

# The Economic Impact of Climate Change

October 2017: Issue Twenty One

*The earth's climate is changing. Few summers go by without breaking a wildfire or extreme heat record; few winters go by without breaking a flood or storm strength record. Scientific reports on the causes and impacts of climate change are piling up, leading to calls and commitments to limit this phenomenon, including the 2015 Paris agreement by which almost 200 countries committed to tackle climate change together. In this newsletter, we do not seek to opine on the causes of climate change, but rather review the main expected impacts of climate change on the global economy as well as the potential risks and opportunities it represents.*

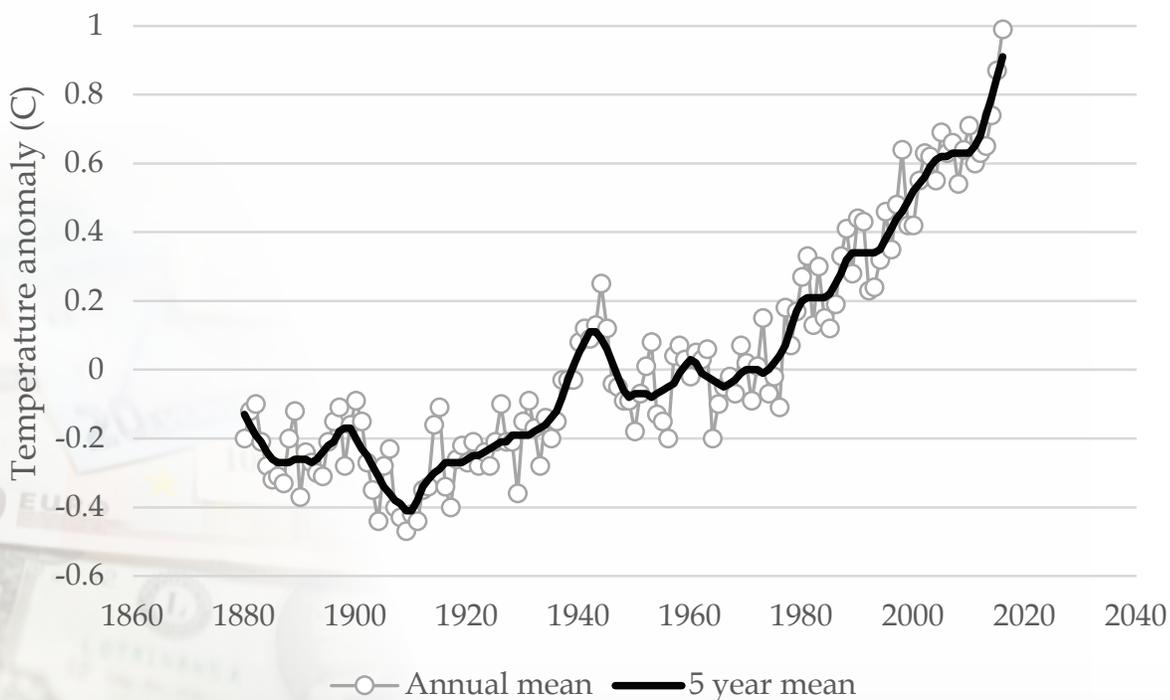
## BACKGROUND: WHAT IS CLIMATE CHANGE

According to NASA<sup>1</sup>, the earth's average temperature has increased by 1.1 degrees Celsius (or about 2.0 degrees Fahrenheit) since pre-industrial times, with most of the increase taking place during the past 35 years (Figure 1). Most scientists agree that this global warming has been mostly driven by the growing

concentration of greenhouse gases (especially carbon dioxide), which trap heat in the atmosphere. Climate change is already clearly visible with the melting of polar ice sheets and glacier retreats. It has also started to affect crops and animal life.

