BANK FOR INTERNATIONAL SETTLEMENTS

Regulation automata: efficient supervision of distributed-ledger based finance

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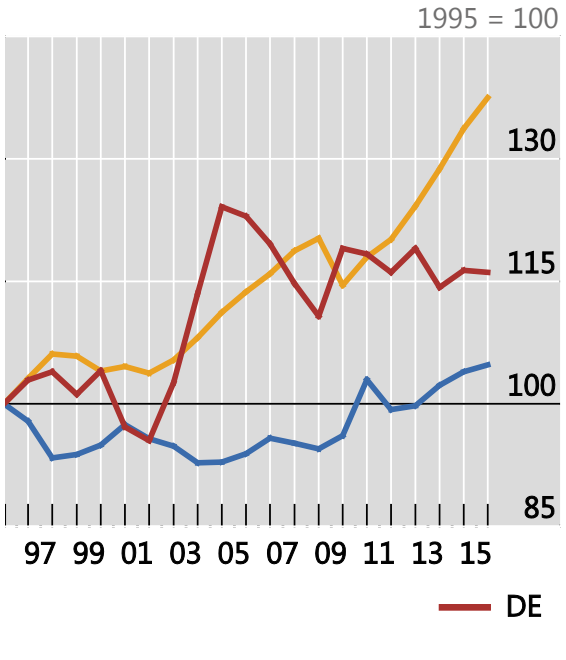
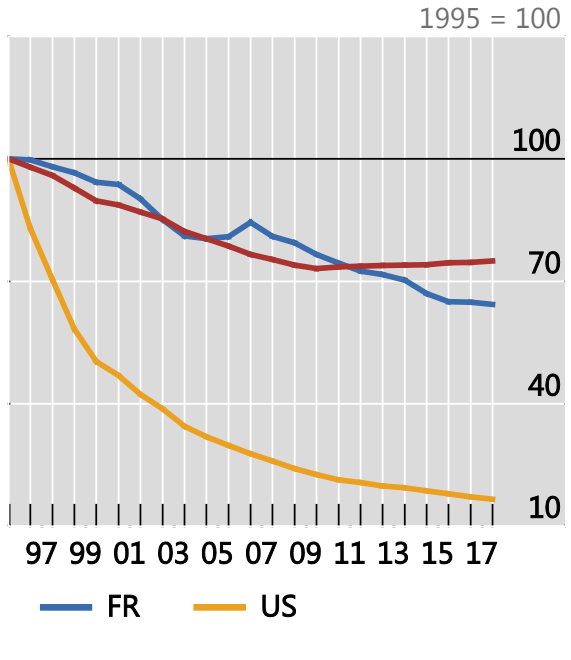
Can DLT bring down the cost of financial services?

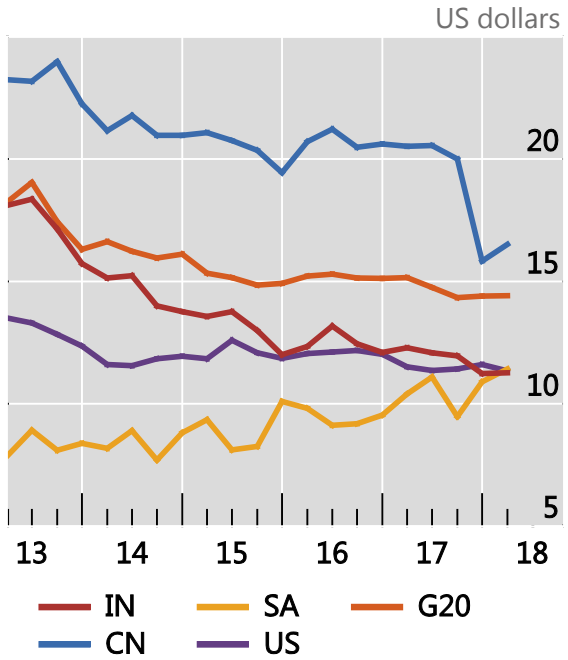
Prices of financial services have not come down…[1]



…despite availability of low-cost IT[2]



Cross-border payments are particularly costly[3]



[1] Gross output price index normalised to equal 100 in 1995. [2] Simple average of the prices of computer components, software and communication equipment. For DE, price of software. [3] Average total cost for sending $200 with all remittance service providers worldwide. For CN and IN, receiving country average total cost; for G20, SA and US, sending country average total cost.

