

SPEECH

Central banks on-chain

Speech by Isabel Schnabel, Member of the Executive Board of the ECB, at the Jackson Hole Economic Policy Symposium on “Financial Innovation: Implications for Payments and Policy”

Jackson Hole, 28 August 2026

It is a great pleasure to discuss Darrell Duffie’s paper “Tokenized finance and the perimeter of central banking” at this year’s Jackson Hole Economic Policy Symposium.^[1]

Tokenisation in wholesale finance has emerged as one of the most promising applications of distributed ledger technology (DLT), allowing financial assets and money to be represented as digital tokens on programmable platforms.

The potential benefits of tokenisation are substantial. This is particularly true for the euro area, as tokenisation presents an opportunity to foster integration by enabling assets and settlement to operate on common infrastructures.

However, as Darrell argues, the take-off of tokenised finance has so far partly been held back by the lack of a safe settlement asset. His paper provides an excellent overview of where central banks stand in filling this gap.

Drawing on the work currently underway in the euro area, I would like to explore three key questions.

First, is central bank money critical for the development of tokenised finance, or could well-designed stablecoins take over the role of a safe settlement asset? My conclusion is very much in line with Darrell’s: stablecoins are dominated by settlement solutions based on central bank money, reflecting in part the unique ability of central banks to elastically provide liquidity.

Second, should central bank money remain outside of distributed ledger platforms, whether by relying on private intermediaries or on bridge solutions? Or should central bank reserves themselves become native programmable assets?

Here I will suggest that central banks should embrace DLT and go on-chain themselves. Bringing central bank money on-chain would not only preserve its role as the foundation of settlement – it would also enable central banks to leverage the programmability of distributed ledgers to modernise monetary policy implementation, collateral management and liquidity provision, thereby also fostering financial stability.^[2]

The final question is *how* central banks should go on-chain. Should central bank reserves be integrated with tokenised assets on one or more shared ledgers? Or should they be issued on a central bank-operated ledger that connects to other platforms?^[3]

I will argue that the answer to this question depends on the following trade-off: a more unified infrastructure for tokenised financial markets via a single ledger or a small number of large ledgers

reduces issues of interoperability and fragmentation. But it also creates challenges for resilience, innovation and governance.

Tokenisation could bring significant benefits to the euro area

Tokenisation offers two closely related benefits for wholesale finance: atomicity and programmability.

Atomicity implies that the legs of a transaction settle together or not at all, thereby eliminating settlement risk. *Programmability* means that settlement can be made conditional on a set of rules that are executed automatically rather than being processed as a series of manually sequenced steps (Slide 2).

Neither benefit is unique to tokenisation.

In the euro area, for example, a domestic securities trade already achieves delivery-versus-payment (DvP) through the Eurosystem's central securities settlement platform TARGET2-Securities (T2S). DvP delivers atomicity for security-against-cash transactions.

T2S also embeds a degree of automated settlement: through auto-collateralisation, the platform automatically generates a repo against eligible collateral for intraday credit if a participant lacks sufficient cash to settle a purchase.

Tokenisation makes such programmability general-purpose, allowing market participants themselves to define conditions that span the entire lifecycle of a financial instrument.

Repo transactions illustrate these benefits well, as they involve not only the initial exchange of cash and collateral but also collateral substitution, margin management and the return of collateral at maturity.

On a programmable platform, these processes can largely be automated through smart contracts, thus reducing messaging, reconciliation and manual interventions across multiple institutions and infrastructures.

It is this architectural change that generates benefits such as faster and safer settlement.^[4]

These benefits are particularly large in cross-border transactions and across time zones.^[5] Since collateral often has to be pre-positioned overnight, cross-border repo transactions require significant prefunding. Programmable settlement could largely eliminate this operational friction and improve the mobility and availability of collateral.^[6]

But the implications of tokenisation extend well beyond settlement mechanics, as it also affects who can participate in financial markets and on what terms.

On the supply side, tokenisation can lower barriers to entry for both infrastructure providers and firms. France's "Lightning Stock Exchange" (Lise), for example, illustrates how tokenisation can support new trading venues tailored to smaller companies by reducing the costs for operating small-cap public markets.

