...INTO THE FIRE

FINANCIAL SUPERVISION IN A POST-CRISIS / PRE-CRISIS WORLD

DISCUSSION PAPER
DECEMBER 2019

1 THE WORLD OF FINANCIAL SUPERVISION IS CHANGING

The world of financial supervision is changing. The last decade of financial supervision has largely been dedicated to dealing with the fallout of the global financial crisis of 2007-2008, nursing financial institutions and markets back to health. The past one or two years have slowly seen the rise of a change in narrative, as the aftermath of the financial crisis starts to recede from view and a return to normalcy is on the horizon.

In this context, financial supervision starts to enjoy the space to assess its future role. In using this space, it faces an out of the frying pan into the fire metaphor. The post-crisis world is very much the pre-crisis world in terms of the medium- and long-term risks it faces. Of course, this dynamic also represents an opportunity to strengthen the role of financial markets in protecting the common good – aligning with and contributing to macro policy objectives.

In facing this challenge, financial supervision will need to develop new tools and instruments to respond to these challenges. The relative calm before the storm financial markets enjoy today needs to be used by financial supervisors as the moment to prepare for the future. While many of these dynamics may have their origin in the economy, financial supervisors, given their focus on the future, the governors of capital allocation and safeguards of the system that propagates risks (finance), are in a unique position to respond to them. Each individual drivers will fundamentally disrupt the global economy. In unision, they are set to create an unprecedented dynamic.

Financial markets face three new types of risks.

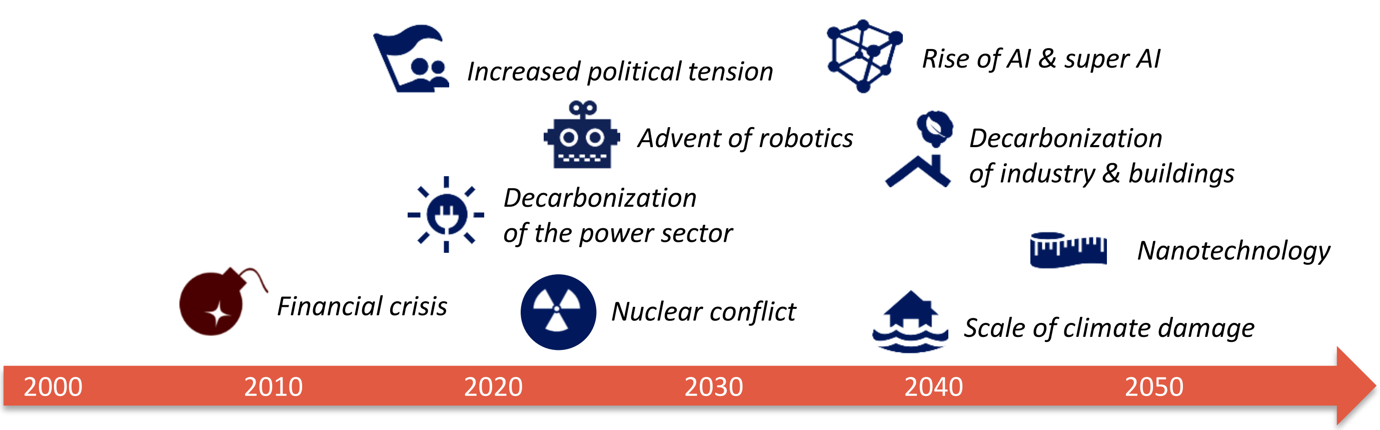
1. **The advent of mega risks.** The modern economy faces risks at unprecedented scale, dwarfing previous calamities. Climate change – depending on the severity of impact – may literally wipe out large parts of the global economy. The threat of nuclear warfare is returning to the agenda, and our growing forays into space may heed new risks. New technologies like (super) artificial intelligence create new risks.

2. **The 3rd, 4th and 5th industrial revolution(s).** We are in the midst of a fundamental change to the economy, driven by climate objectives designed to decarbonize the economy, technology breakthroughs in artificial intelligence, robotics, 3D printing, and new economic structures ("sharing economy"). Many of these trends are linked as technology breakthroughs in AI and robotics may also accelerate decarbonization. Capital in 2050 will look fundamentally different to Capital in 2018, giving rise to potential risks.

3. **The accelerating speed of financial markets.** The first and second trend occur in the context of ever-faster and automated financial markets. Fintech is disrupting finance itself, independent of the first two points and the rise of algorithm trading is set to amplify risk pass-through in the system. It also has implications for the required speed of financial supervision.

The objective of this paper is to map these challenges and potential solutions that can be designed in response.

FIG. 1.1 AN IMAGINED AND INCOMPLETE TIMELINE OF FUTURE RISKS (SOURCE: AUTHORS)



2 CAPITAL IN 2018

2.1 HOW DOES THE ECONOMY WORK TODAY?

Three features of the modern economy. There are dozens, indeed hundreds or thousands of different ways to describe the modern economy in the teenage years of the 21st century. Of particular interest here however are not broader political economy questions, like the shift of the economic epicentre from 'west' to 'east', but at its fundamental level, the question of how things get produced.

Here, three key characteristics stand out as under-pinning the global economy:

- ***Humans currently are the primary generators of value*** in terms of the production of goods and services.
- ***Production is globalized***, both in terms of the markets that products serve as well as the supply chains on which these products (and increasingly services) rely.
- Economic value creation relies heavily on the extraction of natural resources, and the emission of CO_2 as a by-product of energy generation, motorization, and a range of industrial processes. ***We are a 'resource economy'.***

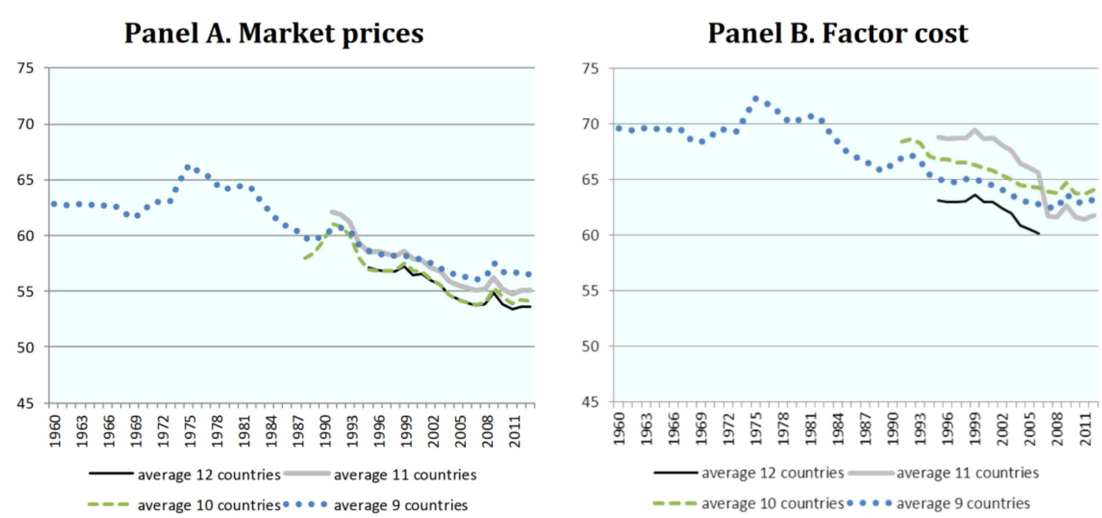
Each of these features will be discussed in turn.

Humans produce value. We are at the tail end of what is frequently described as the 'third' industrial revolution, where value add in production continues to be dominated by the input of human capital.

While there isn't a clearly defined, precise way to measure how the economy divides itself between 'human capital', in other words human labour, and 'capital proper', machines, etc., there are a number of different ways to try to approach the issue and each of these points to a significant role of humans:

- **The share of wages in the economy:** Arguably one of the most straight forward ways to think about the role of humans in producing value is the wage share, which is directly related to capital. While some wages are obviously generated through the manipulation of machines, they do suggest the prevalence of 'human work' value generation. Statistics across OECD countries suggest the wage share in GDP is around 55%-65%, depending on whether its measured in terms of market prices or factor costs. Noticeable here is a significant downward trend (Fig. 2.1).
- **Intangible capital:** While the measure of intangible capital is not strictly speaking equivalent of human labour, it is arguably entirely generated and preserved by humans. The challenge in intangible capital is that while it makes up a growing share of market value (~84% of the S&P500), it isn't limited to human labour. Statistics breaking out this 'human labour' component don't exist however

FIG. 2.1: THE PERCENTAGE SHARE OF LABOUR – MEASURED IN MARKET PRICES OR FACTOR COSTS – IS DECLINING, BUT REMAINS ABOVE 50% ACROSS OECD ECONOMIES (SOURCE: OECD 2015)



Note: The 9 countries are Australia, Canada, Germany, France, Italy, Japan, Spain, the United Kingdom and the United States. The other series include respectively the Republic of Korea (10 countries), Mexico (11 countries) and Turkey (12 countries).

