Lesson 48: CBDCs and Future of Digital Finance

Module 4: Traditional Digital Finance

Digital Finance Course

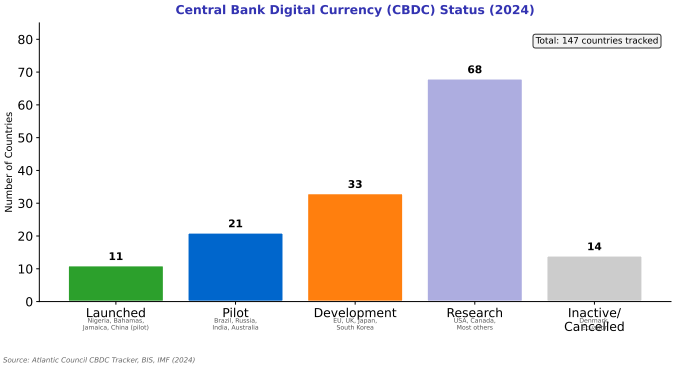
2025

Learning Objectives

- Understand Central Bank Digital Currency (CBDC) design principles and architectures
- Analyze Digital Euro project and global CBDC landscape
- Examine retail vs wholesale CBDC models
- Evaluate programmable money and smart contract integration
- Assess future trends in traditional digital finance

Source: Financial industry data and regulatory publications

Global CBDC Adoption Status



Central bank digital currency projects span research, pilots, and live deployments.

What is a CBDC?

Definition:
Central Bank Digital Currency (CBDC) is a digital form of central bank money, distinct from balances in traditional reserve or settlement accounts.

Key Characteristics:

- **Central Bank Liability:** Direct claim on central bank (like cash)
- **Digital:** Electronic, not physical currency
- **Legal Tender:** Government-backed, accepted for payments
- **Programmable:** Potential for conditional payments
- **Account-Based or Token-Based:** Identity vs bearer instrument

CBDC vs Other Digital Money:

- **Commercial Bank Deposits:** Bank liability, deposit insurance
- **Cryptocurrencies:** Decentralized, volatile, no legal tender status
- **Stablecoins:** Private issuers (Tether, USDC), reserves backing

Motivation for CBDCs:
Policy Goals:

- **Payment Efficiency:** Faster, cheaper cross-border payments
- **Financial Inclusion:** Access for unbanked populations
- **Monetary Sovereignty:** Counter private stablecoins (Libra/Diem threat)
- **Cash Decline:** Digital alternative as physical cash usage drops
- **Innovation Platform:** Programmable money, smart contracts

Risks and Concerns:

- **Bank Disintermediation:** Flight to CBDC during crises
- **Privacy:** Central bank surveillance potential
- **Cybersecurity:** Attractive target for attacks
- **Cross-Border Capital Flows:** Bypass capital controls
- **Operational Complexity:** 24/7 availability, scalability

Clear definitions are essential for understanding complex technical concepts.

Retail vs Wholesale CBDCs

Retail CBDC (General Purpose):
Users:

- Households and businesses
- Direct access to central bank money
- Digital cash alternative

Use Cases:

- Everyday payments (groceries, bills)
- P2P transfers
- E-commerce
- Government disbursements (stimulus, benefits)

Design Considerations:

- Distribution model (direct vs two-tier)
- Anonymity vs AML compliance
- Interest-bearing vs non-interest
- Holding limits (caps to prevent bank runs)
- Offline capability (resilience)

Wholesale CBDC (Limited Access):
Users:

- Banks and financial institutions
- Authorized payment service providers
- No public access

Use Cases:

- Interbank settlements (RTGS enhancement)
- Securities settlement (DVP)
- Cross-border payments (FX vs payment)
- Central bank operations (repo, monetary policy)

Advantages:

- Less disruptive to banking system
- Lower technology scaling requirements
- Easier privacy/AML balance
- Building block for retail later

Most advanced projects: Wholesale (e.g., Project Jura, Aber) vs retail still exploratory (Digital Euro, e-CNY pilot)

