



ALIGNING FINANCE FOR THE NET-ZERO ECONOMY:

new ideas from leading thinkers

#4 FINANCE 2030: A TIME TRAVEL EXERCISE

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in partnership with



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ABOUT THE RESEARCH

This report is part of 2DII's long-term risk management research program, which aims to integrate long-term risks, especially those related to climate change, into financial markets and supervisory practices. The program combines a number of current and past research streams, including the Tragedy of the Horizons research project (2015-2017), 2DII's work on climate and sustainability stress-testing, and its broader research initiatives on integrating long-term risks into private sector and government practices. The program is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag. This report also received funding from EIT Climate-KIC.

Disclaimer

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Foreword

Eric Usher, Head of UNEP FI &
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Since the 2015 Paris Agreement, conditional pledges have fallen well short of the target of holding the global temperature increase to well below 1.5°C above pre-industrial levels. To reach the aim of decreasing global greenhouse gas emissions annually by 7.6% up to 2030¹, we need to increase collective ambition by more than fivefold over the next ten years.

The low-carbon transition will require the integration of climate action into the economic, social and environmental dimensions of development: a distinguishing feature of the 2015 UN Sustainable Development Goals (SDGs). Interlinkages within and across the goals have been created to build on lessons from the past that sustained systemic change cannot be achieved through single-sector goals and approaches. Investing in climate-resilient infrastructure and the transition to a zero-carbon future can drive job creation while increasing economic, social and environmental resilience. Investing in innovation will further reduce the costs of climate change and generate

options for alternative business models and ways of living that contribute to economic stability and to a smooth transition.

Short-term thinking in investment cycles and in ideas of economic value are acting to prevent the 1.5°C transition we need, and this will require transformation and innovations in the financial system. Financial institutions play a leading role in allocating and pricing the investment necessary for business development and economic growth. Our financial systems cannot afford to view investments in economic recovery as separate from the sustainability agenda. Therefore, financial actors need to embrace new concepts of value, monetization and externalities, and to address underlying behaviours and mindsets, including short-termism, that govern choices and decisions. Above all, the financial system needs to redefine what it is in service of.

Reviews of the effectiveness of research and innovation activities funded by Europe's Horizon 2020 programme have led to calls for more systemic and cross-sectoral approaches, breakthrough thinking

¹ United Nations Environment Programme (2019) Emissions Gap Report 2019. Nairobi, Kenya. Available at: unenvironment.org/resources/emissions-gap-report-2019

and solutions, deep demonstration projects and social inclusion through citizen engagement and participation. The final Report from the High Level Panel of the European Pathways to Decarbonisation initiative, released in November 2018, specifically calls for a focus on: “system-level innovation, promoting sector-coupling so that the individual elements of decarbonisation fit together in a coherent whole” and recommends the establishment of large mission-oriented programmes of a cross-cutting nature for the deployment of system-level transdisciplinary innovation.²

In the meantime, the coronavirus pandemic has triggered a major global public health and economic shock. We can draw comparisons between pandemics and the climate emergency: as systemic, non-stationary, non-linear, risk-multiplying and regressive shocks. Many countries have been unprepared for a global shock of this scale and it is clear that we must collectively build a more coherent response to the potentially more disruptive climate emergency and build an anti-fragile capability for resilience and renewal.

The pandemic has also shown that business-as-usual cannot deliver the necessary emissions reductions. Despite international travel plummeting, factories scaling down production, and employees working from home, the annual drop in emissions has only been around 8% and unemployment has soared. Emergence from lockdown in China, for example, has shown that emissions quickly reach or even exceed pre-COVID levels,³ while government stimulus packages have only partially delivered transition-oriented funding and, in some cases, thrown a lifeline to high emissions industries.

Leading banks and investors have recognised that there is no alternative to a low-emissions, sustainable economy. Convened by UNEP FI and partners, the Net-Zero Asset Owners Alliance and the Collective Commitment to Climate Action by banks worldwide, have brought together over 70 financial institutions, committed to working with governments and other stakeholders, to support the financial and economic transformation needed to help deliver the Paris Agreement by aligning financial portfolios with the corresponding emissions pathways – a step that was hitherto unheard of – and deliver what the IPCC report calls, “rapid, far-reaching and unprecedented changes in all aspects of society”.⁴

However, the climate emergency will require current thinking and paradigms to be challenged and questioned. This is why EIT Climate KIC, in partnership with UNEP Finance Initiative, is convening leading thinkers to present their ideas for sustainable financial and economic transformation. We hope that this inspires financial actors to work across the field to draw up a financial system that enables the low emission societies of the future.



Eric Usher
Head of UNEP FI



Dr. Kirsten Dunlop
CEO of Climate-KIC

² European Commission (2018) Final Report, High Level Panel of the European Pathways to Decarbonisation. Brussels, Belgium. Available at: op.europa.eu/en/publication-detail/-/publication/226dea40-04d3-11e9-adde-01aa75ed71a1

³ World Economic Forum (2020) China’s air pollution has overshoot pre-pandemic levels as life begins to return to normal. Geneva, Switzerland. Available at: weforum.org/agenda/2020/07/pollution-co2-economy-china/

⁴ IPCC (2018) Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C. WMO, Geneva, Switzerland. Available at: ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/



THERE IS
NO

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B

Aligning Finance to the new carbon economy: new ideas from leading thinkers

Series Introduction

The IPCC Special Report, released in late 2018, highlighted the urgency of minimising global temperature rise to 1.5°C and emphasised the need for systems transitions that can be enabled by investments in climate change mitigation and adaptation, policy and acceleration of technological innovation and behavioural changes (IPCC; 2018). Amongst the emissions pathways scenarios, it proposed, for the first time, a limited or no overshoot scenario – the P1 low energy demand (LED) scenario, where future energy demand could be met through low-emission energy sources and enhanced energy efficiency. This scenario presupposes that system changes are more rapid and pronounced over the next two decades.

Five years after the Paris Agreement, and with calls by the IPCC for urgent action in the coming decade to prevent climate change catastrophe, 2020 was billed as a key year for climate action. The COVID-19 crisis that has accompanied this year marks a point of transformation for the economy and society: it has demonstrated how remarkable and rapid systems change can be. The global pandemic has given us a clear opportunity to pave the way for building back better and establishing new norms,

as well as lessons that can inform how we might face the unabated climate crisis and future climate shocks.

A paradigm shift is needed if we are to move towards a limited or no-overshoot climate scenario. Stakeholders in financial markets, capital and investment represent important levers of change, as they have a key allocative role in society, and can enable investment into a net-zero low-energy future. Financial intermediaries can effectively support and enable societies to mobilise the investment required for the systems change needed to transition economy and society onto a net-zero pathway that is compatible with 1.5°C by 2100.

EIT Climate KIC has been working over the past decade to catalyse systemic transformative change through innovation and has supported the development and uptake of innovations that could help financial markets scale up investment in green technologies and transformative alignment. Action has to move beyond disclosure of climate-related financial risks towards proactive interventions, from engaging the world's emitters to set GHG reduction targets that are sufficiently ambitious, credible and science-based to investing in, financ-

ing and helping enable the breakthrough technologies and business models of the future. Moreover, a focus on the role of regulators, fiduciary duty and other fiscal incentives is imperative to understand how we might reset the rules to develop a more regenerative and resilient economy.

The United Nations Environment Finance Initiative (UNEP FI) is a partnership between UNEP and the global financial sector to mobilise private sector finance for sustainable development. UNEP FI has been leading two initiatives, which aim to move beyond a passive risk disclosure perspective to a more active engagement of private sector actors in committing to meet the objectives of the Paris Agreement and support the low-carbon transition. 38 banks have committed to align their portfolios with Article 2.1c of the Paris Agreement under the aegis of the Principles for Responsible Banking, while UNEP FI has partnered with PRI, WWF, and Mission 2020 to launch the Net Zero Asset Owner Initiative, bringing together 29 institutional investors as of September 2020 to commit to net zero emissions by 2050.

EIT Climate-KIC has therefore partnered together with UNEP FI to produce this thought leadership series that aims to inspire financial actors worldwide to move from risk to alignment, challenge current assumptions around climate alignment and develop ideas and concepts on how alignment can best be achieved. We hope to encourage stakeholders that a proactive climate response is not only about disclosing risks, but also about investing in green opportunities that can enable the low emissions societies of the future. This series convenes innovators and industry experts to provoke discussion, challenge the status quo and guide the transformation of business and finance towards a sustainable future.

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THE PAPERS IN THIS SERIES WILL RESPOND TO A NUMBER OF KEY QUESTIONS :

- What economic system transformation is actually required to deliver the Paris Agreement?
- How do financial institutions achieve alignment with the Paris Agreement and how does it differ from transition risk transparency as captured in the TCFD?
- What is the future of financial institutions as a result of these changes?
- What are the various strategies and action tracks through which financial institutions can enhance and achieve full portfolio alignment?
- What are the pathways and choices needed for financial institutions and the financial system to drive an active transition to a net zero-carbon economy?



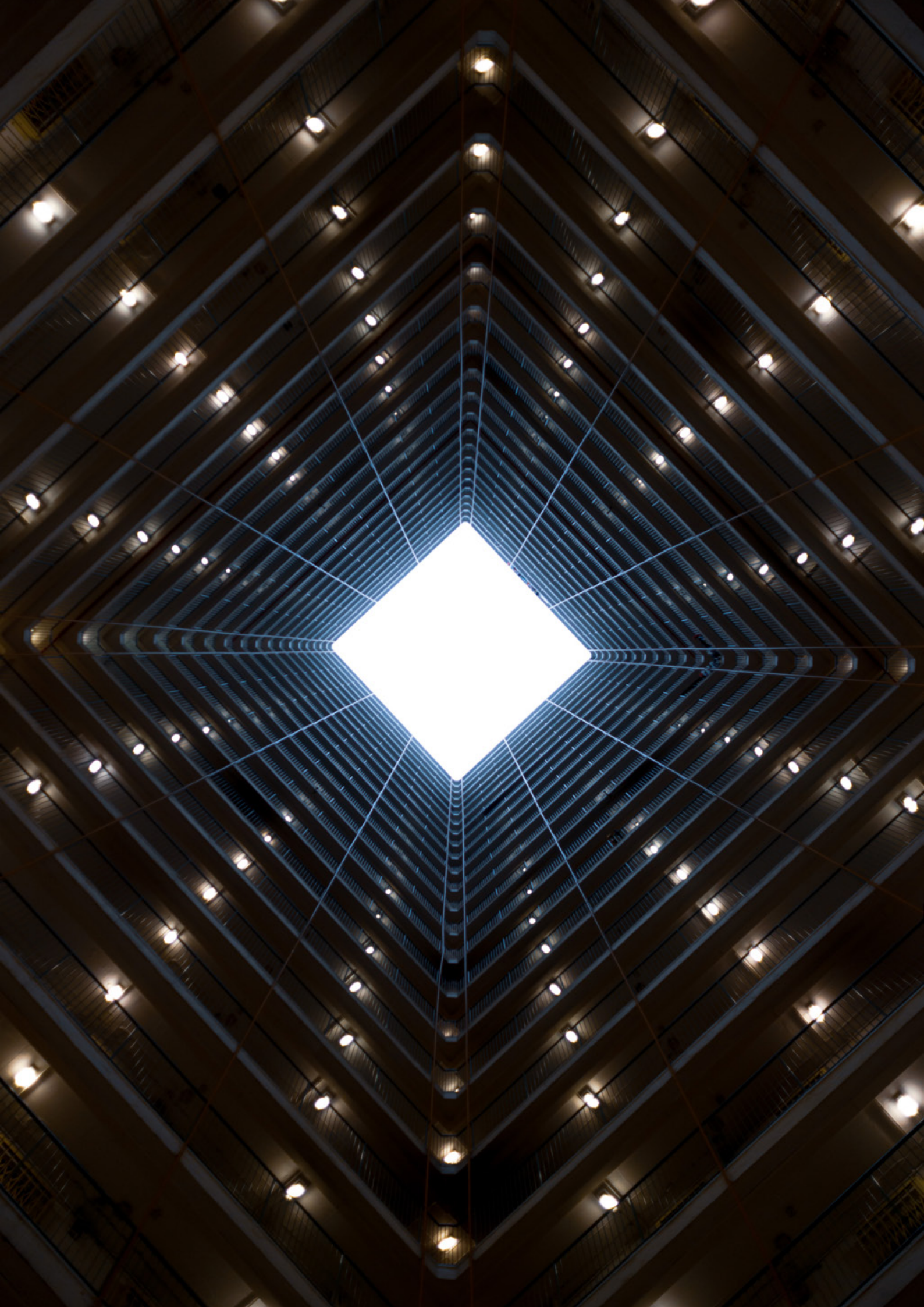
Jakob Thomä

Jakob Thomä is Managing Director of 2° Investing Initiative Deutschland. He co-founded the 2° Investing network in New York and Berlin and manages the think tank's research on climate scenario analysis and stress-tests for financial institutions and companies, as well as its supervisory and governmental partnerships. Jakob led the development of the first climate scenario analysis tool for financial portfolios, applied by over 1,000 organizations around the world running about 600 portfolio tests a month. The tools are used by one third of the largest 75 banks, and the Japanese, European, and California financial supervisory authorities. He authored the first COVID-19 stress-test scenarios, informing the regulatory response of supervisors in Europe and the United States to the crisis. Jakob also leads the organization's partnerships with a number of financial supervisors and governments in Europe, including as Advisor to EIOPA, Special Research Fellow to the Japanese Financial Services Agency, and previously as Academic Advisor to the Bank of England. He holds a PhD in Finance from the Conservatoire National des Arts et Metiers. Jakob is also Senior Fellow at the School of Oriental and African Studies, University of London, where he teaches a Green Finance course.



