The Economics of Distributed Ledger Technologies (DLT) in Securities Settlement

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The current settlement landscape

- **Central Security Depositories (CSDs)** facilitate settlement

- Three main functions:
  1. *Notary function*: keep safe records of issued securities to ensure no one fraudulently creates and trades non-existent securities
  2. *Settlement*: facilitate the transfer of legal ownership of securities from sellers to buyers, typically via DvP
  3. *Account maintenance*: update ownership records following each transaction.

The current settlement landscape

- **Highly intermediated**: monopolistic at a domestic level, with little or no competition among providers. The situation is similar at a global level, with most of CPMI countries having a single domestic CSD.

- **Inefficient**: According to industry calculations, market participants spend $17bn to $24bn per year in core post-trade processing, reference data, reconciliations, trade expense management, client life-cycle management, corporate actions, tax and regulatory reporting (Broadridge 2015).
  - For the most standardized classes - equities and fixed income, excluding OTC derivatives, costs amount to $6bn to $9bn annually.

What DLs and block chain can offer

- P2P process ($\Rightarrow$ disintermediation, cost reduction)
- Synchronized shared databases ($\Rightarrow$ no need for reconciliation)
  - 50% savings on security transactions (Mainelli and Milne 2016)
  - $20 billion a year (Santander 2015)
- Irreversibility of records
- Traceability
- Improved security and resilience (no single point of failure)
- Smart contracts

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Innovation Basics

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1. **Schumpeter (1942)**: Innovation is more likely in concentrated industries with few large firms
    - *Scale argument*: Firm A produces 100 cars pa and firm B produces 10,000 cars pa. Only B will invest in a $10,000 tech that cuts production costs by $1 per car, per annum because B recoups technology costs in 1 year, whereas A in 100 years.
    - *Concentration argument*: If you are a monopolist, then you extract more profit per $ of investment made.

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   - *Concentration argument*: If you are a monopolist, then you extract more profit per $ of investment made.
2. **Arrow (1962)**: The "peculiar attributes" of knowledge
   - Knowledge is easily duplicated and hence has low appropriability: it may make monopoly power difficult to exert

Innovation Basics

- The technology of DL-based settlement (like pretty much all tech) has **public good** properties:
  - **Non-rivalrous**: Use by one party does not preclude use by another
  - **Non-excludable**: Once the technology is developed it would be easy to duplicate

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- Market participants have an incentive to **under-invest** in the DL-based settlement technology (as they do not internalize the benefits that accrue to others) $\rightarrow$ competitive outcomes are inefficient

An illustration

- Based on **Bozeman et al (1986)**
- Firms A and B have fixed budgets for R&D denoted by a and b
- Budget is allocated between applied component x_i and public component y.
- Assume for simplicity that the MRT between the two components equals 1.

An illustration

- Firm A solves:

$$\max_{x_A} \Pi(x_A, y)$$

st

$$0 \leq x_A \leq a, \quad y = a - x_a + b - x_b$$

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- Private Solution (Nash equilibrium):

$$\frac{\partial \Pi_A(x_A, a - x_A + b - x_B)}{\partial x_A} = \frac{\partial \Pi_A(x_A, y)}{\partial y} \Rightarrow MRS_A(x^*) = 1$$

An illustration

- The joint (planner's) problem:

$$\max_{x_A, x_B} \Pi(x_A, y) + \Pi(x_B, y)$$

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- Planner's solution:

$$\frac{\partial \Pi_A(x_A, a - x_A + b - x_B)}{\partial x_A} = \frac{\partial \Pi_A(x_A, y)}{\partial y} + \frac{\partial \Pi_B(x_B, y)}{\partial y}$$

$$\Rightarrow MRS_A(x^{**}) + MRS_B(x^{**}) = 1 \quad (\textbf{Samuelson condition})$$

