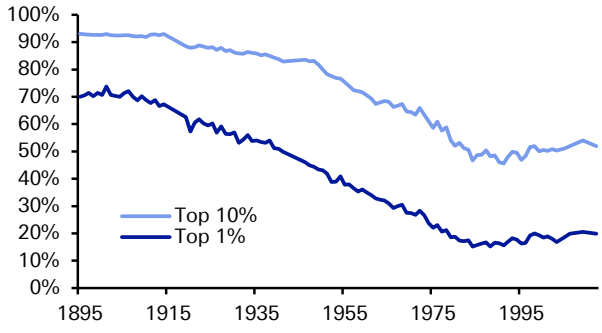
Prior to the twentieth century, wealth was heavily concentrated in the elites of society. Figures 11 and 12 show this for France and the UK (where we have long time series). From around 1900 to the end of the 1970s, both nations' wealth spread out from the top one per cent and ten per cent of the population. Since then, this spread has stopped. It is interesting that even though France is one of the more redistributive societies in the world, even here, the trend started to plateau and steadily reverse.

Figure 11: French Wealth Shares



Source : World Inequality Database, Deutsche Bank

Figure 12: UK Wealth Shares

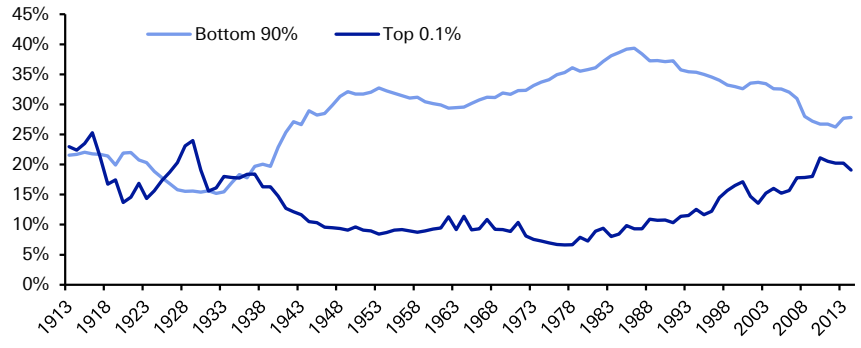


Source : World Inequality Database, Deutsche Bank

If France is one of the more redistributive countries in the world, the US is arguably at the other end of the spectrum and as Figure 13 shows, the share of the pie owned by the bottom 90 per cent of the population rose consistently between the time of

the Great Depression in the 1930s to the start of the 1980s. From this point, it has fallen sharply with the share owned by the top 0.1 per cent having approached the share owned by the bottom 90 per cent in recent years, after being far apart just four decades ago.

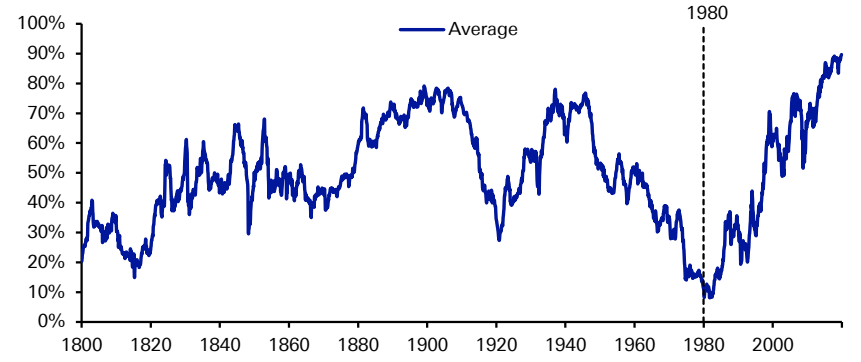
Figure 13: US Wealth Shares



Source : World Inequality Database, Deutsche Bank

In many ways, this change in wealth is tied to asset prices. Figure 14 shows an index we have created of 15 developed market government bond markets and 15 equity markets over the last 200 years. The cheapest valuation mark is zero per cent, and 100 per cent is the most expensive. As can be seen, assets (typically owned by the better-off in society) have gone full circle from being the cheapest in history around the turn of the 1980s to the most expensive in recent years.

Figure 14: Global equity and bond market valuations (cheapest=0, most expensive=100)



Source : Deutsche Bank, GFD

Exacerbating the problem shown in this chart is that fact that it does not include housing. With the explosion of widespread property ownership in recent decades, the increase in debt, and the reduction of interest rates, we have seen a huge rise in house prices. Anyone who has ridden this rise in property prices will now likely have higher wealth than those who have not. This certainly helps to widen wealth inequality. It also causes big inter-generational problems as the young have less means to buy property.

So while there are some unresolved questions over income inequality, there is little doubt that those exposed to asset price growth have done exceptionally well over

the last 40 years. This has left a society of haves and have nots and a generational divide between young and old. Given that the assets of the older generation will eventually be passed on to today's young, in some way or another, this is not a permanent problem but in the immediate period it adds to a divided society.

