The macroeconomic effects of introducing a central bank digital currency

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9 Jul 2025 – Published by VOXEU

Central bank digital currencies are gaining traction as a potential innovation in central banking, with numerous countries considering their implementation. However, given the limited real-world experience with such currencies, researchers and policymakers depend on theoretical analysis to assess their potential. This column presents a new macroeconomic model that reveals significant welfare gains from introducing central bank digital currencies, particularly those that offer interest. Despite the stronger interest in such currencies in Europe, the potential welfare gains may be even higher for the US.

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Central banks worldwide are increasingly exploring the potential introduction of central bank digital currencies (CBDCs). As of 2024, a significant number — 134 countries representing 98% of global economic output — are actively researching or preparing to launch their own digital currencies. This group includes most of the G20 economies, with particularly prominent initiatives such as the digital euro in the euro area (see, for example, the Atlantic Council's CBDC tracker).

The introduction of a CBDC could substantially change the financial and monetary landscape. As central banks venture into this digital currency territory, numerous critical questions emerge: Will the introduction of a CBDC genuinely benefit an economy as a whole? How should central banks set the interest rate on CBDCs? And how does this rate relate to broader economic conditions, particularly existing interest rates?

Since practical experience with CBDC is still limited, policymakers turn to theoretical economic models for insights into these questions. In new work (Paul et al. 2025), we provide such guidance by proposing a novel general equilibrium model that features a realistic banking sector to study the macroeconomic effects of introducing a CBDC.

Our model reveals a critical trade-off with CBDC implementation. On the one hand, households benefit from CBDC because it provides an additional secure and convenient savings option and because it competes with traditional bank deposits, prompting banks to offer better deposit rates to retain customers. On the other hand, banks not only have to raise their deposit rates, but they also face deposit outflows, both lowering their profitability and their lending to businesses, leading in turn to lower investment and production.

Given this trade-off, we use our framework to investigate how the impact of CBDC introduction varies with the interest rate paid on CBDC. Interestingly, the model delivers a unique optimal CBDC rate that implies a welfare improvement for the overall economy. For our baseline calibration to US data, this rate lies at around 0.8% per year, rather than zero as often envisioned by policymakers.

Expanding our analysis beyond a specific economy, we further study the effects of introducing CBDCs in many economies that differ solely in the general level of their interest rates. For each economy, we identify the CBDC rate that maximises overall welfare. We discover significant welfare improvements when countries adopt a straightforward rule to determine CBDC interest rates: setting the rate at either 0% or at 1% below the current policy rate, whichever is higher. This rule effectively balances the potential benefits and drawbacks of CBDCs and avoids controversial outcomes such as negative CBDC rates, which are politically challenging and unpopular.

A macroeconomic model of central bank digital currency

Our theoretical model incorporates several critical components of an economy, including households, banks, firms, and the government. Households make spending and saving decisions, banks accept household deposits and provide loans to businesses, and firms borrow funds to invest.

Our model has two notable features. First, households gain liquidity benefits from cash, deposits, and CBDCs, as these instruments can facilitate transactions. Importantly, households view these three options as not perfectly interchangeable. Instead, factors such as convenience for online payments, anonymity, or government backing influence their choice, beyond just interest rates.

Second, banks hold market power in deposit markets, allowing them to set deposit rates below the central bank's policy rate. The difference between these two rates is known as the deposit spread. Bank market power, along with competition among liquidity options, determines this spread.

