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The Coming Battle of Digital Currencies

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New Era of Electronic Payments and Digital Currencies

- Digitization, P2P networks, and on-demand economy.
- Rise of private payment systems: PayPal, Alipay, M-Pesa, etc. Digitization of money (Brunnermeier, James, & Landau, 2019).
- Blockchain technology (e.g., Cong & He, 2019, Chen, Cong, & Xiao, 2020), cryptocurrencies, & DeFi (Harvey, Ramachandran, & Santoro, 2021; Cong, He, & Tang, 2022).
 - Cryptocurrency market cap has surpassed 3T\$ in November 2021.
 - ▶ Stablecoins (200B\$) and DeFi (TVL 21B \$ Oct 2020 \rightarrow 326B \$, Oct 2021).
 - Categories and Functions of Crypto-tokens (Cong & Xiao, 2020; Cong et al., 2021).
 - Platform tokens, general payment tokens, ownership tokens, & cash-flow tokens.



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 - Platform tokens, general payment tokens, ownership tokens, & cash-flow tokens.
- Academics and central banks (\approx 100) actively research CBDCs (Bech & Garratt, 2017; Duffie and Gleeson, 2021; Chiu et al., 2021; Fernandez-Villaverde et al., 2021).
- March 9th, 2022: President Biden signs Executive Order on Ensuring Responsible Development of Digital Assets.

CBDC Initiatives around the World (CBDCTracker.org)





Introduction

Dynamic Model

Implications & Predictions

Conclusion

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Example of CBDC: China's e-CNY



- Public debates: Concern that e-CNY challenges USD dominance.
 - Ehrlich (2020, Forbes): "Not a cold war: China is using a digital currency insurgency to unseat the US dollar."

The (Coming) Battle of (Digital) Currencies

- How does the emergency of crypto shape international currency competition?
- Will digital currencies challenge the supremacy of USD?
- Should countries implement CBDC and, if so, which countries, when, and why? What are the relevant trade-offs?
- What is the role of stablecoins in these developments? Is reserve requirement an effective policy?



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This Paper: Dynamic currency competition among countries involving fiat currencies, private cryptocurrencies, and CBDCs.

- Game-theoretical analysis of currency digitization.
- Rationalize recent events in digital currency development.
- Implications on the effects and benefits of CBDC issuance and digitization of money.



Overview of Model

• Two-period & dynamic models of currency competition:

- ► Two countries with currencies: A ("strong") and B ("weak").
- One representative cryptocurrency *C*.

• Currencies fulfill three functions of money:

- 1. Store of Value: Households store wealth.
- 2. Medium of Exchange: Convenience yield.
- 3. Unit of account: Contracts denominated in strong (reserve) currency.



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- Endogenous and dynamic growth of cyber/crypto sector & adoption of cryptocurrencies.
- Countries strategically "innovate" by launching CBDC.



Introduction

Main Results

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- CBDC issuance pecking order:
 - 1. Non-dominant currencies (e.g., RMB): First mover advantage.
 - 2. Dominant currency: Killer adoption or unavoidable digitization.
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 - 3. Very weak currencies (e.g., El Salvador): Adopt crypto instead.
- \implies Digitization of money in the long run:
 - Weaker country's CBDC hurts crypto sector more.
 - Countries with weak currencies prone to digital dollarization.
 - Strong currencies as potential beneficiaries.
- \implies Rise of cryptocurrencies spurs financial innovation; the impact of CBDCs depends on fiat strength.



Additional Results

Representative cryptocurrency also describes stablecoins

- Cryptocurrencies (typically) pegged to USD.
- Some stablecoins (e.g., USDC) backed by US Dollar assets.
- Regulatory reserve/backing requirements on USD stablecoins:
 - US captures part of the "crypto" seigniorage: Strengthens USD but weakens other currencies ("digital dollarization").
 - Viable alternative to CBDC issuance: Delegate digital dollar development to private sector.
 - ⇒ Potential for USD to become a winner out of the "Coming Battle of Digital Currencies."
- Developing countries' challenge; digital dollarization.



