Financial Supervision beyond the Business Cycle

Towards a new paradigm

2° investing initiative

Contents

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ABOUT THE 1in1000 PROGRAM

1in1000 is a new research program by 2° Investing Initiative (2DII) that brings together new & existing research projects on long-termism, climate change, and (inter-)connected future risks for financial markets, the economy, and society.

Its objective is to develop evidence, design tools, and build capacity to help financial institutions and supervisors to mitigate and adapt to future risks and challenges. The program focuses on climate change and the universe of risks and challenges linked to climate change, notably ecosystem service and biodiversity loss, as well as risks from a decline in social cohesion and resilience.

To achieve this objective, 1in1000 focuses on three main areas: i) Long-term metrics; (ii) Risk (management) tools and frameworks; and (iii) Policies & incentives.

The name '1in1000' represents three ideas. First the challenge of dealing with high impact events that are perceived as having a low probability (e.g., financial markets might perceive those risks as one in one thousand type events). Second, the inevitability of these risks and challenges materializing over the long-run. And third, the lack of capacity and resilience of financial markets currently to deliver an adequate response towards those risks. For more information please visit: https://www.1in1000.com/
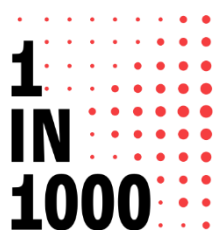
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Globally focused with offices in **Paris, New York, Berlin, London, and Brussels,** we coordinate some of the world's largest research projects on climate metrics in financial markets. In order to ensure our independence and the intellectual integrity of our work, we have a multi-stakeholder governance and funding structure, with representatives from a diverse array of financial institutions, regulators, policymakers, universities, and NGOs. For more information please visit: https://2degrees-investing.org/.

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Executive Summary

At the turn of the decade, a class of risks are coming increasingly into focus – long-term risks (LTRs). Pandemic, climate change, and social resilience represent major threats both to economies and sound and stable financial markets. This paper explores both the extent to which these types of risks are on the radar of financial supervisors and central banks (CBs), as well as the mechanisms to drive financial supervision "beyond the business cycle".

To this end, the paper reviews over 2,000 speeches, reports and press releases as well as other public documentation such as Financial Stability Reports across eight major CBs in the Global North and Global South: the Federal Reserve Board (FED), European Central Bank (ECB), the German Bundesbank (BuBa), the Bank of England (BoE), the Central Bank of Nigeria (CBN), the Bangladesh Bank (BB), the Banco Central do Brazil (BCB) and the People's Bank of China (PBoC).

The paper presents an initial audit of the risk management activities of the eight CBs (see the overview of LTRs management of CBs below) – categorized into measuring, monitoring and mitigation activities - and comes to the following conclusions:

- Most quantitative measuring activities – in form of stress testing – do not extend beyond the business cycle. The focus of those CBs that include LTRs is limited to climate change, and the regulatory use of climate stress tests remains unclear. Moreover, CBs seem to mention LTRs more often in speeches than they research LTRs, suggesting that awareness of LTRs is present but the need to study these risks in financial markets remains limited.

- Monitoring of LTRs – tracked through Financial Stability Reports – is mostly backward and not forward-looking. The most monitored risks are those LTRs that recently materialised, such as Covid-19.

- Mitigation policies, such as decarbonising monetary policy, or setting green capital requirements rarely consider LTRs. Even though we argue that mitigation policies are the most important step of risk management, CBs – in particular CBs of the Global North – do not have mitigation policies in place that included LTRs.

Having identified such management gaps the paper takes a step back and discusses a required change in thinking that is necessary to address those gaps. Before tackling these gaps, a more resilient financial system needs to be built, moving away from efficiency towards building up over-capacity, through implementing precautionary measures and supporting effective policy coordination. By accepting those principles, they will also realise that acting upon the identified gaps in this paper is more than necessary to be properly prepared for LTRs in the future.

Overview of LTRs management of CBs

Measure: Stress test

		Are LTRs included?
FED	3	🚫
ECB	3 / ?	🚫 / ✅ (2021)
BuBa	3	🚫
BoE	30 / ?	✅ (2021) / ✅ (2019)
BCB	1	✅ (2011)
BB	3	🚫
CBN	0.75	🚫
PBoC	?	✅ (2016/2017)

Measure: Speeches, Research, Press Releases

	FED			ECB			BuBa			BoE			BCB			BB			CBN			PBoC		
	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press	Research	Speeches	Press

Legend:
- 🟩 > 20 % is about LTR
- 🟢 11-20 % is about LTR
- 🟨 6-10 % is about LTR
- 🟧 3-5 % is about LTR
- 🟥 1-2 % is about LTR
- 🟥 0 % is about LTR

Monitor: Financial Stability Report

	🌳	🏛	⚛	🖥
FED	dark red	orange	orange	red
ECB	orange	orange	orange	red
BuBa	orange	orange	yellow	red
BoE	orange	orange	yellow	yellow
BCB	dark red	red	orange	orange
BB	red	red	orange	red
CBN	red	orange	orange	red
PBoC	red	red	red	orange

Legend:
- 🟩 ≥2 times per page
- 🟢 ≥1 but < 2 times per page
- 🟨 ≥0.5 but < 1 times per page
- 🟧 ≥0.1 but < 0.5 times per page
- 🟥 > 0 but < 0.1 times per page
- 🟥 LTR is not mentioned

Mitigate: Policy Measures

	FED	ECB	BuBa	BoE	BCB	BB	CBN	PBoC
Microprudential tools								
Risk management	🚫	✅	🚫	✅	✅	✅	✅	✅
Disclosure requirements	🚫	🚫	🚫	✅	✅	✅	🚫	✅
Stress testing	🚫	🚫	🚫	✅	🚫	🚫	🚫	✅
Macroprudential tools								
Capital requirements	🚫	🚫	🚫	🚫	🚫	✅	🚫	🚫
Measuring exposure	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Market standards	🚫	🚫	🚫	🚫	✅	✅	🚫	🚫
Monetary policy								
Unconventional m. policy	🚫	(✅)	🚫	🚫	🚫	🚫	🚫	🚫
Collateral framework	🚫	🚫	🚫	🚫	🚫	🚫	🚫	✅
Direct credit to government	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Capital reallocation								
Asset allocation mandates	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Targeted refinancing	🚫	🚫	🚫	🚫	✅	✅	🚫	✅
Long term bonds	🚫	✅	🚫	🚫	🚫	🚫	🚫	✅
Mix and max credit quotas	🚫	🚫	🚫	🚫	🚫	✅	🚫	🚫
Preferred interest rates	🚫	🚫	🚫	🚫	🚫	✅	🚫	✅

Legend:
- 🚫 Measure does not include LTRs
- ✅ Measure includes LTRs

General Results

LTRs that are best understood

Category of LTR (bar chart): Technological Risks, Societal Risks, Geopolitical Risks, Environmental Risks

x-axis: Percentage of mentions of LTR (0%, 5%, 10%, 15%)

Legend: Press Release, Speeches, Research

LTRs that are best monitored over time

Year (bar chart): 2018, 2019, 2020

x-axis: # of mentions (0, 200, 400, 600, 800, 1000)

Legend: Technological risk, Societal risk, Geopolitical risk, Environmental risk

Note Section

- ⧗ Time Horizon in Years
- 🌳 Environmental risks
- 🏛 Geopolitical risks
- ⚛ Societal risks
- 🖥 Technological risks

Note: overview of stress tests is not complete, only concentrating on the most frequent stress tests and/or the ones referring to LTR

1

Introduction

A range of initiatives over the past years has supported the integration of climate change into the practices of financial supervisors and central banks (CBs), notably mediated through the work of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS). The main arguments behind this dynamic are that climate change may affect the monetary policy transmission channels (NGFS 2020a) and create transition and physical risks to the financial system (NGFS 2019).

