

Central banking & digital currencies

Lecture II

Lars Hupel
2026-02-03

Agenda

6. Tokenisation of (real world) assets
7. Retail CBDC deep dive
8. Homework exercise



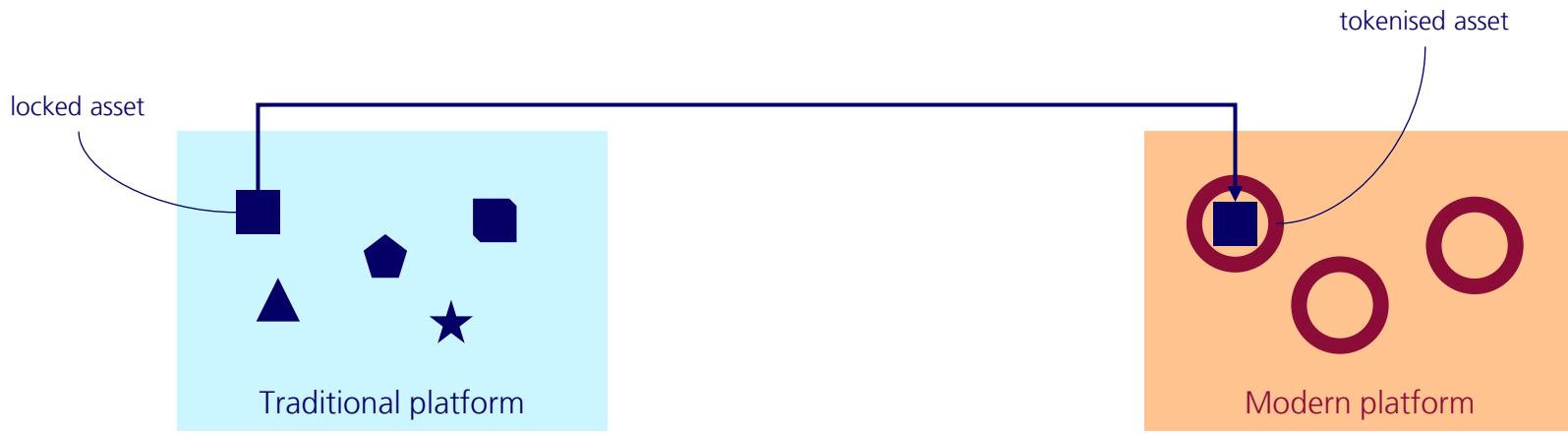


6. Tokenisation of (real world) assets





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2021: Germany allows “disembodied” securities
(DLT and non-DLT)