Anne Schönauer

Anne Schönauer joined 2° Investing Initiative in 2020 and is based in the Berlin office. She manages projects for the long-term risk management research program which aims to integrate long-term risks, especially those related to climate change, into financial markets and supervisory practices. Prior to joining 2° Investing Initiative, Anne worked as a research assistant at SOAS University of London in the area of decarbonising monetary policy. She also gained experience in the public sector, with experience at the German Federal Ministry of Education and Research, the German international development agency, as well as at a public sector consultancy and an economic research institute. Anne holds a MSc. in International Finance and Development from SOAS University of London, where she specialised in sustainable finance and monetary policy. She holds a bachelor's degree in Philosophy and Economics from the University of Bayreuth.



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⋮ Executive Summary

CONTEXT

This paper is an exploration into the key characteristics that will define the finance sector in 2030. Accordingly, we have organized the paper around four key characteristics of the future economy that will shape finance: Controlled, Automatic, Local, Low-Carbon & Resource (“CALL” for short). “Controlled” refers to the increasing control that consumers and companies have on each other, for example consumers through social media campaigns and companies through the use of micro-data or the supervision of online activities. “Automatic” refers to the increasing automatization and the rise of the complexity of the production process with the use of robotics and artificial intelligence. “Local” refers to the increasing local delivery of goods and services that is driven by 3D printing, the reduction in the role of natural resources, and the emphasis on non-tradeable products and services. And the last characteristic “Low-Carbon & Resource” refers to the significant reduction in the use of natural resources in favor of renewable

and synthetic resources. Highlighting potential risks and opportunities, the report highlights the following implications for financial institutions and financial supervisory authorities and central banks:

Implications for financial institutions

- **Prepare for an empowered consumer base.** As there will be a shift in consumers’ expectations towards sustainability and social issues, financial institutions need to pivot towards meaningful sustainability actions in terms of financial products and services.
- **Engage in technology and the promise of a redefinition of the financial sector.** Financial institutions will need to compete digitally and should prepare themselves to use technology as a tool to reduce transaction costs.



- **Manage long-term risks.** Financial institutions should broaden the scope of thinking about long-term risks; i.e. recent commitments to climate actions need to be backed up by a broader commitment to long-term risks management including events like pandemics, terrorist attacks or nuclear catastrophes.
- **Support the public and economic policymakers in understanding and navigating the transition.** Since central banks own the richest research resources and have unique access to data, central banks should play a role in supporting governments in understanding the trends that are highlighted in this report.

Implications for financial supervisory authorities and central banks

- **Regulate for the economy and financial sector of tomorrow.** One crucial step is to anticipate the risks of tomorrow, as done in this paper. Only if financial supervisors and central banks do this will they be able to prepare for calculable risks, for example how to effectively regulate algorithms that replace humans in decision-making processes.
- **Supervise long-term risks.** Financial supervisors and central banks need to manage long-term risks through effectively measuring, monitoring and mitigating long-term risks.
- **Align practice with mandates.** As research showed, supervisors and central banks already have some sustainability mandates that are still not actioned today. At the same time, central banks' mandates related to financial stability are almost always interpreted to have financial stability among the business cycle. Central banks should extend such time horizons and also officially include long-term supervision in their mandates.

⋮ Introduction

This paper forms part of the UNEP FI / EIT Climate-KIC Thought Leadership Series and is a thought experiment into the key characteristics that will define the finance sector in 2030. It outlines those key characteristics about the likely economic transition over the next decade and evolution set to take place in parallel. To do so, the paper is organized around the idea that the finance sector and economy of tomorrow can be described across four key characteristics: Controlled, Automatic, Local, and Low-Carbon & Resource (“CALL” for short). By looking into the future and characterizing economic and financial trends, the paper identifies potential opportunities and risks that the world of tomorrow will face.

Of course, some of the identified trends in this paper are already visible today and may emerge before 2030. Others are more long-term, while other trends surely will be missed in this discussion and are not yet on the radar of the authors. Perhaps even for society more broadly, as yet unanticipated realities will shape the future. However, whatever the actual future may be, the authors contend that the implications are likely to hold even under various scenarios. They are not contingent on a

specific set of events materializing, but rather a representation of ideas that will shape our future and ways to prepare for them.

Notably, the paper does not seek to prove or necessarily even convince but is designed as a journey for the reader into thinking about a different type of financial system and the implications for financial institutions, as well as for supervisors and central banks. Even though not comprehensively treated in this paper, the authors also recognize when talking about the finance sector that many different agents with different roles and interests are involved and thus, naturally, each agent will deal with the trends differently.

The paper has three sections. Section I discusses the CALL concept in terms of how it will shape the economy as a way to provide context to the finance sector trends. Section II describes a potential trajectory for the finance sector as it adapts to the changing economy and shapes it. Section III concludes by briefly summarizing key implications for financial institutions, as well as for supervisors and central banks that monitor and regulate these institutions.



Section 1:

Economy 2030

1.1

ECONOMY 2030

In order to understand what the financial sector in 2030 will look like, the point of departure has to be the question, “What the economy will look like?” 2° Investing Initiative (2DII) (2019a) outlined the idea of the “ALL” economy in 2030 – automatic, local, and low-carbon & resource. This framework is updated in this paper to add another feature or characteristic – “controlled” – representing the idea that the economy in 2030 will involve a significant increase in the control mechanism between economic actors – in both directions.

The “CALL” economy – Controlled, Automatic, Local, and Low-carbon & resource is briefly outlined below, copying in part from the ideas first presented in 2019 (2DII, 2019a).

i. Controlled

Citizens and consumers may be empowered through technology to exert significantly more control over brands – the US debate around “cancel culture” and the effects that social media campaigns (notably around climate) have had in 2020 alone on corporate decision-making. Already, campaigns like “Sleeping Giants” in the United States are using public pressure from consumers to change ad buy behavior on Fox News (New York Times, 2018) for example.

On the other hand, governments and companies have more control over citizens and consumers through microdata, surveillance, and supervision of online activities, and also the expansion of hardware control mechanisms in some countries (Business Insider, 2018) (e.g. face recognition software, collection of biometric data).

The net effect of this mechanism – again something already visible today – will change the way companies interface with their consumers, with more direct feedback, more corporate accountability beyond the individual product (notably on sustainability and political engagement issues), and more input by consumers in the product design.

The issue is of course also the extent to which consumers are also more controlled. The Center for Humane Technology (2020) in San Francisco is exploring the question of how to manage that

dynamic and mitigate some of the more hazardous dynamics arising from social media and technology and have developed a set of principles that can inform that future dynamic (see Fig. below).

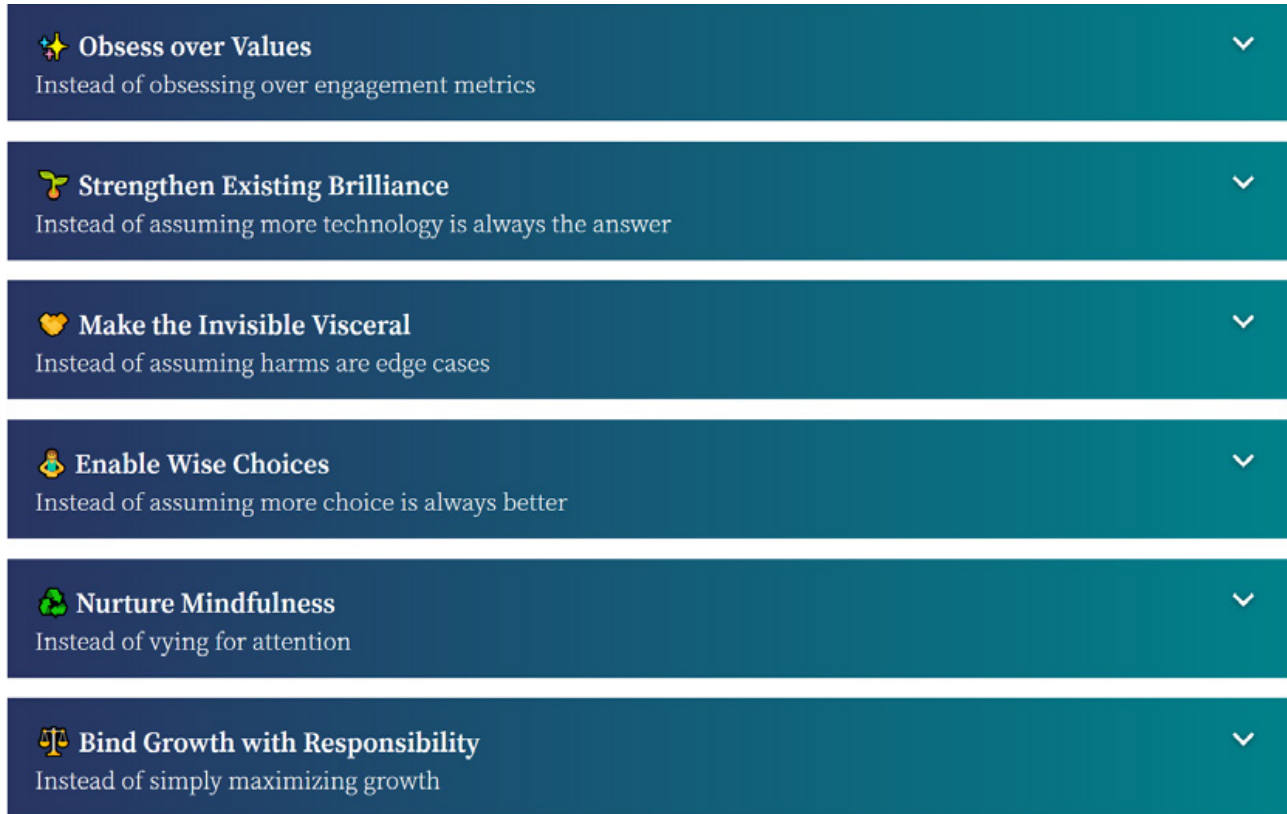


FIGURE 1: Principles for future dynamics (Source: Humanetech, 2020)

ii. Automatic

The production process will increasingly become automated, a trend that is already visible in many industries. This automation process has three key drivers:

- **Robotics.** The increasing sophistication of robotics, coupled with declining costs, will be able to replace a growing set of 'predictable

physical activities' currently delivered through human labor. According to estimates by the McKinsey Global Institute (2017), around 81% of predictable physical activities could be replaced in this way in the next decades. This will impact production in all industries and sectors, with around 5-10% of professions subject to over 90% of their roles becoming automated.

