RISKS AND REGULATION OF AI IN FINANCIAL MARKETS

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SUMMARY

1. THE USE OF AI IN FINANCIAL SERVICES INTRODUCES NEW RISKS AND REQUIRES NEW CONTROLS.

2. CURRENT REGULATIONS LIMIT FULL DEPLOYMENT OF AI BUT ARE EVOLVING AND ADAPTING TO THEIR USE

3. TO REALIZE THE FULL POTENTIAL OF AI WILL REQUIRE INSTITUTIONS AND REGULATORS TO CO-CREATE NEW APPROACHES AND SOLUTIONS.

AGENDA

INTRODUCTION
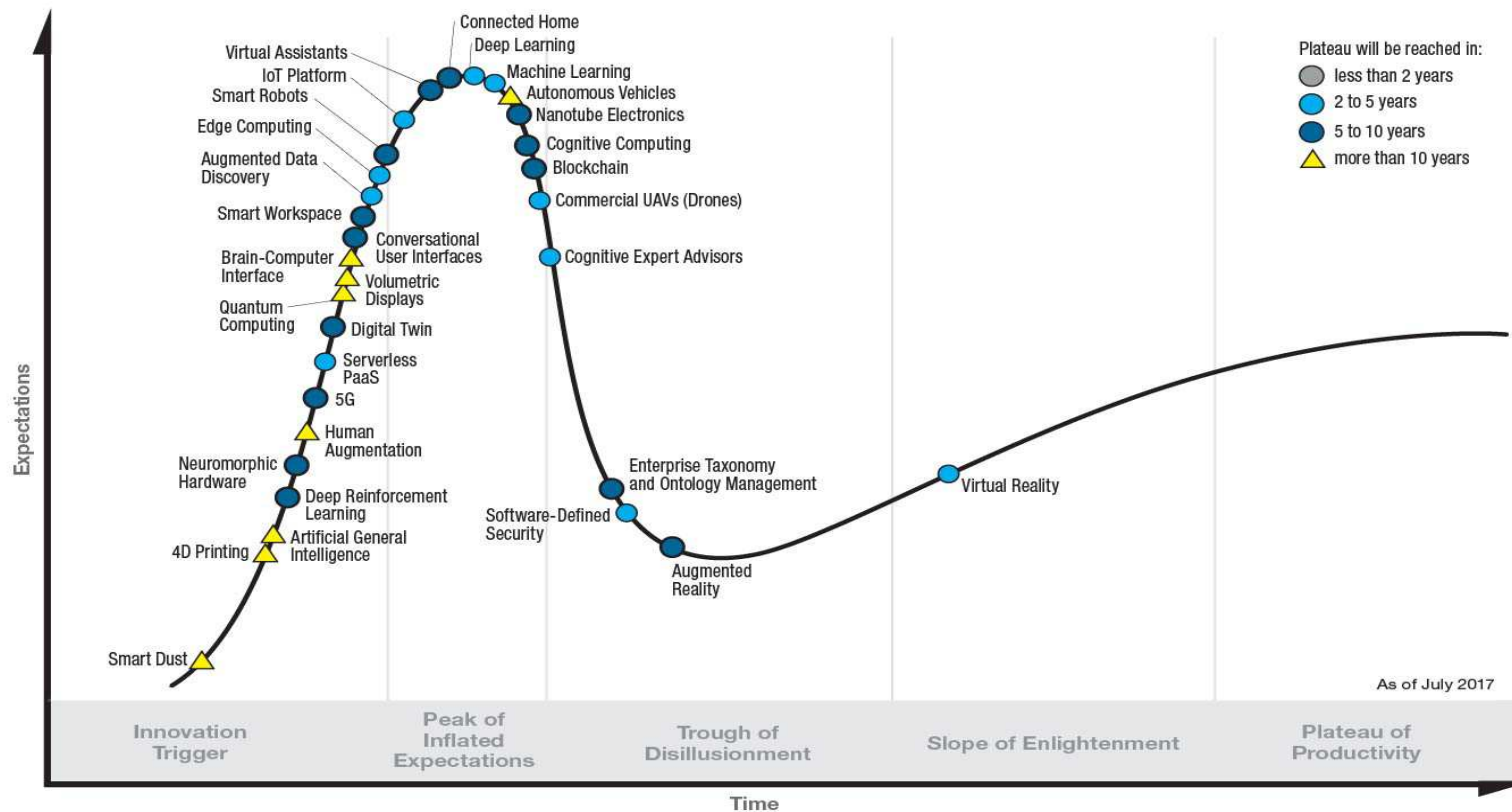
RISKS

REGULATIONS

SOLUTIONS/CONCLUSIONS

INTRODUCTION

We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run*

WHERE IS AI IN THE HYPE CYCLE?

