

## Finance and Economics Discussion Series

Federal Reserve Board, Washington, D.C.

ISSN 1936-2854 (Print)

ISSN 2767-3898 (Online)

# Retail CBDC and U.S. Monetary Policy Implementation: A Stylized Balance Sheet Analysis

Matthew Malloy, Francis Martinez, Mary-Frances Styczynski, and Alex Thorp

**2022-032**

Please cite this paper as:

Malloy, Matthew, Francis Martinez, Mary-Frances Styczynski, and Alex Thorp (2022). "Retail CBDC and U.S. Monetary Policy Implementation: A Stylized Balance Sheet Analysis," Finance and Economics Discussion Series 2022-032. Washington: Board of Governors of the Federal Reserve System, <https://doi.org/10.17016/FEDS.2022.032>.

NOTE: Staff working papers in the Finance and Economics Discussion Series (FEDS) are preliminary materials circulated to stimulate discussion and critical comment. The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the research staff or the Board of Governors. References in publications to the Finance and Economics Discussion Series (other than acknowledgement) should be cleared with the author(s) to protect the tentative character of these papers.

**Retail CBDC and U.S. Monetary Policy**  
**Implementation: A Stylized Balance Sheet Analysis**

Matthew Malloy, Francis Martinez, Mary-Frances Styczynski, and Alex Thorp<sup>1</sup>

April 2022

**Abstract**

This paper discusses how a Federal Reserve issued retail central bank digital currency (CBDC) could affect U.S. monetary policy implementation. Using a stylized balance sheet analysis, we analyze the effect a retail CBDC could have on the balance sheets of the Federal Reserve, commercial banks, and U.S. households. Then we consider how these balance sheet changes could affect monetary policy implementation for the Federal Reserve. We illustrate that the potential effects on monetary policy implementation from a retail CBDC are highly dependent on the initial conditions of the Federal Reserve's balance sheet. Moreover, the analysis demonstrates how the Federal Reserve may use its existing tools to manage the effects of a retail CBDC on monetary policy implementation.

---

<sup>1</sup> The authors thank James Clouse, Margaret DeBoer, Jane Ihrig, Lorie Logan, Laura Lipscomb, Antoine Martin, David Mills, and Patricia Zobel for their valuable comments as well as the many staff and colleagues from the Board of Governors and the Federal Reserve Bank of New York for helpful suggestions. The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of New York, or its staff.

## 1. Introduction

As interest in digital currencies picks up around the world, many central banks are evaluating the pros and cons of issuing a central bank digital currency (CBDC).<sup>2</sup> A key consideration in this assessment is the potential effect of a CBDC on monetary policy implementation, including but not limited to the CBDC's potential interaction with the central bank's balance sheet, the commercial banking sector, and money markets. These effects will differ depending on the type of CBDC issued and unique characteristics of the issuing country.

In this paper, we focus on how a Federal Reserve issued retail CBDC could affect U.S. monetary policy implementation. Using a stylized balance sheet analysis, we analyze the effect a retail CBDC could have on the balance sheets of the Federal Reserve, commercial banks, and U.S. households.<sup>3</sup> Then we consider how these balance sheet changes could affect monetary policy implementation for the Federal Reserve. This analysis presented is predicated on several assumptions. For example, we define a retail CBDC as a liability of the central bank that is only available to U.S. households and businesses.<sup>4</sup> In addition, the introduction of a retail CBDC occurs at a time when the Federal Reserve is operating with an ample supply of reserve balances and the retail CBDC is unremunerated.<sup>5</sup>

Based on our balance sheet analysis, we find that the effect on monetary policy implementation from a retail CBDC would depend significantly on the scale and variability of CBDC adoption and how this adoption affects the supply of reserves relative to the reserve demand curve. Demand for a retail CBDC will likely depend on several factors, including whether it is widely accessible, how transferrable or substitutable it will be with other retail payment platforms; whether there are limits on the size of holdings, what degree of privacy it provides; and whether it is remunerated. A thorough exploration of these drivers would require weighing pros and cons of alternative technologies used in implementing a retail CBDC. We leave this discussion to future research. In this working paper, we explore implications for monetary policy implementation from a scenario where demand for retail CBDC is high.<sup>6</sup> By high demand, we mean there is widespread adoption of retail CBDC by U.S. individuals and small businesses as a means of payment and as a store of value. Such strong retail CBDC demand could manifest itself as a conversion of physical Federal Reserve notes or deposits at banks, or potentially money funds or U.S. Treasury bills, into retail CBDC. While the exchange of Federal Reserve notes for retail CBDC may not have a direct effect on the supply of aggregate reserves, the exchange of deposits for retail CBDC would lead to a decrease in the supply of aggregate reserves. The decrease in reserves could shift the aggregate reserve supply to the left far enough to intersect with the steep portion of the reserve demand curve. This type of a shift would likely result in upward pressure on the federal funds rate.

---

<sup>2</sup> The Federal Reserve issued a discussion paper called "[Money and Payments: The U.S. Dollar in the Age of Digital Transformation](#)" in January 2022 on this topic.

<sup>3</sup> Stylized balance sheets, or a general ledger, are a common way to visualize transactions that affect the balance sheets of organizations.

<sup>4</sup> We assume that the retail CBDC would be a separate liability on the central bank's balance sheet, and distinct from reserve balances.

<sup>5</sup> For more information on the supply and demand dynamics in an ample reserves regime, please see Ihrig, Senyuz, and Weinbach (2020).

<sup>6</sup> If demand is low relative to the size of other Federal Reserve liabilities, the potential effects of a retail CBDC on monetary policy implementation would likely be more muted.

We also show through our balance sheet analysis that unwanted, upward pressure on the federal funds rate could be counteracted with existing Federal Reserve policy tools. The Federal Reserve could increase the supply of reserves through permanent open market operations such as reserve management purchases (RMPs).<sup>7</sup> In addition, the Federal Reserve could also make technical adjustments to administered rates to steer rates within the target range of the federal funds rate.

The remainder of this analysis is organized as follows. In Section 2, we review the existing literature on a CBDC as it relates to monetary policy implementation. Section 3 outlines the main assumptions and methodology we use in the balance sheet scenario analysis. Section 4 presents balance sheet scenarios where we demonstrate the potential effects of a retail CBDC on the balance sheets of the Federal Reserve, commercial banks, and U.S. households. In Section 5, we discuss the balance sheet scenarios more generally and what it means for monetary policy implementation. Section 6 concludes.

