

# Central Bank Digital Currencies (CBDCs)

## L03: The Economics of Public Digital Money

Economics of Digital Finance

BSc Course

## Today's Topics

1. CBDC design choices and trade-offs
2. Monetary policy transmission
3. Bank disintermediation risk
4. Financial inclusion economics
5. International currency competition

## Learning Objectives

- Analyze CBDC design trade-offs
- Assess monetary policy implications
- Evaluate disintermediation risks
- Understand global CBDC landscape

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CBDCs represent central banks' response to private digital currencies

## Central Bank vs. Commercial Bank

### Central bank (e.g., ECB, Federal Reserve):

- The government's bank
- Creates the national currency
- Sets interest rates for the economy
- Lender of last resort in crises

### Commercial bank (e.g., Deutsche Bank, Chase):

- Private companies where you have accounts
- Accept deposits, make loans
- Can fail (unlike central banks)
- Must hold reserves at central bank

**Key Point:** Your savings account is at a commercial bank. The central bank is the bank for banks.

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Understanding this distinction is essential for CBDC analysis

## Money Creation Through Lending

Banks don't lend from a vault of cash:

- When a bank lends you 100 EUR, it *creates* 100 EUR in your account
- Most money in modern economies is created this way
- This is called **fractional reserve banking**

## Why Deposits Matter to Banks

- Banks borrow from depositors at low rates (e.g., 1%)
- Banks lend at higher rates (e.g., 5%)
- The difference is their profit

## Bank Runs

A **bank run** occurs when:

- Many depositors withdraw simultaneously
- They fear the bank will fail
- Banks don't keep all deposits as cash
- Mass withdrawal causes collapse

## Why Interest Rates Affect Spending

- Lower rates = cheaper loans
- Mortgages at 3% vs 6% = more homebuyers
- Cheap business loans = more investment

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These mechanics explain why CBDCs could disrupt traditional banking

# What is a Central Bank Digital Currency?

## Definition

A CBDC is a digital form of central bank money:

- Direct liability of central bank (a legal obligation—the central bank owes you that value)
- Digital (not physical)
- Widely accessible (retail) or restricted (wholesale)

## Not a CBDC

- Bank reserves (money banks hold at the central bank—like a bank's own bank account) are already digital
- Commercial bank money (*Your bank deposit is a promise from your bank, which can fail. CBDC is a promise from the central bank, backed by the state—it cannot fail.*)
- Stablecoins (private liability—can collapse, as Terra/UST did in 2022 losing \$40B+)

## Motivations

Central banks cite multiple goals:

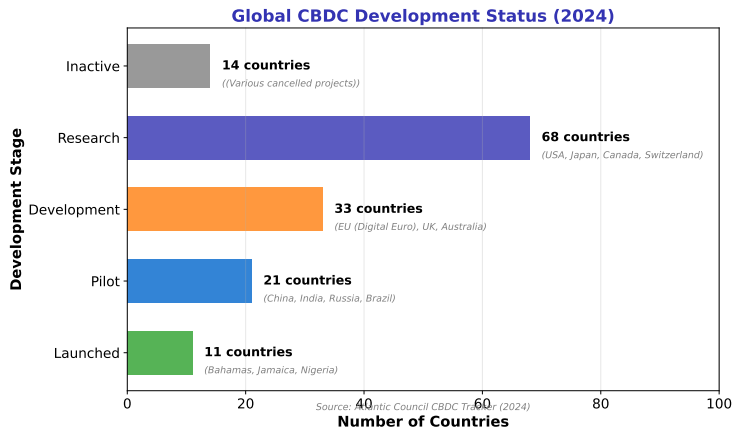
- Maintain monetary sovereignty—without it, a country cannot fight recessions independently (like Greece in 2010, which couldn't devalue its currency)
- Improve payment efficiency
- Promote financial inclusion
- Counter private digital currencies—if citizens abandon national currency for Bitcoin or stablecoins, the central bank loses its ability to stabilize the economy

## Key Economic Question

Does public benefit exceed costs and risks?

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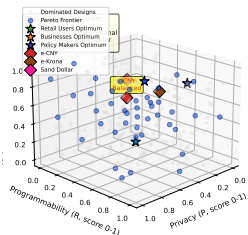
CBDC = digital cash issued by central bank; distinct from existing digital money



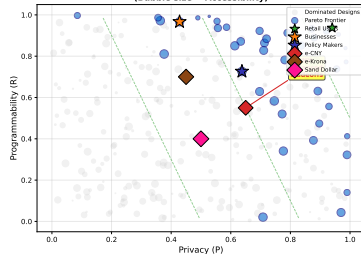
130+ countries exploring CBDCs; China's e-CNY (digital yuan) is most advanced large-economy pilot