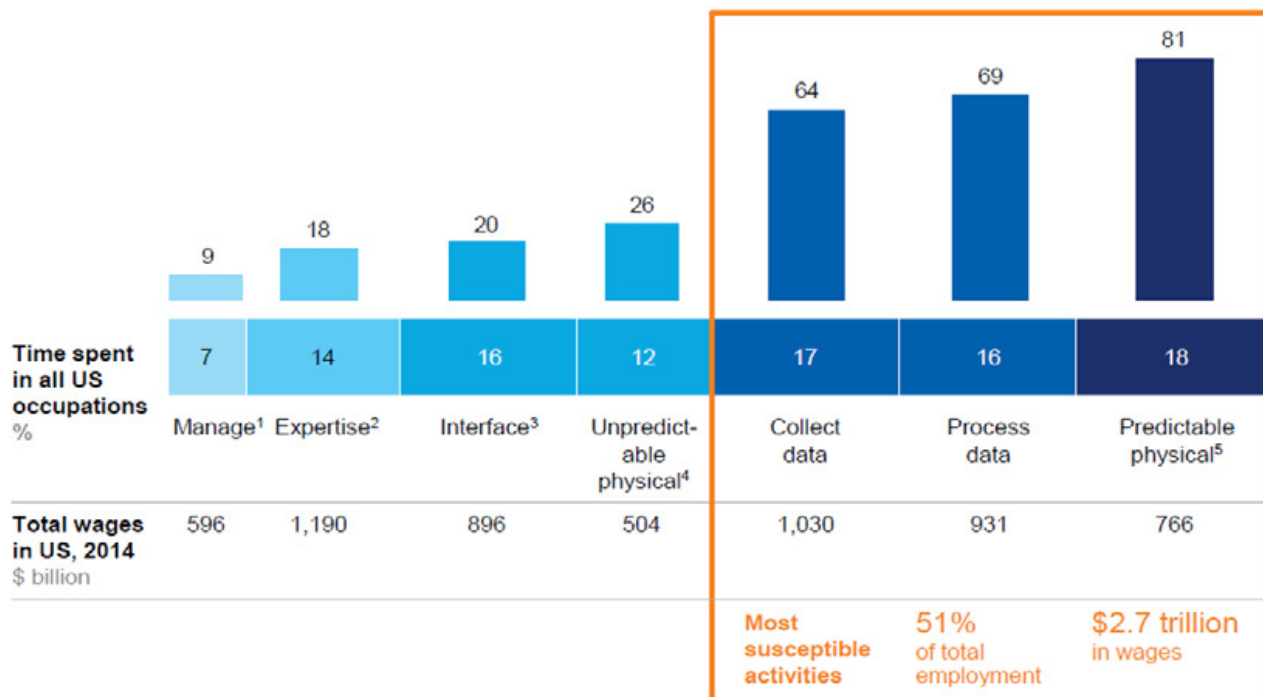


FIGURE 2: Time spent on activities that can be automated by adapting currently demonstrated technology (in %) (Source: McKinsey Global Institute, 2017)

Source: McK

- Artificial intelligence.** Artificial intelligence involves machines that exhibit human-like intelligence for specific tasks or in the case of super-artificial intelligence, the whole suite of human intellect and beyond. It can relate for example to the capacity to process and respond to text (e.g. AI assistants) or estimate the movements of financial asset prices (e.g. AI traders). In the short-term, this will be particularly relevant for activities related to processing and collecting data, with an estimated automation potential in the mid to high 60%, and eventually advance to more complex activities such as interfacing with stakeholders, decision-making, planning, etc. As machines deploy artificial intelligence, they will replace a growing number of human tasks (Chui, Manyika & Miremadi, 2016).

- Rise of complexity.** A corollary, but distinct trend from the two mentioned above will be the rise of complexity in production processes. This increased complexity is driven by the growing inability of humans to replicate the

capabilities of the combination of robotics and artificial intelligence. As we access new production techniques – for example in the context of nanotechnologies – we will need to deploy non-human labor immediately given the “baseline” complexity. The demand for non-human labor will likely accelerate the deployment of the technologies described above (Chui, Manyika & Miremadi, 2016).

iii. Local and de-centralised

Another potential feature of the future economy is the increasingly local delivery of goods and services, i.e. a contraction of global supply chains. There are several drivers behind this:

- **3D printing.** 3D printing is already allowing companies to manufacture on-demand and highly bespoke parts of the supply chain. In the future, 3D printing may be able to replace a range of production inputs that now require bespoke manufacturers associated with a distributed supply chain (2DII, 2018).
- **Reduction in the role of natural resources.** A key feature of the global supply chain involves the role of commodities in it. Depending on their type, commodities tend to be highly concentrated in certain regions. The global commodity extends from agricultural commodities (primarily wheat, corn, but also coffee and rice), to minerals (copper, zinc, lithium) and fossil fuels (oil, gas, coal). As outlined in the next section on low-carbon and low-resource commodities, at least some of these commodities are likely to largely disappear from the global supply chain

over the next 30 years, most notably fossil fuels, but also potentially metals such as gold currently used in mobile phones (2DII, 2018).

- **Emphasis on non-tradable products & services.** The global economy is likely to see a growth in products and services that do not lend themselves very well to international supply chains or markets. This will be driven both by a shift in many economies to in-person services, like nursing, but also other drivers, like a potential reduction in long-distance tourism as a result of further development of virtual and augmented reality technologies (2DII, 2018). Some of this is obviously amplified by COVID-19.

The figure below highlights anecdotally the potential scale of some of these effects, notably as they relate to 3D printing, a decline in commodities, and a growing emphasis on non-tradable goods and services.

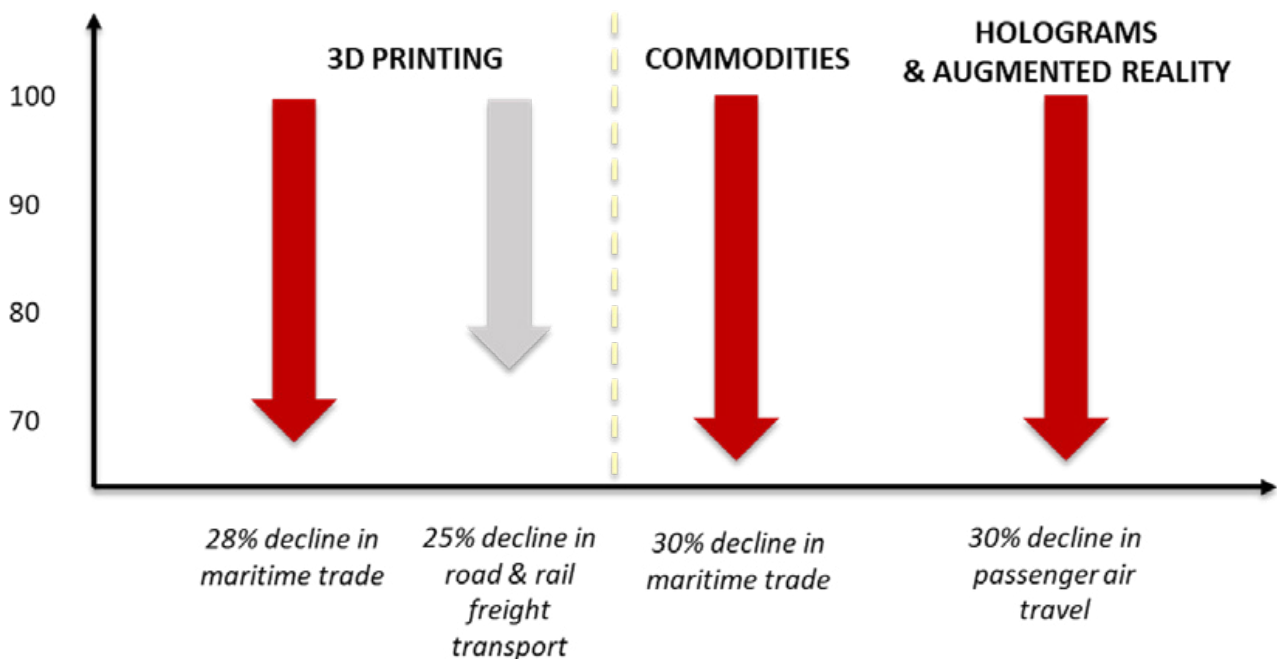


FIGURE 3: Global Trade is set to be significantly disrupted as a result of the decline in fossil fuels and the rise of new technologies (3D printing, holograms, etc.) (Source: 2DII 2018)

iv. Low-carbon and low-resource

The future economy is set to see a significant reduction in the use of natural resources in favor of renewable and synthetic resources. This will be a function both of the relative competitiveness of these resources vis-à-vis traditional extractive or semi extractive (e.g. agricultural commodities including meat) and the scarcity of natural resources. For energy resources specifically, some of this will be driven by the additional constraint of decarbonizing the economy – sustainability considerations that may also eventually extend to other resources (e.g. wood, coal, lignite). Each of these drivers will be discussed in turn.

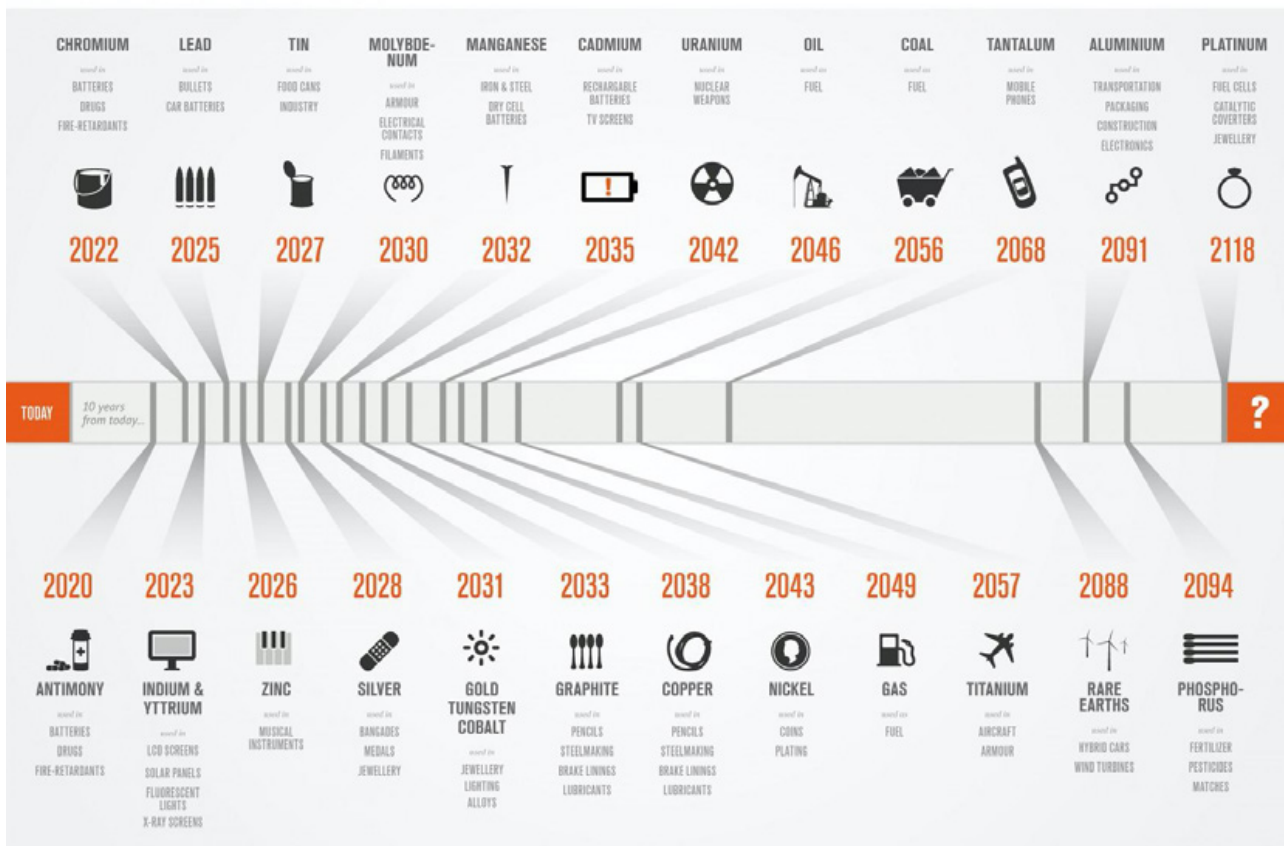
- **Peak resource.** Part of the decline in the exploitation of natural resources may be a function of their natural depletion. A series of natural resources are set to disappear in the next decades. While forecasts as to depletion have been notoriously wrong (peak oil is a case in point), even without depletion, costs of extraction are likely to go up as the low-hanging fruit disappear. This will of course potentially have negative economic effects as they disappear from the supply chain, as well as leading to new industries set to create synthetic alternatives (see bullet below) (Lampert, 2019).