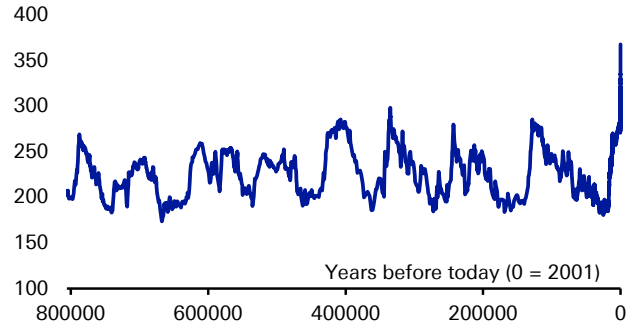
Environmental issues

Financial crises – as painful as they are – can be fixed over time, and their impact might not be cumulative. However, damage to the environment is more likely to be irreversible if a tipping point is reached. In the eyes of many scientists, such a point is close if not already passed. Just as growth in emissions is falling, the public's agitation on the issue has reached the point at which it now affects politics, policy, consumer behaviour, and share prices. Public support is moving towards environmental issues at a breathtaking pace, and governments and companies need to make sure they keep up.

At the start of this piece we showed that for most of the last millennium there was little economic growth, and little improvement in living standards or life expectancy. The Industrial Revolution was a key tipping point for economic growth, and it subsequently facilitated massively improved living standards, health, education, personal security, and, eventually, the extraordinary population growth of the twentieth century.

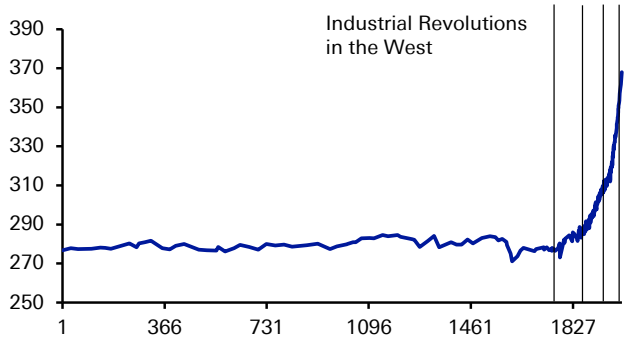
While correlation doesn't equal causality, there is widespread scientific agreement that humans have created the dramatic increases in carbon in the Earth's atmosphere. Today's levels are unprecedented in at least 800,000 years. Furthermore, when we zoom in on the last 2,000 years, we can see that carbon density in the atmosphere shot up right after the first Industrial Revolution.

Figure 15: The amount of carbon dioxide in the atmosphere has reached unprecedented levels (CO2, parts per million by volume)



Source : World Data Center for Paleoclimatology, Boulder and NOAA Paleoclimatology Program, Deutsche Bank

Figure 16: Looking at the same graph over the last 2000 years shows the dramatic transformation since the first Industrial Revolution.



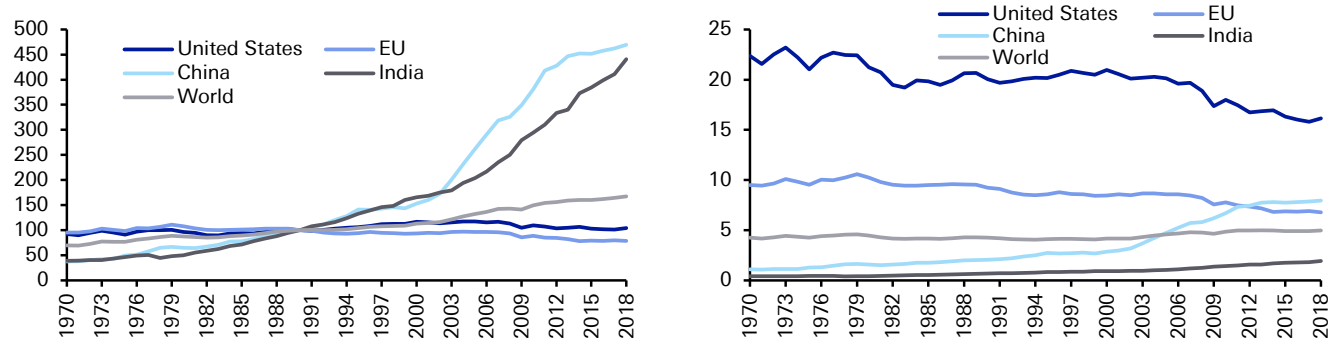
Source : World Data Center for Paleoclimatology, Boulder and NOAA Paleoclimatology Program, Deutsche Bank

While the US is the largest contributor to carbon emissions, the rapid emergence of China and India in the globalisation era has led to them emitting a greater share. The good news is that the US has reduced its emissions on a per capita basis for several decades, even if its total emissions are now similar to what they were in 1970. On the whole, they do seem to have declined slightly from their peak in the early years of this century.