However, despite the dynamic around climate change, other long-term "sustainability" risks (e.g. zoonotic diseases that can cause pandemics) are largely off the radar screen of CBs and supervisors until they materialise (e.g. Covid 19). Besides, many of the current initiatives on making the financial system more sustainable remain ad-hoc, one-off exercises or statements and are not properly embedded into mainstream supervisory practice. Finally, even where these initiatives are starting to be embedded, critical questions remain: How can so-called "long-term risks" (LTRs) be integrated into today's decision-making of CBs and financial supervisors? What are the most effective policy instruments? How can we ensure permanence to the analytical and regulatory exercises? And what are – beyond climate change – the key issues that need to be addressed by financial supervisors and CBs?

This paper makes the case for the need for a more permanent concept of long-term financial supervision (LTS) and central banking "beyond the business cycle". It reviews the current evidence as to the extent to which LTRs and societal challenges like climate change are considered by CBs. The exercise is based on a comprehensive review of over 2,000 speeches, reports, press releases, and other public documentation as Financial Stability Reports across 8 major CBs in both developed and emerging markets (Germany, EU, UK, USA, China, Nigeria, Bangladesh, Brazil). It highlights the case for considering these issues and the opportunity set to expand the integration of LTS into the practice of CBs.[1] The objective is to map a way forward to ensure that financial risks and issues are supervised beyond the business cycle and that by extension the mandate of CBs and supervisors is fully realized. Note that the report is a purely quantitative exercise that does not comment on the quality of the long-term supervision of LTRs.

The structure of the paper is as follows. Section 2 defines and discusses the impact of LTRs on the financial system. Section 3 collects evidence on LTRs management for eight CBs: the Federal Reserve Board (FED), European Central Bank (ECB), the German Bundesbank (BuBa), the Bank of England (BoE), the Central Bank of Nigeria (CBN), the Bangladesh Bank (BB), the Banco Central do Brazil (BCB) and the People's Bank of China (PBoC). Section 4 makes the case that current actions are not enough. The way forward needs to strengthen the resilience of the financial system – emphasizing the concept of "overcapacity" or "slack" in the system. Section 5 concludes.

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[1] While the sample of institutions "only" covers central banks, the concept can be extended to financial supervisors. The central banks analyzed also carry supervisory functions.

2

Long-term risks and the need for central banks to manage them

2.1. Defining long-term risks

LTRs derive their name from the fact that they are overlooked in financial analysis that is often calibrated to a short-term time-horizon. They are characterised by their potential systemic impact and materiality to investors, the non-negligible likelihood of highly catastrophic outcomes, and the high degree of uncertainty surrounding their outcomes, which poses a challenge to conventional risk analysis methods.

Specifically, LTRs in this paper are defined as follows:

LTRs are a class of risks that are highly material to financial markets, but whose materiality is potentially limited in the short-term. This may be either because they are unlikely to happen at any given point in time but highly likely to happen at some point, or because their likely materialization is slow-building over an extended period. As a result, LTRs are unlikely to be captured by traditional short-term financial analysis.

Examples of risks we define as LTRs include:

- Environmental Risks: transition and physical risks associated with climate change, loss of biodiversity, global water crises
- Societal risks such as pandemics or the breakdown of social order;
- Technological risks including disruption of industries through artificial intelligence and digitalisation trends;
- Geopolitical risks such as the collapse of global governance structures or deployment of weapons of mass destruction / nuclear catastrophes.

To categorize these risks in a more structured manner, we adopt the risk framework used by the IPCC AR5 (2014) report which identifies the risk driver, exposure, and vulnerability as the three components that together constitute a risk.

The risk driver (or hazard) refers to the event that adversely impacts the system in question - for example, sea-level rise, the collapse of an ecosystem or the outbreak of a pandemic. Exposure describes the interface between the risk driver and the system at risk, whereas vulnerability refers to characteristics of the system studied that determine its predisposition to be adversely impacted by the event.

Table 1 provides more details on this, and the box below shows how this definition applies to a LTRs such as biodiversity.

Table 1: Characteristics of Long-term risks. Source: own representation.

Characteristics	Long-term risks
RISK DRIVER	
Probability of highly catastrophic outcomes	*Probability of high impact either increases with time (slow-building) or the probability of high-impact events at any given point in time is non-negligible (point in time).*
System characteristics	*The risk driver is characterized by non-linear dynamics: Exhibit bifurcation points (tipping points), sensitivity to initial conditions and feedback loops.*
Historical precedent	*The risk driver is often non-cyclical and potentially without recent historical precedent.*
Influence of the financial system	*Financial system has an influence on the risk driver itself.*
EXPOSURE	
Materiality	*The risk is financially material.*
Scale	*Exposure is systemic, meaning that the risk potentially affects a large number of sectors and regions.*
VULNERABILITY	
Time horizon	*Risks are currently under-investigated due to the short-term investor time horizon, and due to a lack of frameworks and metrics.*
Challenges to conventional tools of risk analysis	*Possible outcomes are not known and standard methods of risk management such as Value at Risk analysis are not necessarily applicable.*

BOX: Example of long-term risks – Destruction of ecosystems and loss of biodiversity[2]

Risk driver: the destruction of ecosystems and extinction of species in all regions of the world

- **An infrequent or slow-building** risk that might not materialize fully within the next 3-5 years
- **Non-linear effects** of the loss of biodiversity include tipping points such as the collapse of important ecosystems, as well as interlinkages and knock-on effects on other planetary boundaries such as land-system change and freshwater use
- **Radical uncertainty involved with limited historical precedents** since the impacts of the destruction of important ecosystems are not fully understood, therefore outcomes and associated probabilities are not fully known.
- **Financial system influences risk drivers** and the other way around: financial institutions will be financially impacted by the loss of biodiversity and are at the same time invested in companies contributing to biodiversity loss such as agriculture, mining, fishing, and logging companies.

Exposure

- **Material to investors and banks** since various estimates of the magnitude of the economic impact of this risk has been made: the annual economic value of insect pollinating activity is estimated at US$153 billion (9.5 % of agricultural output) and the overexploitation of fishing resources leads to US$50 billion shortfalls, at the global level. Constanza et al. (2014) estimated the annual value of global ecosystem services at US$125 trillion dollars.
- **Systemic exposure** since the loss of biodiversity is occurring globally and thus affects all regions. In addition, the collapse of particularly important ecosystems can have global impacts. Potentially all sectors are in some way impacted by the loss of biodiversity, as the economy as a whole depends on a number of ecosystems services such as security from disasters. More specifically, the health industry, the tourism sector and the companies driving the loss (such as fishing and logging companies) will be directly impacted.

Vulnerability

- **Currently, no existing disclosure frameworks** or indicators to measure, monitor or mitigate the effects of this risk. Therefore, response mechanisms are under-developed which leads to a vulnerability of the financial system.

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[2] Partly based on Autissier and Buberl 2019.

2.2. The negative implications of long-term risk management failure

Failure to manage LTRs can create issues at various levels of the economy, financial markets and ecosystems. Each of these are outlined below.

1) **Non-economic risks to ecosystems.** The first level of LTRs is non-economic and non-financial risks to ecosystems. While arguably any destruction of ecosystems poses some risk to overall economic well-being, the misuse of an ecosystem that is outside the economic system does not necessarily have a negative economic impact on human well-being. While these types of risks are largely ignored both by economic and financial agents, they may be material from a moral or reputational standpoint.

2) **Failing of internalising externalities to economic activity**. The second level involves risks for the economy where externalities are not priced and where such externalities ultimately create economic damages. This level is different from the first insofar as it creates economic welfare loss. Effectively, there is mispricing within the economy. This mispricing may or may not be mirrored in financial markets when it is corrected, but it may never be corrected. It seems unlikely to imagine the historical externalities generated by high-carbon industries will ever be fully internalized. In such a scenario, externalities depress economic activity and thus productivity of finance and overall welfare but may not necessarily lead to financial shocks if this effect is continuously priced by financial markets.

3) **Misallocation of finance due to dysfunctional price mechanisms.** The third avenue creates a mechanism where mispricing in financial markets leads to value destruction when risks materialize. Mispricing of LTRs means that capital isn't deployed "at its most productive use" and that when the risks materialize, individual financial institutions will see their capital buffer weakened. At this level, however, there isn't necessarily an effect on financial stability. An example of this type of risks can be a climate transition risk, which is unlikely to have implications on financial stability, but might weaken banks' balance sheets where they are not prepared.