Globalized trade and complex supply chains. The current economy is highly dependent on international and complex supply chains, both intra- and inter-firms. Trade has grown from around 25% to around 55% of global GDP since the mid 1960s (see Fig. 1.2). It is an integral part of almost every product we consume. - even if its prominence is somewhat dependent on the sector (e.g. lower levels of trade in the agricultural sector versus merchandise goods).

It is not just the volume of trade, but also the complexity of the supply chains underpinning it that have increased. A smart phone may be designed in the United States, source minerals from Central Africa and Australia, be partly assembled in East Asia and Latin America, and 'travel' back and forth several times before it reaches markets. This trend is to a significant degree driven by the collapse in transport costs, as well as trade liberation, in the course of the past century, making it profitable to produce where it is cheapest.

Transport costs for sea freight for example dropped by about 80% since 1930. Related, passenger air travel costs have dropped by about 90% and international calling costs have for all intents and purposes disappeared with the advent of internet communications technology.

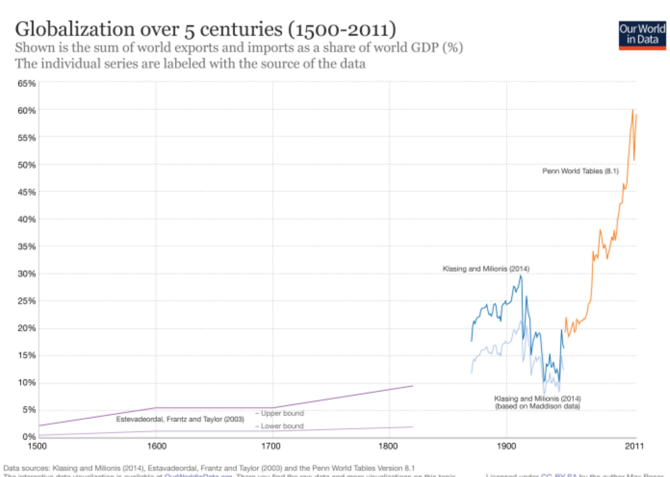
Crucially, this trend has also made producers ever more dependent on just in time and reliable supply chains, the panic and fear of UK producers following the Brexit negotiations are case in point.

Resource & carbon intensive. The third key feature of the economy in 2018 is the intensity of production from a 'natural resource' perspective. Foremost among these are fossil fuels, the energy that powers the global economy. Energy use and GDP have moved largely in lockstep at least since the 1980s.

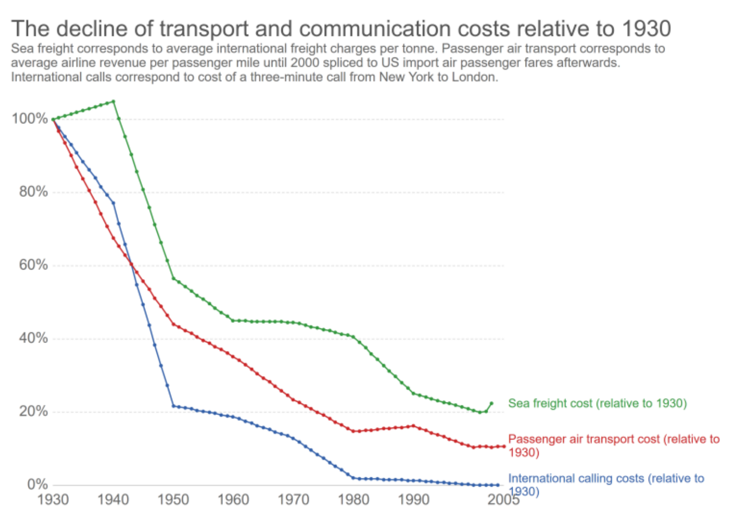
Today, the global economy remains as resource intensive as ever across a range of commodities. Some of this is a function of sheer size – 7 billion plus people will consume a lot of resources. Some of this however remains a reality of being wedded to specific and usually scarce natural resources – for a number of minerals a reality that is increasing dramatically. Copper consumption for example is set to nearly triple between 1990 and 2020. Lithium demand in turn doubled in the past 5 years alone and is set to double again according to forecasts by Deutsche Bank.

This resource intensity remains reflected in capital market indexes. Energy and materials as sector represent roughly 10-15% of global stock market capitalization on the 'supply' side. The 'demand side' has a similar size – across the utility, transport, and industrial sectors.

FIG. 2.2: GLOBAL TRADE HAS INCREASED AS TRANSPORT AND COMMUNICATION COSTS HAVE DRAMATICALLY DECREASED IN THE LAST CENTURY (SOURCE: OURWORLDINDATA.ORG)



Source: https://ourworldindata.org/international-trade



3 CAPITAL IN 2050

3.1 WHAT WILL THE ECONOMY OF TOMORROW LOOK LIKE

Automatic, Local, Low-Carbon & resource. Capital markets – and by extension the economy more broadly – are likely to look fundamentally different by the middle of the century relative to today. These differences operate on two axes: First, the next decades are set to see a fundamental shift in the way value gets generated, with a shift away from current practice towards an "ALL" economy: automatic, local, and low-carbon & resource.

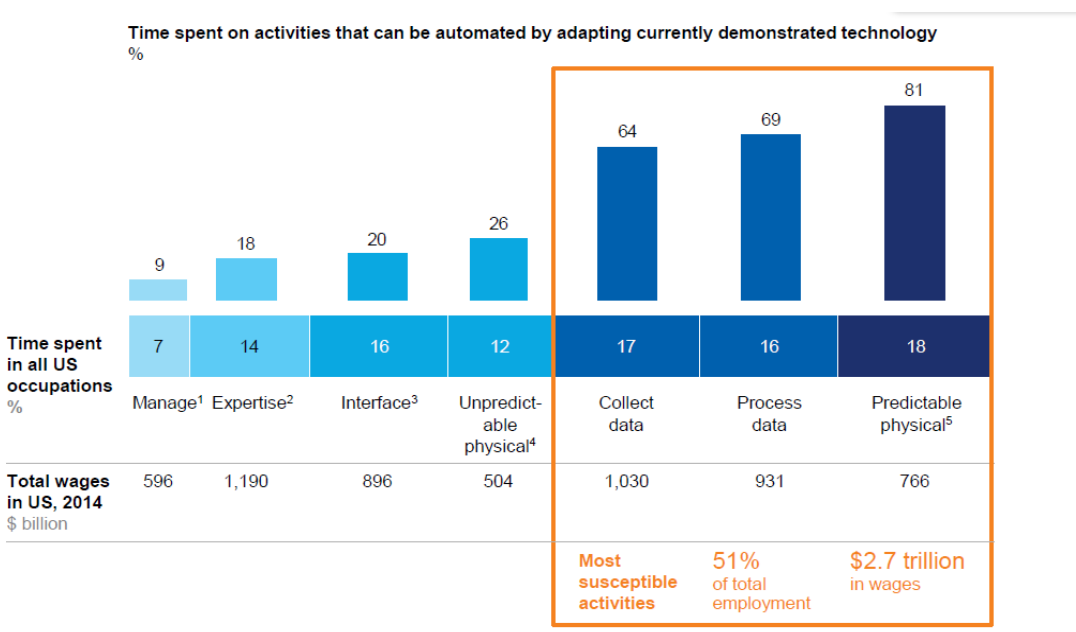
In addition, human development is likely to increase the strain on the economic and social ecosystem, increasing – at least in the short- and medium-term – the risk of systemic shocks related to global events. Notable and at least somewhat predictable among these events is climate change and the impact that will have as temperatures rise 2° C or more above pre-industrial levels. Potential knock-on effects on things like the direction of the Gulf Stream, the release of methane in the Arctic ice sheet, etc. will amplify this challenge. As the planet warms, so too will in all likelihood human conflict, with a growing risk of nuclear engagements, as well as potentially other unknown unknowns. Case in point is the threat that artificial and super artificial intelligence are set to pose to civilization.

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.** Increasing sophistication of robotics, coupled with declining costs, will be able to replace a growing set of 'predictable physical activities' currently delivered through human labour. According to estimates by the McKinsey Global Institute, around 81% of predictable physical activities could be replaced in this way in the next decades. This effect will impact production in all industries and sectors, with around 5-10% of professions subject to over 90% of their roles becoming automated.

- **Artificial and super artificial intelligence.** Artificial intelligence involves machines that exhibit human-like intelligence for either specific tasks or in the case of super-artificial intelligence, the whole suite of human intellect and beyond. Artificial intelligence 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). Artificial intelligence in the short-term will be particularly relevant for activities related to processing and collecting data, with an estimate 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.

