Solvency 2 News, March 2018

Dear members and friends,

EIOPA recommends further simplifications and improvements to the calculation of capital requirements

- EIOPA issued its second and final set of Advice to the European Commission on the Solvency Capital Requirement (SCR) standard formula.

- EIOPA recommends further simplifications and improvements to the calculation of capital requirements

- EIOPA's ultimate goal is to ensure a proportionate and technically robust, risk-sensitive and consistent supervisory regime for the insurance sector

The European Insurance and Occupational Pensions Authority (EIOPA) submitted its second and final set of Advice to the European Commission.

Previously, EIOPA submitted a first set of Advice to the European Commission in October 2017.

Reflecting developments in the insurance sector and in the wider environment, EIOPA recommends a mixture of revised calibrations, simplifications and, where needed, proposals to achieve greater supervisory convergence.

The availability of more recent data requires revised calibrations in a number of areas such as natural catastrophe risks, assistance and medical expenses, as well as legal expenses risks.
EIOPA advises to further simplify calculations for natural, man-made and health catastrophes, in particular fire risk and mass accident.

Other simplifications include the treatment of look-through to underlying investments.

With respect to the treatment of unrated debt and unlisted equity, EIOPA outlines circumstances and recommends objective criteria, such as financial ratios, when these important asset classes can be given the same treatment as rated debt and listed equity.

In the area of the calculation of interest rate risk, where the current approach does not cater for negative interest rates and is not effective when interest rates are low, EIOPA recommends new calibrations that take recent evidence such as negative rates into account.

In some areas the analyses of recent developments do not provide for sufficient reason to change the calibrations.

That is the case for mortality and longevity risks, but also for the cost-of-capital, the latter one of the key elements of the risk margin.

Other elements of the risk margin should be assessed in the upcoming overall review of the Solvency II regime due in 2021.

As a follow-up to its analysis of the loss-absorbing capacity of deferred taxes (LACDT), which showed divergent supervisory practices of 25% of LAC DT, EIOPA has developed a set of key principles to strike a reasonable balance between flexibility and to foster greater supervisory convergence.

For example, these principles specify the assumptions for projecting future profits after a loss based on credible evidence.

The Advice is accompanied by a full impact assessment, which considers the overall impact of both sets of Advice and provides an assessment of the components of this second Advice.

It also reflects the intensive engagement with stakeholders since the start of the exercise in 2016.

Gabriel Bernardino, Chairman of EIOPA, said: "EIOPA's goal is to simplify the supervisory regime to remove technical inconsistencies and at the same time to ensure that Solvency II remains fit for purpose, proportionate, technically robust, risk sensitive and consistent.

In changing economic circumstances the proposed adjustments to the capital requirements are necessary.

With the SCR review, EIOPA has started a rigorous, evidence-based and transparent review of the Solvency II regime."

Statistics on euro area insurance corporations

• Total assets of euro area insurance corporations increased to €7,883 billion in the fourth quarter of 2017, from €7,848 billion in the previous quarter.

• Total insurance technical reserves of euro area insurance corporations increased to €5,972 billion, from €5,930 billion.

Total assets of euro area insurance corporations increased to €7,883 billion in the fourth quarter of 2017, from €7,848 billion in the previous quarter.

Total insurance technical reserves of insurance corporations were €5,972 billion in the fourth quarter, up from €5,930 billion in the third quarter.

Life insurance technical reserves represented 91.2% of total insurance technical reserves in the fourth quarter.

Unit-linked products amounted to €1,163 billion and accounted for 19.5% of total insurance technical reserves.

In terms of assets, euro area insurance corporations' holdings of debt securities increased to €3,323 billion in the fourth quarter of 2017, from €3,311 billion in the previous quarter.

In the same period net purchases of debt securities totalled €7 billion and were supplemented by €5 billion in price and other changes.

Total debt securities amounted to 42.2% of the sector's total assets in the fourth quarter of 2017.

The year-on-year growth rate in debt securities held was -0.2% in the fourth quarter of 2017.

Looking at holdings by issuing sector, debt securities issued by general government in the euro area amounted to €1,561 billion and represented 47.0% of total debt securities held.

The year-on-year growth rate of debt securities issued by general government was 1.2% in the fourth quarter of 2017.