The EU has done an even better job in managing its emissions on both measures since the 1970s. Of course, many developed countries have 'outsourced' their emissions as they have moved factory production to emerging countries. This reduces the beneficial impact of lower emission data. That said, some countries that outsource emissions are still lowering their 'consumption emissions'. For example, the UK's 'consumption' emissions are still below 1990 levels based on the latest data from the University of Leeds, even though 'territorial' emissions are well below.

Meanwhile there is good evidence that China's emissions will level off at much lower levels on a per capita basis than the US saw at its peak.

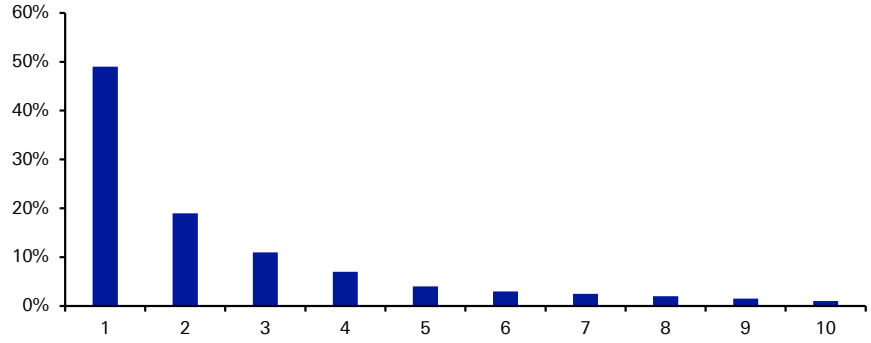
Figure 17: Fossil CO2 Emissions (1990 = 100) (LHS) and Fossil CO2 Emissions Per Capita (tonnes CO2/capita/year) (RHS)



Source : European Commission, EDGAR - Emissions Database for Global Atmospheric Research, Deutsche Bank

There is also an interesting link between emissions and inequality. Work by Oxfam shows that the rich overwhelmingly pollute more than the poor. For example, the poorest half of the Chinese population (over 600m people) have a total emissions footprint that is still only one-third that of the richest ten per cent of US citizens (around 30m people). Similarly, the poorest half of the Indian population (around 600m people) emits only half as much – again, about the same – as the richest ten per cent of people in Japan (around 12m people).

Figure 18: Percentage of CO2 emissions by income decile, world population. The top 10% by income generate nearly 50% of emissions



Source : Oxfam, Deutsche Bank

This fact also feeds into one of the key difficulties in the climate change debate. While the rich are responsible for most emissions on a consumption basis, the

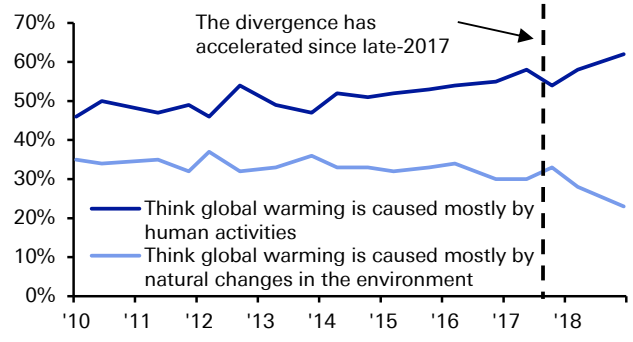
production of the things they consume is frequently done in less-well-off countries. So while some emerging countries use dirty forms of power generation compared with some advanced countries, the poorer countries have a legitimate argument to make that they should not be penalised for both the demands of advanced consumers and the fact that their standard of living is still catching up. In other words, many now-advanced countries acquired their wealth by polluting the environment, so it can be seen as unfair for them to now limit the capacity of poorer countries to catch up. There are, of course, complexities around this debate, and it is one to which policymakers need to be particularly attuned.

Public support and the awareness of trade-offs

There is no question that climate change is one of the biggest and most tangible challenges the world has ever faced. And there is no question that coordinated global action is urgently needed. But when the discussions about this action are taking place, policymakers must have an understanding of the trade-offs involved so they can act to mitigate any negative consequences. That is what this section aims to present.

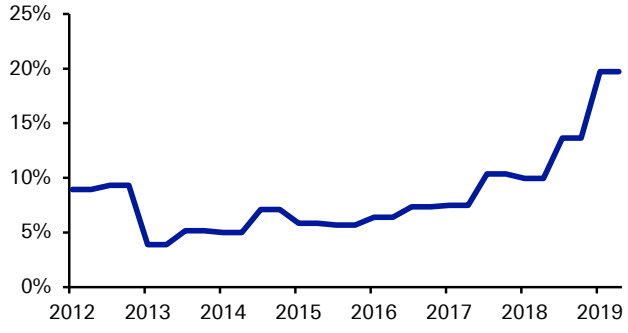
The last few years have seen a significant tipping point in the awareness of the human impact on the environment. Even in the US where there has been more scepticism, Figure 19 shows that in the last two years alone, the proportion of Americans who think that global warming is caused by natural changes in the environment has fallen sharply from 33 per cent to 23 per cent after a near decade of being static at the former figure. Meanwhile in the EU, over the last 18 months, the share that suggests that environment-related issues are among the two most important issues in their country has doubled to 20 per cent.

