

October 2022

U.S. Coin Circulation: The Path Forward

(Follow up to the State of Coin Paper)

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Executive Summary

In early 2020, the COVID-19 pandemic precipitated an acute coin circulation challenge in the United States, leading to significant costs for ecosystem participants, including consumers, merchants and retailers, and financial institutions (FIs).[1] In response, the United States Mint increased its production of coins by ~25%, and the Mint and Federal Reserve Banks released approximately five billion pieces of coin reserves. Meanwhile, many ecosystem participants took significant action to mitigate the impact of the circulation challenge. For example, retailers instigated rounding programs, while FIs shipped coin across the country to meet demand. In June 2020, with no full resolution in sight in the near-term, the Federal Reserve was forced to impose allocation limits on coin orders from FIs in order to allocate the scarce supply of coin in an equitable way.

A group of coin industry representatives also formed the U.S. Coin Task Force,[2] which launched an investigation into the circulation challenge, and took early action with the #GetCoinMoving campaign. This report follows the U.S. Coin Task Force's "State of Coin" paper , offering a deeper analysis of the root causes of the circulation challenge, and a potential solution roadmap toward a more transparent, resilient, and efficient future coin ecosystem.

While coin was circulating relatively freely prior to the pandemic, the coin ecosystem already had multiple major structural weaknesses that exacerbated the circulation shock induced by the COVID-19 pandemic. These weaknesses included a low level of transparency (borne of chronic underinvestment in coin infrastructure), a large unbanked or underbanked population in comparison with other highly developed countries, a very fragmented financial services industry, and a substantial percentage of low denomination coins that were already in active circulation. While these weaknesses did not themselves cause the circulation shock, they heightened its severity relative to similar shocks experienced by coin ecosystems in other countries.

The actual cause of the shock was the erosion of consumer pathways to return coin to circulation via commercial avenues such as tolls, laundromats, mass transit, casinos, and to a lesser degree, directly to bank branches. This erosion resulted from an acceleration of structural changes during the pandemic, including a shift to digital payments and changing physical bank footprints. These changes are secular in nature - that is, they are long-term, macro trends. It is therefore unlikely that former recirculation pathways will return to a pre-COVID status quo. Moreover, while the supply of recirculated coin declined, demand for coin has remained persistent due to the continued need to make cash transactions at retailers and other merchants. As a result, consumer coin jars, which already represented the largest holdings of actively circulating coin, grew by as much as 15-20% during the pandemic.

Given that this circulation challenge has lasted for more than two years, with little sign of easing, bold action via transformative solutions must be considered. These solutions are generally neither rapid nor simple and require considerable investment from the coin ecosystem. Nevertheless, such investment would produce a range of far-reaching results. It would resolve the circulation challenge, thereby resolving the frictions and real costs borne by the ecosystem; strengthen the resilience of the ecosystem to withstand future shocks; lower the cost of circulating coins; and reduce the environmental and societal costs of coin production, storage, and recirculation.

The report identifies four potential solution pillars, addressing the acute circulation challenge and generating long-term change, as follows:

1. Increase transparency into coin inventories and flows across the coin ecosystem
2. With increased transparency, develop new coin inventory management practices
3. Shift the mix of denominations produced by the U.S. Mint toward higher value coins

[1] "Financial Institution" denotes any institution engaged in the business of providing financial services to customers who maintain credit, deposit, trust or other financial accounts or relationships with that institution. This includes, but is not limited to, banks of all sizes (e.g., national, regional, community) and credit unions.
[2] The U.S. Coin Task Force is a cross-functional coin ecosystem body with representation from all major participants in the coin supply chain, including large and small financial institutions, retailers, aggregators, the Federal Reserve System, armored carriers, and the U.S. Mint

4. Boost consumer awareness and reinforce consumer options for depositing loose coin cheaply and conveniently

Along with cohesive action, successful execution will require investment in data sharing, talent, and technology.

While solutions to the coin circulation challenge are inherently complex, genuine collaboration among ecosystem participants can overcome this challenge and create a more transparent, efficient, and resilient coin ecosystem.



