

Content Reference: Programmable Money

Digital Finance — BSc Course

Section 1: Key Definitions

- **Programmable money** — currency that carries embedded, self-enforcing rules; the money itself decides whether a transaction is valid, not an external intermediary.
- **Conditional payment** — a transfer that executes only when a specified condition is met (e.g. delivery confirmed, identity verified, date reached).
- **Money streaming** — continuous, per-second payment flows rather than periodic lump sums; pioneered by protocols like Sablier and Superfluid.
- **Expiring money** — tokens with an embedded validity period; unspent funds revert to the issuer after a deadline, used in fiscal stimulus pilots.
- **Geo-fenced money** — tokens restricted to a geographic area; transactions outside the boundary are rejected by the smart contract.
- **Composability** — the ability to chain financial protocols so that the output of one becomes the input of another (“money legos”).
- **Atomic settlement** — a transaction where all legs succeed or all legs fail; no partial execution, eliminating counterparty risk during settlement.
- **Smart contract wallet** — a blockchain wallet governed by code rather than a single private key; can enforce spending limits, multi-signature approval, and time locks.
- **CBDC (Central Bank Digital Currency)** — a digital form of sovereign money issued by a central bank, potentially carrying government-defined programmable rules.
- **Purpose-bound money** — tokens restricted to specific spending categories (e.g. food, medicine, education); spending outside approved categories is blocked at the protocol level.

Section 2: Core Concepts

Programmable Payment Logic

If-then-else payment logic: IF condition is met THEN release payment ELSE revert funds to sender. Conditions can be time-based, identity-gated, geo-fenced, or event-triggered.

Streaming formula: $\text{payment rate} = \frac{\text{total amount}}{\text{duration in seconds}}$. A \$5,000 monthly salary streams at $\$5,000 \div (30 \times 24 \times 3,600) = \$0.0019/\text{second}$.

Composability (money legos): output of Protocol A becomes the input of Protocol B. Example: salary streamed via Sablier → auto-deposited into Aave for yield → interest auto-donated to charity. Three protocols, zero human intervention.

Conditional escrow: funds locked in a smart contract until multi-party conditions are met. Buyer deposits; goods ship; oracle confirms delivery; contract releases payment. No intermediary needed.

Five rule types: (1) conditional — if/then logic; (2) time-based — expiry, vesting, streaming; (3) geo-fenced — location-restricted; (4) identity-gated — KYC/age/credential checks; (5) auditable — every transaction traceable on-chain.

Section 3: Use Case Comparison

Use Case	Traditional	Programmable	Key Benefit
Salary	Monthly lump sum	Per-second streaming	Real-time liquidity
Disaster relief	Cash via NGOs (30% leakage)	Restricted tokens (5% leakage)	Anti-fraud
Loyalty rewards	Points, manual redemption	Auto-converting tokens	Composability
Carbon credits	Offset certificates	Auto-retire on purchase	Transparency
Supply chain	Invoice factoring, Net 90	Milestone-triggered release	Trust-free escrow

Section 4: CBDC vs Crypto Programmability

Aspect	CBDC (e.g. digital yuan)	Crypto (e.g. USDC on Ethereum)
Issuer	Central bank	Private company
Programmability	Government-defined rules	Open, permissionless
Privacy	Full state visibility	Pseudonymous
Legal tender	Yes	No
Expiry / geo-fence	Technically possible	Uncommon
Composability	Limited (walled garden)	Full (DeFi ecosystem)

Section 5: Key Facts & Figures

- **China’s digital yuan:** tested expiry dates in Shenzhen pilots (2022); unspent tokens reverted to the issuer after a set deadline.
- **Australia Cashless Debit Card:** restricted 80% of welfare payments to approved spending categories, blocking alcohol and gambling.
- **Sablier:** \$100M+ streamed via real-time payment protocol; salary, grants, and vesting schedules settled per-second on-chain.
- **Circle USDC:** \$30B+ supply, fully composable across 15+ blockchains; the most widely integrated programmable dollar.
- **EU digital euro:** legislative proposal 2023; programmability explicitly discussed as a feature for conditional payments and fiscal policy.
- **BIS “Blueprint for future monetary system” (2023):** identified programmable payments as a core pillar of tomorrow’s financial infrastructure.
- **World Bank:** estimates 25–30% of welfare spending in developing nations lost to leakage — programmable disbursement could cut this to <5%.

Section 6: Key Risks

1. **Surveillance** — programmable rules give issuers (especially governments) full visibility into every transaction; cash anonymity disappears.
2. **Paternalism** — “approved categories” embed value judgments into money itself; who decides what counts as a legitimate purchase?
3. **Two-tier money** — restricted tokens may be worth less than unrestricted cash, creating a de facto discount for controlled populations.
4. **Smart contract bugs** — immutable code errors can freeze funds permanently; no bank to call, no transaction to reverse.
5. **Financial exclusion** — edge cases (birthday gifts, informal economy, cash-only vendors) are blocked by rigid rule engines.
6. **Censorship** — authorities can freeze or expire funds of targeted individuals; programmability becomes a tool of political control.

Section 7: Further Reading

- Auer, R., Haslhofer, B., Claessens, S. (BIS, 2023). “Blueprint for the future monetary system.” *BIS Annual Economic Report*, Ch. III.
- ECB (2023). “A digital euro” — legislative proposal and impact assessment. *European Commission*.
- Sablier.com — real-time payment streaming protocol; documentation and live dashboards.
- Carstens, A. (BIS, 2024). “Innovation and the future of the monetary system.” Speech, BIS General Manager.