On the demand side, tokenisation enables fractional ownership, allowing investors to gain exposure to assets that would otherwise be indivisible or require substantial minimum investments, such as fractional ownership in a gold bar or real estate.

Hence, tokenisation reduces barriers to entry in financial markets, whether for infrastructure providers, firms or investors.

In the euro area, this argument extends to the financial system as a whole. Europe's financial infrastructure remains fragmented along national lines, creating frictions that limit scale, competition and cross-border capital flows (Slide 3).^[7]

For example, investing in sovereign bonds across the euro area often requires access to multiple central securities depositories, increasing operational complexity while favouring larger market participants that can absorb the associated costs.

Tokenisation offers a route to an ecosystem that is integrated by design rather than stitched together across national systems. It is therefore closely aligned with the objectives of the European savings and investments union.^[8]

Stablecoins cannot be a substitute for central bank money in settlement

A prerequisite for unlocking the benefits of tokenisation is the availability of a trusted settlement asset within a tokenised environment.

Modern fiat monetary systems are built on a two-tier structure: central banks issue the ultimate settlement asset for wholesale financial transactions – central bank money – while commercial banks issue money-like claims that circulate at par (Slide 4).

Over time, this architecture emerged because it helped to solve coordination, trust and stability problems exposed by centuries of experimentation with private money.^[9]

During the free banking era in the United States, for example, state-chartered banks issued their own notes, resulting in a fragmented monetary system in which notes at times traded at substantial discounts, especially if issued by distant, less-trusted banks (Slide 5).^[10]

This is why banks today settle claims on one another using the liabilities of the central bank, which stands outside the private credit hierarchy. Central bank reserves do not carry credit or liquidity risk.

While tokenisation changes the technology through which money and assets are transferred and settled, it does not remove the need for an institutional framework that preserves par convertibility and monetary stability.

Tokenised systems must either replicate the current plumbing or build new plumbing.

This is where Darrel's work comes in. He discusses two different settlement assets for tokenised finance: stablecoins and central bank reserves.^[11]

To see why central bank reserves remain superior to stablecoins as a settlement asset, it is helpful to recall the two fundamental criteria a settlement asset must satisfy.

First, it must be safe – that is, free of credit, liquidity and redemption risk.

And second, its supply must be able to expand elastically in response to changes in liquidity demand.

Darrell's proposal of a floating-rate government security-backed coin shows that a stablecoin could, in principle, satisfy the first criterion – it could be designed in an almost perfectly safe way with zero credit and duration risk.^[12]

But a stablecoin issuer has no independent capacity to meet the second criterion: the ability to expand liquidity elastically, especially during periods of stress when funding markets experience strains and confidence shifts abruptly.

This is not a new problem. The difficulty of ensuring an elastic supply of currency was a central concern motivating the Federal Reserve Act of 1913. Under the National Banking System, money supply was tied to bank holdings of eligible government bonds.

This meant that liquidity could not expand smoothly to meet surges in demand for cash, aggravating seasonal liquidity pressures and financial panics, such as the banking panic of 1907 (Slide 6, left-hand side).^[13]

Modern central banks, by contrast, can expand liquidity elastically to counter financial stress and stabilise the monetary system if needed (Slide 6, right-hand side).^[14] This is what establishes the credibility of par convertibility – the singleness of money – between the deposits of different commercial banks.

In this sense, Darrell rightly recognises that stablecoins cannot replace central bank reserves as the economy's ultimate settlement asset.

Stablecoins are best understood as complements to central bank money, not substitutes for it. If designed and regulated appropriately, they can broaden the set of payment instruments available to households and firms and support new forms of digital economic activity.

But no matter how advanced the technology or how deep the liquidity of private tokens, financial markets can only scale safely if transactions settle in a risk-free asset that can be supplied elastically to accommodate changes in liquidity demand and ensure monetary and financial stability.

Central bank money is uniquely suited to assuming that role.

Central banks should go on-chain

The question is therefore not whether central bank money should continue to anchor the financial system, but *how* it should be made available in a tokenised environment.