Source: Financial industry data and regulatory publications

Digital Euro: Design and Timeline

ECB Digital Euro Timeline:

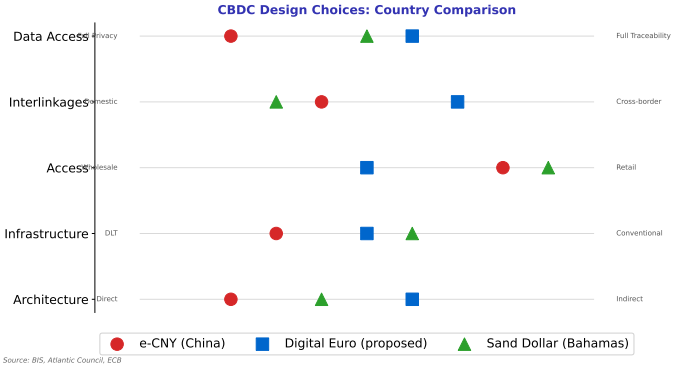
- **2020-2021:** Investigation launch, 8000+ consultation responses
- **2021-2023:** 24-month investigation, prototypes, rulebook
- **2023-2025:** Preparation phase, tech provider selection
- **2025-2027:** Implementation, pilots, potential launch

Key Design Choices:

- **Two-Tier:** ECB issues, banks/PSPs distribute (no direct ECB accounts)
- **Privacy:** Offline = anonymous; Online = privacy + AML compliance
- **Holding Limits:** EUR 3-4k cap to prevent bank disintermediation
- **Offline:** NFC/Bluetooth, resilience during outages

Digital euro design balances privacy, financial stability, and payment efficiency. [Source: ECB Digital Euro Reports 2024]

CBDC Design Choices



CBDC design involves fundamental choices about architecture and access models.

Swiss CBDC: Project Helvetia

Project Helvetia Overview:

- SNB + BIS + SIX collaboration
- Wholesale CBDC pilot (not retail)
- Launched December 2023
- Runs until at least June 2027

Key Milestones:

- Phase I (2020): Proof of concept
- Phase II (2022): Integration tests
- Phase III (2023-): Live pilot

2024 Achievements:

- CHF 750M+ in digital bonds settled
- CHF 64M SNB bills issued (June 2024)
- World's first monetary policy op on DLT
- 6 major banks participating

Participants:

UBS, Zuercher KB, Basler KB, BCV, Commerzbank, Hypo Lenzburg

Project Helvetia represents the world's first wholesale CBDC on a regulated third-party DLT platform. Source: SNB (2024)

Swiss Position on Retail CBDC

SNB Retail CBDC Position:

- Currently: No retail CBDC planned
- Swiss payment system "works well"
- TWINT mobile payments widespread
- No urgent need identified

Concerns Raised:

- Bank disintermediation risk
- Financial stability concerns
- Privacy considerations
- Implementation complexity

Focus on Wholesale CBDC:

- Institutional settlement focus
- Integration with existing FMI
- Lower disruption risk
- Clear efficiency gains

Key Quote (SNB):

"With the ongoing improvement of the payment system, the SNB currently sees no need for digital central bank money for the general public."

Switzerland prioritizes wholesale CBDC for institutional settlement while maintaining a cautious stance on retail CBDC.

Digital Euro: Central Architecture

Technical Approach:

- ECB leaning toward centralized database (not DLT)
- Hybrid possible: Central ledger + DLT for settlement

Three-Layer Architecture:

1. Settlement Layer (ECB):

- Central ledger of all digital euro balances
- Final settlement authority and reconciliation

2. Distribution Layer (Intermediaries):

- Customer onboarding (KYC/AML)
- Wallet provision (mobile, hardware)
- Payment initiation and customer service

3. Interface Layer:

- APIs for merchants and developers
- POS integration, e-commerce, P2P protocols

Digital euro uses a three-layer architecture with ECB as settlement authority.