## 2. Literature Review

Over the past few years, literature on CBDCs has grown rapidly. Recent papers analyze different design parameters for a CBDC—in a more general setting—against monetary policy implementation and central bank balance sheets. Such papers include those that investigate potential effects on monetary policy of the different collateral backing a CBDC ([Fraschini, Somoza, and Terracciano 2021](#)) and over different time horizons ([Boser and Gersbach 2020](#)), whether a CBDC is wholesale or retail ([Pfister 2019](#)), as well as what entities have access to a CBDC ([Pfister 2017](#)). Notably, Pfister’s 2017 paper conducts a scenario analysis that incorporates retail CBDCs; however, it does so broadly, while we focus on the potential implications for a retail CBDC in the United States.

Researchers are also evaluating how CBDCs may affect monetary policy transmission in general, as well as spillovers to international jurisdictions ([Meaning, Dyson, Barker, and Clayton 2018](#) and [Minesso Ferrai, Mehl, and Stracca 2020](#)). Using stylized balance sheets, researchers from the Bank of England, investigate the effect that a CBDC could have on the monetary policy transmission mechanism, as changes to the policy instrument could affect financial market movements leading to changes in the real economy. Minesso Ferrai, Mehl, and Stracca (2020) examine the implications of a CBDC and monetary policy linkages to other jurisdictions when a CBDC is issued in a home jurisdiction and used in a foreign jurisdiction. In contrast to these two papers that examine international spillovers, we evaluate the monetary policy implications of a retail CBDC issued by the Federal Reserve in the home jurisdiction (the United States).

Other researchers have focused on the potential effects of interest-bearing retail CBDCs on the implementation of monetary policy. Carapella and Flemming ([2020](#)) review the existing literature on interest bearing CBDCs. Keister and Sanches ([2018](#)) investigate CBDC design parameters—namely, whether it should pay interest or not, and how widely it should circulate, as well as a CBDC’s effect on interest rates. Barrdear and Kumhof ([2016](#)) find that an interest-bearing CBDC that competes with bank deposits could improve a central bank’s monetary policy influence, particularly in times when the central bank is using quantitative easing (QE) to provide additional stimulus. In our example, the Federal Reserve adopts a retail CBDC that is not interest bearing, and we describe the potential implications an

---

<sup>7</sup> Reserve management purchases represent the provision of a supply of reserves that can sufficiently absorb normal fluctuations in non-reserve liabilities, so shifts in these balances do not bring reserves below desired levels and potentially compromise effective interest rate control.

unremunerated, retail CBDC could have on the balance sheets of the Federal Reserve, the U.S. banking sector, and U.S. households balance sheets.

### 3. Assumptions and Methodology

As there are many CBDC design parameters to consider, we simplify our analysis by focusing on a strict set of assumptions that still allow us to draw some broad insights. For all scenarios, we focus on a stylized retail CBDC that is issued by the Federal Reserve and is categorized as a separate and distinct liability relative to balances of depository institutions (or reserve balances), the U.S. Treasury, and other traditional Federal Reserve account holders or counterparties. Further, we assume the retail CBDC is exchangeable 1-for-1 with other Federal Reserve liabilities, such as Federal Reserve notes or reserve balances (that is, when commercial bank deposits are converted to a retail CBDC). This stylized retail CBDC is not remunerated and may only be held by U.S. domestic households and businesses.<sup>8</sup> For the purposes of this analysis, financial institutions do not hold significant quantities of the retail CBDC.<sup>9</sup> In addition, we assume that the Federal Reserve will back its retail CBDC with investments primarily in U.S. Treasury securities. We do not take any position on the technology platform for implementation.

Our analysis explores a scenario where retail CBDC issuance could be on a large scale—on the order of trillions of U.S. dollars—based on an assessment of the stock of likely alternative money instruments that could be converted, such as physical cash, coins, and balances in bank accounts. As of August 2021, the Federal Reserve’s broadest money stock measure—M2—averaged \$21 trillion, which includes about \$2.1 trillion of currency in circulation (CIC) and \$4.5 trillion in demand deposits.<sup>10</sup> In this analysis, we assume some fraction of M2 CIC and demand deposits could be converted to a retail CBDC. Although still in initial research stages, the Bank for International Settlements (BIS) cited recent studies estimating CBDC demand to range between 4 percent and 55 percent of cash and deposit holdings and even between 4 percent and 12 percent of bank funding depending on the study ([BIS 2021](#)). Demand for a retail CBDC could be driven by factors such as its convenience to consumers and acceptance by retail merchants as a medium of exchange, usage by the public sector to disburse payments or transfers more easily, or availability as an alternative safe-haven asset ([BIS 2021](#)). In addition to usage factors, retail CBDC demand could also be driven by CBDC design parameters that focus on privacy, transferability across multiple payment mechanisms, accessibility, programmability, and security ([BIS 2021](#)).

A final assumption in our analysis is that commercial banks’ aggregate demand for reserve balances does not change. This assumption may not hold in a real-world scenario, and the direction (increase or decrease in demand) is also not fully clear. This issue is discussed in more depth in Section 5.

Stylized balance sheets are a common way to visualize transactions that affect the balance sheets of organizations. We construct our stylized balance sheets with assets on the left-hand side of the ‘T’ and

---

<sup>8</sup> The choice not to remunerate the retail CBDC in this analysis aligns with the remuneration of Federal Reserve notes and simplifies our analysis. Understanding the dynamics of remunerated CBDC is an important area for further research.

<sup>9</sup> Financial sector holdings of a retail CBDC could be minimized by introducing quantity limits on holdings of a retail CBDC or expressly disallowing certain types of institutions from opening a retail CBDC account. Significant holdings of a retail CBDC by the financial sector could affect both the demand for central bank reserves and the dynamics in short-term liquidity markets.

<sup>10</sup>Board of Governors of the Federal Reserve System (2022), Statistical Release H.6, “Money Stock Measures” (January 25), <https://www.federalreserve.gov/releases/h6/20210928/.20220125/>.

liabilities and capital on the right-hand side. Within this framework, we can visualize the changes in Federal Reserve, commercial banks, and U.S. households' assets and liabilities caused by retail CBDC-related transactions. For example, when the Federal Reserve purchases a Treasury security from a primary dealer, the Federal Reserve's assets go up by the purchase amount (value of Treasury) and liabilities (reserve balances) go up by the same amount; for the commercial banking sector, assets (reserve balances) increase by the same amount and deposits (commercial bank liabilities to the primary dealer that sold the Treasury security) increase as well.