# CBDC Design Space: Key Choices

CBDC Design Space: Multi-Attribute Utility Trade-offs



2D Projection: Privacy vs Programmability  
(Bubble size = Accessibility)



Theory: Keeney & Raiffa (1976) Multi-Attribute Utility Theory | Constraint: Cannot maximize all three attributes simultaneously

Design choices involve trade-offs between privacy, efficiency, and policy goals

## Retail CBDC

For general public use:

- Replaces/complements cash
- Consumer payment instrument
- Requires distribution network

Economic considerations:

- High operational costs
- Privacy vs. AML (Anti-Money Laundering—criminals using untraceable money enables drug trafficking, terrorism financing, and tax evasion) trade-off
- Competition with banks

## Wholesale CBDC

For financial institutions:

- Interbank settlement (transferring money between banks)
- Securities transactions (buying/selling stocks and bonds between institutions)
- Cross-border payments

Economic considerations:

- Lower operational burden
- Efficiency gains clearer
- Less disruptive to banking

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Most advanced economies focus on retail; wholesale offers clearer near-term benefits



## Token-Based

Like digital cash:

- Verify the instrument, not holder
- Can enable anonymity
- Offline transactions possible

Economic implications:

- Lower transaction costs
- Privacy preserving
- Harder to implement AML

## Account-Based

Like bank accounts:

- Verify the identity of holder
- Full transaction records
- Programmable features possible—e.g., stimulus payments that can only be spent at small businesses, or rent subsidies that can only pay landlords

Economic implications:

- Interest-bearing feasible
- Targeted policies possible
- Privacy concerns

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Most designs are hybrid: token-like for small values, account-like for large

## Traditional Channels

Interest rate channel:

$$i_{\text{policy}} \rightarrow i_{\text{deposit}} \rightarrow C, I$$

*(When the central bank changes its policy rate ( $i_{\text{policy}}$ ), banks adjust deposit rates ( $i_{\text{deposit}}$ ), affecting consumption ( $C$ ) and investment ( $I$ .)*

- Works through bank intermediation
- Banks pass rate changes to customers
- Time lags in transmission (months can pass before rate changes affect consumer behavior)

## CBDC Impact

If CBDC is interest-bearing:

$$i_{\text{CBDC}} \rightarrow i_{\text{deposit}}$$

*(If CBDC pays 2% interest, banks must match or exceed this to keep deposits—CBDC rate sets a floor.)*

- Direct transmission to public
- Floor on deposit rates

## Enhanced Policy Options

Interest-bearing CBDC enables:

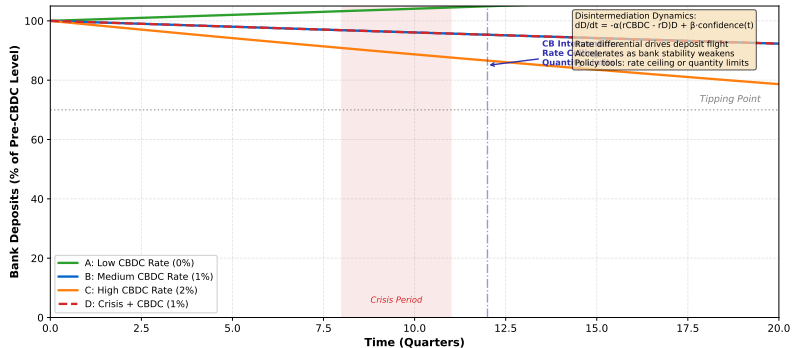
- Negative interest rates (charging people to hold money, to encourage spending)
- Helicopter money (direct cash from central bank to citizens—named for the image of dropping money from helicopters)
- Time-limited money—e.g., China's Chengdu pilot gave citizens digital yuan that expired in 3 months, forcing spending to boost local businesses

## Concerns

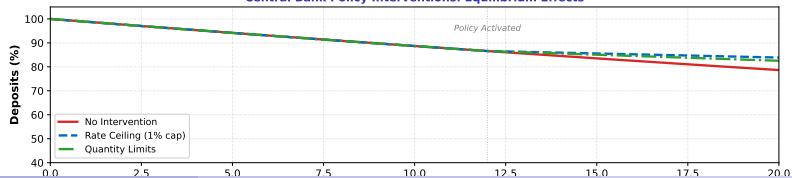
- Political resistance to negative rates (*Why accept losing money? Without physical cash, people cannot escape—some see this as coercive.*)
- Privacy implications of targeting
- Complexity of implementation

# Bank Disintermediation Risk

## Bank Disintermediation Dynamics Induced by CBDC Introduction



## Central Bank Policy Interventions: Equilibrium Effects



## The Concern

If CBDC is attractive:

- Deposits migrate to CBDC
- Banks lose cheap funding
- Credit supply (total loans available) may contract

