

# CBDC and banks: Disintermediating fast and slow

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- Quantitative evaluation & policy analysis of CBDC
  1. **Novel survey results** from German households
  2. **New quantitative macroeconomic model** with the CBDC and bank runs

# Overview and Main Takeaways

- Survey results: German households appear 'open' to the D€
  - 46% of surveyed households would adopt the D€, with substantial reallocation from bank deposits to the D€
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  - CBDC reduces banks' leverage in normal times → increases stability
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- Model: 'Slow' and 'fast' disintermediation has opposing stability impact
  - CBDC reduces banks' leverage in normal times → increases stability
  - However, CBDC is a convenient asset to run to → decreases stability
- Implications for financial stability, policy design and welfare
  - Unremunerated CBDC has adverse effects on financial stability and welfare
  - But, holding limits can reverse this and make CBDC welfare-improving
    - Quantitative model suggests an optimal limit between €1500 – 2500



# Survey Questions on the Prospective Adoption of the D€

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  - System-wide banking distress scenario
  - Interest elasticity (allowing remunerated CBDC)

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  - Status quo scenario
  - System-wide banking distress scenario
  - Interest elasticity (allowing remunerated CBDC)
- How do the survey results contribute to the discussion around CBDC?
  - Limited survey evidence available (e.g., Austria, Netherlands, South Korea)
  - We provide a new dimension on financial stability and banking distress

# Description of the D€ to Households in the Survey

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*The digital euro would be digital money that would be used like money on a current account. However, it would be **issued and guaranteed by the ECB and the national central banks.***

*The digital euro would **not replace cash or accounts with commercial banks**, but would be an additional offering alongside these. The digital euro would enable **everyday payments to be made digitally, quickly, easily, securely and free of charge** throughout the euro area.*

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## 1. Portfolio choice (**without D€**)

*Now imagine you have €1000 available each month to allocate across different asset classes. In this context, please assume that **the digital euro does not yet exist**.*

*How much of the €1000 per month would you hold as cash, deposit into your current account, or invest in other financial instruments?*

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## 2. Portfolio Choice (**with D€**)

*Please now assume that the digital euro has been introduced. Please also assume that you have a digital euro account that you can use to hold digital euro. **You would receive no interest on this digital euro account.***

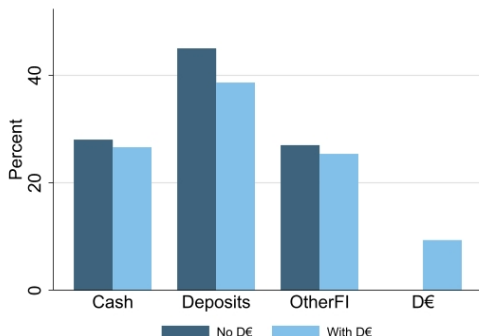


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- Households appear 'open' to the D€
  - Around half of respondents (46%) would hold the D€
- On average households allocate around 10% to the D€
  - The D€ to cash ratio is around half
  - Substantial reallocation from deposits to D€
  - For 'keen' respondents (with positive d€) demand for d€ surpasses cash



# A Banking Distress Scenario

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*Imagine that you have €5000 on your current account.*

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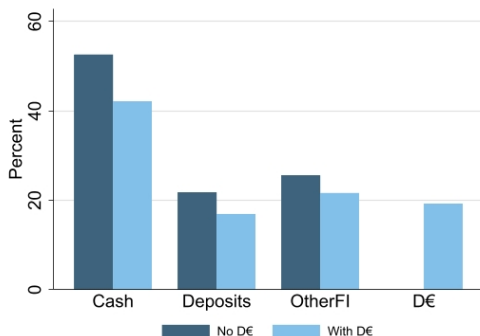
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1. Agents are first asked to allocate the funds in the absence of the D€
2. Asked to repeat allocation with the D€ as an additional choice

# Allocation During Period of Banking Distress

- Somewhat **greater openness to D€** than in normal times
  - 56% of respondents would hold D€ (vs 46% in previous scenario)
  - Cash is dominant asset to run to, but less so with the D€
  - **Fewer deposits remain in the bank** when the D€ is available