The majority of euro area government bonds held were issued in the country in which the insurance corporation is located.

These amounted to a total of €1,051 billion, compared with €511 billion of investments in other euro area countries' debt securities.

Debt securities issued by euro area monetary financial institutions (MFIs) totaled €454 billion or 13.7% of total debt securities held.

The second largest category of holdings (26.2%) was investment fund shares including money market fund shares.

These holdings increased to €2,062 billion in the fourth quarter of 2017, from €2,009 billion in the previous quarter, with transactions of €42 billion supplemented by price and other changes of €12 billion.

The year-on-year growth rate in the fourth quarter was 8.9%.

To read more:
http://sdw.ecb.europa.eu/browse.do?node=9693350

Reflections on leadership in a disruptive age

Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, at Regent's University, London.

Introduction

I was asked to reflect tonight on leadership and values. This is somewhat dangerous territory, and certainly one that creates a target-rich environment for critics who can spot gaps between preaching and practising.

Indeed, a review of a recent book on leadership and values suggested that it's very publication signaled overconfidence – the complacency before the storm – and cautioned that CEOs and investors ought to be wary of the 'curse of authorship'.

There are countless examples of pride coming before the fall in finance.

Think of those who dubbed the period before the Global Financial Crisis the 'Great Moderation'. Or the four most expensive words in the English language.

But, because we can learn from experience, and because leadership lies at the heart of Regent's University's mission- literally 'Developing tomorrow's global leaders' - I will forge ahead.

I will begin by reviewing the main activities of leaders and the core attributes of leadership. I will try to address what leadership is and isn't and whether it's inherent or can be developed.

I will conclude with some perspectives on the challenges and opportunities you will face leading in our disruptive age.

Leadership Activities

It's important to distinguish between what leaders do and who they are. Of the many things leaders must do, I would emphasise three:

1. Finding and developing the right people;
2. Setting priorities; and
3. Catalysing action.

To read more:
https://www.bis.org/review/r180220g.pdf

EBA launches 2018 EU-wide stress test exercise

The European Banking Authority (EBA) launched its 2018 EU-wide stress test and released the macroeconomic scenarios.

The adverse scenario implies a deviation of EU GDP from its baseline level by 8.3% in 2020, resulting in the most severe scenario to date. The EBA expects to publish the results of the exercise by 2 November 2018.

Key features of the exercise

The stress test is designed to provide supervisors, banks and other market participants with a common analytical framework to consistently compare and assess the resilience of EU banks to economic shocks. For the first time, it incorporates IFRS 9 accounting standards. No pass-fail threshold has been included as the results of the exercise are designed to serve as an input to the Supervisory Review and Evaluation Process (SREP).

The EBA's 2018 stress test methodology was published in November 2017 and is to be applied to the scenarios released today.

The baseline scenario is in line with the December forecast published by the European Central Bank (ECB), while the adverse scenario assumes the materialisation of four systemic risks, which are currently deemed as representing the most material threats to the stability of the EU banking sector:

- Abrupt and sizeable repricing of risk premia in global financial markets, which would spill over to the European countries and lead to a tightening of financial conditions;

- Adverse feedback loop between weak bank profitability and low nominal growth resulting from the decline in economic activity in the European Union. This will affect, in particular, banks in those countries facing structural challenges in their banking sector;

- Public and private debt sustainability concerns amid potential repricing of risk premia and increased political uncertainty;

- Liquidity risks in the non-bank financial sector with potential spill-overs to the broader financial system.

The adverse scenario is designed to ensure an adequate level of severity across all EU countries. The implied EU real GDP growth rates under the adverse scenario amount to -1.2%, -2.2% and +0.7%, in 2018, 2019 and 2020 respectively.

Overall, the scenario implies a deviation of EU GDP from its baseline level by 8.3% in 2020, resulting in the most severe scenario in terms of GDP deviation from baseline levels compared with the previous EBA exercises.

Detailed information about the scenario can be found in the note produced by the European Systemic Risk Board (ESRB).

Process

The adverse macroeconomic scenarios have been developed by the ESRB and the ECB in close cooperation with the EBA, competent authorities, and national central banks.