7. Retail CBDC deep dive



Seamless integration of on- and offline payments



Re-spendable offline transactions



Highest security and resilience



Balancing privacy versus transparency



Foundation for innovative solutions

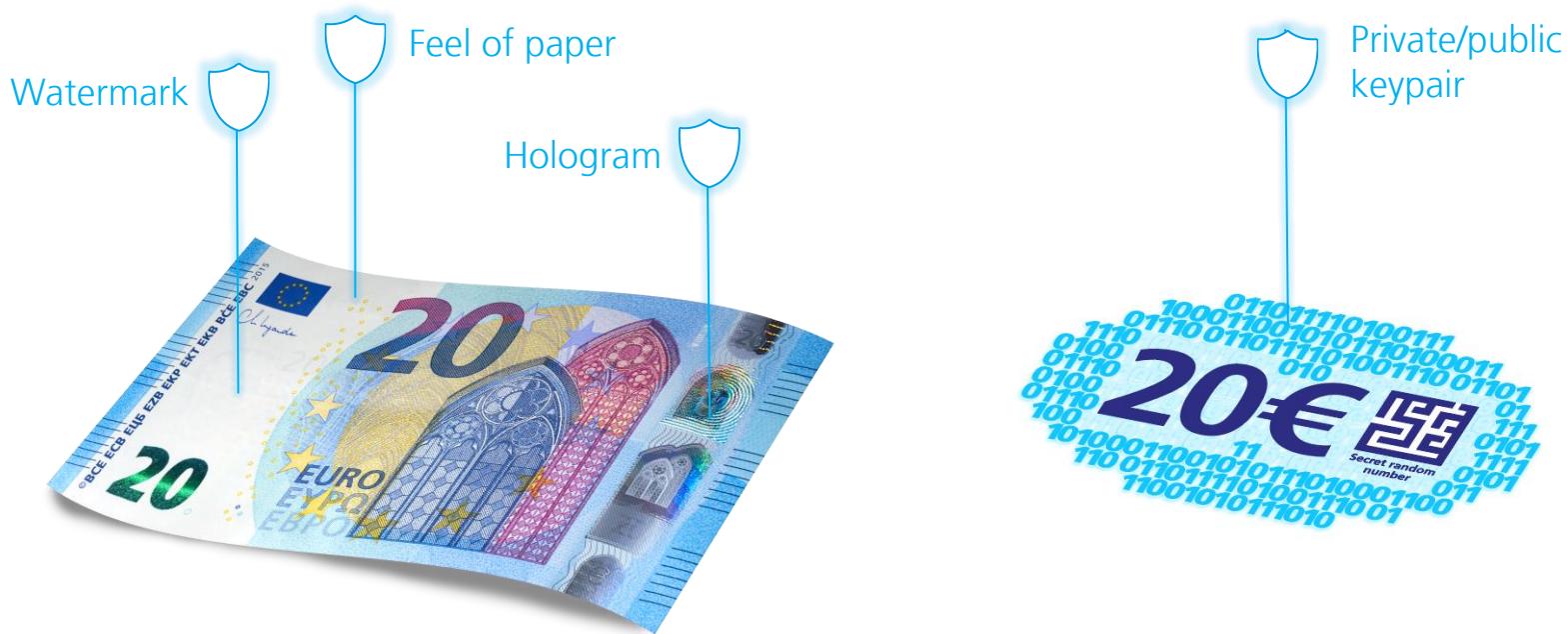


Production level performance

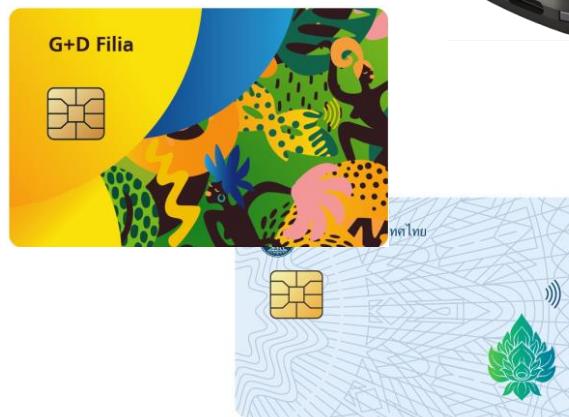


7.1. CBDC design & offline capability

Modelling digital cash after physical cash



Wallet form factors



Current payment solutions

No Internet

Only one party (payer or payee) is offline

One-time offline transaction

Offline payments at POS of merchants

Payments is settled online

Payment requires onboarding (KYC)

Limited to small value payments

Dual offline capability

Neither Internet nor mobile connectivity

Both parties are offline

Consecutive offline transactions

Both POS and person-to-person payments

Instant settlement (re-spendable)

Pay without any onboarding (full privacy)

