Monetizing Privacy with Central Bank Digital Currencies*

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The Value of Payments Data

- Majority of payments are electronic
- Virtually all electronic payments are tracked, collected, aggregated
- Payments data is valuable:
  - Identification, demographic and financial info
  - Enhance design
- BigTech entry in payment space
  - GooglePay, ApplePay, AliPay, Libra/Diem

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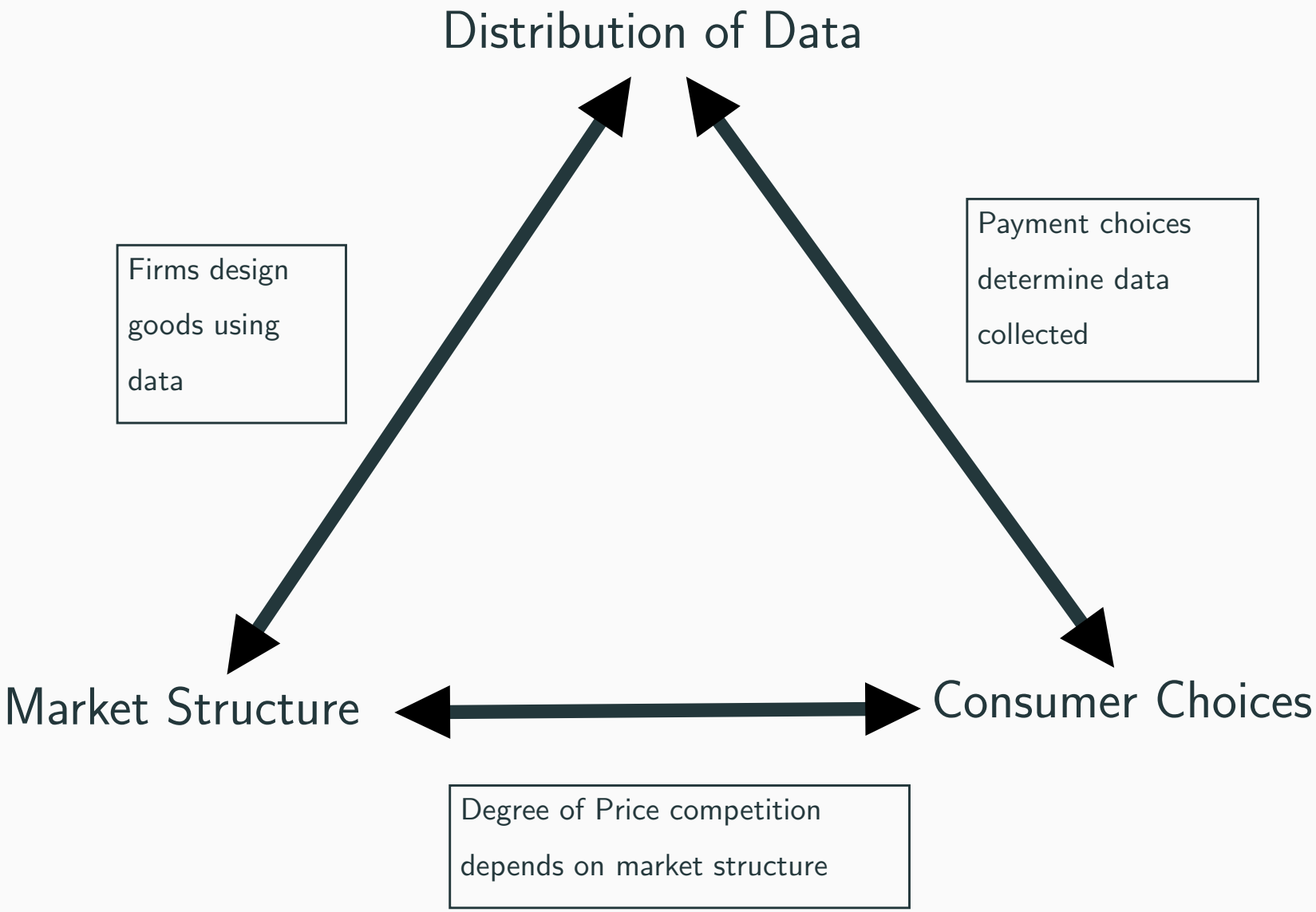
Nov 2020 – EU regulators sued Amazon for anti-trust practice