Chapter 1: Broader context and study approach

Coin circulation in the context of COVID-19 and secular trends

Coin was circulating relatively freely in the years after the Great Recession. Prior to the COVID-19 pandemic, the Federal Reserve Banks (FRB) distributed an average of 70 billion pieces[3] of coin annually to financial institutions (FIs). FIs then circulated coin throughout the broader ecosystem, including to retailers and small businesses.[4] The bulk (~80%) of the demand for coin was met by recirculating coin from consumers back to FIs via pathways such as consumer deposits to aggregators or FIs, or through consumers using coin at commercial service providers such as mass transit, toll roads, laundromats, casinos, and others. In total, this amounted to an average of 57 billion pieces per year.[5] The remainder of circulating

[3] As per Federal Reserve data from 2011-2019

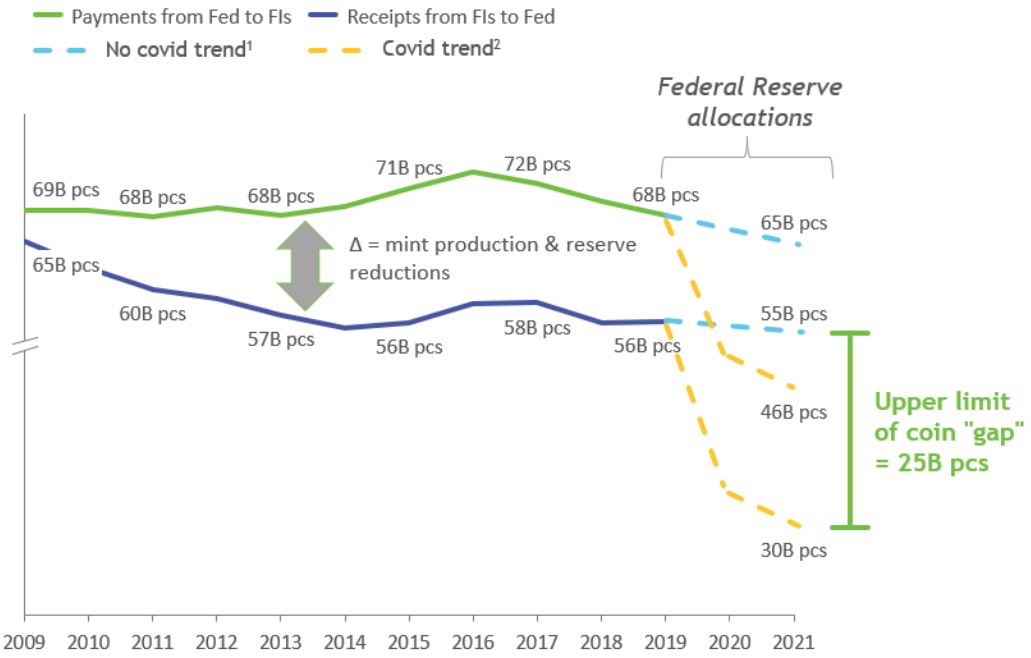
[4] In this report, the coin ecosystem includes all firms and individuals who handle coin, including merchants, consumers, Financial Institutions, Cash-In-Transit companies, aggregators, consolidators & government agencies. Aggregators are companies that operate loose coin deposit machines where a consumer may go to deposit their loose coins in exchange for cash, a gift card (or as a donation to a non-profit). Consolidators count, wrap, and package coin for customers and may also facilitate the purchase and sale of coin between other ecosystem participants (e.g., aggregators and retailers)

[5] Federal Reserve data

coin (around 20%) was supplied by new coin provided to the Federal Reserve Banks by the U.S. Mint. The pandemic fundamentally disrupted this circulation pattern and created a circulation challenge that has now persisted for more than two years.

Shortly after the United States enforced COVID-19 public health measures in 2020, there was a precipitous drop in coin deposits from FIs to the Federal Reserve Banks. Circulating coin in 2021 decreased by approximately 25 billion pieces (worth around $2.5 billion) in comparison with the circulation trend beforehand (**Figure 1**). Despite this decrease, the demand for coin from the Federal Reserve Banks did not fall at an equivalent rate, thereby creating a gap in coin availability across the ecosystem. In response to this circulation challenge, the U.S. Coin Task Force was convened in July 2020 to identify sources of friction and develop preliminary recommendations.