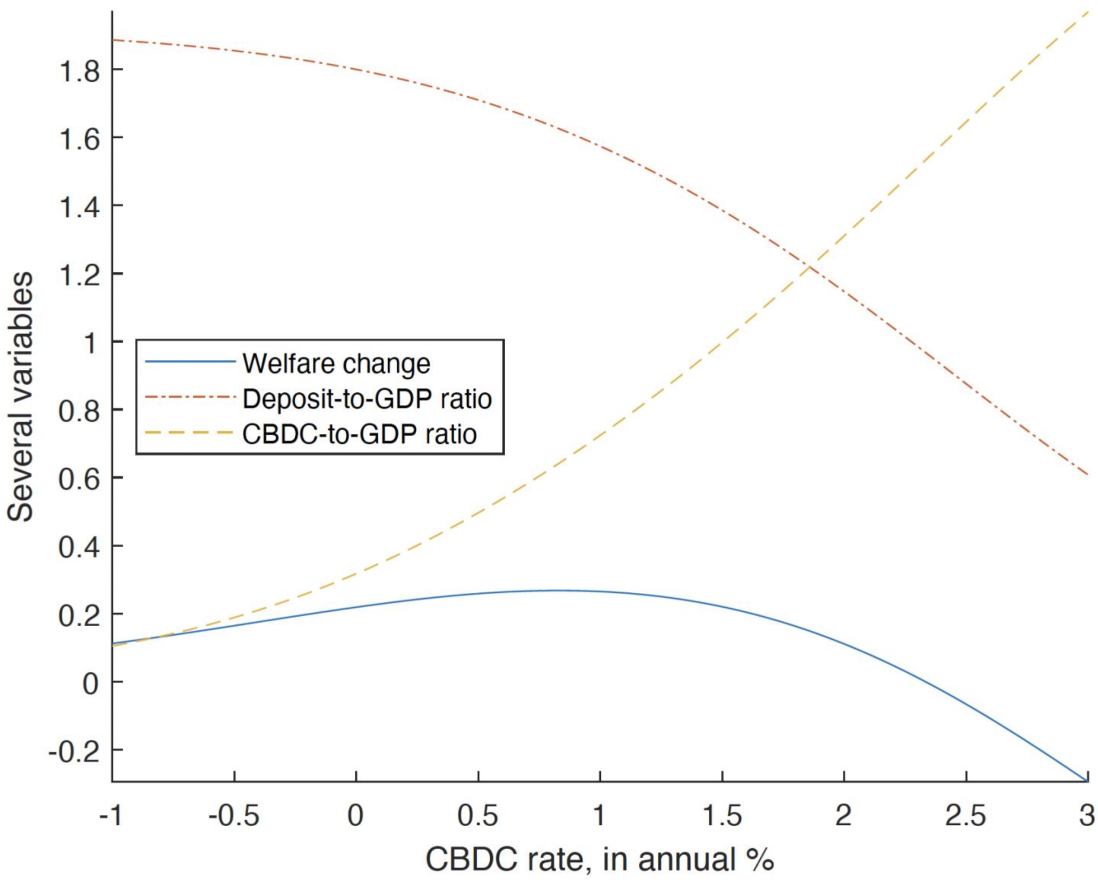
Given these two features, our framework has the following properties. In the absence of a CBDC, the deposit spread rises with the level of the policy rate, since banks gain market power as the rate on cash is fixed at zero (e.g. Drechsler et al. 2017). When a CBDC enters the economy, this spread shrinks because households enjoy the liquidity benefits of CBDC and consequently reduce their bank deposits. The greatest reduction in spread occurs when the CBDC rate is close to the policy rate, as a CBDC is a strong competitor to traditional deposits within that range. Thus, in environments with high policy rates and wide deposit spreads, an interest-bearing CBDC significantly reduces banks' market power.