# Relative safety of D€ and Runs on Bank Deposits

- Relative safety of D€ can be a **challenge during a banking crisis**

*“Experience shows that in a banking crisis, depositors become quickly and keenly aware of the risk and tend to ‘run’ away from risky deposits. In that eventuality, they would surely understand the difference between bank deposits and the prospective D€ and would want to run on the former in favour of the latter.” (Angeloni, 2023)*

- **Extra info on safety of D€** relative to bank deposits for some participants
  - Reminder that D€ could always be used for payments and converted to cash
- Information **raises the rate of positive withdrawals** from 51% to 61%
  - Mirrors concern that depositors become aware of riskier deposits in a crisis



# Summary on hypothetical survey evidence

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+ Heterogeneity in CBDC adaption with trust in ECB being a key driver [More](#)

# Macroeconomic Model with CBDC and Bank Runs

- **Novel macroeconomic model with CBDC and system-wide bank runs**
  - Structural and quantitative framework calibrated to the euro area
  - Informed by the survey evidence on 'slow' and 'fast' disintermediation
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- ⇒ Evaluation of D€ design features' effectiveness (e.g. holding limits)

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- ⇒ Implications of the D€ for financial stability, broader economy and welfare
- ⇒ Evaluation of D€ design features' effectiveness (e.g. holding limits)
- How can this model contribute to the discussion around CBDC?
  - Quantitative New Keynesian model to assess financial stability implications
    - Policy-relevant framework for CBDC debates

# Two Key Features of our Model

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## 2. Occasional [runs on the banking sector](#)

- Possibility of runs depends on state of the economy, banking sector and policies
- During a run, household shifts from deposits to cash and the CBDC
- Absence of storage costs implies that CBDC is especially convenient to run to



# Calibration and Global Solution Method

- Calibrate the model to euro area data and exploit the survey
  - Historical data and existing literature guide most parameters
  - No historical data for CBDC!
  - Match the CBDC to cash ratio from survey
    - Baseline scenario and a 'keen' scenario with a larger uptake

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  - **Match the CBDC to cash ratio** from survey
    - Baseline scenario and a 'keen' scenario with a larger uptake
- Nonlinear model is **solved with global solution methods**
  - Accounts for **bank runs** (multiple equilibria) and their nonlinear dynamics
  - Handles **occasionally binding constraints** (lower bound, holding limits)

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⇒ Financial stability increases

## 2. **Storage at scale channel** of CBDC during runs

- No inherent technological barrier that prevents scaling up CBDC holdings
- CBDC can be held in large amounts - unlike cash - in the event of a run

⇒ Financial stability decreases

# Financial Stability and Welfare implications

- What are the implications of unremunerated CBDC?
  - Comparison of an economy with CBDC to an economy without CBDC
  - Financial stability criterion: Annual run probability
  - Economic criterion: Welfare in the economy (in consumption units)
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Run probability (%)	2.51	1.34	2.20
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- CBDC decreases financial stability & welfare due to 'fast' disintermediation
  - **Storage at scale channel dominates** liquidity premium channel
  - Results reverse if there is very strong CBDC demand (far from survey) [More](#)

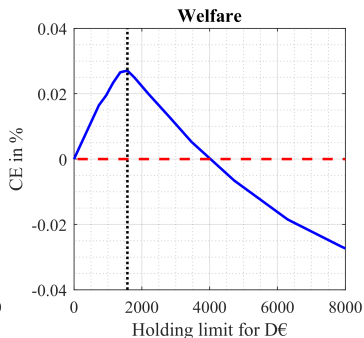
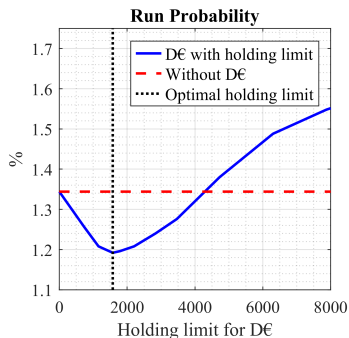


