FINTECH NOTES

Evaluating the Implications of CBDC for Financial Stability

Marco Gross, Marcello Miccoli, Jeanne Verrier, and Germán Villegas-Bauer

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Prepared by Marco Gross, Marcello Miccoli, Jeanne Verrier, and Germán Villegas-Bauer*

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Introduction and Summary of Findings

This Fintech Note discusses the potential implications of retail central bank digital currency (CBDC) for financial stability, a primary question central banks consider when evaluating CBDC.[1] CBDC has been proposed as a more stable, secure, and efficient alternative to private forms of digital money. Nonetheless, there are concerns that wide acceptance of CBDC could disrupt the business models of financial institutions, reduce credit provision to the economy, and increase the risk of bank runs[2].

The financial stability implications of CBDC have been researched in academia and policy institutions, primarily from a theoretical perspective and with applications to specific countries. The contribution of this Note is twofold. First, it provides a framework to think through the financial stability implications of CBDC, taking a broad perspective on financial systems in different types of economies, and drawing insight from studies that have quantified some of these effects. Second, this Note offers guidance for practitioners on tools and models to evaluate financial stability risks in their economies and discusses strategies to mitigate them.

This Note focuses narrowly on the effects of CBDC on domestic financial stability. As a consequence, it does not provide an integral assessment of the implications of CBDC, nor does it opine on the appropriateness of issuing CBDC. Instead, the Note strives to summarize existing knowledge to support countries in their own evaluations of the risks and benefits of CBDC for financial stability. As more work is undertaken at the IMF and in jurisdictions around the world, results will evolve. Other questions related to CBDC are explored in further chapters of the IMF's Virtual CBDC Handbook. Key findings are summarized in the following.

As a new liquid, safe, and widely accessible payment instrument and a store of value, CBDC could substitute for other forms of money, including bank deposits. A foundational principle of CBDC is that it should be designed to coexist with existing forms of money. Still, agents may choose to decrease their holdings of bank deposits as well as safe and money-like assets, in favor of CBDC. Such substitution would introduce competitive pressures in the financial system, potentially affecting financial stability.

Financial stability should be seen holistically, as it is rooted in a variety of elements. Some relate directly to banks' balance sheets, such as profitability, liquidity, and solvency. And others are broader, relating to risk-taking behavior, interconnectedness, and resilience. It is therefore important to take a holistic view of financial system dynamics.

This Note identifies six interrelated channels through which CBDC could affect financial stability negatively or positively. These operate through changes in the size and composition of financial institutions' liabilities and assets and, relatedly, through an increase in the cost of funding and lending (liability and asset channels), a reduction in banks' income from collected fees (fee income channel), an

[1] See Soderberg and others (2023) for a discussion of CBDC policy questions and management.
[2] The link between financial development and economic growth is well established in the literature. The financial sector promotes economic growth by mobilizing and pooling savings, facilitating information sharing, contributing to the allocation of resources to productive uses, and exerting corporate control. See, for example, Goldsmith (1969), McKinnon (1973), King and Levine (1993), Levine and Zervos (1998), Rajan and Zingales (1998), Beck, Levine, and Loayza (2000), and Levine, Loayza, and Beck (2000).

increase in the risk and intensity of runs on banks and issuers of safe and money-like assets in stress times (run-risk channel), changes in the flow of information on borrowers and CBDC users (information channel), and an increase in competition in retail payment markets and changes in the operational resilience of payment systems (resilience channel).

The relative strength of these channels and their economic significance are theoretically ambiguous. They depend on factors such as the level of CBDC adoption, country characteristics, and design features. The application of economic models to real-world data can help determine how these factors affect the magnitude of each channel and the overall impact in practice.

To date, quantitative studies have found that CBDC would not pose significant financial stability risks under scenarios of mild adoption, though country characteristics need to be factored in. Existing studies have focused primarily on the effects on banks' balance sheets and are calibrated to specific country circumstances. The findings from these studies suggest that, although banking system profitability may decrease, the impact on financial stability is likely to be limited overall—especially in countries with financial systems characterized by low competition, low reliance on deposit funding, and sufficient access to alternative sources of funding. Still, these findings should not be a reason for complacency, as the complexity of interactions within the financial system and the need for nuanced modeling underscore the uncertainty surrounding CBDC's real-world effects.

Countries can get a sense of the possible impact of CBDC on their own financial systems by using various tools and models. A useful starting point is to explore how the balance sheets of financial institutions could respond, along with those of the central bank, government, and private sector. Financial and macrofinancial models typically require more modeling capacity, but capture richer dynamics in the financial sector, as well as consumer/borrower and government behavior. Analysis should be rooted in data such as the balance sheet composition of banks and the central bank, their profitability, metrics of competition in the banking system, and other financial indicators related to the broader financial system.

Countries can contain financial stability risks with appropriate CBDC design and policies. These include quantity limits on CBDC holdings or fees applied to holdings above a certain limit. However, restricting CBDC adoption can also undermine other CBDC objectives. In any case, traditional safeguards for financial stability, such as prudential and crisis management policies, remain useful.

This Note is organized as follows. The "Conceptual Framework" section offers a qualitative analysis of the different channels through which CBDC may affect financial stability. Next, the "Insights from Quantitative Studies" section discusses the quantitative assessments of the potential effects on financial stability, drawing insight from selected studies. The "Practical Considerations" section offers practical guidance to country authorities on how to organize their research efforts, and reviews tools and analytical frameworks for quantifying these effects. Finally, the "Design and Policy Options to Mitigate Downside Risks" section explores the design and policy options to mitigate downside risks.

I. Conceptual Framework

This section presents a general framework to explore the potential implications of CBDC for financial stability and provides a qualitative discussion of the main transmission mechanisms. Aspects related to quantification are discussed in the "Insights from Quantitative Studies" section.

Introducing Central Bank Digital Currency

This section considers a stylized financial system, which comprises commercial banks, nonbank financial institutions (NBFIs) (for example, insurance firms, pension funds, or mutual funds), nonbank payment service providers (PSPs), and the central bank, along with nonfinancial private sector agents such as households and nonfinancial firms. Before CBDC is introduced, private sector agents hold their money in the form of cash, bank deposits, private forms of digital money (such as e-money) and safe and money-like assets (such as short-term government securities, commercial paper, certificates of deposits, and well-regulated stablecoins fully backed with safe and liquid assets).[3,4] They decide in what form to hold their funds based on the product attributes (such as risk, return, cost, and convenience) and their own consumption and saving preferences (Li 2023).

A new liquid, safe, and widely accessible asset—CBDC—is introduced in this environment, which can generate new competitive pressures on banks and issuers of safe and money-like assets. A foundational principle of CBDC is that it should be designed to coexist with existing forms of money (BIS 2020). Still, depending on their preferences, agents may choose to decrease their holdings of other forms of money in favor of CBDC, either for payments or as a safe and liquid asset for savings. Agents may value that, as a direct liability of the central bank, CBDC bears no credit and liquidity risk, contrary to private money (bank deposits, e-money) or stablecoins. In addition, CBDC is digital. Some private sector agents may prefer CBDC for its convenience and efficiency as a means of payment and exchange, as compared to nondigital central bank money (cash).

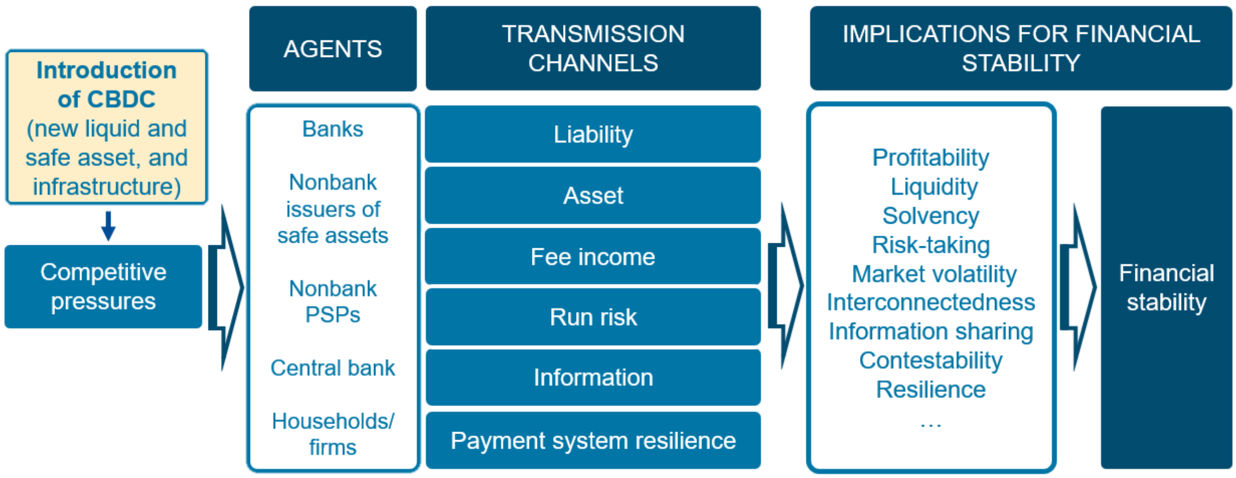
Transmission Channels

Financial stability is a multifaceted concept that is rooted in a multiplicity of elements. These are directly related to banks' balance sheets, such as profitability, solvency, and liquidity ratios. They also include aspects such as risk-taking, market volatility, interconnectedness, information sharing, contestability, and resilience. This Note aims to shed light on how CBDC may affect these elements through various channels, potentially affecting one or more types of agents in the financial system.[5]

[3] For a definition of digital money and assets, see Adrian and Mancini-Griffoli (2021) and IMF (2021). Stablecoins are crypto assets that aim to keep a stable value with respect to an asset or pool or assets, commonly with respect to a specific currency (IMF 2023b). They perform poorly as a substitute for money. The reasons are that concerns over their backing may results in deviations from their peg (Adrian and others, forthcoming).
[4] Safe and money-like assets are two distinct concepts that can overlap, especially in normal times (Potter 2018).
[5] Financial Stability Board (2021) can also serve as a general framework through which the implications of CBDC can be examined, just as any other structural changes facing a financial system. It includes a definition of financial stability, channels, shocks, and mitigating factors that are in line with this Note.

This section identifies six main transmission channels through which CBDC may affect financial stability (Figure 1). Although the proposed classification is useful to understand the fundamental mechanisms, in practice the channels are closely interconnected and operate simultaneously, as further discussed at the end of this section. This section also sets aside CBDC designs and policies aimed at mitigating financial stability risks, which are discussed in the "Design and Policy Options to Mitigate Downside Risks" section.

Figure 1. CBDC Transmission Framework



Source: Authors.
Note: CBDC = central bank digital currency; PSPs = payment service providers.

Liability Channel

The liability channel relates to the impact of CBDC-induced competitive pressures on the liability side of financial institutions' balance sheets, in particular changes in their composition and the cost of funding.

The introduction of CBDC could lead to outflows of bank deposits into CBDC, potentially changing banks' funding structures. The impact will depend on how banks respond to deposit outflows. Four main possible scenarios need to be considered.