- Use of sellers' data on Amazon to develop in-house products
- *Amazon used "very granular, real-time" data about listing and sales by other merchants on its platform to help decide what products to launch, what prices to set, how many items to stock, and which suppliers to use.*

Data vs. Privacy

- Firms highly value private info of consumers
- Consumers often not compensated
- Potential reasons
  - Monopoly power
  - Value in aggregated, not individual data
  - **Difficult to collectively bargain**
- But data accumulated can be a violation of privacy


Distribution of Data
Firms design goods using data
Payment choices determine data collected
Market Structure
Consumer Choices
Degree of Price competition depends on market structure

Goal

Study a theoretical environment where

- Firms use payment data to develop goods to match consumer preferences
- Consumers choose between different goods, and also payment method
- Market structure endogenously determined by competition, data, and consumer choices

Main Questions

Main questions:

- How much surplus is generated from data and how is it divided?
- How do policies, and the set of available payment instruments affect surplus and consumer welfare?
- How does introducing a privacy-preserving CBDC impact the real economy?

Main Results

1. Payments data drives the formation of a *data monopoly*
   - Small advantages in information snowball
   - Allows one firm to build and maintain a dominant position in the market
   - Surplus in a data monopoly
     - Data concentration $\Rightarrow$ maximizes surplus from data
     - Monopoly $\Rightarrow$ price mark-ups $\Rightarrow$ small share for consumers
2. Data-sharing policies restore competition, but reduce total surplus and consumer welfare
3. Privacy-preserving CBDC, i.e. **digital cash** preserves the market structure and improves consumers' welfare by enabling them to monetize their private information

Related Literature

- **Monetary policy.** Barrdear and Kumhof (2016), Bordo and Levin (2017), Fernandez-Villaverde et al. (2020b), Garratt and Zhu (2021)
- **Disintermediation.** Andolfatto (2018), Keister and Sanches (2018), Chiu et al. (2018)
- **Financial stability.** Keister and Monnet (2020), Fernandez-Villaverde et al. (2020a), Monnet et al. (2019), Williamson (2018)

- **Economics of Data and Privacy.** Acquisti et al (2016); Johnson (2013); Choi et al. (2019); Garratt and van Oordt (2019); Bergemann et al. (2020); Odlyzko, 2004; Rayna et al., 2015; Acquisti and Varian, 2005; Ichihashi (2020); Bourreau et al. (2017); Liu et al. (2020)
- **Data and Payments.** Parlour, Rajan, and Zhu (2019); Garratt and van Oordt (2019)
- **Data and Market Structure.** Farboodi et al. (2019); Furman et al. (2019)