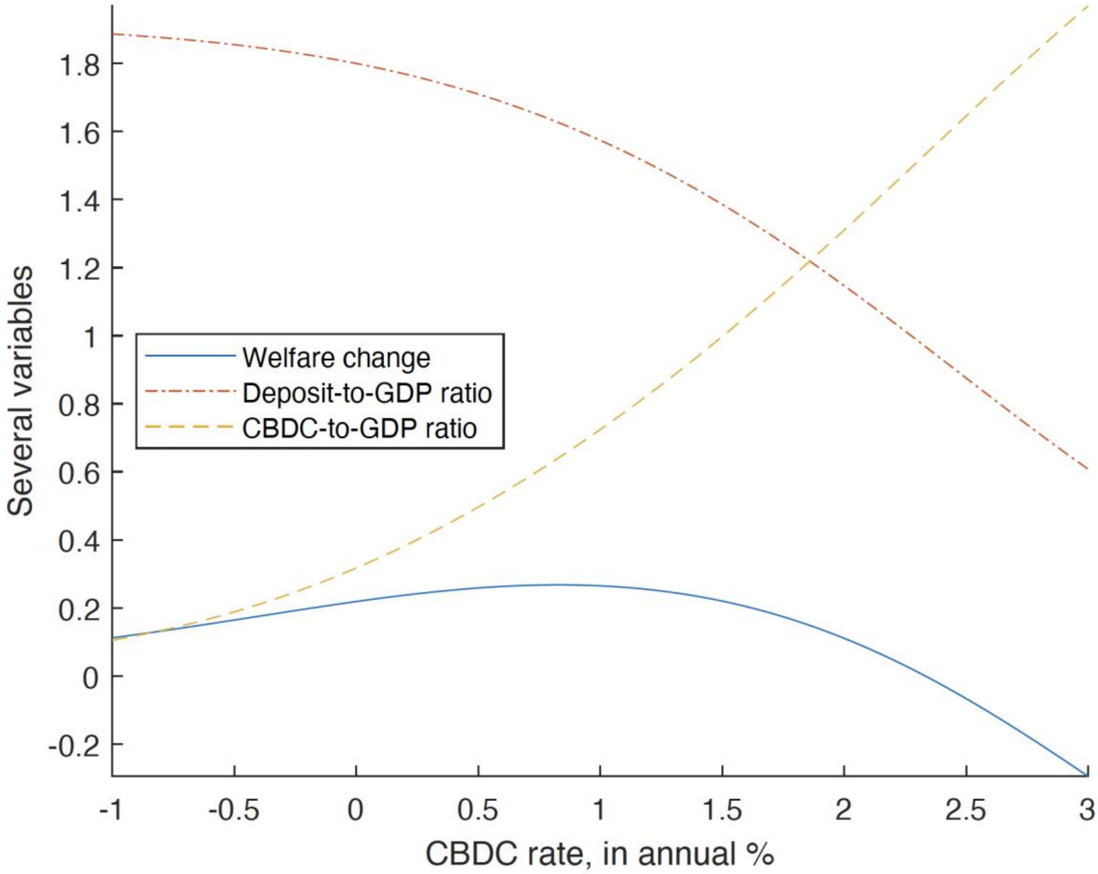
Besides the aforementioned features, the model also incorporates financial frictions so that bank profitability influences bank capital and lending, a bond market that can substitute for bank financing, a central bank, and nominal price rigidities building on the New Keynesian tradition. Calibrated carefully to US data, the model accurately replicates historical patterns in loan rates, deposit rates, and bond spreads.

CBDC introduction for different CBDC rates

We use the model as a laboratory to explore the effects of introducing a CBDC. First, we investigate how the impact of CBDC introduction varies with the CBDC rate. Figure 1 shows how deposit holdings are affected (orange dash-dotted line), CBDC adoption (yellow dashed line), and overall welfare changes (blue solid line), measured as the multiplicative consumption-equivalent variation required to keep households indifferent between the pre-CBDC and the post-CBDC steady states.

Figure 1 Effects of central bank digital currency introduction





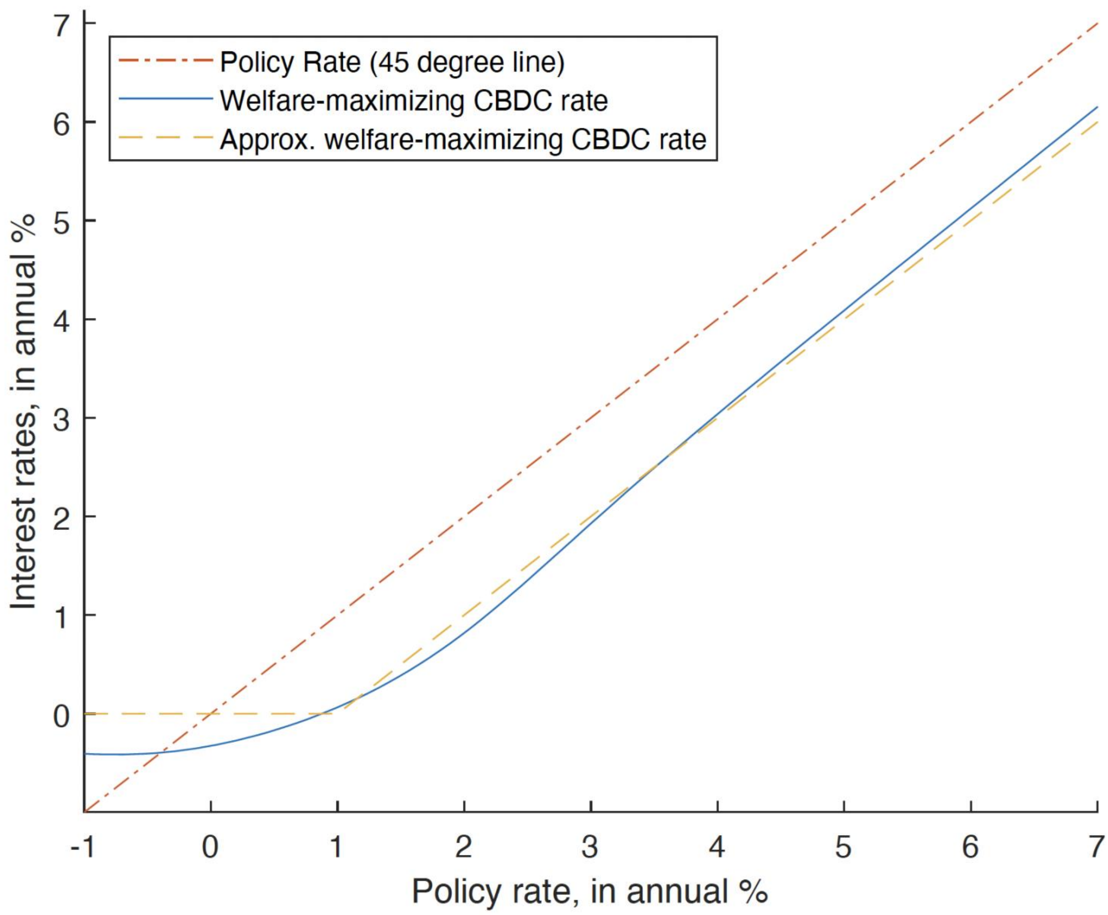
***Notes*: This figure displays the behaviour of several variables for different levels of the CBDC interest rate. The welfare change (gain if positive, loss if negative) from CBDC introduction, in percent, is in blue, the deposit-to-GDP ratio is in orange, and the CBDC-to-GDP ratio is in yellow.**

