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 productivity
- BigTech entry in payment space
  - GooglePay, ApplePay, AliPay, Libra/Diem

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

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.

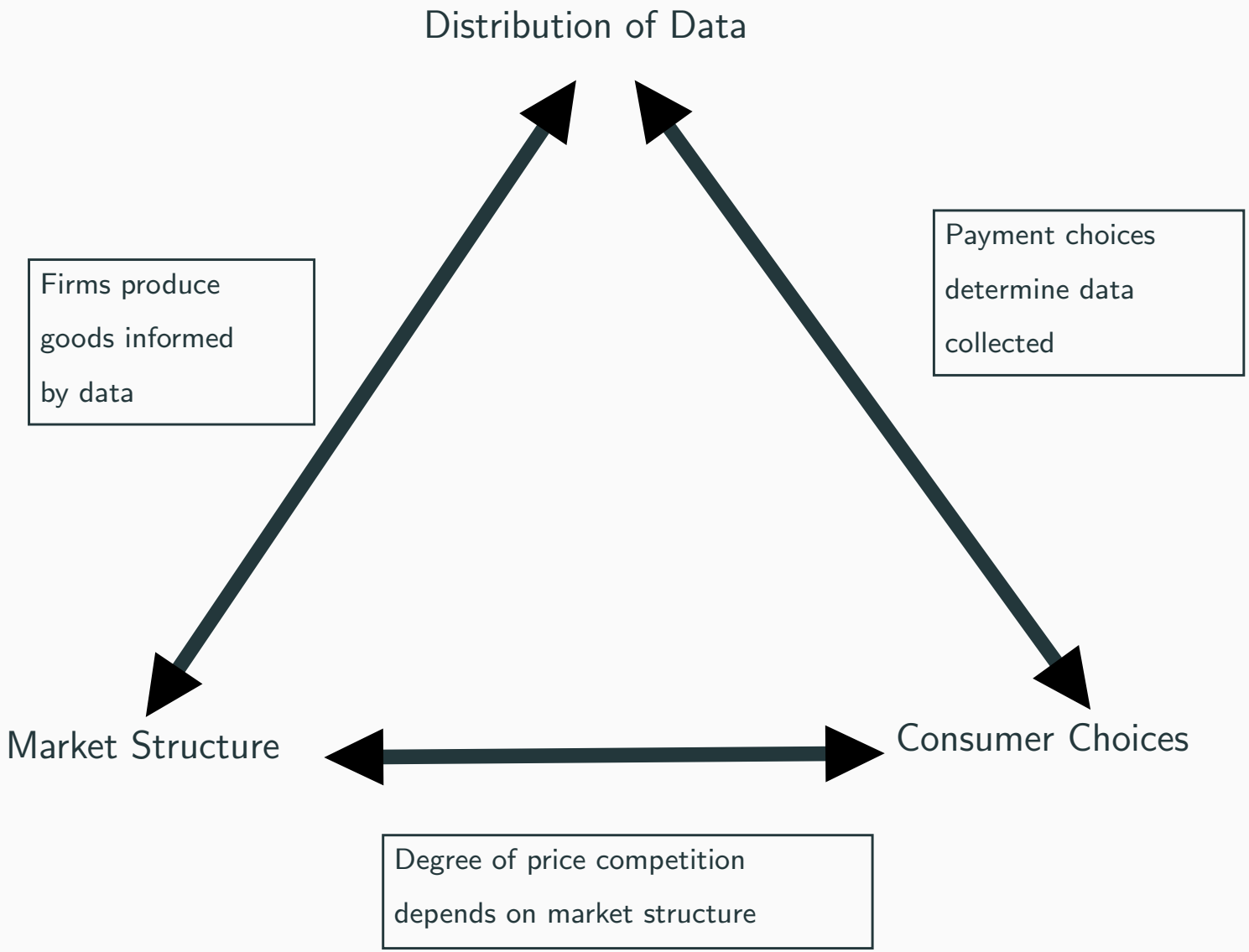
The Price of Privacy

- Customer's private data valuable for firm decisions and productivity
- Are consumers adequately compensated for forgoing privacy?
- Potential reasons why they are not
  - Monopolization
  - Value in aggregated, not individual data
  - **Difficult to collectively bargain**

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 privacy-preserving CBDC** impact the real economy?