4) **Financial instabilities.** If the LTR is sufficiently material and "systemic", it may contribute to the collapse of the financial system through defaults of systemically important financial institutions or more broadly through mechanisms that lead to a freezing up of financing and investment. Financial stability is likely affected where capital or value more generally is destroyed at a systemic level. Extreme climate change outcomes are likely to operate at this level of risk. Furthermore, a systemic lack of internalization may of course yield to systemic financial shocks at Level 2, but again, the relationship between this level and Level 2 is not necessarily stable. For example, failing to internalize externalities may depress long-run growth which will reduce returns in financial markets, but that does not necessarily mean that there are immediate risks to financial assets.

The key question for CBs and financial supervisors is which levels warrant intervention and action. Are LTRs only relevant to the mandate of a central bank where they may be "systemic" to the functioning of the financial system, or also where they create mispricing? Perhaps mandates may even extend to the broader economic risks (most if not all will effectively in all likelihood translate into financial risks in some form) that may depress long-term returns, but do not pose necessarily immediate risks. Some mandates may even consider broader non-economic issues.

A review of the eight CBs further analysed in this report suggest all of them have mandates that would require them to consider financial and price stability aspects, even when only framed in a narrow way, and that some of these mandates may even be interpreted to extend to broader economic and ecosystem considerations.

Figure 1: Overview of primary objectives of CBs. Source: Mandates Bibliography

Central Bank	Primary objective	Written mandate
Federal Reserve Board (FED)	Price stability and maximum sustainable employment	*"...long run growth of the monetary and credit aggregates … to increase production, so as to promote … employment, stable prices, and moderate long-term interest rates..."* (Fed 1977)
European Central Bank (ECB)	Price stability	*"...shall be to maintain price stability..."* . And without prejudice to the first *"...shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress ... protection and improvement of the quality of the environment..."* ECB (2016). ECB (2008)
Bundesbank (Buba)	Price stability, financial stability	*"...it shall participate (…) with the primary objective of maintaining price stability…"* and *"…it shall contribute to safeguarding the stability of the financial system (financial stability) in Germany..."* BuBa (1992). BuBa (2012)
Bank of England (BoE)	Price stability, financial stability, prudential regulation	*"(a) to maintain price stability, and (b) subject to that, to support the economic policy of Her Majesty's Government, including its objectives for growth and employment."* BoE (1998)
Central Bank of Nigeria (CBN)	Price stability, economic policy	*"...the attainment of price stability and to support the economic policy of the Federal Government..."* CBN (2007)
(Bangladesh Bank) BB	Price stability, economic growth	*"...maintain price stability and financial system robustness, supporting rapid broad based inclusive economic growth, employment generation and poverty eradication..."* BB (n.d.)
Banco Central do Brazil (BCB)	Needs of the economy, development	*"...adapt the money supply to real needs of the national economy and its development process"* BCB (1964)
People's Bank of China (PoBC)	Price stability, economic growth	*"...maintain the stability of the value of the currency and thereby promote economic growth…"* PoBC (2007)

BOX: WHY DO WE THINK LONG-TERM RISKS ARE NOT ALREADY PROPERLY PRICED AND MANAGED?

Under the Efficient Market Hypothesis (EMH) developed by Fama (1970) and Samuelson (1965) more or less in parallel, "market in which prices always 'fully reflect' available information is called efficient" (Fama 1970, p. 383). In financial markets, the pricing of an asset is normally determined by the function of its risk probability distribution. The risk probability distribution "provide[s] market actors with knowable information about the future [and thus] capital portfolios can be adjusted to maximise profits and mitigate possible risks" (Chenet et al. 2019, p.7). The assumption here is that market participants are consistent in their taste and action over time (Samuelson 1937). Put differently, since asset prices fully reflect the available information on the risks underlying these securities, market participants are able to integrate that information instantly into price formation and do so constantly over time (Fama 1970).

Therefore, there are two conditions necessary for the EMH to hold: First, as highlighted, prices need to fully reflect available information and second market participants are rational, utility-maximising agents (Fama 1965, 1970). However, the two conditions do not hold for LTRs:

- First, LTRs differ from calculable financial risks since there is limited information. As we seen in Table 1, LTRs often do not have a known probability function, are non-cyclical and involve skewed, fat tail risks. Furthermore, there are challenges around trying to turn uncertainty into measurable and quantifiable risks (Thomä and Chenet 2017). In other words, under conditions of fundamental uncertainty, the market prices of securities will most likely always be wrong because markets are blind to radical uncertainty (Chenet et al. 2019).

- Second, even though the EMH assumes that consumers are consistent in their tastes and actions over time, there is very weak theoretical and empirical foundation for this assumption. There is evidence that in practice economic agents discount the future based on a hyperbolic discount function (Thaler 1981). In such a case, economic agents have a 'present-biased preferences' valuing the present heavily over the long-term. While such present-biased preferences might not be harmful when risks are materialising in the short-term, they are in the light of LTRs. Since LTRs, as the name points out, will most likely materialise over time, the inconsistency of market participants leads to the fact that LTRs are heavily discounted over the short-term (Thomä and Chenet 2017).

Since recent models are not integrating the nature of LTRs, as well as recent assumptions are proven wrong in the light of LTRs, LTRs are not managed properly which might in turn lead to financial and price instabilities.

3

The status quo: do central banks manage long-term risks?

3.1. Measuring long-term risks

The first step of long-term supervision beyond the business cycle is to understand the nature and materiality of LTRs and the exposure of today's markets to these risks – in other words, to measure LTRs. Quantitatively, this is traditionally done through stress testing and scenario analysis. Stress-tests are in most jurisdictions a formal regulatory instrument with direct concrete regulatory implications (e.g. changes in capital requirement).

As we see in Figure 2 on the next page, only the BCB, the PBoC and BoE have already included LTRs in stress testing activities in some form. Already in 2011, the BCB announced a resolution that requires banks to take risks through environmental damage into account during the year. Based on the results of the stress test, the BCB assesses capital adequacy based on E&S risk exposure (Dikau and Ryan-Collins 2017) addressed at insurance companies. The PBoC also developed an environmental stress test for banks in 2015 that were tested between 2016 and 2017 and covering asset management, insurance, credit and the stock and bond market. The stress test addresses the thermal power, cement, iron, and steel industry (UNEP 2017). The stress test of the BoE is addressed to the insurance sector, implemented in 2018. Among those already implemented, the ECB and the BoE plan climate stress tests - the EU wide stress test is planned for 2021 and the BoE Biennial Exploratory Scenario (BES) also for 2021. However, none of the stress tests included other LTRs as we defined in Section 2.1, with the exception that the BES plans to do so in the future.

Even though some CBs included LTRs in their stress tests, there are still several gaps:

1) **Lack of regulated regulatory responses:** while analytically interesting, those stress tests including climate, struggle to drive regulatory responses. Most of the climate risk exercises conducted by financial supervisors to date, including those highlighted above, explicitly preclude regulatory intervention in the form of changes to capital requirements, in so far, they are considered as "exploratory" exercise.

2) **Insufficient time horizon:** Figure 2 provides evidence that currently, quantitative risk exercises conducted by financial supervisors – primarily in the form of stress-tests – generally have in the median a 3-year time horizon, and are therefore unlikely to capture or be well adapted to the time horizon or nature of LTRs.

3) **No incorporation of LTRs beyond climate:** while a minority of CBs are starting to investigate climate change in some form in their stress-testing work, even if limited to analytical exercises, other LTRs are largely ignored.

4) **Limited scenarios:** current stress-tests are usually limited to 2-3 scenarios, reflecting what have traditionally been significant costs of designing and implementing stress-tests. Such an approach to LTRs – while feasible – is unlikely to do justice to the radical uncertainty associated with these risks. It may be appropriate to simulate hundreds of different futures, rather than just two or three.

Note that the analysis of stress tests is only based on quantitative explicit modelling of LTRs. Of course, in some stress tests, financial institutions are asked to qualitatively assess the relevance of LTRs. Thus, although LTRs are not explicitly modelled as a scenario in the stress test, to a certain extent the supervisor can assess how exposed institutions are to LTRs (see e.g. the LSI stress test of the Bundesbank).

