Central Bank Digital Currency and Banking Choices

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Introduction

- CBDC is a digital form of central bank issued money that is available to the general public and can be used for retail payments.
- Many central banks are considering the issuance of a CBDC.
- Despite widespread interest, concerns that a CBDC would crowd out too many bank deposits.
- To what extent would a CBDC crowd out bank deposits?

This paper

This paper develops and estimates a structural model to study the impact of CBDC on banks in the deposit market.

Apart from the interest rate, we incorporate two key attributes that can differ between CBDC and bank deposits:

- Service locations: where to get in-person services
- Complementarity across different financial products

Methodology

1. Develop a structural model of consumer banking choices:
    - Demand side: households choose their deposit bank after considering
        - branch networks
        - complementarity across different financial products
    - Supply side: banks with differentiated deposit products compete in prices
2. Estimate the model using household- and branch-level data:
    - Demand side: Obtain demand parameters, including households' preferences for rate of return, branch network, etc.
    - Supply side: Estimate each bank's marginal cost
3. Introduce CBDC in the counterfactual analysis
    - CBDC is viewed as a new product that households can choose
    - CBDC attributes are chosen exogenously by the central bank

Literature review

Existing works on CBDC mostly theoretical:

e.g. Barrdear and Kumhof (2016), Andolfatto (2018), Davoodalhosseini (2018), Agur et al. (2019), Brunnermeier and Niepelt (2019), Keister and Sanches (2019), Chiu et al. (2020), Fernández-Villaverde et al. (2020), Williamson (2020), Assenmacher et al. (2021), Garratt et al. (2021), Abad et al. (2023), Chang et al. (2023), Cheng and Izumi (2023), Jiang and Zhu (2023), Liu et al. (2023), Tan (2023)

Few empirical works on CBDC:

- structural model approach: Huynh et al. (2021), Li (2023), Whited et al. (2023), Lambert et al. (2024), Nocciola and Zamora-Perez (2024)
  - This paper shows the importance of two key differences between bank deposits and CBDC:
    - network of branches that provide access to in-person services
    - complementarity between deposits and other financial products
- survey/experiment approach: e.g. Bijlsma et al. (2021), Choi et al. (2022)

Outline

- Model
- Introducing CBDC
- Data
- Estimation
- Counterfactual analyses
- Conclusions

Households' problem

Which deposit bank to choose? Solve by backward induction

Stage 1. Choose a deposit bank $j \in (1, .., J)$

Utility for bank j depends on branch networks $X_{i,j}$, together with utilities $V^b_{i,j}$, $E[V^k_{i,j}]$

Stage 2. Allocate endowed liquid assets w_i between cash and deposits

$\rightarrow$ Indirect utility $V^b_{i,j}$ from holding liquid assets at bank j

Stage 3. May need to choose a bank $n \in (1, .., J)$ for product k

$\rightarrow$ Expected utility from product k $E[V^k_{i,j}]$ depends on preferences for home bank j

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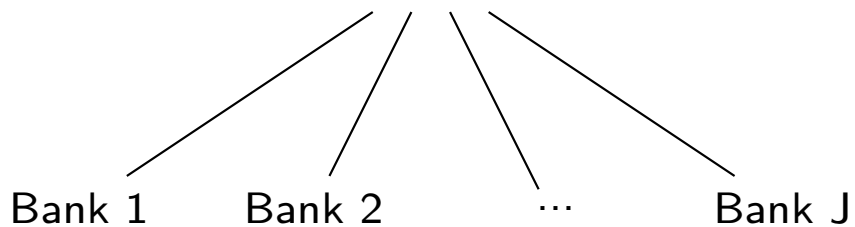