- **Transition to a low-carbon economy.** The transition to a low-carbon economy is set to almost completely eliminate fossil fuels as an energy source – as well as eventually as a chemical source – in the economy. Fossil fuels by themselves account for over half of all-natural resource use – measured in monetary terms. Fossil fuels are set to be replaced by renewable energy and bio-alternatives / geomimicry in the plastic and cement sector (IEA, 2020).
- **New technologies.** Beyond drivers on the supply side, there are also drivers related to improvements in alternative technologies. Nanotechnologies will help create synthetic alternatives to natural resources. Bio alternatives and geomimicry (e.g. eggshells in the cement sector) are set to compete. While some of these alternatives also consume some type of resource, these may be synthetic, renewable, or ‘semi-extractive’ insofar as they fit more naturally in the concept of a circular economy. One significant degree of uncertainty in these trends is the potential risk of chemical alternatives to agricultural commodities and traditional foodstuffs (i.e. synthetic food). To what extent these types of alternatives (e.g. Huel) will be adopted by consumers remains uncertain (Cadwallar, 2016).



POOF!

AT THE CURRENT GROWTH RATE OF THE USAGE OF THESE NON-RENEWABLE RESOURCES, THESE PRODUCTS/SERVICES WILL SOON HAVE DISAPPEARED FROM THE FACE OF OUR PLANET EARTH. WHEN? SEE FOR YOURSELF!



Sources (minerals): US Geological Survey, Adroit Resources, World Bureau of Metal Statistics, International Copper Study Group, World Gold Council, Minormetals.com, Roskill Nickel Report, Cordell et al (2009), Smil (2000), Silver Institute, World Nuclear Association, International Lead and Zinc Study Group, Wikipedia. Source (fossil fuels): BP Statistical Review of World Energy 2010.

FIGURE 4: The disappearance of non-renewable resources (Source: Projects in Motion, 2016)

1.2

ECONOMY 2030 - THE RISKS

The changing nature of the economy also gives rise to and will be accompanied by a new (and recurrent) set of risks, increasing both in magnitude and probability. As a result, the next decades may in hindsight be considered the “era of existential risks” (Thomä, 2020a), the COVID-19 pandemic being only the opening salvo.

This section is not meant to be a comprehensive guide to these risks, but simply a sample of the types of events society is likely to face by or in 2030. The types of risks can be classified into four different categories: “risks where humans influence changes to the ecosystem (climate change), “risks where humans directly change the ecosystem (nuclear conflict & terrorism), “risks where humans are subject and largely at the mercy of exogenous changes to the ecosystem (meteorite impact), and “risks arising as a result of humans interacting with the ecosystem (biohazards). All of these four except the risks due to exogenous changes (meteorite impact) are discussed below.

i. Climate change

Climate change represents an existential risk to economic and social welfare, health, and human civilization more generally. While many of the extreme outcomes may not materialize until the end of the century, unanticipated tipping points or 'tail probability events' may dramatically alter economic activity before then. These can either be extreme events related to 'climate tipping points' that literally threaten the habitability of economic centers. They may also involve the reality of a world beset by a growing number of natural disas-

ters and irregularities in weather patterns making predictable economic planning that is contingent on these patterns close to impossible. The risk will touch every part of our lives, from the safety of air travel to the functioning of agriculture and the reliability of data and IT systems, to ultimately our health and livelihoods (Oppenheimer et al., 2014).

Climate change will need to be mitigated as rapidly and effectively as possible to reduce the scale of these events. But under all climate outcomes, investments in adaptation are needed at a massive scale to protect societies from the changing planet.

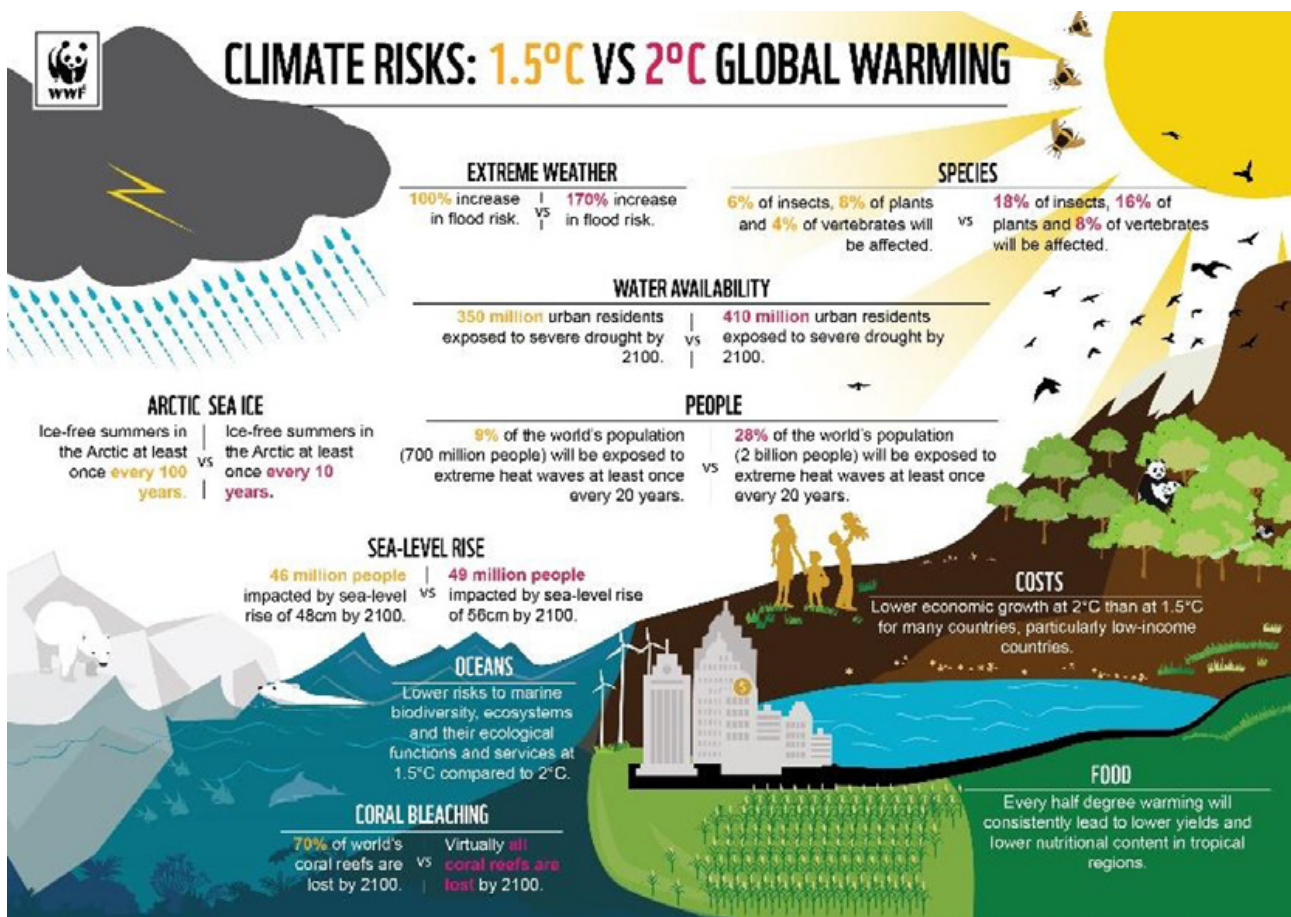


FIGURE 5: Climate risks: 1.5 Degree vs. 2 Degree global warming (Source: WWF, 2018)

ii. Nuclear conflict and / or terrorism.

Nuclear conflict and / or terrorism is at once one of the prominent and neglected mega-risks facing society over the next decade. Prominent in light of the general awareness among the public given recent nuclear crises such as the Fukushima disaster in 2011. Neglected given that there is a real and meaningful chance of accidental or intentional nuclear conflict that could lead to a “nuclear winter” and destroy large parts of the global economy. This particular risk is amplified by the continued uncertainty as to the timeline by when terrorist organizations will have access to a nuclear weapon

and the means and willingness to detonate it in a major international city. Of course, governments may also start (intentionally or unintentionally) a conflict using nuclear weapons.

Individuals working on forecasting and estimating the timeline by which terrorists will both have the means and the desire to detonate a nuclear bomb have previously suggested that a nuclear terrorist attack would be “more likely than not” by as early as 2014 (Allison, 2018). These estimates of course have been proven false, although it is clear that some terrorist actors are pursuing that route. Even a 1% probability of a terrorist organization planning a nuclear attack would render a 25% likelihood by 2030.

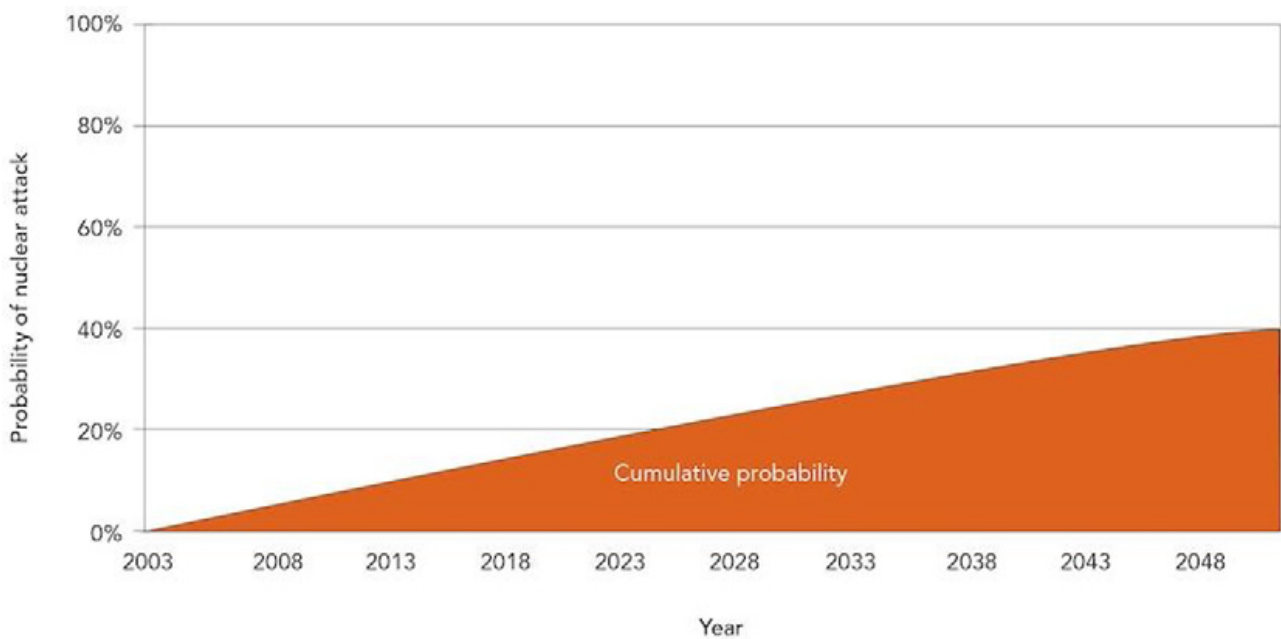


FIGURE 6: The cumulative probability of nuclear attack (Source: Allison, 2018)

The fact that we have not yet seen a nuclear bomb may be driven by a combination of the “risk” of detection, which is likely higher when procuring nuclear material than renting a van and running it through a crowd, and the potential backlash such an explosion may have for the support of terrorist groups among their “base”. For the goals of most terrorist organizations, nuclear bombs may actu-

ally be less effective than other means of violence given the likely resources that would be mobilized to destroy the group in response, the risks of trying to achieve this objective versus other means of violence, and the potential loss in moral support among the population.