As a starting point for our analysis, we create a baseline stylized version of the balance sheets for the Federal Reserve, the banking sector (denoted as All Commercial Banks), and U.S. households as presented in Figure 1. The banking sector is assumed to be made up of two banks, and reserve balance holdings, which total \$50, are split evenly between these two banks. The supply of reserve balances at \$50 is assumed to intersect the flat portion of the reserve demand curve, and thus marginal changes in supply should have no effect on the effective federal funds rate. The household balance sheet has been laid out to mirror the major asset and liability categories for households and nonprofits as presented in the Financial Account of the United States (Z.1 Statistical Release).<sup>11</sup> Retail CBDCs held by U.S. households would likely be included under financial assets. We assume households may exchange their holdings of Federal Reserve (FR) notes and deposits for a retail CBDC.

**Figure 1. Baseline Balance Sheet Conditions**

| Federal Reserve          |     |                  |     |
|--------------------------|-----|------------------|-----|
| Securities               | 95  | FR Notes         | 40  |
| Loans                    | 5   | Reserve balances | 50  |
|                          |     | Capital          | 10  |
| All Commercial Banks     |     |                  |     |
| FR Notes                 | 5   | Deposits         | 160 |
| Reserve balances         | 50  | Other            | 30  |
| Loans                    | 145 | Capital          | 10  |
| U.S. Households          |     |                  |     |
| Nonfinancial             | 180 | Home mortgages   | 110 |
| Financial                | 420 | Consumer Credit  | 50  |
| <i>FR Notes</i>          | 35  | Other            | 25  |
| <i>Deposits at banks</i> | 105 |                  |     |
| <i>Other</i>             | 280 | Net Worth        | 555 |

<sup>11</sup> For our purposes, we break out Federal Reserve notes from deposits in the U.S. Households balance sheet. For a list of the major asset and liability categories, please refer to [The Fed - Chart: Balance Sheet of Households and Nonprofit Organizations, 1952 - 2021 \(federalreserve.gov\)](https://www.federalreserve.gov/chart-the-fed/balance-sheet-of-households-and-nonprofit-organizations-1952-2021).

#### 4. Scenario Analysis

##### ***Scenario A: Individuals exchange \$25 of Federal Reserve notes for retail central bank digital currencies***

For this scenario, we assume that individuals exchange their physical FR notes for a retail CBDC.<sup>12</sup> Changes to balance sheet components are noted in bold, with the amount of change denoted in parentheses to the right of the balance sheet item (Figure 2). Individuals exchange \$25 of FR notes for a retail CBDC, which changes the composition of Federal Reserve liabilities. FR Notes decrease from an original level of \$40 to \$15; a new liability item is added to the balance sheet, called Retail CBDC, and its balance increases to \$25. On net, the Federal Reserve's total liabilities remain unchanged. A similar dynamic plays out on the U.S. households balance sheet. On the assets side, a new asset category appears called Retail CBDC, and this new category has a balance of \$25, reflecting the shift from FR notes. The overall size of the Federal Reserve, bank, and U.S. households balance sheets remain the same.

In this case, there would be no implications for monetary policy implementation because reserve demand and supply do not change. Depending on the configuration of the retail CBDC, the public may exchange more than physical FR notes for retail CBDCs. In the next scenario we examine the effect of converting private digital money, such as deposits at commercial banks, to a retail CBDC.

##### ***Scenario B: Individuals exchange U.S. dollars held as deposits at commercial banks into retail CBDC***

In this scenario, individuals exchange private digital money from their deposit accounts at commercial banks into a Federal Reserve-issued retail CBDC (Figure 3). Like in Scenario A, a retail CBDC appears as a new liability item on the Federal Reserve's balance sheet, and this item rises to \$25. The offset in this scenario is to reserve balances rather than FR notes. Reserve balances decrease from \$50 to \$25 as commercial banks facilitate the exchange of their customers' deposits for a retail CBDC. After this transaction, the overall size of the Federal Reserve's balance sheet is left unchanged. Commercial banks' balance sheets, in contrast, shrink by the amount of the retail CBDC issued. In Figure 3, reserve balances (asset) and deposits (liability) both decline by \$25, respectively, as individuals exchange private digital money (for example, funds in checking accounts) for public digital money (retail CBDC). The U.S. households' balance sheet moves similar to what we observed in scenario A except that the shift in the assets is from deposits at banks (private money) into retail CBDC (public money). Thus, banks are directly affected by U.S. households' asset decisions.

The Federal Reserve would monitor how the decline in the level of reserve balances and the changes in the distribution of reserves across the system affects the general level of short-term interest rates in unsecured and secured markets. The decline in reserve balances may have no effect on short-term interest rates in these markets assuming the Federal Reserve has supplied enough reserve balances to meet bank demand for these balances and the process by which reserve balances are distributed across banks remains orderly. Recall, for these scenarios, we are assuming that bank demand for reserves is fixed and does not change as a result of a retail CBDC. The potential redistribution effects from the decline in the aggregate supply of reserves are discussed further in Scenario C.

---

<sup>12</sup> The process by which individuals exchange their physical currency is not documented in the balance sheet movements. If commercial banks are involved in the exchange process, then their balance sheets could temporarily increase as FR notes are collected and transmitted to Federal Reserve Banks.