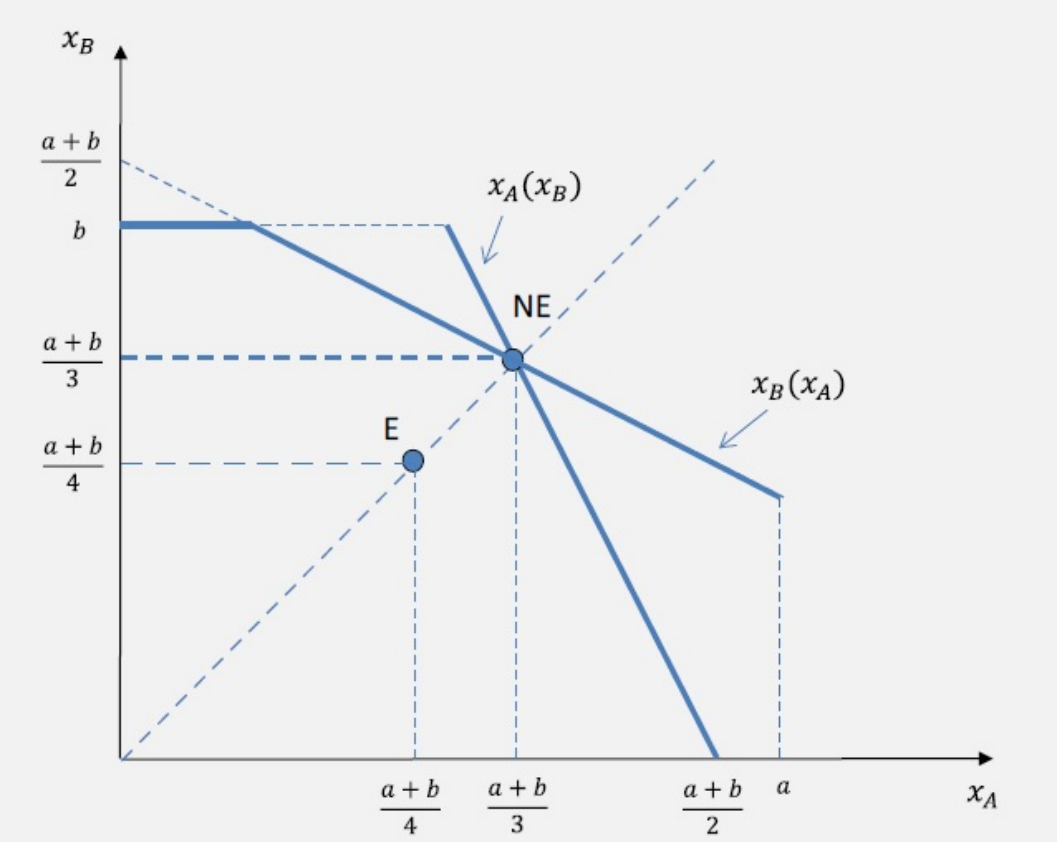
An illustration

- In the private solution, the Samuelson condition is violated:

$$MRS_A(x^*) + MRS_B(x^*) = 2 > 1$$

- Firms substitute too little into the public good because they do not internalize the benefits this substitution has for others.

An illustration



- $x_A(x_B)$ and $x_B(x_A)$ are the reaction functions of firms A and B
- **NE** denotes Nash equilibrium quantities of applied research
- **E** is the socially optimal level of applied research

Patents?

- Patents are a solution to under-investment in know-how:
  - Without some (intellectual) property rights no single party will have sufficient incentives to invest
  - But cost of transmitting information is near zero so distribution of know-how should be unlimited

- Arrow (1962) states, "precisely to the extent that [the attainment of property rights] is successful, there is an under-utilization of the information."

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- Role for cooperation between Fintech start-ups and large incumbents (banks, custodians, CSDs)
  1. *Benefits to start-ups*: Incumbents have a better understanding of the legal and economic dimensions of post-trade processes
  2. *Benefits to incumbents*: Incumbents less able to innovate on their own due to structural inertia and sunk costs. Also, drastic innovations (such as DLT) may give the entrant an advantage over the incumbents.

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- Best outcomes are achieved via **cooperation**

Policy takeaways

1. Role for central banks and other government agencies to participate directly in collaborative research efforts.
   - BoE Fintech Accelerator
   - Project Jasper in Canada
2. Government agencies can also play a role in facilitating the success of private R&D.
   - Clarification of industry rules and the regulatory framework for DLT. E.g. UK Financial Conduct Authority (FCA) Regulatory Sandbox
   - Industry standards (ISO 20022)
   - A legal definition of DL-based security ownership

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The future DLT settlement industry?

