The Digitalization of Money
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On the Equivalence of Private and Public Money
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Introduction

Ubiquitous private money
- Claims on central bank money, claims on claims, …
- Private digital “currencies” (e.g., M-Pesa, Alipay, Libra)

Currency Competition: Will new private money drive out cash?
- Will central banks lose their grip on monetary policy
- Digital Dollarization
- Digital Currency Areas
- Will CBDC be the answer? Embrace it, rather than fight it.
- How to design CBDC in a “neutral way”? Can it be done?
Currency Competition

Hayek’s (1976) idea: competing private currencies

**Unbundeling** of the 3 *roles of money*

- **Unit of account**
  - fewer relative prices (bounded rationality) - stickiness
  - nominal debt contract - affects risk sharing

- **Store of value**
  
- **Medium of exchange** ⇒ liquidity value

**Re-bundeling** with *platform/ecosystem*
Currency Competition

Unbundeling of the 3 roles of money

Re-bundeling with platform/ecosystem

- Money product-differentiation
- “Privacy currency”
- Bundle with platform/eco system - discounts
- smart contracts
- closed ecosystems ⇒ Digital Currency Areas
International Monetary System

Digital Currency Area (new concept)

- Complementarity with platform, data linkages (not geographic)
- Price discounts, discovery, transparency within

Digital Dollarization (new concept)

- Store of value vs. payment/invoicing
- Sudden take-over due to non-linearity
- Vulnerability: small socially open countries

Digital Synthetic World Currency
Public vs. Private Money Competition

Loss of “monetary power”

- Store of value focus: Tax backing
  Iraqi dinar, Somali shilling

- Medium of exchange focus: Payment settlement outside

- Unit of account feature is key
  - New Keynesian: stickiness in private/public money
  - FinFrictions: Denomination of nominal debt contracts
CBDC to maintain monetary sovereignty

Cash is poor substitute ⇒ calls for CBDC

• Back “stable coins” with CBDC
• Retail CBDC

Key policy decisions

• Interoperability
• Convertibility
How to design CBDC in a “neutral” manner?

“On the Equivalence between Private and Public Money”
(with Dirk Niepelt)

- Money creation generates rents—they belong to the public
- Outside money crowds out capital—inside money funds it
- CBDC chokes off credit
- CBDC triggers bank runs
Contributions

- Generic model of money, liquidity, financial frictions
- Liquidity and value
  Liquidity (relaxation of means-of-payment constraints) renders bubbles more likely, generates seignorage rents
- Sufficient conditions for equivalence of monetary systems
  Swap public, private money
- Applications: CBDC, Chicago Plan, ...
Does swap undermine credit, financial stability?

- Not, with pass-through funding by central bank

Central bank intermediates between non-banks and banks

Digitalization of Money & Equivalence of Private and Public Money

How to design CBDC in a “neutral” manner?
Does swap undermine credit, financial stability?

- Not, with pass-through funding by central bank
  Central bank intermediates between non-banks and banks
  Implicit LOLR guarantees become explicit
- Run from deposits into CBDC
  Bank funding *automatically* replenished
Equivalence—under broad conditions

- Wealth neutrality
- Liquidity neutrality (requires condition)
- Invariant asset span (condition)
- Same resource cost private/public liquidity (Friedman, 1969)

Implementation

- Pass-through funding subject to deposit rates, to insulate (even non-competitive) banks
- Contingent transfers to compensate for payoff differentials

Unless little heterogeneity (cf. Barro, 1974)
Theorem serves as benchmark

- To identify possible sources of non-equivalence
- In spirit of Modigliani and Miller (1958), Barro (1974), . . .
Related work

• Fisher (1935), Gurley and Shaw (1960), Tobin (1963; 1969; 1985)

• Wallace (1981), Bryant (1983), Chamley and Polemarchakis (1984), Sargent (1987, 5.4)


• Niepelt (2018; 2020)

• Merkel (2019) “On Narrow Banking”
Model

Stochastic, discrete time, finite or infinite horizon
Households, government, firms, banks (owned by households)
General technologies, securities
Complete or incomplete markets
Households

\[ \mathcal{U}^h(x^{\cdot,h}) \text{ s.t. } \sum_j a^{j,h}_t p^j_t = \sum_j a^{j,h}_{t-1} (p^j_t + z^j_t) - \sum_n x^{n,h}_t q^n_t - \tau^h_t (x^{\cdot,h}, q) \forall t \]

\[ \mathcal{L}^h_t (\{a^{j,h}_t p^j_t\}_j, \{a^{j,h}_{t-1} (p^j_t + z^j_t)\}_j, p, x^{\cdot,h}, q) \geq (=) 0 \forall t \]

NPG

Stochastic security price (e.g., bank run), distorting transfers/taxes

Vector of medium-of-exchange restrictions, \( \mathcal{L}^h_t \)
Examples (without/with $L^h_t$)

- Incomplete markets: Brunnermeier and Sannikov (2016)
Firms

Profit maximization s.t.

