Central Bank Digital Currency with Adjustable Interest Rate in Small Open Economies

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Circulation of notes and coins smaller than $50 (2007-2017)

(b) Change from 2007 to 2017

Source: Bank for International Settlements – CPMI Red Book
Traditional Money Could Be ‘Surpassed’ By E-Money, Stablecoins: IMF Paper
Jul 16, 2019 at 12:31 | Daniel Palmer
A new IMF paper suggests that cash and bank deposits could be left behind as digital money and fiat-pegged cryptos see greater adoption.

Bank of Japan: Adopting Central Bank Crypto Would Mean Dropping Cash
Jul 5, 2019 at 08:00 | Daniel Palmer
A Bank of Japan official has ruled out the launch of a central bank digital currency because to do so may require the country to abandon cash.

Russia's Central Bank Is Considering Launching a Digital Currency
Jun 17, 2019 at 13:30 | Daniel Palmer
The head of Russia's central bank has said the institution is investigating the possible future launch of a digital currency.

14 Banks, 5 Tokens: Inside Fnality’s Expansive Vision for Interbank Blockchains
Jun 13, 2019 at 02:00 | Ian Allison
Fresh off a $63 million raise, execs at bank blockchain consortium Fnality shed some light on the often-secretive project's plan to tokenise fiat...

Bundesbank Chief Warns on Risks of Central Bank Digital Currencies
Jun 3, 2019 at 01:04 | Benedict Allen
The head of Germany's central bank has said central bank digital currencies could destabilize financial systems and worsen bank runs.

ECB Official Says Wholesale Central Bank Digital Currency a ‘Viable Option’
May 28, 2019 at 09:06 | Yeliz Khadi
A European Central Bank council member has come out generally in favor of wholesale central bank digital currencies.

Source: CoinDesk
Introduction

- What this paper is about
  - Retail CBDC for domestic general use, and not (yet) accessible to foreign entities
  - Digital money that replaces, instead of competing with, cash
  - CBDC as a secondary policy instrument, not just to eliminate the ZLB
What is CBDC? We use the definition from Barrdear and Kumhof (2016)
  ▶ “... a **universally accessible** and **interest-bearing central bank liability**, implemented via **distributed ledgers**, that competes with bank deposits as **medium of exchange**...”
  ▶ Being "interest-bearing" is a key innovation in CBDC

Kumhof and Noone (2018) finds an adjustable interest rate to be one of the CBDC design principles
  ▶ Interest-bearing vs adjustable
Objective
- To assess the welfare and stability outcomes of an adjustable interest rate on money in small open economies

Reference model:
- Closed-economy DSGE framework proposed in Barrdear and Kumhof (2016)

Main takeaways:
- Welfare and economic stabilisation improve under the price-based regime
- There are distributional effects
- Exchange rate and foreign debt tend to be more stable
Existing practices and literature

- Existing practices among central banks
  - Monetary Authority of Singapore, European Central Bank, Bank of Japan, Bank of Canada, Bank of England, Bank of Thailand, and more...
  - Mainly on building the DLT infrastructure, not as an asset

- Existing research
  - Emphasise on the benefits of adjustable-interest design

- We fill the gap – Examine CBDC with adjustable and non-adjustable interest returns in the same framework
An adjustable return to monetary assets

- Log-linearised money demand function as in Woodford (2003)

\[ \hat{m}_t = \eta_y \hat{Y}_t - \eta_i (\hat{i}_t - \hat{i}_t^m) + \epsilon_t \]  (1)

quantity of money is negatively associated with the opportunity cost

- \( \hat{i}_t - \hat{i}_t^m \): opportunity cost of holding money

- Non-adjustable interest: \( \hat{i}_t^m = 0 \)
  - Analogous to cash
  - Quantity of money (cash) adjusts passively, following changes in returns of alternative assets (e.g. bonds and deposits)

- Adjustable interest: \( \hat{i}_t^m \) varies with economic conditions
  - Central bank specifies \( \hat{m}_t \) or \( \hat{i}_t^m \), in addition to \( \hat{i}_t \).
  - Effects of \( \hat{i}_t \) and \( \hat{i}_t^m \) on money demand are opposite
Why $\hat{i}_t^m$ should be adjustable

- Consider a situation when there is an oversupply of currency
- Two scenario if $\hat{i}_t^m = 0$  
  1. currency depreciates against alternative assets, e.g. bonds  
  2. general price level rises
- If $\hat{i}_t^m$ is adjustable  
  - $\hat{i}_t^m$ is lowered to reduce demand for money
Methodology

- Barrdear and Kumhof (2016) — BoE working paper
  - Simplified version for clarity
  - New Keynesian model with price rigidity
  - Extended to incorporate an exogenous foreign sector

- Dynamics are driven by three exogenous shocks
  - Domestic productivity shock
  - Foreign interest rate shock
  - Foreign demand shock

- CBDC with the following regimes
  - Non-adjustable interest
  - Adjustable interest – price rule
  - Adjustable interest – quantity rule

- Solved at second order in Dynare
CBDC issuance

- Deposits and CBDC are not perfect substitutes in providing liquidity services
  - Transaction cost is lower with CBDC
  - Interest rate on CBDC does not follow deposit interest, $r_t^m \neq r_t^d$
- CBDC is part of government budget

$$b_t + m_t = r_{t-1} b_{t-1} + r_{t-1}^m m_{t-1} + g_t - Tax$$  \hspace{1cm} (2)

- No guaranteed on-demand exchange with bank deposits
- Model parameters follow Barrodear and Kumhof (2016)
Monetary and fiscal policies