Larger amounts paid (consecutively) offline



NETFLIX



7.2. CBDC pilot projects

Reference projects



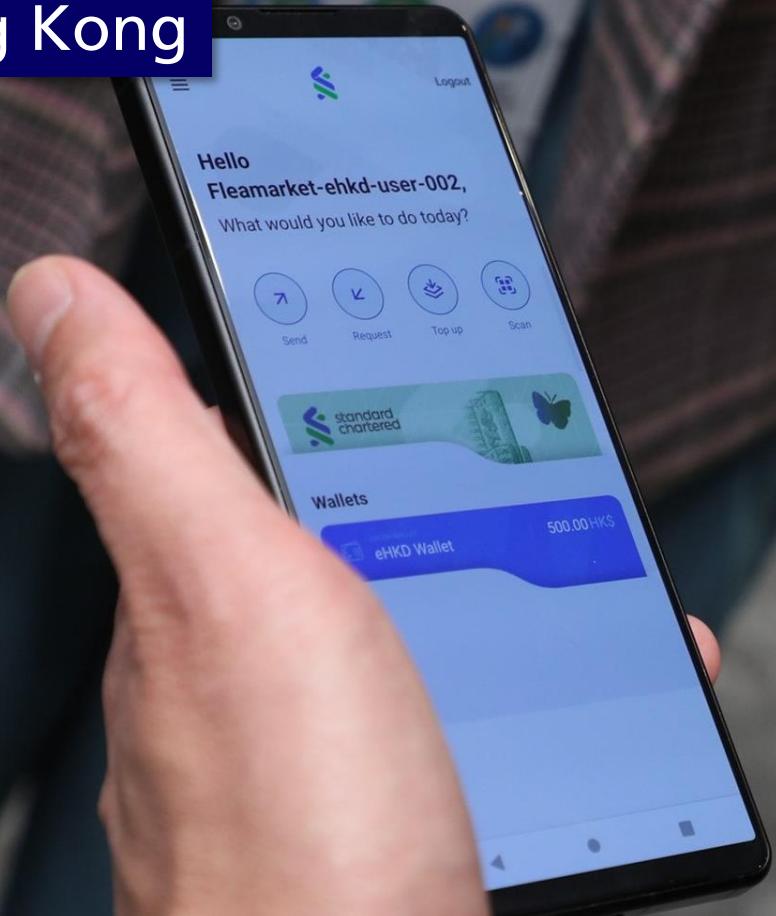
Hong Kong



Hong Kong



Hong Kong



Ghana

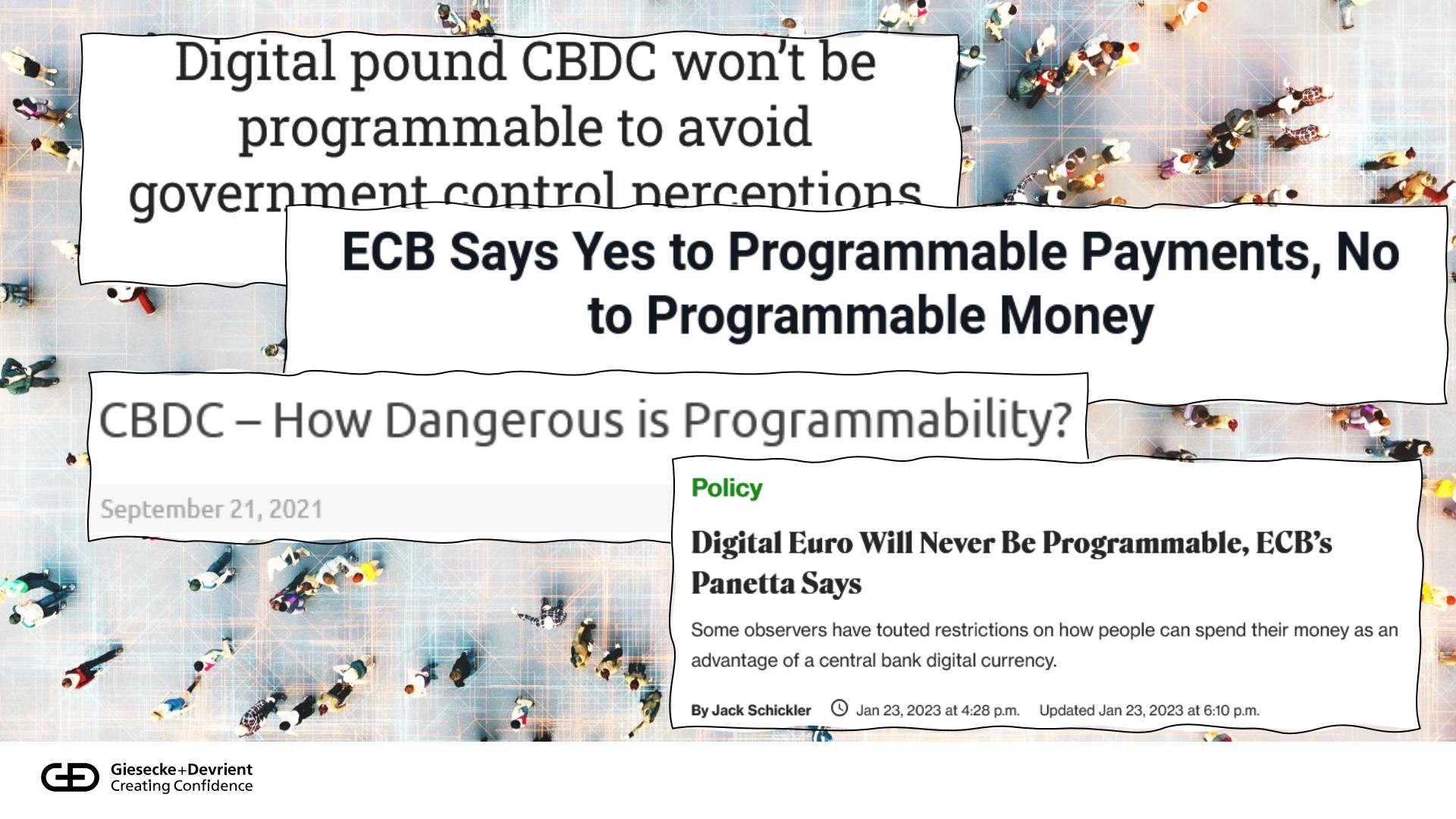


Ghana





7.3. Programmability



Digital pound CBDC won't be programmable to avoid government control perceptions

ECB Says Yes to Programmable Payments, No to Programmable Money