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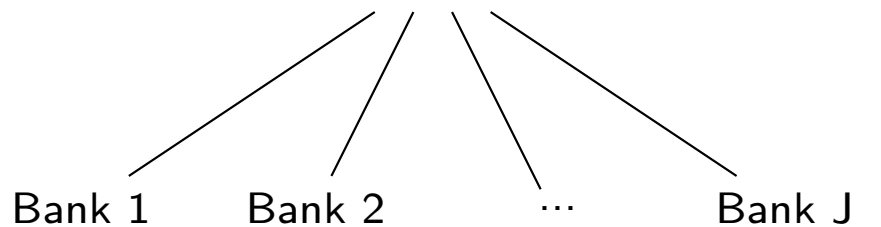

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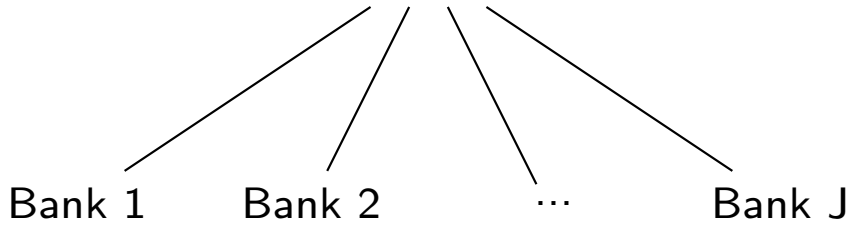

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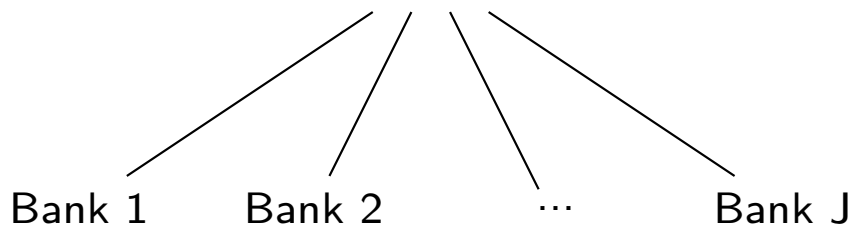

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Banks' problem

- Aggregate each household's deposit demand to the bank level $D_j(r_j, \boldsymbol{r}_{-j})$
- Bank j takes $\boldsymbol{r}_{-j}$ as given and sets deposit rate r_j to maximize profit:

$$\pi_j(r_j, \boldsymbol{r}_{-j}) = (r_j^l - r_j - mc_j) D_j(r_j, \boldsymbol{r}_{-j})$$

  where r_j^l is the exogenous return on loans and mc_j is the marginal cost.

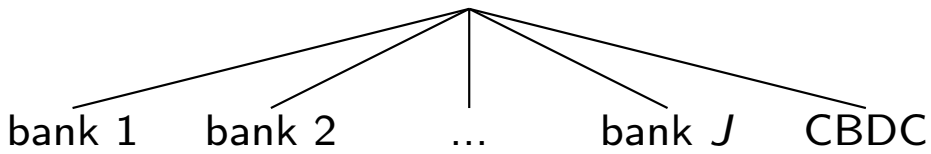
- First-order conditions $\Rightarrow$ equilibrium deposit rates $\boldsymbol{r}^*$:

$$\underbrace{r_j^l - r_j^* - mc_j}_{\text{markup}} = \left(\frac{\partial D_j}{\partial r_j^*} \frac{1}{D_j} \right)^{-1} \quad \forall j$$

Introducing CBDC

A new product for depositing the digital balance

CBDC as a new alternative in each household's choice set $\mathcal{J}_i$:



- Introducing CBDC reduces the probability of choosing each incumbent
- CBDC design choices:
  - CBDC interest rate: affects utility of holding liquid balances $V^b_{i,cbdc}$
  - no complementarity with other financial products, so $E[V^k_{i,cbdc}]$ is lower
  - network of service locations $X_{i,cbdc}$

