Transactional demand for CBDC*

Luca Nocciola
European Central Bank

Alejandro Zamora-Pérez
European Central Bank

26 September 2024
BoC– NY Fed – SNB – Queen's University workshop on the future of the monetary system

Why we care

- Demand for cash for transactions is declining and payments are becoming increasingly digital

- Private digital assets may become the dominant medium of exchange (e.g., Libra), with consequences for monetary policy

- In reaction, central banks are thinking to introduce CBDCs

- Key question: is there any demand for CBDC for transactions?

What we do

- We estimate transactional demand for CBDC at the point of sale (POS) against different CBDC designs

- We model user's choice in two stages, adoption and usage, and show that modelling adoption is critical to understanding demand

What we find

- Without appropriate policy, CBDC demand is contained, but optimal design, information campaigns and network effects can boost it

Literature (i) – big picture

- Challenge lies in striking the "right" balance between "too much" and "too little" demand for CBDC (Ahnert et al., IJCB 2022)

- Community researched extensively situations in which a CBDC may be "too popular", potentially undermining banks

- However, less research investigated whether there is sufficient interest in a CBDC as a regular means of payment
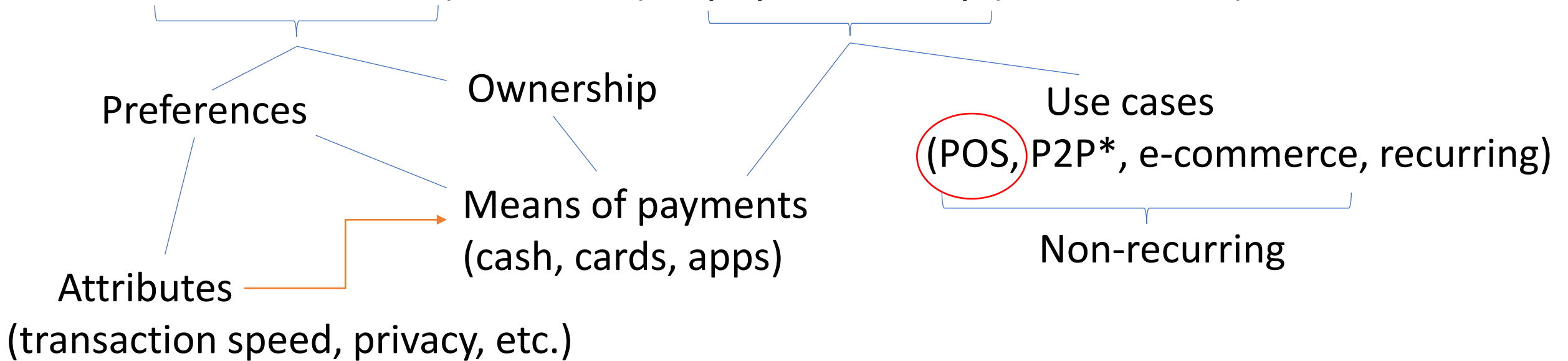
- Our work contributes to the latter strand

Literature (ii) - contribution

- We model demand for CBDC as a means of payment, decoupling transactional from store-of-value demand (vs Li, JME 2023)

- We extend existing models for means of payment' demand to include CBDC (vs Koulayev et al., RAND J 2016)

- We exploit data on mobile payment applications ("apps"), rather than cards, to model CBDC adoption (vs Huynh et al., BoC WP 2020)

- We show that, without appropriate policy, CBDC demand is limited, in line with observations (e.g., China), and provide a rationale for it

- We explore two drivers of the adoption cost, information frictions and gradual network effects, and show how to tackle them to boost adoption

Data

- Representative sample of ~ 40,000 individuals and ~ 100,000 transactions from the euro area over 2021-22

- Questionnaire (individual) + payment diary (transactions)

Preferences

Ownership

Use cases
(POS, P2P*, e-commerce, recurring)

Means of payments
(cash, cards, apps)

Non-recurring

Attributes
(transaction speed, privacy, etc.)