Figure 2: Overview of most important stress tests of the eight assessed CBs. Source: see Stress Test Bibliography

Central Bank	FED	ECB	BuBa		BoE			BCB		BB	CBN	PBoC	
Name of the stress test	Dodd-Frank Act Stress Test	EU-wide stress test exercise	New climate stress test (2021)	Less significant institution stress test (LSI)	Normal stress test	Stress test for insurances (2019)	Biennial exploratory scenario (BES) (2021)**	Capital stress test	ICAAP BCB35 2011	Stress test guidelines	Banking Industry Solvency Stress Test	The Banking Sector Stress Test	Environmental stress testing (2016-2017)
Addressed at	banks	banks	banks	banks	banks	insurances	banks and insurers	banks	banks	banks	banks	banks	Investment practices of enterprises and financial institutions
Regulatory	yes	yes	n/a	yes	yes	yes	?	yes	?	yes	yes	yes	no
Time Horizon	3 years	3 years	more than 3 years expected	3 years	5 years	?	30 years	3 years	1 year	n/a	3 quarters	3 years	?
Frequency	2-year-cycle	1-year-cycle**	n/a	2-year-cycle	1-year-cycle	2-year-cycle	2-year-cycle	half-year-cycle	1-year-cycle	half-year-cycle	half-year-cycle	1-year-cycle	tested between 2016-2017
Description of the risk*	general	general	n/a	general	general	Climate-related risks; physical risks, transition risks	Climate-related risks; physical risks, transition risks	general	Risks given by BCB (environmental and social)	general	general	general	Carbon price risk, water resource risk and environ-mental penalty risks
Variables that are impacted (macroeconomic/sectoral)	general	general	n/a	general	general	general, physical, climate shocks (hurricanes, earthquakes, windstorm, floods)	general, physical variables (e.g. sea level rise), transition variables (e.g. carbon price)	general	?	general	general, but also sectoral specific variables as e.g. Oil prices	general	general
Considering long-term risks?	no	no	yes	no (only to certain extent qualitatively)	no	yes (next stress test also includes Covid-19 and potentially cyber)	yes (climate-induced risks)	no	yes (with a 1-year-time horizon)	no	no	no	yes (climate-induced risks)

Note: *not complete, only concentrating on the most frequent stress tests and/or the ones referring to LTR, **thematic stress tests are conducted in the years where there is no EU-wide stress test, ***general: general financial values (e.g. solvency, credit, liquidity) under severe economic downturn. Question marks indicate that we couldn't find the information, but we assume that the information is given somewhere. N/a means that the data is not available yet. The Industrial and Commercial Bank of China (ICBC) conducted 2015 an environmental stress test in China's aluminium sector, however, due to the scope of the paper, we concentrate on the PBoC.

Next to the analysis focusing on the quantitative aspect of LTRs management through stress testing, we examined 1,629 research documents and 832 speeches of the CBs to analyse if the eight CBs understand and recognise LTRs. In cases in which we could not find more than 50 documents or speeches, we relied on a secondary data set of 1,258 press releases as a proxy for the research activities. We screened each of the data pieces for LTRs and identified if the research documents, speeches or press releases mainly addressed LTRs. We then put those data pieces in relation to the overall amount of screened data. Figure 3 shows an overall assessment of all CBs.

Two aspects stand out: The first aspect that immediately strikes the attention is that CBs are more likely to mention LTRs in speeches than research on LTRs. The second aspect is that CBs speak most frequently about technological risk, in particular about digital currencies such as Libra and cyber-attacks. Technological risks are followed by societal risks which are mainly due to the ongoing Covid-19 crisis since societal risks also include pandemics. However, overall, the average percentage of all research, speeches and press releases that mention LTRs is in average quite low.

Figure 3: Research, speeches, press releases of CBs about LTR (in %) of all available research, speeches and press releases available between 2018-2020. Sources: Research, Speeches and Press Releases Bibliography
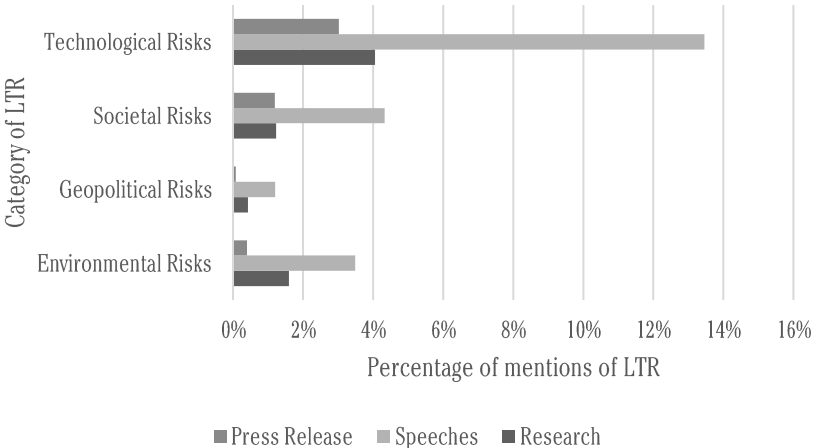
Note: Environmental risks include climate change, natural disasters, extreme weather events, biodiversity loss; Geopolitical risks include events like Brexit, political conflicts, terror attacks, war, nuclear weapons/catastrophes; Societal risks include diseases, food/water crises, pandemics (COVID-19), migration; Technology risks include digitalisation, technology, big data, FinTech, cyberwar.

Figure 4 shows a comparison between the different CBs investigated. In general, the CBs in the Global North conduct more research about LTRs than the CBs in the Global South. For example, the BuBa speaks about LTRs most frequently, whereas the BB does not do so at all.

Figure 4: Percentage of all research documents, speeches and press releases that are about LTRs in comparison to all research documents, speeches and if necessary press releases that are available. Source: CBs website (see Bibliography) and BIS 2020.
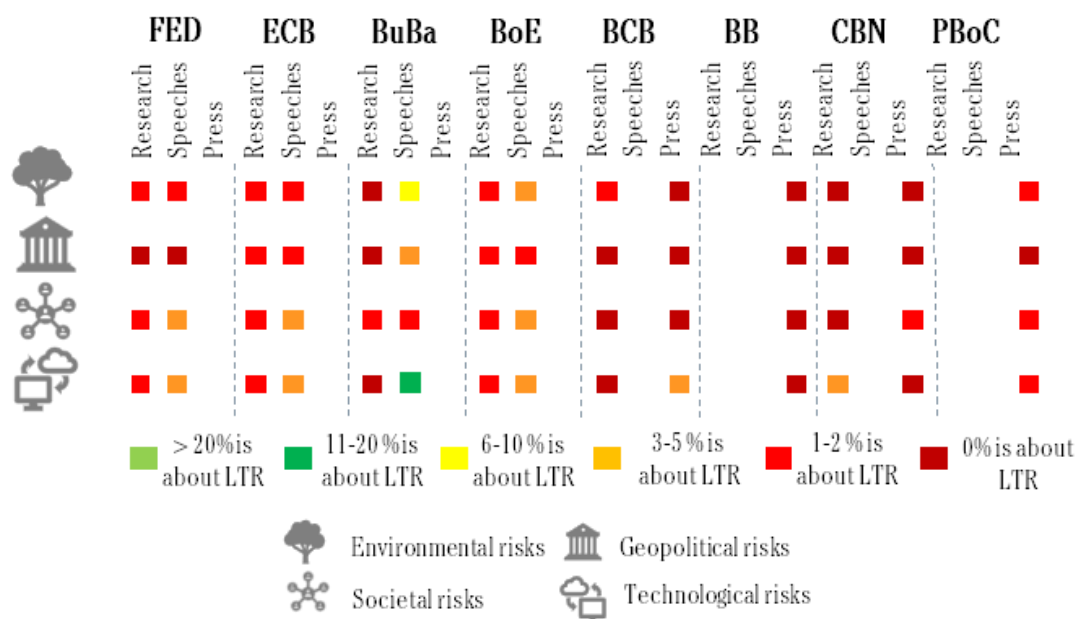
Note: Environmental risks include climate change, natural disasters, extreme weather events, biodiversity loss; Geopolitical risks include events like Brexit, political conflicts, terror attacks, war, nuclear weapons/catastrophes; Societal risks include diseases, food/water crises, pandemics (COVID-19), migration; Technology risks include digitalisation, technology, big data, FinTech, cyberwar. No analysis if not more than 50 documents or speeches

3.2. Monitoring long-term risks

Each CB has its monitoring system of risks. To create a comparable dataset, we took the Financial Stability Report – a consistent and comparable output across CBs – as the reference of choice in terms of "monitoring" exercises. Financial Stability Reports are supposed to be the output linked to the monitoring done by CBs and create a review of the threats to financial stability and the assessment of their status, materiality, and potentially likelihood.