Darrell discusses three options (Slide 7): (i) issuing tokenised reserves directly on a programmable ledger; (ii) linking current payment systems to programmable platforms via bridging or synchronisation; or (iii) using a private intermediary to tokenise reserves on behalf of the central bank through an omnibus account.

This choice will determine the extent to which central banks will participate in, rather than merely support, the next generation of financial market infrastructures.

Indeed, only under the first option will central bank reserves be natively tokenised. Under the second and third options, reserves either remain outside of the tokenised ecosystem or tokenisation is delegated to a private institution.

In assessing these options, let me start with the omnibus account model – that is, the question of whether the immediate settlement asset should be public or private.

In some ways, this question has historical parallels.

It resembles the debate in the United States over whether interbank settlement should run through a pyramid of private correspondent claims, as under the National Banking System, or through a unified public settlement asset, as provided by the Federal Reserve since 1913.

The omnibus account narrow bank proposal could recreate a version of the old pyramid (Slide 8).

Rather than issuing tokenised central bank reserves directly on a distributed ledger, eligible participants transfer reserves into the dedicated omnibus account of a private intermediary at the central bank, against which an equivalent amount of tokens is issued on the distributed ledger.

These tokens can then be used to settle transactions on the platform and are redeemable at par for the underlying reserves held in the omnibus account.

Under this arrangement, the settlement asset circulating on the ledger is not itself a direct claim on the central bank. Instead, the token is a private law liability backed one-for-one by central bank reserves held in the omnibus account.

This setup has two major implications.

First, if reserves are represented on-chain by a proxy, their value depends on the continued operational, financial and legal soundness of the intermediary. The incentive to replicate such wrappers across platforms risks fragmenting settlement into multiple parallel private claims rather than one common asset.

The second implication is that, in this setup, the central bank is just a passive balance sheet counterparty and gatekeeper on eligibility. It does not harness the technological benefits of tokenisation.

This is also true under the second option – the bridge solution – where the cash leg of a DLT-based transaction continues to be settled in traditional central bank money off-chain.

Essentially, under both models, the central bank continues to use the same operational framework as today. Standard repo operations would still inject reserves into banks' traditional reserve accounts.

By contrast, if the central bank issued tokenised reserves itself, it could conduct monetary policy operations natively on the DLT platform, using smart contracts.

Project Pine, a joint research study by the New York Fed and the BIS Innovation Hub, has demonstrated that using smart contracts could make monetary policy implementation nimbler and more efficient.^[15]

For example, if both collateral and reserves exist in a programmable environment, a standard repo operation could be executed atomically, eliminating the need for separate messaging and reconciliation.

Programmability would also allow the rules governing collateral management to be incorporated directly into the settlement process. Smart contracts could automatically request additional collateral or substitute securities in real time or apply differentiated remuneration rates.

These features are not merely refinements in a tokenised world. They are essential for central banks to be able to stabilise liquidity conditions as tokenisation changes the speed at which liquidity needs can propagate through the system.

For instance, automated margin calls, triggered directly by price movements through smart contracts, can force rapid asset sales, reinforcing procyclical price dynamics. More frequent, less nettable payments may also increase banks' intraday liquidity needs and thus their demand for reserves.^[16]

As a result, the central bank may need to supply liquidity faster than today's operational frameworks allow.

This is precisely why operating on-chain matters. Smart contracts could make monetary policy implementation more flexible by allowing central banks to create new operational facilities and adjust parameters such as interest rates, collateral requirements and access conditions with immediate effect.^[17]

Taken together, these considerations suggest a strong case for central bank money itself becoming a native programmable asset and for the ultimate settlement asset to remain a direct claim on the central bank in a tokenised world.^[18]

Design of tokenised architecture needs to balance trade-offs

This leaves the question of *how* tokenised reserves should be issued.

The Eurosystem's long-term work programme under Project Appia is exploring a spectrum of possible architectures for Europe's tokenised financial ecosystem (Slide 9).