Figure 1. Total yearly payments to and receipts from financial institutions at the Federal Reserve Bank



1. No COVID trend is 2016 – 2019 CAGR extrapolated to 2020 and 2021
2. COVID trend is 2019 – 2021 CAGR
Note: data only indicates filled orders and not total FI demand from the Fed for coins.
Source: Federal Reserve Coin Volume Data

The U.S. Coin Task Force carried out important foundational work by beginning to assess the circulation challenge, and the task force also began to take action through the #GetCoinMoving campaign. Additionally, in an effort to guarantee continued availability, the U.S. Mint increased coin production by approximately 25% in 2020 and 2021,[6] while the Federal Reserve Banks and the U.S. Mint also released about five billion pieces in coin stock over a two-to-three-month period at the beginning of the pandemic.

Lastly, in the summer of 2020, the Federal Reserve imposed allocation limits on FIs in an attempt to allocate the scarce supply of coin in an equitable way. Nevertheless, these measures only temporarily lessened the impact of the circulation challenge for retailers, their customers, and other coin users. Two years later, the coin circulation challenge continues to create issues for banks, merchants, and consumers.

[6] Per U.S. Mint data

It is within this context that this paper will outline an evaluation of root causes and recommendations for implementing practical solutions to the coin circulation challenge and securing the future resilience of the ecosystem.

Study approach

As a follow up to the "State of Coin" paper published by the U.S. Coin Task Force, the U.S. Mint and the Federal Reserve's FedCash Services business line facilitated a six-month study. The study involved a close partnership with stakeholders across the coin ecosystem to diagnose the root causes of the circulation challenge (Chapter 2) and develop potential solutions to both address the challenge and build toward a more resilient, transparent, and efficient coin ecosystem (Chapter 3). A third-party consultant was engaged to gather data and provide support for quantitative and qualitative analyses**,** and to assist with preparing this follow-up report.

Inputs to the study included:

- More than 120 hours of confidential interviews and follow-up conversations with 80 stakeholders and experts, including financial institutions of all sizes, multiple types of retailers, bank and retail associations, aggregators, both national and regional Cash-In-Transit (CIT)[7] firms, and other key members of the coin ecosystem[8]
- Responses from a 5,000-person consumer survey aimed at understanding consumer behavior with respect to coin use[9]
- Coin inventory and flow data from more than 20 coin ecosystem stakeholders,[10] collected and analyzed by the third-party consultant
- Analysis of macroeconomic and demographic datasets[11] provided by the third-party consultant and obtained from open-source databases[12]
- Learnings from other global coin ecosystems, central banks, and mints
- Best-in-breed case studies from other industries such as glass bottles, healthcare, and others that have complex ecosystems which rely on recirculation

In partnership with the third-party consultant, the U.S. Mint and Federal Reserve teams used these multiple inputs to develop a set of holistic analyses and arrive at a robust, data-backed evaluation of root causes and potential solutions.

It is important to note that the engagement and partnership of the coin ecosystem was critical to the development of this report. Stakeholders were willing to share their time, experience, and their data with the third-party consultant.

[7] A Cash-In-Transit firm (more commonly known as "armored car services") is a firm that provides outsourced services to store, transport, and handle coin for the Federal Reserve Banks, Financial Institutions, and their clients.
[8] Confidential stakeholder interviews included the Federal Reserve, the U.S. Mint, financial institutions of all sizes, credit unions, large national retailers, commercial associations, armored carriers, coin aggregators, and experts from coin heavy industries (e.g., casinos, mass transit, laundromats, etc.).
[9] The survey population was aligned to the US census demographics, fielded anonymously, leveraged internet-based and phone-based platforms, and developed to be congruous with the Diary of Consumer Payments Choice (an annual Federal Reserve System survey that tracks consumer payment trends).
[10] All data received were handled per mutually agreed upon confidentiality agreements. The participation, support, and willingness to share data of ecosystem stakeholders were critical to the analysis.
[11] These datasets include statistical abstracts of the United States population and payment landscape
[12] For example, the Diary of Consumer Payment Choice and Federal Reserve Economic Data (FRED)