Figure 19: Public Opinion on climate change in the US



Source : Yale program on climate change communication

Figure 20: Percentage saying the environment, climate and energy issues are among the two most important issues facing the EU



Source : European Commission, Haver Analytics, Deutsche Bank

It's not unreasonable to suggest that this awareness and concern will continue to spread. However, the difficulty might come when we all become aware of the hard choices that need to be made on a personal level and how many noble lifestyle changes might in reality make limited difference.

Do we have the luxury of time?

According to the United Nations Climate Change group, to avoid the worst effects of climate change, science tells us we need to limit global temperatures to a rise of 1.5 degrees Celsius, or a maximum of 2 degrees above pre-industrial levels. This is also the central goal of the Paris Agreement. According to the UN, the warming is now at 1.1 degrees and could easily reach 1.5 degrees by 2030.

While it is difficult to precisely predict how much time the world has before climate change results in irreversible damage, it seems certain that governments around the world will take more assertive action on the issue. The extent to which governments take action is a matter of public policy and something that voters will effectively approve or reject. As policymakers are considering their action, it is important that they understand the trade-offs involved.

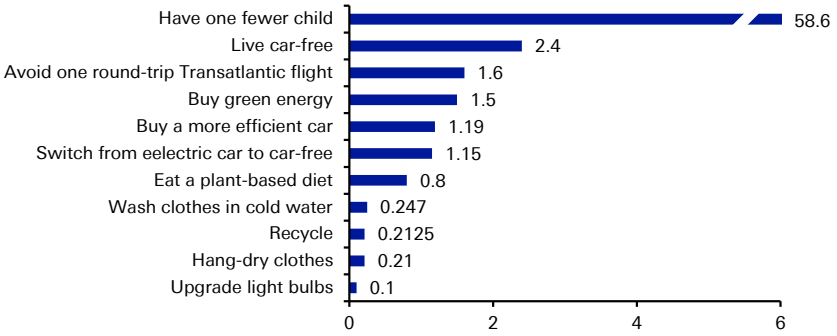
The trade-offs and the risks of international disagreement

It is clear that we have reached a tipping point for public awareness around the need to act on climate change. However, we think there is much less understanding of the economic and lifestyle trade-offs that are needed to meet current climate targets.

While there are certainly environmental benefits to making individual lifestyle changes, such as moving to a plant-based diet, it remains that about three-quarters of carbon emissions come from three sources: transport, industry, and electricity generation. So while the small changes that people make to their lifestyle should be applauded, even in aggregate, some of these may not make a material dent in the globe's emission profile if aggressive short-term climate action is required.

To really have an impact in the short term, there must be action on the big-picture items that matter – and that involves hard decisions and trade-offs. For a small taste of the difficult big-picture decisions that need to be made, consider a controversial study by Wynes & Nicholas in 2017. This showed that having one fewer child is 24 times as effective at reducing personal annual carbon emissions as the next-best alternative of living car-free.

Figure 21: Tonnes of CO2 equivalent per year



Source : Wynes & Nicholas, Environmental Research Letters, 2017, Deutsche Bank

According to this research, while other lifestyle choices have a positive impact on a person's emissions, they do not begin to compare to the impact of reducing family

sizes. While this work has been debated since its publication, the point is that as the environment becomes more and more important an issue across the globe, to really make a difference, populations will increasingly be confronted with incredibly difficult choices. These are not just related to family sizes but other big macro issues.

Notwithstanding the moral and ethical landmine within this part of the study, population growth has historically been a big component of economic growth. And with a heavy debt burden and an ageing population, without continuous population growth, the current economic model will become unsustainable.

Another example of why a big-picture holistic solution is needed comes from research by Levine in 2019 (Global Warming: What Sort of Mess Have We Made?). In this study, he argues the resources being used to combat climate change can be inefficiently allocated as most countries focus only on their own use of carbon. For example, some rich cities spent large amounts of money electrifying buses. Yet, if that money were used to subsidise green energy in a developing country, it could offer a much greater environmental benefit. Many of the hurdles here are, of course, political.

Even if humans do nothing to mitigate climate change, the economic impact is likely to be minimal. To illustrate, the oft-cited Stern Review points out that warming of 8.6 degrees will reduce per capita global GDP by 13.8 per cent by 2200 and only 2.9% by 2100 (4.3 degrees). In addition, a recent NBER report estimated that world real per capita GDP could fall 7.2 per cent by 2100 if nothing is done about climate change.

Even the IPCC's most severe scenario, RCP 8.5, would entail a mean warming of the global temperatures of 3.7C by 2081-2100 relative to the 1986-2005 average. And the upper end of the 90% confidence interval (for what is already the most extreme scenario published) is 4.8C warming.