Interestingly, the welfare change displays an inverted U-shape. If a CBDC pays a very low interest rate, households show minimal interest in holding the digital currency and banks' deposit market power is largely unaffected, limiting the potential gains from CBDC introduction. Conversely, if the CBDC interest rate is set very high, households shift dramatically from traditional bank deposits to CBDCs. This shift leads to significant declines in bank profitability and lending capabilities. Consequently, business investments suffer, and overall economic activity declines, ultimately harming welfare. Thus, the model identifies an optimal CBDC rate of around 0.8% annually. This rate ensures the maximum economic benefit without unduly harming the banking sector.

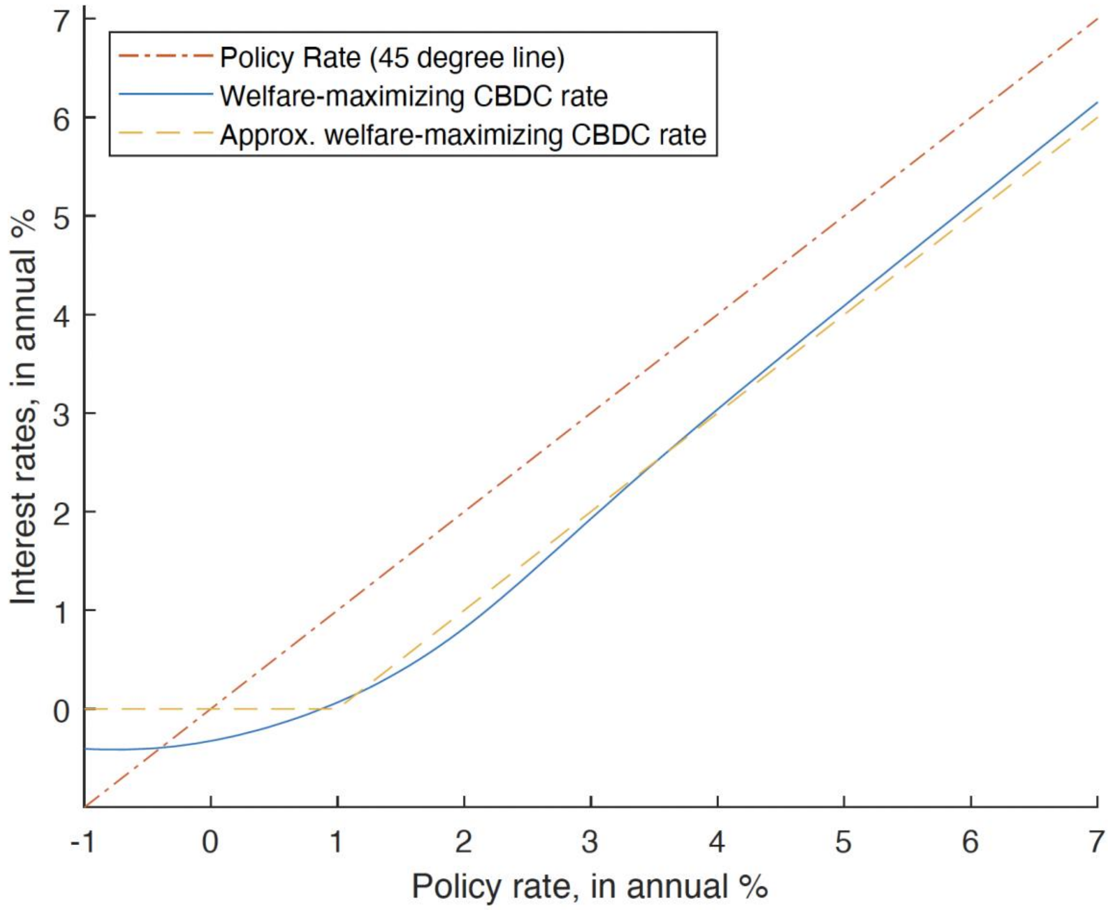
Welfare-maximising CBDC rate across policy rates