FIG. 3.1: A GROWING SHARE OF ACTIVITIES CAN BE AUTOMATED BASED ON ADAPTING CURRENTLY DEMONSTRATED TECHNOLOGIES (SOURCE: MCKINSEY 2018)



- **Rise of complexity.** A corollary, but distinct trend from the three mentioned above will be the rise of complexity in production processes. This increased complexity is driven both by the inability of humans to replicate the capabilities of the combination of robotics, artificial intelligence, and machine learning, creating production systems that ultimately don't just replace human labour, but where humans are no longer able to actually deliver the product, creating an irreversibility. As we access new production techniques – for example in the context of nanotechnologies – we will need to deploy non-human labour immediately. The demand for non-human labour as the basic premise will likely accelerate the deployment of the technologies described above, since the political economy question is less pronounced for tasks where humans cannot perform them to begin with.

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

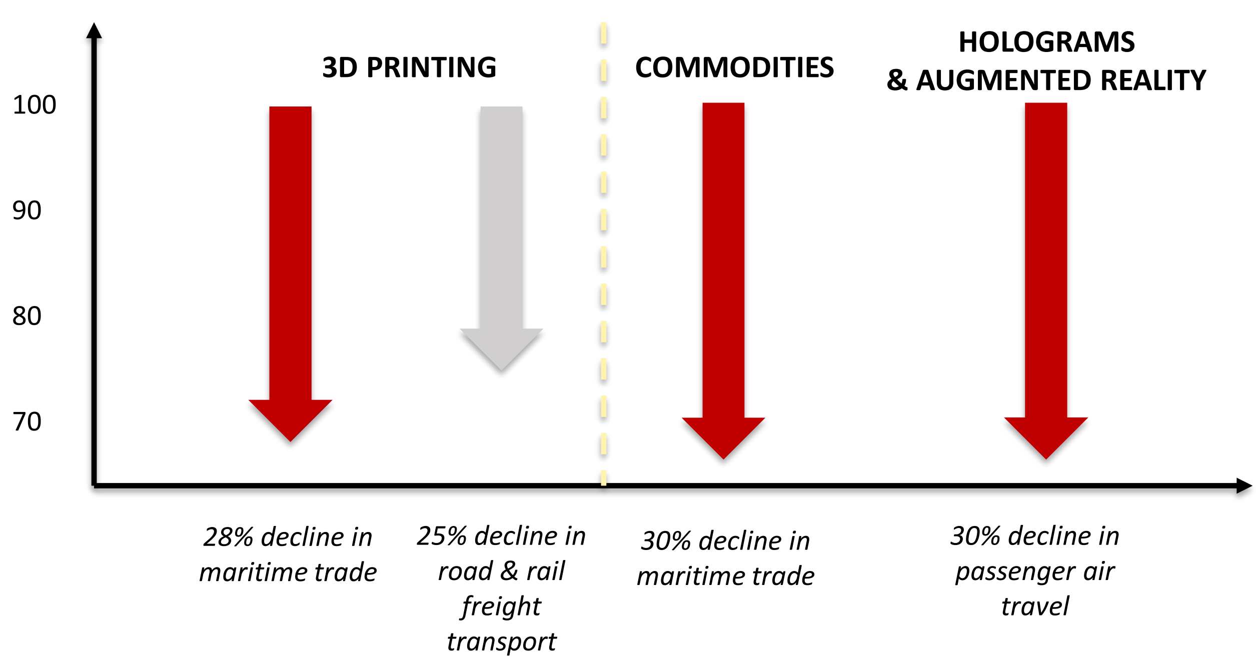
- **3D printing**. 3D printing is already allowing companies to manufacture on-demand and highly bespoke parts of the supply chain. In the future, 3D printing may be able to replace a range of product inputs that now require bespoke manufacturers associated with a distributed supply chain.

- **Reduction in the role of natural resources.** A key feature of the global supply chain involves the role of commodities in it. Commodities tend to be – depending on their type – highly concentrated in certain regions. The global commodity extends from agricultural commodities (primarily wheat, corn, but also coffee and rice), to minerals (cooper, zinc, lithium) and fossil fuels (oil, gas, coal). At least some of these commodities will likely largely disappear in the global supply chain over the next 30 years, notably fossil fuels, but also potentially minerals like gold, that are currently used in mobile phones, but that may potentially be ultimately replaced by synthetic alternatives.

- **Emphasis on non-tradable products & services.** The global economy is likely to see a growth in products and services that don't lend themselves very well to international supply chains or markets. This will be driven both by a shift in the economy to in-person services, like nursing and live entertainment, but also see more un-orthodox drivers, like a potential reduction in long-distance tourism as a result of further development of virtual and augmented reality technologies.

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

FIG. 3.2 GLOBAL TRADE IS SET TO BE SIGNIFICANTLY DISRUPTED AS A RESULT OF DECLINE IN FOSSIL FUELS AND THE RISE OF NEW TECHNOLOGIES (3D PRINTING, HOLOGRAMS, ETC.) (SOURCE: 2ii 2018)



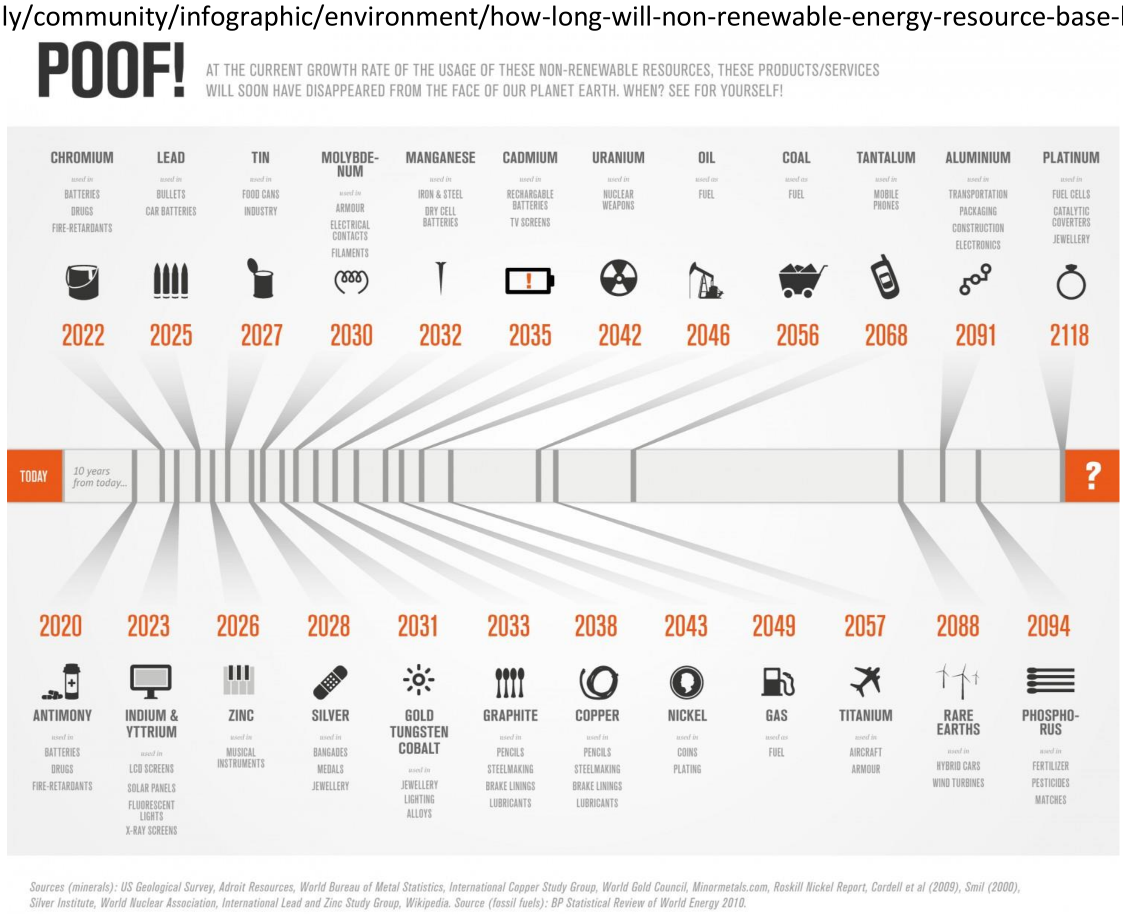
Reduction in natural resources. As highlighted on the previous page, the future economy is set to see a significant reduction in the use of natural resources in favour of renewable and synthetic resources. This will be a function both of the relative competitiveness of these resources relative to traditional extractive or semi extractive (e.g. agricultural commodities including meat) and the relative 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, mining). 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. While the concept of 'peak resource' has proved wrong in the past (peak oil being perhaps the most prominent example), there is some concept of peak resource that rings true. Depending on the metal and the degree of optimism, a series of natural resources are set to disappear in the next decades. 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.

- **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 potentially 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.

- **Nanotechnology.** Beyond drivers on the supply side, there are also drivers on the 'demand side' in terms of improvements in alternative technologies. Nanotechnologies will help create synthetic alternatives to natural resources. Bio alternatives and geomimicry (e.g. egg shells 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' (e.g. egg shells) insofar as they slot in more naturally in the concept of a circular economy. One significant degree of uncertainty in these trends is the potential rise of chemical alternatives to agricultural commodities and traditional foodstuffs and to what extent these types of alternatives (e.g. Huel) will be adopted by consumers.