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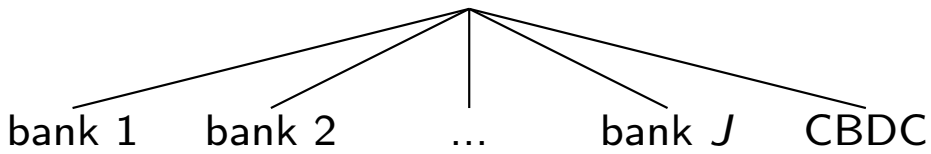

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Data

- Canadian Financial Monitor (2010–2017) household survey:
  - Banking choices: holdings of cash and deposits + bank choices for deposits, mortgages, credit cards, GICs, etc.
  - Location and other characteristics
- Location datasets:
  - FCAC bank branch location (2010–2017)
  - Canada Post office location (2021)
- Cannex bank-level interest rates (2010–2017)
  - Demand deposit rates
  - 5-year closed mortgage rates

Demand estimation

Summary of demand results

Demand estimation: obtain demand parameters in three steps

- Bank choice of product k (i.e. mortgage, credit card, GIC)

  $\star$ strong preference for getting the product from home bank

  $\rightarrow$ obtain expected utility from the product $E[V_{i,j}^k]$

- Portfolio allocation choice

  $\star$ higher deposit rate increases holding of deposits relative to cash

  $\rightarrow$ obtain utility from liquidity holding $V_{i,j}^b$

- Deposit bank choice

  $\star$ strong preference for better branch network

  $\rightarrow$ apart from branch networks, $V_{i,j}^b$ and $E[V_{i,j}^k]$ also matter

Supply estimation

Obtain bank's marginal costs using estimated demand and banks' FOCs

- Supply estimation: obtain marginal costs using estimated demand.
- In 2017, on average banks have:
  - 5-year closed mortgage rates r_j^l: 4.8% (exogenous)
  - Deposit rate r_j^*: 0.1%
  - Estimated markup (inverse semi-elasticity of deposit demand): 2.0%

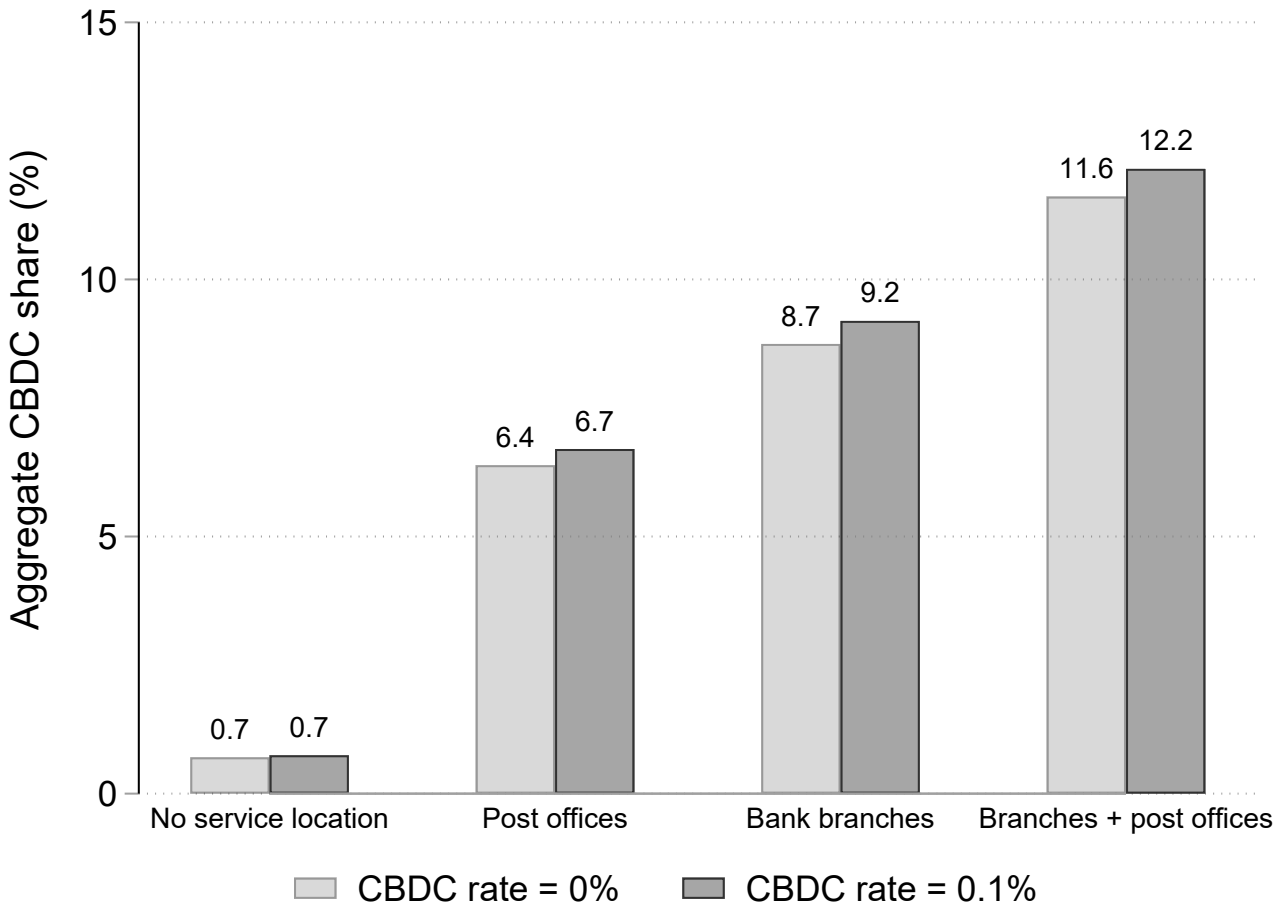
  $\Rightarrow$ Estimated marginal cost mc_j: 2.7% (exogenous)