CBDC – How Dangerous is Programmability?

September 21, 2021

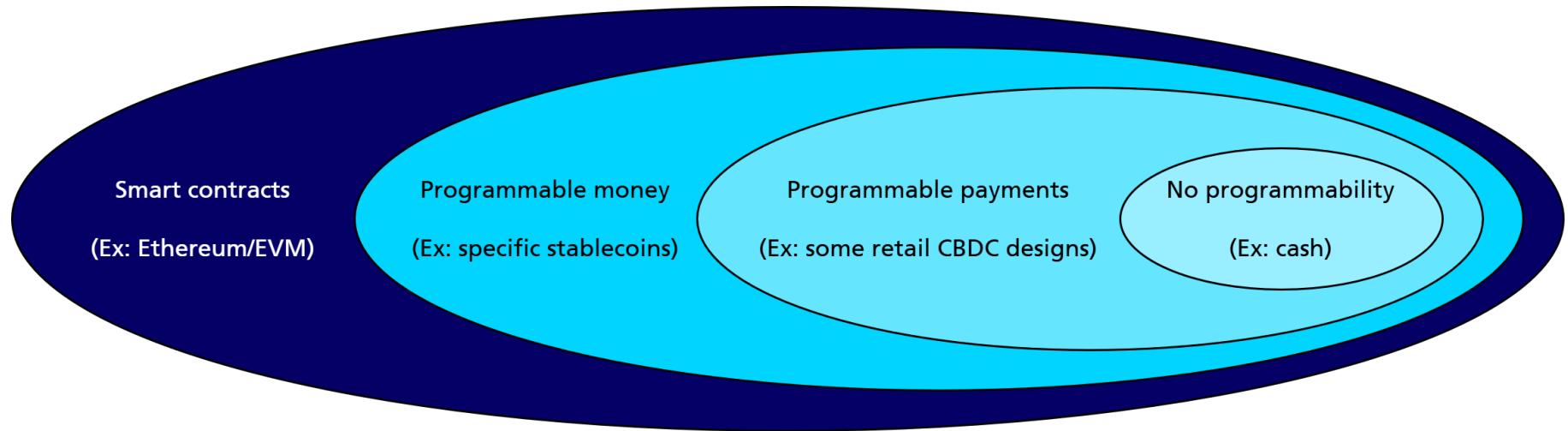
Policy

Digital Euro Will Never Be Programmable, ECB's Panetta Says

Some observers have touted restrictions on how people can spend their money as an advantage of a central bank digital currency.

By Jack Schickler | Jan 23, 2023 at 4:28 p.m. Updated Jan 23, 2023 at 6:10 p.m.