# Optimal Holdings Limits

- Widely circulated idea is to complement CBDC with holding limits
  - Enables the gains of CBDC, while containing the storage at scale channel
  - Active debate exists over the level of the holding limit

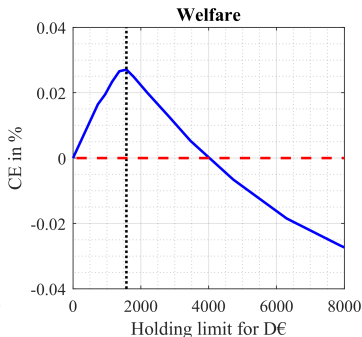
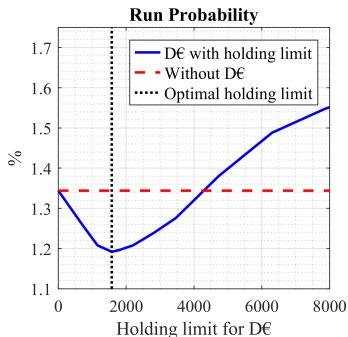
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- **Keen scenario** about D€ adoption results in a **value of €2500** [More](#)

# Remuneration Pegged to Policy Rates

- A second design feature is **whether or not to remunerate**
  - Often discussed feature, even though less in recent times
- **CBDC remuneration tracks the policy rate**, less a fixed spread
- Such a policy **improves stability and enhances welfare** More
  - During a boom, remuneration of D€ increases → more attractive
  - During a run, remuneration would be negative → less attractive
  - The possibility for negative remuneration is important for financial stability effects

# Conclusion

- Examine the **impact of CBDC on financial stability and the economy**
  - Drawing on novel survey evidence and a structural macroeconomic model
- Survey indicates substantial demand for CBDC
  - Results imply 'slow' and 'fast' disintermediation
- Macro model to quantify stability risks and to discuss policy prescriptions
  - Unremunerated CBDC **decreases financial stability and welfare**
  - **But, holding limit** or remuneration can **reverse the result**

# Appendix

# D€ adoption and heterogeneity

- Who is **less** / **more** likely to adopt CBDC
  - Results are based on regression analysis of extensive margin
  - Variables can be categorized loosely as 'economic', 'demographic', 'activity', and 'trust'-based
  
- **Low trust in ECB (22%)**
- **High deposit ratio (13%)**
- **East German adult (4%)**
- **High E[inflation] (3%)**
- **Investor (4%)**
- **Old (7%)**
  
- **High trust in ECB (8%)**
- **Low income (6%)**
- **Low net worth (7%)**
- **Transactor (3%)**

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# Macroeconomic model: Overview

- Nonlinear New Keynesian model with three key features
  1. Endogenous **runs on the banking sector** (Gertler et al., '20; Rottner, 23)
  2. **CBDC** is - next to cash and deposits - **mean of payment and store of value**
  3. Money reduces **transaction costs of consuming** (Schmitt-Grohe & Uribe, '10)
- Agents in the model
  - Households: consume, work, invest, (and run)
  - Banks: intermediate between households and firms
  - Non-financial firms: produce output
  - Monetary authority: sets policy rate, issues cash and CBDC
  - Government authority: sets taxes

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# Households

- Consume  $C_t$ , provide labor and face a portfolio decision
- Access to **three liquid assets**: cash  $Ca_t$ , CBDC  $D_{CB,t}$  and deposits  $D_t$ 
  - Two differences: 1) benefits as means of payment and 2) return
- Aggregation of liquid assets to **money**  $M_t$

- **Different relative weights** of imperfectly substitutable assets

$$M_t = \left[ Ca_t^{\frac{\eta_m-1}{\eta_m}} + \mu_d D_t^{\frac{\eta_m-1}{\eta_m}} + \mu_{cb} D_{CB,t}^{\frac{\eta_m-1}{\eta_m}} \right]^{\frac{\eta_m}{\eta_m-1}}$$

- **Money reduces transaction costs**  $s(M_t/C_t)$  that occur during consuming
  - Money holdings decrease the transaction costs
  - Transaction services provide additional gain beyond return