Model Environment

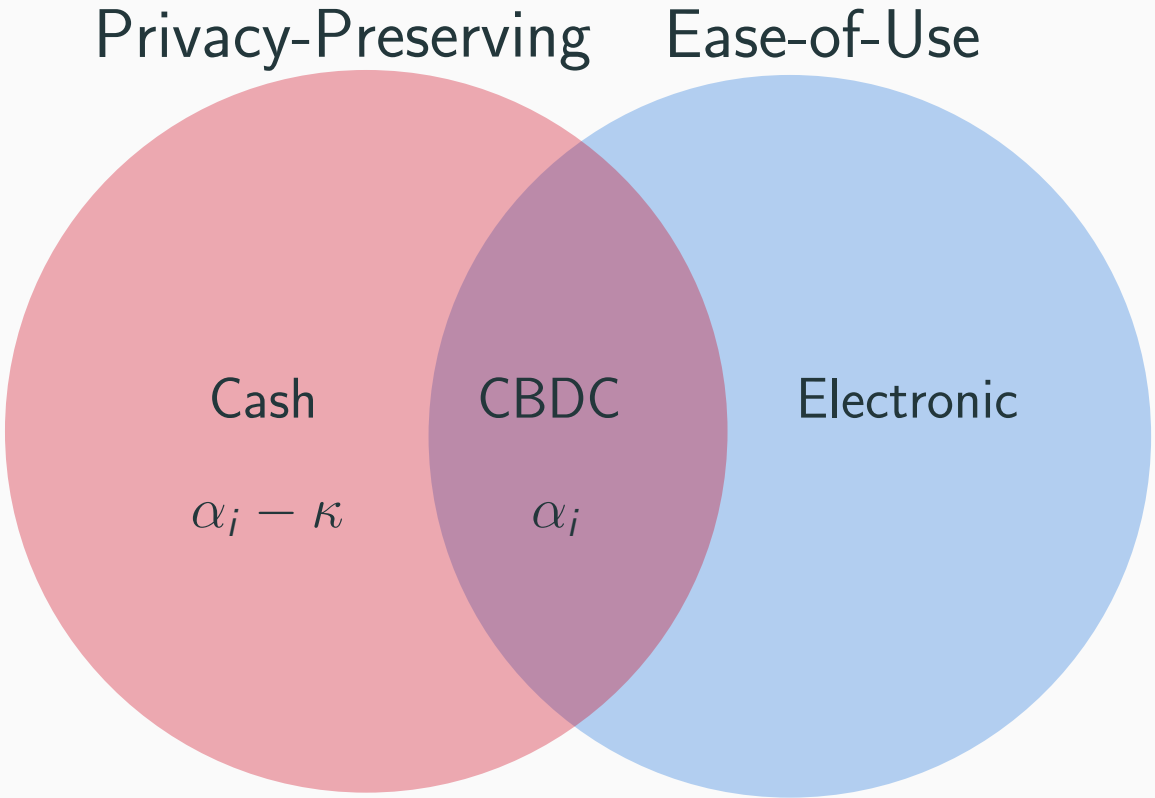
Model

Agents

- Time is discrete and infinite
- Discount rate $\beta \in (0, 1]$
- Consumers, indexed $i \in [0, 1]$
- 2 Firms, indexed $j = 1, 2$

Payment Vehicles

- Each consumer seeks to purchase 1 unit of a good
- (Eventually) three different payment options:
  - physical cash (c)
  - electronic (e)
  - CBDC (d)
- Tradeoff between privacy and convenience
  - Cash less convenient than electronic $\Rightarrow$ disutility cost of $-\kappa$
  - Cash preserves privacy $\Rightarrow$ utility benefit of $\alpha_i \sim U[0, \alpha]$


Privacy-Preserving
Ease-of-Use
Cash
$\alpha_i - \kappa$
CBDC
α_i
Electronic

Product Design

Firms design and produce goods with characteristics

- Goods are defined by set of characteristics θ
- In each period, there is an "ideal" design x_θ per characteristic θ
- Consumers enjoy products that match more of their preferred characteristics
- Firms can discover some of the preferred characteristics using data collected from the past period

Data

- Each firm's data in period t is μ^e_{jt-1}: **electronic sales** in previous period
  - Measure of consumers who purchase firm j's good using electronic payments
- Firm j learns x_θ for $\rho(\mu^e_{jt-1})$ fraction of characteristics θ
  - More data is good ($\rho' > 0$)
  - We say data exhibits network effects if $\rho'' > 0$
- Random initial stock $\mu^e_{j0} \sim G[0, \frac{1}{2}]$
- Each firm's data is **exclusive**

Product-Price Competition

Firms compete with product design and payment-vehicle-specific prices

- Design products that match desirable characteristics
- Set prices p^m **for each payment vehicle** m
- Unit production cost k

Consumer Preferences

- Consumers' decisions
  - choice between firms' goods
  - choice of payment vehicle

- Utility from purchasing firm j's good

$$\underbrace{v + \gamma \cdot \rho(\mu^e_{jt-1})}_{\text{consumption value of firm } j\text{'s good}} \qquad -p^m + \underbrace{\alpha_i \cdot \mathbf{1}_{m\in\{c,d\}} - \kappa \cdot \mathbf{1}_{m=c}}_{\text{payment-dependent utility}}$$

  - v reservation utility
  - γ taste parameter, assume γ sufficiently large ($\gamma > \frac{2\alpha}{\beta}$)

Equilibrium

Each period

- Firms develop products and set prices per payment vehicle to maximize total expected profits
- Consumers choose product/payment-vehicle pairs to maximize utility

Steady-State Equilibrium.

