

Central Bank Digital Currency and Banking Choices

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Preliminary and Incomplete

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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 central bank digital currency compete with traditional banks?

This Paper

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

- How much will banks raise their deposit rates?
- How many deposits will different banks lose to CBDC?
- How do the impacts differ across different CBDC designs?
 - Interest rate
 - ★ Service locations: bank branches or no branches?
 - ★ No complementarity from other financial products/services
 - ★ Holding limit

Methodology

1. Develop a structural model of consumer banking choices:
 - Demand side: households choose their deposit bank after considering
 - branch networks
 - utility from portfolio allocation between cash and deposits
 - utility from potentially obtaining other financial products from the bank
 - 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 “bank” that households can choose
 - CBDC attributes are chosen exogenously by the central bank

Literature Review

Existing work on CBDC mostly theoretical:

e.g. Ahnert et al. (2022); Assenmacher et al. (2021); Garratt and Zhu (2021); Chiu et al. (2020); Fernández-Villaverde et al. (2020); Schilling et al. (2020); Williamson (2020); Agur et al. (2019); Brunnermeier and Niepelt (2019); Keister and Sanches (2019); Andolfatto (2018); Davoodalhosseini (2018); Barrdear and Kumholf (2016)

Scant empirical work on CBDC:

Li (2023) predicts households' demand for CBDC relative to deposits and cash;
Whited et al. (2023) quantify CBDC's impact on bank lending;

Huynh et al. (2021) predict the adoption and usage of CBDC at point of sale

- ▶ This paper focuses on the impact of CBDC on the deposit market, capturing two key differences between bank deposits and CBDC:
 - network of branches that provide access to in-person services
 - presence of complementarity between deposits and loans

Outline

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

Households' Problem

Which deposit bank to choose? Solve by backward induction

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



Utility for bank j depends on branch networks $X_{i,j}$, together with utilities $\ln L_{i,j}^b$, $E[V_{i,j}^l]$

2. Allocate endowed liquid assets w_i between cash and deposits

→ Indirect utility $\ln L_{i,j}^b$ from holding liquid assets at bank j

→ Important for studying deposit rate, holding limit

3. May need to choose a mortgage bank $n \in (1, \dots, J)$



→ Expected utility from borrowing $E[V_{i,j}^l]$ depends on preferences for home bank j

→ Important for introducing complementarity between deposits and loans

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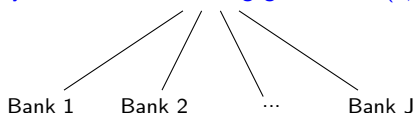
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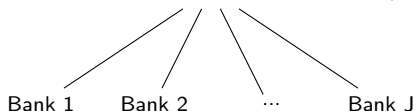


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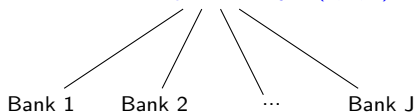


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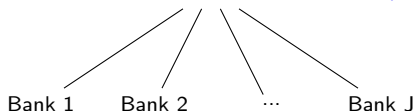


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Banks' Problem

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

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

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

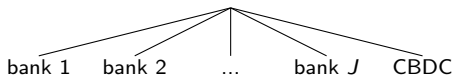
- First-order conditions \Rightarrow equilibrium deposit rates \mathbf{r}^* :

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

Introducing CBDC

A new “bank” to deposit 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 $\ln L_{i,cbdc}^b$
 - no loan complementarity, so $E[V_{i,cbdc}^l]$ is lower
 - network of service locations $X_{i,cbdc}$
 - Limit on CBDC holdings: $\ln \bar{L}_{i,cbdc}^b$ for constrained households
 - CBDC fixed effect: requires an assumption

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

- Portfolio allocation choice
 - obtain utility from liquidity holding $\ln L_{i,j}^b$
 - ★ higher deposit rate increases holding of deposits relative to cash
- Mortgage bank choice
 - obtain expected utility from borrowing $E[V_{i,j}^l]$
 - ★ strong preference for borrowing from the home bank
- Deposit bank choice
 - apart from branch networks, $\ln L_{i,j}^b$ and $E[V_{i,j}^l]$ also matter
 - ★ strong preference for better branch network