FIG. 3.3: COMMODITY LIFECYCLES IMPLY A POTENTIAL DEPLETION THROUGHOUT THIS CENTURY (SOURCE: https://visual.ly/community/infographic/environment/how-long-will-non-renewable-energy-resource-base-last)



3.2 LONG-TERM RISKS TO THE COMMON GOOD

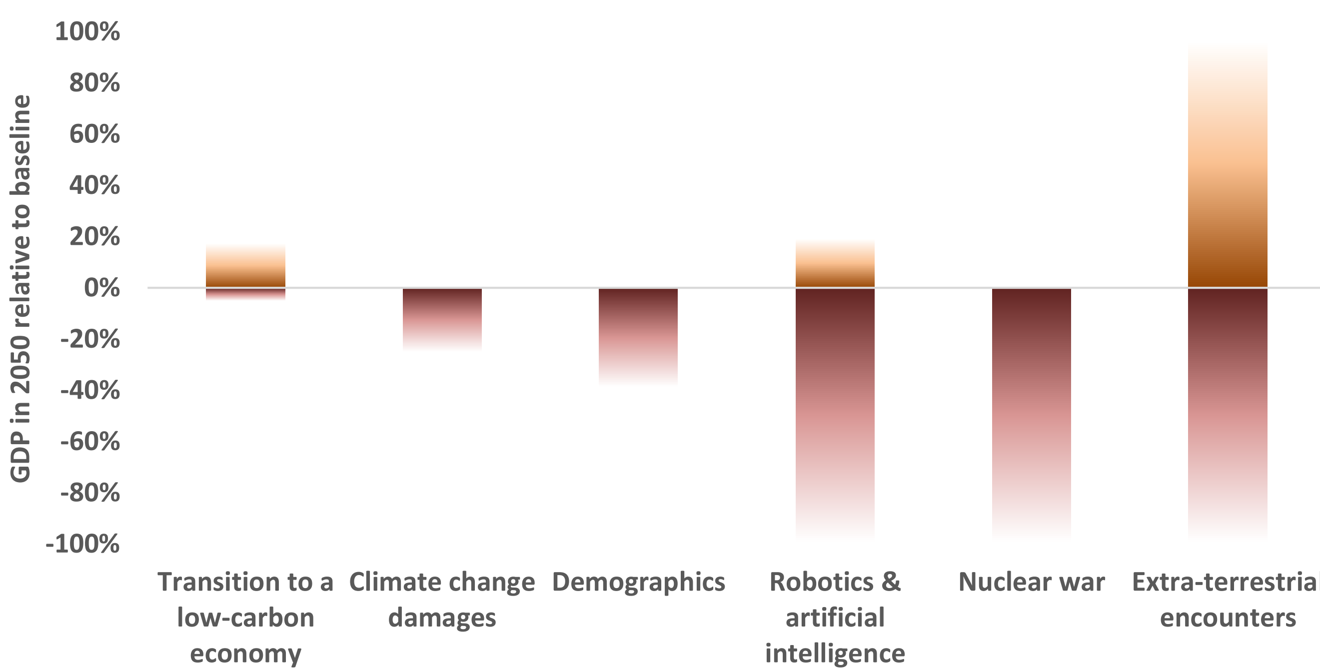
Other disruptive trends. In the next decades, a range of 'almost certain' disruptive trends come into play – especially when considering a longer time horizon. The economy of tomorrow will likely be very different from today. All things being equal, the average returns per asset class is expected to be lower than what has been experimented over the past 30 years, due to factors such as global aging and emerging economies reaching maturity, etc.).

Moreover, there are a range of disruptive trends and potential shocks that from a macroeconomic perspective are likely to be more impactful than the transition to a low-carbon economy. The Fig. below highlights a sample of these potential trends, based on a range of third party literature and their potential effect on GDP. As shown by the graph, from a pure GDP effect perspective, demographic trends are likely to have a higher impact on GDP than both the transition to a low-carbon economy and climate change damages.

Demographic trends however are unlikely to have disruptive effects related to 'sentiment shocks' of the kind described by CISL (2016) for climate damages. At the same time, robotics and artificial intelligence are expected to have significant positive impacts. Finally, disruptive 'shocks' like a nuclear war or extra-terrestrial encounters can have extreme and sudden consequences, which are fundamentally difficult to anticipate (even if a few organizations are looking to quantify this and – in the case of extra-terrestrial encounters – historical role models from colonialization abound).

Looking at these risks in conjunction is critical both from the broader objective of anticipating long-term risks and potentially disruptive risks to financial markets, understanding the potential interplay between the risks (e.g. demographic trends, artificial intelligence, and climate change are all risks and opportunities that influence each other), and potential policy responses.

FIG. 3.4: THE POTENTIAL GDP EFFECT OF LONG-TERM RISKS (SOURCE: 2II 2018)



Source: https://ourworldindata.org/international-trade

3.3 CHANGE TO FINANCE

As the world changes, so does finance. The trends outlined on the previous pages by themselves will fundamentally disrupt financial institutions and markets more generally. At the same time, they will confront a financial system that is also changing. Specifically, finance faces three major disruptive trends:

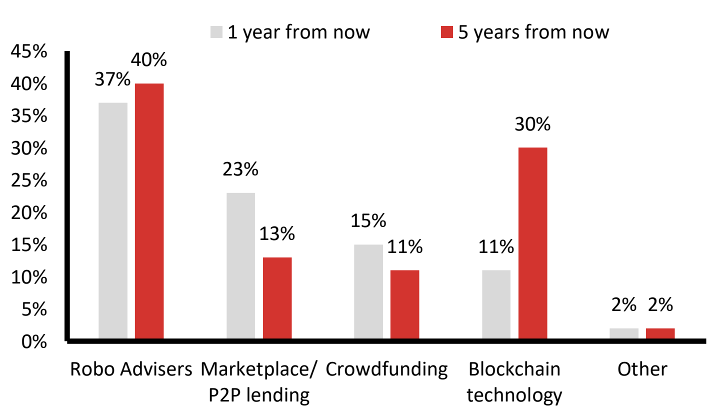
- **Automated (algorithm) trading system.** Describing automated (algorithm) trading strategies as a future trend might seem somewhat ridiciulous in the face of around 85% of market volume based on algorithmic trading. Within that group however there is a growing share of algorithmic trading that are driven by artificial intelligence rather than algorithmic trading say that is done for index funds – where the original strategy can still be described as human. As non-human strategies overtake it will become both increasingly difficult to regulate and supervise, as well as increasingly likely that computers amplify real economic trends. Of course, these types of trading systems may also themselves generate financial crashes through malfunctioning or misconfiguration. The 2010 Dow Jones Industrial Average flash crash is a case in point, where the index lost 9% of its value within minutes. The exact relationship between economic risks and machines is still poorly explored and understood.

- **Robo services.** Just as financial transactions and investing are being automated, so too is the financial advice to retail and institutional investors underpinning such advice. The most prominent example for this is the rise of robo-advisors in the retail market that are replacing traditional retail banking services from banks. It also is starting to increase into equity and credit research however (e.g. automatically generated portfolio analytics reports). As these services reduce costs, they can be passed on to consumers. They too however may give rise to biases as customers no longer interface with humans – as well as amplifying 'herding' as systems connect. The market, while starting at low levels, may reach 10-15% market share by 2020 and command over $10 trillion in assets under management.

- **(Cost) disintermediation.** A third key aspect of the revolution gripping finance can broadly be labeled as the advent of (cost) disintermediation. Technology is breaking up natural monopolies and vertical integration. Blockchain has the potential to replace some of the traditional market functions of banks – with uncertainty as to which economic actors will structure and organize these functions and the extent to which this will be a 'crowd-based' future. On the other hand, complex technologies may create new natural monopolies, as it is currently doing in tech – which may disrupt competition.

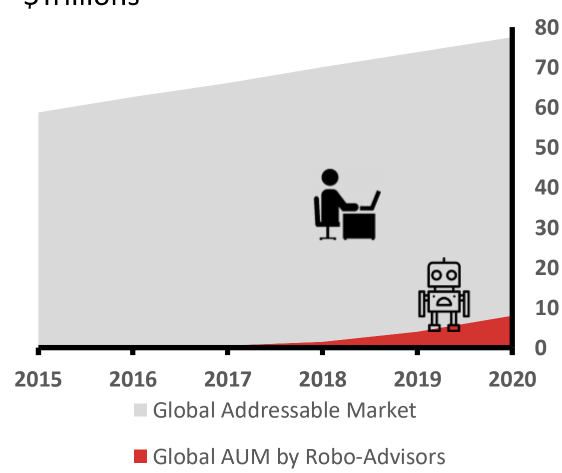
FIG. 3.5: THE RISE OF TECHNOLOGY IN FINANCIAL MARKETS (SOURCE: 2° II 2017)

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 15

Source: https://ourworldindata.org/international-trade

4 REGULATING CAPITAL IN A NEW WORLD

4.1 THE FUTURE WE WANT

Out of the frying pan into the fire. Financial supervisors face a daunting future. Mega risks are set to increase in number and potential destructive scale. Some of these risks are mutually reinforcing and although have their origin in economic trends may be amplified by financial markets – in particular financial markets that themselves become automated and faster.