- ECB (2016), ESMA (2016,2017), FRB (2017), CPMI (2017), BoE (forthcoming), SWIFT and Accenture (2016), Mainelli and Milne (2016), World Economic Forum (2016), Euroclear (2016), MS (2015):
  - Research into DLTs still at early stage/potential impact is still unclear
  - Many technological, legal and risk management issues still unresolved
  - No single mature DLT solution ready for enterprise-grade implementation

The future DLT settlement industry?

- Future scenarios:
  1. DLT is adopted to improve internal efficiency while business practices largely remain as they currently are
  2. Core players deploy DLT in specific markets, with some players becoming redundant
  3. DLT is fully implemented, allowing a P2P, largely disintermediated system for securities transactions.
- Routes:
  1. Mandated policy, where regulators direct industry to adopt new structure
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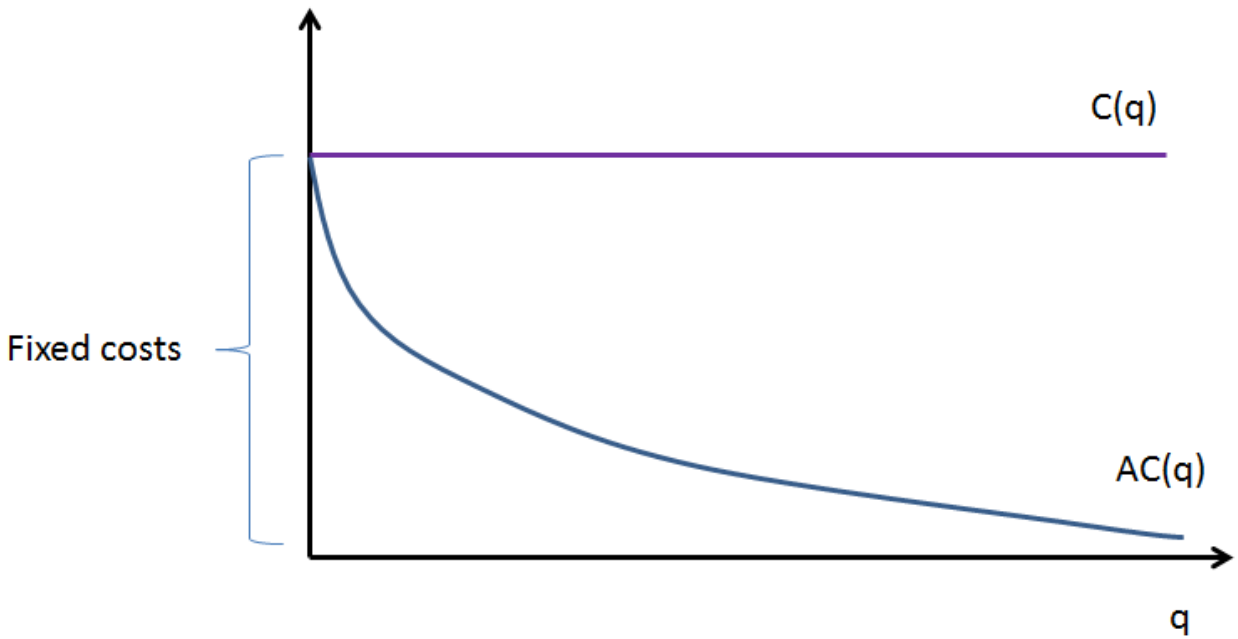
The DLT cost function

- Large fixed costs (initial R&D expenditure)
- Small (or zero) marginal costs
- Declining average costs



Other characteristics

- **Network externality**: The more market participants adopt a given DL solution, the more valuable this solution becomes to existing and potential new users...
- ...meaning that early entrants in this industry may have a significant **first-mover advantage**.
- Once the ledger is up and running it **can be excludable** to outside participants
- The large fixed costs, the network externality and the first-mover advantage all make it highly likely that the DL industry might be a **concentrated** one (i.e. a monopoly or oligopoly)