Counterfactual analyses

- We hold demand and cost primitives the same as before CBDC issuance
- Solve Nash-Bertrand game for each CBDC design:
  - CBDC interest rate
  - CBDC branch network:
    - No network
    - Canada Post
    - All bank branches
  - No complementarity between CBDC and other financial products

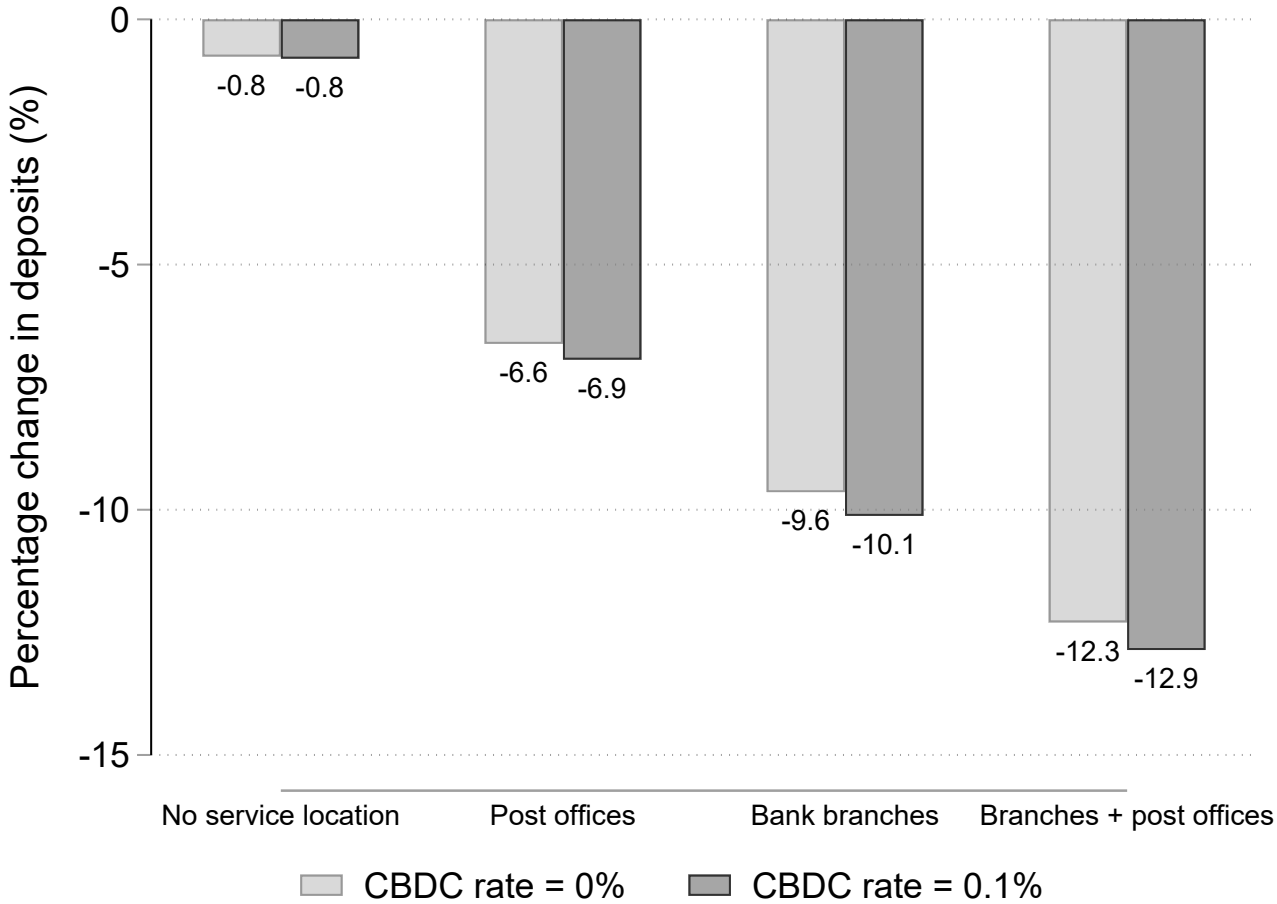
Aggregate CBDC shares under different designs

Service locations for CBDC matter



Average reduction in deposits

Service locations for CBDC matter



Response in deposit rates differs by bank

- Banks with higher market shares also have higher markups and they
  $\rightarrow$ respond more in rates
  $\rightarrow$ lose fewer deposits

Limits on CBDC holdings

- Many jurisdictions are considering limits on the holding of CBDC.
  - Bank of England: £10,000 –£20,000
  - ECB: €3000 –€4000
- If a household chooses CBDC, they allocate endowed liquid assets between CBDC and cash
  - if constrained by the limit, must hold the remainder in cash