To understand if those CBs started to monitor LTRs we reviewed all available Financial Stability Report for the last 3 years (2018-2020).[3] As we did with assessing the measure activities of CBs concerning LTRs, we reviewed the reports for keywords that indicate if CBs are aware of LTRs and monitor them. Figure 5 shows an overall assessment, meaning the absolute number of how many times LTRs were mentioned in the Financial Stability Reports of all eight CBs.

We find that financial stability reports primarily mention those risks that have recently materialized. This shows the backward rather than forward-looking nature of existing LTR management (see Figure 5). Due to Covid-19, societal risks topped the list of most frequently mentioned LTRs in 2020. The mentioning of societal risks already saw a small increase in 2019 due to the PBoC that had already started monitoring the pandemic in the last quarter. Furthermore, geopolitical risk refers to the risks that evolved through Brexit or trade tensions with the United States under the Trump administration. In other words, the mentions of risks due to Covid-19, Brexit and trade tensions with the United States were increasing in Financial Stability Reports at times when such events already materialised. The other take-away is that there seems to be some displacement effect between LTR. Thus, environmental issues were significantly less prominently represented in 2020 vis-à-vis 2019, clearly overtaken in attention and focus by the pandemic. Based on this, it could be argued that although some LTRs such as pandemics or social disruption due to Brexit have found their way into CBs' assessments, this happened at a point at which the risk had already materialized and therefore did not indicate actual management or monitoring of the risk.

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[3] If there was no financial stability report available for 2020, we took the last 3 years starting backwards from the last available report.

Figure 5: Number of mentions (absolute) of LTRs in all available Financial Stability Reports of the eight CBs according to each LTR category over time (2020-2018). Sources: Financial Stability Reports of each CB (see Bibliography)
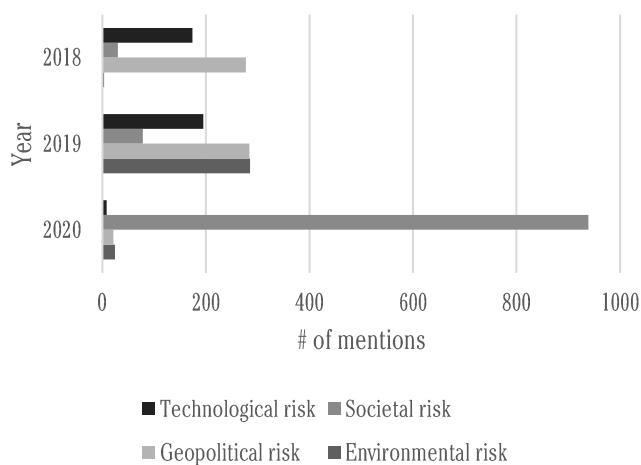
Note: Environmental risks include climate change, natural disasters, extreme weather events, biodiversity loss; Geopolitical risks include events like Brexit, political conflicts, terror attacks, war, nuclear weapons/catastrophes; Societal risks include diseases, food/water crises, pandemics (COVID-19), migration; Technology risks include digitalisation, technology, big data, FinTech, cyberwar

The overall picture is also mirrored in the assessment of each CB (see Figure 6). Specifically, we find that the best-monitored risks of each CBs are societal risks (due to COVID-19) and geopolitical risks (due to Brexit). This is followed by technological risks (due to digitalisation, digital currency and cyberwar) and finally environmental risks (as climate-related risks). Figure 6 gives a further indication that the monitoring of LTRs is not focused on the future, but on the risks that have already occurred.

Figure 6: Numbers of mentions of LTRs per page of Financial Stability Report, Source: Financial Stability report of each CB (see Bibliography). If available 2018-2020, otherwise last 3 years that were available.
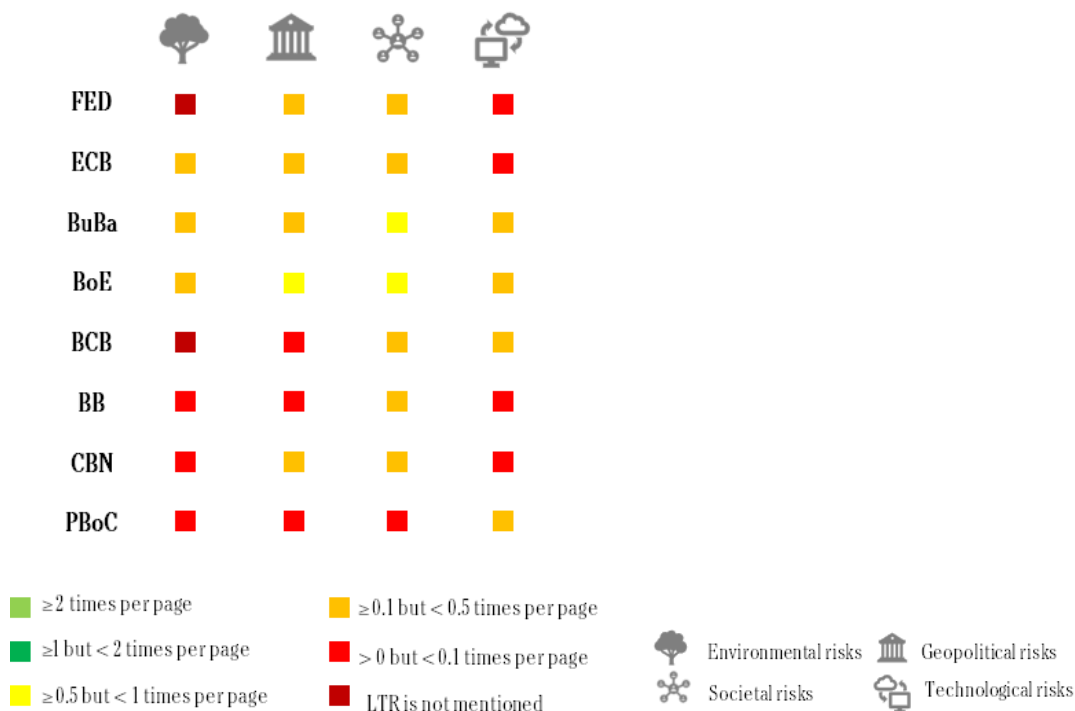
Note: Environmental risks include climate change, natural disasters, extreme weather events, biodiversity loss; Geopolitical risks include events like Brexit, political conflicts, terror attacks, war, nuclear weapons/catastrophes; Societal risks include diseases, food/water crises, pandemics (COVID-19), migration; Technology risks include digitalisation, technology, big data, FinTech, cyberwar.

3.3. Mitigating long-term risks

Mitigation measures could be for example microprudential tools like disclosure requirements, i.e. CBs could determine disclosure of LTRs in annual reports. Such disclosure requirements are already in use. For example, the BuBa set forth requirements for financial institutions to manage risks that include counterparty risks, market price risks, liquidity risks and operational risks (BaFin n.d.). Another measure could be capital reallocation through targeted refinancing measures, i.e. that when a commercial bank needs to refinance their assets they could do so at preferential terms for specified assets, such as assets that incorporate LTRs. The CB of Nigeria has such measure in place for assets of small and medium-size companies, for example, supporting such assets (CBN n.d.). A summary of potential mitigation policies can be found in Figure 7. Note that the overview is a selection of the most important mitigation policies among all eight central banks. However, we acknowledge that, e.g., depending on regions, also other monetary policy instruments might be important. For example, in China and also in other countries of the Global South, central bank reserve management is still an important monetary policy instrument. Thus, targeted (green) adjustment of reserve requirements for different banks can be a powerful tool (see e.g. The People's Bank of China n.d.).