The EBA, which is responsible for coordinating the whole exercise, developed a common methodology and will act as a data hub for the final dissemination of the results, in line with its commitment to enhancing the transparency of the EU banking sector. Competent authorities will assure the quality of the results and decide on any necessary supervisory reaction measure as part of the SREP process.

To read more:
http://www.eba.europa.eu/documents/10180/2106649/2018+EU-wide+stress+test+-+Methodological+Note.pdf

Supervision in a post-Basel III world

Keynote address by Mr Agustín Carstens, General Manager of the BIS, at the 13th Asia-Pacific High-level Meeting on Banking Supervision, Singapore.

Introduction

Ladies and gentlemen, good morning.

I am delighted to join you today at my first Asia-Pacific High-level Meeting on Banking Supervision. I would like to thank the organisers for the invitation. Let me also take this opportunity to extend my gratitude to the Monetary Authority of Singapore for their warm hospitality and superb organisational arrangements.

One key development in the past year has no doubt been the finalisation of Basel III. It is a landmark achievement that significantly strengthens the capital and liquidity shock absorbers within the global banking system and at individual banks.

The finalisation of Basel III is a reminder of the public good that can be achieved with international cooperation, but this does not mean that we can now let our guard down and be complacent. Indeed, the heavy lifting for banking organisations and prudential authorities - that is, effective implementation of the new rules and robust supervision in the post-crisis environment - has only just begun.

In that context, my remarks will not be about the regulatory reforms but will give emphasis to the less glamorous yet equally important subject of day-to-day supervision. As all of you are undoubtedly aware, no amount of financial buffers - even those under Basel III - can ever be a substitute for effective supervision. The overall theme that I would like to convey will therefore be "going back to basics" - that is, alongside the new regulatory

framework, effective supervision remains essential for fostering the safety and soundness of both individual banks and the broader financial system.

Indeed, the demands placed on supervisors are greater than ever. On the one hand, they must be able to digest and oversee a complex set of new rules. On the other, they must also have a nuanced understanding of each regulated entity's overall risk profile and be able and willing to take actions at an early stage, perhaps well before there is tangible evidence of deterioration in a bank's financial condition.

The latter responsibility, in particular, is critical because effective supervision is countercyclical in nature and can be much more powerful than any regulatory-oriented countercyclical tools that have been developed post-crisis.

With this in mind, I will talk about three key challenges in the conduct of effective supervision:

- first, the need to maintain and, if necessary, improve the monitoring of the main traditional sources of risks, such as asset quality deterioration and provisioning;

- second, to adjust the scope of supervisory reviews to address new risks, such as those associated with technological developments; and

- third, to develop and utilise new forward-looking supervisory tools to enhance the supervisory review of both traditional and emerging sources of risk.

Asset quality

One key area of supervisory focus is asset quality and credit risk - that's the single biggest form of risk in most banking systems, including in Asia.

Loans typically comprise the largest portion of bank assets in most jurisdictions; therefore, the quality of the loan portfolio drives an institution's earnings capacity and is a good barometer of its financial health.

With this in mind, the supervisory review of asset quality plays a key role in assessing a firm's overall risk profile and in determining whether the minimum regulatory capital requirements are sufficient in relation to a bank's identified risks.

As an example, during cyclical upswings - as is the case in many Asian countries that have benefited from favourable economic conditions, low real rates of interest, continued capital inflows, rapid credit growth and rising asset prices - loan underwriting standards and credit administration practices of banks may come under pressure.

Strong, proactive supervision can flag degradations in credit origination standards to a bank's board and senior management at an early stage. Through thematic reviews, supervisors can also determine whether a relaxation of credit underwriting has become an industry-wide issue. In these cases, the insights provided by supervisors can help inform whether changes to prudential policy or possibly macroprudential measures are needed.

When problem assets do build up, supervisors also play a crucial oversight role in ensuring the timely identification and measurement of non-performing assets. It is hard to believe but, until April 2017, when the Basel Committee on Banking Supervision (BCBS) issued guidance on the prudential treatment of problem assets, there was no globally harmonised definition of a "non-performing exposure".

With this publication, supervisory authorities now have a basis to adopt a uniform definition for a non-performing asset (NPA) - and to enforce its application through on-site supervision - which should, one hopes, foster an early identification of NPAs.