Chapter 2: Root causes

Although coin was circulating relatively freely in the years immediately before the COVID-19 pandemic (2015 – 2019), there were multiple broad, secular macro-trends challenging the long-term health of the ecosystem. These included the low utility of consumer coin payments due to generational inflation,[13] and an accelerating shift away from cash and toward digital payments[14]. In conjunction with structural factors in the U.S. coin ecosystem (such as low transparency into coin inventories and flows, continued underinvestment in coin infrastructure, and a more fragmented banking system in comparison with other countries), these trends led to significant hidden instability, and produced an environment that compounded the pandemic-induced circulation challenge.

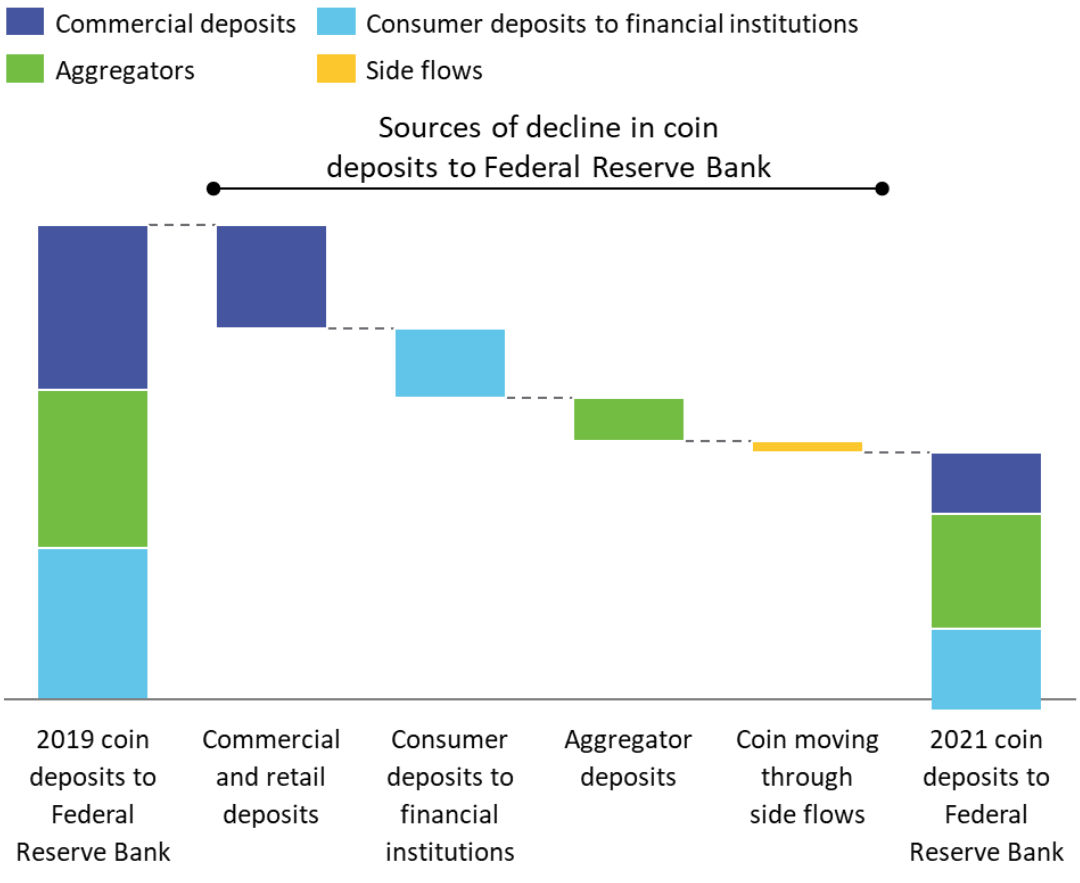
[13] For example, the purchasing power of a penny has declined more than 30x from 1900 to 2022 (per Federal Reserve data on inflation)