- Budget constraint
- Production possibilities
- Medium-of-exchange constraints ($L^f_t$)

Possibly price, wage setting friction (Calvo, 1983; Clarida, Galí and Gertler, 1999; Woodford, 2003; Galí, 2008)
Banks

\[ \sum_t \mathbb{E}_0 \left[ \mu_{0,t} z_t^b \right] \quad \text{s.t.} \quad \sum_{j \neq b} a_{t}^{j,b} p_t^j = \sum_{j \neq b} a_{t-1}^{j,b} (p_t^j + z_t^j) - z_t^b \quad \forall t \]

\[ C_t^b(a_t^{i,b}, p_t^{D,b}, z_{t+1}^b, \text{state}_t^b) \leq (\leq) 0 \quad \forall t \]

\[ \mathcal{L}_t^b(\{a_t^{j,b}, p_t^j\}_j, p) \geq (\geq) 0 \quad \forall t \]

NPG

Non-competitive bank chooses deposits, return subject to \( C_t^b \)

\( \mathcal{L}_t^b \)-constraint due to regulation, money markets, incentive constraints (Calomiris and Kahn, 1991; Diamond and Rajan, 2001)

Zero marginal cost of deposit creation, possibly fixed cost
Central Bank/Government

\[ \sum_{j \neq c} a_{t,c}^j p_t^j = \sum_{j \neq c} a_{t-1,c}^j (p_t^j + z_t^j) + \int_h \tau_t^h (x^{:,h}, q) dh \forall t \]

NPG
Liquidity and Value

Security price, from Euler equation

\[ \hat{\mu}_t^h p_t^j = \mathbb{E}_t \left[ \hat{\mu}_{t+1}^h (p_{t+1}^j + z_{t+1}^j) \right] + p_t^j \hat{\lambda}_t^h L_t^h \]

\[ p_t^j = \mathbb{E}_t \left[ \mu_{t,t+1}^h (p_{t+1}^j + z_{t+1}^j) \right] + p_t^j \lambda_t^h L_t^h \]

\[ p_t^j = \mathbb{E}_t \left[ \frac{\mu_{t,t+1}^h}{1 - \lambda_t^h L_t^h} (p_{t+1}^j + z_{t+1}^j) \right], \quad \Lambda_{t,t+1}^h \geq 1 \]
Liquidity modifies fundamental, bubble values

\[ p^j_t = \lim_{T \to \infty} E_t \left[ \sum_{s=1}^{\infty} \mu^h_{t,t+s} \Lambda^h_{t,t+s} z^j_{t+s} \right] + \lim_{T \to \infty} E_t \left[ \mu^h_{t,t+T} \Lambda^h_{t,t+T} p^j_{t+T} \right] \]

Liquidity payoff

- Effectively lowers discount rate
  
  Renders bubble more likely
- Creates rents for issuer
  
  Franchise value, reflected in equity value
Equivalence

Swap CB money for bank deposits, for one period (generalizes)

Open market operation at \( t \)

- CB money, deposits, possibly third security
- Latter could be implicit (cf. Barro, 1974)

Contingent transfers at \( t + 1 \), compensate for payoff differentials
Wealth Neutrality

Lemma  Given SDF, security prices, fundamental payoffs OMO with compensating transfers does not change date-t financial wealth iff unchanged liquidity payoffs of portfolios

Proof. Asset pricing condition, OMO

Market value of contingent transfers then equals zero
Liquidity Neutrality

Definition  Given prices, fundamental payoffs
Swap liquidity neutral if for any plan in agents’ choice sets, swap
does not change $L_t^i$- or $L_{t+1}^i$-function values, nor derivatives

Baseline Case  $L_t^i$(weighted sum (CB money, deposits), other)
& swap leaves weighted sum unchanged

Examples of liquidity neutral swap
  • CIA (with two monies), different “liquidity,” payoffs
  • Almost all standard models (with two monies), to first order

Counterexample: Svensson (1985) CIA in some cases
Equivalence

**Theorem** Given equilibrium, consider span neutral, liquidity neutral OMO with compensating transfers
Central bank can always assure same equilibrium allocation, prices
Equivalence

**Theorem** Given equilibrium, consider span neutral, liquidity neutral OMO with compensating transfers. Central bank can always assure same equilibrium allocation, prices.

*Proof.* Conjecture unchanged prices

**PE:** Liquidity neutrality $\Rightarrow$ wealth neutrality $\Rightarrow$ unchanged choice sets of households, firms $\Rightarrow$ unchanged choices.

Pass through deposit supply *schedule* $\Rightarrow$ unchanged bank choices.

**GE:** Unchanged commodity demands, supplies $\Rightarrow$ market clearing; securities markets continue to clear.

Unchanged allocation, liquidity neutrality $\Rightarrow$ unchanged liquidity payoffs, prices.
Applications

Central Bank Digital Currency

Equivalence

- No security $s$ needed if same liquidity
- But possibly transfers at $t + 1$, depending on risk characteristics of CBDC vs. deposits

Not needed if deposits are insured to start with (or households have same exposures to deposits, taxes)
What about bank runs . . .?

- Theorem: Initial equilibrium (or equilibria) still supported
- Beyond theorem: Should expect fewer bank runs

One large depositor, optimally behaves differently
Remaining small depositors have less incentive to run
Chicago Plan and “Vollgeld” - for “stable coins”

Equivalence

- Extreme form of CBDC
- Requires pass-through at deposit rates
  But “Vollgeld” proposal aims at redistribution
Cryptocurrency

Proof of work

• No equivalence

No proof of work

• Stable coin: Equivalence

• Partial backing (fractional reserve): Sufficient conditions for equivalence require transfers
Conclusions

Contributions

- General model Liquidity and value, bubble, seignorage
- Equivalence conditions Applications, CBDC, run risk

When should we expect *non*-equivalence?

- Limited transfers, limited substitutability of monies
- Restrictions on pass through: Information, differential collateral requirements (central bank independence)
  
  Not an issue with competitive banks

- Political economy (Gonzalez-Eiras and Niepelt, 2015)
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