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- Concentration in CSDs $\rightarrow$ **Concentration in DLT providers**

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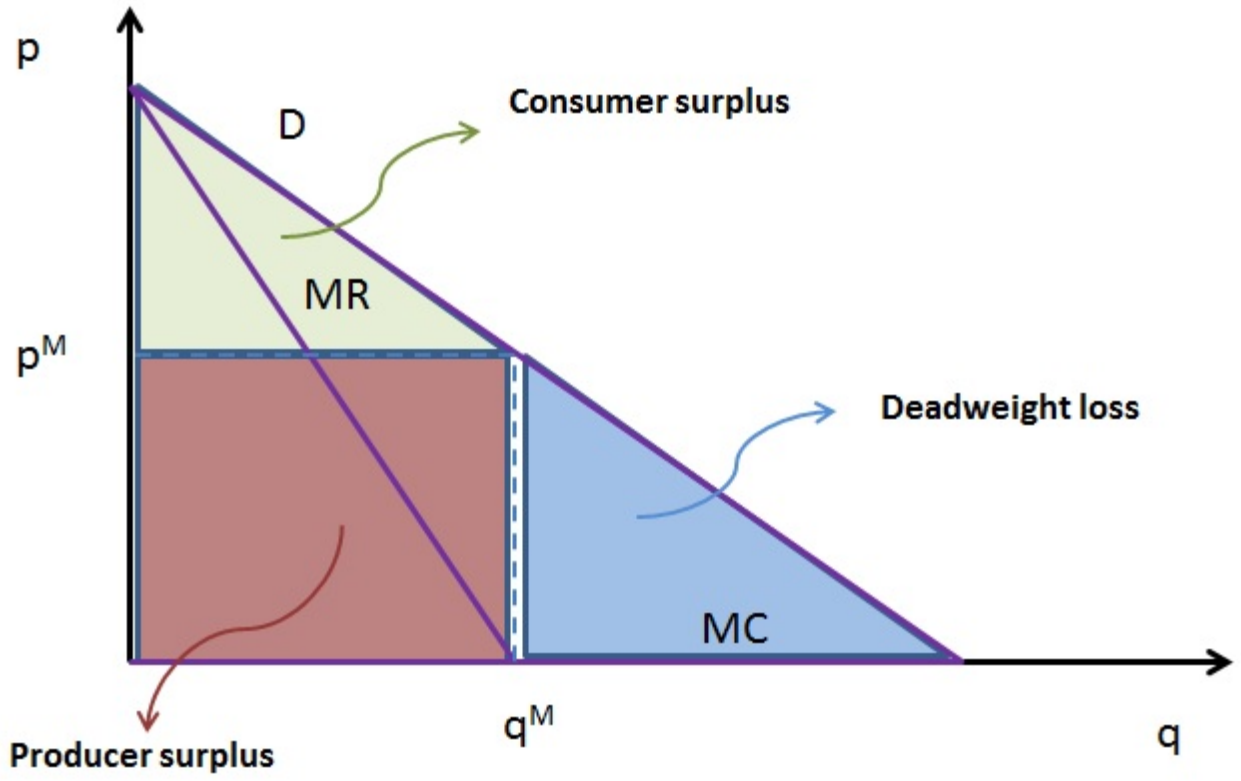
- *Example: Simple monopoly pricing*



The cost of concentration II

- A monopolist may engage in non-simple pricing in order to maximize her surplus (e.g. block pricing, two-part tariffs, price discrimination)
- This eliminates the deadweight loss but all economic surplus accrues to the monopolist $\rightarrow$ **unequal distribution of income**