Digital Euro: Offline and Privacy Technology

Offline Payment Technology:
Hardware Wallets:

- Secure element (SIM card, smart card)
- Local encrypted storage
- NFC contactless + Bluetooth transfers

Offline Protocol:

- Cryptographic signature verification
- Double-spending prevention (local nonce)
- Periodic sync; limits EUR 100-500

Privacy Architecture:

- Blind signatures / zero-knowledge proofs
- Pseudonymous identifiers (rotating)
- ECB sees aggregates only
- Intermediaries handle AML checks

Key Challenge:
Balance privacy (citizen demand) with AML compliance (regulatory requirement).

Offline capability enables cash-like privacy while maintaining security.

Digital Euro Stakeholder Perspectives

Central Bank (ECB) Goals:

- Monetary sovereignty (counter BigTech stablecoins)
- Ensure access to central bank money (cash declining)
- Support European payment autonomy (reduce Visa/Mastercard dependence)
- Platform for innovation (programmable euro)

Commercial Banks Concerns:

- **Disintermediation:** Customers move deposits to CBDC
- **Funding Costs:** Higher deposit rates to compete
- **Profitability:** Lower payment fee revenue
- **Mitigation:** Two-tier model, holding limits, no interest on CBDC

Banks' Requested Safeguards:

- Low holding caps (EUR 3,000 or less)
- No interest or negative rates (unattractive for savings)
- Compensation for distribution services
- Gradual rollout with monitoring

Citizens and Businesses:
Potential Benefits:

- Free or low-cost payments (no card fees)
- Instant settlement (vs T+1 bank transfers)
- Privacy for small transactions (cash-like)
- Pan-European acceptance (vs fragmented schemes)

Concerns:

- Privacy vs surveillance fears
- Complexity (another payment method)
- Holding limits (restrictive for some)
- Transition costs for merchants (POS upgrades)

Payment Providers (Visa, Mastercard):

- Competitive threat (direct ECB payment rail)
- Opportunity: Provide infrastructure services
- Push for open standards and interoperability

Political dimension: 2024 EU elections, Digital Euro Regulation debate (data protection, privacy, holding limits)

Source: Financial industry data and regulatory publications

CBDC Projects Worldwide

Live CBDCs (2024):

- **Bahamas Sand Dollar (2020):** First retail CBDC; blockchain-based, inclusion focus
- **Eastern Caribbean DCash (2021):** 7 nations on Hyperledger Fabric
- **Nigeria eNaira (2021):** Africa's first; 1M+ wallets, low active usage
- **Jamaica JAM-DEX (2022):** Retail CBDC with government incentives

Advanced Pilots:

- **China e-CNY:** 260M+ wallets, $250B+ transactions; 26+ cities
- **Sweden e-Krona:** R3 Corda tested; no launch decision yet
- **India Digital Rupee:** 5M retail users + wholesale pilot on Hyperledger

Global Statistics (2024):
130+ countries exploring (98% of GDP), 11 live, 20+ in pilot phase.

CBDCs represent the digitization of central bank money. [Source: Juniper Research, BIS 2024]

Cross-Border CBDC Projects

Multi-CBDC Platforms (mCBDC):

- **mBridge:** China, HK, Thailand, UAE, Saudi Arabia; $22B+ pilot (2023)
- **Jura:** SNB + Banque de France; CHF-EUR on R3 Corda
- **Aber:** Saudi-UAE dual CBDC on Hyperledger Fabric
- **Dunbar:** Australia, Malaysia, Singapore, South Africa; Quorum

Benefits:

- Instant settlement (vs 2-5 days SWIFT), lower fees
- Atomic FX swaps, real-time finality

Challenges:

- Governance, legal harmonization, capital controls
- Interoperability, geopolitical tensions

Multi-CBDC platforms aim to transform cross-border payments with instant settlement. [Source: BIS Innovation Hub 2024]

CBDC Status by Major Economies (2024)

United States - Digital Dollar:

- **Status:** Research phase, no pilot
- **Fed Position:** Cautious, awaiting Congressional authorization
- **Concerns:** Privacy, need unclear (stablecoins, private innovation)
- **Political:** Divided (Republicans skeptical, Democrats open)
- **Alternatives:** FedNow instant payments (2023 launch)