Next, we examine CBDC effects across economies that differ only in their baseline policy rates and determine the optimal CBDC interest rate for each economy. Figure 2 shows the optimal CBDC rate (blue solid line) compared with the policy rate (the 45-degree line).

Figure 2 Optimal central bank digital currency rate



Policy Rate (45 degree line)
Welfare-maximizing CBDC rate
Approx. welfare-maximizing CBDC rate
Interest rates, in annual %
Policy rate, in annual %
7
6
5
4
3
2
1
0
-1
0
1
2
3
4
5
6
7

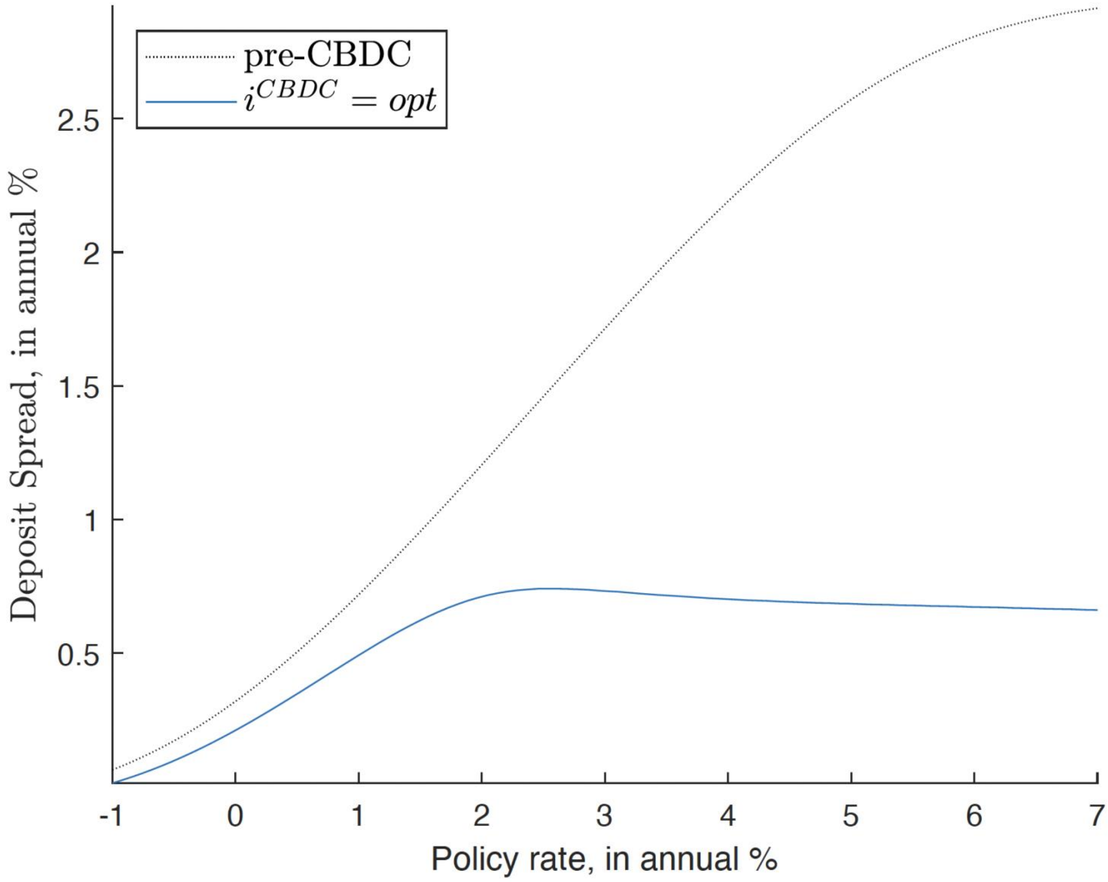


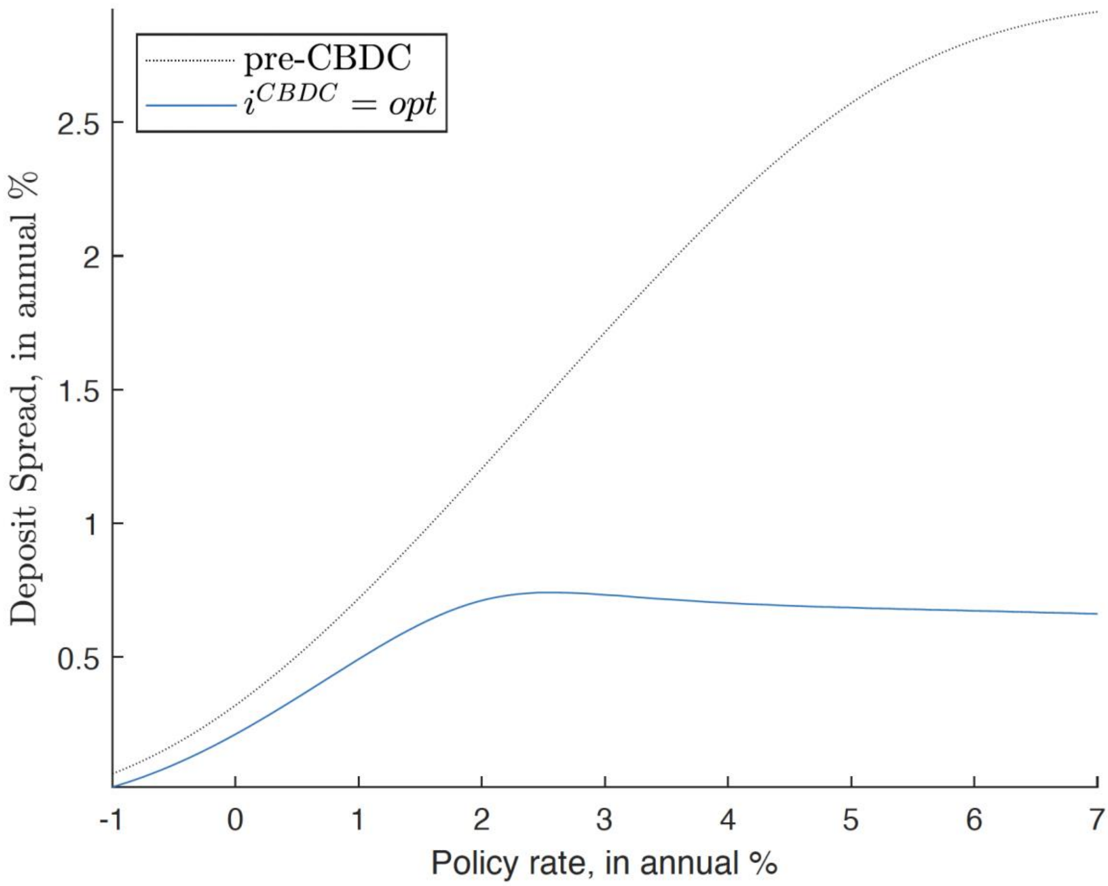
***Notes*: This figure displays the policy rate in orange (in both axes, so it is the 45-degree line), the welfare-maximising level of the CBDC rate in blue, and an approximate welfare-maximising rule-of-thumb rate, which is the maximum between 0 and the policy rate minus 1%, in yellow.**

For policy rates below 1%, the optimal CBDC rate is slightly negative or can even exceed the policy rate. For rates above 1%, the optimal CBDC rate lies approximately 80 to 120 basis points below the policy rate. We demonstrate that a simple guideline, setting the CBDC rate at the higher of 0% or 1% below the policy rate, closely matches this optimal rate (the yellow dashed line in Figure 2). This simple rule of thumb can easily be applied to diverse economies and avoids the contentious issue of negative CBDC rates.

Introducing a CBDC with this design significantly impacts the banking sector. Figure 3 highlights how banks' market power declines substantially, especially in high-interest-rate environments. At a 5% policy rate, banks typically charge a high deposit spread of around 2.5% without CBDC (black dotted line). Introducing a CBDC at the optimal rate (blue solid line) increases the deposit rate to 4.3%, reducing the spread to just 0.7%. Indeed, introducing an optimally remunerated CBDC stabilises deposit spreads around 70 basis points for policy rates between 2% and 7%, significantly reducing banks' market power in deposit markets.