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# Households (cont'd)

- Varying return on the liquid assets
  - Cash: unremunerated, but faces positively increasing storage costs
  - CBDC: unremunerated/remunerated
  - Deposits: promised return  $\bar{R}_t$ , but pays only a fraction in case of run
- Remarks on benefits as means of payment and return:
  1. Introduction of CBDC affects the transaction services of deposits
  2. CBDC faces no storage costs - can be held 'cheaper' in large quantities
- Can also invest securities - provide direct ownership in non-financial firms
  - Earn stochastic return and can trade securities for price  $Q_t$  with banks & HH

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# Banking sector

- Banks are more efficient than households in managing securities
  - Follows Brunnermeier and Sannikov ('14) and Gertler et al. ('20)
  - Costly for banks to hold more securities than target share
- Banks face risk-shifting incentives, face runs and have liquidity premium
  1. Limited liability distorts the choice between assets with different risk profile
  2. Run possibility also affects decision
  3. Deposits provide transaction services → liquidity premium⇒ Endogenously determines size leverage and of bank sector
- Volatility  $\sigma_t$  affects risk-shifting incentives of banks
  - Low volatility implies less distortion → larger size and leverage
  - Creates 'credit boom gone bust' dynamics for the model

# Endogenous runs

- Runs on the banking sector
  1. Households **withdraw their deposits - reallocate to cash, CBDC and securities**
  2. Banks' security demand collapses and they sell assets at firesale price
  3. Run possible initially if banks cannot repay households at firesale price
- Partition of state space in two regions
  - Safe region: Banks can always pay back depositors  $\Rightarrow$  No runs
  - Fragile region: Banks cannot repay if run occurs  $\Rightarrow$  Runs are possible
    - **Economic & financial fundamentals determine the region endogenously**
- Fragile region: Outcome is not determined only by fundamentals
  - **Multiplicity of equilibria - in spirit of Diamond and Dybvig (1983)**
  - Sunspot shocks as non-fundamental coordination device

# Non-financial firms and nominal rigidities

- Non-financial firms
  - Non-financial firms produce output using labor and capital
  - Pay state contingent interest rate on securities
- Nominal rigidities
  - Rotemberg pricing

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# Monetary authority

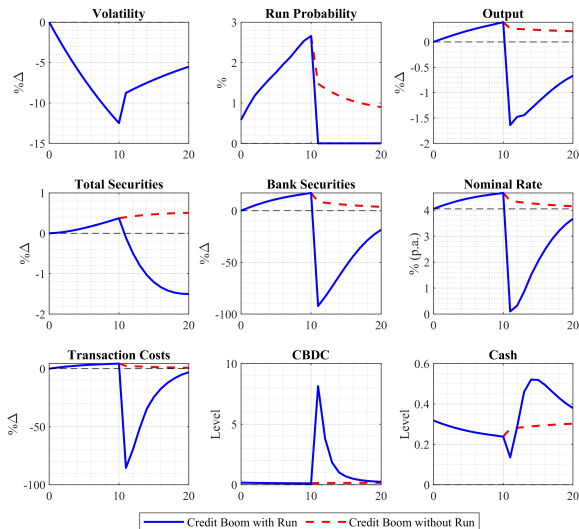
- Issues liabilities (cash and CBDC), purchase assets, rebates profits
- Uses funds from issuance to buy securities at market price  $Q_t$

$$Q_t S_{CB,t} = Ca_t + D_{CB,t}$$

- Important dimension: How effective is the central banker as investor
  - Conservative choice: As (in)efficient investor as households
    - Equivalent to central bank rebating holdings in lump-sum manner
- Taylor Rule for setting the nominal interest rate  $R_{I,t}$ 
  - Features a lower bound  $R^{LB}$  on interest rates