Whatever the political equation, the fact of the

matter is that it seems reasonable to conclude, as is done across a range of risk assessments,¹ that a sufficiently well-funded and dedicated enterprise by a terrorist organization would allow them eventually to have the means to detonate a nuclear weapon in a major international city.

iii. Biohazards

The risks resulting from biohazards represent a fancy way of saying risks from pandemics, although of course biohazards are not exclusively a function of viruses or bacteria but may also arise from other sources. A nuclear catastrophe like Fukushima, for example, is technically a biohazard risk since it is the radioactive material released by an explosion that will be the primary driver of the impact rather than the immediate “explosion” of the nuclear reactor itself.

Given that we are currently living – at the time of writing – through the most dramatic biohazard

risk and impact since the Spanish Flu of 1918, it is probably not necessary to introduce the risk and flag its materiality too much. In the United States, total COVID-19 related deaths are likely to exceed the total US deaths of World War II and by August were exceeding double those of Vietnam, Korean, and Afghanistan & Iraq War combined (Strochlic, Nowakowski & Armstrong, 2020; Worldometers, 2020). The economic impact is set to exceed at least in GDP contraction terms that of the Global Financial Crisis in 2008 (Tooze, 2020).

It is worth remembering that pandemics are likely to be more regular events in the future and “near misses” with Ebola and SARS (at least in terms of global effect) are a testament to the potential regularity of the risk. The US-based organization Metabiota tracks pandemic risks as part of an Epidemic Tracker and at the time of writing identified 8 epidemics tracked globally. As well as a range of regional hotspots (see Fig. below).

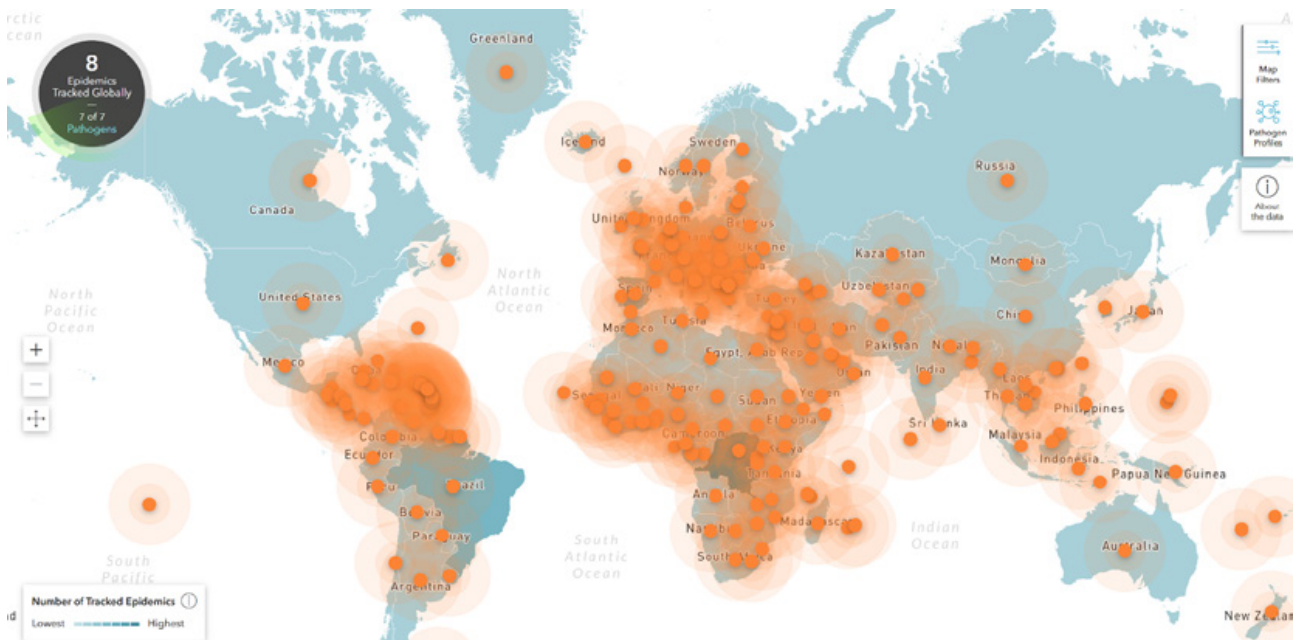


FIGURE 7: The Epidemic Tracker (Source: Metabiota, 2020)

¹ see e.g. Bunn (2009), Bunn and Wier (2006) or UCSUSA (2008)



Section 2:

Finance 2030

2.1

FINANCE SECTOR 2030 – THE OPPORTUNITIES & RISKS

The risks and opportunities facing the global economy over the next decade will fundamentally shape the nature of financial services and the sector more broadly. The “CALL” reality of the economy in the next 10 years can be transposed to financial services. Finance too faces a control, automation, localization, and low-carbon and resource revolution.

i. Control

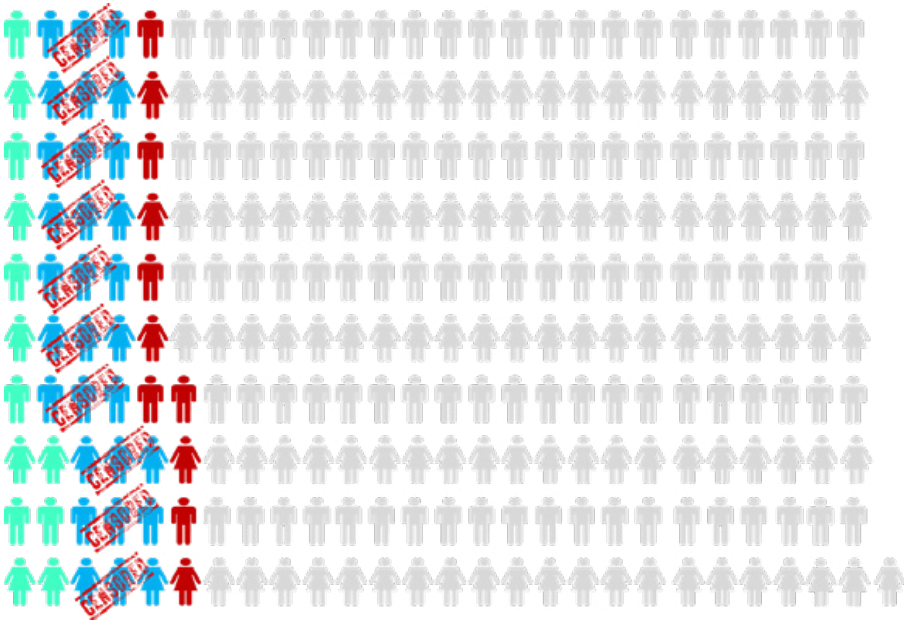
The era of “control” and changes in power dynamics will also radically change the relationship between consumers, savers, and providers of financial services. There are two areas in particular where this trend will be particularly prominent:

- **The “democratization” of finance through shareholder voting power.** Technology and

changes in social norms will fundamentally change the way retail investors and beneficiaries of insurance products and pension funds will seek to wield their power as owners of capital (shares). Currently, less than a quarter of retail investors vote regularly at annual general meetings (AGMs) compared to around 80% voting from institutional behaviors (2DII, 2020). The net voting patterns however suggest that voting practice from institutional investors is systematically misaligned with the interests and wishes of the ultimate beneficiaries. As outlined in a study from March 2020, it can be assumed that climate resolutions at companies would get the majority support of retail investors if their expectations were considered (2DII, 2020). Already now, fintech is breaking open the door to allow retail investors and ultimate beneficiaries to have their say and “vote for Paris” (i.e. the Paris Agreement climate goals) (2DII, 2020). These technology trends will be amplified by policy initiatives designed to strengthen retail investors’ voice, the requirement for suitability of financial products to extend to non-financial objectives (including how the product is managed in terms of voting patterns), and expanded concepts of fiduciary duty and consumer protec-

tion in finance. All this will drive a future, where citizens and savers will “vote with their money” with the same ease as they vote for parliamen-

tary or presidential elections, and a reduction in transaction costs making such voting increasingly accessible and popular over time.



We estimate that over 60 million EU pension fund beneficiaries and members are “forced” to vote against the Paris Agreement...

...either directly through climate resolutions or indirectly through being forced to vote for management that doesn't align with the Paris Agreement.

FIGURE 8: Vote for Paris – vote with money (Source: 2DII, 2020)

- The big data revolution in finance.** The second key driver of control is the ability for financial institutions to use the incredible body of data they are in the process of collecting from consumers through the provision of payment services. As will be outlined in the next section, this data collection will help drive an expanded suite of services beyond narrow financial services. This de-financialization of finance in terms of types of services and products offered by nominally financial institutions will start to mirror the changing perception of companies like Tesla not as a car company but as a technology company. At the same time, however, this data collection comes with new challenges and evolution of the social norms and expectations. It will create new and elevated responsibilities for safeguarding the privacy and good conduct. It will also potentially increase the expectations from policymakers for the provision of information, the tackling of financial crimes, money laundering, etc. Many of these regulations are already emerging and finding a home under a burgeon-

ing industry called “regtech” (Arner, Barberis & Buckley, 2017). Finally, big data will also change the nature of investment and lending decisions and the information that drives these decisions. This is already in many areas of finance “normal business”. Hedge funds using satellite data to measure the cars in Walmart parking lots as a way to anticipate quarterly sales (Partnoy, 2019). Institutional investors using asset-level data to gauge climate transition risk and increasingly physical risk as well (PACTA, 2020). Indeed, this area is probably the one where 2020 is closer to the future described here than 2030 and indeed, in parts, already here.

PANEL 1:

Asset-level data and climate change

Asset-level data is revolutionizing the way climate-related risks are measured and managed in financial markets. By using micro-level data on individual industrial assets, these datasets allow for geolocational mapping of production sites, their physical risk exposure, and of the micro-tracking of emissions. Coupled with satellite data, and new ways to track information, asset-level datasets provide live granular environmental information in a way that circumvents traditional corporate reporting and fills crucial gaps where such reporting is missing. Asset-level data informs climate analytics of the PACTA tool developed by the 2° Investing Initiative, used by over 1,000 financial institutions around the world, as well as the work of commercial tools from Moody's 427 and MSCI Carbon Delta. The map below shows the location of global coal-fired power plants.

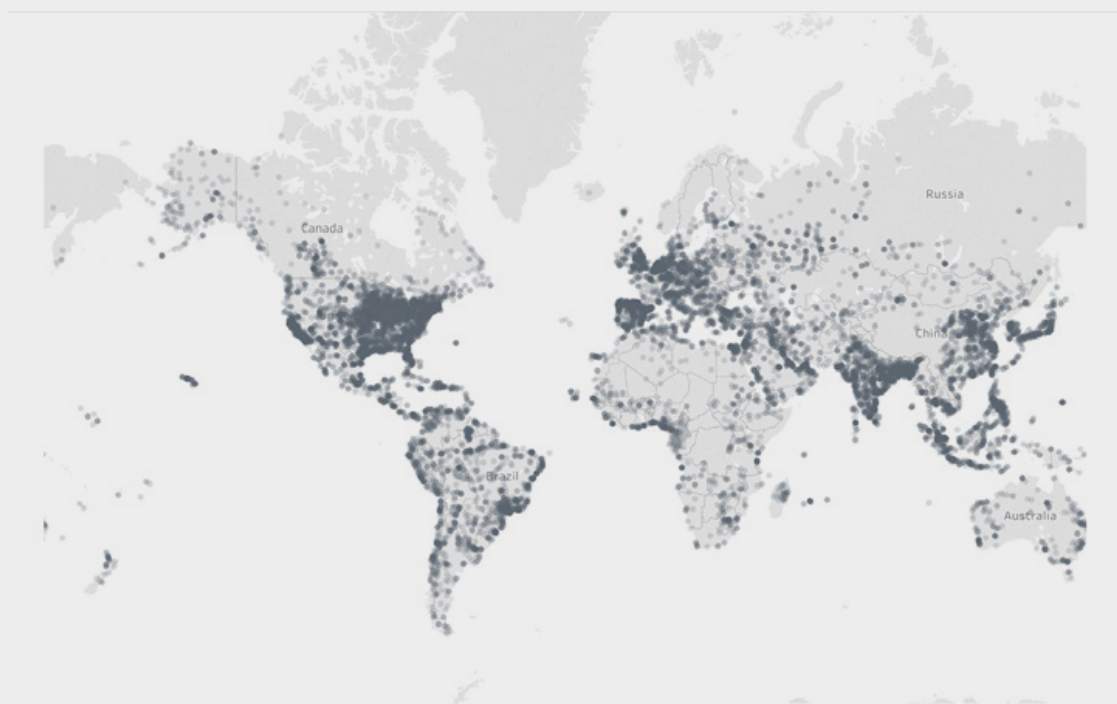


FIGURE 9: Location of global coal-fired power plants (Source: 2DII, 2019b)