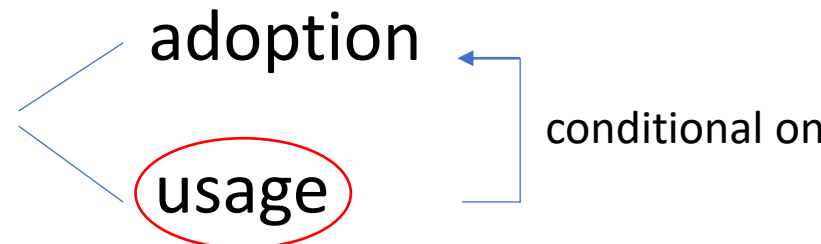*P2P = Person-to-person

= model

Model (i) – CBDC as a bundle of attributes

- Let $x_{i,j}$ be a set of attributes of instrument j (as perceived by user i)

  - acceptance, transaction speed, privacy, ease of use, settlement speed, logistical convenience, usefulness for budgeting

- We introduce a CBDC as a combination of attributes $x_{i,j}$ from different means of payment j

$$x_{i,CBDC} = \lambda' x_{i,card} + (1 - \lambda)' x_{i,cash}$$

$$\lambda \in [0,1]$$

Model (ii) - usage

- Two stages

adoption

usage   conditional on

- User *i* has (possibly) multiple means of payment (*j*) in her wallet
    - e.g., *j ∈ {cash, card, CBDC}*

Assuming, for now, CBDC is adopted

- Using means of payment *j* at POS yields utility $u_{i,j}$

attributes

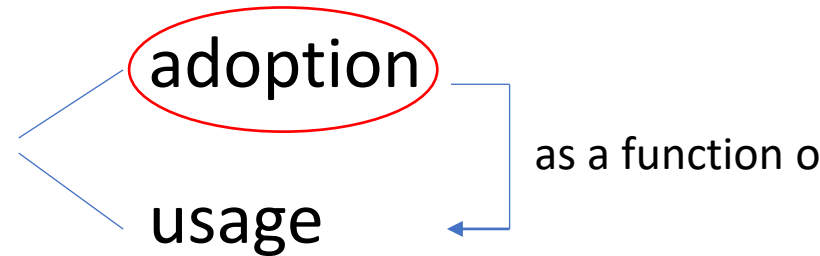$$u_{i,j} = \boldsymbol{\alpha}' \boldsymbol{x}_{i,j} + \eta_j + \varepsilon_{i,j}$$

$v_{i,j}$

randomness

$$P_{i,j}(u_{i,j} > u_{i,k}) = \begin{cases} 0 & if\ j\ not\ adopted \\ 1 & if\ k\ not\ adopted \\ \frac{\exp(v_{i,j})}{\sum_k \exp(v_{i,k})} & otherwise \end{cases}$$

- User *i* chooses (probabilistically) instrument *j* over *k* iff $u_{i,j} > u_{i,k}$

Model (iii) - adoption

- Two stages

  adoption

  usage

  as a function of

- User i faces a wallet expansion choice
  - $\{cash\}$ ⟶ $\{cash, card\}$ ⟶ $\{cash, card, CBDC\}$

- User i chooses wallet b via a cost-benefit analysis
  - Expected* utility $u_{i,b}$ from adopting b
  - Adoption cost c_b from adopting b