Another crucial aspect of dealing promptly with problem loans is to ensure that loan loss provisions are adequate to absorb incurred and expected losses. Indeed, unless there is integrity in the loan loss provisioning process, it is meaningless to assess capital adequacy, even under Basel III.

This is because underfunded provisions necessarily overstate both reported earnings and regulatory capital. Consider also that a 5% decline in loan values will eliminate the minimum Common Equity Tier 1 capital requirements under Basel III.

For these reasons, supervisors play a critical oversight role to ensure that banks conduct rigorous provisioning practices on NPAs. At the same time, I am aware that in many jurisdictions - although less so in Asia - provisions are governed solely by applicable accounting rules and there are limits to what supervisors can do unless they have sufficient powers. From my vantage point, there is a case for prudential supervisors to seek powers, if not yet available, to impose adjustments to regulatory capital when

accounting provisions are insufficient to cover expected losses from a prudential perspective.

Fintech and cyber-security

While supervisors need to stay focused on traditional risks, such as poor asset quality, they also need to be mindful of innovations that can have a bearing on prudential supervision.

Fintech - the use of technology in the delivery of financial services - provides a unique opportunity to democratise finance, while it also raises a range of old risks and introduces new ones.

In this regard, it may be useful to note that a recent BCBS paper on the implications of fintech developments on banks and supervisors assesses how technology-driven innovation in financial services may affect the banking industry and the activities of supervisors.

I am aware that fintech issues will be covered extensively at this High-level Meeting. Therefore, I will limit my remarks to three issues that can have an effect on existing supervisory processes as a means to highlight the broader supervisory implications unleashed by fintech.

1. Credit underwriting: Our traditional view of credit underwriting standards is being transformed in the fintech space, where players use "big data" and mine information from social media to develop algorithms in evaluating creditworthiness.

Supervisors need to understand these methodologies not only to perform backward-looking analysis when a loan turns sour, but also to spot evolving problems. A key question here is how supervisors will judge the quality of credit underwriting under these new methodologies.

2. Scale and speed of fintech: Fintech by its nature has both a need (small-sized, high-volume transactions) and ability to scale much faster than traditional banks. Therefore, the notion of what constitutes "rapid growth" - a traditional area of concern for supervisors - will be challenged by the fintech model.

In this regard, supervisors need to be particularly astute in their supervisory risk assessments, as any underlying problems that go undetected can multiply much more quickly than what supervisors may be accustomed to.

3. Cyber-security: Cyber-risk is a key area of concern, particularly as more consumers and businesses rely on digital platforms to transact financial services. Authorities are taking different approaches to regulating and supervising cyber-risks.

On the regulatory front, differences begin at a fundamental level, starting with whether the nature of cyber-risk is amenable to specific regulatory requirements. Supervisory approaches are also evolving and practices appear to be an extension of their existing risk-based supervisory frameworks that cover technology and cyber-risks.

Whether existing approaches are sufficient to address the growing threat posed by cyber-attacks must now become a key area of supervisory focus. Designing a "fit for purpose" regulatory and supervisory regime applicable to technological developments is a formidable challenge.

Regulators have a difficult balancing act, as they need to ensure all relevant risks are contained, provide a level playing field, and at the same time foster an innovative, competitive and secure financial ecosystem that can be trusted.

Back to basics: make supervision more forward-looking

I mentioned at the beginning of my remarks that effective supervision is an essential complement to the regulatory reforms. One simple way to think about the Basel III reforms is to view them as enhanced capital and liquidity buffers that need to be contextualised against the various risks a banking organisation is inherently exposed to (that is, credit, market, interest rate, liquidity, operational, business and other material risks). An assessment of these risks - and how well they are managed - can only be addressed through the practice of supervision.

Indeed, it is only through the supervisory review process that supervisors can form opinions of an institution's overall risk profile, which, in turn, drives a range of supervisory actions designed to address problems at an early stage, before earnings and capital of the bank are affected.

Arriving at such decisions, however, is easier said than done. It requires the exercise of sound judgment backed by critical analysis. Let me provide one example to illustrate.

Perhaps the leading indicator of a bank's future risk profile is the quality and effectiveness of a bank's governance and risk management practices. Supervisors are usually expected to take actions when risk management shortcomings are identified, depending on the nature of their findings. But what exactly constitutes "sound risk management"? And at what point do weaknesses in risk management become a supervisory concern?