Supply Estimation

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

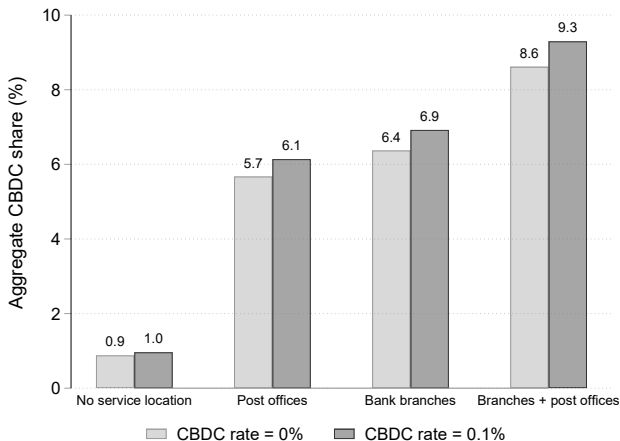
- Supply estimation: obtain marginal costs using estimated demand.
 - In 2017, on average banks have:
 - 5-year closed mortgage rates r_j^l : 4.8% (exogenous)
 - Deposit rate r_j^* : 0.1%
 - Estimated markup (inverse semi-elasticity of deposit demand): 1.4%
- ⇒ Estimated marginal cost mc_j : 3.3% (exogenous)

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:
 - affects allocation between cash and CBDC and thus indirect utility
 - CBDC fixed effect = big 5 fixed effect
 - ★ CBDC branch network:
 - No network
 - Canada Post
 - All bank branches
 - ★ No complementarity between deposits and loans
 - ★ Limit on CBDC holdings

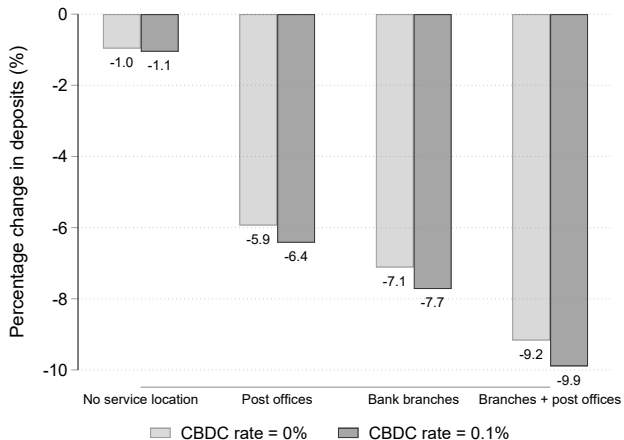
Aggregate CBDC Shares under Different Designs

Service locations for CBDC matter

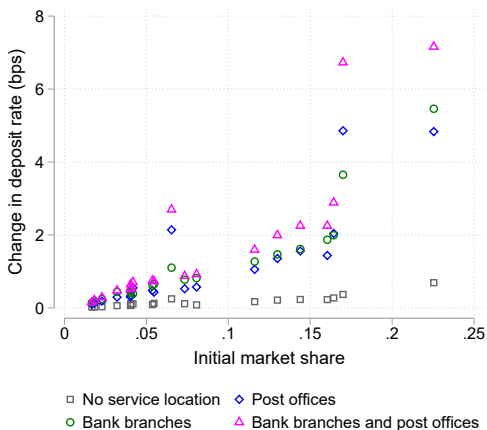


Average Reduction in Deposits

Service locations for CBDC matter



Response in Deposit Rates differs by Bank



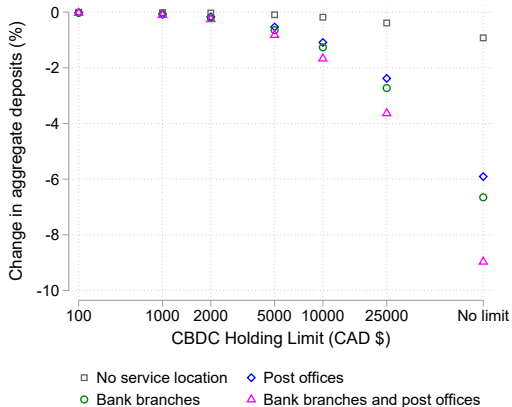
- Banks with the highest market share also have the highest markups
 - also respond most in rates
 - lose fewer deposits