Of course, this is not to say that the effects of a warming planet are purely economic and therefore should be ignored. Many of the effects of climate change, such as the effect on air quality or the heightened risks of natural disasters and loss of life, cannot be measured simply in terms of national accounting. Neither can the wide regional distribution of the likely damage. But it would be unsurprising if some countries chose to prioritise the economics over environmental concerns. Indeed, given the global nature of climate change, at an individual level it may well be advantageous to free-ride off the efforts of others.

Looking forward to the coming century, even if the global economy were to grow by just 1% every year (and bear in mind that since 1983 there has been only one year when the global economy grew by less than 2%), the global economy would still expand by 170% over the next 100 years. And if the global economy sustained growth of 2% a year for the next 100 years, then we would see a 624% expansion over the next century. So from an economic standpoint, losing just a fraction of that future growth would still leave a country vastly richer than it is today.

Given the potential for free-riding, multilateral solutions are therefore mandatory. The worry here is that disagreement between some countries makes it possible that the next trade war could be an environmental one. Consider that proposals in both the US and Europe could see the implementation of country or region-specific 'carbon border adjustment taxes'. These could levy a tariff on imports based on the

carbon used in creating the product.

From one point of view, this could be a good way to discourage countries from 'exporting' their emissions. The tax would ensure that carbon is taxed where it is consumed rather than where it is generated. From another point of view, the policies could be used to protect local businesses. Consequently, it seems likely that while internal political pressure may see some countries implement such a tax, it may ignite a disagreement with a trade partner that could turn into a trade war.

Aside from potential taxes on imported products, countries need to accept that if they wish to pursue a path of aggressive, short-term emission reduction, it will necessarily involve targeting transport, industry, and electricity generation. This could involve policies that restrict factory production at certain times, that restrict transport, in particular people's ability to drive their cars, and that cut peak load power generation at certain times.

There is evidence from both developed and developing countries that have implemented these types of schemes for various reasons. But while it can have positive environmental effects, there are tangible economic consequences that may make those environmental policies unsustainable.

First, consider how these polices to reduce emissions may affect the workforce. It has been observed that mandated hours for factories can lead to unemployment or underemployment. Given how it has recently become very visible that the loss of manufacturing jobs over the last few decades has contributed to a fractured society and politics, this is a topic that needs to be included in the conversation.

For transport, a blanket restriction on the proportion of cars that can be driven on a certain day means people have fewer employment options, while businesses may have to offer longer delivery times. Furthermore, policies to force people into more efficient or electric cars could have the flow-on effect of making existing cars unsellable. For lower-income owners, that could present a very serious problem, especially if their car is financed with debt.

Staying with autos, hitting emission targets will be hard for carmakers. Reaching the goal of halving vehicle emissions by 2030 implies engine efficiency improvements of five per cent each year, well above the three per cent seen over the last decade. Assuming carmakers strive to hit their targets, there are three key things they can do – but there are costs associated with each.

The first is further improving the combustion engine. If the halving of emissions is to be achieved this way, then they need to fall from 119 grams of carbon per kilometre to 60. As a rule of thumb, every gram per kilometre of carbon reduction costs €65 for mass market vehicles and €120 for premium cars. So, if carmakers pass on the entire cost, the price of the average regular petrol car will rise by nearly €4,000, and a premium car by €7,000. At the same time they may have to accept lighter, less powerful cars. How will consumers react to more basic cars and a higher cost? Will it impact their willingness to urgently tackle climate change?

Regarding electricity generation, shortages because of load restrictions on high-pollution power plants will inevitably cause or exacerbate economic problems. Relatively quick alternatives risk political argument. Already, there have been protests in Germany about ending coal-fired electricity. This may be a perfectly good policy, but unless renewable power plants can be brought up to the same level

of capacity as existing high-pollution plants, the only alternative may be widespread nuclear power – a policy for which there is fractured support. The cold truth is that there are still no powerful, reliable, cost-efficient and low-carbon technologies that can satisfy the world's growing appetite for energy.

On the demand side, the global population is growing at a rate of c.80m people each year with a constantly growing economy. This means energy consumption will also increase further in absolute terms. Sadly, efficiency gains are being more than offset by the rebound effect of more users and more intensive usage.

On the supply side, despite the considerable investments, renewable energies, such as wind power and photovoltaics, are still not capable of satisfying the growing global energy demand. Moreover, inexpensive and efficient industrial-sized storage technologies are still lacking, making it impossible to store enough surplus power from renewable sources.

The IEA baseline scenario forecasts that the share of all renewable sources of energy (including hydro and bioenergy) in global electricity generation will rise from 26 per cent currently to 44 per cent by 2040. More than half of this total is to be provided by wind and solar power in 2040. At the same time, the IEA expects the share of wind and solar power in primary energy demand to rise from two per cent currently to seven per cent by 2040. Meanwhile, the share of fossil fuels in global primary energy demand should only decline from 81 per cent currently to 74 per cent by 2040.