One option is a single unified European ledger, bringing central bank money, commercial bank money and financial assets onto a common infrastructure. Alternatively, the Eurosystem could operate its own ledger on which it issues tokenised reserves, which is then connected to privately operated DLT networks. Another possibility would be an ecosystem of multiple interconnected ledgers hosting both central bank reserves and financial assets.^[19]

A key distinction across these models is whether central bank reserves reside on the same ledger as the assets being settled. If they do, settlement can be *strictly* atomic because the transfer of the settlement asset and the asset being exchanged can be executed as a single transaction and validated by the same consensus mechanism.^[20] Moreover, all assets would be governed by the same protocols, thus enhancing programmability.

Under a single unified ledger these benefits are maximised, as the settlement asset and all other assets can be brought together on a common infrastructure.^[21] Project Hangang – under the leadership of Governor Shin – has started to introduce, and successfully test, such a unified ledger in South Korea.^[22]

They demonstrate how this architecture can replicate the two-tier monetary system, with commercial banks continuing to interact with end users and with the central bank providing the ultimate settlement asset (Slide 10).

As a result, under a unified ledger it becomes difficult to identify a compelling role for new forms of private money for domestic payment purposes. If tokenised commercial bank deposits can be programmed, settle in central bank money and interoperate seamlessly with tokenised assets, they provide the key functionalities that stablecoins are intended to offer.^[23]

In the euro area, Project Appia is exploring these architectural choices, which will help inform the further development of the Eurosystem's Project Pontes, which is already putting some of these concepts into operation.

Project Pontes not only provides a synchronisation mechanism, connecting the Eurosystem's real-time gross settlement system TARGET Services with market DLT platforms, but it will also feature a Eurosystem-operated DLT platform for settling DLT-based transactions in central bank money (Slide 11).^[24]

While, at the launch next month, legal settlement finality for the cash leg will still be anchored in the TARGET2 system, settlement finality will ultimately be on the Eurosystem DLT platform itself.^[25] Pontes explicitly foresees the use of smart contracts on the Eurosystem DLT platform as a feature to be added after the initial launch, alongside 24/7 operations.

So, although the name Pontes literally suggests a bridge, it goes far beyond synchronisation as it will bring native tokenisation and programmability onto the Eurosystem's own platform and allow the ECB to extend its operational perimeter into tokenised markets.

The choice between different architectures depends on the following considerations.

One critical aspect is interoperability.^[26] Connecting multiple ledgers requires additional interfaces and coordination mechanisms. As the number of interconnected networks grows, so does the complexity of ensuring seamless and resilient operations.

In particular, if reserves cannot move seamlessly to where they are needed, liquidity becomes fragmented, reducing the efficiency of collateral allocation. As Darrell rightly notes, the frictionless mobility of central bank reserves is fundamental to both monetary policy implementation and settlement finality, and fragmentation could result in a higher demand for reserves.

At the same time, a shared ledger, and a single unified ledger in particular, comes with its own challenges.

Designing a governance model that gives the central bank sufficient control without making it the de-facto operator of part or all of the financial market infrastructure may prove challenging in practice and gives rise to a number of difficult questions: Who is liable if a smart contract fails? How are new participants admitted? Who decides on software upgrades and confidentiality rules?^[27]

Today, TARGET Services belong to the Eurosystem, whereas other parts of the infrastructure are owned by private companies, such as Euroclear or Clearstream. A shared ledger blurs these institutional boundaries.^[28]

Another important consideration is resilience. A unified ledger processing millions of transactions may become a bottleneck, whereas several specialised ledgers can distribute the workload and increase resilience.

One ledger also means one critical infrastructure and technology lock-in, potentially undermining innovation and competition. Interoperable ledgers can isolate failures and allow innovation to flourish. Ultimately, it remains an open question which architecture is best suited to maximise the benefits of tokenisation.

In practice, well-designed interoperability arrangements may be able to preserve most of the benefits of tokenisation while avoiding the governance, concentration and operational challenges associated with a single unified ledger.

Regardless of the architecture that ultimately prevails, traditional and tokenised financial systems will likely operate side by side for a significant period, if not permanently.

To contain the resulting fragmentation of liquidity, a key issue identified by Darrell, central banks will need to ensure that banks can manage their liquidity seamlessly across both environments, for example by reducing the frictions from differences in operating hours and settlement cycles. The need to hold liquidity buffers separately in the two environments could otherwise generate additional liquidity demand and hamper efficiency.