Sources: EU KLEMS; Eurostat; US Bureau of Economic Analysis (BEA); World Bank, *Remittance Prices Worldwide*, remittanceprices.worldbank.org; World Bank; BIS calculations; author's calculations.

Can DLT bring down the cost of financial services?

- Two contrasting visions for DLT:
  A. Permissionless **digital commodities controlled by no one**
  B. Novel **financial technology controlled by entities (ie permissioned)**
- My conclusions thus far:
  A. Economics of **current permissionless DLT too limited to be relevant at large**
     - Auer (2019) "Beyond the doomsday economics of proof-of-work in cryptocurrencies" BIS WP 765
  B. However, decentralised exchange, asset-backed tokens, smart contracts, etc may **evolve operational setup of financial markets**
     - **Regulators can complement technological progress by embedding supervision in the consensus of permissioned DLT-based markets**

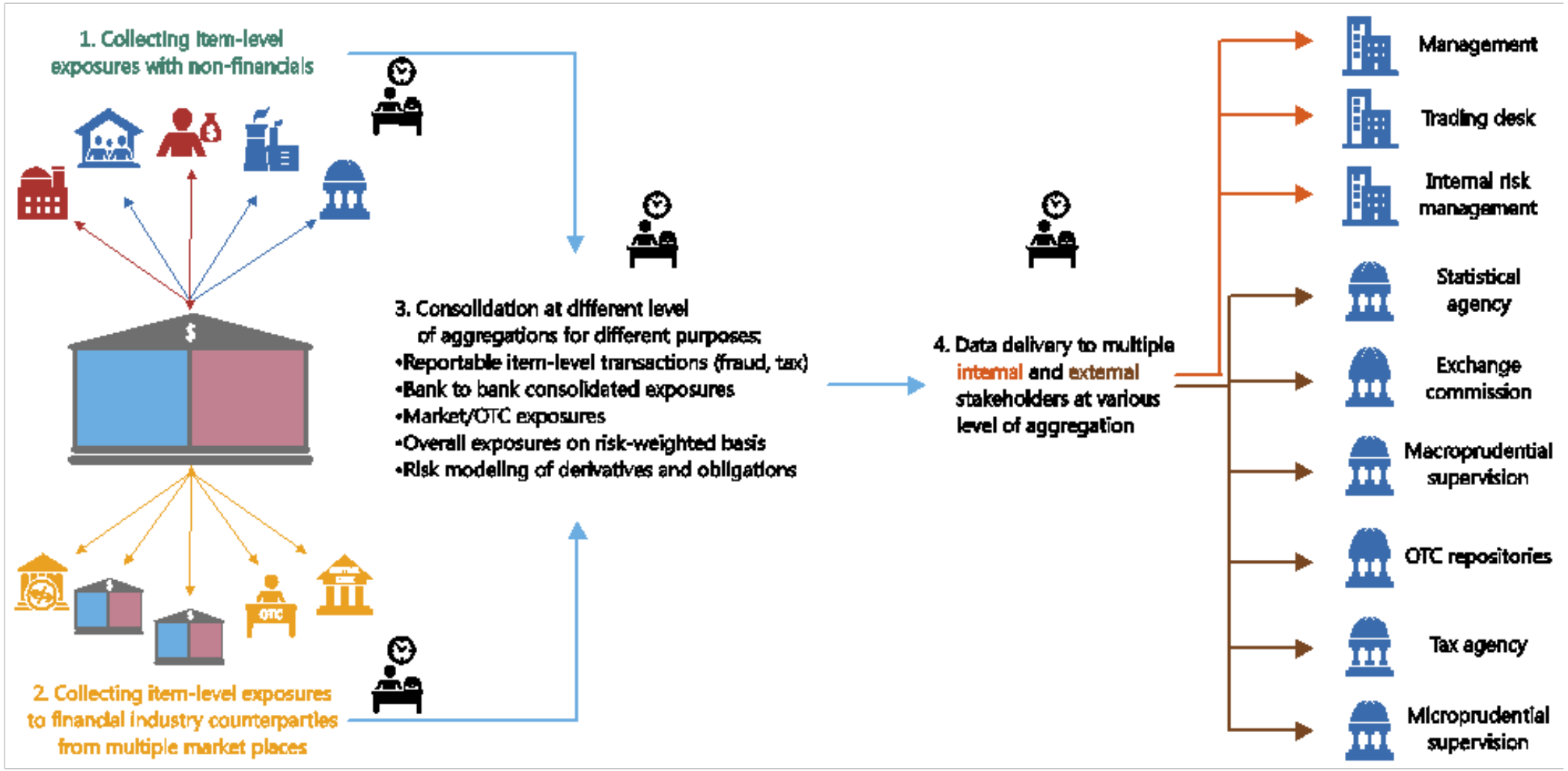
Same risk, same regulation and the case for "Regulation automata"