First, banks may increase their reliance on short-term wholesale funding, with unclear consequences for financial stability ex ante. On the negative side, wholesale funding is inherently less stable, exposing banks to rollover risks, and is generally costlier than retail deposit funding (Huang and Ratnovski 2011; Gertler, Kiyotaki, and Prestipino 2016). In addition, rebalancing toward wholesale funding may increase the interconnectedness between banks and NBFIs (Bouis and others 2024). For instance, if a shock triggers outflows from money market funds (MMFs), a type of NBFI that invests in short-term securities such as commercial paper issued by banks, it could negatively affect the availability of wholesale funding. On the positive side, a shift toward wholesale funding and away from retail funding could instill greater market discipline, since wholesale funding providers are not protected by explicit deposit insurance schemes and therefore have greater incentives to monitor banks than retail depositors (Mancini-Griffoli and others 2018; Das and others 2023).[6]

Second, banks may substitute deposit funding with long-term debt. On the one hand, a greater reliance on long-term debt can reduce rollover risks and improve banks' liquidity positions. On the other hand, it can increase financing costs, as long-term funding typically carries higher interest rates, and hence reduce bank profitability.

Third, domestic financial institutions may rebalance their liabilities toward more foreign funding, potentially leading to higher currency mismatches and funding volatility.[7] Currency mismatches could materialize if foreign funding is denominated in a foreign currency. Funding volatility may increase because foreign lenders tend to exhibit a home bias in their lending portfolio when funding conditions deteriorate (Giannetti and Laeven 2012).

Fourth, banks may consider increasing their reliance on central bank borrowing, resulting in higher funding costs and a heightened sovereign–bank nexus. Central bank borrowing rates are typically set above market rates to discourage excessive use. A stronger sovereign–bank nexus could emerge if banks increased their purchases of government bonds to pledge collateral with the central bank to increase borrowing.[8] Importantly, an expansion in central bank borrowing, if significant, would grow the balance sheet of central banks and expose them to financial risks.[9,10] Outside of a bank run situation, central banks may not consider it a viable policy option nor have the statutory authority to do so (Mancini-Griffoli and others 2018; Bouis and others 2024).

Banks may also respond to CBDC-induced competitive pressures by raising retail deposit rates in an attempt to retain deposit funding. In less competitive banking sectors, banks generally have higher profit margins and thus more leeway to increase deposit rates. While banks would likely raise rates on sight deposits, as these are most closely affected by CBDC competition, banks might also increase rates on term deposits. A reallocation of sight toward term deposits could ensue, which would better align banks' maturity structure on the asset and liability side and improve liquidity positions. Banks may also try to retain deposits with other strategies, such as reducing fees on other services or offering complimentary financial services to improve customer experience (Mancini-Griffoli and others 2018; Das and other 2023). Implementing these strategies may increase operational costs.

CBDC may also affect nonbank issuers of safe and money-like assets. Investors may substitute away from these assets and into CBDC, which would reduce demand for these assets and therefore reduce

[6] However, collective withdrawals during the global financial crisis suggest that wholesale funding providers may fail to impose sufficient market discipline, especially when funds are provided at short maturities (Huang and Ratnovski 2011; Brunnermeier and Oehmke 2013; IMF 2013).
[7] Currency mismatch risk arises when an entity's assets and liabilities are denominated in different currencies, exposing it to potential losses from exchange rate fluctuations.
[8] Similarly, central banks could purchase government bonds to inject liquidity, thereby "pushing" reserves into the banking system.
[9] Generally, an expansion of the central bank balance sheet may lead to more risk exposure of a central bank to the private sector, either indirectly (if banks were to engage in more collateralized reserve borrowing) or directly (if the central bank was to purchase assets/collateral from the market). Prudent risk management on the side of the central bank is important in either case.
[10] In addition, greater reliance on central bank liquidity may lead to collateral shortages as a higher share of the assets that are generally used as collateral would be pledged with the central bank, particularly in emerging markets with limited high-quality liquid assets. This could strain repo markets and amplify fragility (Greppmair, Paludkiewicz, and Steffen 2025).

their prices and raise their yields. However, this substitution effect might not be sizable if CBDCs were not remunerated.

Asset Channel

The asset channel is deeply intertwined with the liability channel but operates through the asset side of financial institutions' balance sheets. It relates to how competitive pressures resulting from the introduction of CBDC may affect the size and composition of financial institutions' assets and increase lending rates.

Competitive pressures driven by CBDC may induce banks to decrease their assets holdings and therefore the size of their balance sheets. Should they hold reserve assets in excess of regulatory requirements, banks may shrink them to service the deposit outflows as a first line of action, which could suffice to cover the decline in retail deposit liabilities. If excess reserves are remunerated, this decline would reduce bank interest income. Banks may also sell other assets to service deposit outflows. In addition, competitive pressures may induce banks to change their asset composition. In particular, banks that are deemed too big to fail may have incentives to take excessive risk to recover their financial position (Baldursson and Portes 2013; Jiang and others 2023).

Depending on the level of competition in the banking sector, adjustments may also happen through the cost of lending. Banks may be able to mitigate the decline in interest margins by increasing lending rates. Higher lending rates would support interest margins but may at the same time result in fewer loans (Agur, Ari, and Dell'Ariccia 2022; Andolfatto 2021; Chiu and others 2023; Keister and Sanches 2023). Banks with more market power are better positioned to pass on higher funding costs to borrowers while limiting the reduction in lending volumes.

CBDC may also exert competitive pressures on nonbank issuers of safe and money-like assets. Similar to banks, increased competition for money-like assets may lead their issuers to sell asset holdings or change their composition. Higher risk-taking can ensue. For instance, MMFs may have incentives to shift to riskier assets to offer higher returns and mitigate the migration of funds into CBDC.

Fee Income Channel

The fee income channel operates through a reduction in fee income, stemming from higher competitive pressures in the market for deposits and for payments.

CBDC-induced competitive pressures could reduce the fee income of banks and nonbank PSPs. Reduced usage of bank checking accounts could decrease the income earned from account-related fees. These include charges for account maintenance and withdrawals, penalties for non-sufficient funds, overdrafts, and late payments. In addition, increased competition in payment markets could lower transaction-related fees, such as interchange, assessment, and end-user fees (Patel, Reshidi, and Reuter 2025).

Since holding a checking account facilitates the use of other bank services—such as personal loans, savings accounts, investment, or insurance products—deposit outflows could also reduce commercial banks' revenues from cross-selling opportunities. This would materialize if, because of deposit outflows, customers have fewer interactions with the bank or leave the bank entirely. At the same time, it is likely that households and firms would still need to maintain some type of bank account to have access to financial services that CBDC would not offer (Garcia and others 2020).

Run-Risk Channel

The run-risk channel relates to how CBDC may exacerbate the runs on banks and issuers of safe and money-like assets during stress times.

CBDC may facilitate bank runs. Bank failures, or the expectation of bank failures, can lead depositors to withdraw their funds. However, withdrawing and storing large amounts of physical cash can be inconvenient and risky, and safe-haven assets (such as precious metals or top-rated sovereign bonds) may be subject to large price fluctuations. CBDC, as a safe and convenient store of value, might facilitate a flight to safety away from bank deposits (Bindseil 2020; Bindseil and Panetta 2020; Kumhof and Noone 2021; Bidder, Jackson, and Rottner 2024).

However, the effect may be muted in countries where liquid and safe alternative options to deposits are already widely available and switching costs are low. For instance, in advanced economies where runs have been largely driven by institutional investors, money market alternatives to which these institutions can run are already accessible in periods of financial stress. Moreover, deposit insurance plans mitigate run incentives for retail depositors. Bank supervision and access to central bank liquidity are additional safeguards which reduce the probability of bank runs in the first place.

At the same time, the availability of CBDC in a banking crisis may help retain funds in the domestic economy, rather than seeing runs to foreign assets, and thus limit the risks of currency crises. This scenario would hinge on depositors' expectations about inflation and trust in the central bank (Bouis and others 2024).

Compositional changes in banks' balance sheets after the introduction of CBDC may affect the severity of bank runs. On the one hand, a smaller deposit base resulting from the conversion into CBDC implies that banks would experience less severe impacts from retail deposit runs (Keister and Monnet 2022; Bidder, Jackson, and Rottner 2024). Furthermore, if the share of bank long-term funding (through term deposits or bond issuance) and central bank borrowing increase, runs may be less likely or less significant (Brunnermeier and Niepelt 2019; Auer and other 2024; Infante and others 2024). On the other hand, a higher dependence on short-term wholesale funding increases banks' exposure to liquidity risk, especially if short-term funding finances long-term illiquid assets.

CBDC may also facilitate runs on issuers of safe and money-like assets. These runs could, in turn, trigger a withdrawal of wholesale funding from banks (Aldasoro and Doerr 2023). For instance, a run on MMFs would reduce demand for short-term, high-quality securities, such as bank-issued commercial paper. In addition, if the withdrawal of wholesale funding results in a shift away from transactions in interbank markets, it could undermine the reliability of key interest rate benchmarks—such as the secured overnight financing rate (SOFR), the euro short-term rate (€STR), and the Federal Funds rate—to the extent that these benchmarks are largely based on actual transactions in active and liquid secured interbank markets (BIS 2021).

Information Channel

The information channel operates through the flow of information on borrowers and CBDC users.

On the one hand, bank deposit outflows can result in a loss of information on borrowers. Banks typically have access to consumers' and firms' transaction data. Empirical studies have shown that this information, which encompasses data on households and their consumption and saving patterns, as well as on firms' cash flows, payment history, income, and fund balances, helps banks assess creditworthiness (Mester, Nakamura, and Renault 2007; Norden and Weber 2010; Puri, Rocholl, and Steffen 2017; Lannquist and Tan 2023). Losing access to this information could increase information asymmetries and default risks in credit markets, and in turn have negative implications for bank solvency.

On the other hand, CBDC transaction data could also be valuable to monetary authorities to support financial stability. First, it can allow policymakers to observe and analyze real-time transaction data, which can improve the effectiveness of central banks in implementing monetary policy and upholding financial stability.[11] More agile monitoring of flows into CBDC in stress times can prove particularly useful to identify weak banks and intervene early, which can in turn decrease bank depositors' incentives to run (Keister and Monnet 2022). Second, CBDC data can help strengthen regulatory compliance and law enforcement, which could reduce illicit activity. This could be reinforced by the specific choice of the infrastructure on which CBDC operates. One such example is the automation of capital flow management measures through smart contracts (He and others 2023). Policymakers would need to strike a balance between data use and privacy protection with appropriate CBDC design. At a minimum, authorities could benefit from the use of aggregated or anonymized data without concerns for privacy protection. Instead, personal data use could pose risks of data leakage, data abuse, or cyberattacks, which could lead to operational instability and undermine trust in public institutions (Murphy and others 2024).

Payment System Resilience Channel

The payment system resilience channel relates to increased competition in retail payment markets, which could have a beneficial impact on financial stability by lowering concentration and fragmentation risks, and by improving operational resilience.

A CBDC ecosystem can lower concentration and fragmentation risks in the context of declining cash use (Liu and others 2023; Infante and others 2024; Patel, Kasiyanto, and Reslow 2024). CBDC can establish a level playing field among private sector participants (such as banks, PSPs, and fintech companies) by providing a public infrastructure and an appropriate regulatory framework.[12] This public infrastructure and regulatory framework can require interoperability among PSPs, thereby reducing market dominance stemming from network effects.[13] This, in turn, can help preserve monetary autonomy and decrease payment fragmentation. However, CBDC could also displace existing competitors and become overly dominant in the payment landscape if not properly designed.