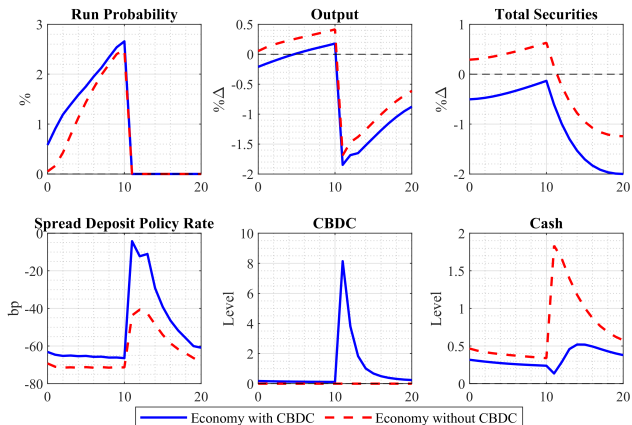
$$R_{I,t} = \max \left[ R_I \left( \frac{\Pi_t}{\Pi} \right)^{\kappa_\pi} \left( \frac{\varphi_t^{mc}}{\varphi^{mc}} \right)^{\kappa_y}, R^{LB} \right],$$

# Endogenous bank run and CBDC



# Economy with and without CBDC

- CBDC plays an important role for the risk of a bank run
  - Run probability is larger with CBDC during a boom
  - Households run to CBDC instead of cash





# Demand for CBDC: Welfare and financial stability

- Variation in the **CBDC weight parameter  $\mu_{cb}$**  for money aggregator
  - If households value enough, CBDC can increase welfare and reduce runs
  - 'Slow' disintermediation as CBDC holdings in normal times increase
  - Implications: CBDC to cash ratio of around 6 - very far from survey evidence

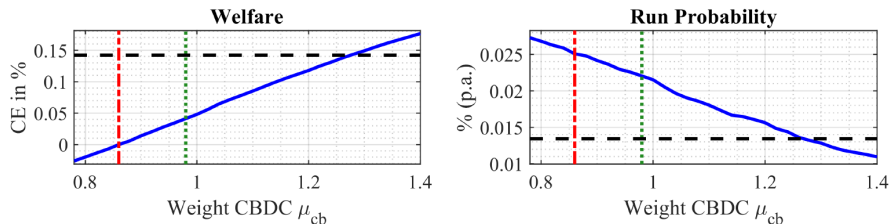
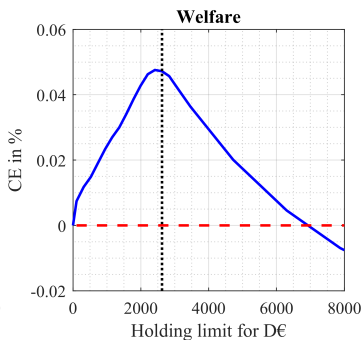
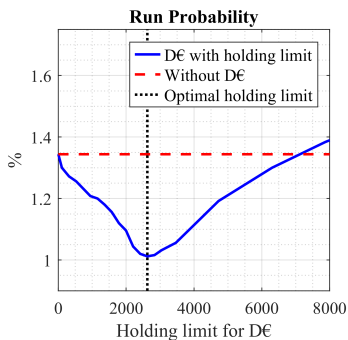


Figure: CBDC economy, No CBDC, Baseline, Keen

# Optimal Holdings Limits: Alternative calibration

- The optimal holding limit varies with the demand of households in normal times
  - Alternative calibration that is based on the D€ to cash ratio of survey respondents with positive D€ holdings
  - Model suggests an **optimal holding of €2500** in this alternative calibration



# Remuneration

- A second design feature is **whether or not to remunerate**
  - This feature is often discussed, even though less often in recent times
- Rate on **CBDC tracks the standard policy rate**, less a fixed spread  $\Delta_{CB}$

$$R_{CB,t} = R_{I,t} - \Delta_{CB}$$

$\Delta_{CB}$  is set to have no no remuneration in the steady state

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# Remuneration (cont'd)

- Policy exploits 'slow' disintermediation and limits 'fast' disintermediation
  - During a boom, remuneration of CBDC increases → more attractive
    - Reduces liquidity premium & 'slow' disintermediation counteracts boom
  - During a run, remuneration would be negative → less attractive
  - But, result requires that central bank can implement negative remuneration