The good news is that investments in renewables look set to rise further in the coming decades; the bad news is that this is already factored into forecasts that suggest fossil fuels will still be overwhelmingly dominant over this period.

According to the baseline scenario presented in the latest World Energy Outlook by the IEA, aggregate investments in renewables are likely to amount to c. USD 8 trn by 2040. This means that they will exceed the sum of all investments in all other sources of energy (oil, coal, natural gas, nuclear energy) taken together. Despite these huge sums, the IEA expects energy-related carbon emissions to rise by 0.3 per cent each year until 2040 on average.

A price worth paying?

Some will argue that the side effects to the wider economy are a price worth paying to more quickly reduce emissions. But while there is certainly a debate to be had over the extent of the economic price worth paying, those involved in the debate should also understand how these policies can contribute to widening inequality.

The reason why the sweeping policies that have the effect of restricting growth can hurt the poorest in society is that they are the people that can least afford to mitigate the effects of those policies on their lives. Take, for example, the policy implemented several times in Paris that has banned cars from driving into the capital on alternating days based on whether the number plate is odd or even. For those who could afford two cars, with alternating number plates, there was relatively little impact on their lives. In contrast, those who could afford only one car were severely impacted. Compounding the problem for one-car families is the fact that workers in lower-income groups tend to have less ability to negotiate their work hours. Indeed, anger of this type was exactly the type of motivation that contributed to the Gilets Jaunes protests in France.

Protest movements of this type should be eye-opening for policymakers as they show that aggressive environmental action, without due respect to the economic consequences, can change the mood of the public which, in turn, may eventually seek new leadership. Consider that one of the key catalysts for the Gilets Jaunes protests was a fuel tax that was intended to disincentivise the use of fossil fuels. Given the power of protest movement, President Macron has responded to some of their demands.

The alternative to blanket restrictions on carbon emissions is to raise prices to disincentivise their use. This can come in the form of higher power prices, higher taxes for old cars, mandatory charges on goods that are made in polluting factories, or many other such initiatives. Again, these widen inequality as those who can't afford to pay are either worse off or miss out.

How to mitigate these pain points

One way around the pain points associated with environmental policies that restrict growth is enormous government spending, particularly on renewable energy projects. This includes subsidies to help refit factories and industrial plants. In the absence of a sharp uptick in inflation, it seems likely that 'Green Quantitative Easing' is inevitable despite the merits of this type of policy not yet being fully discussed.

The problem is that this inevitably means governments taking on more debt right when they already have a debt problem. Of course, the current low level of bond yields means the large debt pile is manageable. However, the picture becomes scary if and when yields rise. That is why increasing amounts of debt will be bought by central banks, either to finance green initiatives or to ensure that legacy debt built up in the years of excess does not default en masse and topple economies.

The other option is placing the onus on the private sector. This would involve enacting policies that make it the obligation of an individual company to refashion itself to reduce carbon within a fixed timeframe. On the face of it, this may seem like a sensible plan. After all, companies are generally in great shape.

Yet there are significant issues to consider. Given the costs involved in aggressively reducing carbon, companies would have to raise large amounts of capital, putting pressure on their ability to create jobs and on equity and debt markets and potentially reducing the value of pension pots.

Finally, there is a tough choice to be made by democratic governments. Should they press ahead with policies to aggressively reduce carbon emissions, then it is almost certain that at least some of the side effects noted above will eventuate. As most governments have a poor record of being re-elected during an economic downturn, those governments will have to implement their policies knowing that there is a risk they will lose their jobs.

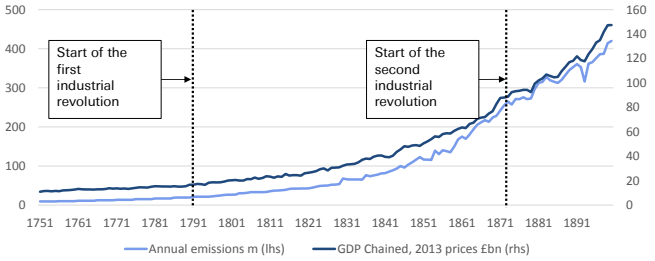
Furthermore, as the last decade has shown, economic malaise fuels populism. So if governments with well-meaning environmental policies are subsequently voted out, there seems to be a material chance that a replacement, populist government will reverse those policies and, if current trends are a guide, become less willing to partake in the multilateral action that is necessary to combat the environmental issues faced by the world.

The good news

While there are trade-offs and hard decisions to be made, there is good news. Specifically, the evidence shows that economic growth does not depend on emissions and can indeed disconnect from them. If this evidence holds more broadly, it means that growth does not have to come at the expense of the environment – and the reason why it has, particularly over the last half century, is that it has been easy to do so and there has been no penalty. Given that environmental externalities have been well known for some time, this essentially means there has been an inefficiency in the market system.