[11] See Murphy and others (2024) for an in-depth discussion of the possible CBDC designs in terms of data collection, access, storage, and usage.
[12] As a payment platform, CBDC systems could offer their own infrastructure through which payments are routed and ultimately settled (Patel, Reshidi, and Reuter 2025).
[13] Chiu and others (2023) and Agur and others (2025). The integration of PSPs into the CBDC ecosystem could also provide them with access to CBDC, a safe and liquid digital asset. Such access could lead to improved liquidity management and lower settlement costs (see Carapella and others 2024).

Increased competition in the payments market could also increase operational resilience. If CBDC reduces market concentration, the failure of a single firm after events such as cyberattacks, operational outages, or natural disasters would become less systemically relevant.[14] A well-functioning CBDC system could also serve as a back-up system for the traditional payment system. It would require a resilient and efficient infrastructure, as large operational outages in the payment system could have repercussions on financial stability (BIS 2022; Bharath, Paduraru, and Gaidosch 2024; IMF 2024).

Overarching Considerations

Although the channels help to conceptually identify the elements that would affect financial stability, all channels are closely interconnected. For example, the optimal contraction and rebalancing on the asset side of bank balance sheets depend on the costs associated with mitigating liability-driven outflows of financial assets. Also, changes in run risks are directly intertwined with changes in bank balance sheet structures. Channels might reinforce each other. For instance, as banks lose profits through lower fees, investors may require higher returns in compensation for greater perceived risks.

The bank liability, asset, and run-risk channels are likely to be the most significant overall. In many banking systems, including in advanced economies, deposits continue to serve as a major source of funding. A direct impact on bank funding structures through the asset, liability, and run-risk channels is likely to dominate the fee income, information, and payment resilience channels whose effect on bank funding structures may be indirect or not material. The literature, too, has largely focused on the asset, liability, and run-risk channels (see the “Insights from Quantitative Studies” section).

The magnitude of the channels will depend on CBDC adoption, which may not necessarily be high. Experiences from countries that have already issued CBDC suggest that adoption may be gradual or limited, particularly in non-crisis times. The extent to which CBDC could substitute existing forms of money—and which ones specifically—will depend on individual preferences and country-specific characteristics. In general, incentives to adopt CBDC are lower when trust in the banking system is stronger, payment systems are more mature, and network effects—whereby adoption by an individual depends on the extent of adoption by others—are larger (Koonprasert and others 2024; Copestake and others 2025). High trust in the central bank, on the other hand, could increase incentives to adopt CBDC.

In addition, adoption will depend on specific CBDC design features, which will affect its attractiveness and accessibility. Most central banks are considering unremunerated CBDC, which curtails the usefulness of CBDC as an asset for savings. Even if they were remunerated, the presence of switching costs could result in sticky behaviors and limit or slow down retail adoption unless users observe clear benefits from holding or transacting with CBDC.[15]

[14] Regulation will continue to play an important role in mitigating risks of banks’ and payment firms’ underinvestment in security. See Khiaonarong, Leinonen, and Rizaldy (2021) and Patel, Reshidi, and Reuter (2025).

[15] Outflows from deposits to money market funds (MMFs) could provide some indications regarding the sensitivity and flow dynamics into CBDC. The literature (largely focused on the US) points to limited interest rate sensitivities (Morgan and others 2022; Afonso and others 2023; Adrian and others 2024). The parallel to MMF dynamics is not easy to draw, however, since MMF holdings pay interest, while they do not offer the payment functionalities of deposits and CBDC.

Even if CBDC were widely adopted, it may not inherently imply large competitive pressures on banks. CBDC may substitute for cash or, to a lesser extent in many countries, for private forms of digital money, in which case the impact on banks would be limited. Moreover, the introduction of CBDC may actually increase deposit holdings, in particular in banking systems characterized by low competition. Banks would see their market power reduced and would optimally react by offering higher deposit rates, thereby making deposits more attractive (Andolfatto 2021; Chang and others 2023; Chiu and others 2023).

In addition, CBDC may reduce banks' net income, yet lower banking system profitability may not necessarily threaten financial stability. Bank capital would come under pressure only if profits fell significantly. For wider financial stability risks to materialize, capital must also be strained for a significant segment of the banking system. However, reduced profit margins, even if nonnegative, would render the system more vulnerable to future profitability shocks, and hinder the ability to rebuild buffers in the aftermath of shocks.

The six channels primarily pertain to a short- to medium-term horizon. They reflect the reaction of the financial system when CBDC is introduced, as well as through a transition phase. The outcomes in medium- to long-term scenarios may differ. For instance, the introduction of CBDC could initially reduce the profitability of weaker banks, leading to short-term instability and possible bank failures. In the longer term, some of the weak banks may close or be acquired, and the system may remain with more efficient banks. Alternatively, bank business models may evolve and improve to better compete with CBDC.

Stablecoins have grown steadily in recent years and may coexist with CBDC in the future. Similar to CBDC, they could generate competitive pressures for the financial sector. Stablecoins are currently mostly used as a settlement asset for crypto trades, but they have the potential to be used in payments. Like CBDC, stablecoins could affect financial intermediation by substituting bank deposits. Unlike CBDC, stablecoins are vulnerable to volatility in value and run risks. In a scenario where both CBDC and stablecoins are used for payments, CBDC could compete with stablecoins; or CBDC and stablecoins could complement each other by focusing on specific use cases. In this scenario, they could potentially reinforce the strength of the channels.

II. Insights from Quantitative Studies

The implications of CBDC for financial stability may be positive or negative. Evaluating the direction and magnitude of the effects requires the application of models to real-world data.[16]

There are no quantitative studies that simultaneously analyze all the channels of transmission highlighted in the previous section. This section looks at estimates based on specific modeling assumptions, channels of transmission, and country characteristics. It also provides suggestions on how results might change as any of these ingredients vary. The section reviews selected quantitative studies, and the range of magnitudes observed under different scenarios. The analytical research has mostly focused on the liability and asset channels, and to a lesser extent on the run-risk channel.

Different types of economic frameworks have been used to analyze the impacts of introducing CBDC, varying in the detail of analysis—from more granular to more macro—and in their complexity (see the "Practical Considerations" section). Each of the different economic modeling techniques has advantages and limitations. Some frameworks have the advantages of deeply exploring financial metrics of the banking system, while usually simplifying the treatment of consumers. Others capture richer dynamics in the financial sector, as well as consumer/borrower and government behavior, but have a more simplified treatment of banks.

The heterogeneity of methods of analysis calls for some caveats. Even for models that report the same outcome variables, comparisons of impact estimates can be misleading, because of different underlying data and behavioral assumptions. Results should thus not be compared without a careful understanding of the relevant channels and modeling assumptions, which this Note tries to elicit.

Measures of financial stability vary across models. Some studies focus on bank profitability by reporting the impact on the return on assets and return on equity (RoE), alongside liquidity metrics such as the net stable funding ratio and the liquidity coverage ratio and other balance sheet ratios. Some focus on the impact on deposit rates, aggregate deposit balances, and lending rates. Others calculate model-specific measures of run risks. Table 1 summarizes an array of empirical studies alongside the primary outcome variables that relate to financial stability.

With respect to the liability channel, empirical analyses find that the impact on deposits depends on the degree of competition in the banking sector. The introduction of CBDC in countries with a fully competitive banking sector is likely to see a conversion of bank deposit liabilities to CBDC and an increase in deposit rates. However, as discussed in the previous section, if CBDC is introduced in countries with a less competitive banking sector, deposits could actually increase. For instance, Chang and others (2023) estimates that deposits could grow by 0.1 percentage points (as a share of total households' wealth) in a scenario where banks are not fully competitive and CBDC adoption is costly for users. This is because, in a context where bank deposit rates are low because of limited competition, competitive pressures from CBDC would lead banks to offer sensibly higher deposit rates, attracting more deposits from relatively

[16] The current lack of historical data on CBDC introductions makes direct econometric modeling unfeasible. Therefore, indirect structural models, that describe CBDC by some of its characteristics, offer the greatest potential to evaluate the impact of introducing CBDC at this time. In this context, the term "empirical" refers here to the anchoring of indirect structural models in data.

wealthier depositors. At the same time, costly CBDC adoption reduces incentives to substitute bank deposits with CBDC.

Studies mostly agree that the introduction of CBDC would decrease profitability in the banking sector, regardless of the impact on deposit volumes. Studies find that, through the liability channel, banks usually suffer a loss in profitability because of the competitive effect of CBDC on deposits.[17] This loss in profitability cannot be fully recouped by increasing rates on lending, as a result of market competition in the lending market.[18] In the scenario where CBDC would increase deposits, profitability would still decrease because of a rise in deposit rates.

The most important feature determining the magnitude of impacts is the scale of CBDC adoption. Models differ in how they treat CBDC demand. Most studies consider ad hoc scenarios, whereas in other studies demand is estimated, involving assumptions about CBDC features, households' behaviors, switching costs, and elasticities of demand. Models that estimate CBDC demand show, as expected, that a remuneration for CBDC would increase CBDC take-up. In general, the larger the demand, the greater the impact on deposits through the liability and asset channels. Unfortunately, there is no good criterion to gauge the plausibility of CBDC demand implied by a model's assumptions, since all models lack some dimensions which could be important for CBDC adoption. For instance, none of the studies consider that, as CBDC is a novel asset, it may take time for demand to build up. Therefore, a sensible approach is to consider implications conditional on CBDC demand, bearing in mind that demand for CBDC can also change over time.

Effects on profitability through the liability and asset channels would not be sizable in baseline scenarios, where CBDC demand amounts to around 10 percent of demand deposits. Garcia and others (2020) and BIS (2021) point to a decrease in the bank RoE of around 0.3 and 1 percentage points, respectively, in the highest CBDC demand scenario. These are deemed mostly manageable as the RoE starts at around 15 percent in Garcia and others (2020) and 7.5 percent in BIS (2021). Bouis and others (2024) find a larger decline in the RoE, between 3 and 8 percentage points, because they assume higher costs of alternative refinancing options for banks, and a large drop in fee income coming from deposits outflows. Gross and Letizia (2023) point to a decrease of the return on assets in the euro area banking system of less than 0.05 percentage points, and its application to the Bahraini banking system suggests a drop of about 0.11–0.15 percentage point (IMF 2023a).

Few studies find much larger effects unless they make more extreme assumptions. For instance, Chang and others (2023) forecast a large 70 percent drop in profitability in the baseline scenario, after a drop of nearly 30 percent in deposits. However, the paper assumes that deposits are the only source of funding for banks and investment opportunities are remunerated at the policy (risk-free) rate. In more typical scenarios of higher returns on investment and additional funding sources, the effects would be smaller.

[17] Some models applied to the US and euro area data find that interest expenses on deposits may fall as the CBDC-induced drop in deposits (volume effect) dominates the increase in the deposit rate (price effect) (Gross and Letizia 2023). Still, a potential loss of interest income on dropping excess reserve assets or more interest expense for reserve borrowing may dominate and make net income drop.

[18] See also Bank of England (2021) for a discussion of how lending rates could change with the introduction of CBDC, depending, among other things, on how banks price new loans and the presence of nonbank lenders.