  $\rightarrow$ lower utility for liquidity holding for constrained households

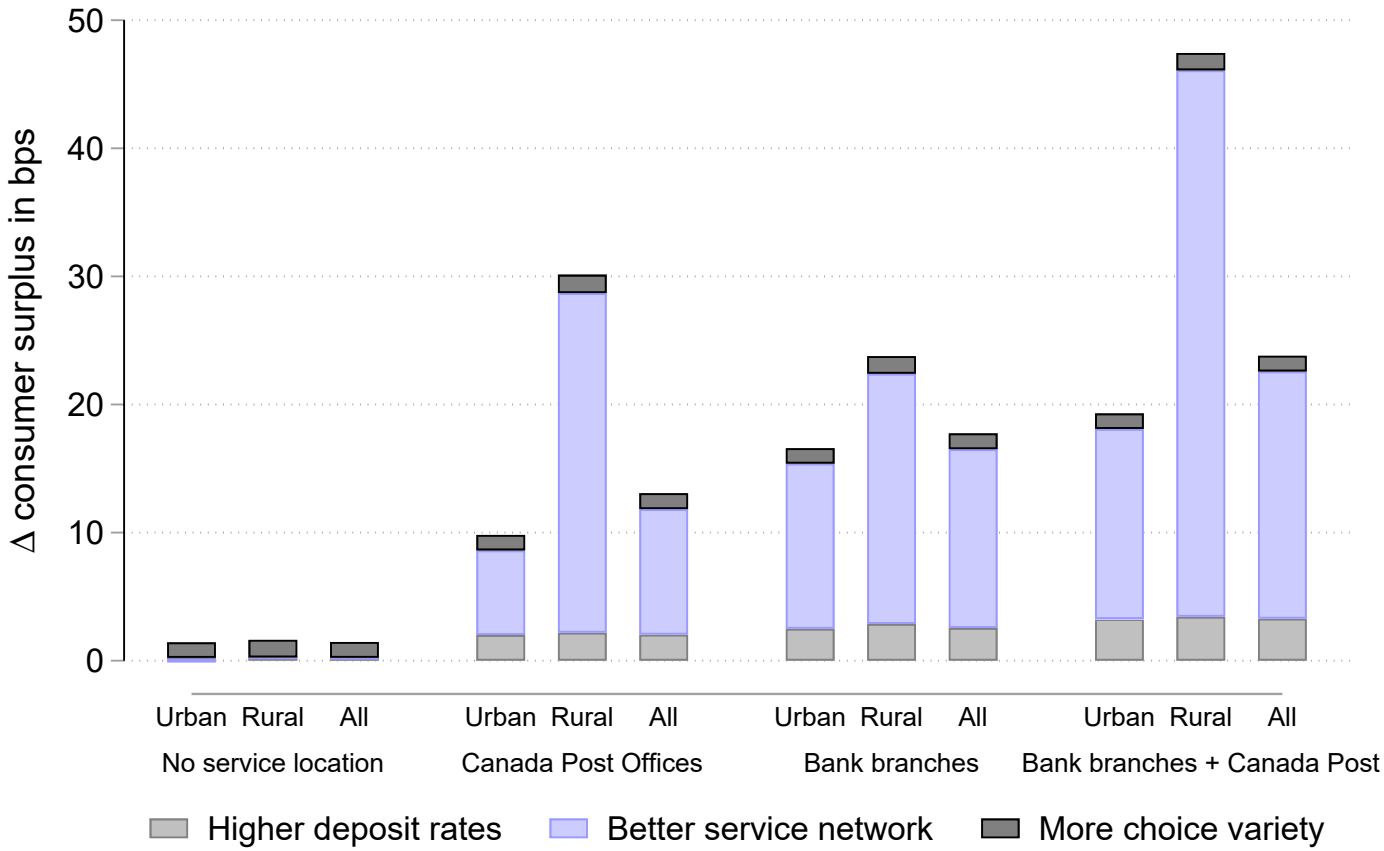
Effects of CBDC limits on aggregate CBDC shares

Even very large limits may greatly limit the takeup of CBDC

- Only 13% of households are constrained by the limit of $25,000

→ but those households hold *most* of the demand deposits.