Gartner **Hype Cycle** for Emerging Technologies, 2017

gartner.com/SmarterWithGartner

Source: Gartner (July 2017)
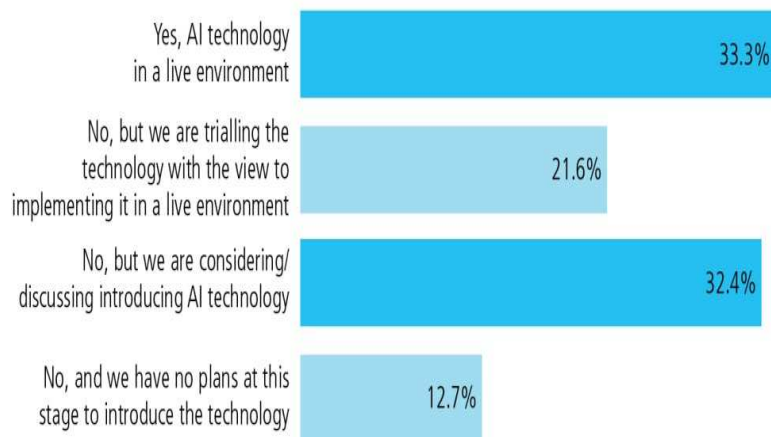© 2017 Gartner, Inc. and/or its affiliates. All rights reserved.
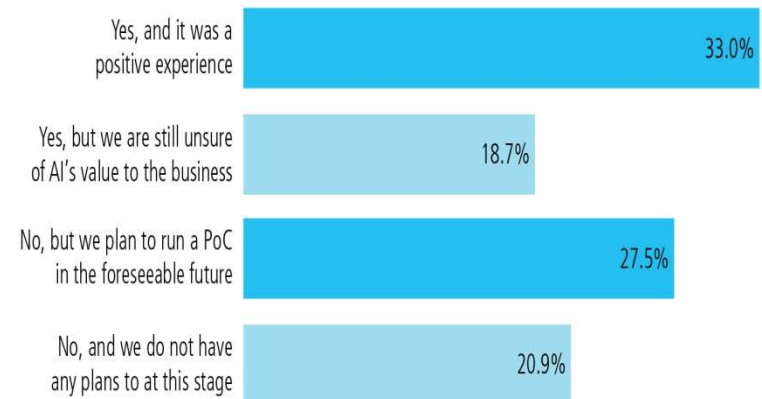
Gartner®

IMPACT OF AI

Artificial Intelligence (AI) is 'General Purpose' technology

- AI is general purpose technology* – similar to electricity and internet
- It is hard to imagine running industries without electricity or internet now and in the future we will think of AI in similar manner

Do you have any AI technology currently in place within your organization?

Yes, AI technology in a live environment	33.3%
No, but we are trialling the technology with the view to implementing it in a live environment	21.6%
No, but we are considering/ discussing introducing AI technology	32.4%
No, and we have no plans at this stage to introduce the technology	12.7%

Have you conducted a proof of concept (PoC) on AI technology for your business?

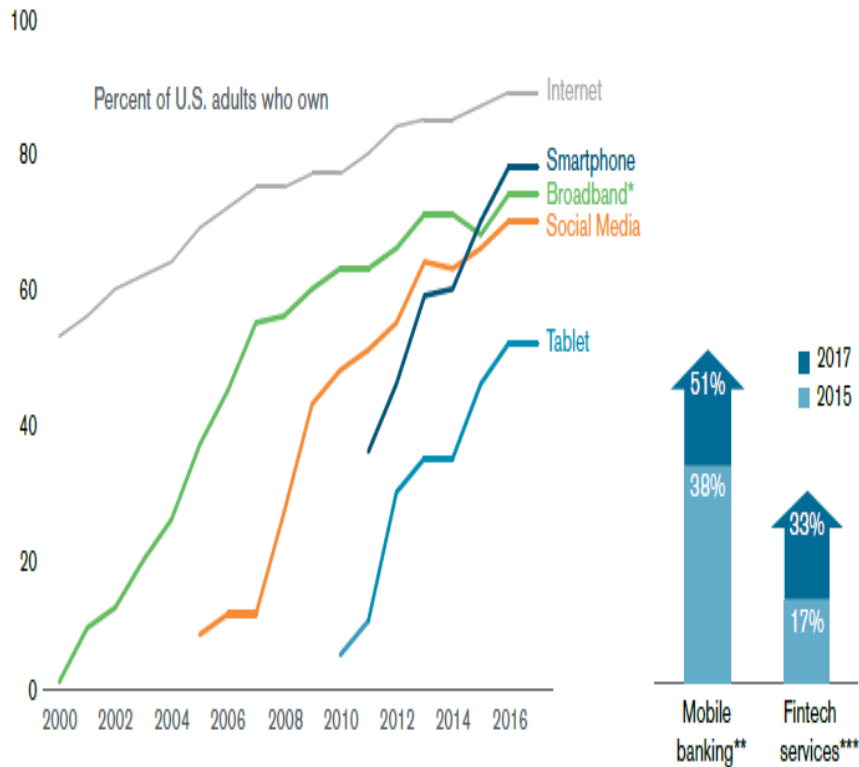|	
Yes, and it was a positive experience	33.0%
Yes, but we are still unsure of AI's value to the business	18.7%
No, but we plan to run a PoC in the foreseeable future	27.5%
No, and we do not have any plans to at this stage	20.9%

AI TRENDS

Trends

- IDC predicts spending on AI which is currently $12B will be around $58B in 2021 [2]

- Survey conducted by Waters Technology in May 2018 across financial firms noted that 33% already employ some form of AI and another 32% are considering to use it [1].

- Nearly 80% of respondents already have or are planning to conduct a Proof of Concept on AI technology for a business case; one-third have done a POC and another 27% plan to conduct one in near future[1].

- In the same survey, more than 50% of respondents agreed that AI technology needs to be regulated to reduce potential risks to organizations and broader markets; 24% voted 'No' and 22% were unsure [1].