Model Ingredients



Main Result

1. Payment data drives the formation of a *data monopoly*
   - Data enables firm to build and maintain dominant position
   - Total surplus maximized under data monopoly
   - Limited benefit accrues to consumers

2. Impact of data-sharing policies
   - Data-sharing policies can restore competition
   - Reduces total surplus and can even harm consumer welfare

3. Introduce privacy-preserving CBDC, i.e. **digital cash**
   - preserves total surplus
   - improves consumers welfare, enabling them to monetize their private info

Related Literature

- **Design and Implications of CBDC**
  - **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**
  - **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, Mihet, Philippon, and Veldkamp (2019); Furman, Coyle, Fletcher, McAuley, and Marsden (2019)

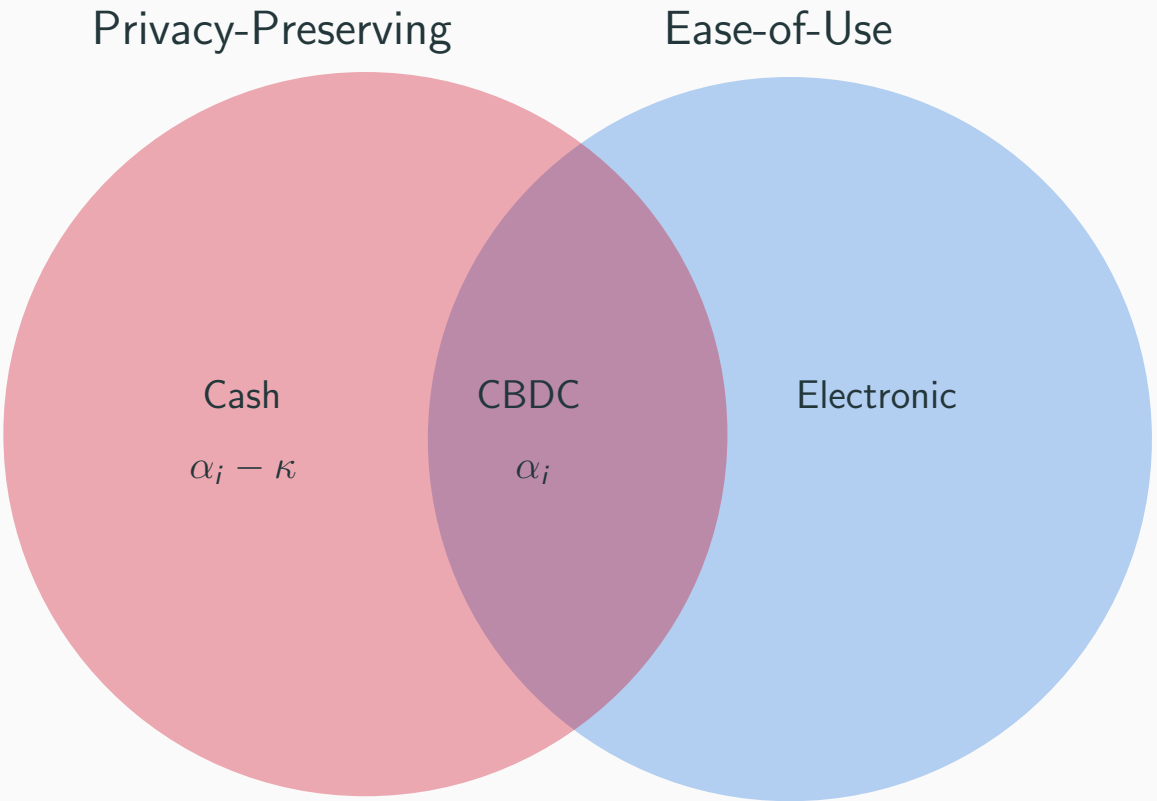
Model Environment

Agents.

- $t = 0, 1, 2, 3, ...$
- Consumers, indexed $i \in [0, 1]$
- 2 firms, indexed $j = 1, 2$

Payment Vehicles

- Each consumer seeks to purchase 1 unit of goods
- 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 α_i
- Consumer i values privacy at $\alpha_i \sim U[0, \alpha]$


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

Product Design

Firms design and produce goods with characteristics θ

- Each period, "ideal" design x_θ (per characteristic θ)
- Consumers enjoy products that match x_θ

Data

Firms can forecast x_θ using historical data

- Each firm's data is q_j is **electronic sales** in previous period
  - Consumers who purchase firm j's good using electronic payments
- Firm j identifies ideal design x_θ for measure $\rho(q_j)$ of characteristics
  - More data is good ($\rho' > 0$)
  - Data exhibits network effects ($\rho'' > 0$)
- 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 with desirable characteristics
- Set prices p^m **per payment vehicle** m
- Unit production cost of c