ii. Automatic – Fintech revolution

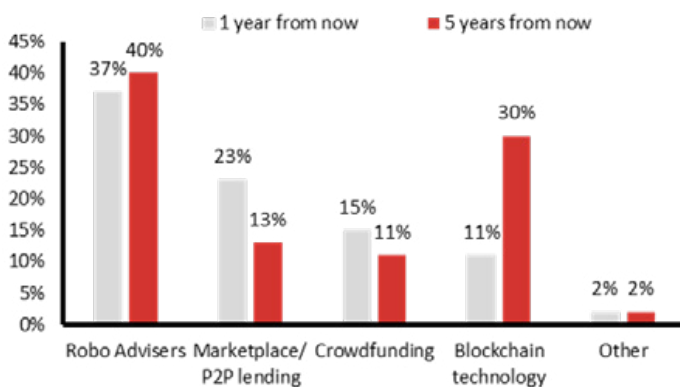
Automation and technology more generally will change the way banks operate. This process is already underway, perhaps nowhere more so than with the rise of algorithm trading, estimated to be

behind upwards of 80% of all trades in capital markets (Bigiotti & Navarra, 2019). It also is increasingly changing the make-up of the “technology” or process behind the delivery of financial services. Obviously, technology represents an incredible opportunity for the expansion of financial services

but also the risk of obviating the original need for a bank.

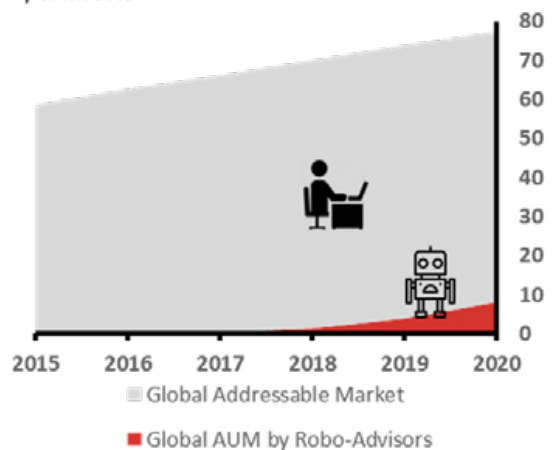
- Traditional use case of a bank.** Fintech is often perceived as an economic trend or activity that disrupts traditional banks or other types of financial services by using technology to deliver the services differently. A growing share of the fintech market goes to companies designing products and services that traditional financial institutions do not actually offer. Peer-to-peer lending platforms and crowdfunding solutions that partly or fully 'cut out the middleman' are on the rise, as well as new forms of retail investing that give users more agency in portfolio design and strategy. The common feature of these trends is the extent to which they eliminate the 'bank' or 'investment manager' in its traditional form and provide a different service. Of course, some of these initiatives also create new "services" entirely, notably in terms of supporting citizens on considering sustainability issues, polling services to engage beneficiaries
- Opportunity to improve business.** The flipside of fintech representing a threat is the extent to which it represents an opportunity. Ability to market a new and expanded set of services, coupled with evermore data collection capabilities put financial institutions into a unique position to retail "non-financial services". Some of this will come through the natural integration of start-up companies' business models into larger organizations, as can be seen in the wave of acquisitions of climate data organizations, and some of this will come through internal innovation. One fascinating area in this regard is the role that financial institutions may play in the future in steering and advising on non-financial consumption choices. First initiatives around carbon footprinting and consumption management represent interesting case studies in that regard.

The growing use of FinTech is likely to change existing processes in financial services. Robo-advisers are expected to have the greatest impact on the sector in the short term



Source: CFA Institute see page 15

Market share for Robo-advisers in \$Trillions



Source: Business Insider see page 1!

FIGURE 10: The rise of technology in financial markets (Source: 2DII, 2017)

iii. Local – Intermediation and fragmentation

The concept of local services seems perhaps misplaced when envisioning the future of finance. One would assume that a departure from “brick and mortar” banking would lead to less ‘local’ business models and centralization of services through digital banks like N26 in many European countries. This trend is clearly visible and seems set to continue. However, a parallel trend entails the increased emphasis on local lending practices among consumers, the rise of local currencies, and the potential future relationship of these currencies to local lending and spending practices (Naqvi and Southgate, 2013). As a result, a local economy for financial institutions can mean more access, but also different expectations.

- **Risk of changes to user expectations and intermediation.** A stronger emphasis on local economic activity is likely to translate into changes in user expectations around what happens with their money. Some of this is captured in the growing interest in ESG products, crowd-funding, and citizen engagement with banks as

a proxy for changes to expectations. This trend is likely to also translate into a desire to bank locally and ensure money is invested locally. In this regard some banks increasingly try to meet such demands, such as some local banks.² Nevertheless, meeting that demand requires – at least for some financial institutions – new capabilities and will likely benefit existing banks that can cater to that demand (e.g. cooperatives, local savings institutions). What may be seen as a return to local lending however will not absolve financial institutions from the desire to be able to cater to these lending practices with a sophisticated digital presence.

- **Opportunity to “Bank the world”.** A cousin of the concept described above is the extent to which a more “local” economy for financial institutions comes with the opportunity to “bank the world”. Technology – through its ability to localize services by digitalizing them – can play a critical role in banking the people around the world that do not have access to financial services. Microfinance – despite some of its controversies and question marks – remains a pillar that can be built on.



FIGURE 11: The six principles of value-based banking of the Global Alliance for Banking on Values a network of local banks around the globe (Source: Global Alliance for Banking on Values, 2019)

² For more information see e.g. GLS Bank (2020) or Global Alliance for Banking on Values (2020)

iv. Low-carbon / Low-resource

The economy of tomorrow will be low-carbon and low-resource, a response to an industrial transformation that represents both dramatic risks of “stranded assets” and opportunities for new types of financial services and products.

- **Risk of stranded assets at scale.** As outlined above, the economy is set to decarbonize and shift from natural to synthetic “resources” or inputs into the production process. This transformation will strand trillions of dollars of industrial assets currently dedicated to the extraction, processing, and end-use of natural resources, in particular fossil fuels. Financial institutions banking these assets or their owners face significant risks if left unmanaged. Estimates on scale differ widely, but according to one study by Citi from 2015 exceed \$100 trillion (Gutske, 2015). Stress-test scenarios developed by financial supervisory authorities and partners suggest certain sectors may lose upwards of 40-50% of

value in the context of this economic transformation (2DII, 2019c). Unexpected technology breakthroughs will accelerate the transition and losses as the economy adjusts even faster than it would be driven purely by policy.

- **Opportunity for product innovation.** While on the one hand, stranded assets loom, the economic transformation will also change the demand for financial services on the other hand. New technologies and a shift to digital solutions will likely shift the demand for different sources of financing and its terms. To state what may be obvious, renewable power has so far been significantly more capital intensive with lower operating costs, but also more accessible to smaller companies that do not operate on the capital market. Similarly, the early innovators will be banked through credit and supported through venture capital, before they appear as the new industrial giants of tomorrow in the passive equity portfolios of large pension funds and insurance companies.

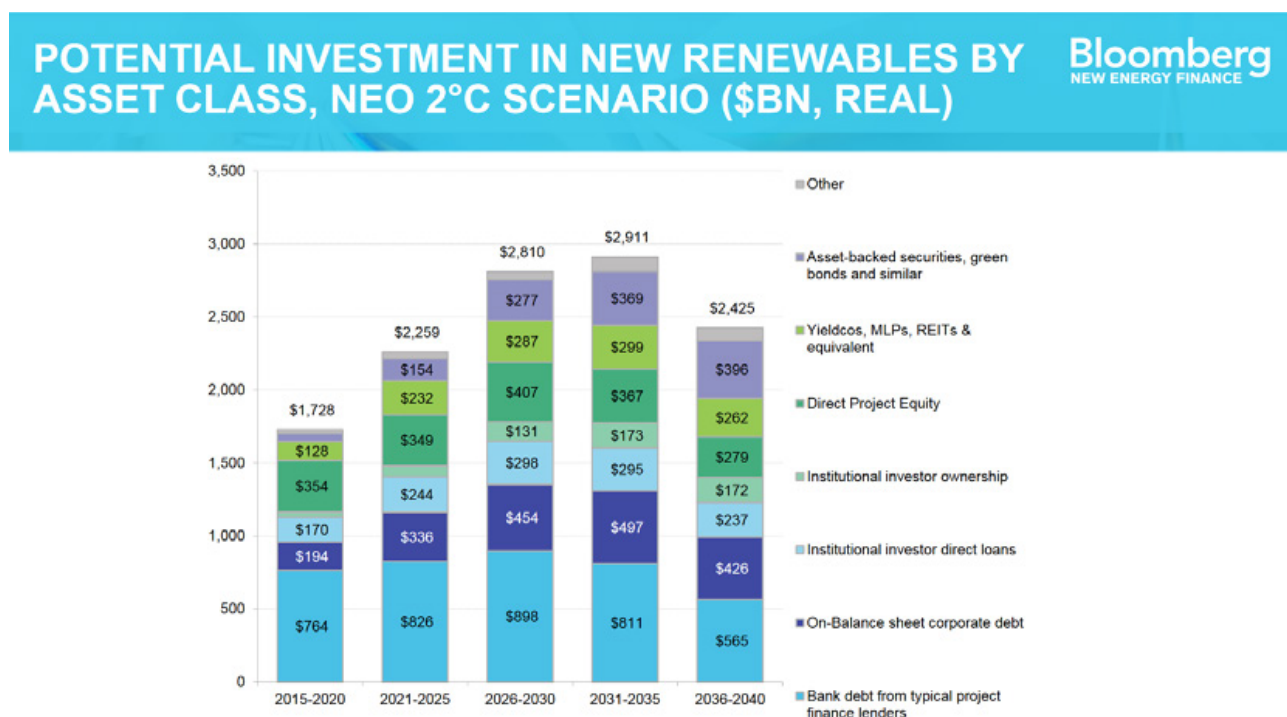
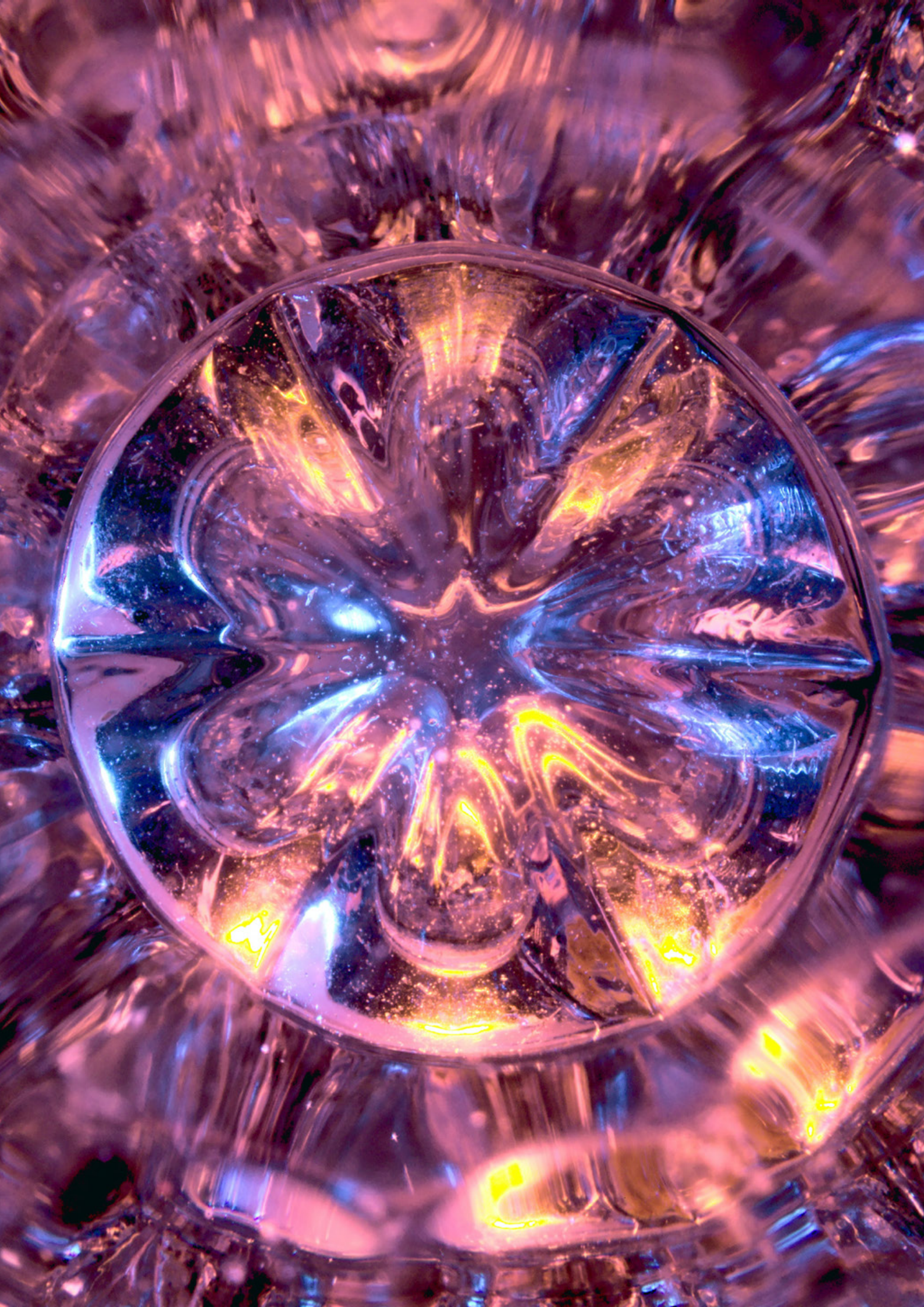