- Reg Tech (e.g. AML/Fraud Detection) - RegTech market expected to reach

$6B by 2020 and growing at an annual rate of 76% ('Frost & Sullivan 2017 report)

However

- 75% of survey do not have confidence that regulators are keeping abreast of the advances in ML/AI [2]

- More than 50% of those surveyed believe that some changes in regulation are needed [2]

DIGITIZATION OF DATA

100

Percent of U.S. adults who own   Internet

80

Smartphone
Broadband*
Social Media

60

Tablet

40

20

0

2000 2002 2004 2006 2008 2010 2012 2014 2016

2017
2015

51%

38%

33%

17%

Mobile
banking**

Fintech
services***

* used at home.
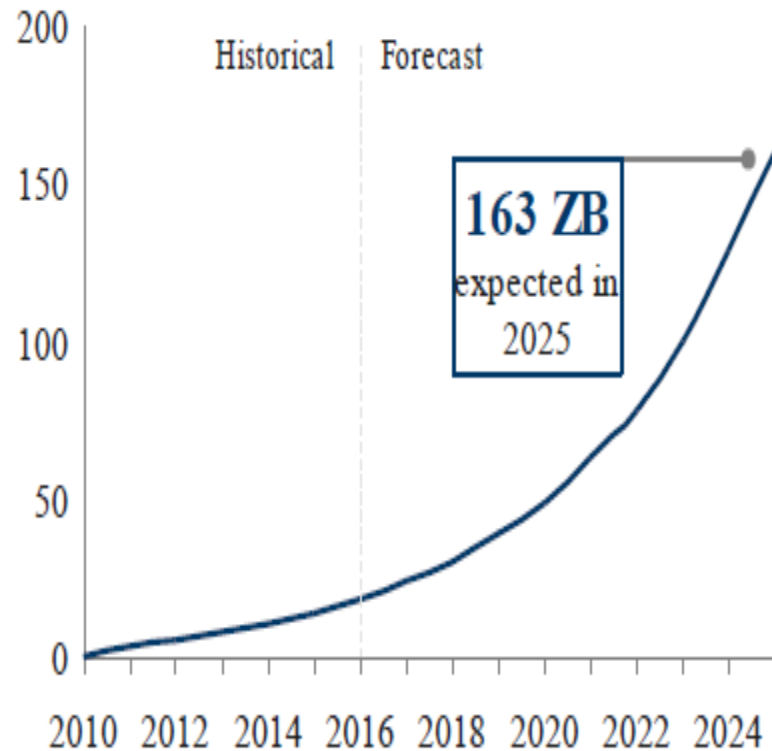** as a percentage of survey respondents that have a bank account.
*** as a percentage of survey respondents that are active online.
Source (left): Chart and data recreated from Pew Research Center analysis.
Sources (right): For mobile banking data, Federal Reserve analysis of Survey of Household Economics and
Decisionmaking and Survey of Consumers' Use of Mobile Financial Services.
For fintech services growth, see Ernst and Young, *EY FinTech Adoption Index 2017*, at 13.
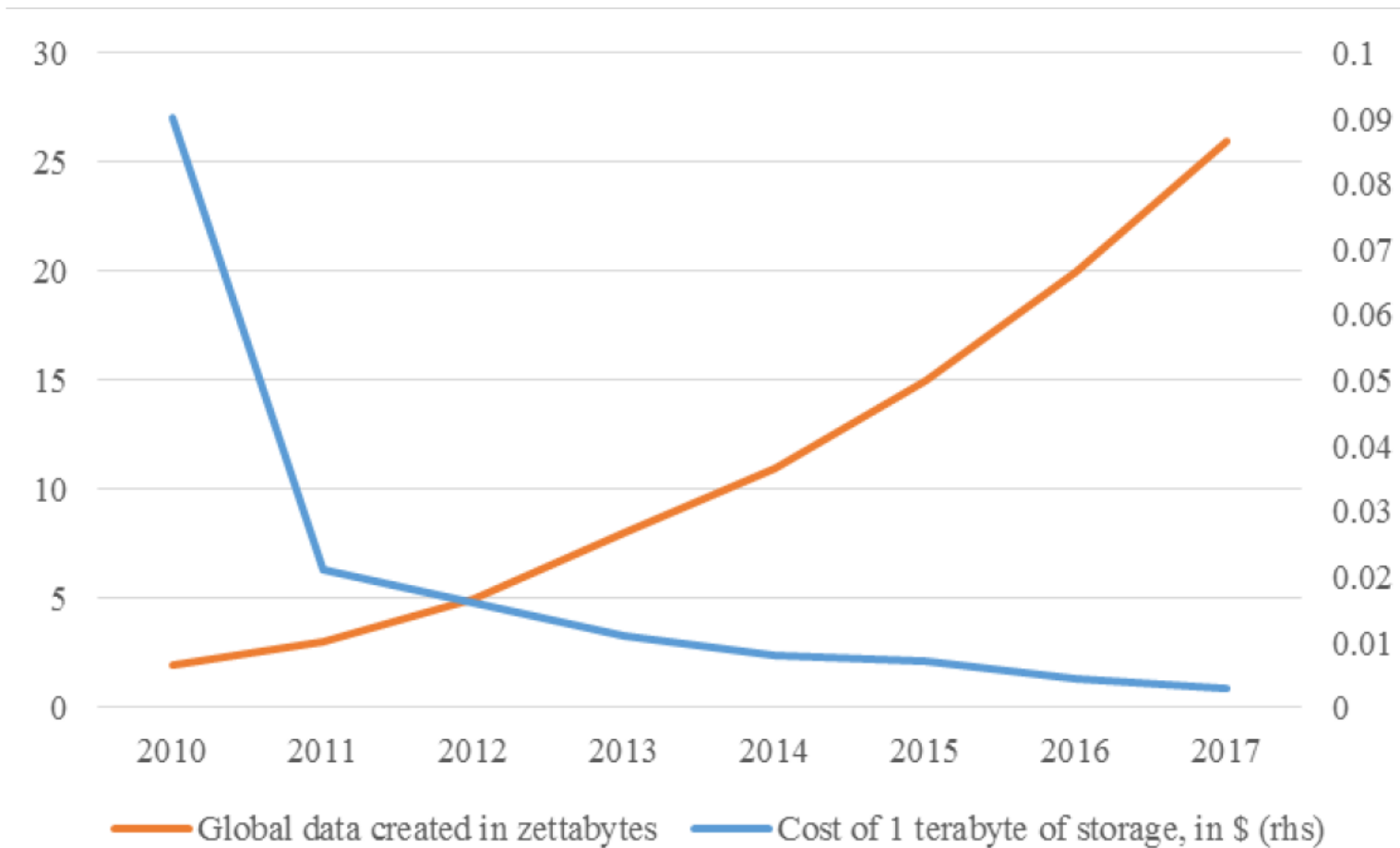
Global volume of data (ZB)