In this context, financial supervisors face two options: Ignore these long-term risks or help shape and protect the future we want. Crucially, this challenge is not just a function of protecting financial markets against risks once they materialize, but interpreting supervision as a form of stewardship that helps prevent these risks from materializing in the first place.

This interpretation of financial supervision is already starting to be explored by financial supervisors. Fintech departments are being set up. A range of central banks and supervisors have set up the Network for Greening the Financial System (NGFS) – looking to address issues around sustainability and climate change. Other challenges like artificial intelligence and physical climate risks are also starting to come to the fore. Despite these initiatives, the toolbox is still being developed to equip financial supervisors with the means to safeguard financial markets and by extension the economy in the face of these trends.

The fire extinguisher toolbox. Supervisors require new tools and mechanisms to adapt to the new twin reality of industrial transformation and rise of mega risks. These aspects can be organized across three axes: i) building the knowledge, ii) macro & microprudential supervision, and iii) algorithmic supervision

- ***Live monitoring of infrastructure & asset networks*** *using asset level data in order to monitor natural & other risks.*

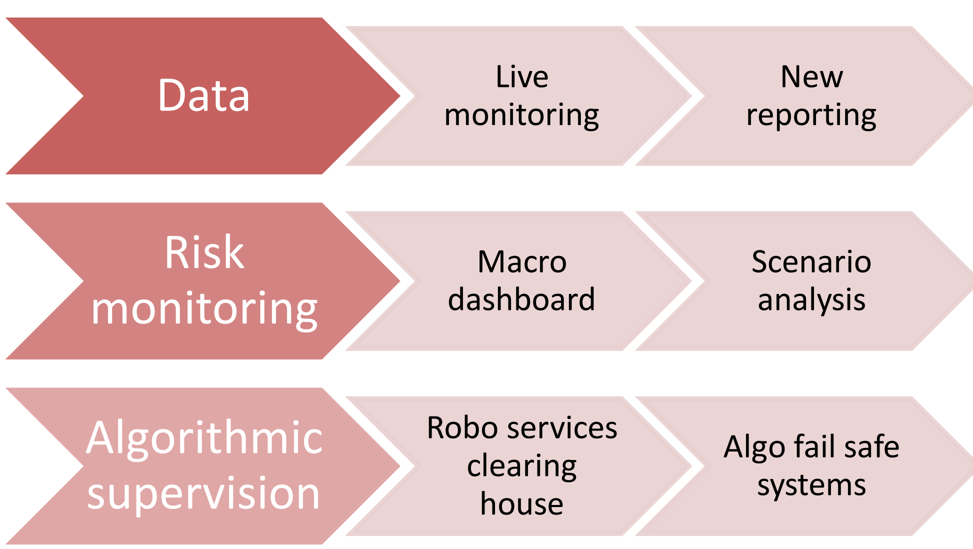
- ***New supervisory reporting mechanisms*** *related to code and software infrastructure of financial institutions (above a reasonable size) and identifies network effects embedded in trading algorithms.*

- *A* ***long-term macroprudential risk dashboard*** *to identify weak signals associated with long-term risks and trends misaligned with public interests.*

- ***Microprudential scenario analysis*** *as a complement to stress-testing frameworks, conducted by financial supervisors and / or regulated entities directly.*

- *A* ***clearing house for robo services*** *that prevents the build-up of monopolies, ensures consumer protection and minimizes biases in robo services.*

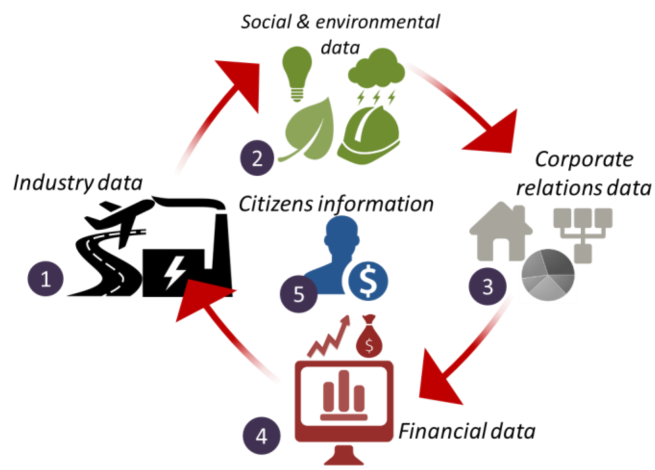
- ***Algorithmic supervisory fail safe systems*** *that get triggered in response to flash crashes or related events in order to ensure liquidity and mitigate network effects.*

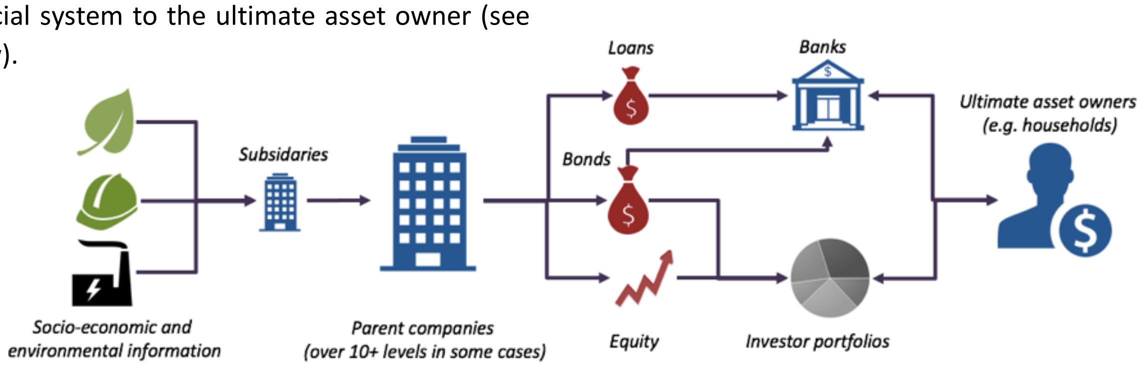


4.2 DATA – LIVE MONITORING & NEW REPORTING CHANNELS

New data for new needs. One of the key prerequisites for tackling the new regulatory challenges described in the previous chapters is mobilizing new data and accounting frameworks. These data needs extend across both traditional financial data as well as micro datasets currently only partially or not at all exploited. These datasets include industrial information, social & environmental data, corporate relations data, financial data, and citizens information. Extending to these alternative data sources is crucial as a way to deliver the policy supervision required to understand the new generation of risks and monitor them appropriately. These alternative datasets then have to be linked to new type of scenario (e.g. climate transition scenarios, AI scenarios, physical risk scenarios) in order to inform macro- and microprudential supervision. One key challenge in this regard is connecting data across the financial network from economic and environmental information at micro asset level all the way through the financial system to the ultimate asset owner (see Fig. below).

The figure blow highlights the relationship between these different datasets, as well as providing more detailed information on what type of data is contained therein. For financial supervisors, some of this data is already collected through different governmental agencies or even by supervisors themselves (e.g. some supervisors already collect financial portfolio data, Solvency II in Europe, Schedule D in USA, Anacredit). The extra costs for data collection appear manageable (see next page).





1 **Industry information** captures economic activity, measured in terms of products / services sold or produced, and investments and retirements of current and future productive assets (including data on investments in intangible assets). Datasets that capture this information are typically labelled 'economic intelligence' or for infrastructure 'physical assets databases, as well as macroeconomic forecasts.

2 **Social & environmental information** captures all social and broader environmental indicators associated with economic activity. This information could relate to indicators around employment, innovation, GHG emissions, etc. Depending on its type this data, will sometimes be collected together with economic information or separate (e.g. ETS data) and can also involve macro forecasts (e.g. IPCC scenarios).

3 **Corporate relations information** provides visibility on the relations between economic actors to themselves and the financial and non-financial assets they are associated with this. This data involves corporate ownership trees, financial assets linkages, and financial asset ownership. This data is typically provided at micro level, although macro relations will sometimes be mapped (e.g. financial flows).

4 **Financial information** maps all non-economic information that can be associated with economic, social, and corporate data. This relates both to financial accounting (e.g. margins, revenues, etc.) and additional financial information related to financial assets (e.g. # of shares outstanding, market capitalization, etc.).