[14] Per the Diary of Consumer Payment Choice, cash as a share of consumer transactions declined from 31% in 2016 to 20% in 2021

From April of 2020, coin deposits from FIs to the Federal Reserve Banks decreased by nearly 50% (an average of 4.7 billion coins per month in 2019 versus an average of 2.4 billion coins during the pandemic). Meanwhile, coin demanded from the Federal Reserve Banks did not decline in a commensurate way.[15] The data-backed analysis shows that the fall in deposits was caused by disruptions across three primary pathways, all related to consumer recirculation of coin, and one secondary pathway **(Figure 2)**:

- **Consumer use of coin at commercial service providers** (such as tolls, parking meters, mass transit)[16]: A primary pathway, and the largest contributor to the decline in recirculation
- **Consumer deposits directly to financial institutions:** A primary pathway, and the second largest contributor to recirculation decline
- **Consumer redemptions at aggregators:** A primary pathway, which experienced a significant decline during 2020, but is now recovering from COVID-19 lows[17]
- **The emergence of side flows:**[18] A secondary pathway, and not a major contributor to the circulation decline

Figure 2. Changes in Federal Reserve Bank deposits from coin ecosystem via financial institutions from 2019 to 2021



[15] While Federal Reserve-imposed order allocations reduced the volume of coin ordered by financial institutions, per third-party analysis of ecosystem data and expert interviews, the actual demand for coin among financial institutions (and their customers, such as grocers and convenience stores) persisted at near pre-pandemic levels

[16] Coin-intensive service providers represent those service providers (not solely private-sector merchants) for whom coin served as a primary vehicle for paying for goods and services

[17] Per third-party data analysis, of 1Q'22, consumer deposits to aggregators had recovered to within ~10% of 1Q'19

[18] A "side flow" is an agreement in which an aggregator or one of their financial institutions sends coin to a non-financial institution, coin ecosystem participant instead of depositing that coin directly with the Federal Reserve Banks

Prior to the pandemic, coin deposited through commercial service providers, bank branches and aggregators all made major contributions to coin recirculation. However, the pandemic disrupted each pathway in material and distinct ways. The primary result of this disruption is that consumers, already the largest holders of coin, increased their holdings by 15-20%.[19]

Moreover, although some financial institutions increased their inventories of coin to ensure they could meet demand from clients, and to manage the difficulties associated with moving coin from regions of oversupply to regions of demand, they did so primarily to protect their ability to serve their customers. While this may have created added friction, the relative scale of inventory increases (two to three billion pieces) was much smaller than the declines in circulation from eroding consumer pathways (15 to 25 billion pieces), and therefore were not a primary factor in creating the coin circulation challenge.

Finally, the U.S. coin ecosystem had key structural factors that affected its state of health relative to other peer countries - lower transparency, a higher proportion of unbanked and underbanked citizens, a greater fragmentation of the banking system, and a higher share of production and circulation dedicated to small denominations. These factors, which were in some cases already being discussed by ecosystem participants prior to the pandemic, exacerbated the coin circulation challenge in the U.S. versus other peer nations.

Each of the above pathways will be further discussed (2a), impacts on the consumer (2b), frictions at financial institutions (2c), and structural factors that impacted the health of the U.S. coin ecosystem (2d) in more detail.

2a: Discussion of circulating pathways

Consumer use of coin at commercial service providers (net coin depositors)

Coin-intensive[20] service providers (such as mass transit, tolls and casinos) have traditionally served as a critical pathway through which consumers returned coin to the ecosystem. These service providers, in turn, would deposit large volumes of coin to the Federal Reserve Banks through their FIs. These coin-intensive service providers constituted the core net-coin-depositing institutions of the coin ecosystem and served the critical role of providing a major pathway for consumers to return coin back into circulation.