200

Historical   Forecast

150

163 ZB
expected in
2025

100

50

0

2010 2012 2014 2016 2018 2020 2022 2024

SOURCE – 2018 US TREASURY REPORT "A FINANCIAL SYSTEM THAT CREATES ECONOMIC OPPORTUNITIES NONBANK FINANCIALS, FINTECH, AND INNOVATION" AND
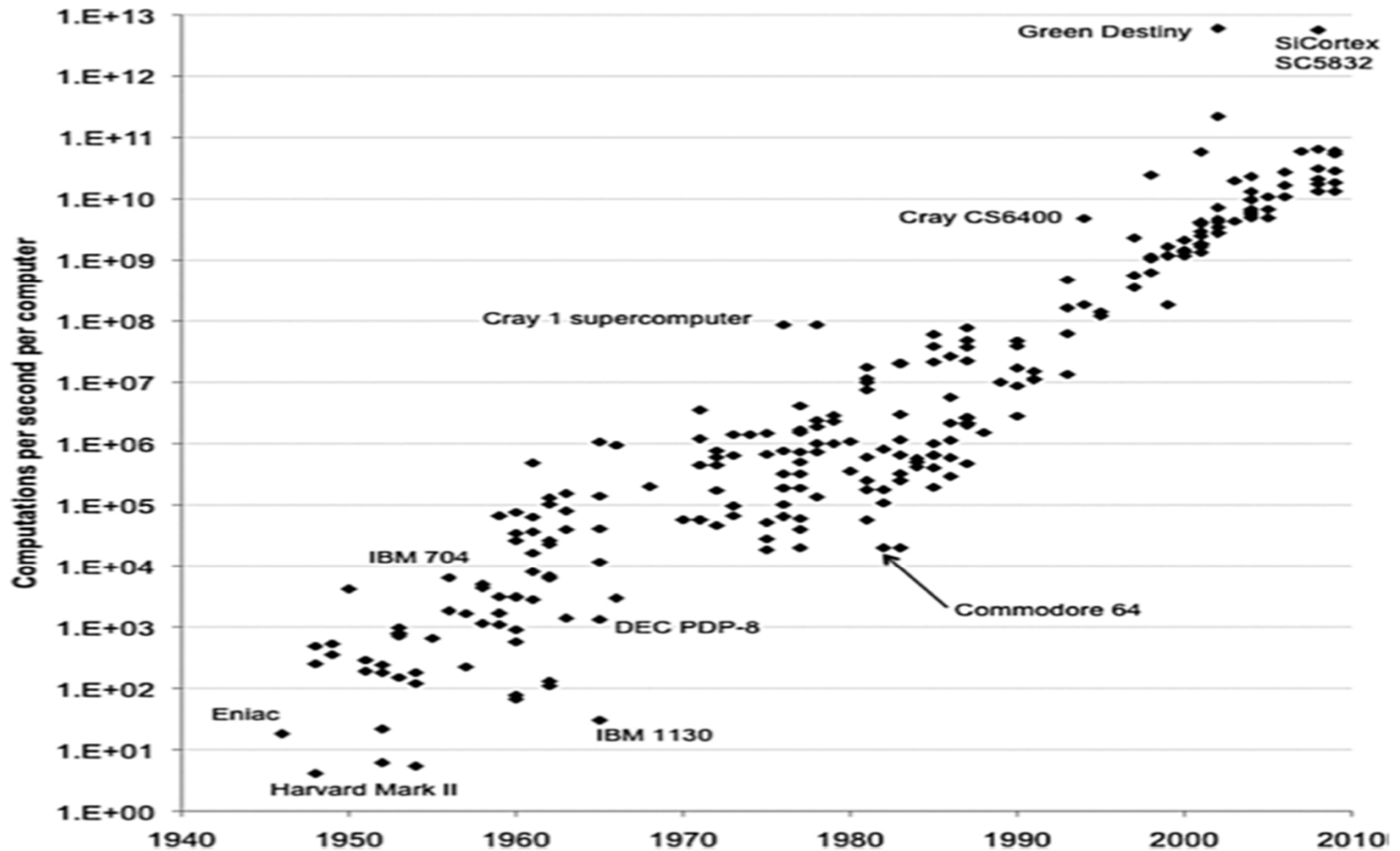
FALLING COSTS OF DATA STORAGE

Source: Reinsel, Gantz and Rydning (2017); Klein (2017). One zettabyte is equal to one billion terabytes.