Warmer temperatures affect precipitation patterns, with wet regions getting wetter and dry regions drier. Warmer temperatures also come with more

Figure 1: Change in Global Temperature Relative to 1951-1980 Average Temperatures



Source: climate.nasa.gov

<sup>1</sup> See: <https://climate.nasa.gov>



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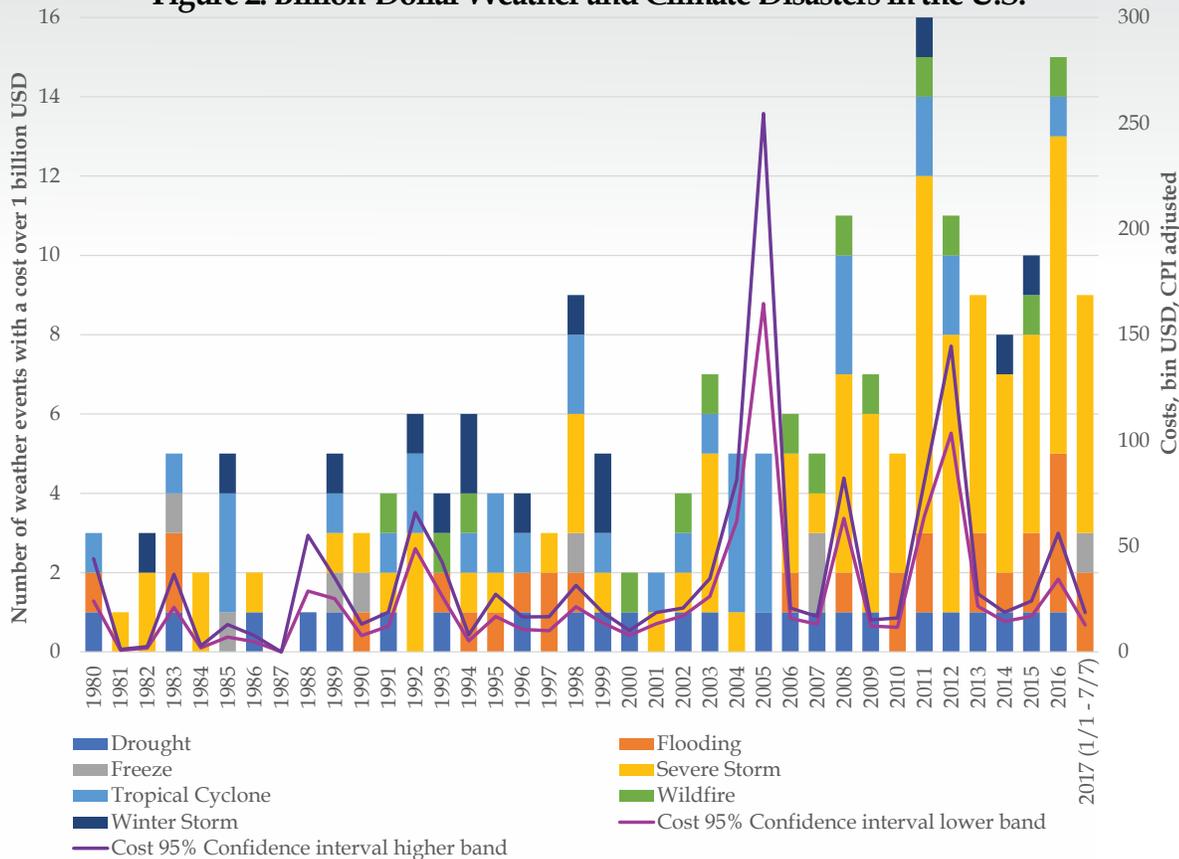
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Figure 2: Billion-Dollar Weather and Climate Disasters in the U.S.



Note: Costs estimates are based total losses (insured or not) from physical damages to buildings, material assets and infrastructure as well as business interruptions.

Source: NOAA's National Centers for Environmental Information, <https://www.ncdc.noaa.gov/billions/time-series>

frequent climate disasters, amplified by coastal development in recent decades, as illustrated by Figure 2 in the case of the U.S.

As oceans get warmer, and ice melts, another major manifestation of climate change is the rise in sea level. According to NASA<sup>1</sup>, the global sea level has increased by 80 millimeters since 1995, with a current rate of increase of 3.4 millimeters per year. The Intergovernmental Panel on Climate Change (IPCC)<sup>2</sup> estimated that the average sea level could rise by between 0.2 and 1 meters by 2100, depending on by how much global temperature increases.

The accumulation of heat trapping gases so far implies that climate change will continue; there is a growing consensus that about 2° C of global average temperature

increase since the pre-industrial times is already locked in. Because greenhouse gases remain in the atmosphere for a long time, and emissions keep rising, additional global warming is likely. Most available estimates range from increases in average temperatures from preindustrial times between 2° and 6° C by 2100, depending on emission patterns, but higher increases are not ruled out.