United Kingdom - Britcoin:

- Consultation phase (2021-2023)
- Design work ongoing (BoE + HM Treasury)
- Potential launch: 2028-2030 (if approved)
- Two-tier model similar to Digital Euro

Japan - Digital Yen:

- Pilot phase (2023-2024)
- BoJ testing with banks and retailers
- No launch decision, monitoring global developments

Canada - Digital Canadian Dollar:

- Research and consultation (ongoing)
- Contingency planning (if cash declines or stablecoins dominate)
- No immediate need identified

Brazil - Digital Real (DREX):

- Pilot launched 2024
- Focus: Programmable payments, tokenized assets
- DLT-based, targeting 2025 launch

Global Statistics (BIS, IMF, Atlantic Council 2024):

- **130+ countries:** Exploring CBDCs (98% of global GDP)
- **11 countries:** Fully launched CBDCs
- **20+ countries:** Pilot phase (including China, India)
- **G7 Principles:** Endorsed CBDC principles (2021) - privacy, no programmability for surveillance

CBDCs represent the digitization of central bank money. [Source: Nilson Report, World Bank 2024]

Programmable CBDC Features

Programmability Concept:
Ability to attach conditions and logic to money itself, enforced automatically.

Use Cases:
1. Conditional Payments:

- Pay only if delivery confirmed (IoT integration)
- Escrow automatically released on milestone
- Salary paid only to authorized accounts

2. Time-Locked Funds:

- Stimulus funds spendable only at local businesses
- Budget allocations released monthly (automatic)
- Pension payments on specific dates

3. Targeted Fiscal Policy:

- COVID relief usable only for essentials (food, rent)
- Expiring money to encourage spending (negative interest)
- Carbon credits embedded in payments

4. Atomic Transactions (DVP/PVP):

- Securities delivery only if payment received (simultaneous)
- Cross-currency swaps (no settlement risk)
- Supply chain: Pay on confirmed delivery (IoT sensors)

Implementation Approaches:
Smart Contract Layer:

- CBDC on blockchain with smart contract capability
- E.g., Ethereum-like execution environment
- Challenges: Complexity, security audits

API-Based Programmability:

- Centralized ledger with programmable payment rules
- Simpler, more controllable
- Example: Brazil DREX design

Concerns:

- Privacy erosion (surveillance capitalism)
- Government overreach (social credit systems)
- Complexity and bugs (financial system risk)
- Financial exclusion (conditions disadvantage some)

CBDCs represent the digitization of central bank money.

Tokenized Deposits vs Synthetic CBDCs

Tokenized Deposits (Private):

- Bank deposits on blockchain (programmable)
- Examples: JPM Coin ($1B+ daily), EURCV
- Pros: Faster, DeFi integration
- Cons: Bank risk, fragmented

Synthetic CBDC (sCBDC):

- Stablecoins backed by central bank reserves
- Private issuance, public oversight
- Example: Project Aurum (Hong Kong)
- Benefits: Private innovation, CB guarantee

Feature	Tokenized Deposit	Synthetic CBDC
Issuer	Commercial bank	Private (CB backed)
Risk	Bank default	Minimal
Speed to market	Fast	Medium

Tokenized deposits offer speed while sCBDC provides safety. [Source: BIS, 2024]

Convergence: TradFi, DeFi, and CBDCs

Key Interoperability Projects:

- **BIS Unified Ledger:** Single platform for CBDC + tokenized assets with atomic settlement
- **Project Guardian (MAS):** DeFi + institutional blockchain; live FX/bond pilots
- **Project Agorá:** 7 central banks; cross-border wholesale CBDC (2025-26)

Instant Payments Competition:

- **FedNow (2023):** 24/7 instant; 300+ banks; reduces US retail CBDC urgency
- **EU Instant (2025):** Mandatory 10-sec SEPA; may delay Digital Euro

Likely Coexistence:
Cash (privacy) + Deposits (savings) + Instant (daily) + CBDC (cross-border) + Stablecoins (DeFi).