- Focus on long-run market outcome
- Requires stable market shares per payment vehicle, e.g. $\mu^m_{jt-1} = \mu^{m*}_j$

▸ Equilibrium Definition

Starting Point: Markets without CBDC

- Consumers face one of two payment options: cash vs. electronic
  - Cash offers privacy, α_i
  - Less convenient than electronic, $-\kappa$

Main forces

- Electronic purchases enable collection of exclusive data
- Data provide competitive edge in producing attractive goods in the future
- Firms use **discriminatory prices** to influence consumers' payment choice

Payment Data Catalyzes Formation of Monopolies

Result 1. $\exists$ a unique steady-state equilibrium in which a single firm dominates the market.

- "Data monopoly" – data acts as key asset to maintain monopoly status

Intuition

One of the firms gains a small informational advantage

$\Rightarrow$ Extend market share

$\Rightarrow$ Acquire more payment data

$\Rightarrow$ Widen market share

...

$\Rightarrow$ Establish dominant control over data and market

Long-run steady-state with a **winner-takes-all market**

Total Surplus

When data is sufficiently valuable, i.e., large enough γ

- Monopolist induces all consumers to use electronic payments.
- Total surplus:

$$v + \underbrace{\gamma\rho(1)}_{\text{total surplus generated from data}} - k$$

Equilibrium Pricing

- Dominant firm produces good with utility $v + \gamma\rho(1)$
- Competitor produces good with utility v at price k
- In order to capture entire market in electronic, monopolist offers:

$$p_J^e = k + \underbrace{\gamma\rho(1)}_{\text{gains from product quality}} - \underbrace{(\alpha - \kappa)}_{\text{attract most private type}}$$

Consumer Surplus

- Pricing determines division of surplus between consumers and firms
- Consumer reap limited benefits from data surplus
- Monopoly firm discounts electronic prices only to acquire more data
  - Cost of data equal to $\alpha - \kappa$
  - Cash becomes more inconvenient (i.e. $\kappa \uparrow$) $\Rightarrow$ consumer share diminishes!

Data-Sharing Policy

Data-Sharing Policies

- **Key policy concern:** data leads to monopolies
- Are there actions that a regulator can take to improve consumer welfare?
- Level the playing field and promote competition
- Lower prices $\rightarrow$ increase consumer surplus

Policy:

Require firms to share any and all exclusive data derived from past activities with other firms

Leveling Competition

Result 2. With a data-sharing policy, monopoly is "broken," and firms acquire equal share of the market.

- "Democratize" data $\rightarrow$ competitors produce goods of comparable quality
- Prices for both electronic and cash driven to marginal cost k
- Consumers that value privacy sufficiently highly use cash

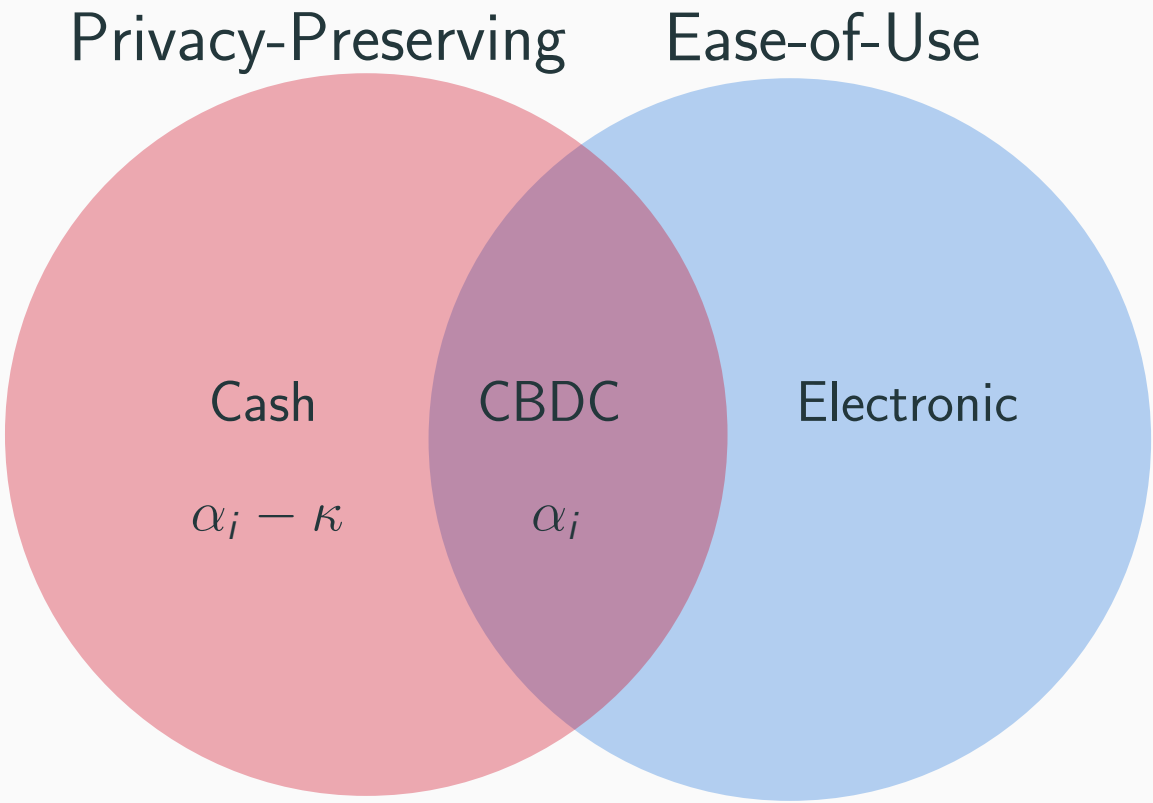
Implications for Total Surplus and Consumer Welfare