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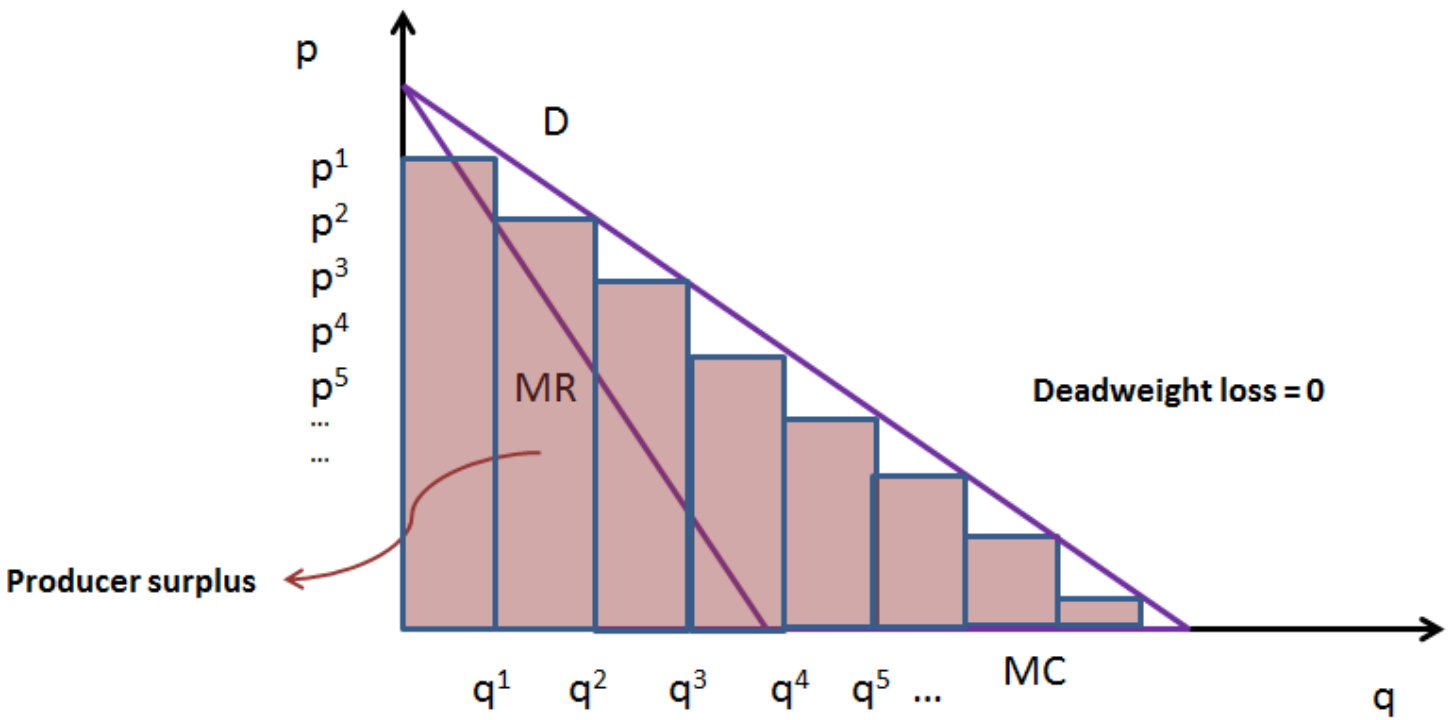

Policy takeaways

1. If the industry becomes concentrated (in terms of DLT solutions) there may be a need to regulate prices in a manner that reduces deadweight losses (but still allows settlement service providers to recoup their costs).
   - Ramsey pricing, cost-recovery
2. Require interoperability
   - Could partially alleviate the role of the network externality in concentrating activity and promote competition
3. Require extensive testing/adherence to PFMIs
   - First-mover advantage/rush to implementation could result in financial stability risks

Thank you!

DLT and block chain basics

- **Distributed Ledger**: A network with nodes in multiple locations, each one keeping a synchronized replica of the database $\Rightarrow$ no single point of failure.
  - **Mutual ownership**: Ownership of the database is shared. Validation is performed by several (or even all) of the nodes in the network through some protocol.
  - **Block chain**: A particular type of ledger where sets of transactions are batched into blocks and are chained to the previous blocks using cryptographic tools.

DLT and block chain basics

- **Access**
  - *Public*: Any user is allowed to read/view the ledger
  - *Private*: Only approved participants have access to the data.
- **Validation**
  - *Permission-less*: Anyone is allowed to build and validate the ledger
  - *Permissioned*: Only a specific group of trusted users can validate or modify entries to the ledger