Future: hybrid ecosystem with TradFi stability and DeFi innovation. [Source: BIS, World Bank 2024]

Technology Trends: Tokenization and AI

1. **Real-World Asset Tokenization:**
   - Real estate, PE, commodities on blockchain
   - Fractional ownership, 24/7 trading
   - $10T+ market by 2030 (BCG)

2. **AI in Finance:**
   - Trading: RL, alternative data
   - Risk: Real-time scoring, fraud
   - Compliance: Automated AML/reporting
   - GenAI: Strategy code, NLP interfaces

Tokenization and AI are reshaping financial services delivery. [Source: BCG, CB Insights 2024]

Technology Trends: Quantum and Identity

3. Quantum Computing:
Threats:

- Break RSA/ECC in 10-15 years
- CBDC and blockchain vulnerable

Response:

- Post-quantum crypto (NIST 2024)
- 5-10 year migration timeline

4. Decentralized Identity (DID):

- Self-sovereign identity
- KYC once, use anywhere
- CBDC wallet integration
- Standards: W3C DID, eIDAS 2.0

Quantum-resistant cryptography and DID are critical infrastructure for future finance. [Source: PitchBook 2024]

Regulatory Evolution and Global Coordination

Global Standards Bodies:

- **BIS Innovation Hub:** CBDC research, mBridge/Dunbar coordination
- **IMF/World Bank:** Developing economy guidance, inclusion focus
- **FSB:** Stablecoin framework (2023), crypto standards
- **G20:** 5x faster, 50% cheaper cross-border by 2027

Emerging Regulatory Themes:

- **Embedded Finance:** BigTech regulation, same activity = same rules
- **AI Governance:** SR 11-7 updates, explainability, EU AI Act
- **ESG/Climate:** Mandatory disclosure (SEC, ISSB), green CBDCs
- **Open Banking:** PSD3 (EU), CFPB rule (US), data portability

Global coordination aims for harmonized digital finance regulation across jurisdictions. [Source: BIS, FSB 2024]

Strategic Implications: Banks

Threats:

- CBDC reduces need for commercial bank money
- BigTech/fintechs capture customer relationships
- Margin compression from instant payments

Opportunities:

- CBDC distribution partners (two-tier model)
- Tokenized deposit issuers
- Digital asset custodians
- Embedded finance (BaaS)

Strategic Responses:

- Invest in technology (cloud, APIs, blockchain)
- Partner with or acquire fintechs
- Focus on high-value advisory services
- Deploy RegTech and SupTech

Bottom Line:
Banks must become technology-first distribution platforms or risk losing relevance.

Banks face disintermediation risk but can thrive as CBDC infrastructure providers.

Strategic Implications: Asset Managers and Fintechs

Asset Managers - New Opportunities:

- Tokenized real assets (real estate, PE, art)
- Digital securities (tokenized bonds/equities)
- 24/7 markets, T+0 settlement
- Fractional ownership, lower minimums

Fintechs and Innovators:
Opportunities:

- Build CBDC wallets and apps
- DeFi bridges to traditional finance
- Cross-border and remittance niches

Risks:

- Regulatory licensing barriers
- Competition from incumbent banks

Digital finance creates opportunities across the financial services ecosystem.

Scenarios for 2030-2035

Scenario 1: CBDC-Dominant World
Characteristics:

- Major economies launch retail CBDCs (Digital Euro, e-CNY, Digital Pound)
- Cash usage ¡ 5% of transactions
- Cross-border mCBDC platforms replace SWIFT for most B2B
- Commercial banks focus on lending, wealth management

Implications:

- Central banks gain powerful monetary policy tools (negative rates, direct stimulus)
- Privacy concerns intensify (calls for regulation)
- Financial inclusion improves (unbanked access CBDC)
- Geopolitical fragmentation (CBDC blocs: US-led, China-led)

Scenario 2: Private Stablecoin Dominance
Characteristics:

- Regulated stablecoins (USDC, EURC) become standard
- CBDCs limited to wholesale use
- BigTech wallets (Apple Pay, Google Pay) integrate stablecoins
- DeFi grows to $5T+ TVL (vs $100B 2024)