Most scientists consider 2° C the threshold above which climate related catastrophic events become more likely.<sup>3</sup> This is why the 2015 Paris agreement aims at containing global warming “well below” this threshold through a reduction in greenhouse gas emissions.

### HOW IS CLIMATE CHANGE AFFECTING THE GLOBAL ECONOMY?

If not arrested, climate change will have major social and economic impacts. Quantifying these impacts is a difficult task. The magnitude of climate change going forward is still uncertain because

1 See: <https://climate.nasa.gov>

2 IPCC (2014) Climate Change 2014, Summary for Policy-makers

3 See for instance Bob Silberg (2016) Why a half-degree temperature rise is a big deal NASA's Jet Propulsion Laboratory.



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emissions depend partly on policies that are yet to be fully defined and because the link between gas concentration and temperature increase is complex. Moreover, identifying the different channels at work and quantifying them is not straightforward; the interaction between the different impacts, their indirect effects on the rest of the economy, including via trade and financial channels, the different local impacts, and possible non-linearity also complicate the task.

Since the 2007 Stern Review<sup>1</sup>, there has been substantial progress in the modelling approaches leading to new quantifications. While these quantifications are surrounded by high uncertainty and sensitive to modelling approaches and assumptions, they are useful to illustrate the main channels by which global warming will potentially affect our economies.<sup>2</sup>

*Direct sectoral effects:* some sectors of the economy that are sensitive to the weather will be directly affected by climate change. This is especially the case in the agriculture, energy, and tourism sectors.

The agricultural sector will most likely be hit negatively by a warmer climate. Crop yields are expected to decline, except in the coldest climates where they may increase. According to some estimates, yields could decline by up to 19% on average by 2050 in the U.S. Midwest in the absence of adaptation to changing weather conditions.<sup>3</sup> However, there is some evidence that a higher carbon concentration could increase crop yields, possibly counterbalancing part of this negative effect. Agriculture will also suffer from disruption to water supplies

(due to higher evaporation and increased rain variability) and losses in output due to more frequent extreme weather events. Climate change will also affect livestock health, while fisheries will face major changes in catch patterns due to ocean warming and acidification.

The likely impact on the energy and tourism sectors is more limited at the global level, despite important local and regional impacts. Climate change affects energy demand with increased demand for cooling and less demand for heating. The two effects may balance each other at the global level but local impacts could be significant. Climate change will also shift tourism activity within and across countries.

The other directly affected sectors include forestry (because of drought, more frequent wildfires, insect outbreaks and tree diseases), real estate markets in coastal regions, and insurance (see below).

*Effects on capital stock, labor, and productivity:* Climate change potentially leads to losses in the capital stock, and in labor force productivity.

First, land and physical capital, including key infrastructure, will be put at risk by rising sea levels as well as damages from more frequent extreme weather such as floods, with important consequences for the insurance sector. For instance, the damage of the 2013 floods in Europe is estimated at 12 billion euros across 9 countries.<sup>4</sup>

Second, warmer global temperatures increase the likelihood of diseases, malnutrition and heat stress that affect human health with implications on the size of the labor force and its productivity, as well as on healthcare expenditures. In currently very cold regions, a more temperate climate may increase productivity. However, land losses, health issues, competition for resources (e.g., water) could trigger population movements within and across national borders and associated social issues or even conflicts.

1 N. Stern (2007) The Economics of Climate Change: The Stern Review

2 See IPCC (2014) op. cit., OECD (2015) The Economic Consequences of Climate Change, OECD Publishing, Paris and J. Harris, B. Roach and A-M Codur (2017) The Economics of Global Climate Change, Global Development and Environment Institute, Tufts University.

3 Risky Business (2014) A climate risk assessment for the United States.

4 See: European Commission (2014) Overview of natural and man-made disaster risks in the EU, COMMISSION STAFF WORKING DOCUMENT.