**Figure 2. Individuals exchange \$25 of FR Notes for Retail CBDC (Scenario A)**

| Federal Reserve      |     |                      |
|----------------------|-----|----------------------|
| Securities           | 95  | FR Notes (-25) 15    |
| Loans                | 5   | Retail CBDC (+25) 25 |
|                      |     | Reserve balances 50  |
|                      |     | Capital 10           |
| All Commercial Banks |     |                      |
| FR Notes             | 5   | Deposits 160         |
| Reserve balances     | 50  | Other 30             |
| Loans                | 145 |                      |
|                      |     | Capital 10           |
| U.S. Households      |     |                      |
| Nonfinancial         | 180 | Home mortgages 110   |
| Financial            | 420 | Consumer Credit 50   |
| FR Notes (-25)       | 10  | Other 25             |
| Retail CBDC (+25)    | 25  |                      |
| Deposits at banks    | 105 |                      |
| Other                | 280 |                      |
|                      |     | Net Worth 555        |

**Figure 3. Individuals exchange \$25 of Deposits for Retail CBDC (Scenario B)**

| Federal Reserve         |     |                           |
|-------------------------|-----|---------------------------|
| Securities              | 95  | FR Notes 40               |
| Loans                   | 5   | Retail CBDC (+25) 25      |
|                         |     | Reserve balances (-25) 25 |
|                         |     | Capital 10                |
| All Commercial Banks    |     |                           |
| FR Notes                | 5   | Deposits (-25) 135        |
| Reserve balances (-25)  | 25  | Other 30                  |
| Loans                   | 145 |                           |
|                         |     | Capital 10                |
| U.S. Households         |     |                           |
| Nonfinancial            | 180 | Home mortgages 110        |
| Financial               | 420 | Consumer credit 50        |
| FR Notes                | 35  | Other 25                  |
| Retail CBDC (+25)       | 25  |                           |
| Deposits at banks (-25) | 80  |                           |
| Other                   | 280 |                           |
|                         |     | Net Worth 555             |

**Scenario C: Bank 1 reacts to reserves declining below its desired level**

Scenario C (Figure 4) is an extension of Scenario B. As bank deposits are converted to a retail CBDC, the aggregate level of reserves declines, with some banks’ reserve levels more effected than others. As a result, some banks may begin to take action to rebuild their reserve balances to their desired level. Commerical banks experiencing a short-fall in their reserve balances could take one or more of the following actions. Depending on balance sheet flexibility, they could offload certain securities or loans to build up their cash holdings. Alternatively, a bank may want to raise deposits by offering more attractive price and nonprice terms on their deposit products to lure customers from other institutions. Banks could also look beyond deposits to unsecured (such as federal funds or commercial paper) or secured (for example, engaging in repurchase agreements or seeking advances from Federal Home Loan Banks) markets for funding.

Depending on the intensity of the competition as banks rebuild their reserve positions, the general level of short-term interest rates in secured and unsecured markets could rise in the process. This competition is demonstrated by breaking aggregate commercial bank balance sheets in two: stylized as one bank that seeks to compete reserves away from a second bank. Recall in Scenario B, aggregate reserve balances declined by \$25 because of the exchange of deposits for retail CBDC. In this scenario, we assume that the \$25 decline is split unevenly between Bank 1 and Bank 2 and that Bank 1 is left with a reserve balance position that is well below its preferred level (these positions are not presented in Figure 4). Bank 1 seeks to reestablish its reserve balances to its preferred level by taking some action, such as raising the interest rate(s) it offers on deposits. Bank 1 successfully attracts \$10 of deposits from Bank 2, restoring its reserve balances to its preferred level. Bank 2, for the time being, does not seek to replenish its lost funding, and a new funding equilibrium is reached.



**Figure 4. Bank 1 raises deposit rates and attracts deposits from Bank 2 (Scenario C)**

| Federal Reserve               |           |                       |           |
|-------------------------------|-----------|-----------------------|-----------|
| Securities                    | 95        | FR Notes              | 40        |
| Loans                         | 5         | Retail CBDC           | 25        |
|                               |           | Reserve balances      | 25        |
|                               |           | Capital               | 10        |
| Commercial Bank 1             |           |                       |           |
| FR Notes                      | 3         | <b>Deposits (+10)</b> | <b>75</b> |
| <b>Reserve balances (+10)</b> | <b>20</b> | Other                 | 20        |
| Loans                         | 80        | Capital               | 15        |
| Commercial Bank 2             |           |                       |           |
| Vault cash                    | 2         | <b>Deposits (-10)</b> | <b>60</b> |
| <b>Reserve balances (-10)</b> | <b>5</b>  | Other                 | 10        |
| Loans                         | 65        | Capital               | 10        |

An increase in bank deposit rates may also reduce the amount of substitution from deposits into a retail CBDC, which could moderate declines in the aggregate level of reserves, and possibly reduce upward deposit rate pressures. We have not included this dynamic in our scenarios for simplification purposes and because the elasticity of demand for CBDCs to price changes in deposits is unknown.

The dynamics between Bank 1 and Bank 2 are illustrative of a broader redistribution of reserves that could occur as banks adjust to changes in their balance sheets because of a flow into a retail CBDC. At the heart of this scenario is a decline in aggregate reserve balances because of households shifting out of deposits and into a retail CBDC. As the aggregate supply of reserve balances declines, the Federal Reserve would be monitoring the general level of short-term interest rates, in particular the federal funds rate to ensure it remained consistent with monetary policy objectives. Potential actions the Federal Reserve could take to counteract unwanted upward pressure on short-term interest rates are discussed in the next scenario.

***Scenario D: Potential Federal Reserve actions to counteract upward pressure on short-term rates***

If the types of flows outlined in Scenario C occur very rapidly, the rise in the general level of short-term interest rates, including the federal funds rate, may be abrupt. In this context, the discount window and the standing repo facility may be effective shock absorbers by providing private market counterparties the ability to draw funds from the Federal Reserve and create more central bank reserves on pre-specified terms. Funding from the discount window or the standing repo facility would temporarily increase the size of the Federal Reserve’s balance sheet. If heightened demand for central bank liabilities was viewed as persistent, then, over time, the Federal Reserve could maintain a permanently larger balance sheet. In this case, temporarily drawing funds from the discount window or standing repo facility may be followed by RMPs by which the Federal Reserve purchases securities, such as Treasuries, and more permanently adds to the supply of reserve balances.

The Scenario D stylized balance sheets demonstrate the effect of RMPs on the Federal Reserve and banking sector’s balance sheets (Figure 5). The Federal Reserve buys \$10 of Treasury securities, for

instance, from the public.<sup>13</sup> Federal Reserve securities holdings increase by \$10 to \$105, and reserve balances increase by \$10 to \$35. The overall effect of the operation is to increase the supply of reserves to the banking sector, which should alleviate short-term interest rate pressures.