Figure 3 Changes in deposit spread


pre-CBDC
$i^{CBDC} = opt$
Deposit Spread, in annual %
2.5
2
1.5
1
0.5
-1
0
1
2
3
4
5
6
7
Policy rate, in annual %


pre-CBDC
$i^{CBDC} = opt$
Deposit Spread, in annual %
2.5
2
1.5
1
0.5
-1
0
1
2
3
4
5
6
7
Policy rate, in annual %

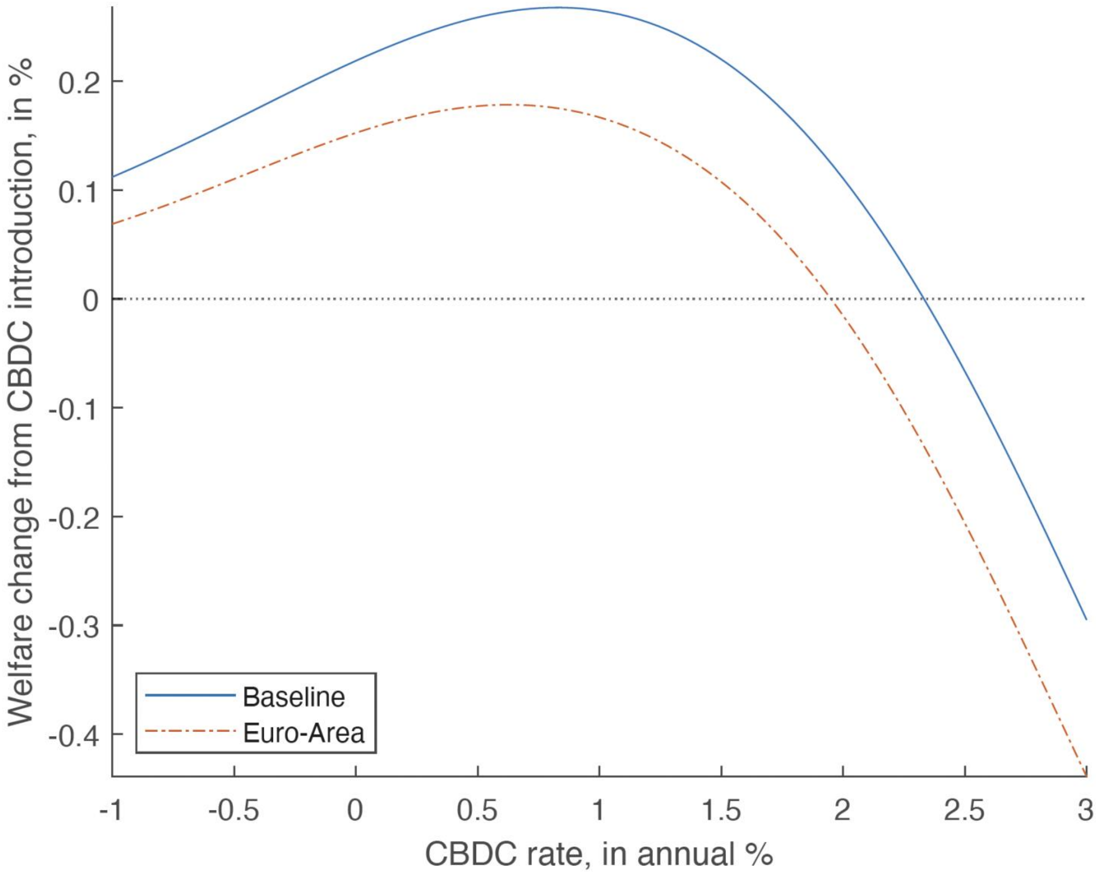
***Notes*: This figure shows the deposit spread, before and after the introduction of CBDC, across levels of the policy rate (on the x-axis).**