- **"Same risk, same regulation"**: market rather than government should determine which technology is successful
- FINMA (2018), FCA (2018), etc.: **DLT does not change underlying risks**
  - ICO & asset-backed tokens subject to security regulation
  - Payment tokens subject to AML/KYC
  - Utility tokens subject to consumer protection laws
- I argue: **DLT improves information about underlying risks**

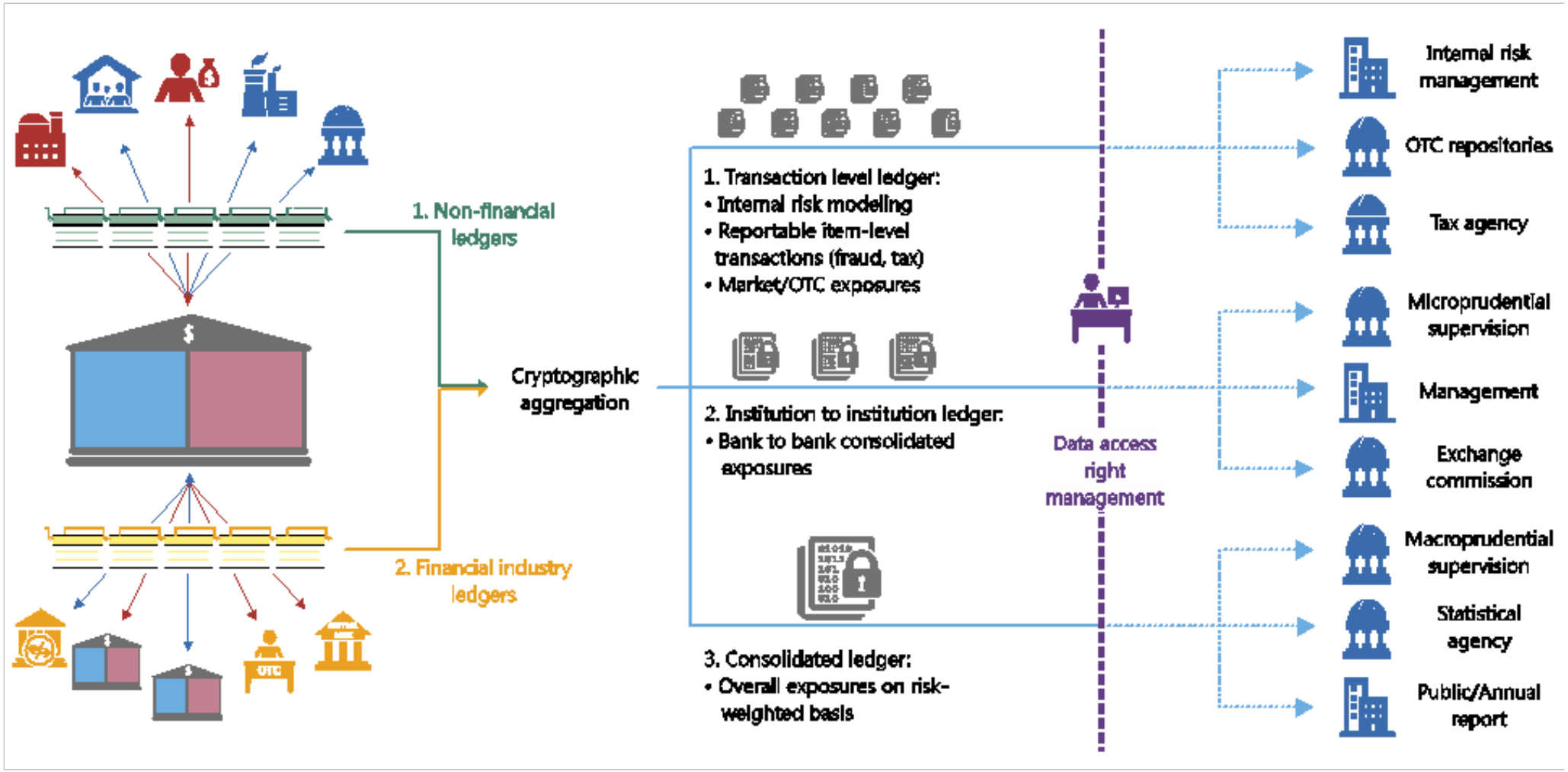
➢ **Same regulation, but evolving supervision!**