For the last decade or more, however, many of these industries had already begun digitizing payment options. The pandemic accelerated this digitization process, and many consumers noted the increase in digital options[21] at these service providers (**Figure 3**), especially the greater availability of debit and credit card options. For example, during the pandemic, many toll roads accelerated their move away from cash and coin, and toward a system of subsequent billing of the consumer through photographing the license plate or via transponder tags (e.g., EZ Pass). Indeed, several mass-transit systems entirely discontinued the acceptance of cash. The analysis also indicates a significant increase in the use of credit, debit, and payment cards at laundry machines and casinos. Moreover, the pandemic made hybrid or remote work much more common, and this may have fundamentally reshaped consumers' long-term behaviors with respect to some coin-intensive industries.[22]

Many of these industries saw declines in coin use of 40% or more.[23] This resulted in a major decrease in deposits from financial institutions to the Federal Reserve Banks. As noted at the beginning of this section, this change is part of a broader secular trend toward the digitization of payments, and so many of the deposits previously sourced through this pathway are unlikely to return.

[19] Per third-party analysis of consumer coin jar growth

[20] Coin-intensive service providers represent those service providers (not solely private-sector merchants) for whom coin served as a primary vehicle for settling cash transactions

[21] Per third-party consumer survey data, consumer payment behaviors shifted away from the use of physical currencies, such as coin

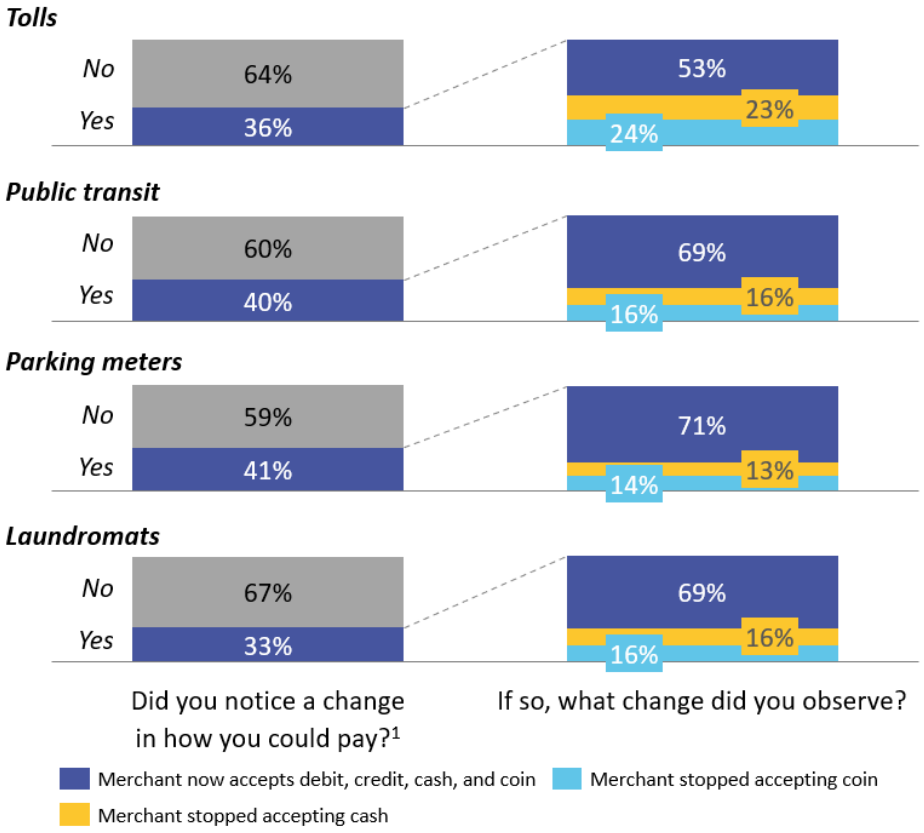
[22] Polzin, Steven; and Tony Choi. (2021). COVID-19's Effects on The Future of Transportation. United States Department of Transportation, Office of the Assistant Secretary for Research and Technology. https://doi.org/10.21949/1520705

[23] Third-party analysis of industry reports, data provided by FIs, and expert interviews

Consumer deposits directly to Financial Institutions

Consumer coin deposits directly to FIs (and subsequently to the Federal Reserve Banks) declined to a significant degree over the course of the pandemic. This decline was caused, in part, by an acceleration of secular trends in banking that were already underway, as well as by changes in consumer behavior. The decline of consumer coin deposits at FI branches has been a secular trend,[24] given their cost for FIs, complexity, operational risk, and declining consumer utility relative to other services provided by FIs to consumers. As a result of these trends, many FIs have stopped accepting loose coin deposits and removed coin-counting machines from their branches.