In most cases, therefore, the impact on financial stability seems manageable. For instance, Adalid and others (2022) estimate that banks in the euro area would need refinancing by the central bank only if CBDC demand were very high (18 percent of deposits). Moreover, the predicted decline in bank profitability would not necessarily be detrimental to bank solvency and financial stability. Chen and Phelan (2025) find that CBDC increases the probability of banks being in a crisis state by 3 percentage points (to around 6 percent).[19] Berg and others (2024) find that announcements hinting at a higher probability of CBDC in the euro area have no impact on banks' stock prices, corroborating the view that the impact on banks would likely be contained.

The literature also points to run risks increasing, but only slightly. The literature on this channel has been predominantly theoretical. One exception is Bidder, Jackson, and Rottner (2024) which estimates that the introduction of CBDC increases the probability of bank runs by 1.2 percentage points, to 2.5 percent.[20] The authors also show that for some optimally calibrated holding limits of CBDC, the increase in the probability of bank runs is negligible.

Empirical evidence of runs from existing safe and money-like assets suggests that the effects could be limited with appropriate CBDC design. In particular, Carapella and others (2024) and Infante and others (2024) find that although past crisis episodes have revealed large reallocations across NBFIs (such as outflows from prime MMFs into government MMFs), there has been limited reallocation toward central bank liabilities in the context of the Federal Reserve's Overnight Reverse Repurchase Facility.

Although these empirical results are based on specific modeling and data assumptions and cannot be immediately extrapolated to countries with other characteristics, some inference is possible. Five key factors are likely to affect results: (1) a more competitive banking sector would see higher outflows of deposits than found in the earlier models; (2) banks' strategic levers to compete with CBDC (such as banks bundling services with deposit offerings) might decrease the impact of CBDC on deposit outflows; (3) higher reliance on deposit funding is likely to increase the impact of CBDC on bank profits; (4) the availability of efficient alternative funding sources for banks would soften the impact of CBDC on banks' balance sheets; and (5) lower competition in lending markets would allow banks to raise lending rates more easily to support margins.[21]

Although results from the literature are relatively benign overall, the inclusion of more transmission channels could lead to stronger effects on financial stability. The fee income channel, for instance, is mostly absent from models. In addition, some channels could reinforce each other (see the "Conceptual Framework" section).

[19] In some models (for example, Gross and Letizia 2023) falling net income flows for banks go along with rising net income flows for the central bank. The latter can distribute the additional net income either in the form of CBDC interest (to stimulate CBDC demand) or through seigniorage to the government and subsequently the private sector, which could lessen the impact on the private sector.
[20] According to the authors, this amounts to a run every 40 years on average, versus a run every 70 years on average in the scenario without CBDC.
[21] The willingness of the central bank to provide more reserves to banks would soften the impact of introducing CBDC on banks. Countries with deep and efficient local capital markets, foreign investors, and favorable risk profiles could see banks tapping private funding sources at potentially low costs. Yet the cost of alternative sources of financing could be high for banks when local capital markets are undeveloped.

Table 1. Magnitudes of Impacts on Financial Stability Metrics in the Literature

	References	Outcome Variables	CBDC Demand Assumption	Country Calibration
Liability channel[22]	Adalid and others (2022)	Banks need refinancing by the central bank only in high demand scenario	Scenario-driven, quantity changes with scenario (0.5–18 percent of deposits)	Euro area
	BIS (2021)	0.05–0.3 pp decrease in RoE	Scenario-driven, quantity changes with scenario (5–25 percent of deposits)	Mix of G7 economies, Sweden, and Switzerland
	Bouis and others (2024)	3–8 pp decrease in RoE 0–17 pp decrease in NSFR 1–83 pp decrease in LCR	Scenario-driven, quantity changes with scenarios (6–17 percent of deposits)	Mix of euro area, Japan, and the US
	Chen and Phelan (2025)	30–40 bps increase in deposit rates 5–6 pp increase in probability of banks in distress state 3–4 pp increase of probability of banks in crisis state[23]	Scenario-driven, quantity changes with scenario (9–13 percent of total money supply, M2)	US
	Chang and others (2023)	40–50 bps increase in deposit rates 58–75 percent decrease in profits	Estimated from the model	US
	Garcia and others (2020)	0.02–1 pp decrease in RoE	Scenario-driven, quantity changes with scenario (5–33 percent of total deposits)	Canada
	Gross and Letizia (2023) and its applications	<0.05 pp decrease in RoA in the Euro Area 0.11–0.15 pp decrease in RoA in Bahrain 0.1–0.6 percentage point decrease in Net Interest Margin in the United Arab Emirates	Estimated from the model	Euro area, the US, Bahrain, Tunisia, Georgia, Qatar, Dominican Republic, United Arab Emirates, and various others[24]

[22] Some models referenced under the liability channel cover the asset channel in terms of compositional changes and related interest income and expense effects. This is due to the inherent connection between the liability and asset channel that can hardly be separated.

[23] In the model, “distress state” refers to when banks are forced to sell capital at fire-sale prices, and “crisis state” to when the fraction of capital sold at file-sale prices is greater than 50 percent.

[24] See Bouza and others (2024) for the application to Tunisia, Georgia, and Qatar. See IMF (2023a) for the application to the Kingdom of Bahrain. See Gross and Letizia (2023) for the applications to the US and the euro area. See Central Bank of the United Arab Emirates (2025) for an application to the United Arab Emirates.

Asset channel	BIS (2021)	2–20 pp increase in lending rates to maintain profitability unchanged	Scenario-driven, quantity changes with scenario (5–25 percent of deposits)	Mix of G7 economies, Sweden, and Switzerland
	Bouis and others (2024)	4–8 percent decrease in loans provided to the private sector	Scenario-driven, quantity demanded changes with scenarios	Mix of euro area, Japan, and the US
Run-risk channel	Bidder, Jackson, and Rottner (2024)	CBDC increases the probability of bank runs by 1.2 pp	Estimated from the model	Euro area
Fee income channel	Bouis and others (2024)	Fee income decreases by 5 percent in proportion of the drop in deposits	Scenario-driven, quantity demanded changes with scenarios	Mix of Euro area, Japan, and the US

Source: Authors.

Note: bps = basis points; CBDC = central bank digital currency; G7 = Group of Seven countries; LCR = liquidity coverage ratio; NSFR = net stable funding ratio; pp = percentage points; RoA = return on assets; RoE = return on equity.

III. Practical Considerations

This section presents practical guidance for organizing research efforts, analytical tools, and relevant models. While the "Insights from Quantitative Studies" section focused on extracting insights from existing studies on the magnitude of financial stability risks, this section emphasizes how to apply such analyses to other countries. The first part of this section deals with initial questions on basic financial system metrics that can be applied without resorting to formal, analytical models. The second part provides guidance on how to apply formal models to obtain estimates of the impact on financial stability.

Recommended Data Collection on the Financial System for an Initial Analysis

Understanding the structure and vulnerabilities of the financial system is the first step in the process of analyzing the impact of introducing CBDC on financial stability. To this end, basic data can be collected and analyzed. Such data relates to the balance sheet composition of banks and the central bank, their profitability, metrics of competition in the banking system, and other financial indicators related to the broader financial system (Table 2). The purpose of compiling and analyzing such data is to gain a detailed, upfront understanding of the financial system's characteristics, its components, and the broader macrofinancial environment.

Examples of questions to address with an analysis of such data include:

- What is the level of competition in the banking system as per metrics such as deposit-policy or deposit-lending rate spreads and concentration measures? Has competition been trending in some direction? How does it compare to peer countries? The initial level of competition and profitability in the banking system relates to financial stability, as discussed in the "Conceptual Framework" section, in particular through the asset, liability, and fee income channels.
- Have cash-in-total money ratios been declining? Are other currencies used to a notable extent? These metrics could inform the potential competition for and from CBDC and thus its possible adoption.
- How have measures of profitability for the banking system evolved over time (including return on assets and net interest margins)? Average levels should be examined (disregarding possible cyclical movements) to assess whether the banks would still be sufficiently profitable amid increased competition.

Answering such questions would contribute to the assessment of financial stability risks. Although the data and indicators in Table 2 would serve to analyze the financial system prior to the introduction of CBDC and thereby support an ex-ante impact assessment, they should be continually monitored once CBDC is introduced. After a launch, it is instrumental to collect and analyze CBDC-related data, such as holdings and flows between bank deposits and CBDC, alongside demographic characteristics of depositors and CBDC holders (in anonymized form), to better understand the motivations behind CBDC demand (store-of-value versus transaction purposes).

Table 2. Data for Analyses in a CBDC Context[25]

Category	Specific Data to Be Collected
Balance sheet composition of banks	• Asset side: loans, bonds, other security holdings, reserve holdings • Liability side: retail deposits, wholesale deposits, other bond finance • Capitalization, for example regulatory capital metrics such as CET1/RWA and total capital/RWA • Distinguish financial assets by encumbered versus unencumbered; for the unencumbered, make an additional distinction between those that are eligible versus those that are not eligible for central bank borrowing • Concentration metrics, for example, based on total assets and deposits, to examine trends in competition • Reserve holdings (required vs. excess) and reserve borrowing across banks • The data needs to have a time dimension, to examine trends
Profitability of banks	• Selected components of the banks' profit and loss statements: interest income, interest expense, fee income, and bottom-line net income before tax; all these variables by bank, at the banking system level, and with a time dimension • Interest income over interest-bearing assets, loan interest rates • Interest expense over liabilities, deposit rates • For a more detailed analysis of the effects of transaction-flow competition, obtain more detailed data on banks' fee and commission income and expenses • Similar data for peer countries would be useful for comparisons
Central bank balance sheet	• Asset side: reserve lending to banks, holdings of government and private sector bonds • Liability side: reserve holdings of banks, possibly bonds issued by the central bank • Judge the net reserve (excess reserve) position of the banking system and the central bank • Reserve requirements
Central bank income/expense and net income (seigniorage)	• Interest income from different sources (for example, for bond holdings and reserve lending) • Interest expenses from different sources (for example, from issued bonds and banks' reserve holdings) • Cost for maintaining cash • Net income, seigniorage redistribution to the sovereign • Policy rates: all corridor components
Other metrics: competition in the banking system; high-level monetary system indicators	• Competition in the banking system: Skew and Herfindahl indices, share of the largest three or five banks in total banking system assets • High-level monetary system indicators: cash-in-total money ratios, extent of use of other currencies (for example, the US dollar or other currencies), reserve coverage

Source: Authors.

Note: CET1 represents the highest quality of regulatory capital, such as common stock and retained earnings. RWA represents a bank's assets adjusted to reflect their associated risk levels. CBDC = central bank digital currency; CET1 = common equity tier 1; RWA = risk weighted assets.

[25] Most of the data indicated in Table 2 should be available through conventional statistics and data repositories maintained by central banks and supervisory institutions. Some of the data are also available through centralized cross-country databases, such as the IMF's Monetary and Financial Statistics and Financial Soundness Indicators.