EXPONENTIAL GROWTH IN COMPUTING POWER

WHY NOW – SUPPLY AND DEMAND

Supply Factors	Demand Factors
Digitization of data	Potential for cost reduction, revenue gains
Falling costs of data storage and hardware (GPU's)	Regulation - new regulations (AML, capital optimization, margin calculations)
Cloud Computing - More computing power through faster processor speeds via cloud computing offers AI to companies with low budgets,	Competition - AI is the new moat providing competitive advantage e.g. more customized financial services
	More accurate estimation of risk (Improved risk management)

CURRENT AND UPCOMING USES

Approach	Use Cases	AI technique used
Classification	○ Sentiment Analysis ○ Customer Behavior Analysis ○ Fraud Detection ○ KYC	Decision Tree, Support Vector Machines, Neural Networks
Clustering or Recommender systems	○ Market Segmentation ○ Portfolio Construction ○ Customer Segmentation (Credit Scoring) ○ Pattern Discovery ○ Network Analysis (Cybersecurity) ○ Pattern Discovery [6]	K-Means, K Nearest Neighbors, Bayesian Networks
Information Retrieval	○ Legal Contract Processing ○ Chatbot [7] ○ Text Understanding and Retrieval	NLP

EXAMPLE OF USE OF AI IN 'SUPTECH' – INTERSECTION OF COMPLIANCE AND AI

- Monetary Authority of Singapore (MAS) is exploring the use of AI and machine learning in the analysis of suspicious transactions [3]

- SEC staff uses ML to identify patterns in text of SEC filings (Scott Bauguess 2017, "The Role of Big Data, Machine Learning and AI in in Assessing Risks: a Regulatory Perspective")

- In Australia, ASIC has also used machine learning software to identify misleading marketing in a particular sub-sector, such as unlicensed accountants in the provision of financial advice [3]

- FCA has conducted proof of concept tests to explore fully automated regulatory reporting where machines both published and checked firms' data.

- Bank of England is working on a Proof of Concept to use AI/ML to detect anomalies in supervisory data [7].

- One regulator is using an external vendor and using AI to analyze bank's annual reports and also analyzing reports from pension funds for certain sensitive information [7]
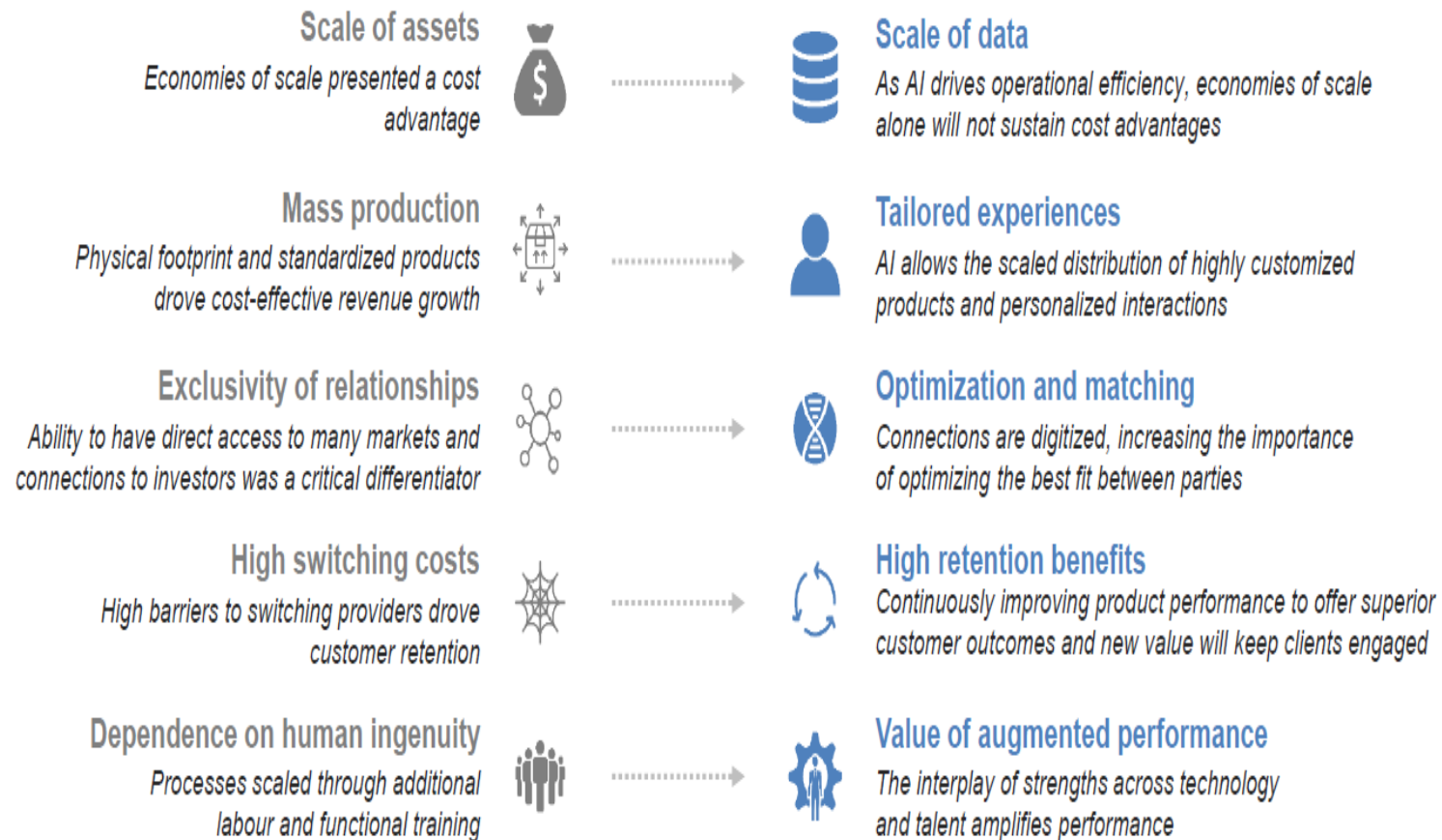
RISKS