Limits on CBDC holdings

- Many jurisdictions are considering limits on the holding of CBDC.
 - Bank of England: £10000 –£20000
 - ECB: €3000 –€4000
- Should a household choose CBDC, they allocate endowed liquid assets between CBDC and cash
 - if constrained by the limit, must hold the remainder in cash
 - 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



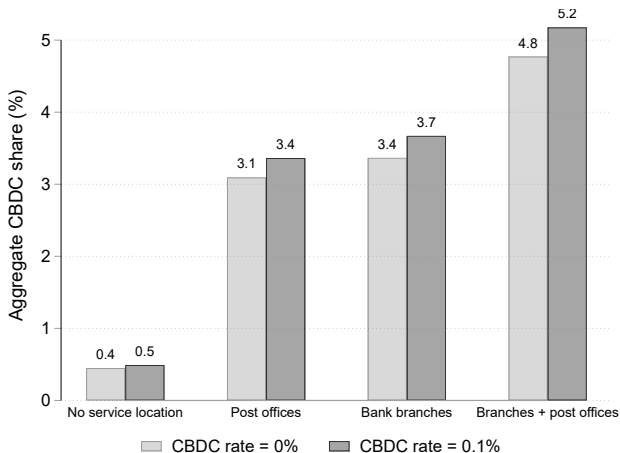
- Only some households constrained: only 13% above \$25000.
→ but those households hold *most* of the transactional deposits.

Conclusions

- We develop and estimate a structural model to quantify the impacts of CBDC on banks' deposits, including key design features:
 - interest rates
 - complementarity between deposits and loans
 - branch network for in-person services
- A non-interest-bearing CBDC that does not provide lending services would have a substantial impact on bank deposits:
 - If every bank branch is a service location for CBDC, crowd out deposits by 7.1% on average across banks
 - If CBDC had no network, crowd out deposits by 1.0% on average
 - Even a very large holding limit can significantly reduce its impact

Aggregate CBDC Shares

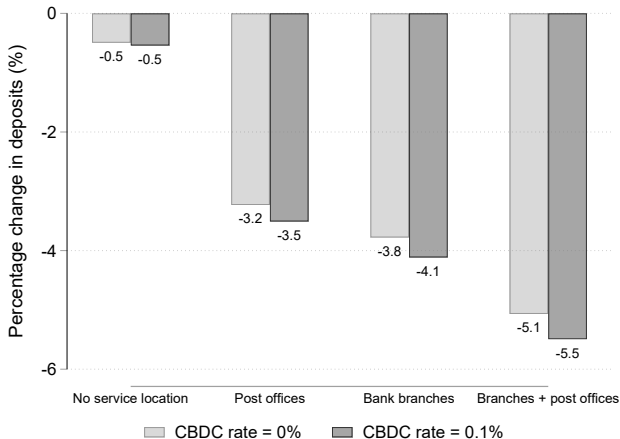
CBDC fixed effect = small bank fixed effect



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Percentage Changes in Deposits on Average

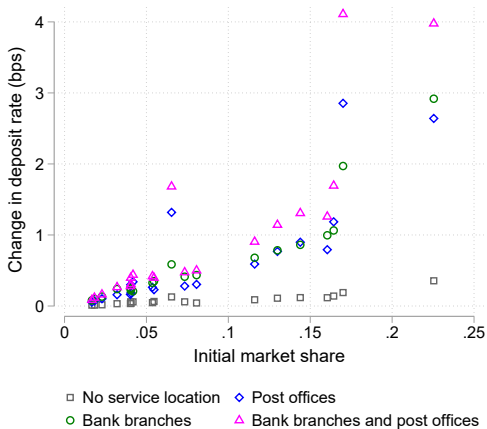
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Banks' Responses in Deposit Rates

CBDC fixed effect = small bank fixed effect



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