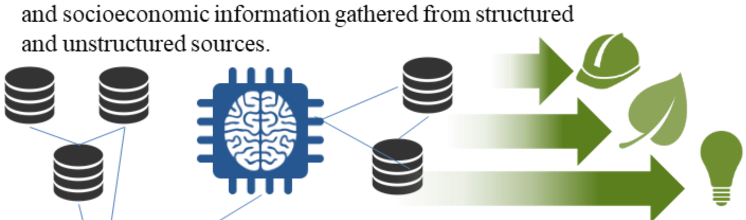
5 **Citizens information** can involve participatory elements around citizens involvement in policy decisions, revealed consumer preferences, mainstream and social media data, and a broader tracking of stakeholders responses to policy incentives and initiatives (e.g. disclosure mandates, tax incentives)

Type	Detailed type	Description	Commercial Examples	Open Source Examples	Regulatory Examples
Industry information	Macro-economic datasets	Macroeconomic performance at country level (GDP, population)	Commercial economic forecasts	Natl. statistics, IMF, World Bank	Internal policy forecasts
	Industry databases	Physical asset level information in terms of e.g. capacity, production & investment	GlobalData*, IHS, Platts*, SNL Financial*, FlightAscend*, etc.	Eurostat/ National statistics offices	Some sector-level internal data
Social /Environmental information	Scenario data	Information on the status and expected evolution of key socio-economic and economic geography indicators	IEA World Energy Outlook* and Energy Technology Perspectives*, IRENA REMap*,	Shared Socio-economic Pathways); WRI Aqueduct	Internal policy forecasts
	Emissions/ impacts data	Data linking companies to their social/ environmental impacts (e.g. GHG emissions, labor practices, water use)	ESG (environmental/social/ governance) data providers, e.g. Oekom, Sustainalytics, Trucost*, MSCI ESG	Emissions reporting to statistics offices (e.g. EU ETS, US GHG Reporting)	Confidential facility-level env., employmentdata
Corporate relations information	Corporate Ownership data	Information on the corporate and beneficial ownership of financial and non-financial listed, state-owned, and private companies	Bureau van Dijk Orbis* (170 million companies across the globe), Factiva**, Hoover's Company history**	OpenCorporates Global LEI Foundation (open standard for corporate entity ID)	NA
	Financial asset ownership data	Databases on financial security ownership by asset managers and owners	Morningstar (Databases on 5000 institutions across 34,000 portfolios with million unique ownerships)	NA	Solvency II reporting to Central Banks* Mutual fund reporting
	Other financial relationship data	Data on financial relationships other than ownership (e.g. debt, underwriting) between entities	Bloomberg, DealScan*, Amadeus*, S&P Cross-Reference Services*	NA	AnaCredit project* (corporate loans)
Financial information	Financial and balance sheet data	Information on company & financial asset financials (e.g. market capitalization, profits, price, etc.)	Bloomberg*, S&P Capital IQ**, FactSet, ThomsonReuters, BVD Bankscope*	OpenFIGI standard (open standard for financial security ID)	BACH (Country-database for 11 European countries)
Media Data	Main-stream media	High-quality information in an unstructured textual form on media exposed issues (in multiple languages)	Bloomberg, ThomsonReuters, NYTimes	EventRegistry.Org, European Media Monitor	Company profiling, Fact extraction, Sentiment detection
	Social media	Fast, massive, low-quality reaction of global audience on a wide-range of issues	Twitter, Facebook		

Live monitoring data. Data of course is not an end in itself, nor is data collection by itself. It requires treatment, the potential development of new accounting rules and modeling infrastructure, enhancement, and pilot applications. This is a new field and experimentation is needed to understand the potential of different datasets.

Specifically, financial supervisors can explore various pilot application across a range of issues (e.g. live monitoring physical risks, real estate prices, see case study boxes on right) using a simple supervisory approach detailed below. The next page summarizes some of the data work potentially required (depending on pilot).

1 Connecting existing big data sources & linking to socioeconomic indicators.
Develop algorithms to compile existing open source and commercial data, and link them to open data standards for company and financial security information, geographic and socioeconomic information gathered from structured and unstructured sources.



2. Developing 'accounting rules'. Develop new accounting rules for connecting financial flows to economic activity in the real economy through data-enabled tracking and monitoring.

3. Visualising the results. Given the difficulty of comprehending big data, proper visualisation techniques are critical for decision support. In particular, the potential of using GIS and mapping techniques to visualise financial flows and socioeconomic effects.

4. Pilot cases. Apply a case study approach in three different steps of the policy process (design, implementation, and monitoring & evaluation)

CASE STUDY: MONITORING PHYSICAL RISKS

One potential application of new datasets is in the live monitoring of physical risks by matching asset level data with geolocational information to physical risk maps and live weather maps (see Fig. below for example results for coal power plants and water risks). This exercise can already be done across a range of industrial assets today and can help financial supervisors estimate exposures to various weather scenarios as well as respond speedily in providing liquidity and financial safeguards.

CASE STUDY: MONITORING REAL ESTATE PRICES

New technologies allow financial supervisors to monitor real estate prices in real time by scrapping price data from rental housing websites. The same type of information can also provide more granular inflation trend data – providing a more up to date and live monitoring instrument for identifying price movements in the economy and facilitating a faster and more targeted response as this information is linked to mortgage-backed securities and credit portfolios. Of course, applying this information also requires granular portfolio data.