Building on the sustainable toolbox by Dikau and Volz (2020), as well as on the report of UNEP and 2DII (2016), we reviewed 14 mitigation measures that will help to either prevent, reduce, or contain LTRs (see Figure 7). According to those mitigation measures, we check the CBs' websites to understand if those measured had been in place in the context of LTRs. Some CBs also put forward certain guidelines such as the CBN (2012) or BB (2017) which we also screened. Furthermore, work by Volz and Dikau (2020) as well as D'Orazio and Popoyan (2019) are used complementary. However again we only rely on publicly available information.

Figure 7: Overview of examples on how to incorporate LTRs in supervision and monetary policy. Source: based on Volz and Dikau (2020); UNEP and 2DII (2016).

Theme	Policy Area	Description	Thoughts/ Examples of LTRs-enhanced calibration	Beyond the price stability mandate?
Micro-prudential tools	Risk management requirements	Creating incentives around financial institutions to consider LTR management.	Create a pledge for financial institutions to commit themselves voluntarily to manage LTRs and be part of a long-term initiative	No
	Disclosure requirements	Determining disclosures of risks in annual reports, investor communication.	Understand long term risk management practices and incorporate them into traditional corporate disclosure.	No
	Stress testing	Testing consequences of certain shocks on banks' capital	Use frameworks that acknowledge LTRs and help firms take into account LTRs	No
Macro-prudential tools	Capital requirements	Setting capital requirements (for example counter-cyclical capital buffers in Basel III)	Set higher capital requirements for assets that do not incorporate LTRs, capital relief when the risk materialises	Depends No
			Set lower capital requirements for assets that incorporate LTRs	Yes
	Measuring systemic financial assets' exposure and related adaptive capacity indicators	Identifying risk wind down capabilities over short-, medium-, and long-term time horizons.	Do macroprudential stress testing.	No
	Market standards and guidance (targeting rating agencies)	Publishing detailed guidelines (definition, methodologies)	Do a pledge, create guidelines that financial institutions commit themselves to use LTR guidelines.	No
Monetary policy	Quantitative Easing	Purchasing the assets that are on the collateral framework (examples are PEPP, APPs of the ECB)	Reflect LTR in purchasing programmes	Depends No
			Exclude assets that exhibit high LTRs	
			Include assets that contain low LTRs	Yes
	Collateral frameworks	Adjusting risk assessment and credit ratings, adjusting haircuts.	Exclude assets that will have proven higher risks (such as carbon-intensive assets). Increasing haircuts of carbon-intensive assets.	Depends No
			Include assets that will have proven a lower risk (such as green assets). Decreasing haircuts of green assets.	Yes

	Direct (short term) credit to the government to support standard fiscal spending.	Purchasing of sovereign bonds.	Purchasing of sovereign bonds that incorporated LTRs	No
Capital Reallocation	Asset allocation mandates	Taking responsibilities for asset allocation and the rules governing financial institutions	Determine certain rules for LTR	No
	Targeted Refinancing	Refinancing for commercial banks at preferential terms for specified assets	Set preferential terms for assets that incorporate the risks and that is long term	Yes
	Long-term bonds	Advocating policies for certain bonds (for example green bonds)	Determine policies that incorporate LTRs	Yes
	Min and max credit quotas	Requiring banks to lend at least a specific quota to certain corporates	Require banks to lend at least a maximum quota to corporates that not incorporate LTR	Yes
			Require banks to lend at least minimum quota to corporates that incorporate LTR	
	Preferred interest rates for priority sectors	Promotion of investment targeting the resilience of LTRs	Set interest rates higher for those corporates that will be most hit by LTR	Yes
			Set interest rates lower for those corporates that will be less hit by LTR	

Note: The evaluation if the measures are beyond the mandate of price stability is the assessment of the authors.

Based on desk-research, we then identified if the eight CBs already implement such mitigation measures including LTRs. Figure 8 gives an overview of this. The first note that should be made is that most measures that include LTRs focus on environmental risks, i.e. most measures are green policies. A striking aspect is that even though in the measure and monitor assessment, CBs of the Global North seemed to be better operating, in the last step of the risk management – namely mitigation, the CBs of the Global South implemented 3-times more mitigation measures than the Global North, especially the BB, CBC and the PBoC. However, Figure 8 includes more red crosses than green ticks, indicating that mitigation measures relating to LTRs are still limited. Note that some of the crosses and ticks are "borderline" cases. For example, the ECB lists green bond purchases through its asset purchase program under its "climate change strategy". However, clearly, other central banks will also by default have these types of instruments in their portfolio. Furthermore, it is not clear if the investment of the ECB in green bonds goes beyond market boundaries since they explicitly state that by investing in green bonds, they avoid market distortions (ECB 2021).

Reasons for the underdevelopment of mitigation policies for LTRs could be related to the narrow scope of CBs' mandates. Recap Figure 1, where we listed all mandates of the eight CBs. Notably, those CBs only focusing on price stability, also have fewer mitigation measures in place than those CBs, mainly from the Global South, that also include economic policy or sustainability in their mandate. Those findings are especially interesting given that CBs of the Global North increasingly talk about LTRs indicating that they know about the magnitude and importance to take care of such risks. However, it seems to be the case that knowledge is not enough to act but that one reason why countries of the Global South are already acting could also be since they are already affected by climate change and not only know about it but also feel the negative consequences (German Watch 2020). It is neither our task nor in our capacity to solve those mandates debates. However, in Figure 7 we identified if for the measures a broader mandate is needed or if the measure could also be implemented with a narrower mandate only focusing on price stability.

Figure 8: Overview of which mitigation measures CBs are currently taking with regard to LTRs. Source: website of CBs and New Economics (Dikau and Ryan-Collins 2017).

	FED	ECB	BuBa	BoE	BCB	BB	CBN	PBoC
Microprudential tools								
Risk management	⊘	✓	⊘	✓	✓	✓	✓	✓
Disclosure requirements	⊘	⊘	⊘	✓	✓	✓	⊘	✓
Stress testing	⊘	⊘	⊘	✓	⊘	⊘	⊘	✓
Macroprudential tools								
Capital requirements	⊘	⊘	⊘	⊘	⊘	✓	⊘	⊘
Measuring exposure	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
Market standards	⊘	⊘	⊘	⊘	✓	✓	⊘	⊘
Monetary policy								
Unconventional m. policy	⊘	(✓)	⊘	⊘	⊘	⊘	⊘	⊘
Collateral framework	⊘	⊘	⊘	⊘	⊘	⊘	⊘	✓
Direct credit to government	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
Capital reallocation								
Asset allocation mandates	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
Targeted refinancing	⊘	⊘	⊘	⊘	✓	✓	⊘	✓
Long term bonds	⊘	✓	⊘	⊘	⊘	⊘	⊘	✓
Mix and max credit quotas	⊘	⊘	⊘	⊘	⊘	✓	⊘	⊘
Preferred interest rates	⊘	⊘	⊘	⊘	⊘	✓	⊘	✓

⊘ Measure does not include LTRs

✓ Measure includes LTRs

3.4. Summary

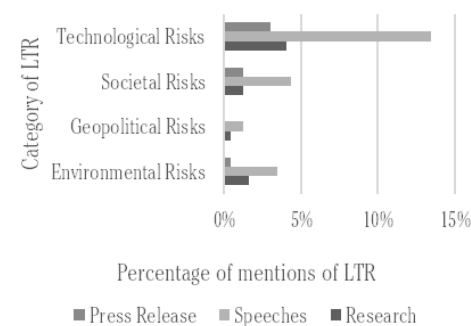## Overview of LTRs management of CBs

Measure: Stress test

Are LTRs included?