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Literature

- Currency competition: Lagos and Wright (2005), Farhi and Maggiori (2018), Fernandez-Villaverde and Sanches (2019), He, Krishnamurthy, and Milbradt (2016, 2019), Benigno, Schilling, and Uhlig (2022), among others ...
- International Finance and Dominance of the Dollar: Gopinath et al. (2020), Eren and Malamud (2021), Du, Pflueger, and Schreger (2020), Maggiori et al. (2020), Jiang, Krishnamurthy, and Jiang (2020, 2021), among others ...
- Digital Currencies and CBDC: Schilling and Uhlig (2018), Brunnermeier, James, and Landau (2019), Fernandez-Villaverde, Schilling, and Uhlig (2020), Piazzesi and Schneider (2020), Fernandez-Villaverde et al. (2021), among others ...



Setup

- Time runs discretely, t = dt, 2dt, 3dt, ... with time increments dt
 - Continuous time limit as in He and Krishnamurthy (2013).
- Representative OLG household endowed with one unit of perishable consumption good (=numeraire).
- Cohort *t* lives from *t* to *t* + *dt* without time discounting:
 - Utility from consumption only at t + dt.
 - Money serves as a store of value.



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- Three currencies in fixed unit supply with endogenous value in consumption goods P_t^x for x = A, B, C:
 - Currency A ("strong" or "dominant"): e.g., USD, Euros,...
 - Currency B ("weak" or "non-dominant"): e.g., RMB, Rupees,...
 - ► Representative cryptocurrency *C*: includes stablecoins.



Dynamic Model — Fiscal and Currency Strength

- Reduced form modelling of link between countries' economic fundamentals and currency strength.
- Country x = A, B raises inflation taxes to cover expenses $\tau_t^x dt = (\kappa^x + \pi^x P_t^A) dt$ (in terms of consumption goods)
- Expenses partially denominated in "international unit of account"
 - International trade invoiced in USD (Gopinath et al., 2020)
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- \implies Higher π^x or $\kappa^x \implies$ Depreciation of currency *x* w.r.t. consumption good (i.e., inflation) and other currencies



Money as a Medium of Exchange — Convenience Yield

- m_t^x : Cohort *t*'s holdings of currency *x* in consumption good.
 - Money as store of value: $m_t^A + m_t^B + m_t^C = 1$.
- Money as a medium of exchange:
 - Convenience yield $Z_t^x v(m_t^x) dt$ from holding currency x = A, B and convenience yield $Y_t v(m_t^x) dt$ from holding cryptocurrency.
 - v'(m) > 0 > v''(m) (Krishnamurthy and Vissing-Jorgensen, 2005).
- Household's utility flow:

$$U_{t} = \underbrace{C_{t+dt}}_{\text{Consumption at } t+dt} + \underbrace{\left(Z_{t}^{A}v(m_{t}^{A}) + Z_{t}^{B}v(m_{t}^{B}) + Y_{t}v(m_{t}^{C})\right)dt}_{\text{Convenience vield}}$$

• Equilibrium consumption: $c_{t+dt} = 1 - \tau_t^A dt - \tau_t^B dt$.



Cryptocurrencies and Market Clearing

- m_t^C : Cryptocurrency adoption and demand
- Cryptocurrency adoption evolves according to:

$$\frac{dY_t}{Y_t} = m_t^C \cdot \mu dt \quad \text{for} \quad \mu > 0.$$
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$$m_t^C \uparrow \Longrightarrow Y_{t+dt} \uparrow \Longrightarrow P_{t+dt}^C \uparrow \Longrightarrow m_t^C \uparrow ...$$



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С

• Market clearing for currency x: $m_t^x = P_t^x$

$$P_t^A + P_t^B + P_t^C = 1.$$

- Stablecoins pegged to USD and crypto with reserve requirements.
 - Fraction θ backed by fiat, $\theta = 0$ in baseline.



• Household is price-taker and maximizes at each time *t*:

$$\max_{m_t^X \ge 0} \mathbb{E}_t \Big[\underbrace{C_{t+dt}}_{\text{Consumption}} + \underbrace{\left(Z_t^A v(m_t^A) + Z_t^B v(m_t^B) + Y_t v(m_t^C)\right) dt}_{\text{Convenience yield}}\Big]$$
(3)

• Equilibrium condition (for i = A, B):

$$\underbrace{Y_t v'(m_t^C)}_{\text{Convenience}} + \underbrace{r_t^C}_{\text{Returns}} = \underbrace{Z_t^i v'(m_t^i)}_{\text{Convenience}} + \underbrace{r_t^i - \frac{\tau_t^i}{P_t^i}}_{\text{Net returns}}.$$
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 - Monetary neutrality: Currency appreciation dP^x_t > 0 could be transformed into interest payments to currency holders



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Parameter Choices and Solution

- Express all equilibrium quantities as functions of *Y* and $z \in \{0, A, B, AB\}$ indicating which countries have launched CBDC.
- $Z_L = 0.5, Z_H = 2, \mu = 1, \alpha = 0.15, Y_t \le \overline{Y} = 75$ (exogenous).
- As in Li (2021), we use CRRA form:

$$v(m_t^x) = \frac{(m_t^x)^{1-\eta} - 1}{1-\eta}$$
 with $\eta = 2$.