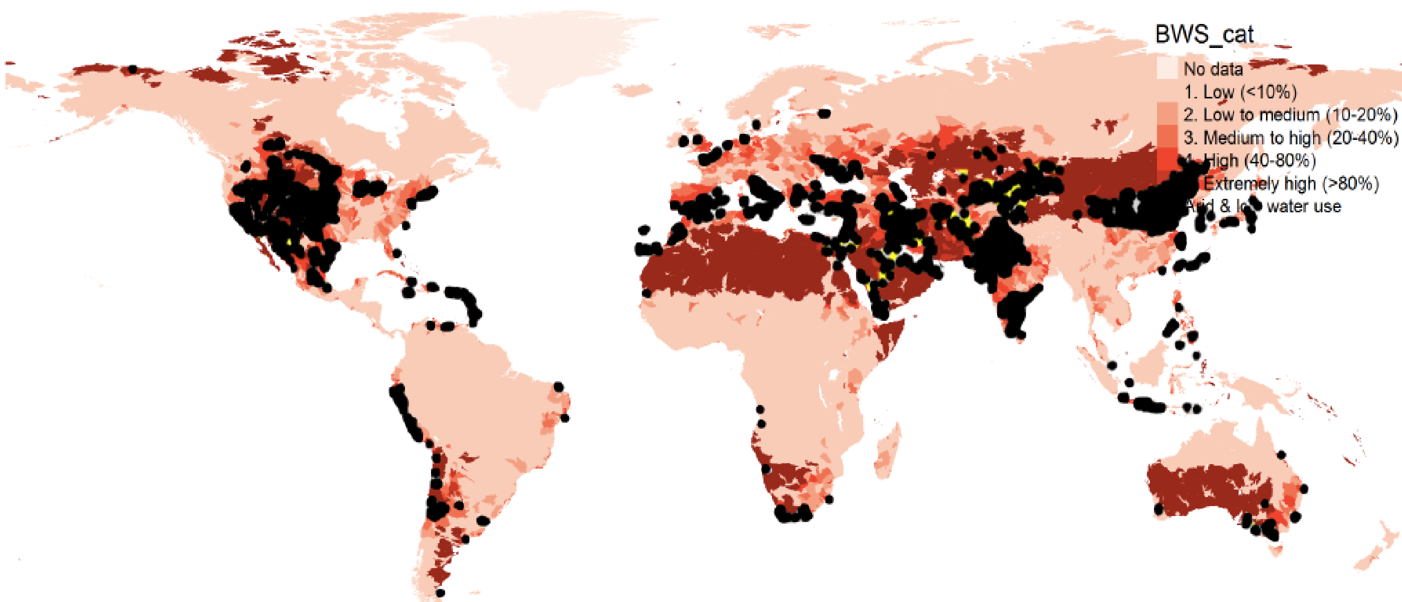


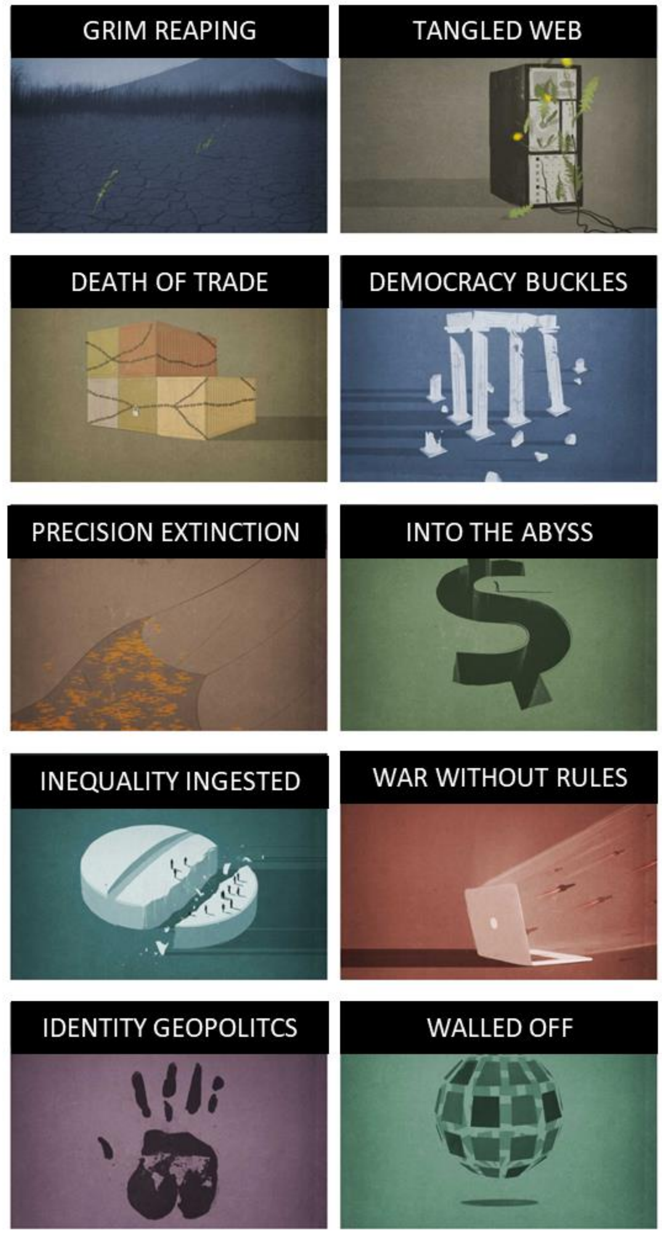
FIG. 4.1: TYPES OF ALTERNATIVE DATA NEEDS FOR FINANCIAL SUPERVISORS(SOURCE: AUTHORS)

Existing Information Asset	Types of assets needed	Current Issue to Overcome	Data Engineering needs
Industry & Corporate	Linked to existing Corporate Ownership	Lack of common identifier	Disambiguation and Entity linking, Network analysis
Borrwing Firms: Corporate	Linked to Financial Lending Institutions, all members of Syndicates	No common identifier; private firms not included; matching not done for all syndicate members	Disambiguation and Entity linking
Corporate & Financial Activity	Enhanced with unstructued Corporate public announcements	Announcements are currently unstrcutured data not linked to structured sources of financial activity, such as transaction data.	Focused web crawling, Text analysis and parsing, Semantic annotation, Information Extraction
Borrowing Firms: Private and Corporate	Enahnced with Social Ties of Borrwing Firms and Lenders obtained from Kantwert, Twitt	Social ties play an important parallel role and are not currently integrate into capital allocation models	Social network analysis, Information propagation
Social & Environmental, Industry data at National level	Geo-spatial attribution to downscale from national to postal code level	Data is often at provided the country level, while physical asset data is local	Semantic annotation and profiling, Information integration and linking
Corporate Data	Structured Non-Financial Reporting Data	Public Non-fianncial reports are not systematically truned into strucured identifiers (existing ESG providers often rely on private data)	Focused web crawling, Text parsing, Semi-supervised information extraction
Residential Real Estate Data	Structured price data; bottom-up real estate assets data	Comprehensive, up-to-date DB does not exist	Web crawling, Information extraction
Citizens/Social Media Data	Enhanced with Knowledge Extraction on Sustainable finance (EventRegistry.org)	Interlinking unstructured media data with structured data sources doesn't exist	Semantic Knowledge Extraction

Source: https://ourworldindata.org/international-trade

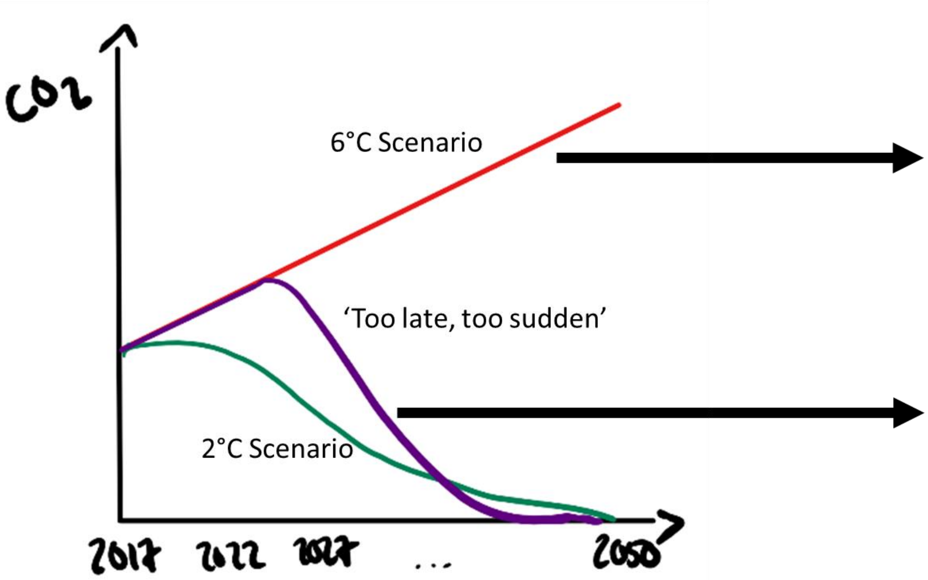
4.3 MACROPRUDENTIAL RISK DASHBOARD & MICROPRDUENTIAL SCENARIO ANALYSIS

Monitoring long-term risks. For financial supervisors, long-term mega risks represent both a macro- and microprudential challenge. Depending on the risk, certain trends may represent a macroeconomic threat – climate change, nuclear war, etc. – whereas other issues like the transition to a low-carbon economy may be more sectoral / micro in nature and thus are likely only to affect specific financial institutions and / or pockets of the market (although of course network effects may amplify this story). The diversity of potential future shocks identified in the WEF Global Risk Report (see Fig. on right) underscores this point).



By extension, the future supervisory toolbox requires both a macroprudential dashboard monitoring the evolution of these risks as well as a microprudential approach related to specific financial institutions. Moreover, both instruments need to consider both the actual risk exposure, but also the extent to which markets are potentially amplifying or reducing these risks. One notable example in this regard is the transition to a low-carbon economy, where a 'smooth transition' from today may actually not represent a risk, whereas a delayed, 'too late, too sudden' future (as highlighted by the European Systemic Risk Board) may represent more of a concern. Supervisory systems thus need to consider both risks arising from the deterioriation of the 'common good' as well as drivers that may contribute to this deterioriation and amplify the fall-out (e.g. investments in high-carbon assets, investments in military). The figure below highlights this dynamic.

FIG. 4.2: MONITORING BOTH THE RISK AND THE EXTENT TO WHICH THE RISK IS BEING AMPLIFIED THROUGH INACTION / ACTION (SOURCE: 2II 2018)

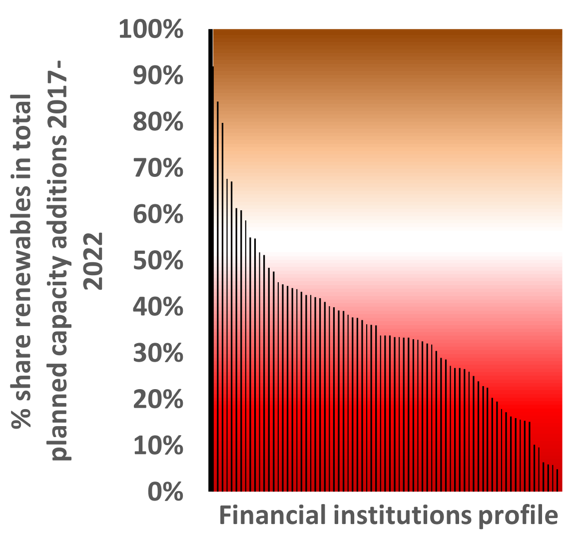


Macro and micro tools. Financial supervisors have two key types of tools at their disposal to respond to these new macro risks:

- **Macroprudential dashboard.** Financial supervisors can develop their capabilities to identify weak signals in the build up of these long-term mega risk and potentially take appropriate action to mitigate subsequent fall-out in advance, as well as 'ready the defences' once these risks materialize. These macroprudential dashboards can monitor a range of issues building on the types of data and live monitoring analytics highlighted earlier. More 'simple' approaches may include for example a dashboard on commodity and resource trends, with more sophisticated approaches extending to issues capturing social media trends, etc. (see box on right)

- **Scenario analysis.** Scenario analysis has become a prominent issue among financial supervisors in the context of the transition to a low-carbon economy and following the publications of the Financial Stability Board Task Force on Climate-Related Financial Disclosures Recommendations, which included a recommendation to conduct 2° C scenario analysis. A number of financial supervisors (Bank of England, Dutch Central Bank, California Insurance Commisioner) have started applying scenario analysis on transition risks – that are risks associated with the transition to a low-carbon economy. In the case of the California Insurance Commissioner's Office, the scenario analysis was directly used as part of its prudential supervision of insurance companies (see box on right and Fig. below)

FIG. 4.2: DIVERSITY IN RENEWABLE POWER EXPOSURES OF SWISS INVESTORS (SOURCE: 2II 2017)



CASE STUDY: COMMODITY & RESOURCE TRENDS

One potential application of new datasets for a macroprudential dashboard is in the area of commodity markets in terms of monitoring the decline of natural resource use. This can extend across fossil fuels and other natural resources and involve close tracking of both commodity markets themselves, as well as companies and governments with significant exposures. The analysis can also extend to analysis of trade imbalances and potential scale of 'shocks' (e.g. autonomous vehicles, breakthrough in synthetic resources) that may materialize. Findings can be integrate dinto traiditonal stress-tests or scenario analysis frameworks (see case study below).