Analytical Frameworks and Their Application

The quantitative tools and models for CBDC analysis developed so far in the literature can be grouped into three categories. As shown in Table 3, these include (1) balance sheet analyses; (2) models with richer descriptions of CBDC users' behavior, labeled "financial models," which include elements of industrial organization, utility and consumer choice, and stock-flow consistency; and (3) macroeconomic models, which usually broaden the analysis to real effects, such as GDP.[26,27]

Table 3. Categorization of Tools and Models for Conducting CBDC-Related Analyses

#	Category	Selected References
1	Balance sheet analyses	Juks (2018, 2020); Bindseil (2020); Adalid and others (2022); Malloy and others (2022); Bouis and others (2024)
2	Financial models (utility, consumer choice, SFC)	Chang and others (2023); Gross and Letizia (2023); IMF (2023a); Li (2023); Meller and Soons (2023); Whited, Wu, and Xiao (2023), Bouza and others (2024); León, Moreno, and Soramäki (2024); Li, Usher, and Zhu (2024)
3	Macro models (NK, DSGE, OLG, NM)	Andolfatto (2021); Barrdear and Kumhof (2021); Jiang and Zhu (2021); Banet and Lebeau (2022); Ferrari Minesso, Mehl, and Stracca (2022); Assenmacher, Bitter, and Ristiniemi (2023); Abad, Nuño, and Thomas (2025)

Source: Authors.
Note: The table contains a subset of approximately 90 papers that were reviewed and were considered useful entry points to the dynamically evolving literature on CBDC. CBDC = central bank digital currency; DSGE = dynamic stochastic general equilibrium; IO = industrial organization; NK = new Keynesian; NM = new monetarist; OLG = overlapping generations; SFC = stock-flow consistency.

Bank balance sheet analyses (Category #1 in Table 3) examine the interconnection between balance sheets of financial institutions, the central bank, government, and private sector. They enable visualization, in either tabular or graphical form, of these interconnected balance sheets. They represent an accounting exercise, to illustrate how various balance sheet items of these sectors would change when CBDC is introduced and demand for it arises.[28] The sectoral balance sheets are usually shown at least for the central bank and the banking system, and occasionally for NBFIs (including MMFs), households, and firms (for example, Adalid and others 2022). Balance sheet analyses are a recommended first step for any CBDC analysis. They provide a first approximation of the balance sheet effects (asset and liability channels) discussed earlier in this Note. Furthermore, they can incorporate the fee income and run-risk channels. However, they are not suited to analyze the information and payment system resilience channels, as these classes of models can only take into account financial-economic metrics.

The interconnected balance sheets are often used to consider hypothetical CBDC adoption scenarios, assuming that a certain amount of bank deposit liabilities and cash are converted to CBDC.[29] Such CBDC

[26] Macroeconomic models include new Keynesian dynamic stochastic general equilibrium, overlapping generations, and new monetarist models.
[27] For a review of existing macrofinancial models, see also Bindseil and Senner (2024).
[28] Examples include Bindseil (2020) for the euro area, Juks (2018, 2020) for Sweden, and Malloy and others (2022) for the US.
[29] The aggregate CBDC adoption scenarios are either directly assumed in an ad hoc manner or calculated by adding up holdings for individuals which are based on assumptions regarding CBDC holding limits per household/individual (for example, Adalid and others 2022).

adoption analyses are useful as a first assessment of how the net reserve position of the banking system may change, to judge whether outstanding excess reserves and eligible collateral may suffice or not for covering the assumed flows into CBDC, and more broadly for assessing financial metrics linked to financial stability. The drawback is that they generally rely on simplifying ad hoc assumptions for the behavior of the various economic sectors involved.[30]

Models in Category #2 go beyond the analysis of changes in connected balance sheets. They incorporate banks that can change their remuneration of deposits (and, sometimes, other features) to maximize profits, alongside ("utility-maximizing") consumers who chose how much to hold of each asset, including CBDC, depending on return/risk evaluations and convenience features. They often also involve the central bank and the government. The key instrument for banks to maximize profits is their deposit interest rate (among some others).[31] These models allow estimating the changes in deposit and lending rates, the interest income and expense effects for all agents, and thereby the impact on solvency (especially of banks), which cannot be assessed with basic balance sheet models.[32] CBDC demand can sometimes be estimated from the model.[33]

Models in Category #3 account for the real economic effects of CBDC. The tools and models in the second category are all nominal in nature, that is, they focus on nominal balance sheet variables, nominal interest rates and income and expense effects, and all solvency and liquidity metrics are functions of such nominal variables. In contrast, models in Category #3 aim to gauge real economic activity, such as real GDP and employment (and ideally their interplay with financial variables, to the extent that these models capture macrofinancial rather than purely macroeconomic features).[34] These models could be used to analyze all channels apart from the information and payments resilience channel. These last two channels would need detailed treatment of payment flows and information, which existing macroeconomic models do not contemplate.

Annexes 1 and 2 describe examples of models in Categories #2 and #3 and their output to illustrate how they can help analyze the potential effects of introducing CBDC.

[30] For instance, banks and consumers do not optimally respond to the introduction of CBDC. Also, in many cases, the options for banks to increase remuneration of deposits to stem outflows is not considered.

[31] These types of models can be found in Chang and others (2023); Gross and Letizia (2023); IMF (2023a); Whited, Wu, and Xiao (2023); and Li, Usher, and Zhu (2024).

[32] The simulation-based model framework as presented in Gross and Letizia (2023) and León, Moreno, and Soramäki (2024) bear some resemblance to the simulation-based payment system models of the Bank of Finland (2005, 2009). Given the interconnected agent-based model structures, they further link to the sizable discipline of network modelling in economics and finance.

[33] The level of utility (value) from holding different forms of money, which helps determine their demand, can be informed by certain benchmarks, for example by equating CBDC base utility (the portion of the utility to the consumer that is not captured by the asset's characteristics incorporated into the model) to that of physical currency, or that of deposits. Deviations from such benchmarks can then be considered and their rationale discussed. Making assumptions for utility and estimating CBDC demand instead of an outright assumption for CBDC take-up as under the balance sheet analyses can be valuable, because the former is not identical to the latter. See Gross and Letizia (2023).

[34] Barrdear and Kumhof (2021) is an example of a new Keynesian dynamic stochastic general equilibrium model with a CBDC focus. The model allows interest on CBDC to be steered by the central bank as a function of their policy objective. CBDC take-up is assumed at 30 percent relative to nominal GDP. The study finds that, when CBDC is introduced, real deposit rates fall and real output reacts positively. The work of Abad, Nuño, and Thomas (2025) is an example of a new Keynesian model. An important feature of that model is that the central bank would lower its policy rate when excess reserves start to become scarce. Under a floor and ceiling system, the higher cost of funding for banks and lower profitability does not impair bank lending.

Model Selection Considerations

The question arises as to how to choose among existing models. In general, all models can be applied to any country. The main factors determining the choice relate to existing capacity within the central bank and data availability.

Balance sheet analyses (Category #1) represent a useful starting point and are always recommended. Balance sheet analyses are usually straightforward to implement and will not require advanced analytical capacity within a central bank. Financial models in Category #2 can subsequently be useful for analyzing compositional effects on balance sheets, optionally including the estimated CBDC take-up, and especially the responses of interest rates (deposit and lending rates), income and expense effects for banks, the central bank (seigniorage and its underlying drivers), and the private sector. These models, however, require some more advanced modeling expertise, as they will, for example, involve coding in specialized software applications. Macroeconomic effects can be explored with the macro models from Category #3. The third category of models requires advanced coding skills and a deep understanding of macroeconomic modeling.

The required data inputs for specific model analyses are largely covered by the data and indicators presented in the previous subsection. Financial models in Category #2, such as those used in Bouza and others (2024), require data on deposit-policy rate (or deposit-lending rate) spreads, observed shares of currency-in-circulation in total money, measures of the velocity of money (GDP flows over the money stock), and central bank policy parameters such as central bank lending and deposit facility rates and reserve requirements. Such data are easy to obtain and provide information on the initial level of competition in the banking system and users' pre-CBDC preference for central bank money. Macroeconomic models (Category #3) require general macroeconomic data, usually at quarterly frequency. All such data, for the models from all categories, would generally be available in the public domain. To augment the analyses and venture deeper into the transaction-flow competition effects, more detailed data on the banks' and nonbank PSPs' fee and commission income would need to be obtained.

IV. Design and Policy Options to Mitigate Downside Risks

Previous sections highlighted that new competitive pressures introduced by CBDC may not necessarily pose risks to financial stability. Moreover, quantitative studies suggest that effects may remain limited under reasonable scenarios. Most of these studies do not explicitly make assumptions on design choices such as holding limits. Once those are factored in, the effects on financial stability are usually even smaller.

However, given the vital role that banks play in the economy—including providing credit to households and firms—it is crucial to carefully analyze financial stability risks and manage them with appropriate design and policies. This section discusses mitigation strategies. Although they are discussed separately here for clarity, in practice these design options and policies are best explored alongside the analysis of financial stability risks.

There is no one-size-fits-all approach to address financial stability risks. Instead, CBDC design and policy choices should be tailored to unique country circumstances. It is essential for country authorities envisaging CBDC to have a clear understanding of the mechanisms affecting financial stability, which agents in the economy are likely to be most affected, whether they are adequately positioned to withstand shocks, and how vulnerabilities may evolve over time.

Design Options

Design options determine the extent to which CBDC is adopted and, in turn, the magnitude of deposit outflows and the strength of the liability, asset and fee income channels. These include, for example, interoperability with existing payment networks, resilience, security, scalability, and choices related to user privacy or environmental impacts. These may be significant drivers of adoption, especially if CBDC is not competitively remunerated (Soderberg and others 2023).[35] In addition, whether CBDC is granted legal tender status with mandatory acceptance by payees will affect the extent to which CBDC is adopted.

However, more targeted levers (referred to as "design features aimed at specific purposes" in Soderberg and others 2023) can be used to mitigate downside risks to financial stability. A menu of options is available (Figure 2). These levers will affect all transmission channels, although to different extents.

Price measures to restrict bank deposit outflows can take the form of sufficiently low (or zero) CBDC remuneration rates, fees on CBDC transactions, or fees on conversions to other forms of money. Remuneration can be set to zero or, depending on the prevailing interest rates in the economy, at a sufficiently low level to encourage users to adopt CBDC as a means of payment rather than a store of value.[36] Similarly, ensuring low (or zero) transaction fees and cost of switching from CBDC to other forms

[35] See, for example, Agur and others (2025) and Copestake and others (2025) on interoperability, Koonprasert and others (2024) on usability, Murphy and others (2024) on privacy, and Agur and others (2023) on environmental considerations.
[36] In theory, remuneration could also be negative. However, most jurisdictions have been reluctant to apply negative remuneration to households, and such actions can be constrained by legal frameworks (European Parliament 2023).

of money and to safe and liquid assets (such as MMFs or short-term government bonds) could incentivize CBDC use for pure payment purposes while remaining money holdings are invested according to risk and liquidity preferences.[37]

Quantity measures include hard limits on holdings, transactions, and convertibility into CBDC. Quantity constraints offer less flexibility than price measures for users but can help regulate deposit substitution with a higher degree of precision. They can be particularly useful for the central bank and for commercial banks during the initial stages of CBDC deployment or in stress times, when dynamics are more uncertain. Limits on holdings can be combined with limits on transactions, although the latter primarily serve financial integrity purposes.[38] However, quantity limits may be prone to operational hurdles, such as failed transactions if limits are exceeded. To address these issues, waterfall (and reverse waterfall) mechanisms have been proposed, which link CBDC wallets to commercial bank accounts to automatically transfer CBDC amounts above the established limits (ECB 2020).