1. The use of AI introduces new risks and requires new controls.

WHAT ARE THE RISKS?

Risk Type	Why is it relevant for AI?
Business Risk	Fragmentation of value chain; financial services become more modulated; battle for customer interface and data [8] [9]
Bias Risk	Input data bias; Training data bias; Programmer's Bias
Opacity	Lack of auditability and transparency of AI
Concentration Risk	Concentration of big data and AI technologies [8]
Market Stability	Increased correlation and volatility [8]; increased risk of contagion due to more inter-connectivity
Conduct and Regulatory Risk	Ignoring regulatory expectations on consumer protection, data privacy, fair lending, transparency
Liability Risk	liability cannot be assigned to a software; European parliament has debated the legal status of autonomous agents [10]
Process Risk/Deployment	Use of AI may not be captured by existing operational risk and controls
Model Risk	AI and ML have features which present unique model risk and will pose a challenge to current model risk management

BUSINESS RISK FROM AI

Scale of assets
Economies of scale presented a cost advantage

→

Scale of data
As AI drives operational efficiency, economies of scale alone will not sustain cost advantages

Mass production
Physical footprint and standardized products drove cost-effective revenue growth

→

Tailored experiences
AI allows the scaled distribution of highly customized products and personalized interactions

Exclusivity of relationships
Ability to have direct access to many markets and connections to investors was a critical differentiator

→

Optimization and matching
Connections are digitized, increasing the importance of optimizing the best fit between parties

High switching costs
High barriers to switching providers drove customer retention

→

High retention benefits
Continuously improving product performance to offer superior customer outcomes and new value will keep clients engaged

Dependence on human ingenuity
Processes scaled through additional labour and functional training

→

Value of augmented performance
The interplay of strengths across technology and talent amplifies performance

SOURCE [11]– 2018 WORLD ECONOMIC FORUM REPORT: "THE NEW PHYSICS OF FINANCIAL SERVICES: UNDERSTANDING HOW ARTIFICIAL INTELLIGENCE IS TRANSFORMING THE FINANCIAL ECOSYSTEM"

CONCENTRATION RISK

USE OF AI IS HEAVILY CONCENTRATED ACROSS FEW FIRMS WITH ACESS TO VAST AMOUNTS OF DATA AND CAPITAL

Concentration of AI technology

- Small number of companies (third-party providers) are leading in AI and machine learning which will become new systemically important institutions.
- 2017 FSB report states that "Banks' vulnerability to systemic shocks may grow if they increasingly depend on similar algorithms or data streams".

Concentration of Data

AI is dependent on data and access to data will be a source of systemic importance, especially if some firms are able to leverage their proprietary sources of big data to obtain substantial economies of scope".

Concentration of Capital including Talent

AI will be affordable to large companies because the deployment requires significant investments in the infrastructure and in the skilled workers.

BIAS RISK IN AI

SOURCES OF BIAS RISK IN AI MODELS

(1) Input data Bias: is not representative or incomplete; lacks richness of information and reflects historical **bias.**
- **Use of Non-Traditional Data** (internet search histories, shopping patterns, social media activity) increases the possibility of bias in Input Data
- **Stability Bias** – ML relies on patterns in in the input data and cannot predict outcomes that have not happened; e.g. models built before 2008 could not predict correlation between credit card defaults and mortgage defaults

(2) Programming Bias: Programming bias could occur in the original design or when a smart algorithm is allowed to learn and modify itself through successive contacts with human users, the assimilation of existing data, or the introduction of new data. Machine-learning algorithms will be prone to incorporating the biases of their human creators.

Programming Bias – Overfitting
- Risk Management applications may miss new types of risks and events due to 'overtraining' on historical data
- Selective bias in insurance companies is predicted to undermine risk pooling and increase premiums for riskier customers

Programming Bias – Biased Outcomes
- Maximizing true positives or minimizing false positives

Programming Bias
- Subconscious bias or lack of diversity among development teams may influence how AI is trained, carrying bias forward

(3) Training bias: Training Data bias could appear in either the categorization of the baseline data or the assessment of whether the output matches the desired result.

FAILURES DUE TO BIAS RISK

SOME PUBLIC EXAMPLE OF DATA BIAS IN AI MODELS

In 2016 a chat bot used by Microsoft used ML to post comments on Twitter started posting racist and misogynistic remarks based on the 'learning' it did in one day from other users interactions

In 2016, a Pro-Publica research highlighted the bias prediction in the AI tool (COMPAS) which is being used to by judges to forecast which criminals are most likely to reoffend as it was built on incomplete data.