Consumer Preferences

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

- Utility from purchasing firm j's good

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

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

Equilibrium

Each period,

- Firms develop products and set prices 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. $\mu^m_{jt-1} = \mu^{m*}_j$

Starting Point: Markets without CBDC

Consumers face one of two 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 can use **discriminatory prices** to influence consumers' payment choice

Payment Data Catalyzes Formation of Monopolies

Result 1. 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, e.g. large γ

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

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

Equilibrium Pricing

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

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

Consumer Surplus

- 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: nature of 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

Leveling Competition

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

- "Democratize" data, competitors produce goods of comparable quality
- Better competition $\Rightarrow$ Prices $\downarrow$ $\Rightarrow$ Consumers extract entire data surplus

Impact on Aggregate Outcomes

Diminishes all firms' ability to price-discriminate $\rightarrow$ total data collection $\downarrow$

Result.

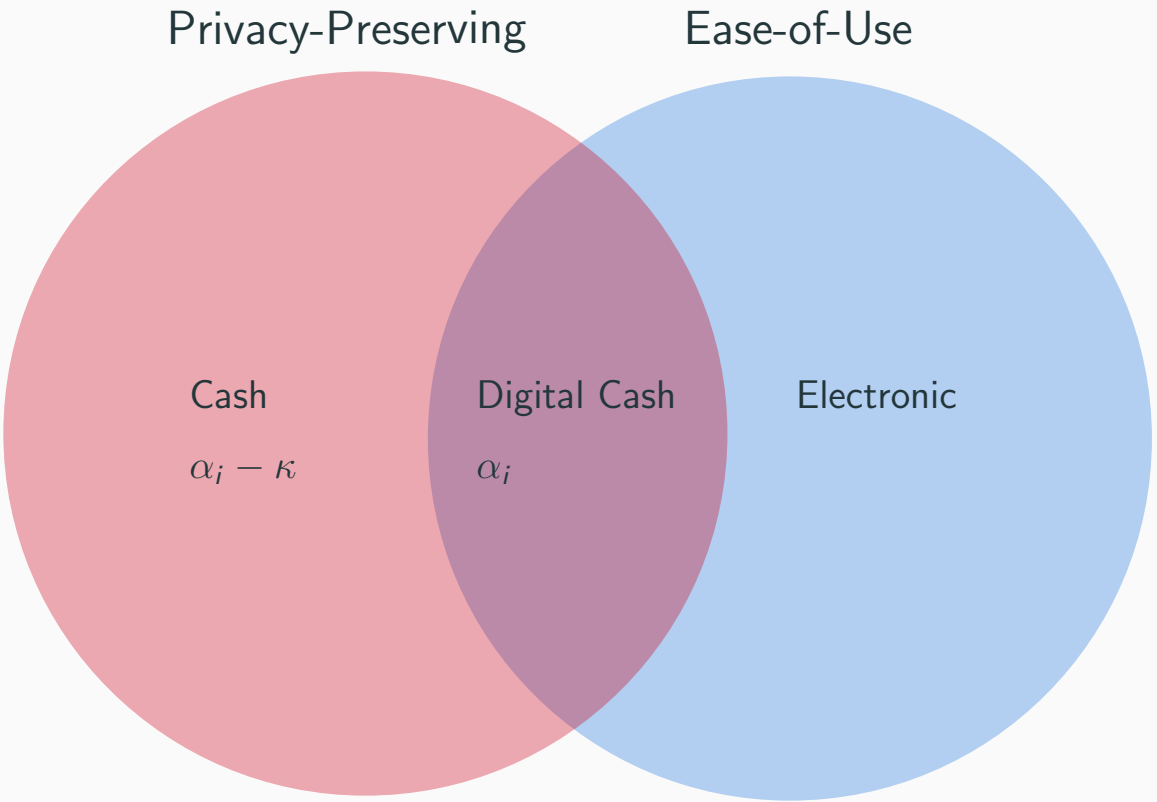
1 Total surplus from data drops.

2 If data collection too low, consumers could be worse off as well.

CBDC and Monetizing Privacy

Introducing a Privacy-Preserving CBDC (Digital Cash)

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



Observation. All things fixed, digital cash is a *dominant* payment method.

Equilibrium Impact of Privacy-Preserving CBDC

Result. With the introduction of digital cash, the data monopoly survives with lower equilibrium prices and higher consumer welfare.