## HOW MUCH GLOBAL GDP COULD BE LOST?

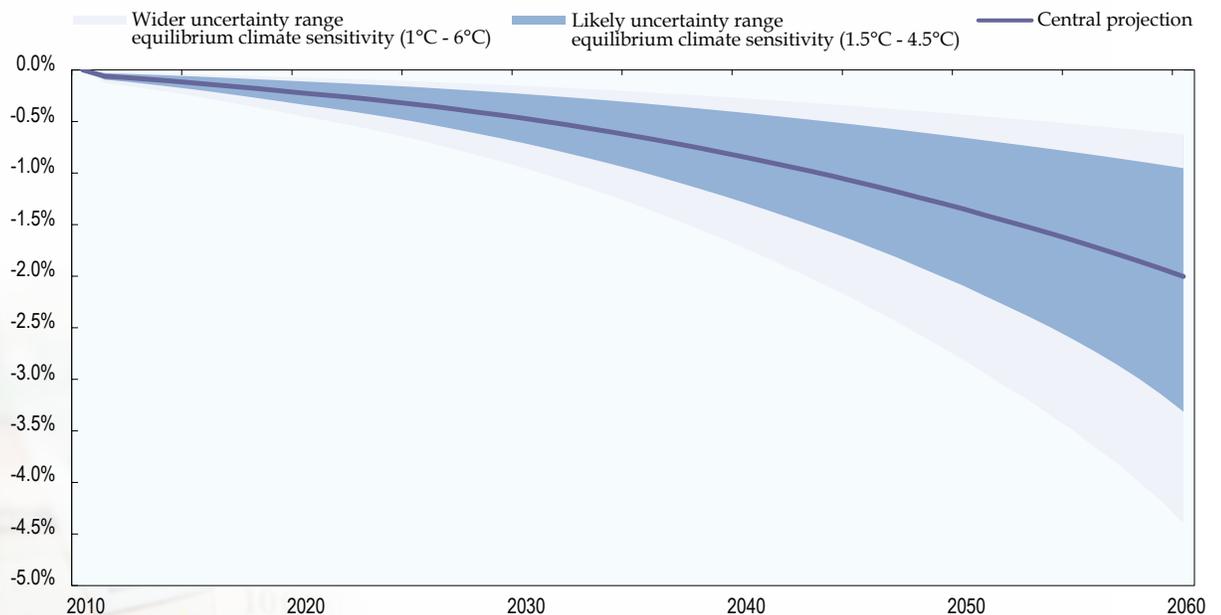
According to 2015 estimates by the OECD<sup>1</sup>, an additional increase in global temperature by 1°-1.5° C (i.e., a total increase of 2° to 2.5° from preindustrial times) would reduce the level of world GDP by about 2% in 2060, compared with a baseline scenario where climate does not change (Figure 3). A recent literature review by the IMF<sup>2</sup> points to a 2% global GDP level loss for a slightly higher total temperature increase (3 degrees). While the impact on the annual growth rate of the world economy is very small (about 0.05 percentage points annually on average), it worsens the already expected long-term world economic slowdown due to demographics.

The longer the horizon, the wider the uncertainty both on the magnitude of global warming and its economic

impact. Damages are also expected to increase with time if gas concentration and climate change continue. For instance, with a temperature increase reaching 6 degrees by 2100, the cost could be over 10% of global GDP.<sup>3</sup> There are also much more dramatic estimations: some American researchers estimate that global incomes could be 23 percent lower by 2100 than they would be in a world without climate change.<sup>4</sup>

The 2015 OECD estimates also illustrate the weight of the different impacts, with the impacts on crop yields, labor productivity, and damages due to the increase in sea level dominating the global impact (Figure 4, on the following page). On the other hand, extreme weather events are unlikely to have a significant global impact, despite important local impacts.

**Figure 3: OECD Estimates of the Global Impact of Climate Change**



Source: OECD (2015), *The Economic Consequences of Climate Change*, OECD Publishing, Paris