"Regulation automata is to verify compliance with regulatory goals by reading the market's ledger, reducing the need for business to actively collect, compile, and deliver data

Regulation automata replaces today's legal compliance process …

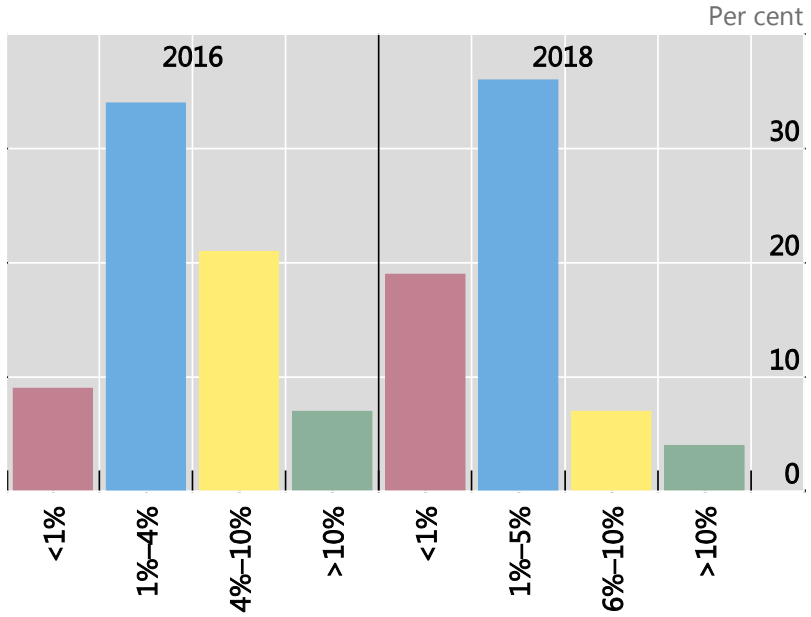