  f(attributes)
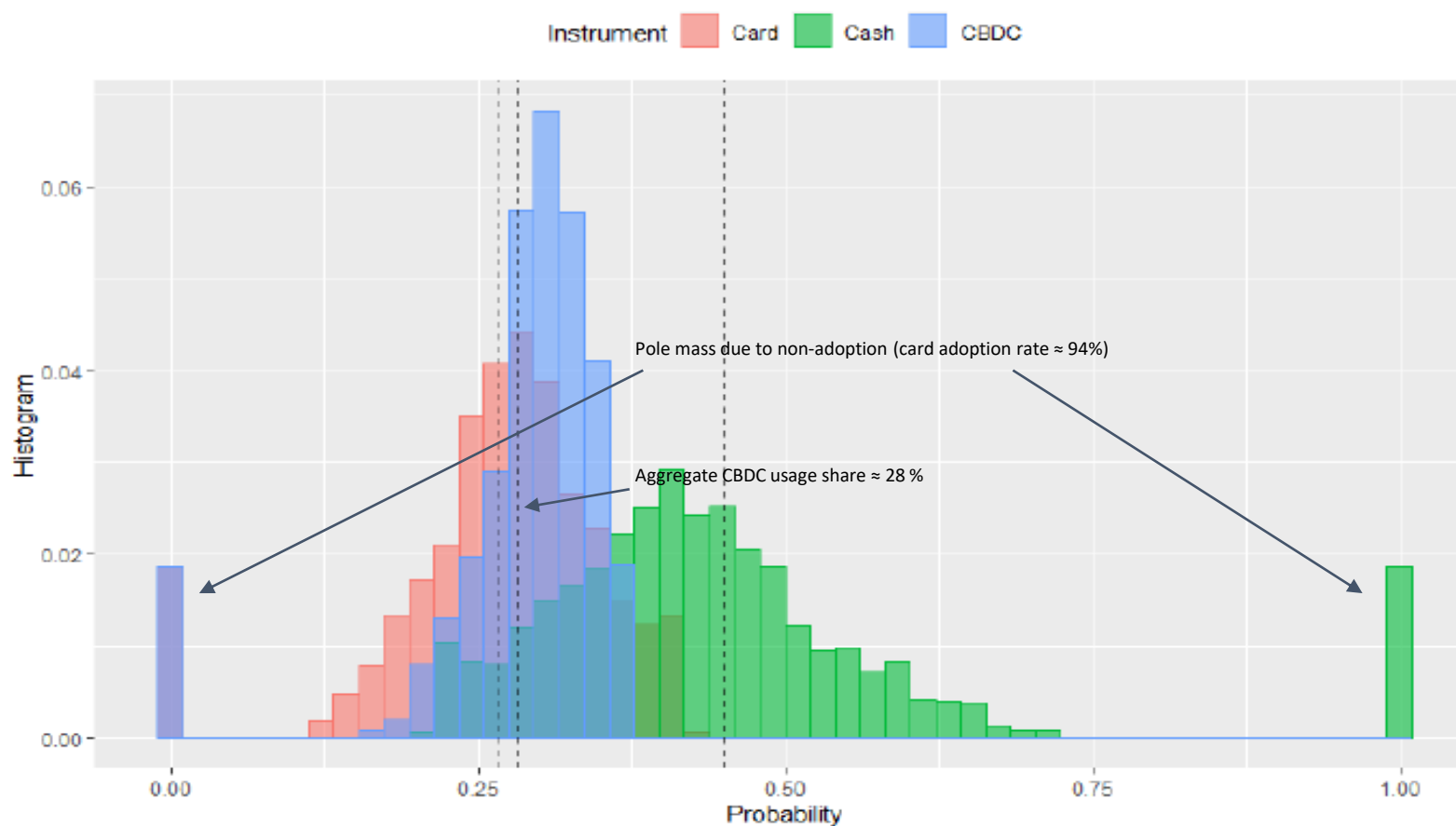
  $$\bar{u}_{i,b} = u_{i,b} - c_b + \bar{\varepsilon}_{i,b}$$

  randomness

  $$P_{i,b}\left(\bar{u}_{i,b} > \bar{u}_{i,b'}\right) = \frac{\exp(\bar{v}_{i,b})}{\sum_{b'} \exp(\bar{v}_{i,b'})}$$