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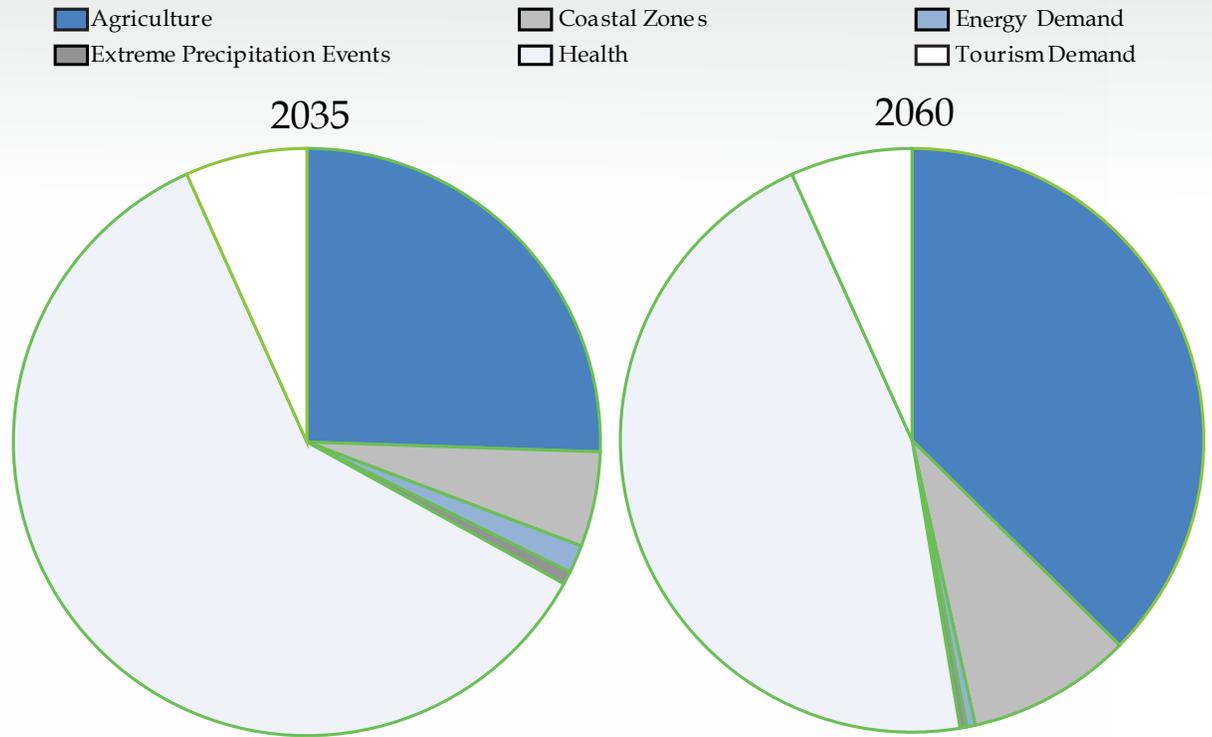
<sup>1</sup> OECD (2015) *The Economic Consequences of Climate Change*, OECD Publishing, Paris.

<sup>2</sup> IMF (2016) *After Paris: Fiscal, Macroeconomic, and Financial Implications of Climate Change* Prepared by Mai Farid, Michael Keen, Michael Papaioannou, Ian Parry, Catherine Pattillo, Anna Ter-Martirosyan, and other IMF Staff.

<sup>3</sup> OECD (2015) *op. cit.*

<sup>4</sup> Marshall Burke, Solomon M. Hsiang and Edward Miguel (2015) "Global non-linear effect of temperature on economic production" *Nature* 527.

Figure 4: Attribution of Damages to Selected Climate Change Impacts, OECD Central Projection



Source: OECD (2015), The Economic Consequences of Climate Change, OECD Publishing, Paris.

### WHAT ARE THE UNKNOWNNS?

Some impacts of climate change cannot be properly evaluated with existing tools, especially at long horizons and when/if temperature increases above 4° C. First, climate related social unrest/conflicts are usually not considered in standard quantifications. This is also the case with feedback effects that could take place after a certain level of temperature increase and would accelerate global warming and magnify its consequences: examples include feedbacks due to increased release of CO<sub>2</sub> from warming arctic tundra or the reduction in carbon absorption due to forest loss.

Scientists have also identified potential damages that, while having a very low probability of taking place, could have a dramatic impact on human life and the global economy. For instance, a collapse of the Greenland and West Antarctic ice sheets could raise sea levels by over 12 meters, with devastating consequences

for coastal cities and infrastructure.<sup>1</sup> In the same way, a shift in the Atlantic Gulf Stream could dramatically change the climate of Europe.

In addition, existing modelling may not fully account for macroeconomic risks associated to the impact of climate change. These risks include the impact of extreme weather events on public finance and the insurance sector, and the financial consequences of a collapse of coastal real estate markets. While less predictable than sectoral impacts, financial crisis associated with climate change could have important medium-term consequences.