Decompose changes in consumer surplus



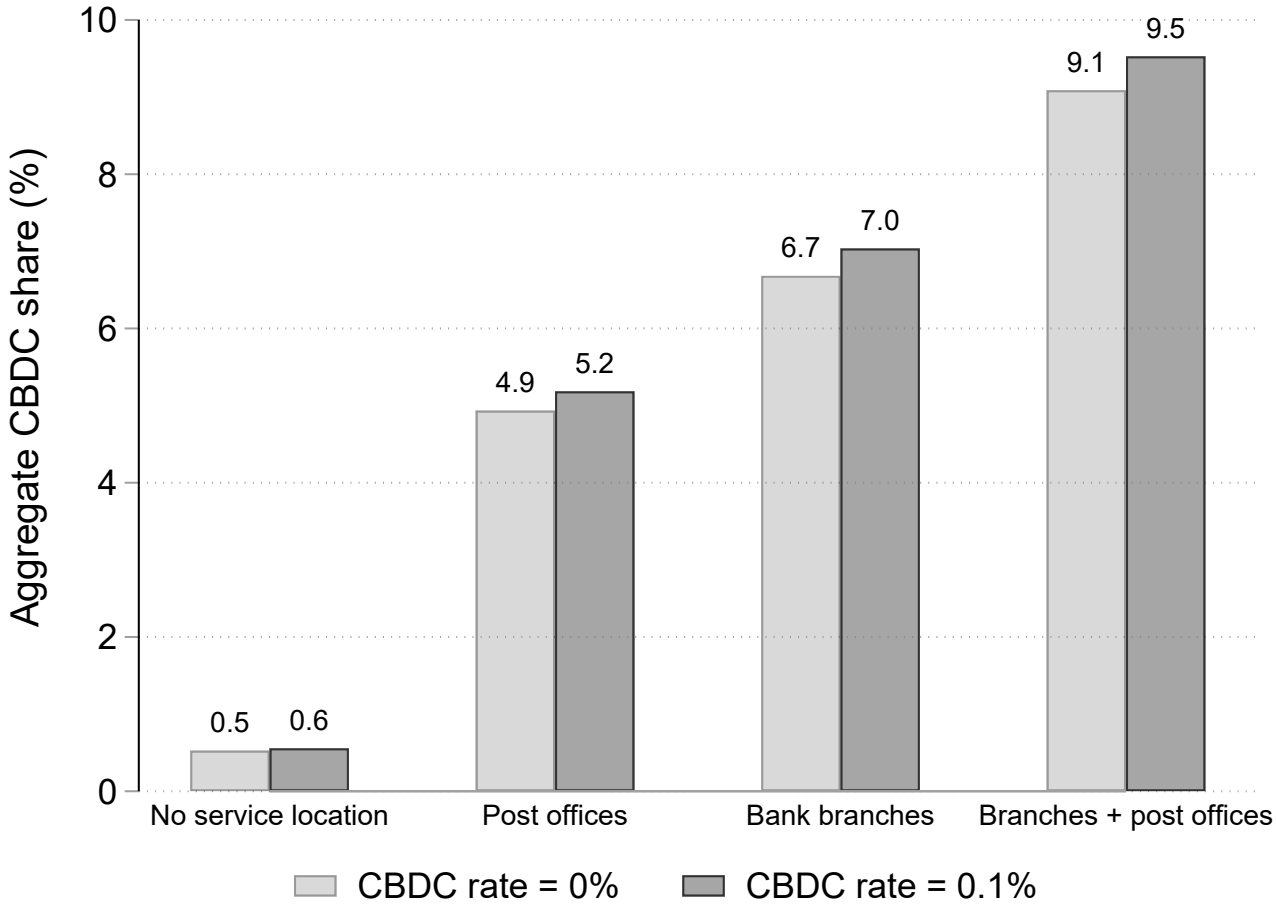
- Rural households benefit more from CBDC than urban households because they tend to be relatively underserved by bank branches

Conclusions

- We develop and estimate a structural model to quantify the impacts of CBDC on banks' deposits, highlighting the importance of:
  - Complementarity between deposits and other financial products
  - Branch network for in-person services
- A non-interest-bearing CBDC that does not provide complementarity nor branch network would have a limited crowding-out effect.
  - Only if CBDC provides an extensive branch network or strong complementarity can it reduce deposits by more than 10%.
  - Even a very large holding limit can significantly reduce the crowding out.