*Example: If 20% of deposits move to CBDC, banks must borrow elsewhere at higher rates, meaning fewer or costlier loans.*

**Andolfatto (2021), a Federal Reserve economist, modeled this:**

- CBDC as outside option (an alternative that improves your bargaining power—if you can switch to CBDC, banks must treat you better)
- Forces competitive deposit rates
- Net welfare effect ambiguous (welfare = total well-being of society—economists cannot agree if everyone is better or worse off overall)

Design constraints trade off CBDC usefulness against banking system stability

## Mitigation Strategies

Design features to limit migration:

- Holding limits (e.g., 3000 EUR)
- Tiered remuneration (different rates for different amounts—e.g., 0% up to 3000 EUR, negative above)
- No interest on CBDC

## Financial Stability

- Digital bank runs faster—in 2023, Silicon Valley Bank lost \$42 billion in 24 hours via mobile apps; traditional runs took days as people queued at branches
- Flight to safety amplified (the rush to safe assets is faster when transfers are instant)
- Requires careful design

## The Unbanked Problem

Globally 1.4 billion unbanked adults:

- Lack documentation for accounts
- Live far from bank branches
- Cannot afford minimum balances

## CBDC Potential

- Lower KYC (Know Your Customer) requirements for small values
- Mobile-based access
- No minimum balance required

## Economic Analysis

Benefits:

- Lower transaction costs
- Entry to formal finance
- Government transfer efficiency (*Example: During COVID, US paper stimulus checks took weeks. Direct CBDC transfers could reach citizens in seconds at near-zero cost.*)

Challenges:

- Digital divide persists (*Example: In India, 300 million people lack smartphones—CBDC only on phones would exclude them, worsening inequality.*)
- Infrastructure requirements
- Financial literacy needs

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Inclusion requires complementary policies; technology alone is insufficient

## Currency Competition

CBDCs could intensify:

- Cross-border CBDC use
- Challenge to dollar dominance (*The US gains immense power from dollar dominance: ability to sanction enemies, borrow cheaply, and export inflation. Challengers want these privileges.*)
- Regional currency blocs

## China's Strategy

- e-CNY for domestic use
- mBridge (a multi-CBDC platform connecting central banks) for wholesale cross-border
- Reduce dependence on SWIFT (the global interbank messaging system)

## US Response Dilemma

- Digital dollar slower to develop
- Privacy concerns prominent
- Risk of losing first-mover advantage

## Economic Implications

- Seigniorage redistribution (*If people worldwide use digital yuan instead of dollars, China earns the profit from money creation that previously went to the US.*)
- Sanctions effectiveness
- Monetary policy spillovers (when one country's policy unintentionally affects others—e.g., US rate hikes cause capital flight from emerging markets)

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CBDCs add new dimension to international monetary system competition

## Current Pain Points

- High costs (average 6%)
- Slow settlement (2-5 days)
- Limited transparency
- Correspondent banking (international payments through intermediary banks)

*Example: A worker sending \$200 home may lose \$12 in fees and wait 3 days.*

## Wholesale CBDC Solution

- Direct central bank settlement
- Atomic swap (both sides of exchange happen together, or neither happens)
- 24/7 operation possible

## Multi-CBDC Projects

- mBridge (China, UAE, HK, Thailand)
- Project Dunbar (Singapore, Australia)
- Project Icebreaker (Nordic countries)

## Economic Benefits

- Reduced FX (foreign exchange) settlement risk
- Lower remittance costs
- Faster trade finance (loans and guarantees for international commerce)

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Wholesale CBDCs show clearer efficiency gains for cross-border payments

## Privacy Concerns

- Government surveillance potential
- Transaction tracking
- Political control over spending

## Design Options

- Tiered privacy (small = anonymous)
- Zero-knowledge proofs (proving you meet a requirement without revealing your data)
- Third-party anonymity services

## Policy Control Benefits

- AML/CFT (Combating the Financing of Terrorism) compliance
- Tax enforcement
- Targeted stimulus (*Example: Instead of giving everyone \$1000, programmable CBDC could give \$2000 only to unemployed workers, or restrict spending to domestic goods.*)

## Economic Framework

Trade-off function:

$$U = f(\text{Privacy}, \text{Policy Effectiveness})$$

*(Usefulness ( $U$ ) depends on both privacy and policy control—more of one often means less of the other.)*

- Social preferences vary by country
- No one-size-fits-all design

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Privacy preferences differ: Germany (with Stasi memories) values privacy; China's social credit system reflects different norms



## ECB (European Central Bank) Design Principles

- Complement to cash, not replacement
- Privacy by design (small payments)
- Holding limits (~3000 EUR proposed)
- No interest initially

## Timeline

- Investigation phase: 2021-2023
- Preparation phase: 2023-2025
- Potential launch: 2027-2028