Implications:

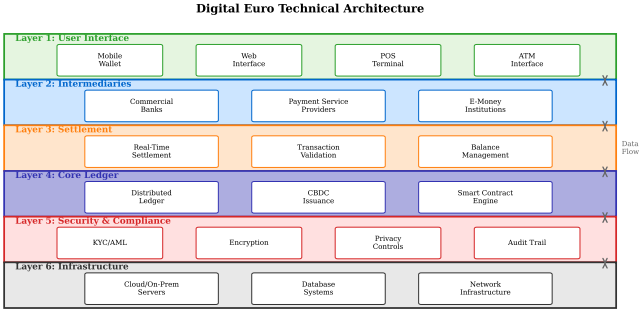
- Central banks lose monetary policy leverage
- Regulatory arbitrage (offshore stablecoin issuers)
- Innovation thrives (private sector experimentation)
- Financial stability risks (stablecoin runs)

Scenario 3: Hybrid Coexistence (Most Likely)
Characteristics:

- Mix of CBDCs (some countries), stablecoins, instant bank payments
- Interoperability via standards (ISO 20022, mCBDC protocols)
- Tokenization mainstream for assets, niche for money
- Traditional finance absorbs blockchain selectively

Source: Financial industry data and regulatory publications

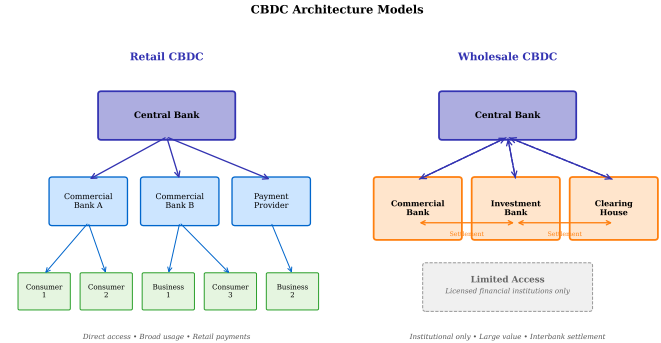
Digital Euro Architecture



Source: ECB Digital Euro (2020-2023), BIS (2021)

The digital euro would complement cash and commercial bank money as central bank money.

Retail vs Wholesale CBDC



Retail CBDCs serve the general public while wholesale CBDCs facilitate interbank settlement.

Summary: CBDCs and Digital Euro

CBDC Fundamentals:

- Digital central bank money (distinct from deposits/crypto)
- Retail vs wholesale models
- Goals: Efficiency, inclusion, sovereignty

Digital Euro:

- Launch potential: 2025-2027
- Two-tier model, privacy-preserving
- Holding limits (EUR 3-4k)

Global Status:

- 130+ countries exploring CBDCs
- 11 live, 20+ pilots (incl. e-CNY)
- mCBDC projects: mBridge, Jura, Dunbar

Programmable Money:

- Conditional payments, atomic settlement
- Tokenized deposits vs synthetic CBDC

CBDCs represent the next evolution of central bank money in the digital age.

Summary: Future Trends and Strategy

Key Trends (2025-2035):

- Asset tokenization: $10T+ by 2030
- AI: Trading, risk, compliance, advisory
- Quantum: Post-quantum crypto migration
- Decentralized identity (DID)

Strategic Implications:

- Banks: CBDC distributors, BaaS providers
- Asset managers: 24/7 markets, T+0 settlement
- Fintechs: CBDC wallets, DeFi bridges

Likely Outcome:
Hybrid coexistence of CBDCs, stablecoins, and instant payments.