CBDC access parameters are an additional lever. Whether CBDC is restricted to retail use or accessible to wholesale depositors affects the extent to which CBDC may substitute for safe and money-like assets and, in turn, the magnitude of the asset, liability, and run-risk channels.

Finally, involving financial intermediaries in the distribution of CBDC can help offset their potential loss of fees (fee income channel) and information (information channel). In a two-tier distribution model, the central bank issues CBDC to banks and nonbank PSPs which, in turn, distribute it to users.[39] With this approach, intermediaries could gain new revenue opportunities by charging fees on CBDC services and leveraging CBDC to cross-sell other products (fee income channel). They might, for instance, offer digital wallets or new services such as programmable payments. By adapting their business models, banks can capitalize on the new possibilities to innovate and mitigate profit losses. In addition, if CBDC data is made available to all intermediaries in the CBDC ecosystem, banks could use this information for credit risk evaluation and cross-selling. This would lower entry barriers in credit markets and help mitigate credit supply friction (information channel) (Hau and others 2019).

Calibration Challenges

Policymakers face a tradeoff: design features that limit or slow adoption may at the same time reduce the benefits that a wider utilization of CBDC could bring, such as financial inclusion. Reducing the availability of monetary instruments distorts payment efficiency, a situation that can lead to welfare losses if financial stability risks are minimal to start with (Auer and others 2022; Assenmacher and others 2024). Conversely, features that limit or slow adoption can be welfare enhancing when financial stability risks are material and sizable.

There is no one-way relation between design features and financial stability. Depending on specific country circumstances, offering remuneration for CBDC or implementing high holding limits could, in fact,

[37] This could be achieved by working with wallet providers and the broader CBDC ecosystem to seamlessly link CBDC wallets to other financial services, leveraging open application programming interfaces to allow different software applications to interact with one another, using attractive software development kits to integrate CBDC into various applications and systems, or with regulation.
[38] For considerations on CBDC and financial integrity, see Schwarz and others (forthcoming).
[39] In contrast, in a one-tier model, the central bank performs all the functions within the CBDC system.

improve financial stability. It could, for instance, further redirect outflows of deposits into CBDC instead of stablecoins, which would mitigate macroeconomic and financial stability risks if stablecoins were poorly regulated or denominated in foreign currencies.[40] By offering a new payment option, CBDC could also increase competition in concentrated payment markets, thereby improving operational resilience (payment system resilience channel).

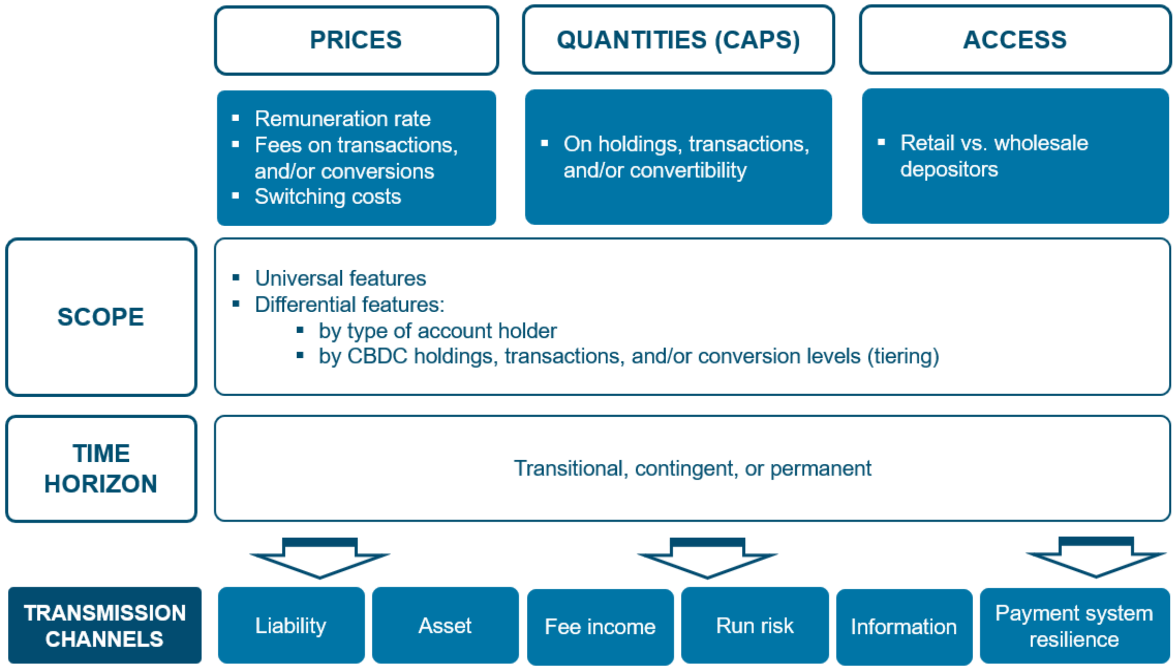
Differential price and quantity measures can help achieve a balance between adoption and financial stability risks. Design features can vary by type of account holder (such as individuals versus merchants, or small versus large merchants) to limit the aggregate level of deposit outflows while facilitating adoption for a large range of users. They can also differ by CBDC holdings or transaction levels to effectively steer CBDC adoption at the individual user level. One example is tiered remuneration, where CBDC wallets with higher holding limits are remunerated at lower rates, potentially negative, which has been proposed as a way to discourage the widespread use of CBDC as a store of value while increasing its attractiveness as a means of payment.[41]

Price and quantity measures can be revised over time. They can be applied during a transition period, such as when CBDC is introduced to avoid excessive CBDC demand and allow for a smooth transition (Bank of England 2021; Assenmacher and others 2024). Countries that foresee potentially destabilizing deposit outflows may choose to adopt a cautious stance, at least initially. Over time, limits could be gradually adjusted if the likelihood of a large negative shock falls and banks adapt to the new competitive environment.

Design features that limit deposit outflows into CBDC can also be applied contingently, such as when signs of financial market stress emerge. Along these lines, the ECB has developed a scenario-based assessment of deposit outflows for calibrating limits (ECB 2024). In case of financial stress, central banks should stand ready to provide emerging liquidity support, just as they would in the absence of CBDC. Similar to bank holidays and deposit freezes, contingent convertibility limits, while potentially very disruptive, could be envisaged as a last resort. These limits could be implemented especially in countries with no deposit guarantees and weak crisis resolution frameworks.[42]

[40] International Monetary Fund–Financial Stability Board (2023) on the macroeconomic and financial risks associated with crypto assets.
[41] Some authors have envisaged remunerating lower tiers at a zero rate, and higher tiers at a negative rate (Bindseil 2020).
[42] Convertibility limits triggered based on pre-defined criteria (for example, speed of deposit conversion into CBDC) could allow for a swift policy response, as compared to discretionary limits.

Figure 2. Design Features Aimed at Safeguarding Financial Stability



Source: Authors.

Note: CBDC = central bank digital currency.

The precise calibration of price and quantity limits presents important quantification challenges. Modeling financial stability risks relies by nature on simplifying assumptions. The reaction of banks and CBDC account holders depends on multiple factors, which are likely to change over time—hence the necessity of forward-looking assessments (Bank of England 2023; ECB 2024). Challenges for calibration will perdure after CBDC is introduced, as a large amount of data would be required to understand users' preferences and price sensitivities, especially if limits vary by type of users or CBDC wallets. Calibration may also require fine-tuning over time, to be balanced with the stakeholders' need for predictability. This is, for example, the course followed by the Central Bank of the Bahamas, which increased holding limits for individuals from BSD 5,000 to BSD 8,000 after the pilot phase (Central Bank of the Bahamas 2019).

Box 1. Mitigating Financial Risks: A Stock-Take of Central Banks' Approaches to Central Bank Digital Currency Design

Central banks largely favor nonremunerated central bank digital currency (CBDC). According to the Bank for International Settlements survey, more than half of central banks do not intend to remunerate CBDC, although some do not exclude the option a priori and consider doing more research into this aspect (Illes, Kosse, and Wierts 2025).

Central banks have proposed a wide range of holdings limits (Box Table 1.1). Although most central banks in advanced stages of CBDC research consider holding limits, in a similar proportion in advanced economies and in emerging and developing economies, there is no consensus on how to

Box 1. (Continued)

calibrate them.[1] Such calibration should be determined based on prevailing financial stability risks and the objectives of CBDC.

Two main approaches have been proposed for the calibration of holding limits. In top-down approaches, the desired level of adoption is determined at the country level, then divided by the eligible population. For example, in the euro area, it has been proposed limiting CBDC adoption to the current holding of banknotes in circulation (EUR 1–1.5 trillion), corresponding to a holding limit of EUR 3,000–4,000 per individual (Bindseil 2020; Bindseil and Panetta 2020). In bottom-up approaches, the desired level of adoption is determined at the individual level, then aggregated. The Bank of England, for example, proposes setting holding limits such that the Digital Pound can be used for day-to-day transactions and salary payments. A limit of GBP 10,000 (GBP 20,000) would allow 75 percent (95 percent) of income earners to do so (Bank of England 2023).

Box Table 1.1. Proposed Holding Limits in Selected Countries (as of July 2025)

Country	Project Phase[1]	Individuals (Lowest Tier)	Individuals (Highest Tier)	Merchants
Sand Dollar (The Bahamas)	Live	B$ 500 (1%)	8,000 (18%)	B$ 8,000–B$ 1,000,000 (18–2227%)[4]
JAM-DEX (Jamaica)	Live	None[2]	None[2]	None[2]
e-Naira (Nigeria)	Live	NGN 120,000 (3%)	NGN 5,000,000 (141%)	No limit
e-Cedi (Ghana)	Live (plans)	Yes (TBD)	Yes (TBD)	Yes (TBD)
Digital Euro (Eurosystem)	Live (plans)	TBD[3]	TBD[3]	0
Digital Pound (United Kindgom)	Live (plans)	GBP 10,000–20,000 (22–43%)[4]		"Significantly higher than individuals"
D-Cash (ECCU)	Pilot	None	None	-
e-CNY (China)	Pilot	RMB 10,000 (6%)	None	-
Digital Rupee (India)	Pilot	INR 100,000 (16%)		-

Source: Central banks' websites, authors.
Note: Percents represent the share of CBDC holding limits in GDP per capita. TBD = to be determined.
[1] The project phase corresponds to the phase for which the specific design features are considered, not to the current phase of the project. For example, the D-cash design features were those considered during the 2021–24 pilot. Those for the Digital Euro and Digital Pound correspond to the proposed design features in the event these CBDCs were introduced in the future.
[2] Limits imposed by wallet providers. Lynk: J$ 0, JNPay: J$50,000 (2 percent of GDP per capita) (lowest tier) and J$100,000 (5 percent) (highest tier).
[3] Bindseil (2020) and Bindseil and Panetta (2020) suggest a limit of EUR 3,000 (6% of GDP per capita). Discussions with stakeholders on limits calibration are ongoing, and decisions will be made closer to the launch date.
[4] Tiered access will be considered.