- User i chooses (probabilistically) wallet b over b' iff $\bar{u}_{i,b} > \bar{u}_{i,b'}$

*User i computes her expected utility she would get from hypothetically using a means of payment belonging to the adopted bundle

Results (i) – demand without policy

Without modelling adoption*

Instrument — Card — Cash — CBDC

Pole mass due to non-adoption (card adoption rate ≈ 94%)
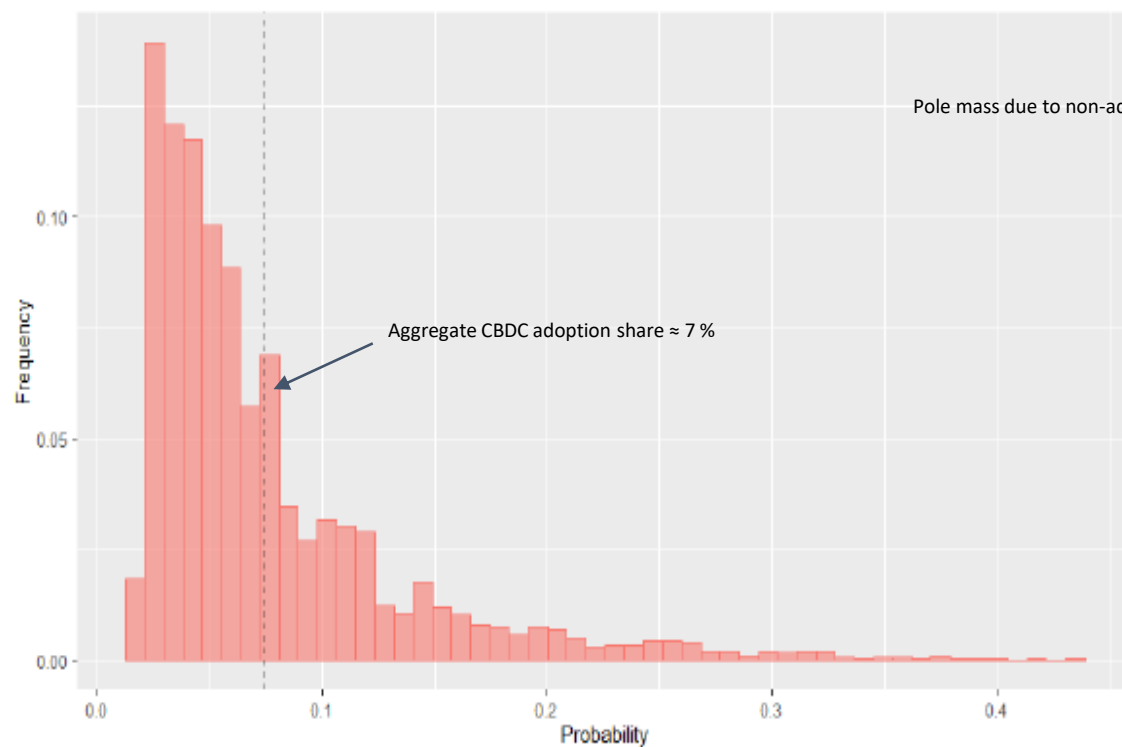
Aggregate CBDC usage share ≈ 28 %

* Hybrid design (card-like, λ=0.8). Exogenously conditioning on adoption. (Optimistic) assumption: users who adopt cards also adopt CBDC.