There are no simple answers. Yet, given the significance of these assessments in constraining excessive risk-taking at banks, opportunities exist to share methodologies and exchange views among supervisors and - I might add - risk managers at banks, to achieve mutually desired outcomes.

Since the financial crisis, more emphasis has been placed on the development of new supervisory tools that have come to be labelled as "forward-looking supervision".

These tools include supervisory scrutiny of the sustainability of business models; a review of compensation arrangements to ensure that incentives do not encourage excessive risk-taking; and an assessment of the culture and behaviour of banks, in some cases through the use of behavioural psychologists.

Collectively, these new supervisory methodologies are welcome developments, but only time will tell whether these tools can be effective in applying early intervention measures while a bank's financial condition remains sound.

Concluding remarks

Let me conclude with three key messages:

- First, completion of the Basel III reforms is a significant milestone and provides much needed regulatory certainty to the banking sector.

- Second, effective supervision continues to be an important, but sometimes forgotten, element of the post-crisis reforms. It provides context to, and reinforces, Basel III. In a post-crisis world, supervisors will need to stay focused on traditional risks such as asset quality. At the same time, they must keep an eye on emerging risks, such as the evolving fintech landscape and the way it can transform our traditional approaches to identifying and assessing risk. In both cases, they will

need to utilise new forward-looking assessment tools and to better employ existing ones to identify and resolve problems at an early stage.

- And third, although it may not be sufficiently emphasised, perhaps the most powerful countercyclical tool available to prudential authorities is their army of front-line supervisors. They are the eyes and ears of policymakers and they see first-hand the impact of, for instance, monetary policy decisions on bank behaviour and risk-taking. Working in concert with risk managers at banks, supervisors are best positioned to say "no", even when society and indeed some governments are saying "yes".

With these considerations in mind, I believe that our Financial Stability Institute (FSI) can play a key role in advancing the supervisory agenda. Through its publications and outreach events such as this High-level Meeting, the FSI facilitates the exchange of supervisory experiences and approaches on a range of prudential issues. It also contributes to capacity-building for supervisors around the world.

I therefore wish you a productive meeting with fruitful discussions. Thank you very much for your attention.

The European Cyber Security Challenge: Lessons Learned report

Both the growing need for IT security professionals and skills shortage are widely acknowledged.

To help solve this, multiple countries have initiated national cybersecurity competitions for students, security professionals and even non-IT professionals, all with a common goal: find cyber talents and encourage all of them to pursue a career in cybersecurity.

The European Cyber Security Challenge (ECSC) builds upon these competitions adding a pan-European layer.

The ECSC is an initiative of multiple European countries supported by the European Union Agency for Network and Information Security (ENISA) that aims at engaging cybersecurity talent across Europe and connecting high potentials.

This report contains a detailed list of the lessons learned from previous ECSCs, of which the key takeaways are:

- The quality of the ECSC is crucial in meeting the participants' expectations. The scenario, stability and complexity of the platform used during the ECSC are key success factors in order to provide a challenging competition that attracts top cyber talent from all over Europe.

- Public relations and communication activities are key in order to meet the objectives on participation and sponsorship.

- The event agenda should be tailored to the participants needs and expectations, and include activities that relate to their interests and subject matter expertise.

- Given the current growth objectives of the ECSC (plus five countries per year), solid back-office processes regarding the organisation of the event are necessary to meet the rising quality expectations from stakeholders. This includes, amongst others, a proper governance structure with clear roles, responsibilities, decision-making, agreed-upon principles and rules with regard to fair play and transparency.

- Sharing lessons learned and recommendations between organisers and participating states is crucial in order to improve the quality of the event and implement best practices.

To read more:
https://www.enisa.europa.eu/publications/the-european-cyber-security-challenge-lessons-learned-report

A Euro Cyber Resilience Board for pan-European Financial Infrastructures

Benoît Cœuré, Member of the Executive Board of the European Central Bank, at the first meeting of the Euro Cyber Resilience Board for pan-European Financial Infrastructures, Frankfurt am Main.

It is a pleasure to welcome you back to Frankfurt. Our last meeting was in June last year.

Today, we will discuss the future course of the high-level cyber resilience forum for pan-European financial market infrastructures, critical service providers and competent authorities.