1. Total surplus from data drops, consumer share rises.
2. If firms are unable to get enough data collectively, consumers are made worse off by data sharing.

CBDC and Monetizing Privacy

Introducing a CBDC

- Low (zero) cost
- Privacy-Preserving
- Convenient



Observation. CBDC is a *dominant* payment method.

Equilibrium Impact of Privacy-Preserving CBDC

Result 3. With the introduction of digital cash, the data monopoly survives with lower equilibrium prices.

- Underlying market structure (data acquisition) is *preserved*
- The same monopolist continues to dominate

Welfare Impact

- Total surplus is maximized
- Consumers' have improved bargaining position, i.e., increased ability to "monetize privacy"
- Consumer surplus increases:

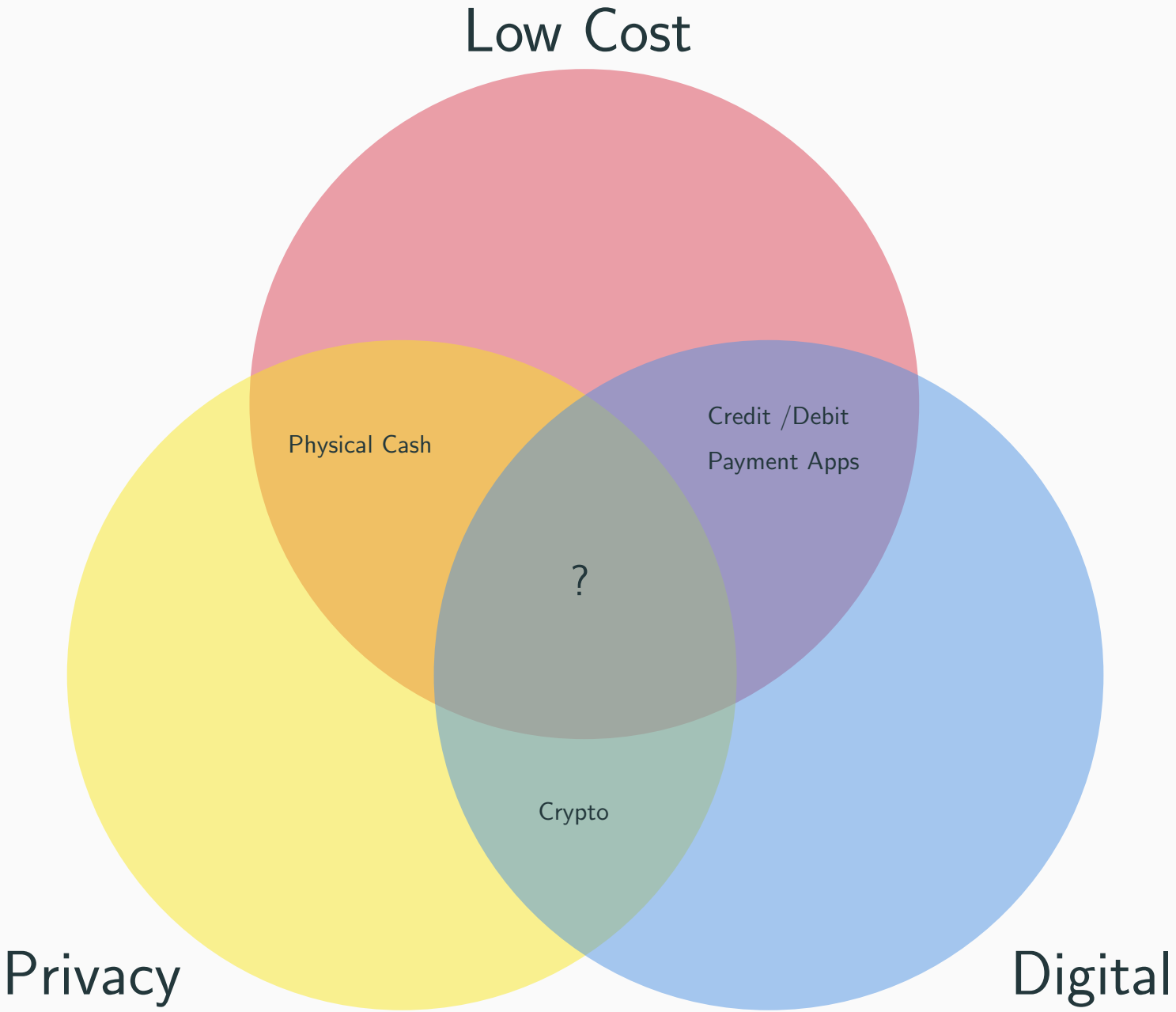
$$v - c + (\alpha - \kappa) \Rightarrow v - c + \alpha$$