Research related to the calibration of other quantity or price measures to safeguard financial stability risks is still nascent**.** Central banks remain unconvinced about transaction limits, especially in advanced economies where less than 30 percent of surveyed central banks are considering them (Illes, Kosse, and Wierts 2025). Although several have proposed ranges for transaction limits (including by wallet

Box 1. (Continued)

tiers), few have proposed a clear rationale for their calibration. In some instances, transaction limits for CBDC

follow those in place for bank deposits or are set by the wallet provider (such as Lynk in Jamaica). Similarly, although central banks have researched liquidity risks, few have communicated around the calibration of convertibility or holding limits during times of stress.

[1] According to a BIS survey of 93 central banks, 56 percent of advanced economies and 63 percent of emerging and developing economies are considering a potential retail CBDC subject to holding limits (Illes, Kosse, and Wierts 2025).

Policy Considerations

Although appropriate CBDC design would serve as a first line of action to manage financial stability risks, traditional safeguards would continue to be relevant. Macroprudential policies can help mitigate many of the risks posed by CBDC. These include, for example, tools to limit excessive risk-taking, reduce leverage, and manage maturity and currency mismatches or sovereign–bank interconnectedness. In addition, standard crisis management policies provide a safety net that would help address run risks. Therefore, gaps in supervision and regulation of the financial system constitute a key vulnerability to address. Nevertheless, relying on these policies alone is likely to be insufficient. Macroprudential policies work imperfectly, and further effort is needed to comprehensively address risks related to market-based funding and NBFIs. For an extensive discussion of CBDC policies, see Bouis and others (2024).

Conclusion

As a liquid, safe, and widely accessible instrument for payments and a store of value, CBDC has the potential to compete with bank deposits and other safe and money-like assets. CBDC may affect financial stability negatively or positively through six main interrelated channels. These operate through the liability and asset sides of financial institutions' balance sheets, the fee income of banks, the risk and intensity of runs, the flow of information on borrowers and CBDC users, and the resilience of payment systems. Through these channels, CBDC can directly affect bank profitability, solvency and liquidity ratios, but also broader financial sector characteristics, such as risk-taking behavior, interconnectedness, and resilience. It is therefore important to take a holistic view of the financial system dynamics when evaluating the financial stability implications of CBDC. The economic significance of the channels will ultimately depend on the level of CBDC adoption, country characteristics and CBDC design features. Quantitative studies estimating the financial stability impacts of CBDC are still limited and rely on specific modeling assumptions. Overall, these studies suggest that, under middle-of-the-road scenarios, bank profitability may decrease but the ultimate impact on financial stability is likely to be contained, especially in countries whose financial systems are characterized by low competition, low reliance on deposit funding, broad access to alternative sources of funding, and innovation so that banks can respond to competition from CBDC. Still, this is no reason for complacency, and the potential impact of CBDC must be carefully analyzed on a country-by-country basis. Various tools and models can be applied to do so, from basic balance sheet analyses to more detailed CBDC counterfactual analyses. Finally, in circumstances where CBDC may be a concern for financial stability, risks can be mitigated with well-calibrated CBDC design features and traditional financial stability safeguards.

Annex 1. Models for Central Bank Digital Currency Analyses

Annex Table 1.1 extends Table 2 provided in the “Practical Considerations” section, by splitting the “macroeconomic model” category from Table 2 into three subcategories: new Keynesian and dynamic stochastic general equilibrium (DSGE) models, overlapping generations models, and new monetarist models.

Annex Table 1.1 Categorization of Tools and Models for Conducting CBDC-Related Analyses (Extended)

<table>
<tr><th>#</th><th colspan="2">Category</th><th>References</th><th>Remarks</th></tr>
<tr><td>1</td><td colspan="2">Balance sheet analyses</td><td>Juks (2018, 2020), Bindseil (2020), Adalid and others (2022), Malloy and others (2022), Bouis and others (2024)</td><td>• CBDC take-up assumptions exogenous; defining the scenarios either ad hoc or informed by holdings caps (see, for example, Adalid and others 2022)
• Assumptions on how much of CBDC take-up subtracts from cash versus deposits largely ad hoc (see, for example, Malloy and others 2022)
• Sometimes addressing collateral scarcity considerations, but not addressing those quantitatively yet
• References on the left entail a balance sheet analysis that is not purely schematic and illustrative, but informed by data, such as through “financial accounts” (integrated balance sheets)</td></tr>
<tr><td>2</td><td colspan="2">Financial models
(IO, utility, consumer choice, SFC)</td><td>Chang and others (2023); Gross and Letizia (2023); IMF (2023a); Li (2023); Meller and Soons (2023); Whited, Wu, and Xiao (2023); Bouza and others (2024); León, Moreno, and Soramäki (2024); Li, Usher, and Zhu (2024)</td><td>• CBDC volumes endogenous in Chang and others (2023); Gross and Letizia (2023); Li, Usher, and Zhu (2024); and Whited, Wu, and Xiao (2023)
• Structural models, anchored in micro/macro data
• Demand functions (price sensitivities) are estimated
• Bertrand competition (adequate for the banking system) plus any level of competition in Gross and Letizia (2023) and Li, Usher, and Zhu (2024)
• Deposit rate spreads to policy are endogenous (in all here-aforementioned, except in Meller and Soons 2024)
• Overall, mostly nominal in nature, not yet covering model structures that allow to analyze real economic effects and welfare implications</td></tr>
<tr><td>3</td><td>Macro models</td><td>NK and DSGE</td><td>Barrdear and Kumhof (2021); Ferrari Minesso, Mehl, and Stracca (2022); Abad, Nuño, and Thomas (2025)</td><td>• CBDC volumes mostly steered exogenously (see, for example, Abad, Nuño, and Thomas 2025)
• Deposit rates (spreads to policy) mostly exogenous
• Impulse response analysis (technology shocks, fiscal shocks, MP shocks, and so on) in terms of deviations from steady state, mostly no statements about arising “levels” for relevant variables</td></tr>
</table>

				• Conventional concerns for DSGE models apply: micro-unfounded axiomatic assumptions, shocks paradigm, banks implemented as intermediaries not as money creators, representative agents
		OLG	Andolfatto (2021), Banet and Lebeau (2022), Kim and Kwon (2023)	• CBDC volumes mostly exogenous, defined by scenarios • Restrictive regarding bank competition: monopoly (Andolfatto 2021) versus full competition (Banet and Lebeau 2022), nothing in between
		NM	Jiang and Zhu (2021); Davoodalhosseini (2022); Williamson (2022); Assenmacher, Bitter, and Ristiniemi (2023); Chiu and others (2023); Keister and Sanches (2023)	• Reference model (Lagos and Wright 2005) does not have banks nor deposits • Combined NM-DSGE model in Assenmacher, Bitter, and Ristiniemi (2023)

Source: Authors.
Note: The table contains a small subset of about 90 papers that were reviewed and were deemed useful entry points to the dynamically evolving literature on CBDC. CBDC = central bank digital currency; DSGE = dynamic stochastic general equilibrium; IO = industrial organization; NK = new Keynesian; NM = new monetarist; OLG = overlapping generations; SFC = stock-flow consistency.

The models would benefit from further development, to enhance their ability to analyze the macrofinancial stability consequences of introducing central bank digital currency (CBDC). The model developments may include, for example, developing “macroeconomic shells” around the mostly nominal models in Category #2, which would allow to complete the analysis in terms of the pass-through to the real economy, for example, in terms of real GDP and employment dynamics. The dynamic stochastic general equilibrium models can provide inspiration for such macro shells (for example, Barrdear and Kumhof 2021). Moreover, it would be beneficial to enhance the models’ liquidity focus, to analyze banking system liquidity dynamics in more detail. The work of Meller and Soons (2023) is a useful example of how liquidity metrics such as the liquidity coverage ratio are integrated in a model. Models such as Meller and Soons (2023), in which all interest rates are exogenous, can be combined with frameworks from Category #2 models that endogenize bank interest rates (as in Gross and Letizia 2023). Category #2 models should be further developed to feature more detailed asset and liability segmentations, with one objective being to determine whether collateral shortages may be expected conditional on some anticipated CBDC demand. Finally, the financial and macrofinancial models would benefit from incorporating nonbank financial institutions, such as money market funds, to examine their role in influencing the balance sheets of other institutions, and liquidity risk dynamics specifically, under CBDC take-up scenarios.

Adequately reflecting banks’ money creation ability in models is important for accurately assessing the implications of a fundamental structural change such as CBDC introduction. Numerous papers already emphasize the role of banks as money creators specifically in the CBDC context (Haldane 2015; Nicolaisen 2017; Norges Bank 2018; Juks 2020; Niepelt 2020; Barrdear and Kumhof 2021; Kumhof and Noone 2021; Meaning and others 2021; Garratt, Yu, and Zhu 2022; Gross and Letizia 2023). However, numerous macro models in the various subcategories that were surveyed do not reflect this reality. It would be instrumental to further reveal the qualitative and quantitative consequence of the model choice in this regard.[43]

[43] As pursued, for example, in a more general context without CBDC focus, in Jakab and Kumhof (2015).

Annex 2. Concrete Applications of Central Bank Digital Currency Models

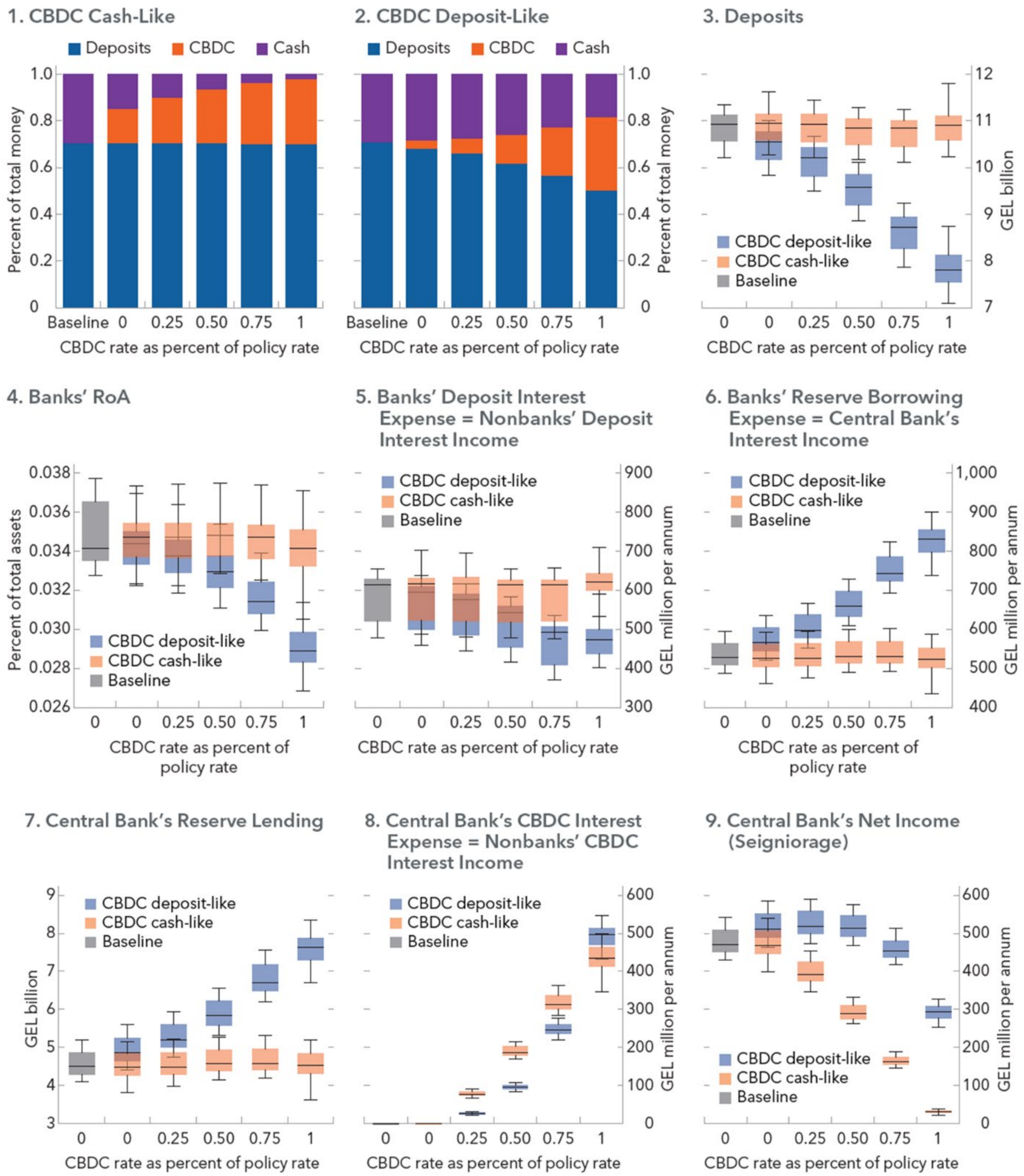
This annex aims to illustrate the type of output that different models can yield in practice. The models presented here are selected papers in Categories #2 and #3, respectively.