…with automated aggregation of information in DLs

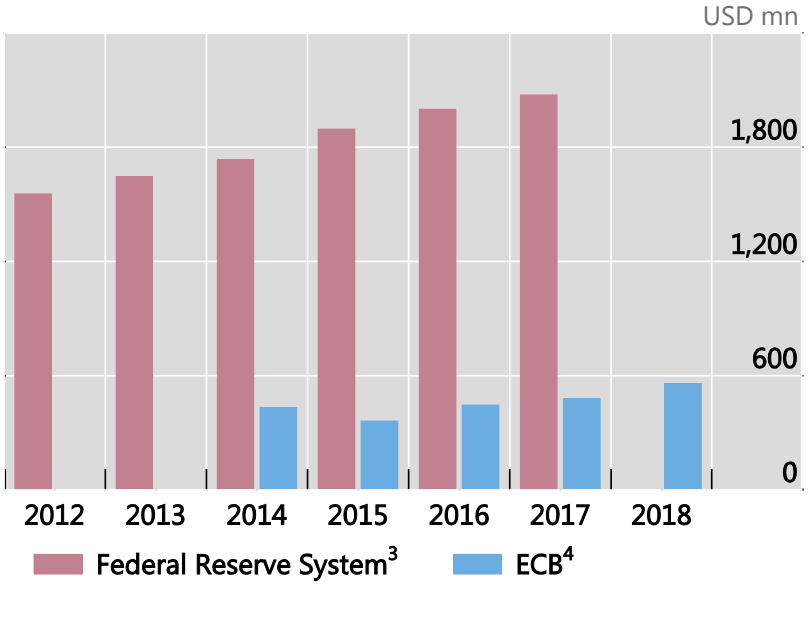


The aim is to bring down compliance costs…

Firm surveys point to high compliance costs[1, 2]



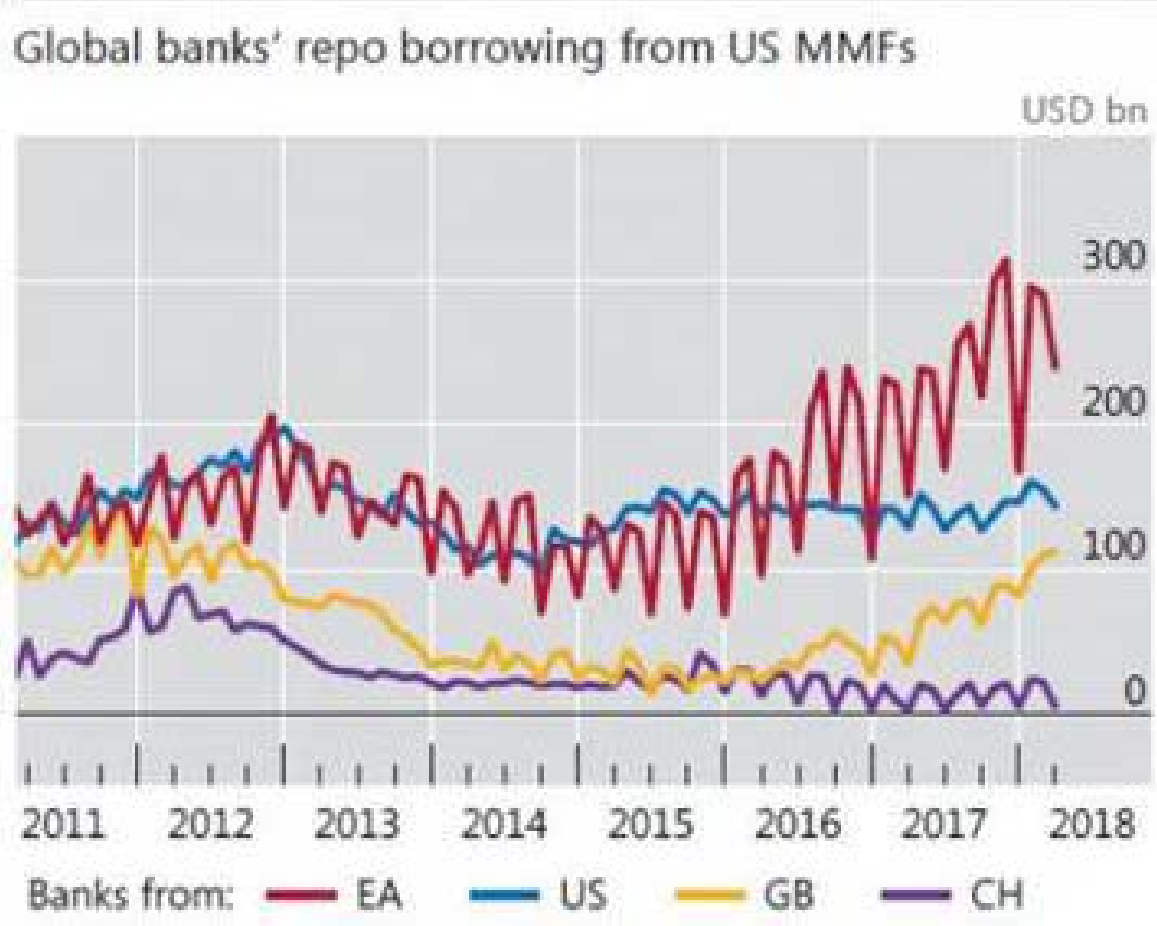
Costs are substantial for regulators too