Establishment of the Euro Cyber Resilience Board for pan-European Financial Infrastructures

Recent technological advances have enabled cybercriminals to conduct ever more sophisticated, precise and powerful attacks.

And nobody is immune to cyber risks, including businesses, financial infrastructures and public administrations. So we should avoid a "blame and shame" culture and work together.

The ECB and the Eurosystem are striving to lead by example. At the ECB, overseers, operators, supervisors and IT security services are working together more closely on cyber issues.

Within the Eurosystem, there has been close collaboration on implementing the Eurosystem oversight cyber resilience strategy for financial market infrastructures that we presented at our last meeting, in line with CPMI-IOSCO's guidance on this topic.

The Market Infrastructure Board, which is in charge of Eurosystem financial market infrastructures, has also scaled up its activities to ensure the continued cyber resilience of its systems and platforms.

Eurosystem initiatives are part of a growing international effort to combat cyber threats. The CPMI-IOSCO guidance is being implemented.

In October 2017, the Financial Stability Board (FSB) delivered a stocktake report of relevant regulations and supervisory practices to G20 finance ministers and governors, and G7 ministers and governors published the "Fundamental Elements for Effective Assessment of Cybersecurity in the Financial Sector".

The FSB will produce a common lexicon of important terms, while the G7 Cyber Expert Group continues to work on third-party risks, cross-sector coordination and threat-led penetration testing, and will make proposals for G7 cross-border cyber crisis simulation exercises.

In this context, the Eurosystem aims at coordinating its own activities in the field of cyber risks with that of market participants and other public authorities to succeed in protecting the financial system from cyber threats. I therefore invite you today to become part of the Euro Cyber Resilience Board (ECRB) for pan-European Financial Infrastructures - a regular forum where we can work together in a trusted environment.

The ECRB's objective is to enhance the cyber resilience of financial market infrastructures and their critical service providers, as well as that of the wider EU financial sector, in line with international standards.

This will be achieved by fostering trust and collaboration and facilitating joint initiatives - whether among market players or between market players and authorities. The ECRB will thus contribute to the overall stability of the EU financial system.

The ECRB will have no formal powers to impose binding measures and will not make supervisory judgements. Its legitimacy will stem from the voluntary commitment of its members to abide by its common positions, statements and strategic views.

The ECRB will be chaired by the ECB, which will be closely involved together with national central banks and observers from the relevant European public authorities. This will ensure that the ECRB acts in the

interest of Europe as a whole. Its common positions, statements and strategic views will be adopted by consensus.

To kick off the work of the ECRB, we would like to reflect with you on possible work items which we could address collectively. As part of this, we will also report on two of our most recent activities.

First, a cyber resilience survey, developed under the Eurosystem oversight cyber resilience strategy, was conducted across more than 75 payment systems, central securities depositories and central counterparties throughout Europe.

As you will see, the survey highlighted a number of very pertinent issues for discussion, such as cyber governance, training and awareness, and cyber incident response.

Second, the Eurosystem is currently finalising the main elements of the European Threat Intelligence-Based Ethical Red-Teaming (TIBER-EU) Framework.

This is an interesting concept which we hope will raise the level of cyber resilience in Europe and enable cross-border, cross-authority testing, which has not been done before.

We look forward to hearing your feedback on these two initiatives. We will also update you on the forthcoming market-wide exercise, which will explore the challenges of a specific cyber scenario and see how we can work closer together in times of crisis.

I am confident that we will have a fruitful discussion. I will now hand over to my colleague Sabine Lautenschläger, who will make some introductory remarks from the supervisory perspective.

After that, I would like to invite the European Commission representative to briefly introduce the very recently published "FinTech Action plan", which presents some interesting points to be considered with regard to the cyber resilience of the financial sector. Thank you.

Artificial intelligence (AI) in finance - six warnings from a central banker

Prof Joachim Wuermeling, Member of the Executive Board of the Deutsche Bundesbank, at the 2nd Annual FinTech Conference, Brussels.

1 Don't miss out on the opportunities of AI in finance -

AI in finance could impact on the functioning of our financial system in a profound way. Some suggest that AI is enhancing the power of the human brain in the same way that electricity enhanced the power of the body 150 years ago. Hence, it could become a big thing in finance.