	Time Horizon	Included?	
FED	3	🚫	
ECB	3 / ?	✅	(2021)
BuBa	3	🚫	
BoE	30 / ?	✅ / ✅	(2021) / (2019)
BCB	1	✅	(2011)
BB	3	🚫	
CBN	0.75	🚫	
PBoC	?	✅	(2016/2017)

Measure: Speeches, Research, Press Releases

	FED Research	FED Speeches	FED Press	ECB Research	ECB Speeches	ECB Press	BuBa Research	BuBa Speeches	BuBa Press	BoE Research	BoE Speeches	BoE Press	BCB Research	BCB Speeches	BCB Press	BB Research	BB Speeches	BB Press	CBN Research	CBN Speeches	CBN Press	PBoC Research	PBoC Speeches	PBoC Press
🌳 Environmental																								
🏛 Geopolitical																								
☸ Societal																								
☁ Technological																								

Legend:
- 🟩 > 20% is about LTR
- 🟢 11-20% is about LTR
- 🟨 6-10% is about LTR
- 🟧 3-5% is about LTR
- 🟥 1-2% is about LTR
- 🟥(dark) 0% is about LTR

Monitor: Financial Stability Report

	🌳	🏛	☸	☁
FED	dark red	orange	orange	red
ECB	orange	orange	orange	red
BuBa	orange	orange	yellow	orange
BoE	orange	yellow	yellow	orange
BCB	dark red	red	orange	orange
BB	red	orange	orange	orange
CBN	red	orange	orange	orange
PBoC	red	red	red	orange

Legend:
- 🟩 ≥ 2 times per page
- 🟢 ≥ 1 but < 2 times per page
- 🟨 ≥ 0.5 but < 1 times per page
- 🟧 ≥ 0.1 but < 0.5 times per page
- 🟥 > 0 but < 0.1 times per page
- 🟥(dark) LTR is not mentioned

Mitigate: Policy Measures

	FED	ECB	BuBa	BoE	BCB	BB	CBN	PBoC
Microprudential tools								
Risk management	🚫	✅	🚫	✅	✅	✅	✅	✅
Disclosure requirements	🚫	🚫	✅	✅	✅	✅	🚫	✅
Stress testing	🚫	🚫	🚫	✅	🚫	🚫	🚫	✅
Macroprudential tools								
Capital requirements	🚫	🚫	🚫	🚫	🚫	✅	🚫	🚫
Measuring exposure	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Market standards	🚫	🚫	🚫	🚫	✅	✅	🚫	🚫
Monetary policy								
Unconventional m. policy	🚫	(✅)	🚫	🚫	🚫	🚫	🚫	🚫
Collateral framework	🚫	🚫	🚫	🚫	🚫	🚫	🚫	✅
Direct credit to government	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Capital reallocation								
Asset allocation mandates	🚫	🚫	🚫	🚫	🚫	🚫	🚫	🚫
Targeted refinancing	🚫	🚫	🚫	🚫	✅	✅	🚫	✅
Long term bonds	🚫	✅	🚫	🚫	🚫	🚫	🚫	✅
Mix and max credit quotas	🚫	🚫	🚫	🚫	🚫	✅	🚫	🚫
Preferred interest rates	🚫	🚫	🚫	🚫	🚫	✅	🚫	✅

- 🚫 Measure does not include LTRs
- ✅ Measure includes LTRs

General Results

LTRs that are best understood

Categories of LTR: Technological Risks, Societal Risks, Geopolitical Risks, Environmental Risks

X-axis: Percentage of mentions of LTR (0%, 5%, 10%, 15%)

Legend: ▪ Press Release ▪ Speeches ▪ Research

LTRs that are best monitored over time

Year: 2018, 2019, 2020

X-axis: # of mentions (0, 200, 400, 600, 800, 1000)

Legend: ▪ Technological risk ▪ Societal risk ▪ Geopolitical risk ▪ Environmental risk

Note Section

- ⧖ Time Horizon in Years
- 🌳 Environmental risks
- 🏛 Geopolitical risks
- ☸ Societal risks
- ☁ Technological risks

Note: overview of stress tests is not complete, only concentrating on the most frequent stress tests and/or the ones referring to LTR

4

A call for resilience

One key takeaway from the previous section is that CBs, especially those of the Global North talk about LTRs but do not manage and act upon them. Furthermore, we found that measuring activities mainly address the short-term, monitoring activities are backwards rather than forward-looking and mitigation actions for LTRs are underdeveloped. These issues all have a technical component - which we also have not cracked yet - relating to the availability of data and frameworks to manage LTRs.

However, in this section, we follow the hypothesis that managing LTRs not only means to have the technical capacity to do so but that the system is able to withstand and recover from the shock – in other words, that it is resilient (Adger 2000). If we achieve this shift from efficiency to resilience, people might start valuing more the need to also manage LTRs and understand the need to act on LTRs by preparing for them. Without this shift, it seems to be difficult that institutions start acting. CBs can play an important part in this regard.

The ongoing COVID-19 pandemic illustrated the importance of resilience by demonstrating the weaknesses of our systems highlighted fragilities and making us aware of the interconnectedness of our world. In particular, the pandemic has shown the repercussions that a single-minded focus on efficiency can have in times of crisis. Across economies, we often focus on short-run cost optimization, when what we need to do more is build-in structural resilience, mainly in the form of some overcapacity, so we can efficiently respond to surge conditions. Over the long run, this is cost-optimal in an age of risk and uncertainty.

Due to a lack of corporate resilience, large companies relied heavily on governments bailouts in the face of this crisis. This represents a 'sub-optimal' policy tool not only because of the moral hazard it can create, or the questionable net benefits compared to other expenditures such as education, but also because of the erosion of public trust large bailouts can lead to. Not suggesting that bailouts cannot function as risk pooling, but that ad hoc and not transparent bailouts are not the optimal way to manage risks (Thomä and Schönauer 2020). Furthermore, the COVID-19 pandemic highlights the importance of early action in the face of a crisis – in the case of this pandemic to flatten the infection rate curve and prevent a break-down of the health system. Similarly, several LTRs we are facing are known and can be reduced through early action (for example, transition risks from climate change).

We investigate the following three measures to increase the resilience of a system: 1) having over-capacity in place, 2) implementing precautionary measures and 3) effective policy coordination. Resilience will help society to manage LTRs effectively in the future and CBs and financial supervisors can play an important part here. Let us consider each aspect of resilience[4] in greater detail:

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[4] Please also find Biggs 2012 who puts up certain criteria that need to be fulfilled that systems become more resilient.

1) Having over-capacity in place

Over the years, a mentality of "short-term cost optimisation" and "short-sighted cost-cutting" has led to a failure to build capacity that ensures a buffer to better deal with crises (Caldecott 2020; Taleb 2012). For efficiency reasons, companies, financial institutions but also public organization or institutions like hospitals are missing buffers that could have reduced the impact of crisis such as the global financial crisis or the Covid-19 crisis. For example, an analysis of Thomä and Schönauer (2020) showed that if US companies would have forgone share buybacks, they would have had about 5 months of cash reserves rather than the 1 month they actually had at the beginning of the Covid-19 crisis. The question here is how much money could have been saved in bailouts if companies had the necessary buffers to better deal with a crisis. Actions here could be (public) insurance schemes for upcoming crises (ibid.).

The 'short-run cost optimisation' and 'short-sighted cost cutting' mentality also exists in the financial system. Such a mentality is dangerous, especially in the light of LTRs. Let us give two examples here:

First, current MiFID II minimises the research budget which can lead to less research conducted on LTRs. The European Commission (2020) recently stated that the legislative framework MiFID II regulates financial markets and improves protection for investors reduces research budgets and lowers research prices. This, in turn, leads to a decrease in research coverages and volumes (European Commission 2020). Furthermore, within research budgets, demand for LTRs research is lacking. So, decreased research budget along with lacking demand for long-term research from institutional investors could also mean that the quality of research is deficient in terms of assessing LTRs.

Such research is highly needed as these risks proliferate. This could be addressed through a requirement to regularly assess LTRs and allocate more resources in general to the management of LTRs. This could for example be implemented through a mandated or voluntary private sector initiative to allocate a certain percentage of research budgets to 'long-term research'. CBs could encourage such initiatives, as well as expand their research budgets on LTRs.