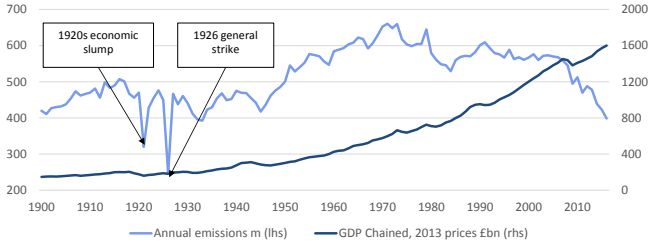
The UK is a good example of what can be done when an economy moves from being an industry-based economy to being one based on services. The following charts show how economic growth and carbon emissions were tightly tied during the UK's period of industrialisation. However, since the UK finished its industrialisation process, emissions have disconnected from growth, particularly over the last 50 years.

Figure 22: Carbon emissions and economic growth went hand-in-hand



Source : Bank of England, Our World in Data, Deutsche Bank

Figure 23: Carbon Emissions disconnected from growth in recent times



Source : Bank of England, Our World in Data, Deutsche Bank

A similar trend of disconnection can be seen when emissions are compared with wages and productivity.

In summary, the trajectory of the UK's economic growth has continued in a relatively stable direction whilst carbon emissions have fallen. Of course, some of the drop in carbon emissions can be accounted for by the 'exporting' of emissions to other countries for manufacturing, but the phenomenon of this decoupling of emissions from growth has persisted nonetheless.

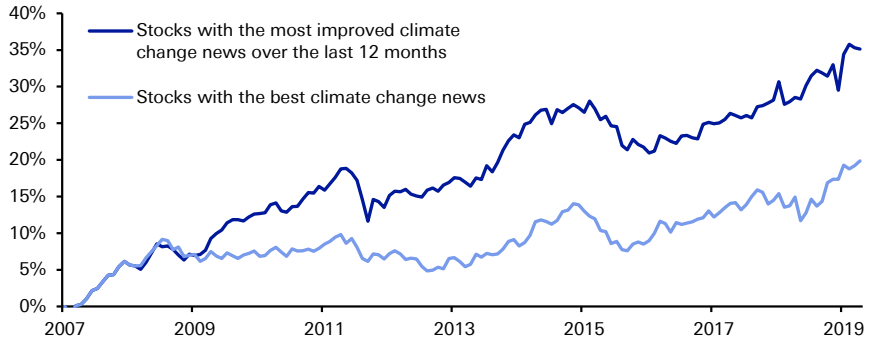
Against the backdrop of the largest developed countries having seen much economic and technological progress since their emissions peaked, it seems unlikely that rapidly developing emerging nations will reach the same emission peaks. But if developed countries are serious about reducing global emissions, and not just embarking on virtue-signaling domestic policies, they need to help the developing world transition. Therefore, multilateral agreements are critical. If they can be made, it is not unreasonable to suggest that we are not too far away from a world in which emissions fall everywhere. That said, it is worrying that at the very time that multilateral organisations are needed the most to combat climate change and help deal with inequality and debt, the world faces a backlash against globalisation in some quarters and these organisations are under fire.

We can draw some optimism from the evidence that global growth potential is higher than at many times in the past. That is because globalisation has eroded some of the roadblocks that previously held back some countries. 'Technology skips' have already been witnessed in telecommunications, particularly in Africa and India where the uptake of smartphones and data usage is exponential. This has helped millions of people engage in the local and global economy and boost their incomes, without the country needing a build-up of heavy industry.

The investment world is changing fast too, so there is now a financial incentive to 'do the right thing'. Almost half of the world's assets under management fall under an ESG banner in some way, and this will likely increase to 95 per cent over the coming decade.

The greater awareness of how ESG issues affect companies is already having an impact on share prices. The following chart shows that positive climate change news and actions lead to higher company share prices; the move towards more assets coming under an ESG umbrella should only amplify this trend.

Figure 24: Stocks with positive climate change news outperform the market



Source : Deutsche Bank α-Dig

This gives weight to the evidence that environmental degradation is not an inherent part of economic growth and that the relationship between growth and carbon emissions cannot only be severed, but it can actually be reversed so that companies have financial incentives to maintain a sustainable business model.

We need new sources of growth

Even if there is evidence that growth can coincide with falling emissions, the need to accelerate progress is fairly urgent if you accept the climate emergency. Given that the economic growth and financial performance we are familiar with have been tied to environmental damage, it is necessary to find new sources of growth to take advantage of the fact that growth and pollution do not have to be linked.

One avenue for growth is to take advantage of new technologies. Indeed, there is reason to hope that if the world is on the cusp of a fourth Industrial Revolution – one of artificial intelligence – then technological advancements could reach a point over the coming decade where they begin to be implemented at a rapid pace. This could also help reverse the hard-to-explain dip in productivity growth over the last few decades.

Cutting-edge advancements bear much promise for growth. Just one example comes from the industrials sector, where the Internet of Things is just beginning to shake up manufacturing and logistics. Indeed, ABB, the engineering group, estimates that digitalisation technologies could be a $20bn revenue opportunity and result in $1tn of annual savings in operating expenditures for its customers.