FIGURE 12: Potential investment in new renewables by asset class (Source: Bloomberg NEF, 2016)



Section 3:

Implications

3.1

IMPLICATIONS FOR FINANCIAL INSTITUTIONS

Financial institutions seeking to prepare for the brave new world of finance, and the economy in which it operates, face the following implications:

a. **Prepare for an empowered consumer base.** The future will see a shift of consumer expectations on sustainability, social issues, and their ability to exert their influence to drive corporate action. Institutions anticipating and responding to such a consumer base through their business practice and the nature of their products and services will likely win out in such a scenario. This implies pivoting towards a strong suite of meaningful sustainability actions in terms of financial products and services and implementing mechanisms and processes to ensure consumers' expectations are understood, integrated into service offerings, and respected.

- b. **Engage in technology and the promise of a redefinition of the financial sector.** Competitive banks have to be able to compete digitally: so far, intuitive and banal. The question is not if to compete digitally, but how. The key areas to explore here are expanding beyond financial services (including through supporting sustainable consumption patterns as expressed through payments), and access to new potential customers. Technology is also a critical tool in reducing the transaction costs of the intermediation of capital, especially as it seeks to continue non purely financial issues (e.g. local lending practices) that traditionally have been more expensive to deliver.
- c. **Manage long-term risks.** Competitive financial institutions will want to manage the long-term trends and risks that come with them. Climate change has arguably reached the mainstream in terms of visibility within many financial institutions around the world. The scope is broader, however, as the current pandemic, and growing threats related to other aspects (nuclear conflicts, breakdown of social order) demonstrate. Crucially, the 'commitment' to climate actions

that many financial institutions are taking needs to be backed up by a broader commitment to long-term risk management. One idea in this

regard is a “pledge” to dedicate a minimum amount of an organization’s research budget to ‘long-term risk management’.

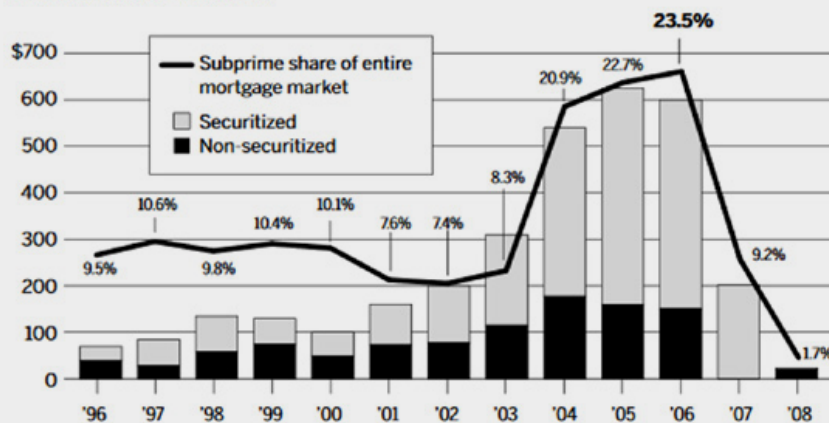
PANEL 2:

Why acting today is so important

The current pandemic demonstrates how even a few weeks of faster action could have dramatically inhibited the spread of the virus in some areas, a concept that likely equally applies to financial markets. One example is the Global Financial Crisis in 2008, where subprime lending accounted for roughly a third of all mortgage originations in the United States in 2006-2007, at a time when default rates for these loans were already increasing (Financial Crisis Inquiry Commission, 2011). Although the probability of default on mortgage loans in the first year of lending is historically very low, there was a dramatic increase in premature defaults between 2004 and 2007 which was another sign for the looming financial crisis. Even though, default rates within the first 12 months roughly increased from about 2% to 8% between 2004 and 2008 (Mayer, Pence, and Sherlund, 2008), subprime mortgage originations still increased to a new record in that time period. Thus, trying to measure and to understand such risks today, as well as implementing early warning systems that monitor the evolution of risks is crucial. Anticipating these types of risks earlier than they would have been otherwise will give more time to mitigate the fallouts.

In 2006, \$600 billion of subprime loans were originated, most of which were securitized. That year, subprime lending accounted for 23.5% of all mortgage originations.

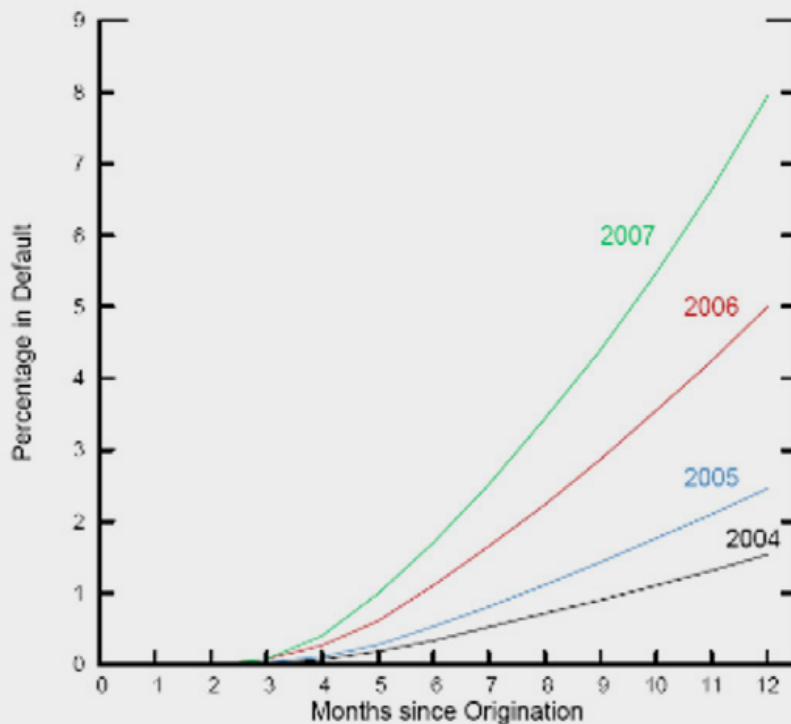
IN BILLIONS OF DOLLARS



NOTE: Percent securitized is defined as subprime securities issued divided by originations in a given year. In 2007, securities issued exceeded originations.

SOURCE: Inside Mortgage Finance

FIGURE 13: Subprime mortgage originations (Source: Garg, 2018)



Source: Calculations from First American LoanPerformance data.

Note: Figure 2 shows the percentage of borrowers with subprime mortgages in the 2004, 2005, 2006, and 2007 vintages whose mortgage balances in a given number of months were in default. Sample restricted to thirty-year, first-lien mortgages originated on one- to four-family properties in the contiguous United States. Adjustments have been made for calendar effects.

FIGURE 14: Early Payment Defaults on Subprime Loans (Source: Mayer, Pence & Sherlund, 2008)

iii. Implications for financial supervisory authorities and central banks

Financial supervisory authorities and central banks seeing these trends can prepare and shape these dynamics through the following aspects.

a. **Regulate for the economy and financial sector of tomorrow.** A critical step for financial supervisory authorities is to anticipate the nature of tomorrow's financial markets and the risks they may be exposed to. Design of policies related to investor advice, fiduciary duty, and investment research needs to anticipate the revolution

underway in these fields. One interesting example of this is the question of how to effectively regulate and supervise algorithms as they replace humans in decision-making processes. The box on the next page explores the line of thinking in this regard.

b. **Support the public and economic policymakers in understanding and navigating the transition.** Financial supervisors and central banks in particular command some significant research resources, at scale and depth often superior to the in-house research of governments themselves. Coupled with their unique data access and insights into financial markets, financial

supervisors and central banks are in a unique position to support the public and policymakers in understanding the trends highlighted in this report and the potential risks that come with them.

- c. **Supervise long-term risks.** In addition, monitoring, researching, and reporting on these risks, the crucial role of financial supervisors is of course to supervise and act on them as well in the context of the stability and efficacy of financial markets. Here, traditional instruments come to mind, although a more holistic process is likely needed for the class of “long-term risks” that supervisors will have to investigate. As outlined by Schönauer, Thomä and Caldecott (2021, forthcoming), the potential mechanism underpinning this can be a process of measuring, monitoring, and mitigating.

- d. **Align practice with mandates.** Finally, it is critical that practice is aligned with supervisors and central bank mandates. As outlined by Dikau and Volz (2019), financial supervisors and central banks frequently already have sustainability mandates that are “not actioned”. At the same time, with the NGFS initiatives underway a notable exception, mandates related to financial stability are often if not almost always interpreted to mean financial stability over the business cycle. This artificial shortening of the mandate prevents or is at the very least a barrier to long-term supervision. Aligning practices with mandates (or vice-versa) can help overcome this gap and ensure supervisors and central banks are prepared for the economy and financial markets of tomorrow.



PANEL 3:

The idea of a “Prudent Algorithm Principle”

Arguably, the two core regulatory concepts governing transactions in financial markets are “fiduciary duty” and the “prudent person principle”. According to the German financial supervisor BaFin, the “prudent person principle stipulates that insurers may only invest in assets and instruments whose risks the undertaking concerned can properly identify, measure, monitor, manage, control and report and appropriately take into account in the assessment of its overall solvency needs. All assets are to be invested in a manner that ensures the security, quality, liquidity and profitability of the portfolio as a whole.”

As financial decisions are taken over by algorithms, it raises the question as to whether the prudent person principle should be complemented by a prudent algorithm principle. One suggestion for such a concept can be found in Thomä (2020b).

“Financial institutions using algorithms to inform decision-making must ensure that both the decision-making process within that algorithm and the outcomes it suggests do not threaten or otherwise work against public policy goals in financial markets (e.g. stability). Financial institutions have the responsibility to identify for each algorithm the outcome it informs, the nature by which the algorithm can represent a threat to the public policy goals associated with that outcome, the auditing procedure by which financial institutions plan to prevent this outcome, and the ‘fail safe mechanism’ designed to prevent contagion or scaling of negative outcomes should they materialize. The Prudent Algorithm Principle also confirms that financial institutions are legally liable for the outcomes created by the algorithms.”

So, the first step in deploying any algorithm is clearly defining: i) the objective of the algorithm, and ii) the mechanism by which the algorithm could hypothetically create an undesirable outcome as described above.