## Economic Rationale

- Strategic autonomy (not dependent on Visa, Mastercard, or US tech giants)
- Payment system resilience (if Visa goes down or a foreign company exits, CBDC ensures people can still pay)
- Declining cash usage—if cash disappears, citizens lose their only form of public money; all transactions would go through private banks or card companies who charge fees and track purchases

## Criticisms

- Banks lobby against disintermediation
- Privacy advocates concerned
- Unclear consumer demand

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Digital Euro reflects European values: privacy, strategic autonomy, bank coexistence

## Main Conclusions

1. CBDC design involves fundamental trade-offs
2. Disintermediation risk requires mitigation
3. Monetary policy transmission could improve
4. International competition is intensifying

## Core Insight

CBDCs are not simply “digital cash”—they require careful economic analysis of trade-offs between competing objectives. No design satisfies all goals simultaneously.

## Economic Framework

- Retail vs. wholesale scope
- Token vs. account architecture
- Privacy vs. policy control
- Inclusion vs. stability

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Next lesson: Payment Systems Economics

**CBDC (Central Bank Digital Currency)** Digital cash issued by the central bank. If you hold 100 in CBDC, the central bank guarantees you that value—unlike bank deposits which depend on your bank staying solvent.

**Retail CBDC** CBDC available to the general public for everyday transactions.

**Wholesale CBDC** CBDC restricted to financial institutions for interbank settlements.

**Token-Based CBDC** CBDC where validity is verified by the instrument itself (like cash), enabling offline transactions.

**Account-Based CBDC** CBDC where validity requires verification of the holder's identity against an account.

**Bank Disintermediation** Risk that CBDC adoption draws deposits away from commercial banks, reducing their lending capacity.

**Monetary Sovereignty** A nation's ability to control its own money supply and monetary policy independently.

**Seigniorage** The profit a government earns from issuing currency—the difference between the face value of money and its production cost.

**AML (Anti-Money Laundering)** Laws and regulations designed to prevent criminals from disguising illegally obtained money as legitimate income.

**KYC (Know Your Customer)** The process of verifying the identity of customers, required by financial regulations.

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Terms continued on next slide

**Correspondent Banking** An arrangement where one bank provides services on behalf of another, commonly used for international payments.

**Atomic Swap** A technology enabling exchange of different currencies simultaneously—both transfers complete or neither does.

**Wholesale Funding** Money banks borrow from other financial institutions (rather than customer deposits) to fund operations.

**Tiered Remuneration** Different interest rates for different amounts held—e.g., 0% on first 3000 EUR, negative rates above.

**Helicopter Money** Direct cash transfers from central bank to citizens, bypassing banks—named for the image of dropping money from helicopters.

**Negative Interest Rates** A policy where depositors pay to keep money in accounts rather than earning interest—used to encourage spending.

**Interbank Settlement** The process by which banks transfer money between themselves to complete transactions.

**Flight to Safety** When investors move money from risky assets to safe ones during uncertainty—with CBDC, could mean moving from bank deposits to CBDC.

**Financial Inclusion** Ensuring all people have access to useful and affordable financial services.

**Zero-Knowledge Proofs** Cryptography that proves you meet a requirement without revealing your data—like proving you're over 18 without showing your birthdate.

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CBDC design choices have profound implications for monetary policy and financial stability

**Liability (Finance)** A legal obligation to pay—if you hold CBDC, the central bank owes you that value. Unlike an asset (what you own), a liability is what you owe.

**Monetary Policy** The central bank's decisions about interest rates and money supply to control inflation and support the economy. Examples: raising rates to fight inflation, cutting rates to boost growth.

**Bank Reserves** Money that commercial banks hold at the central bank—like a bank's own bank account. Required by regulation to ensure banks can meet withdrawals.

**Credit Supply** The total amount of loans banks can offer to businesses and people. When credit supply contracts, fewer loans are available, slowing economic activity.

**Spillovers** When one country's policy unintentionally affects other countries. Example: US interest rate hikes cause capital to leave emerging markets, weakening their currencies.

**Trade Finance** Loans and guarantees that help companies buy and sell goods internationally. Without trade finance, global commerce would be much slower and riskier.

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Understanding these foundational terms is essential for analyzing CBDC policy

### Academic Papers

- Andolfatto (2021): “Assessing the Impact of CBDC on Private Banks”
- Brunnermeier & Landau (2022): “The Digital Euro”
- Auer et al. (2022): “CBDCs Beyond Borders”

### Central Bank Publications

- ECB (2023): “A Stocktake on the Digital Euro”
- BIS – Bank for International Settlements (2021): “CBDCs: An Opportunity for the Monetary System”
- Fed – Federal Reserve (2022): “Money and Payments”

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All readings available on course platform