Result 4. The introduction of digital cash improves consumer welfare in a data monopoly equilibrium.

Why CBDC?

Privacy as a Choice

- Cash was not specifically created to provide privacy
- Privacy is a feature inherent in its use.
- Privacy feature of cash just as important as its role to substitute credit relationship (Kahn et al. (2005))
- As cash use continues to decline should central banks continue to support private payments?


Low Cost
Physical Cash
Credit /Debit
Payment Apps
?
Crypto
Privacy
Digital

Who is the Best Steward of Private Information?

- Critique leveled against Dinéro Electronico in 2014 (See Arauz, Garratt and Ramos, **LAJCB 2021**)

  It has the potential to be a surveillance programme. Alejandro Salas, former regional director for the Americas of Transparency International, *Guardian*, 2014.

- Data was handled automatically by the platform, requiring minimal human intervention, unless a judicial provision to disclose the information was presented
- Similar claims made by Apple regarding ApplePay
- Central banks have no profit motive to exploit payments data

Summary

- Market structure is endogenously determined by competition, consumer choices, and data acquisition
- Payments data leads to the formation of data monopolies: large surplus, but consumers only marginally benefit
- Data-sharing policies restore competition, but lower total surplus and may worsen consumer welfare
- Digital cash improves consumers' bargaining position and allows them to **monetize privacy** without changing market structure

Equilibrium Definition

Equilibrium. Given $\mu^e_{1t-1}, \mu^e_{2t-1}$, a steady-state equilibrium consists of firms' equilibrium strategies, M^*_j and $(\mathbf{y}^*_j, p^{m*}_j)$, and consumers' consumption decisions and firms' equilibrium data μ^{d*}_j such that:

1. **(Utility Maximization)** consumers maximize their utility given the set of goods and prices $(\mathbf{y}^*_j, p^{m*}_j)$;
2. **(Profit Maximization)** each firm j chooses a set of payment vehicles to accept, M^*_j, and a good type and prices $(\mathbf{y}^*, p^{m*}_j)$ to maximize profits.
3. **(Stationarity)** firms' historical market shares by payment vehicle μ^m_{jt-1} are equal to its current shares: $\mu^m_{jt-1} = \mu^m_{jt} = \mu^{m*}_j$ for $m \in \{c, e, d\}$.

▸ Back