Google classified dark-skinned humans as gorillas on some photos

Most recently, Amazon scrapped an internal AI recruiting tool that repeatedly showed a bias in giving lower scores to women candidates. The bias was unintentional and reflected the male-dominated working environment of the tech world.

POSSIBLE SOLUTIONS TO MANAGE BIAS

➢ LOOK FOR BIAS

  ▪ Researchers at Carnegie Mellon have developed a method called Quantitative Input Influence (QII) that can detect potential for bias in an opaque algorithm.

➢ ELIMINATE BIAS

  ▪ Eliminate specific components of the data causing bias e.g. strip data related to gender, race and other factors not permitted in Fair Lending

➢ COUNTER BIAS

  ▪ Expand the offsetting bias

  ▪ Introduce a mirror image of the bias and merge with the existing data set with bias to offset and create a nullified data set. This technique has been developed by researchers at Boston University and Microsoft Research.

➢ BE TRANSPARENT

  ▪ Explainable AI

MODEL RISK FOR AI

Traditional Models	AI Models
Periodic Model Calibration	Continuous Model re-training
Non-complex data; structured data	Big Data and structured and unstructured data; Multi-dimensional data (e.g. social media and images)
Known Formula, Variables and Parameters	Unknown weights and parameters; optimization technique is not transparent
Output verifiability	Output cannot be attributed to variables, features
Overfitting	Bias in AI (training data, input data, programming bias)

MODEL RISK FOR AI

Key Areas of challenge for review of AI Models	
Transparency	While regulators require audits of new processes (e.g. to verify independence), many AI processes are not easy to audit (e.g. traditional interim working steps are often skipped entirely)
Conceptual Soundness and Performance Monitoring	Since output cannot be attributed to specific variables, features in some cases, this objective cannot be fully realized however is still important to manage bias
Documentation and Transparency	There are no standards on how to create documentation for even supervised models leaving aside more complex AI models
Skilled Resources	There is a war of talent for AI and getting dedicated AI resources to manage model risk will be challenging

REGULATIONS

2. Current regulations limit full deployment of AI but are evolving and adapting to their use

CURRENT LAWS IMPACTING AI

Data Privacy and Security

- Privacy and data protection (GPDR) place new limitations and requirements on collection, transmission and storage of personal data
- Consumers gain more control over their data including who can access that data and 'right to be forgotten'

Data Portability

- Regulations in Europe (PSD2, UK Open Banking) require that financial institutions share customer's financial data with third parties (at request of customer)

Vendor and Third Party Services Laws

- Ability to use public and private clouds is critical to deployment of AI applications however regulations on cloud usage vary globally with stricter requirements in Europe [15]
- SEC Rule (17a-4) has additional requirements for broker-dealers who use third-party recordkeeping services (including cloud) to maintain their records.
- OCC expects* that third-party relationships should be subject to the same risk management, security, privacy, and other consumer protection policies as that applies to the banks

CURRENT LAWS IMPACTING AI

IP and Patent Laws

- People invent things and not machines
- Learning by models cannot be patented currently

Copyright Laws

- Currently cannot register learning by machines and copyright is assigned only to humans

Agency Laws and Fiduciary Laws

- Agency and Fiduciary laws applicable for a relationship between humans and there is no exemption or provision for a "robo-advisor"

Product Liability

- Reps and Warranties cannot be linked to a machine since software is treated as service and not as product
- Lack of clarity in responsibility in the event of loss or negative outcome increases likelihood that regulators will likely hold the primary institutions responsible if there are damages to recover

EVOLVING REGULATORY FRAMEWORK

Recent Papers give indication of the evolving Regulation

- 2016 President Report on AI prepared by National Science and Technology Council Committee
  https://publicintelligence.net/white-house-preparing-artificial-intelligence/

- 2017 Financial Stability Board – 'AI and ML in Financial Services
  http://www.fsb.org/2017/11/artificial-intelligence-and-machine-learning-in-financial-service/

- 2018 Big Data and AI report by German Regulators (BaFin)
  https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Fachartikel/2018/fa_bj_1806_BDAI_Studie_en.html

- FTC published a report in 2016 on fairness in AI and Big Data
- https://www.ftc.gov/reports/big-data-tool-inclusion-or-exclusion-understanding-issues-ftc-report

- OCC is considering a special purpose national bank charter for fintech companies in a whitepaper published in 2016]. The OCC paper makes it clear that existing laws apply to all creditors even those that are not banks and that any company issued a fintech charter would be expected to comply with applicable fair lending laws. [13]

- 2018 Treasury report on Big Data
  https://www.treasury.gov/press-center/news/Pages/A-Financial-System-That-Creates-Economic-Opportunities---Asset-Management-and-Insurance.aspx

- 2018 European Supervisory Authorities Joint Committee Report on Big Data
- 2017 Basel Committee report on Fintech developments for Banks and Bank Supervisors
- 2017 European Banking Authority discussion paper on Financial Technology

REGULATORY EXPECTATIONS

Regulatory expectation are mainly around 3 broad categories;

1) **Financial Stability and Market Stability**

2) **Firm Supervision**

3) **Consumer Protection**

Financial Stability and Market Stability

- **Maintaining Transparency and avoiding Opacity** - Lack of interpretability or 'auditability' of AI and machine learning methods has the potential to contribute to macro-level risk [8] ; Supervisory and regulatory authorities will not accept any models presented as an unexplainable black box