In a nutshell, the greater the interoperability across platforms and environments, the lower the risk of fragmentation – and the weaker the case for shifting to a single, fully integrated platform.

Conclusion

Let me conclude.

Tokenisation has the potential to fundamentally reshape wholesale financial markets.

Its benefits are likely to be particularly pronounced in the euro area, where tokenisation could not only improve market efficiency but also help overcome the long-standing fragmentation of European financial infrastructures.

But private markets cannot unlock the full potential of tokenisation on their own. For tokenisation to take off, a safe and scalable settlement asset is indispensable, and this is best provided by central banks themselves.

To reap the full benefits, central banks need to go on-chain too. That means bringing central bank money into the tokenised environment and modernising the tools of policy implementation.

This is precisely where the ECB is heading with its Pontes and Appia projects, paving Europe's path towards a tokenised financial system.

Thank you.

Annexes

28 August 2026

[Presentation slides: Central banks on-chain](#)

Duffie, D. (2026), “Tokenized Finance and The Perimeter of Central Banking”, paper prepared for the Jackson Hole Economic Policy Symposium on “Financial Innovation: Implications for Payments and Policy”, 8 July. I would like to thank Antoine Lallour for his contributions to this speech.

2.

Although central banks have spent decades refining the conduct of monetary policy, the technological infrastructure through which monetary policy is implemented has changed remarkably little. While the settlement infrastructure has been incrementally modernised, such as through faster batch cycles and expanded operating hours, there has been no change in the underlying architecture for monetary policy implementation.

3.

Shared ledger means that the ledger hosts different kinds of assets. Moreover, access to the ledger is open, i.e. it is not restricted to the owner or operator. One can have a single shared ledger or multiple shared ledgers.

4.

Similarly, the Bank of Canada's Project Samara demonstrated how issuing, trading and settling tokenised securities on a distributed ledger has the potential to compress processes that currently take days into near-instantaneous execution. See Arora, R. et al. (2026), “[Project Samara Research Paper](#)”, *Staff analytical papers*, No 2026-8, Bank of Canada, March.

5.

Tokenisation can provide tangible benefits even for simple cross-border payments, as such transactions are still routed through correspondent banking chains, which introduce cost and delay through sequential processing. Where a currency exchange is involved, this is compounded by settlement risk – in the absence of payment-versus-payment (PvP) arrangements, one leg of the exchange can settle without the other. Tokenisation's promise of continuous, atomic PvP settlement addresses this latter risk directly.

6.

Tokenisation could also improve the transferability and collateral usability of assets that are currently difficult or costly to trade. However, tokenisation does not by itself create liquidity, which ultimately depends on the availability of buyers and sellers, transparent pricing and appropriate market infrastructure.

7.

Lagarde, C. (2024), “[Follow the money: channelling savings into investment and innovation in Europe](#)”, speech at the 34th European Banking Congress: “Out of the Comfort Zone: Europe and the New

World Order”, Frankfurt am Main, 22 November; Draghi, M. (2024), [The future of European competitiveness](#), European Commission, September.

8.

These efficiency gains can only be realised if the asset represented on the ledger is legally uniform across the jurisdictions the ledger spans. A 28th regime, if designed accordingly, would enable tokenisation to deliver on its integration promise. For a discussion on the benefits of a 28th regime, see Schnabel, I. (2026), [“Made in Europe”](#), speech at a lecture in memory of Eugen Böhm von Bawerk, Österreichische Akademie der Wissenschaften, Vienna, 11 February.

9.

Monetary policy can be viewed as a consequence of central banks occupying the centre of the payments and settlement system. The settlement role gave central banks the leverage over the financial system that later enabled monetary policy to become a powerful macroeconomic stabilisation tool.

10.

See, for example, Carlson, M. (2026), [“A brief history of bank notes in the United States and some lessons for stablecoins”](#), *FEDS Notes*, 6 February.

11.

See also BIS (2026), [“Anchoring trust in money: innovation beyond stablecoins”](#), *Annual Economic Report 2026*, 28 June.

12.