**Figure 5. Federal Reserve engages in permanent open market operation to add reserve balances (Scenario D)**

| Federal Reserve               |            |                               |            |
|-------------------------------|------------|-------------------------------|------------|
| <b>Securities (+10)</b>       | <b>105</b> | FR Notes                      | 40         |
| Loans                         | 5          | Retail CBDC                   | 25         |
|                               |            | <b>Reserve balances (+10)</b> | <b>35</b>  |
|                               |            | Capital                       | 10         |
| All Commercial Banks          |            |                               |            |
| FR Notes                      | 5          | <b>Deposits (+10)</b>         | <b>145</b> |
| <b>Reserve balances (+10)</b> | <b>35</b>  | Other                         | 30         |
| Loans                         | 145        |                               |            |
|                               |            | Capital                       | 25         |

### **Scenario Summary**

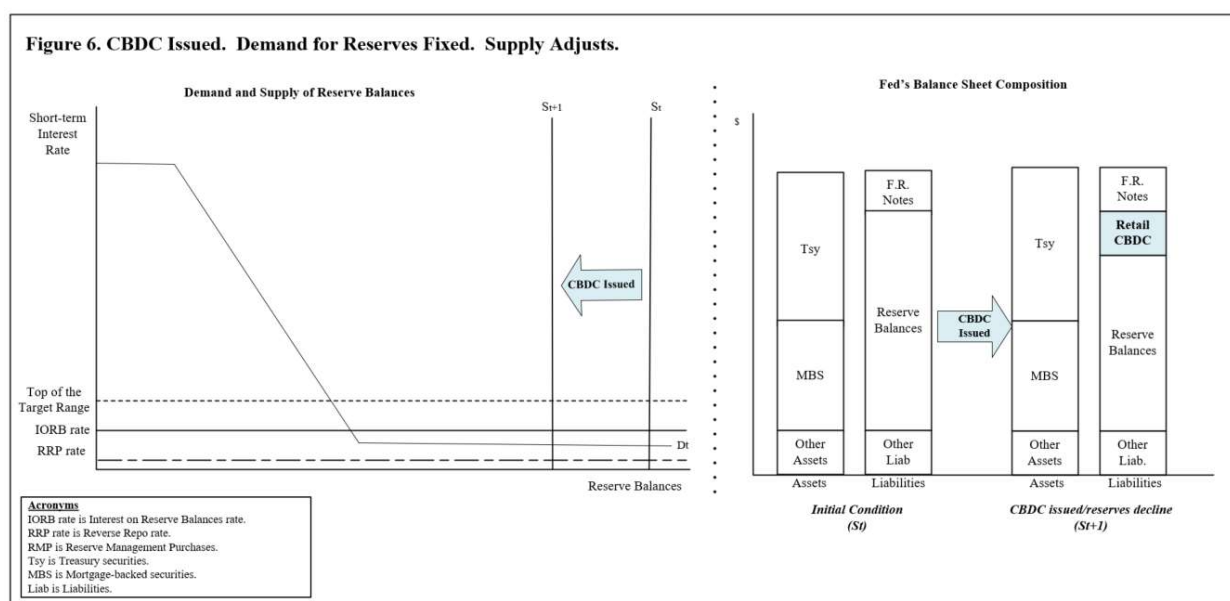
Through these stylized balance sheets, we have demonstrated the potential effects of a retail CBDC on the Federal Reserve’s, commercial banks’, and U.S. households’ balance sheets and some ways in which these changes could affect the Federal Reserve’s monetary policy implementation. As shown in Scenario A, the exchange of FR notes for retail CBDC would alter the composition of the Federal Reserve’s liabilities, which the Federal Reserve would need to monitor and manage, but the supply of reserve balances to the banking system after the exchange would be unchanged. Thus, assuming the volatility of demand for retail CBDC is similar to that of FR notes, this scenario is likely to have a limited effect on how the Federal Reserve conducts monetary policy. The next scenario (B) looks at the exchange of deposits at banks for a retail CBDC. The exchange of private money, such as bank checking accounts, for a retail CBDC results in a decline in the aggregate supply of reserve balances. The banking sector’s response to the decline in reserve balances depends on the size and distribution of the change relative to their reserve demand. If reserve demand at the individual and aggregate bank level is fully satiated by the supply post-decline, then we should not observe any pressures on short-term funding rates and monetary policy implementation could persist without any adjustment. As presented in Scenario C, some banks may find their reserve balance position below their preferred level and may compete for funding to return their reserve position to their desired level. As banks compete for funding, the general level of short-term interest rates is likely to rise. If upward pressures on the federal funds rate are significant and persistent enough, the Federal Reserve could respond to the rate pressure by engaging in RMPs to replenish the supply of reserve balances (as described in Scenario D).

<sup>13</sup> It is also possible that the Federal Reserve could purchase securities directly from commercial banks. In that case, commercial banks assets would on net remain flat, with reserve balances going up by \$10 and securities going down by \$10. The liability side of commercial banks’ balance sheets would remain unchanged.

## 5. Discussion

### ***Impact of a Retail CBDC on the Federal Reserve Balance Sheet***

The condition of reserve markets at the time of retail CBDC introduction will have important implications for monetary policy implementation. If the aggregate reserve supply curve intersects with the flat portion of the demand curve and the federal funds rate sits well within the target range of the federal funds rate, there may be room for a retail CBDC to grow as a Federal Reserve liability with modest immediate impact on monetary policy implementation. We demonstrate this in Figure 6, which presents an illustrative graph of supply and demand for reserves alongside a bar chart showing the composition of the Federal Reserve's balance sheet before and after retail CBDC issuance. In this figure and as described in Figure 3 (Scenario B), the supply of reserve balances intersects demand on the flat part of the demand curve both before ( $S_t$ ) and after retail CBDC issuance ( $S_{t+1}$ ), and thus short-term interest rates, in particular the federal funds rate, remain within the Federal Reserve's target range.



In contrast, if retail CBDC aggregate balances increase significantly during a period when aggregate supply is closer to the steep portion of the demand curve, as shown in Figure 7 and noted in Figure 4 (for Scenario C) and Figure 5 (for Scenario D), the provision of a retail CBDC may result in a meaningful change in the size and composition of not just the Federal Reserve's liabilities but also its assets. If the growth in retail CBDC balances is expected to persist and pushes the reserve supply curve onto the steep portion of the reserve demand curve, RMPs may be conducted to restore reserve balances to ample. This type of scenario could result in occasional volatility in short-term rates as the Federal Reserve recalibrates the aggregate supply of reserves through RMPs. RMPs would offset the decline in reserve balances from the issuance of a retail CBDC ( $S_{t+2}$  in Figure 7) leading to a larger overall balance sheet.