- **Control for Market Inter-connectedness -** AI will increase inter-dependence ('domino effect') among firms resulting in increased volatility and more complex system

- **Manage systemic and heightened vendor Risk** - New forms of inter-dependence and systemic risk due to concentration of AI technology; establish controls over outsourced technology and processes [8]

- **Address increased information security and Cyber Risk** ([8] and [14]

REGULATORY EXPECTATIONS

Regulatory expectation are mainly around 3 broad categories;

1) **Financial Stability and Market Stability**

2) **Firm Supervision**

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Firm Supervision

- **Embed use of AI within Governance routines** – Senior management remains responsible and responsibility for actions cannot be shifted to machines ; AI enabled systems should be governable, open, transparent and their operation should be consistent with Firm's existing values and aspirations [8]

- **Establish Transparency** - Responsibility of supervised firms to guarantee the explainability / traceability; supplement documentation with more testing under controlled conditions [14]

- **Extend Internal Controls to AI development** - Key functions such as risk management and internal audit and the administrative management and supervisory body should be fit for controlling and managing the use of applications [8]

- **Establish controls for Model Risk** - AI models should be subject to internal and external approval [14]

REGULATORY EXPECTATIONS

Regulatory expectation are mainly around 3 broad categories;
1) **Financial Stability and Market Stability**
2) **Firm Supervision**
3) **Consumer Protection**

3) Consumer Protection

Fairness and Conduct Risk
- **Prevent discrimination and bias** - AI should promote justice and fairness and AI should be accountable to stakeholders (2016 report)
  - 2015 Supreme Court Ruling stated that plaintiffs need only prove that policy was discriminatory and not that discrimination was intentional.
  - In a Nov 2016 report, the UK Government Office for Science expressed concern that algorithmic bias can contribute to risk of stereotyping and recommended regulators to prevent biased outcome.
  - A 2016 FTC published report which described bias in algorithms used to decide credit-worthiness and showed scenarios in which a neutral algorithm could lead to a unintended discrimination

Transparency (Explainable AI)
- **Disclosure** – Failing to disclose in advance to customers on what factors will be used to deny credit can cause reputational and bad customer experience. e.g. for Fair Lending need to explain why credit was denied

REGULATORY EXPECTATIONS

Regulatory expectation are mainly around 3 broad categories;
1) **Financial Stability and Market Stability**
2) **Firm Supervision**
3) **Consumer Protection**

3) Consumer Protection

Privacy – Guarantee personal privacy and data self-determination
- **Meet Compliance Risk for Data Privacy** - UK Data Protection Act 1998 and EU General Data Protection Regulation of 2016 require customers to opt out of 'automated decisions' based on their personal data and those who do not opt out have to be notified of any such decision and be permitted to make such decisions.
- **Data Sovereignty** - Consumers must be allowed to decide for themselves whether they would like to use AI-based financial services and, if necessary, permit the use of their data in such cases.
- Adherence to relevant protocols regarding data privacy and conduct risks (FSB Report)

SOLUTIONS / CONCLUSIONS

3. To realize the full potential of AI will require institutions and regulators to co-create new approaches and solutions

SOUND BITES FROM THE 2018 US TREASURY REPORT

- *"Financial regulators must consider new approaches to effectively promote innovation, including permitting meaningful experimentation by financial services firms to create innovative products, services, and processes"*

- *"Treasury encourages all financial regulators to stay abreast of developments in technology and to properly tailor regulations in a manner that does not constrain innovation"*

- *"Regulators should provide regulatory clarity for the use of new data and modeling approaches (AI/ML) that are generally recognized as providing predictive value consistent with applicable law for use in credit decisions"*

Treasury's recommendations in 2018 report can be summarized in the following four categories:

- Adapting regulatory approaches to changes in the aggregation, sharing, and use of consumer financial data, and to support the development of key competitive technologies;

- Aligning the regulatory framework to combat unnecessary regulatory fragmentation, and account for new business models enabled by financial technologies;

- Updating activity-specific regulations across a range of products and services offered by nonbank financial institutions, many of which have become outdated in light of technological advances; and

- Advocating an approach to regulation that enables responsible experimentation in the financial sector, improves regulatory agility, and advances American interests abroad.

POSSIBLE SOLUTIONS

➢ **Regulatory Sandboxes (e.g. Singapore, UK)**

  ➢ Aligning the regulatory framework to combat unnecessary regulatory fragmentation, and account for new business models enabled by financial technologies

➢ **Governance**

  • Clarify where and how testing is done
  • Run tests under attorney client privilege to test for unwanted outcomes
  • Analyze data inputs for selection bias and for privacy compliance
  • Have an independent body review data sets
  • Training for developers on expected regulations (e.g. factors used in credit selection should nit be factors prohibited in Fair Lending)
  • Human Supervision and Circuit Breakers

➢ **Privacy**

  • Integrate data protection requirements directly in data analysis through "privacy preserving data mining" – anonymization and secure distributed computing [14]
  • Human Supervision and Circuit Breakers

➢ **Auditability**

  • How is it audited for illegal and discriminating use?
  • Rational for decision making should be documented and verifiable
  • Provide business justification for selection of attributes and input data

Conclusion

1. The use of AI in financial services introduces new risks and requires new controls.

2. Current regulations limit full deployment of AI

3. To realize the full potential of AI will require institutions and regulators to co-create new approaches and solutions.

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