Aggregate CBDC Shares

CBDC fixed effect = small bank fixed effect



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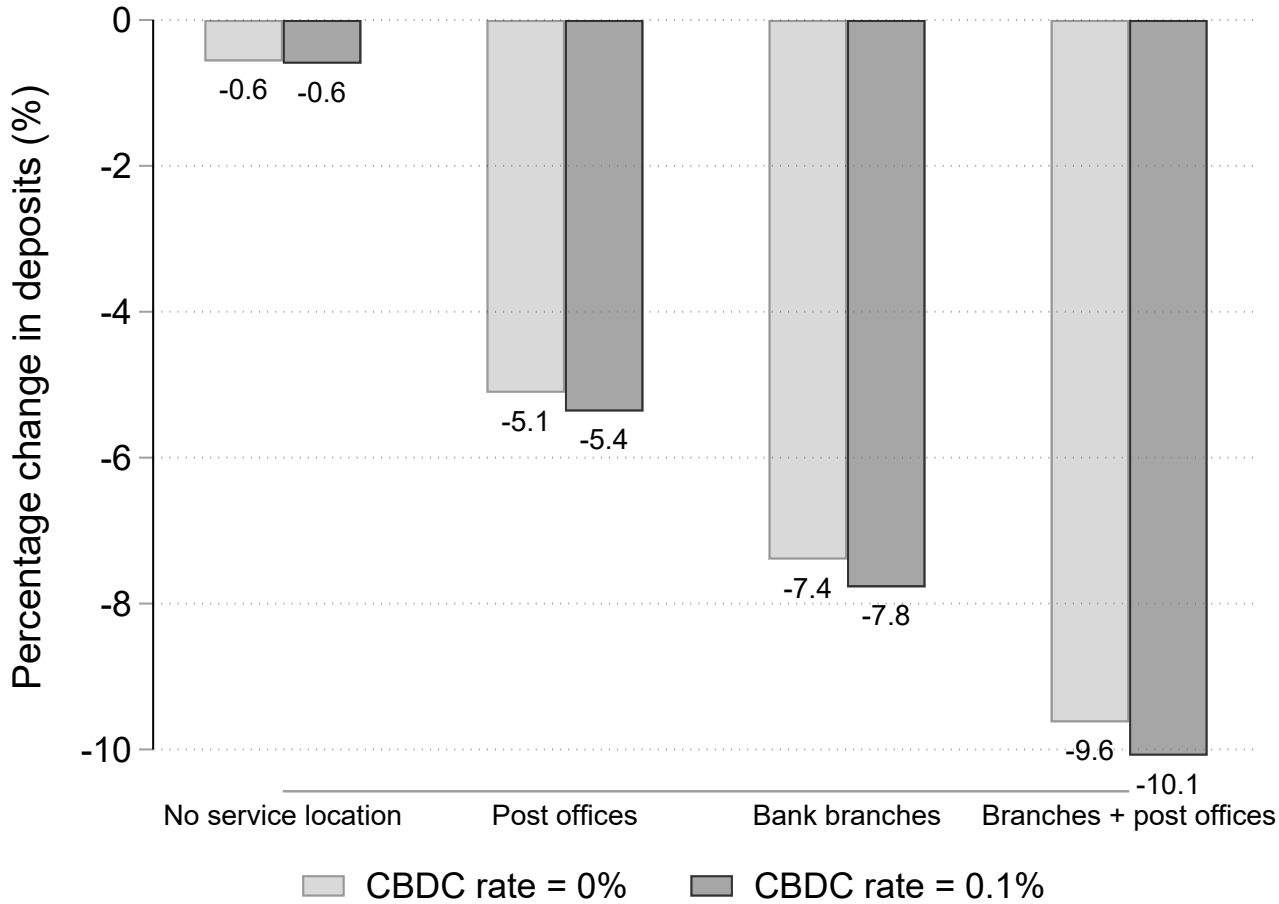
Percentage Changes in Deposits on Average

CBDC fixed effect = small bank fixed effect



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Banks' Responses in Deposit Rates

CBDC fixed effect = small bank fixed effect

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