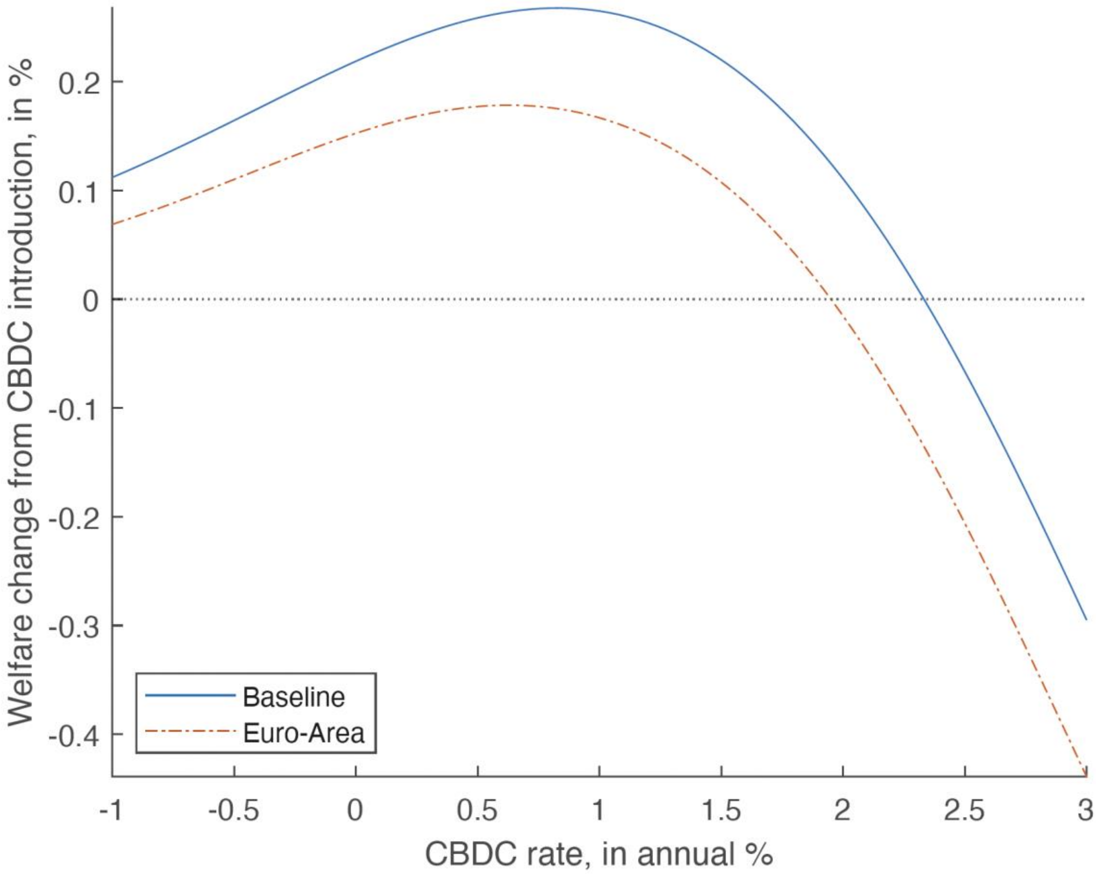
This reduction in banks' market power also improves welfare, especially in high-interest-rate environments. For policy rates below 2%, welfare gains are modest, around 0.25%, but rise significantly at higher policy rates. For example, at a 6% policy rate, we find that welfare improves notably by around 1%.

Euro area calibration

Lastly, we recalibrate our model to the euro area, where the European Central Bank (ECB) is actively preparing the digital euro. The euro area differs from the US notably due to the higher reliance on bank lending for non-financial businesses (around 80% versus 30% in the US). Consequently, welfare gains from introducing a CBDC are smaller in the euro area (Figure 4), as the negative bank disintermediation effect weighs more heavily.

Figure 4 Welfare change comparison: Euro area vs. US





Notes**: This figure displays the welfare change (gain if positive, loss if negative) from CBDC introduction, in percent, across levels of the interest rate on CBDC for two different calibrations. The results under the baseline calibration are in blue (replicating the solid blue line in Figure 1) and the results under the euro area calibration are given by the dashed-dotted orange line.**

In Figure 4, the solid blue line represents the US baseline, peaking at a welfare gain of 27 basis points with a CBDC rate of 0.8%. The euro area (orange dashed-dotted line) achieves a lower peak welfare gain of 18 basis points at a lower optimal CBDC rate of 0.6%. Thus, despite stronger interest in CBDCs in Europe, potential welfare gains may be higher for the US.

References

Drechsler, I, A Savov and P Schnabl (2017), "The Deposit Channel of Monetary Policy", *Quarterly Journal of Economics* 132(4): 1819–1876.

Paul, P, M Ulate and J Wu (2025), "A Macroeconomic Model of Central Bank Digital Currency", Federal Reserve Bank of San Francisco Working Paper 2024-11.

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