- **Baseline regime:** Taylor rule + fiscal rule
  - Policy interest rate, $i_t$, responds very to output and inflation
    \[ i_t = \rho_i i_{t-1} + (1 - \rho_i) (\phi_{i,\text{gdp}} gdpt + \phi_{i,\pi} \pi_t) \]  
    (3)
    where $\rho_i \in [0, 1)$, $\phi_{i,y}, \phi_{i,\pi} > 0$.
  - Government budget responds very to output
    \[ gdx_{t}^{\text{rat}} = \overline{gdx}_{t}^{\text{rat}} - \phi_{b,\text{gdp}} \ln \left( \frac{gdpt}{gdp} \right) \]  
    (4)
    where $gdx_{t}^{\text{rat}}$ is the adjusted budget deficit to GDP ratio.
  - Grid search for optimal coefficients $\rho_i, \phi_{i,\text{gdp}}, \phi_{i,\pi}$, and $\phi_{b,\text{gdp}}$. 
Alternative monetary policies

- CBDC regimes
  - Non-adjustable CBDC interest: $i_{m,t}$ is constant
    \[ i_{m,t} = \bar{i}_m \] (5)
  - Price rule: $i_{m,t}$ follows $i_t$, but also responds to inflation
    \[ i_{m,t} = \rho_{i_m} i_{m,t-1} + (1 - \rho_{i_m}) (i_t - \phi_{i_m,\pi} \pi_t) \] (6)
    When inflation is high, $i_{m,t}$ is lowered, increasing the opportunity cost of liquidity
  - Quantity rule: quantity of money responds to inflation
    \[ \frac{m_t}{gdp_t} = \rho_m \frac{m_{t-1}}{gdp_{t-1}} + (1 - \rho_m) (-\phi_{m,\pi} \pi_t) \] (7)
    where $\rho_{i_m}, \rho_m \in [0, 1), \phi_{i_m,\pi}, \phi_{m,\pi} > 0$.
  - When inflation is high, liquidity is withdrawn from the economy
Optimal monetary policy

- Life-time welfare as a function of consumption, labour, and holdings of deposits and CBDC

\[ W_t = U(c_t, n_t, d_t, m_t) + \beta E_t W_{t+1} \] (8)

- Policies are optimal when the welfare is maximised

**Table: Optimal coefficients**

<table>
<thead>
<tr>
<th></th>
<th>( \rho_i )</th>
<th>( \phi_\pi )</th>
<th>( \phi_{b,gdp} )</th>
<th>( \phi_{i,m,\pi} )</th>
<th>( \rho_{i,m} )</th>
<th>( \phi_{m,\pi} )</th>
<th>Welfare Society</th>
<th>Welfare Household</th>
<th>Welfare Financial Investor</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>0.9</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-2.1227</td>
<td>-2.2495</td>
<td>0.2865</td>
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<tr>
<td>Price rule</td>
<td>0.9</td>
<td>1</td>
<td>2</td>
<td>0.2</td>
<td>0.9</td>
<td>-</td>
<td>-2.1224</td>
<td>-2.2490</td>
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<tr>
<td>Quantity rule</td>
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<td>2</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>-2.1228</td>
<td>-2.2495</td>
<td>0.2851</td>
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</tbody>
</table>

- Price rule is welfare-improving, but not Pareto-optimal
- Quantity rule does not improve welfare
Welfare changes under individual shocks

- Welfare effects may vary when some shocks are absent
- We simulate the model again with individual shocks

**Table:** Welfare and sources of shocks.

<table>
<thead>
<tr>
<th></th>
<th>Productivity shock</th>
<th></th>
<th></th>
<th></th>
<th>Foreign demand shock</th>
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</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>-2.1269</td>
<td>-2.2543</td>
<td>0.2945</td>
<td>-2.1232</td>
<td>-2.2500</td>
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<tr>
<td>Price rule</td>
<td>-2.1269</td>
<td>-2.2543</td>
<td>0.2945</td>
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<tr>
<td>Quantity rule</td>
<td>-2.1269</td>
<td>-2.2543</td>
<td>0.2945</td>
<td>-2.1232</td>
<td>-2.2500</td>
</tr>
</tbody>
</table>

- Households are better off under a foreign interest rate shock
- Financial investors are better off only under a foreign demand shock
Responses of the economy: Productivity shock
Responses of the economy: Foreign interest rate shock
Responses of the economy: Foreign demand shock
Stabilisation effects

- We compare the second moments of key macroeconomic variables under alternative policy regimes

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Price Rule</th>
<th>Quantity Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.0089</td>
<td>0.0074</td>
<td>0.0074</td>
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<tr>
<td>Consumption</td>
<td>0.0271</td>
<td>0.0268</td>
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<tr>
<td>Inflation</td>
<td>0.0057</td>
<td>0.0047</td>
<td>0.0047</td>
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<tr>
<td>Exchange rate</td>
<td>0.0496</td>
<td>0.0486</td>
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</tbody>
</table>

**Note:** This table reports the standard deviations of key variables obtained from a stochastic simulation of the models using second-order perturbations around the stochastic steady state in Dynare 4.5.3. Variables are expressed in percentage deviations from the steady states.

- Price rule delivers the best stabilisation effect for these variables
Our limitation and extension

- We do not discuss cross-border flows of CBDC in this paper
  - Central banks are experimenting cross-border payment based on DLT
  - It may entails more complicated dynamics via the exchange rate channel
- With the present framework, central banks in emerging markets may find it possible to relax the macroeconomic trilemma
Concluding remarks

- We introduce CBDC with adjustable interest rate to a small open economy model
  - CBDC is not transferred internationally
  - Alternative regimes are simulated
- Price rule provides improvements in welfare, with distributional effects
  - Households possessing CBDC are better off
  - Financial investors with no CBDC are worse off
- Better stabilisation effects
- Ongoing and future work
  - Macroeconomic trilemma and CBDC
  - Access by nationality
Thank you.