Second, the financial institution needs to identify mechanisms to identify whether or under which circumstances this undesirable outcome or process might come into play. Here, financial institutions can build on the burgeoning literature addressing the question of the ‘interpretability’ of algorithms. This includes random simulations at scale to identify conditions of undesirable outcomes, and targeted simulations related to specific issues (e.g. testing outputs based on input data designed to identify racism or other types of discrimination).

Third, it needs to identify 'fail safe' or response mechanisms should these undesirable outcomes or processes materialize. Crucially, the Prudent Algorithm Principle is general in the sense of not outlawing algorithms that may under certain circumstances deliver such undesirable outcomes within the Principle itself. For example, if financial supervisors want to prevent lending in sectors that involve illegal practices (e.g. child labor), then the rule needs to be built into the system itself, and one cannot rely on the algorithm to identify that independently.

Finally, the Principle does not prescribe that algorithms under no circumstances ever create undesirable outcomes. It does, however, reiterate the accountability of financial institutions for these algorithms where they break the law.



⋮ Concluding remarks

This paper represents a thought experiment around the key mechanisms, concepts, and drivers that will shape our understanding of what financial markets will look like in 2030. In doing so, it maps a series of key trends both in the economy and finance as a way to understand what kind of economy finance will experience and how the core trends driving economic change filter through to the financial sector. It uses the concept of the CALL economy (control, automatic, local, low-carbon & resource) to identify trends for finance and the economy.

As with any such exercise, the paper must marry courage in thinking about alternative futures with humility in respecting the uncertainty behind such futures. This paper erred on the side of courage. This is not meant to suggest the authors know the future. Rather, it should reflect the need to think of the future and the potential radical ways it will be different from today. Even here, it is more

likely than not that in myriad ways this paper will underestimate that radical change, driven by factors not yet on the horizon. Also exciting and not captured by this paper are the potential drivers that will accelerate or slow down one trend or another, or how even the trends might interdependently accelerate or slow-down each other (e.g. the data revolution in finance could have a major impact on the investment in green technologies).

Whatever the specific nature of future trends, the private and public sectors are likely similar. Manage long-term risks, integrate sustainability, align practice with mandates, and respond to the changing power dynamic between consumers and companies, all these issues are likely to dominate the trends over the next decades.

⋮ Bibliography

2DII (2017): Non-Financial Message In A Bottle. Available at: 2degrees-investing.org/wp-content/uploads/2017/10/Retail-savings-report.pdf.

2DII (2018): The Bigger Picture. Available at: 2degrees-investing.org/wp-content/uploads/2018/05/The_Bigger_Picture.pdf.

2DII (2019a): ...Into the fire. Financial supervision in a post-crisis/pre-crisis world. Available at: 2degrees-investing.org/wp-content/uploads/2020/03/Financial_Supervision_Report.pdf

2DII (2019b): Climate Alignment Assessment 2020. Briefing for Investors. Available at: transitionmonitor.com/wp-content/uploads/2019/12/PACTA2020_Investor_Briefing.pdf.

2DII (2019c): Storm Ahead. A Proposal for a Climate Stress-Test Scenario. Available at: 2degrees-investing.org/wp-content/uploads/2019/02/Stress-test-report_final.pdf.

2DII (2020): Retail Clients Want to Vote for Paris. Available at: 2degrees-investing.org/wp-content/uploads/2020/03/Retail-Clients-Want-to-Vote-for-Paris-1.pdf.

Allison, G. (2018): Nuclear Terrorism: Did We Beat the Odds or Change Them? PRISM Volume 7, 3 (2018). Available at: cco.ndu.edu/News/Article/1507316/nuclear-terrorism-did-we-beat-the-odds-or-change-them/.

Arner, D.W., and J. Barberis, and R.P. Buckley (2017): Fintech and Regtech in a Nutshell, and the Future in a Sandbox. Available at: cfainstitute.org/-/media/documents/article/rf-brief/rfbr-v3-n4-1.ashx.

Bigiotti A., and A. Navarra (2019): Optimizing Automated Trading Systems. In: Antipova T., A. Rocha: Advances in Intelligent Systems and Computing, 850 (2019). Available at: link.springer.com/chapter/10.1007/978-3-030-02351-5_30.

Bloomberg NEF (2016): Mapping the Gap: The Road from Paris. Available at: data.bloomberglp.com/bnef/sites/4/2016/01/CERES_BNEF_MTG_Overview_Deck_27January.pdf.

Bunn, M. (2009): Reducing the greatest risks of nuclear theft & terrorism. Available at: amacad.org/publication/reducing-greatest-risks-nuclear-theft-terrorism.

Bunn, M., and Anthony Wier (2006): Terrorist Nuclear Weapon Construction: How Difficult? The Annals of the American Academy of Political and Social Science 607, pp. 133–149 (2006). Available at: [jstor.org/stable/25097844?seq=1](https://www.jstor.org/stable/25097844?seq=1).

Business Insider (2019): Amazon adds fear detection and age ranges to its facial-recognition tech as the Border Patrol looks to award a \$950 million contract. Available at: [businessinsider.com/amazon-fear-detection-age-ranges-added-facial-recognition-rekognition-tech-2019-8?r=DE&IR=T](https://www.businessinsider.com/amazon-fear-detection-age-ranges-added-facial-recognition-rekognition-tech-2019-8?r=DE&IR=T).

Cadwallar, C. (2016): Could you stomach Huel, the food of the future? Available at: [theguardian.com/science/2016/jul/31/huel-human-fuel-hi-tech-food-powder](https://www.theguardian.com/science/2016/jul/31/huel-human-fuel-hi-tech-food-powder).

Chui, M., J. Manyika, and M. Miremadi (2016): Where machines could replace humans—and where they can't (yet). Available at: [mckinsey.com/business-functions/mckinsey-digital/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet#](https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet#).

Dikau, S., and U. Volz (2019): Central Bank Mandates, Sustainability Objectives and the Promotion of Green Finance. Working Papers 222, SOAS, University of London, UK. Available at: ideas.repec.org/p/soa/wpaper/222.html.

Financial Crisis Inquiry Commission (2011): The Financial Crisis Inquiry Report. Available at: govinfo.gov/content/pkg/GPO-FCIC/pdf/GPO-FCIC.pdf.

Garg, N. (2018): Subprime Lending and Credit Risk Management In Securitization. Available at: researchgate.net/publication/331319674_Subprime_Lending_and_Credit_Risk_Management_In_Securitization.

Gutske, C. (2015): The fossil fuel-free future of mutual funds. Available at: [cnn.com/2015/11/02/few-mutual-funds-prepared-for-this-100-trillion-global-risk.html](https://www.cnn.com/2015/11/02/few-mutual-funds-prepared-for-this-100-trillion-global-risk.html).

Global Alliance for Banking and Values (2020): About us. Available at: gabv.org/about-us.

Global Alliance for Banking on Values (2019): Annual Report 2019. Available at: <file:///C:/Users/Anne/AppData/Local/Temp/Annual%20Report%202019%20EN.pdf>.

GLS Bank (2020): English Portrait. Available at: [gls.de/privatkunden/english-portrait/](https://www.gls.de/privatkunden/english-portrait/).

Humanetech (2020): For Technologists. Principle of Humane Technology. Available at: [humanetech.com/technologists](https://www.humanetech.com/technologists).

IEA (2020): Renewables 2020. Available at: [iea.org/reports/renewables-2020](https://www.iea.org/reports/renewables-2020).

Lampert, A. (2019): Over-exploitation of natural resources is followed by inevitable declines in economic growth and discount rate. Nature Communications 10, 1419 (2019). Available at: [nature.com/articles/s41467-019-09246-2](https://www.nature.com/articles/s41467-019-09246-2).

Mayer, C., K. Pence, and S. Sherlund (2008): The Rise in Mortgage Defaults. Available at: [federalreserve.gov/pubs/feds/2008/200859/200859pap.pdf](https://www.federalreserve.gov/pubs/feds/2008/200859/200859pap.pdf).

McKinsey Global Institute (2017): A future that works: Automation, employment and productivity. Available at: [mckinsey.com/~/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.pdf](https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.pdf).

Metabiota (2020): Epidemic Tracker. Available at: epidemictracker.com/.

Naqvi, M., and J. Southgate (2013): Banknotes, local currencies and central bank objectives. Available at: bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2013/banknotes-local-currencies-and-central-bank-objectives.pdf?la=en&has_h=95BAD173D3267307336144D544709BFAC-10DA92A.

New York Times (2018): Revealed: The People Behind an Anti-Breitbart Twitter Account. Available at: nytimes.com/2018/07/20/business/media/sleeping-giants-breitbart-twitter.html.

Oppenheimer, M., M. Campos, R. Warren, J. Birkmann, G. Luber, B. O'Neill, and K. Takahashi (2014): Emergent risks and key vulnerabilities. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1039-1099. Available at: ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap19_FINAL.pdf.

PACTA (2020): Paris Agreement Capital Transition Assessment. Available at: 2degrees-investing.org/resource/pacta/.

Partnoy, F. (2019): Stock Pics From Space. Available at: theatlantic.com/magazine/archive/2019/05/stock-value-satellite-images-investing/586009/.

Projects in Motion (2016): POOF! Available at: web.facebook.com/ProjectsInMotion/photos/poof-at-the-current-growth-rate-of-the-usage-of-these-non-renewable-resources-th/1099089136802382/?_rdc=1&_rd.

S&P Global (2016): An introduction to fintech: Key sectors and trends. Available at: spglobal.com/marketintelligence/en/documents/an-introduction-to-fintech-key-sectors-and-trends.pdf.

Schönauer, Thomä and Caldecott (2021, forthcoming): Financial Supervision beyond the business cycle. Towards a new paradigm.

Strochlic, N., K. Nowakowski, and K. Armstrong (2020): U.S. coronavirus deaths now surpass fatalities in the Vietnam War. Available at: nationalgeographic.com/history/2020/04/coronavirus-death-toll-vietnam-war-cvd/.

Thomä, J. (2020a): Is COVID19 the end of ESG and the beginning of existential risk management? Available at: responsible-investor.com/articles/is-covid19-the-end-of-esg-and-the-beginning-of-existential-risk-management.

Thomä, J. (2020b): The Prudent Algorithm Principle: A new paradigm for financial supervision. SUERF Policy Note, 154 (2020). Available at: suerf.org/policynotes/11465/the-prudent-algorithm-principle-a-new-paradigm-for-financial-supervision.

Tooze, A. (2020): Is the Coronavirus Crash Worse Than the 2008 Financial Crisis? Available at: foreignpolicy.com/2020/03/18/coronavirus-economic-crash-2008-financial-crisis-worse/.

UCSUSA (2008): Nuclear Terrorism Overview. Available at: ucsusa.org/resources/nuclear-terrorism-overview.

Worldometers (2020): Coronavirus United States. Available at: worldometers.info/coronavirus/country/us/.

WWF (2018): Our warming world: How much difference will half-a-degree really make? Available at: wwf.org.uk/updates/our-warming-world-how-much-difference-will-half-degree-really-make.



About EIT Climate-KIC

EIT Climate-KIC is Europe's largest climate innovation initiative, leveraging the power of innovation in pursuit of a zero-carbon, climate-resilient, just, and inclusive society. Established in 2010 and headquartered in Amsterdam, EIT Climate-KIC orchestrates a community of more than 400 organisations including large corporations and SMEs, municipal and regional governments, universities and research institutes, as well as non-governmental organisations and uncommon actors. The organisation uses a portfolio approach for developing and deploying innovation to achieve systemic change in those human systems that matter for long-term prosperity, combining activities and innovation outputs from applied research, education, start-up incubation, and innovation ecosystem building. EIT Climate-KIC is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

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United Nations Environment Programme Finance Initiative (UNEP FI) is a partnership between UNEP and the global financial sector to mobilize private sector finance for sustainable development. UNEP FI works with more than 350 members—banks, insurers, and investors—and over 100 supporting institutions—to help create a financial sector that serves people and planet while delivering positive impacts. We aim to inspire, inform and enable financial institutions to improve people's quality of life without compromising that of future generations. By leveraging the UN's role, UNEP FI accelerates sustainable finance.

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