Levels of programmability





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7.4. Security & privacy



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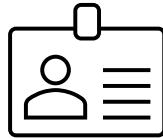
Payer identity

Ownership

Payee identity

Authenticity

Security requirements of (digital) money



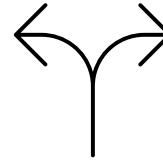
Payer identity
Payee identity



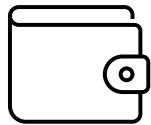
Non-repudiation



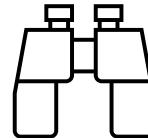
Authenticity



No double spending



Ownership

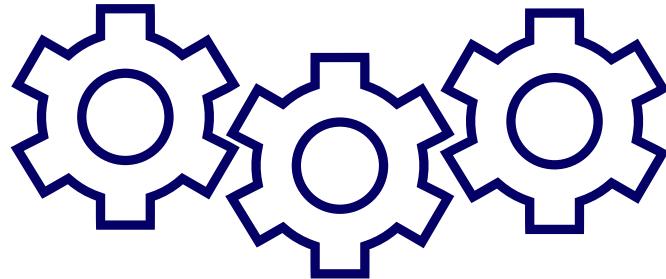


No tracing

Roles & responsibilities

Central Bank

- Issuance & Management of CBDC
- Financial stability
- Payment efficiency & integrity



Public Sector

- Ensure financial inclusion
- Regulatory oversight
- Fraud detection & investigation

Private Sector

- Distribution & custody of CBDC
- Providing additional innovative services



7.5. Motivations

Financial stability

Resilience

Financial inclusion

Cross-border payments

Payments efficiency

Monetary policy



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8. Homework exercise

Homework on digital currency

Exercise statement:

Design an innovative Retail CBDC Use Case

Your task is to propose a **precise and commercially meaningful** use case for a retail central-bank digital currency (CBDC) in the Eurozone. The aim is to identify a real-world payment problem and show how a retail CBDC—distributed through intermediaries, subject to holding limits, and capable of instant settlement—could solve it more effectively than today's payment systems.

The proposal must be **specific**. It should:

- define the target users and involved stakeholders;
- describe the payment journey;
- outline the incentives of all parties involved, from consumers and merchants to payment providers and public authorities;
- demonstrate **business value**; and
- explain why the idea cannot be replicated easily with other or existing tools such as card networks, SEPA credit transfers, mobile wallets, or stablecoins.

Form

Submissions should include a **3–5 page brief** and two visual elements (for example, a system diagram or user-journey sketch). Make sure to include a short analysis comparing the proposed solution with the current landscape, highlighting the features that make a CBDC genuinely advantageous.

Instructions & guidelines

The best proposals are the most concrete and the most focused. Here are some instructions that help you guide towards a good brief.

- **Start with inspiration from your day-to-day life:** What currently causes you troubles when making payments? What could be made more efficient?
- **Focus on a specific scenario or environment:** Examples include public transport or other city services; a festival or concert; a school, university or cafeteria; a farmer's market.
- **Think creatively and identify root causes:** For example, if a payment fails, is it because of a lack of convenience or a technical issue? Technical issues are often

easier to address than user experience. Therefore, the latter may result in higher impact in the real world.

- **Do not try to solve all problems, but only one:** Often, an iterative approach is best. Start small and work from there.
- **A picture says more than a thousand words:** User journeys and flows are often best explained with a diagram.

When working on your proposal, keep the following guidelines in mind:

1. **Intermediated model:** distribution of wallets via regulated PSPs/intermediaries; end-users hold CBDC in wallets provided by intermediaries.
2. **Retail CBDC only** (no wholesale settlement use).
3. **Offline, small-value payments** are possible (assume realistic scenarios).
4. **CBDC is not "programmable money" but supports programmable payments** (conditions and workflows around a payment, not altering the currency itself).
5. **Compliance:** adherence to AML/CFT, GDPR, and strong consumer protection.
6. **Eurozone focus.**

But feel free to deviate if you can give a good reason!

Suggested homework structure

Executive Summary: one-sentence value proposition, target user and the pain point being solved, CBDC-specific feature(s) that make it possible, expected impact (e.g., cost reduction, inclusion, resilience).

Problem & Context: who is the user, where/when does the need occur, quantify today's problem (friction, latency, reconciliation pain, fraud/privacy gaps, fees, failed payments, offline gaps, cross-system fragmentation), why does it matter.

Stakeholders & Incentives: map all relevant parties, show incentive alignment (who gains what; who pays; win-win dynamics).

Why CBDC: compare with other options, what cannot be done today or is materially inferior?

User Journey & Payment Flow: step-by-step user journey (happy path and edge cases), sequence diagram, if applicable handling of offline mode.

Business Model & Compliance: provide a basic outline of the pricing model, potential cost drivers, user value, adoption, AML approach, and consumer protection, explain how your idea could be rolled out successfully and what partners would be required.

Questions? Answers!

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