Furthermore, new technologies are beginning to help combat climate change and other environmental issues. For example, Australia is developing a blockchain tool to help make its complex water rights and trading systems more efficient. Water is also critical to India, where the country has developed an IoT cloud-based system to help clean up the Ganges, while another IoT system in Kanpur is helping improve air quality. Across the world, countries are implementing new technologies that allow real-time monitoring of environmental infrastructure to maximise efficiency and minimise downtime.

While there is real and legitimate excitement in the promise of technologies such as artificial intelligence and 5G communications, it is necessary to be pragmatic as well as hopeful. After all, AI and associated technologies – such as the Industrial Internet of Things – are currently nowhere near as widespread as they need to be to have a material impact on any of the mainstream measures of growth. Together, they contribute to around one per cent or less of global production. And consider that robotics, now a decades-old technology, contributes to less than ten per cent of global production. These figures need to push up to 20 per cent or more in order to meaningfully add to GDP growth.

Due to the slow contribution to growth of cutting-edge technology, some of the 'big picture' gains may be found elsewhere. We discussed earlier that it is the developing world where some of the best uses of funds to mitigate climate change can be applied. Similarly, we should look to the developing world to find the most reliable sources of growth. This is because if developing countries can be assisted to implement technologies that are already established and proven in advanced countries, they can provide an outsized contribution to global growth compared with advanced countries trying to implement as-yet-unproven new technologies.

Conclusion

There is no question that climate change, inequality, and debt are amongst the biggest issues of our time. And given that a deterioration in all three for many countries has been accompanied by solid global economic growth over the last four decades, it is no wonder that many question whether growth is a false necessity or even a phenomenon the world can do without. As this conversation takes place, it is vital that policymakers consider three things.

First, the historical evidence strongly suggests a world without growth would be bad for human health and progress. Indeed, as the world's population inevitably grows, economic growth, managed the right way, is not just a key mechanism to solving all three problems, it is a necessity. Therefore, we need to find a way to grow the global economy while managing debt, reducing inequality and, above all else, respecting the environment for future generations.

Second, as a tipping point has been reached in terms of climate awareness, the next stage of the conversation will likely move to the discussion of the huge trade-offs associated with tackling climate issues. It is therefore vital that policymakers fully

appreciate the flow-on effects from the significant changes required in transport, industry, and electricity generation, which could include unemployment, increased inequality, and a possible debt-centred financial crisis.

Third, if assertive action is taken, it will have to be managed very carefully. History shows that countries are hard to govern during times of economic malaise. Democratic governments may find themselves removed from office and replaced with more populist politicians. With this in mind, globally coordinated policy is necessary. This would facilitate 'technology skips' in developing countries. If advanced countries can assist in bringing proven technologies to developing countries, not only can swathes of 'dirty' industry be quickly cleaned up, but also, more people can be connected to job opportunities and equality gaps can be shrunk.

Whatever short-term trade-offs are made, significant investment is required in clean technology, research, and infrastructure for the future. As government balance sheets are stretched and advanced countries face demographic constraints, this will not allow for a direct large green investment program without risks of setting off a debt crisis. As such it is likely that central banks will increasingly create money to finance 'Green projects' either directly, through buying government bonds that finance it, or through vehicles such as the European Investment Bank.

While this will add to large existing debt piles, the reality is that this debt may never be repaid to central banks or will be partially inflated away over time. As such, it could be akin to a 'cost free' fiscal injection into the economy. Even the most prudent of governments could use the cover afforded by a response to climate change to authorise such green helicopter money.

Perhaps the most worrying thing is that just as global co-ordination becomes increasingly important in tackling these problems, so the world is seeing a reversal of multilateralism. Without multilateral solutions it will be near impossible to meet UN-sponsored targets for the climate. As a result, countries may choose to impose unilateral measures, including carbon border adjustment taxes that may ignite new trade wars and be counterproductive for growth.

With a multilateral 'grand bargain' and sizeable investments in technology (green and otherwise) it may still be possible to see economic growth that works towards the goals of greater equality, debt sustainability, and climate security. As the debate over sustainable growth intensifies though, we need to be aware of how difficult and complicated this topic is and consider all the associated trade-offs before we make grand policy decisions.

Appendix 1

Important Disclosures

*Other information available upon request

*Prices are current as of the end of the previous trading session unless otherwise indicated and are sourced from local exchanges via Reuters, Bloomberg and other vendors . Other information is sourced from Deutsche Bank, subject companies, and other sources. For disclosures pertaining to recommendations or estimates made on securities other than the primary subject of this research, please see the most recently published company report or visit our global disclosure look-up page on our website at https://research.db.com/Research/Disclosures/CompanySearch. Aside from within this report, important risk and conflict disclosures can also be found at https://research.db.com/Research/Topics/Equities?topicId=RB0002. Investors are strongly encouraged to review this information before investing.

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