Data sources: CB Insights, BIS, Statista 2024

Course Conclusion: Traditional Digital Finance

Module 4 Journey:
Lessons 37-39: Foundations

- Financial markets infrastructure (exchanges, clearinghouses)
- Core banking systems (CBS, digital banking)
- Payment rails (ACH, wires, real-time, cards)

Lessons 40-42: Trading and Risk

- Electronic trading and HFT (market microstructure)
- Risk management systems (VaR, stress testing, model risk)
- RegTech and compliance (Basel III, IFRS 9, EMIR)

Lessons 43-45: Markets and Derivatives

- Capital markets technology (OMS, EMS, PMS, T+1)
- Derivatives technology (pricing, CCPs, EMIR, SOFR)
- Wealth management systems (robo, hybrid, direct indexing)

Lessons 46-48: Data and Future

- Financial data vendors (Bloomberg, LSEG, FactSet, alternative data)
- CBDCs and future (Digital Euro, e-CNY, programmable money, scenarios)

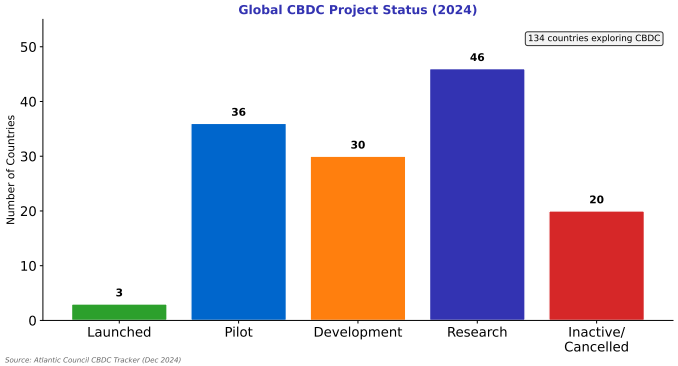
Key Themes Across Module:

1. **Digitalization:** Paper → Electronic → Real-time → Programmable
2. **Automation:** Manual → STP → AI/ML → Autonomous
3. **Integration:** Siloed systems → APIs → Platforms → Ecosystems
4. **Regulation:** Reactive → Proactive → RegTech → Embedded compliance
5. **Convergence:** TradFi ↔ Fintech ↔ DeFi ↔ CBDCs

Looking Ahead:
The future of digital finance is not a replacement of traditional systems but an evolution—integrating the stability and trust of central banks with the innovation of technology, creating a hybrid ecosystem where efficiency, inclusion, and sovereignty coexist.

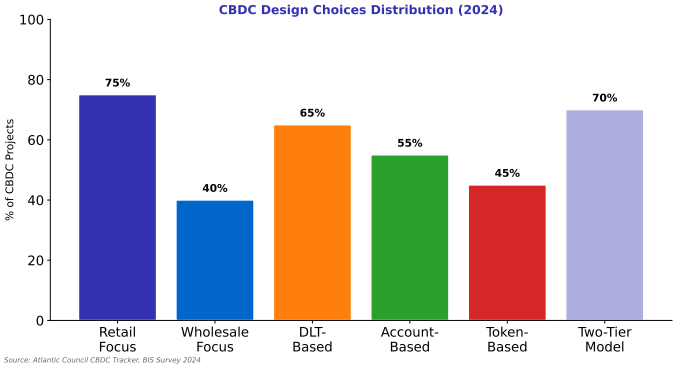
Source: Financial industry data and regulatory publications

CBDC Project Status



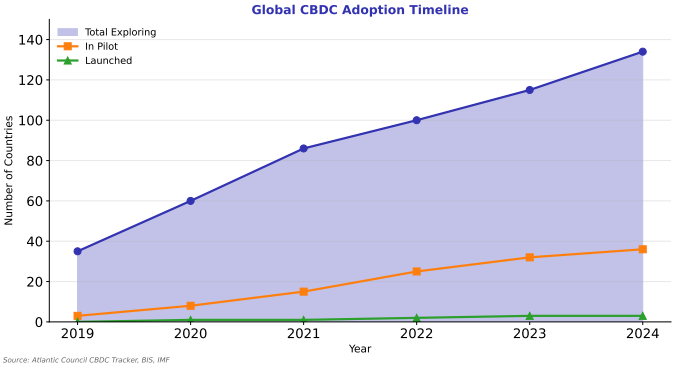
Most major economies exploring CBDC options.

CBDC Design Decisions



Retail CBDCs favor account-based models.

Digital Currency Projections



CBDCs expected to coexist with traditional money.