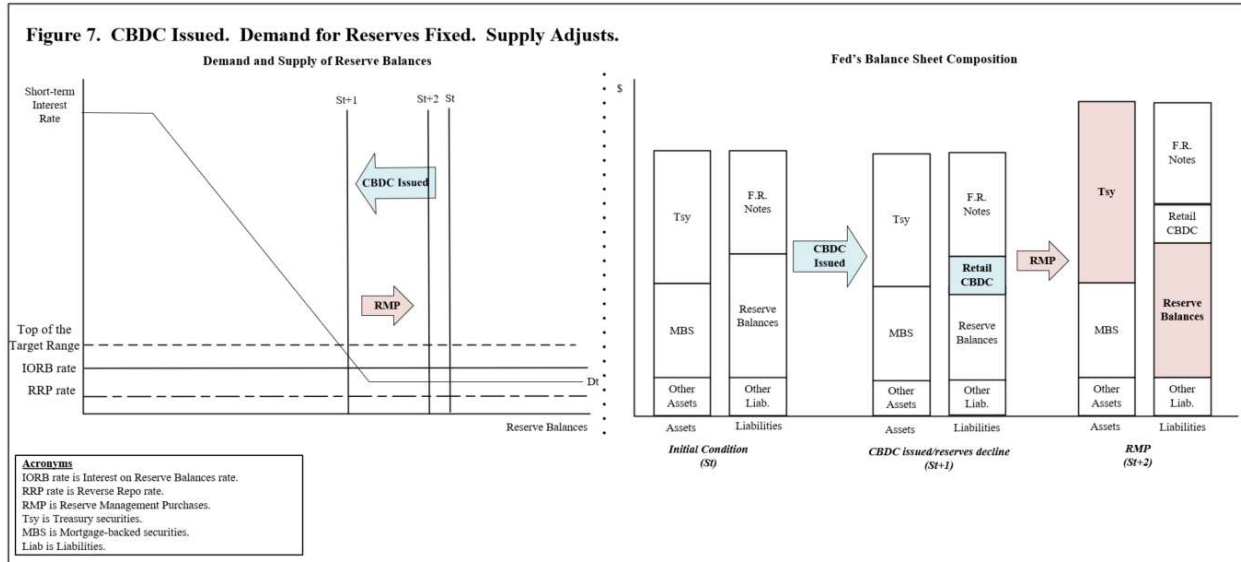


Figure 7 illustrates how both the composition and size of the Federal Reserve balance sheet could change with the introduction of a retail CBDC. Over a longer horizon, if a retail CBDC is principally a substitute for private-sector bank deposits (as highlighted in Scenarios B, C, and D) and demand for a retail CBDC grows consistently over time, this process could result in a permanently larger central bank balance sheet, similar to the impact of trend growth of currency. Depending on the trajectory of demand for retail CBDC, the Federal Reserve’s longer-term footprint in certain asset markets, such as in U.S. Treasuries could become more pronounced.

In addition to absorbing the size of the new aggregate CBDC liability on the balance sheet, the Federal Reserve may need to manage the volatility of CBDC demand. Without any empirical data, it is difficult to know ahead of time if the CBDC liability will have low volatility such as the case with Federal Reserve notes. Notably, the demand for traditional Federal Reserve notes is driven by a number of factors including demand from overseas, usage for (or alternatives of) payments, and the interest rate environment. Retail CBDC demand, however, could be driven by a different set of factors that may be challenging to forecast and might change over time. It may be the case, for example, that demand for a retail CBDC goes up sharply during periods of financial sector stress, possibly complicating the Federal Reserve’s balance sheet management during those periods. It is also possible that the aggregate CBDC liability could decrease when returns on alternative money-like assets (deposits or money market funds) are elevated. As highlighted in a recent paper by a group of central banks, there are a number of “safeguard” measures central banks could take to moderate take-up or volatility of a retail CBDC ([BIS 2021](#)).

An unremunerated retail CBDC also could reinforce the zero lower bound (ZLB), functioning similarly to current unremunerated Federal Reserve liabilities such as physical cash and unremunerated accounts for government-sponsored enterprises (GSEs). Demand for an unremunerated retail CBDC could increase when policy rates are close to zero, given the narrower spread between the retail CBDC rate of zero and broader money market rates during these periods. Beyond comparing the nominal return of retail CBDC against alternative products such as cash, bank deposits, or money fund investments, potential CBDC users may also assess other dimensions of these products such as fees and convenience. To the extent that they find a retail CBDC compares favorably, on net, across these dimensions, this

would increase demand for the CBDC. During periods when the policy rate is zero or close to zero, a retail CBDC could support money market rates remaining above zero, complementing the existing overnight reverse repurchase agreement (ON RRP) facility. In an abundant reserves environment, if a retail CBDC drains deposits and reserves from banks, there may be less pressure among banks to actively shed reserves, thus supporting deposit and money market rates.<sup>14</sup> The impact on money funds and the ON RRP may be similar. For some investors the combination of features in a retail CBDC may be preferable to placing a portion of their cash with money funds. In an environment of abundant central bank liquidity with a retail CBDC available, take-up at the ON RRP and money fund assets under management may both be lower than in the same scenario without a retail CBDC offering. In other words, at the ZLB, retail CBDCs could drain reserves like ON RRP, but may also result in lower ON RRP take-up than otherwise. Like the ON RRP, a retail CBDC would expand the number of counterparties that could invest in a digital asset backed by the Federal Reserve.

Finally, while we assume in our scenarios that the demand for reserves is fixed, we recognize that there are reasons why this assumption may not hold true in a real-world scenario.<sup>15</sup> If the overall size of commercial bank balance sheets declined (as in Scenarios B and C), banks may demand fewer reserves. Additionally, if a portion of payments activity shifted to using new retail CBDC payments rails, payments directly affecting banks' intraday reserve levels could become less volatile, possibly decreasing banks' precautionary need for reserves for payment purposes. On the other hand, if commercial banks lost retail deposit funding, which is among the more stable funding sources, and a greater share of their funding came from more flighty sources, such as wholesale funding, it is possible that banks may need to hold more high-quality liquid assets and the demand for reserves could increase.