Duffie, D. and Wilson Jr., D.R. (2025), [“The case for a new floating rate Treasury note”](#), Brookings, 2 December. In practice, of course, most stablecoins are not perfectly safe and face credit, liquidity and valuation risk. See Schnabel, I. (2026), [“From money market funds to stablecoins: lessons for central banks”](#), speech at the 2026 Bank of Korea International Conference on Central Banks and the Future of Money, Seoul, 1 June.

13.

The New York Clearing House acted to some extent as lender of last resort, but its actions were insufficient and lacked legal backing. See Tallman, E.W. and Moen, J.R. (1990), “Lessons from the Panic of 1907”, *Economic Review*, No 75, Federal Reserve Bank of Atlanta, pp. 2-13.

14.

This function is closely linked to the central bank’s traditional role as lender of last resort. See Bagehot, W. (1873), *Lombard Street: A Description of the Money Market*, H.S. King, London.

15.

BIS (2025), "[Project Pine: Central bank open market operations with smart contracts](#)", BIS Innovation Hub, 14 May.

16.

At the same time, innovations such as intraday money markets could partly offset this by improving real-time liquidity redistribution.

17.

Earlier this year, the Eurosystem already took a first step in this direction: marketable assets issued in central securities depositories using DLT are now eligible collateral for Eurosystem credit operations.

See ECB (2026), "[ECB paves way for acceptance of DLT-based assets as eligible Eurosystem collateral](#)", *press release*, 27 January.

18.

This need not preclude a complementary role for private sector solutions based on omnibus accounts. Where supported by appropriate governance, legal certainty and risk management safeguards, such arrangements could coexist with on-chain central bank money, extending innovation while preserving the central bank's role as the issuer of the ultimate settlement asset.

19.

European Central Bank (2026), [Appia – paving the way for a future-ready, integrated financial ecosystem leveraging tokenisation and DLT](#).

20.

Kunaratskul, T. et al. (2025), "[Central Bank Exploration of Tokenized Reserves](#)", *Fintech Notes 2025*, No 011, IMF. On interoperable ledgers, the smart contract must instead obtain reliable information from another ledger, requiring messaging and synchronisation. So, if central bank money remains on a separate ledger, every transaction in a tokenised economy relies on weak atomicity.

21.

BIS (2025), "[The next-generation monetary and financial system](#)", *Annual Economic Report 2025*, June.

22.

The final step – moving tokenised securities on the same platform – is still in the proof of concept phase. See Shin, H.S. (2026), "A unified ledger in practice: lessons from Project Hangang", paper presented at the ECB Forum on Central banking "Shaping Europe's future: innovation, growth and stability", Sintra, 29 June to 1 July.

23.

Stablecoins may retain some benefits as freely transferable digital instruments that are not tied to a particular commercial bank or banking relationship.

24.

European Central Bank (2025), "[ECB commits to distributed ledger technology settlement plans with dual-track strategy](#)", *press release*, 1 July; and European Central Bank (2025), "[Bridging innovation and stability: The Eurosystem's exploratory work on new technologies for wholesale central bank money settlement](#)", June.

25.

Cipollone, P. (2026), "[Building the rails for Europe's tokenised financial markets](#)", keynote speech at an event on "Building Europe's integrated digital asset ecosystem: from vision to implementation" hosted by the House of the Euro, Brussels, 23 March.

26.

Cipollone, P. (2026), "[From vision to delivery: building Europe's tokenised financial market](#)", speech at the Deutsche Bundesbank's Symposium on "Future of payments: trends and innovations in Germany and Europe", Frankfurt am Main, 26 August.

27.

Certain central bank operations require a high degree of confidentiality and cannot become visible on a shared infrastructure. Conversely, the central bank must retain sufficient visibility over aggregate reserve balances and liquidity conditions to implement monetary policy effectively and safeguard financial stability.

28.

Agreeing on governance of a shared platform for central bank money across borders, as is foreseen in Project Agorá, is arguably even more challenging. For more on Project Agorá, see BIS (2026), "[Project Agorá: A shared programmable platform for wholesale cross-border payments](#)", BIS Innovation Hub, 27 May.

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