Second, recent 'efficient' capital requirements are set without considering LTRs. Only after the global financial crisis, Basel III introduced countercyclical capital buffers that address a source of systemic risk and reduces the risks by adjusting capital requirements (Dafermos forthcoming). The idea is that banks "face higher capital requirements during periods of excess aggregate credit growth and lower capital requirements during periods of low credit growth" (ibid, p. 13). Following this, banks are encouraged to reduce credit availability in upturns and increase credit availability during downturns and thus reduce system-wide risks as happened with the subprime crisis in 2008 on a macroprudential level.

Despite these learnings, recent discussions on higher capital requirements for carbon-intensive assets again follow a microprudential approach, aiming to protect individual institutions from LTRs. For example, current stress testing activities only consider higher capital requirements for

individual banks. However, LTRs are systemic in nature meaning that it is necessary to include macroprudential considerations when discussing certain capital requirements for certain assets. Capital requirements could be adjusted based on concentration risk arising from specific types of LTRs (e.g. concentration risk to high-carbon assets exposed in the context of the transition to a low-carbon economy) or even based on shortcomings in risk management practices identified in the context of monitoring.

Besides, independent of these specific adjustments at microprudential level, it may be worth re-evaluating optimal requirements in the face of growing LTRs. The literature here is quite extensive, but – as with most literature in finance – largely relies on historical data to assess "optimal requirements". An era of high risks like the one we are set to enter may thus justify higher capital requirements.

In both cases, it would make sense to increase the buffer to shift away from the thinking of short-run cost optimisation or short-sighted cost-cutting. More resources for research as well as expanding capital requirements for LTRs not only from a microprudential but also from a macroprudential perspective would contribute to building resilience in the financial sector. CBs can play an active role in both regards.

2) Implementing precautionary measures

The second aspect of how financial systems could become more resilient is to implement policies according to the precautionary principle. "The 'precautionary principle' encourages preventative policies that protect human health and the environment in the face of uncertainty. It is well established in the environmental protection sphere but was less well accepted in the sphere of financial regulation up until the global financial crisis (GFC)of 2007-08" (Chenet et al. 2019, p. 2). The precautionary principle advocates that since we do not know what will happen in the future and we cannot be sure how LTRs will materialise and are therefore confronted with a situation of fundamental uncertainty, we need to have preventive measures in place that go beyond efficiency in the face of risk with potentially high impact on society. Let us understand fundamental uncertainty in more detail.

Already in 1921, Knight distinguishes between risks – measurable and quantifiable – and uncertainty – not measurable nor quantifiable. Fundamental uncertainty can be divided into epistemological uncertainty and ontological uncertainty. Epistemic uncertainty covers both the lack of all the information needed to properly measure the impact of LTRs and the inability of people to properly comprehend the available information. In the case of climate change, for example, there is a shortage of data for emissions from many companies worldwide, which prevents an in-depth understanding of how different companies might be affected under different climate transitions. Ontological uncertainty, in contrast, is associated with the fact that the future is transmutable through the decisions taken by individuals and institutions. Those decisions, in turn, might lead to changes in climate risks that could not be foreseen even by those causing these changes, for example through feedback loops.

For example, if some global significant banks stop giving credit to carbon-intensive companies due to climate transition risks considerations, such carbon-intensive companies will lose access to credit from these banks. This lost access, in turn, might deteriorate their financial position. This, in turn, could mean that companies will need to reduce their production and workers might need to stop working. In short, climate transition risks might be exacerbated which banks, in turn, tried to quantify in the first place (Dafermos forthcoming). The crux is that climate change is so complex that we may not even be aware of some of these feedback loops - we face ontological uncertainty.

The existence of fundamental uncertainty, and the possibility that accurate measurement and monitoring of LTRs might never be possible, should however never delay a CB's action upon them. On the contrary, the existence of fundamental uncertainty highlights the importance of mitigation action: Although measuring and monitoring activities can be still useful for illustrative and explanatory purposes and shed more light on the unknown future by identifying possible outcomes (Dafermos forthcoming), mitigation activities can help as prevent, reduce and contain the risk following the precautionary principle. In conclusion, acknowledging fundamental uncertainty presents an argument for a precautionary approach and active risk mitigation action from CBs (Chenet et al. 2019). This, however, requires broadening the mandate of some CBs (compare Figure 1) which should be a crucial topic of future debate.

3) Coordination among fiscal, monetary and financial policies is key

The COVID-19 pandemic has also reinforced voices calling for a better understanding of how monetary, prudential, and fiscal policy can work hand-in-hand to face such a crisis. The European parliament (2020) recently published a report with the title "Covid-19 and Economic Policy Toward the New Normal: A Monetary-Fiscal Nexus after the Crisis?" in which they put forward the idea of policy coordination. After the global financial crisis, the IMF for example also suggested fiscal policies to coordinate with monetary policy responsive. The idea is that monetary and fiscal policies are very closely related to each other since they both have an impact on savings, investments, economic output, and employment and thus can be used complementary within crises.

In light of climate change, a research paper by the IMF also proposes a policy mix (Krogstrup and Oman 2019). To achieve a large-scale transition to a low-carbon economy the paper argues that there is a need for a policy mix, but that literature is scarce and that more research is needed here. However, first ideas of how such a policy mix could be effective are the mix of collateral framework policies, stress testing activities and carbon taxes. For example, monetary policy on the collateral framework as well as stress testing activities could trigger divestment from carbon-intensive goods since the assets will get a higher risk premium. However, the sold assets might be bought by risk-seeking firms that are attracted by the increased premium (Ansar et al. 2013). This effect could be partly offset by the carbon tax that increases the cost of production for carbon-intensive firms so that they become less profitable in total.

Based on the discussions above, it is needless to say that CBs should not be left alone with the task to handle LTRs but that it is ensured that there is effective coordination between fiscal and monetary policy as well as financial markets to mitigate LTRs (Dafermos et al. 2020). CBs should get involved in discussion with fiscal policymakers to ensure the effects of their policies. More debates are needed here, also in the light of CBs' independence. Nevertheless, effective coordination again will contribute to a more resilient system overall.

5

Conclusion

This paper aimed to track long-termism in CBs' supervision policies and assessed in Section 3 eight CBs according to their LTR management. Hereby, we focused not only on environmental risks but also included a wider range of LTRs, such as geopolitical, societal and technological risks. The results can serve as initial ideas of an auditing system that assesses the LTRs practices of CBs and financial supervisors.

Note that the paper was heavily relying on desk research with limited qualitative research. Looking ahead, conducting interviews and iterate with CBs would be necessary. Furthermore, some documents about the risks management of CBs are not publicly available. Documents as the minutes of CBs supervisory meetings would be useful for example.

While facing the caveats, this paper gives an initially systemically overview of the current status quo of CBs. We identified for measuring, monitoring and mitigation activities some gaps of the CB's LTR management.

- Most quantitative measuring activities – in form of stress testing – did not go beyond the business cycle. Those CBs that included LTRs only focused on climate change and the regulatory use of those climate stress tests is unclear. Furthermore, the CBs speak more about LTRs than researching LTRs, providing evidence that they are aware of LTRs but that the understanding of the effects of LTRs on the financial market is limited.

- Monitoring of LTRs – in form of the Financial Stability Report – is mostly backward and not forward-looking. The most monitored risks are those LTRs that recently materialised, as Covid-19, Brexit and trade tensions with the United States.

- Mitigation policies rarely include LTRs. Even though, we argued that mitigation policies are the most important step of risk management due to fundamental uncertainty, CBs – in particular CBs of the Global North – did not have mitigation policies in place that included LTRs. We defined 14 mitigation measures along which we assessed CBs.

Having identified such gaps, the paper went one step back and discussed a required overall change in thinking within the financial systems from efficiency towards resilience. In the face of LTRs, there is the need to build up a more resilient financial system that builds up over-capacity, implements precautionary measures and allows for effective policy coordination. CBs should agree on those principles of resilience and start acting to fill the gaps in the management of LTRs.

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