Artificial intelligence and big data are currently the strongest and most vivid innovation factors in the financial sector. Using AI in finance may trigger dramatic improvements in many businesses. AI elevates the role of data as a key commodity. Used wisely, big data make outcomes more reliable and may improve financial mediation. Process chains can be organised in new ways. "The scope and nature of banks' risks and activities are rapidly changing," as a recent Basel Committee analysis puts it.

This evolution towards increased use of non-human intelligence is not something that has just occurred in the last few years. The first invention of neural networks, a central pillar of most AI systems, dates back to the year 1943.

Until a few years ago, the main users of big data and AI in the area of finance were certain hedge funds and high-frequency trading firms. In recent times, the application of AI in finance has begun to spread widely, via "normal" banks, FinTechs and other financial service providers, to the general public.

Since 2011, HFT has accounted for about 45-50 % of all trading in US equities. The figures for the main European indices are in the same region (with about 40 % for German DAX futures).

Taken together with all other "normal" algorithmic trading activities, we currently estimate the amount of algorithmic trading to be in the realm of 80-90 % of the entire trading volume for equities (and somewhat less but still very high in other market segments).

A single normal trading day generates about 3-6 million data points about prices, order deletions and modifications in DAX futures alone. No human can analyse these amounts of data simply by looking at them in an Excel spreadsheet. More sophisticated and sometimes also AI-driven techniques are necessary to do the job.

AI profoundly changes the functioning of our financial system in at least three areas: products, processes and analysis. This is true for both front office functions (eg customer business, trading) and back office functions (eg executing trades, risk management, market research). Special-purpose AI can solve specific problems, eg in customer engagement, financial management or cybersecurity.

Applications focused on market operations cover various core areas eg trading, portfolio composition, backtesting and validation of models, market impact analysis, modelling trading of large positions and stress testing. Dynamic portfolio adjustment, depending on the macro environment, may be strengthened by AI.

With the help of AI, various human shortcomings in dealing with finance can be mitigated. As behavioural finance has taught us, biases, inertia and ignorance lead to the malfunctioning of markets. AI allows humans to reach out beyond their intellectual limits or simply avoid mistakes.

2 - but beware of the risks

But opportunities are always accompanied by risks. As regards the financial system, if too much trust is put in "intelligent" systems, the stability of financial markets may be at stake. The workings of AI can be a mystery; it can trigger loss of control, make fatal errors, and have a procyclical effect due to its mechanistic functions.

Pattern recognition has its limits. This can be dangerous particularly in crisis scenarios. An autopilot would never have been able to land a jet on

the Hudson River. Nor can algorithms stabilise in periods of financial stress.

Looking at the recent turbulence in equities and the market for VIX-related financial products, it can be concluded that the events of 5 February share many similarities with a "flash crash".

Unfortunately, as with the original flash crash of May 2010, we have only limited knowledge about the direct drivers that triggered the event. It can be assumed that algorithmic market participants were quite active during the relevant period.

But as to which strategies were applied and to what effect, we have no knowledge so far. The rise in volatility in the S&P 500 then nearly instantly affected the VIX industry, making it not the cause but more the first victim of this market event, with losses up to 95 % on assets. We do not expect this phenomenon to disappear in the future. On the contrary, more of these flash events are to come.

AI is still in its infancy. Continuous processes for the entire AI lifecycle still have to be defined and scaled for business needs. That means that AI must be embedded in the process of acquiring and organising data, modelling, analysis and delivering analytics.

The skills gap, particularly with regard to data science and machine learning expertise, is the foremost challenge. At this stage, non-human intelligence is far from replacing the human brain in any respect. Computers are like school pupils dividing numbers mechanically without having understood what they were doing.

3 Consumers should take care: they remain the risk-takers

What makes this development so significant is the fact that it is not just occurring at the level of systemic institutions, markets and stock exchanges. With robo advisers, for example, AI can directly influence and control the daily financial decisions of customers and ultimately their personal wellbeing. Society has barely begun to understand the economic, ethical and social implications of AI.

While client interaction is made more convenient by mobile banking, chatbots or virtual customer assistants, banks can find out more about customer habits and provide them with tailor-made financing.