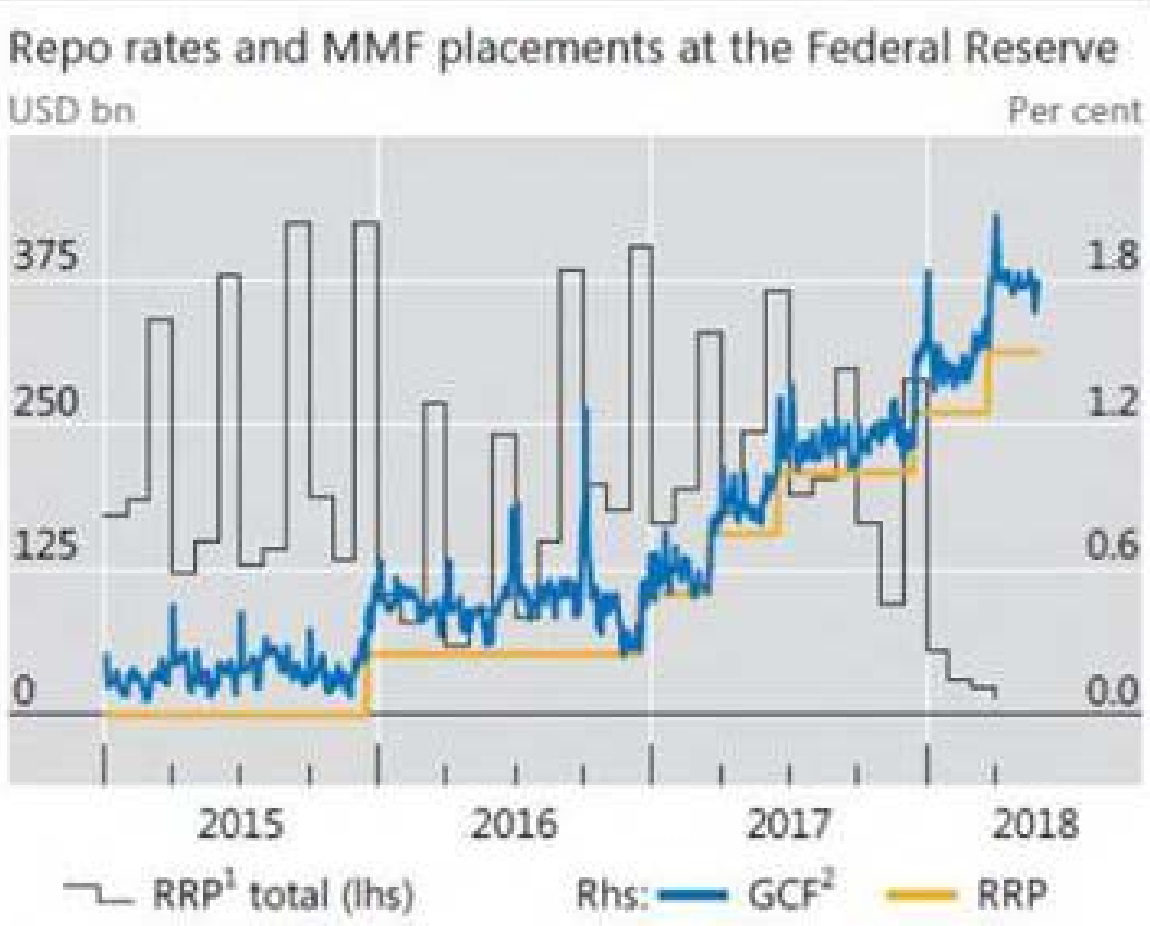


[1] Question: "As a percentage of annual revenue, how much do you believe your company spent or will spend on compliance?" [2] Remaining percentage of respondents answered "did not know". 3 Overall supervision and regulation and related operating expenses of the Federal Reserve System. [4] Supervisory fees.