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

Welfare Impact

- Total surplus is maximized under data monopoly
- But with digital cash, consumers bargaining position improved

  i.e. increased ability to monetize privacy

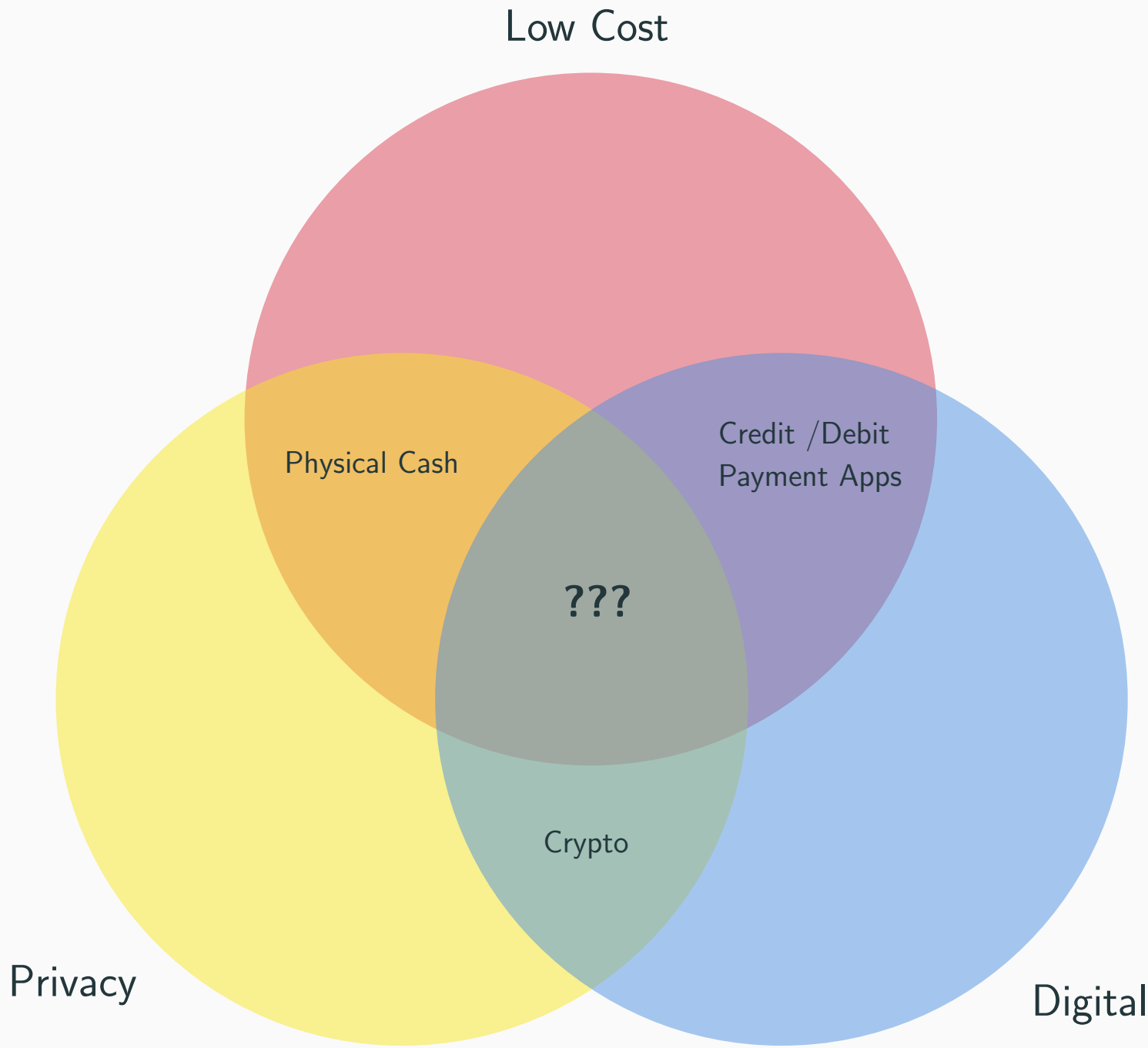
- Consumer surplus increases:

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

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 provide a digital alternative to cash?


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

Privacy in the Design of CBDC in the US

- Could the private sector provide digital cash?
  - High costs with privacy-centric digital payments, e.g. cryptocurrencies
  - Privacy erosion with initiatives proposed by BigTech firms
- Central banks better positioned to commit to safeguarding data
  - no profit motive to exploit payments data
  - Ubiquitous, low-cost digital cash is costly, *especially* if utilization is low
- Consideration for the design of CBDC

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