But the impact of climate change may also be less than expected if adaption moderates its negative impact and creates new opportunities for growth. As the recognition of climate risks increases, national and local actors have started to adapt to changing climate conditions. For instance, Californian food producers have

<sup>1</sup> J. Harris, B. Roach and A-M Codur (2017) *op. cit.*



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started to adapt to drought by turning to less water dependent crop varieties; Southeast U.S. cities have started to respond to flooding threats with sea walls, pumps, desalination, relocation of infrastructure, etc. It is highly possible that the counterbalancing effect of adaptation is underestimated, especially if it leads to new disruptive technologies that boost productivity.

### WHO WILL BE HIT THE MOST?

The impact of climate change is not uniform and varies across countries and within countries. A few may even benefit from climate change. The local impact of climate change will depend mostly on two types of factors:

- Sensitivity to climate change, which depends on the geographic situation, as well as the type of economic activity.
- Ability to adapt, which is shaped by several factors including the business environment, available skills, institutional capacity, and capital.

Therefore, low income countries will be the most affected by climate change as they often have geographical disadvantages and a limited ability to adapt. This will worsen poverty and population movements, and increase the risks of conflicts especially in fragile states. In high income countries, the impact of climate change will be less acute, as they benefit from better geographical situations as well as stronger adaptation capacity.

### WHAT IS THE EXPECTED IMPACT ON THE U.S.?

The United States will not be spared by climate change. A good illustration is the Risky Business<sup>1</sup> estimate that the average number of days with

1 Risky Business (2014) *op.cit.*

2 For more details see Third National Climate Assessment Report of the US Global Change Research Program.

temperature above 95°F in many parts of the U.S. could increase to between 27 to 50 days each year by 2050 and could reach between 45 to 96 days in 2100.

However, compared with the rest of the world, the economic impact of climate change on the U.S. economy will be moderate, with a dent on the level of GDP of about 0.5% by 2060, according to the OECD estimates, but with major local differences.<sup>2</sup> The northern states would benefit from more bearable winters, a positive impact of tourism, and higher crop yields. This would partly compensate a negative impact in southern states, especially on the east coast, where temperatures would become unbearable part of the year with strong negative effects on productivity and where the rise in sea level could be particularly damaging.

### WHAT ABOUT MITIGATION POLICIES AND CHANGES IN PREFERENCES?

Current climate change mitigation policies primarily seek to contain or reduce greenhouse gas emissions. These policies have a strong impact on the business environment with new regulations and taxes but also technological disruptions (for instance electric cars) that affect business models.

Overall, mitigation policies tend to favor low-emission businesses at the expense of high-emission ones, especially harming fossil fuel producers and traditional industrial sectors, but also affecting agriculture. Awareness of climate risks is also slowly shifting consumers' and investors' preferences towards greener products and technologies, adding to the potential difficulties in high-emission sectors. On the other hand, mitigation policies will drive new spending on infrastructure, and cleaner technologies.

CONCLUSION: RISKS AND OPPORTUNITIES ASSOCIATED  
WITH CLIMATE CHANGE

Climate change is a source of risks but also opportunities for businesses and investors. Even if its global impact by 2050 seems small, especially in terms of the growth rate, it varies greatly across sectors, regions, and businesses.

Financial markets may have some way to go to price fully the impact on expected returns. For instance, according to the IMF<sup>1</sup>, few investors are aware of the contribution to emissions of the companies in their portfolios and companies exposed to future regulatory risks could still be overvalued. The AODP Global Climate 500 Index 2017<sup>2</sup> shows nonetheless that an increasing number of asset owners and managers recognize the financial risks and opportunities of climate change and have started to act

accordingly, with Europe and Australia taking the lead. For instance, Aviva Investors has warned companies that it will vote against the annual reports and accounts of companies failing to publicly disclose the risks posed to their business models by climate change and will consider selling its shares in companies that repeatedly fail to provide such information.<sup>3</sup>

Going forward, as stock market valuations adjust to both research progress on the magnitude of climate change, and its impact, and to the implications of mitigation policies on companies' medium-term earning prospects, a somewhat heightened level of financial instability cannot be ruled out.



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<sup>1</sup> IMF (2016) *op.cit.*

<sup>2</sup> [http://aodproject.net/wp-content/uploads/2017/04/AODP-GLOBAL-INDEX-REPORT-2017\\_FINAL\\_VIEW.pdf](http://aodproject.net/wp-content/uploads/2017/04/AODP-GLOBAL-INDEX-REPORT-2017_FINAL_VIEW.pdf)

<sup>3</sup> Financial times, July 20, 2017.