- Normalize: $\kappa^{x} = \theta = 0$.
- Baseline π^A and π^B non-divergent (e.g., $\pi^A = 1 < \pi^B = 4$):
 - Currency A: Dominant and reserve currency (USD).
 - Currency B: Strong but non-dominant currency (e.g., Euro or RMB).

Feedback Effect, Crypto Buffer, Currency Valuation Dynamics

- Cryptocurrency as buffer zone between A and B.
- Rise of cryptocurrency hurts A, but may benefit B: direct competition for B (-) vs. weakened competition from A (+).
- Weakness of fiat facilitates growth of crypto sector.



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Effects of CBDC issuance



- $\Delta(x) \simeq$ change when country *x* launches CBDC (at time T^x)
- CBDCs by non-dominant currencies have largest effects
- Cryptocurrency kill zone: nips crypto growth in the bud.

CBDC Issuance: A Pecking Order



- $e^B > e^A$: *B* has higher incentives (becoming first-mover).
- Strong country A: Killer adoption (first peak) and unavoidable currency digitization (second "peak").



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CBDC Issuance and Digitization: A Pecking Order



 A country's incentives to develop CBDC follow an inverted U shape in the strength of its currency (relative to other currencies).



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Strategic Effects of CBDCs: Substitutes or Complements?



- CBDC implementation by strong country wipes out weaker country's incentives to gain first mover advantage.
- CBDC issuance by weaker country challenge dominance of currency *A* and may strengthen stronger country's incentives.



Currency strength and Incentives to launch CBDC



- $\pi^A \uparrow$: Currency A becomes "weaker."
- Currency A's dominance lowers incentives to issue CBDC.
 - Dollar dominance leads to inertia regarding payment innovation.
 - Lack of competition undermines incentives for digitization and innovation.



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Currency Competition and Financial Innovation



- *Prob_t* : Probability that CBDC is launched by time *t*.
- The competition from cryptocurrencies stimulates (possibly valuable) financial innovation.
- Countries react to growing competition by implementing CBDC competition.



Fiat-backed cryptocurrency and stablecoins

- Many stablecoins are pegged to U.S. dollar and partially backed by U.S. dollar reserves
 - Reserves may include cash or cash equivalents (T-bills)
 - Examples: USDC or BUSD
- Consider that fraction θ of cryptocurrency market cap P^C_t is backed by reserves consisting of currency A (i.e., U.S. dollars).



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Fiat-backed cryptocurrency and stablecoins



- Stablecoins backed by currency A benefit A but harm B
- Requiring backing of stablecoins (θ ↑) as alternative to developing CBDC: U.S. could "delegate" digital dollar development

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Developing Countries, Small Open Economies, and Digital Dollarization



Change in P^B when A (e.g., the US) launches CBDC:

- Higher In(Y): Very weak currencies (e.g., $\pi^B = 20$) suffer more.
- Eventually suffer from digital dollarization (Brunnermeier, James, and Landau, 2019).

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Developing Countries and CBDC Pecking Order



- The larger π^B (2 vs. 4 vs. 20), the "weaker" currency *B*.
- Weaker currencies benefit relatively more from crypto growth.
- Developing countries opt to "adopt" cryptocurrencies/stablecoins.

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Conclusions

- Dynamic model of currency competition across countries using cryptocurrencies, fiat currencies, and CBDC.
- CBDC issuance as strategic responses to competition from cryptocurrencies and other digital currencies.
- Novel pecking order of CBDC issuance:
 - 1. Strong but non-dominant currencies (e.g., RMB).
 - 2. Strongest currencies (e.g., USD).
 - 3. Weakest economies (e.g., El Savaldor).
- Further implications:
 - Vicious circle of inflation and depreciation.
 - Fiat strength and payment innovation.
 - Weak currencies benefit from the rise of cryptocurrencies but eventually suffer from digital dollarization.
 - Eventual digitization of money and dollar dominance.