An Example of a Stock-Flow Consistent Model for Central Bank Digital Currency Counterfactual Analysis

Bouza and others (2024) employ the model of Gross and Letizia (2023) to analyze what consequences the introduction of central bank digital currency (CBDC) would have for banks, the central bank (and government), and the private sector, in their application to Tunisia, Georgia, and Qatar.[44] The model is stock-flow consistent, connecting all balance sheets of individual agents from a stock and flow perspective. It has utility-maximizing private sector agents (households and firms), similar to Chang and others (2023) and Li, Usher, and Zhu (2024), alongside profit maximizing banks that set their deposit rates optimally. Demand for CBDC is an outcome of the model.[45] Before conducting the CBDC counterfactual analysis with the model, it is estimated to match private sector agents' preference for central bank money (cash) before CBDC, and the deposit-policy rate spreads, that is, the initial level of competition. An example output for Georgia is shown in Annex Figure 2.1.

[44] An application of the model to Bahrain can be found in IMF (2023a).
[45] The demand for the three forms of money (cash, deposits, CBDC) is endogenous (that is, model-implied) through a utility function for money, distinguishing a "base utility" that captures all sources of utility other than interest, alongside a price sensitivity and interest. For details, see Gross and Letizia (2023).

Annex Figure 2.1. Results for Georgia from the SFC Model Application of Bouza and Others (2024)



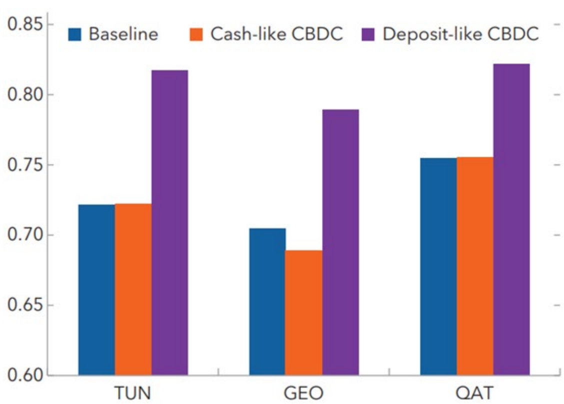
Source: Bouza and others 2024 (Annex Figure 5.3 therein).
Note: The chart panels show the dynamics of certain variables under various CBDC interest rate settings on the horizontal axis. They start from a pre-CBDC simulation (gray), and continue with CBDC simulations, considering different levels of CBDC interest rates (from zero, toward 100 percent of the policy rate). CBDC = central bank digital currency; RoA = return on assets; GEL = Georgian lari.

The CBDC interest rate is varied on the horizontal axis. CBDC is assumed to be either “cash-like” (orange) or “deposit-like” (blue), which relates to the base utility of CBDC. Cash ratios are determined within the model, with the baseline value being matched to existing ratios in the economy, for example at about 30 percent for Georgia.

Selected findings include (1) banks’ excess reserves get depleted or additional reserve borrowing is needed when CBDC demand increases; (2) deposit interest expenses for banks either rises or falls, depending on how the opposing volume (down) and rate effects (up) balance, with volume effects dominating for the Georgia example, so that deposit expenses fall (panel 5); (3) banks’ net income (expressed in terms of return on assets) falls as a result of higher CB reserve borrowing costs, which are assumed constant (unlike in Abad, Nuño, and Thomas 2025) (panel 4); (4) the banks’ return on assets remains in positive territory however, so that their solvency ratios do not drop; and (5) central bank net income (seigniorage) follows a hump-shaped pattern (panel 9). It first increases with higher CBDC take-up (here through considering interest on CBDC) because of more central bank reserve lending-based income for the central bank, or less of an expense for remunerating the dropping excess reserves; when CBDC interest rises further, CBDC interest expense (panel 8) starts dominating however, so that net seigniorage for the central bank starts falling again. Nevertheless, it remains positive throughout. The flow of seigniorage profits from the central bank to the government and back to the private sector is properly accounted for in the model.

Monetary policy pass-through increases because of the additional CBDC-induced competition (Annex Figure 2.2). The gain in pass-through strength is more pronounced for countries that start from lower pass-through intensities, which correlates with lower levels of initial competition.

Annex Figure 2.2 Monetary Policy Pass-Through Estimates



Source: Bouza and others 2024.
Note: CBDC = central bank digital currency; TUN = Tunisia; GEO = Georgia; QAT = Qatar.

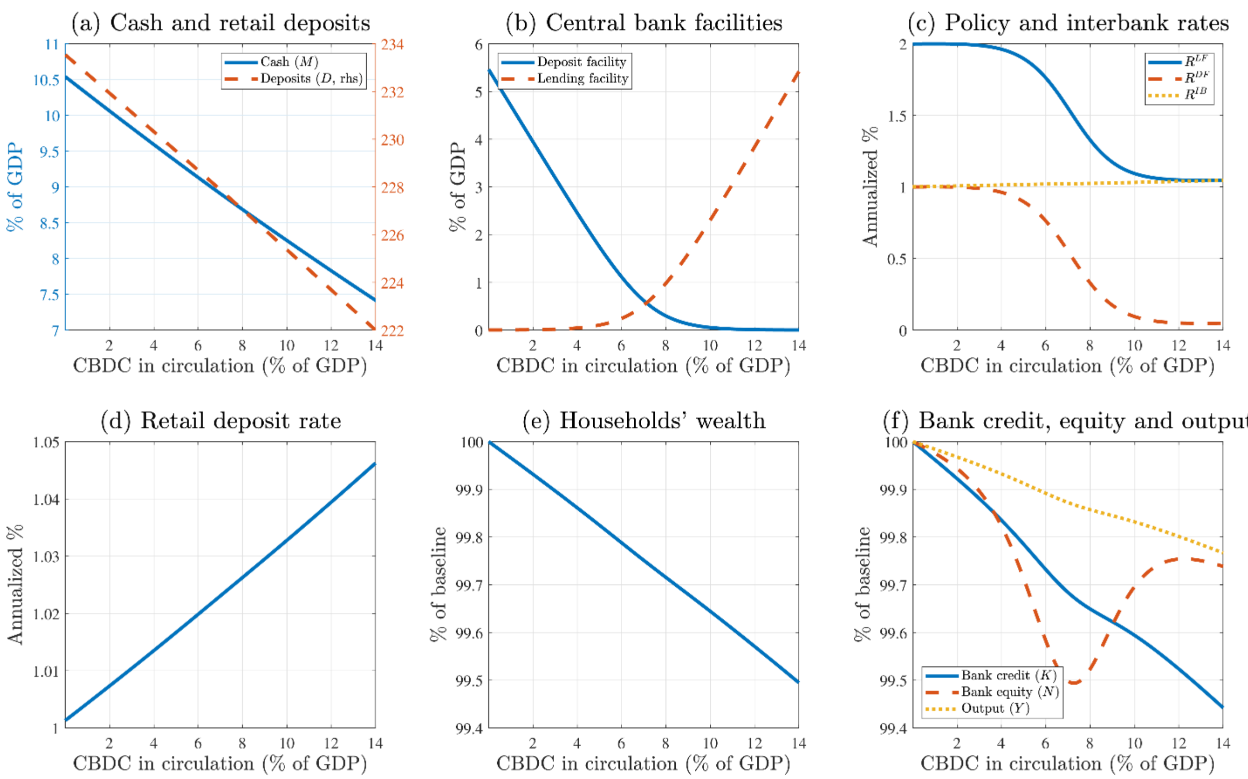
An Example of a New Keynesian Model for CBDC Analysis

Abad, Nuño, and Thomas (2025) employ a new Keynesian model with banks, an interbank market, a central bank, households, and firms that borrow from banks. The model is calibrated to the euro area. CBDC volumes are steered by changing the CBDC utility parameter in the model. The model is used to examine both unremunerated and remunerated CBDC scenarios. They distinguish between an operational monetary policy floor and ceiling frameworks, corresponding to situations of excess reserves and of structural central bank borrowing, respectively.

The authors show that a drop in deposits does not imply a credit reduction, as deposit liabilities can be replaced by central bank borrowing. An assumed CBDC take-up amounting to 14 percent of GDP in their paper reduces bank deposits by 11 percent of GDP (the remaining 3 percent of CBDC take-up relative to GDP subtracts from cash holdings), while lending drops only by 0.6 percent relative to its pre-CBDC outstanding stock.

For CBDC levels below 4 percent of GDP, the system rests in a floor system. Beyond that level, some banks need to start borrowing reserves, resulting in a corridor system. With a CBDC take-up beyond 10 percent, the system reaches a ceiling state, that is, the banking system structurally borrows from the central bank, and the interbank market rates are pushed against the central bank lending facility rate. A quantitative output that such model can produce is shown in Annex Figure 2.3.

Annex Figure 2.3. Selected Model Results from Abad, Nuño, and Thomas (2025)



Source: Abad, Nuño, and Thomas 2025.
Note: CBDC = central bank digital currency.

The CBDC take-up is varied by the model user, on the horizontal axes of the charts. Cash and deposits drop mechanically (panel 1); banks' excess reserves get depleted and, at some point, the net reserve borrowing position builds up instead (panel 2); policy rates fall (panel 3); and deposit rates rise (panel 4).

Total household wealth, defined as cash plus deposits plus CBDC holdings, declines (panel 5) because CBDC is not, in this example, remunerated, so households save less, the model suggests.[46]

[46] For an explanation of why bank equity has a hump shape, in panel 6, see page 26 in Abad, Nuño, and Thomas (2025).

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