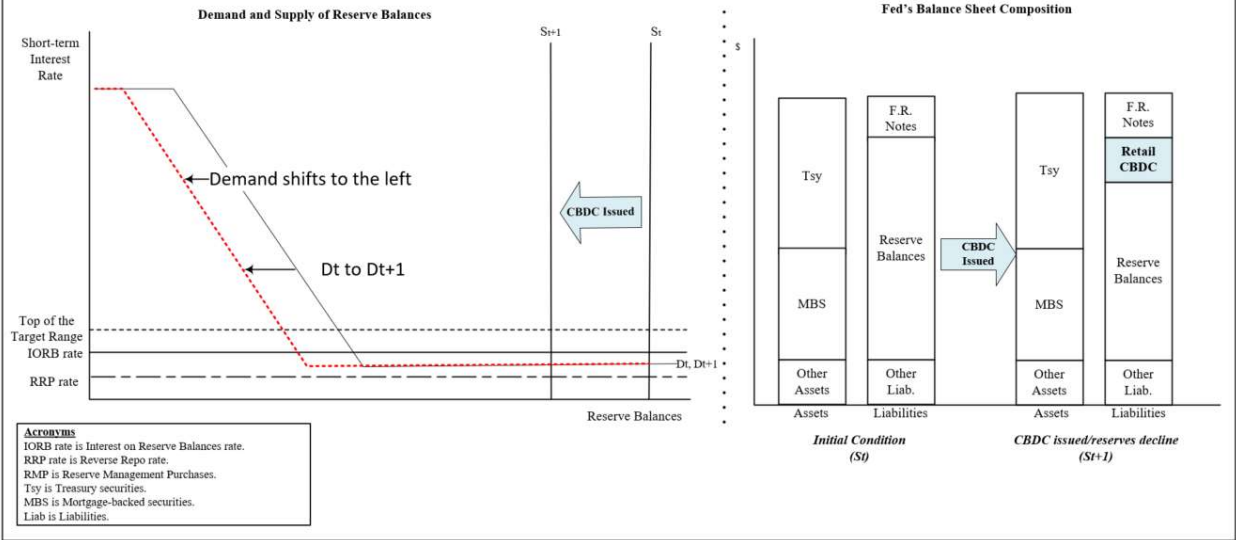
On balance, we assess that the demand for reserves would likely decrease as the demand for a CBDC increased, though the magnitude of the decrease is difficult to determine without any empirical experience. Figure 8 illustrates a decrease in the demand for reserves concurrent with a decrease in the supply of reserves. As the demand for retail CBDC increases (reserve demand shifts to the left), it may take longer for the reserves supply curve to "catch up" to the steep portion of the demand curve. This may allow the Federal Reserve to absorb a larger retail CBDC liability before it is necessary to expand the overall size of its balance sheet through RMPs (as described with Figure 7).

---

<sup>14</sup> If banks offered both a retail CBDC and deposits to its customers, individual banks could potentially encourage customers toward a retail CBDC to shed reserves and adjust the overall size and composition of their balance sheet. In this way, a retail CBDC could be another tool for banks to manage their reserve level.

<sup>15</sup> As noted in the methodology section, we assume for the purposes of simplifying our analysis that financial institutions do not hold significant balances of a retail CBDC and thus are not a significant source of demand for the retail CBDC. As such, we do not expect a retail CBDC to be a substitute for other bank high-quality liquid assets (HQLA), including reserves.

**Figure 8. CBDC Issued. Demand and Supply of Reserves Both Adjust.**



**Impact of a Retail CBDC on Commercial Bank Balance Sheets**

A retail CBDC could serve as a substitute for commercial bank deposits and other short-term assets whether the retail CBDC was remunerated or not. As described in Scenarios B and C, this migration would mechanically decrease central bank reserves and may increase short-term rates, including deposit rates. The rate pressure could be alleviated if the Federal Reserve supplied more reserves to the system, bringing reserve supply back to intersecting the flat portion of the reserves demand curve. The provision of additional reserves would place downward pressure on short-term rates and may increase the supply of deposits to commercial banks. Given this equilibrating mechanism, over the long run, the structure of the banking sector may not be affected much from the introduction of an unremunerated retail CBDC.

There may, however, be some cost to banks from the transition phase to a retail CBDC or during periods of financial sector stress. As rates on deposits increase because of competition with a retail CBDC, either banks’ profitability would decrease or, alternatively, to maintain profit margins, banks could raise lending rates. With the decline in the supply of reserves to banks, the aggregate commercial banking sector balance sheet would likely decrease when retail CBDC is first introduced. However, as noted previously, much of the sector’s response to the decline depends on initial conditions in the reserve market at launch of the retail CBDC. Additionally, a decrease in the size of commercial banks in these scenarios does not necessarily imply a decrease in bank lending.

If a particular bank lost a significant amount of deposits to a retail CBDC and its level of reserves fell below its preferred level, it may not have time to attract new deposits. The bank could turn to the Federal Home Loan Banks (FHLBs), or it may need to source higher cost funding or sell non-reserve assets. This could occur, for example, during a period of broader financial sector stress, when the relative safety of holding a central bank asset may look more attractive. In this way, a retail CBDC could magnify financial sector stress, forcing the Federal Reserve to provide more liquidity to banks through existing tools like the discount window or a standing repo facility. Longer-term financing from the

Federal Reserve could be helpful for banks in this context to provide time to absorb the impact of an increase in retail CBDC demand.

### ***Impact of a Retail CBDC on Asset Markets***

The scenarios in this paper have focused on the effects of retail CBDC on commercial banks and we have assumed that retail CBDC could be a substitute for bank deposits. However, given its relative safety and liquidity, an unremunerated retail CBDC may also serve as a substitute for other retail money market assets, such as retail money market funds, particularly during times of market or economic stress as retail clients sell assets to build cash reserves for precautionary reasons. A retail money market fund could experience similar funding pressures as banks during times of stress if a retail CBDC is widely available. Since money funds invest in many different markets—commercial paper for prime money funds and U.S. Treasury securities for government money funds—any changes in demand for money fund assets could affect the supply of credit to these markets. This highlights the importance of considering the effects of a retail CBDC on the non-bank sector.

The introduction of a retail CBDC by the Federal Reserve could potentially affect the Federal Reserve's footprint in the Treasury market. As the supply of reserve balances are affected by retail CBDC demand, in scenarios with very large or rapid retail CBDC adoption, the Federal Reserve may decide to conduct RMPs. This could result in larger Federal Reserve holdings of U.S. Treasury securities relative to a world without this retail CBDC, assuming the demand for reserves or currency remain unchanged.