Results (ii) – demand without policy
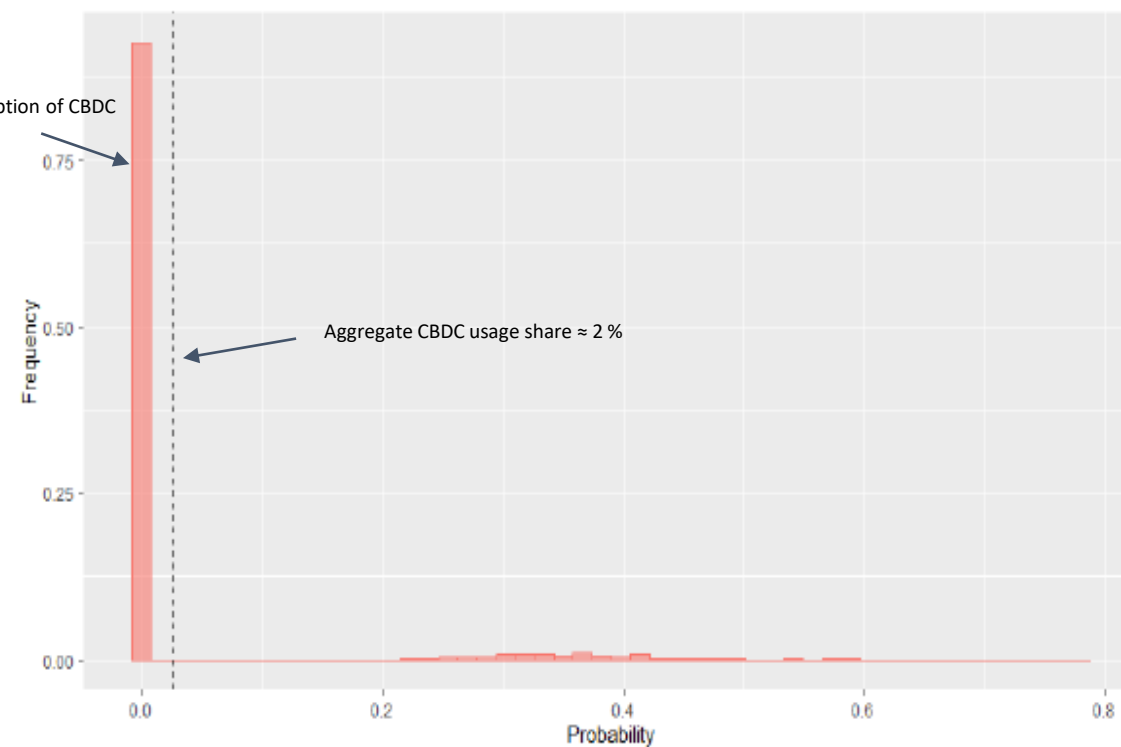
When modelling adoption