Sources: Duff & Phelps "Global regulatory outlook", various years; ECB Banking Supervision, www.bankingsupervision.europa.eu; Board of Governors of the Federal Reserve System, Supervisory Assessment Fees Archive, www.federalreserve.gov/supervisionreg/supervisory-assessment-fees-archive.htm; national data; author's calculations.

…and minimise and reporting gaps that open opportunities for window-dressing (i.e. Aldasoro et al. (2018)/ BIS AER)





What are the guiding principles for regulation automata?

I. It can function as **part of a wider regulatory framework** that is backed up by an effective judicial system and supporting institutions

II. Regulation automata **applies to markets that achieve economic finality**

III. The market consensus must be strong enough to withstand being regulated in automata

IV. Design should encourage a **level playing field for entrants**

I. Regulation automata can function as part of a wider regulatory framework that is backed up by an effective judicial system and supporting institutions

- Near term applications of DLT **is intermediary-free financial engineering based on asset-backed tokens**: tokenized investments, stablecoins, etc.
- But legal system remains paramount backstop:
  - **Asset-backed tokens** only as good as underlying real asset
  - **External reference points ("oracles") can manipulate payoffs** of smart contracts
  - Host of other issues (faulty code, obfuscation, illegality, …) need to be resolved via legal processes

II. Regulation automata applies to markets that achieve economic finality

- For a regulator to accept information of a ledger, **there must be a notion of transaction finality**:

  "a transfer of funds [or] a transfer of securities that have become **irrevocable and unconditional**" (see CPSS (2003, p. 496))

- I build on Auer (2019) and focus on **finality via economic incentives**
  - DLT achieves consensus via the incentives of individual actors (miners, stakers, validators)
  - If the cost of an attack is larger than the gain, a market is economically final

Modelling economic finality

- In the paper, I set up a **permissioned DLT-based market**:
  - Agents write financial contracts into a blockchain
  - Blocks are verified by **validators standing to loose their verification capital** should a blockchain reversal ever occur

- Contracts generate losers, who could bribe validators into undoing the chain (like double-spend attack in Bitcoin)

➢ **A market achieves economic finality if there is sufficient validation capital in relation to the volume of potential losses**

Economic finality in a block

- Transaction are final iff "***Probability that a coalition of loosing parties will find it profitable to bribe verifiers to undo the chain is 0***."
  - Define loss in block b at time t by $\overline{\boldsymbol{C}}_{\boldsymbol{b,t}}$:

$$\overline{C}_{b,t} \equiv \sum_{i \in b} \Pi_{i,t} max\left[\left|\underline{c_{i,t}}\right|, \left|\overline{c_{i,t}}\right|\right] = \begin{cases} \beta^{(t+1)-b} \sum_{i \in b} max\left[\left|\underline{c_{i,t}}\right|, \left|\overline{c_{i,t}}\right|\right], & t-b < L \\ 0, & t-b \geq L \end{cases}$$

- Where $\Pi_{i,t}$ denotes indicator function=1 if contract is active (fraction of contract expires each period, maximum length L)

Economic finality in a blockchain

- Need to show: it is not profitable to undo the last block, neither the last 2 blocks, …
- For example, no 1-block attack requires:

$$\boldsymbol{\beta \overline{C}_{b,t} = \beta N_b \bar{c} \leq v_b s}$$

- Generally:

$$\max_{x<L} \left[\sum_{k=o}^{x} \overline{C}_{b-k,t} - v_{b-k} s \right] \leq 0$$

- In the paper, I solve this problem and show how high the verifier's skin in the game has to be to ensure that the blockchain will never be reversed.