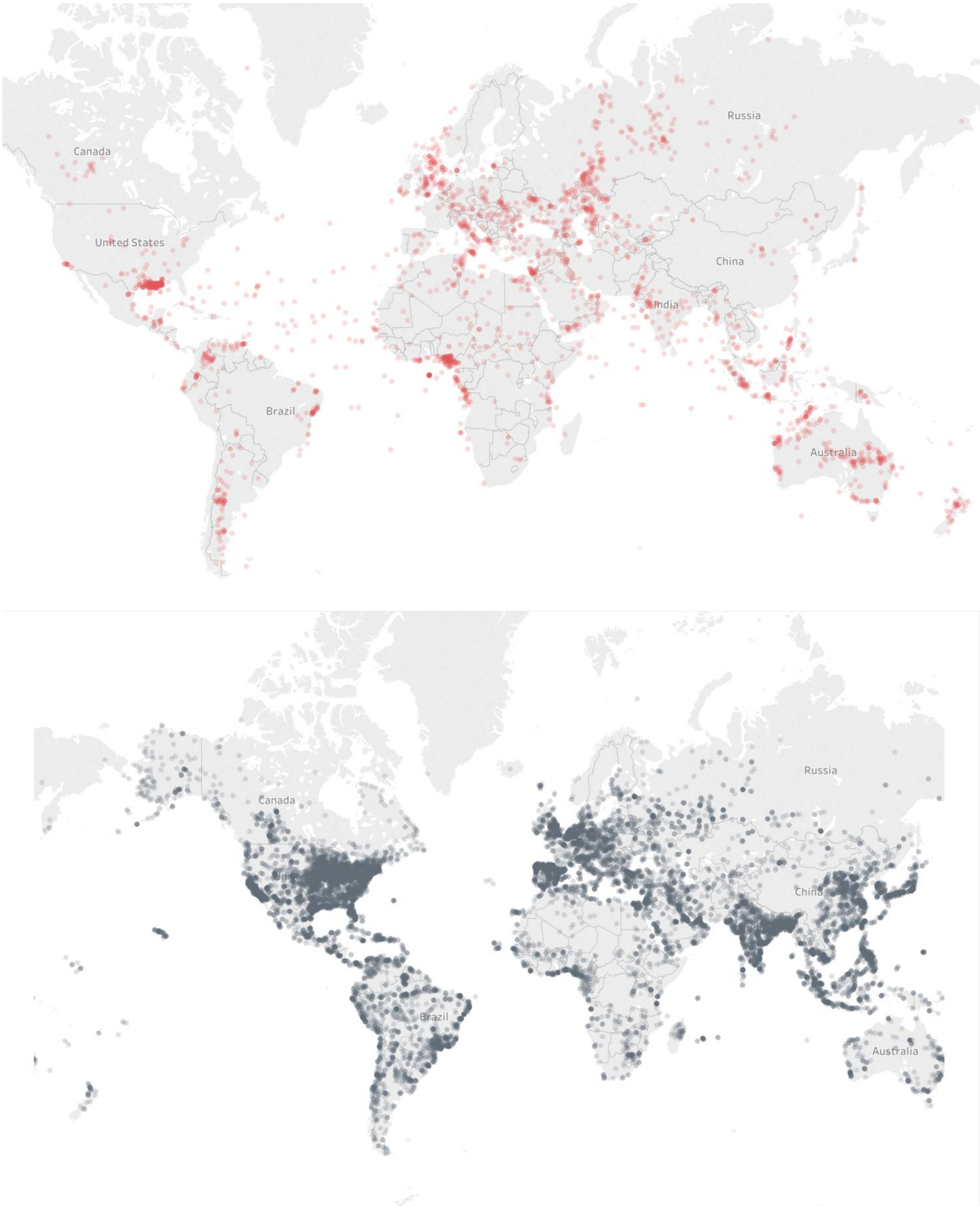
CASE STUDY: SCENARIO ANALYSIS ON TRANSITION RISKS

A number of financial supervisors have begun conducting scenario analysis on their regulated entities using the data described earlier (see next page for asset level data examples for the coal power and oil production sector) and portfolio data to analyze the potential 'accumulating transition risk' of these entities and their individual exposure should these risks materialize. This work has been coordinated by the Paris Agreement Capital Transition Assessment (PACTA) project, providing a free, open-source IT and data infrastructure that supervisors can apply. The following describes the key steps of the exercise:

1. *Collect regulated entities portfolio data (i.e. ownership of financial assets);*
2. *Quantify asset and investment exposure of financial portfolios for key transition-related business segments;*
3. *Define benchmark scenario (i.e. stress-test or climate transition scenario)*
4. *Calculate 'misalignment' / 'misallocation' relative to benchmark scenario;*
5. *Calculate 'economic risk' associated with potential 'misallocation' (i.e. impact on economic asset valuation and potential company cash flows);*
6. *Calculate potential associated 'financial risk' (i.e. impact on financial asset valuation).*

Where portfolio data is not accessible, financial supervisors are developing software that loads the PACTA IT and data infrastructure with the objective to disseminate that to their regulated entites.

FIG. 4.3: ASSET LEVEL DATA USED BY FINANCIAL SUPERVISORS FOR SCENARIO ANALYSIS – OIL FIELDS (RED) AND COAL FIRED POWER PLANTS (GREY) (SOURCE: AUTHORS)



Source: https://ourworldindata.org/international-trade

4.4 NEW SUPERVISION – ROBO CLEARING HOUSE AND ALGORITHMIC SUPERVISION

Beyond the fire extinguisher – New tools. The previous two sections have highlighted the potential for existing regulatory tools, complemented by new data and monitoring infrastructure, to respond to the new challenges of monitoring long-term risks. However, the nature of these challenges will likely require moving beyond the traditional instruments, specifically as it relates to technological changes in financial markets themselves. The mega risks described above require new more sophisticated supervision mechanisms – notably through the addition of scenario analysis and live monitoring tools, and potentially alternative accounting and modelling infrastructure – but can largely build on existing concepts. The technology revolution in finance requires a potential rethink as to how financial supervision can ensure that the mega risks described above are not amplified. It also requires a rethink as to how to ensure market forces regarding competition and the avoidance of 'algorithm biases' can be ensured – especially as financial services are intermediated online with global access of service providers to domestic customers and clients.

Protecting these customers and safeguarding the system will likely require a range of creative policy solutions, some of which still need to be developed. Two examples are highlighted in the red boxes on the side. The first relates to the potential design of a 'robo service' clearing house that ensures all robo services are intermediated through the financial supervisor, with full transparency on potential biases, herding, transaction costs, monopolistic pricing, etc. as well as related opportunities to reduce shadow transactions in a global online marketplace outside of supervisory certification and control.

The second consideration relates to the potential need of algorithmic supervision that involves supervisors themselves deploying algorithms to respond in real-time to shocks in markets (see box on right).

CASE STUDY: ROBO CLEARING HOUSE

One potential challenge with the advent of online robo services is the concentration of market power across a few entities with the necessary sophistication and scale to service the retail and institutional customers of tomorrow and their new demands (e.g. individualized "ETFs of Me"). In order to avoid creating monopolies and ensure proper supervision of financial services with service providers that may be outside of the supervisors jurisdiction, one potential future involves the setting-up of a supervisory robo service clearing house, where all robo service transactions are intermediated. This will enable supervisors to properly measure and track capital allocation decisions, potential biases in algorithms and suitability questionnaires, as well help facilitate an accreditation system that limits shadow transactions outside of the supervised system.

CASE STUDY: ALGORITHMIC SUPERVISION

As algorithms become a threat, traditional 'human supervision' is unlikely to be fast enough to respond. Fighting fire with fire, financial supervisors will at some point need to identify how and where to apply algorithms on the supervision side to respond with sufficient speed and focus to algorithm-induced shocks and risks. Of course, this approach brings its new set of risks and concerns, but is likely the only solution for certain subset of risks and shocks set to emerge (e.g. flash crashes). These algorithmitic fail safe systems already partly exist across market actors (most stock exchanges have a variant of such a system to stop trading if prices move too much) and supervisors are looking at similar tools. These aspects require further exploration as to where they are needed and how they can be developed in a meaningful way.

2dii welcome comment and discussion on this study. For more information please visit www.2degrees-investing.org

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