Adoption

Usage

Wallet {cash,card,CBDC}

Instrument CBDC

Pole mass due to non-adoption of CBDC
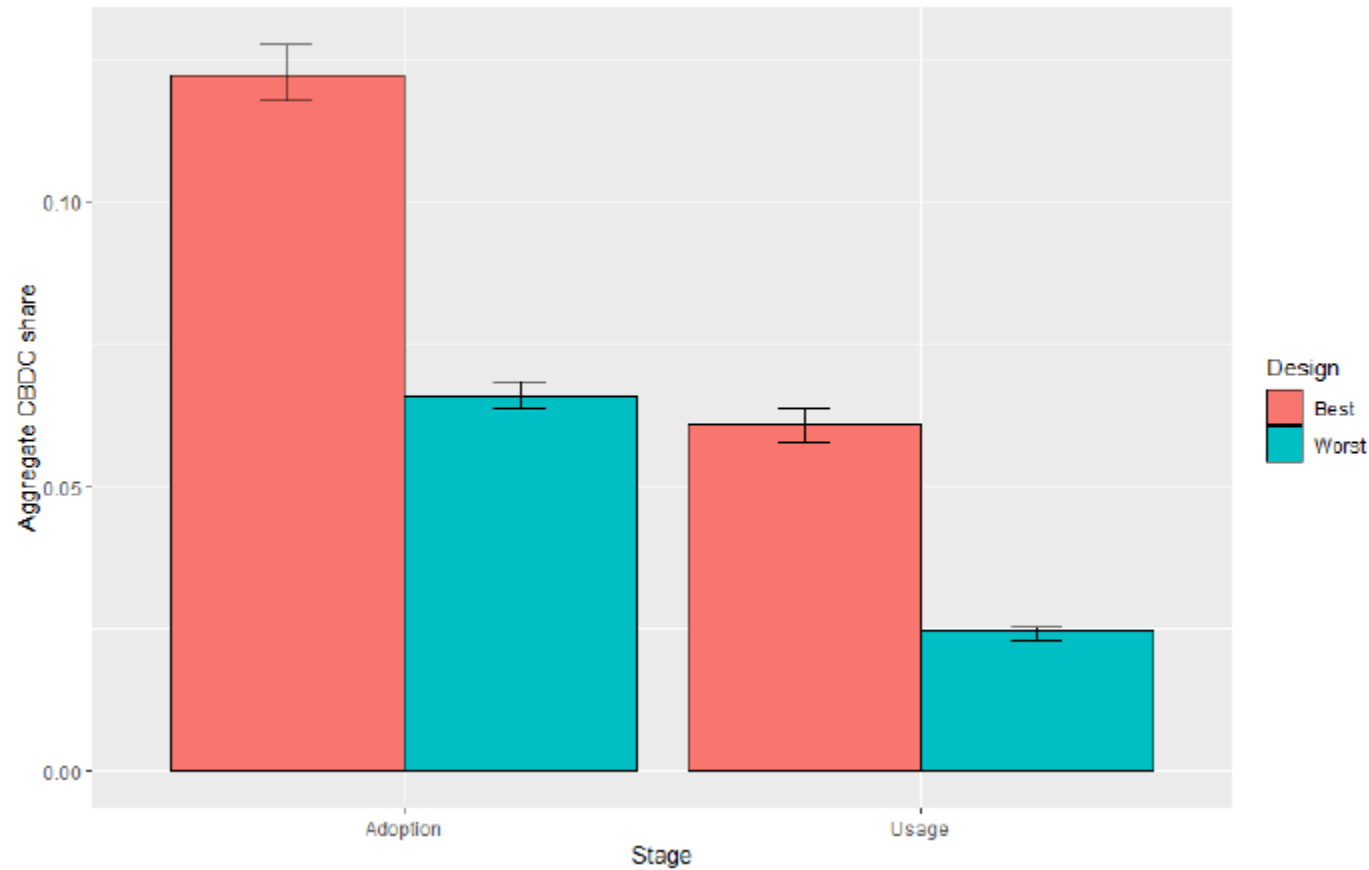
Aggregate CBDC adoption share ≈ 7 %

Aggregate CBDC usage share ≈ 2 %

Results (ii) – optimal design

Aggregate CBDC adoption and usage shares (y-axis) based on the best (red bars) and worst (blue bars) design scenario. The x-axis reports the stage: adoption and usage. The best design consists of an app-like CBDC for transaction speed, ease of use, safety and convenience, while it consists of a cash-like CBDC for acceptance, privacy, settlement speed and usefulness for budgeting. The worst design consists of the reverse.

Conclusion

- If CBDC is designed as a means of payment, it is relevant to analyse its demand as such

- Without appropriate policy, CBDC demand as a payment instrument is limited

- With appropriate policy, like optimal design, raising awareness and leveraging network effects, CBDC demand can be boosted

- Potential aggregate deposit outflows are probably overstated in the extant literature, at least in normal times

References

Ahnert, T. et al. (2023), "The economics of central bank digital currency", *International Journal of Central Banking*

Huynh, K. et al. (2020), "Demand for payment services and consumer welfare: the introduction of a central bank digital currency", *Bank of Canada Working Paper Series*

Koulayev, S. (2016), "Explaining adoption and use of payment instruments by US consumers", *Rand Journal of Economics*

Li, J. (2023), "Predicting the demand for central bank digital currency: A structural analysis with survey data", *Journal of Monetary Economics*