III. The market consensus must be strong enough to withstand being regulated in automata

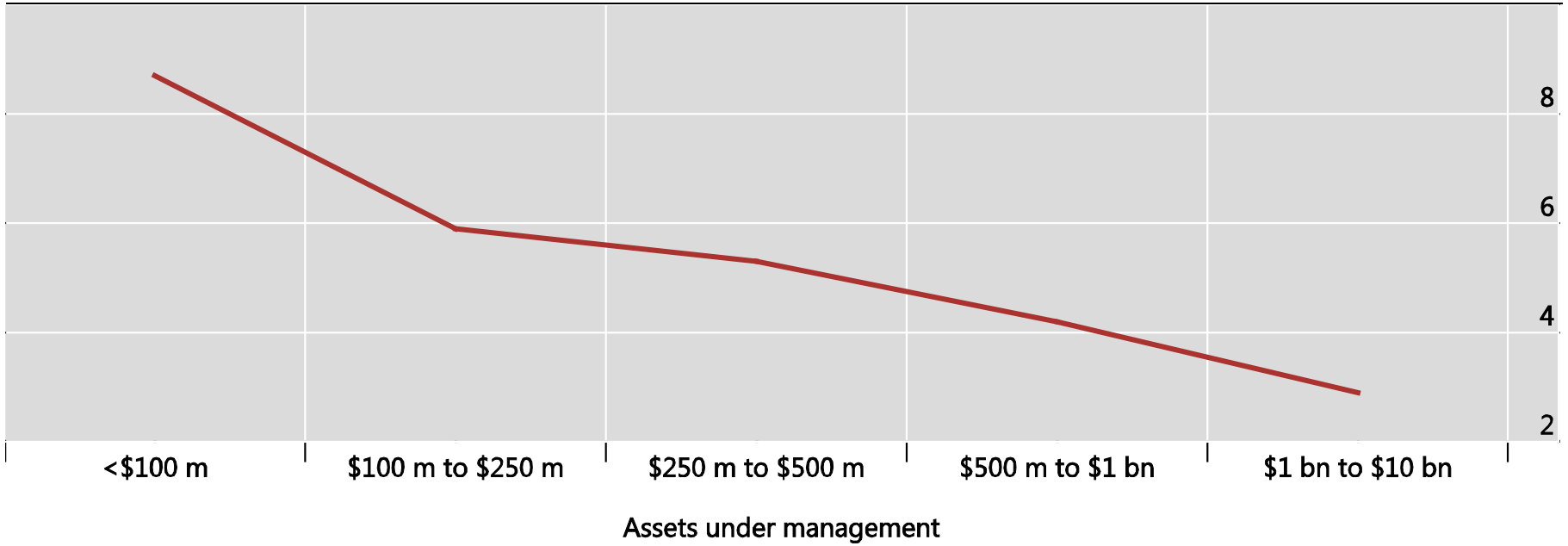
- Compliance with regulation comes at a cost (otherwise no need to regulate)
- This gives incentives to cheat the regulator
- Consensus needs to be strong enough to deter this.

IV. Design should encourage a level playing field for entrants

Smaller banks are disproportionately affected by compliance costs

In per cent

Graph 6



Source: D Dahl, A Meyer and M Neely, "Scale matters: community banks and compliance costs", Federal Reserve Bank of St Louis, *The Regional Economist*, July 2016, www.stlouisfed.org/~/media/publications/regional-economist/2016/july/scale_matters.pdf.

Conclusion

- **Regulation automata is an opportunity**: a new ecosystem co-created by regulators and innovators
- What can generate a level playing field?
  - **Low fixed costs of compliance** - regulators could develop a basic open source suite of risk assessment and compliance tools
  - Set standards for **blockchain-interoperability**
  - Need to evaluate novel aspects of decentralisation (see Walsh (2019))
- **Official institutions could become reference points/oracles** (i.e. offer digitally signed, time-stamped information such as exchange rates, etc.)