Consumers may be rated by AI when applying for a mortgage. Pooling data points from internal transactions, social networks and other sources provides a more meaningful picture of banks' borrowers. But denials may be hard to understand. It may become even harder to challenge a decision made by algorithms.

The proper functioning of the applications is not a given. Simple flaws, cyberattacks and criminal behaviour render the systems extremely vulnerable. Consumers should be cautious. They need to be protected. Laws may have to be modified to cover new threats. Responsibility and liability in the case of malfunctioning machines have to be clarified.

4 FinTechs should not ignore the legitimate concerns of society and supervisors

Agile tech companies are driven by an admirable energy and inspiration. By nature, they take risks. They create an idea, build a prototype and try it out immediately in the real world. Regulation, supervision, obligations and requirements must make them extremely nervous.

But the wellbeing of society depends on rules. The public demands cybersecurity, data privacy, consumer protection and financial stability. FinTechs should not brush aside the concerns of their stakeholders. Business can only flourish if it is broadly accepted by citizens.

FinTechs usually pick up specific elements of the work chain of finance or create new features. Using technology, they modularise and customise products as a third party or standalone provider.

FinTechs are part of the finance sector but are not necessarily supervised. As long as they carry out tasks for supervised entities, these institutions are responsible for the behaviour of the FinTech.

5 AI needs new forms of supervision

"Artificial intelligence" may sound glamorous from a technological perspective, but in banking supervision, the well-established principle of "same business, same risk, same rules" has so far proved to be a sound standard for innovations. Whether they employ AI themselves or outsource it to FinTechs, from the supervisors' point of view responsibility remains entirely with the bank.

For German supervisors, IT governance and information security nowadays are equally as important as capital and liquidity requirements.

All financial institutions should address the risks posed by new technologies. Banks have to implement effective control environments needed to properly support key innovations.

This includes the requirement to have appropriate processes for due diligence, risk assessment and ongoing monitoring of any operations outsourced to a third party.

The European MiFID II includes the requirement that firms applying algorithmic models based on AI and machine learning should have a robust development process in place.

Firms need to ensure that potential risks are considered at every stage of the process.

Regulators increasingly have to apply AI-supported analytical methods themselves to recognise vulnerability patterns, scan lengthy reports or analyse incoming data.

In any case, we must strike a balance between financial stability and avoiding barriers for potential new entrants, products and business models.

Alongside technological progress, regulators have to constantly reassess the current legal framework, supervisory models and resources.

6 Central banks should embrace AI

Central banks have access to huge amounts of very valuable data stemming from market operations, supervision, payments and statistics.

They are well positioned to tap the benefits of AI so they can enhance their ability to fulfil their mandate for price stability and the stability of the financial system.

Machine learning is already being used at the Bundesbank in different narrow segments.

The experiences of all users have been good without exception. While monitoring the technical progress, we are currently discovering further use cases and defining our AI foundation, strategy, organisation and processes. Here is a list of examples, which is by no means exhaustive:

In risk management, neural networks assess and evaluate the financial soundness of the markets. Market research is supported by adopting web mining techniques and machine learning in content analysis, topic modelling and clustering of relevant articles.

In statistics, machine learning enables new methods for data quality management, eg in the context of securities holdings or the classification of company data.

Furthermore, the informational content of seasonality tests is assessed by a random forest machine learning technique.

For our IT user help desk, the handling of routine requests via automated chatbot responses could be a useful support measure.

We use social media data to detect trends, turning points or sentiments. Machine learning methods can be applied for variable selection purposes in econometric models.

ANNEX: Use case - monitoring of real estate markets

An interesting data source is internet platforms. For example, some rental and housing platforms have the potential to improve the analysis and monitoring of real estate markets via the provision of information such as list prices and structural and locational characteristics of the property market at a disaggregated level.

This is mainly based on the assumption that these data contain information on the expectations and interests of economic agents with respect to future decisions.

In such contexts, a wide range of topics or "search strings" are often potentially relevant. This can result in many different, highly correlated time series.

Furthermore, the "textual analysis" method is increasingly applied in research, as large amounts of "unstructured" information on businesses and the economy are available electronically on the internet.

In order to operationalise textual data for econometric analysis, machine learning algorithms can be helpful.
Learning methods can be applied to classify textual documents into different categories which can then be used to draw statistical inferences.

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