## **6. Conclusion**

This paper highlights some of the balance sheet implications that could stem from the introduction of a retail CBDC in the United States, as well as some of the possible effects on monetary policy implementation. We illustrate that the potential effects on monetary policy implementation from retail CBDC are highly dependent on the initial conditions of the Federal Reserve's balance sheet—particularly the amount of reserves and level of rates in the market. If a retail CBDC is introduced when reserve demand is closely balanced with supply, the issuance of a retail CBDC could decrease the reserve supply to a point that would result in upward pressure on the effective federal funds rate. Regardless of the initial conditions in reserve markets, we also show that the adoption of a retail CBDC could be a direct substitute for bank funding sources, such as deposits, and thus could put upward pressure on prices in short-term funding markets. The amount of pressure on money market rates would also depend on the level of demand for a retail CBDC and how that interacts with banks' demand for reserves.

The Federal Reserve has tools to manage banks' short-term liquidity needs and pressure on prices in short-term funding markets. For example, we discuss how existing Federal Reserve tools, such as the discount window and the standing repo facility, could act as shock absorbers and ease bank funding strains during a roll out of a retail CBDC. Moreover, if these tools are found to be insufficient, the Federal Reserve could implement technical adjustments on administered rates to affect pricing in short-term funding markets, or it could increase the supply of reserves by adding assets permanently to its balance sheet through RMPs. The use of RMPs to offset the growth of retail CBDC liabilities—akin to growth in currency in circulation—would increase the size of the Federal Reserve's balance sheet over time, all else being equal, while also potentially increasing the Federal Reserve's presence in the Treasury market. This trend toward a larger Federal Reserve balance sheet could be offset somewhat if the increase in demand for retail CBDCs also caused a decrease in demand for reserves.

There are two key areas of the retail CBDC design that this paper does not explore in detail that are critical for monetary policy implementation: 1) remunerating the CBDC and 2) allowing foreign holdings of a U.S. dollar CBDC. Remunerating the CBDC at the interest on reserve balances rate could result in much more substitution away from U.S. currency, commercial bank deposits and other money-like products, intensifying the dynamics described in the above balance sheet scenarios. Creating such a strong substitute for deposits could be destabilizing for bank funding conditions, possibly requiring more central bank liquidity to support banks. Allowing foreign holdings of U.S. dollar CBDCs could significantly increase demand as well as the size and volatility of the Federal Reserve balance sheet. If foreign demand for U.S. dollar CBDCs proved volatile or difficult to predict, this could impact the supply of reserves and money market rates in the United States, creating an additional spillover channel from foreign to domestic markets.

Finally, a key assumption in this paper is that financial sector entities do not hold large amounts of a retail CBDC. This could be achieved, for example, through having account balance limits oriented toward households and small businesses. If financial sector entities or large nonfinancial corporations held large amounts of a retail CBDC for liquidity purposes, this could both increase the demand for a retail CBDC and further complicate monetary policy implementation. Further analysis on how a possible retail CBDC could be utilized by financial sector entities would be important information for central banks to consider when developing a retail CBDC's initial parameters.



## References

- Bank for International Settlements (2021). *Central bank digital currencies: financial stability implications*, Basel: BIS, [https://www.bis.org/publ/othp42\\_fin\\_stab.pdf](https://www.bis.org/publ/othp42_fin_stab.pdf).
- Bank for International Settlements (2021). *Central bank digital currencies: user needs and adoption*, Basel: BIS, [https://www.bis.org/publ/othp42\\_user\\_needs.pdf](https://www.bis.org/publ/othp42_user_needs.pdf).
- Barrdear, John, and Michael Kumhof (2016). "The Macroeconomics of Central Bank Issued Digital Currencies," Working Paper No. 605. London, England: Bank of England, July, <https://www.bankofengland.co.uk/working-paper/2016/the-macroeconomics-of-central-bank-issued-digital-currencies>.
- Böser, Florian, and Hans Gersbach (2020). "Monetary Policy with a Central Bank Digital Currency: The Short and the Long Term," September, <https://ssrn.com/abstract=3723511>
- Carapella, Francesca, and Jean Flemming (2020). "Central Bank Digital Currency: A Literature Review," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, November 9, <https://doi.org/10.17016/2380-7172.2790>.
- Ferrari, Massimo Minesso, Arnaud Mehl, and Livio Stracca (2020). "Central Bank Digital Currency in an Open Economy," ECB Working Paper No. 20202488. Frankfurt: European Central Bank November 19, <http://dx.doi.org/10.2139/ssrn.3733463>.
- Fraschini, Martina, Luciano Somoza, and Tammaro Terracciano (2021). "Central Bank Digital Currency and Quantitative Easing," Swiss Finance Institute Research Paper No. 21-25. Zurich: Swiss Finance Institute, July, <http://dx.doi.org/10.2139/ssrn.3804966>.
- Ihrig, Jane, Zeynep Senyuz, and Gretchen C. Weinbach (2020). "Implementing Monetary Policy in an "Ample-Reserves" Regime: The Basics (Note 1 of 3)," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, July 1, <https://doi.org/10.17016/2380-7172.2552>.
- Keister, Todd, and Daniel Sanches (2018). "Should Central Banks Issue Digital Currency?" Basel: Bank for International Settlements, October, [https://www.bis.org/events/eopix\\_1810/keister\\_paper.pdf](https://www.bis.org/events/eopix_1810/keister_paper.pdf).
- Meaning, Jack, Ben Dyson, James Barker, and Emily Clayton (2018). "Broadening Narrow Money: Monetary Policy with a Central Bank Digital Currency," Bank of England Working Paper No. 724. London: Bank of England, May 18, <http://dx.doi.org/10.2139/ssrn.3180720>.
- Pfister, Christian (2017). "Monetary Policy and Digital Currencies: Much Ado About Nothing?" Banque de France Working Paper No. 642. Paris: Banque de France, September <http://dx.doi.org/10.2139/ssrn.3038906>.
- Pfister, Christian (2019). "Central Bank Digital Currency: One, Two or None?" Banque de France Working Paper 732. Paris: Banque de France, October, <https://ssrn.com/abstract=3470143http://dx.doi.org/10.2139/ssrn.3470143>.