Figure 3. Consumers indicated increased digitization of payment options at traditionally coin-intensive merchants (2019 vs. 2022)



In addition, while many bank branches only closed temporarily as part of public health measures associated with the pandemic, the pre-existing trend towards digital banking and branch consolidation accelerated during this period. Throughout the industry, FIs have been slowly consolidating their branch networks and shifting to smaller footprints that focus on value-added services (such as financial advisory), rather than transactions (such as check cashing and deposits, cash and coin deposits, and withdrawals). During the pandemic, net branch closures increased from approximately 1.2% per year in 2014 - 2019 (around 1,600 net branch closures per year) to 2% (2,500 net branch closures per year)[25]. Furthermore, the pandemic altered the expectations of consumers when it came to engaging with physical bank branches, as they became still more accustomed

[24] Confidential third-party stakeholder and expert interviews (n=60+)

[25] Per S&P Global Market Intelligence and FDIC data

to fewer in-person interactions, such as for the depositing of checks, cash, and coins.

These trends, put together, resulted in declining consumer coin deposits to their FIs.

Consumer redemptions at aggregators

Consumer redemptions at aggregators dropped sharply during the initial phases of the pandemic. However, this decline was only temporary, as consumers' use of coin aggregator services in 2022 has nearly returned to pre-pandemic levels. Despite this rebound in consumer pours,[26] aggregator deposits to the Federal Reserve Banks via their FIs continue to be at a level somewhat below that of the rebound in consumers depositing coin with aggregators. This is likely to be due to the growth of side flows (such as the sales of coin to retailers) and greater use of aggregator coin by FIs to meet their clients' needs for coin (discussed more in the following section).

The emergence of side flows

In its simplest form, a side flow is an agreement by which an aggregator (or other non-FI ecosystem stakeholder) sells coin to a retailer (potentially via a non-FI third party) rather than depositing that coin to the Federal Reserve Banks via an FI. This trend emerged as retailers faced a declining supply of coins from FIs and increasingly sought alternative channels to procure coin. Although the volume of side flows has remained, and will likely continue to be, relatively small,[27] preliminary data from the first quarter of 2022 gives some indication that they have continued to grow, possibly due to persistent retailer demand for coin in order to have change available for cash transactions.[28]

Persistent coin demand despite decreased consumer coin utility

Although consumers sharply reduced their use of coin at traditionally coin-intensive service providers, overall demand for coin as a settlement instrument for cash transactions (i.e., to provide change) among retail, grocery and other commercial merchants has been persistent for three key reasons:

- Cash use at merchants has remained high among key customer segments, including lower-income and underbanked customers.[29]
- Large retailers have increased their adoption of self-checkout machines, which require up to three times the amount of coin inventory to operate.[30]
- There was continued consumer demand during the pandemic for in-store financial services (such as cash checking) offered by many large retailers, reinforcing the need for coin to settle transactions.

[26] Consumers "pour" coin to redeem value at loose coin machines, often operated by coin aggregators

[27] The cost and complexity of arranging for a side flow is larger than that of depositing coin directly to a financial institution

[28] Side flows continue to recirculate coin via the private coin ecosystem and not the Federal Reserve Banks. However, they may add costs to retailers and friction to the coin circulation ecosystem

[29] Per third-party proprietary data, U.S. consumer cash transactions have declined at 2.4% per annum from 2007 to 2021, with primary users driven by consumer groups who continue to prefer cash as a transaction medium

[30] Self-checkout machines require more coin given their programming for cash transaction settlement and the relatively higher rate of low-value, high-throughput transactions, which are more frequently settled using cash

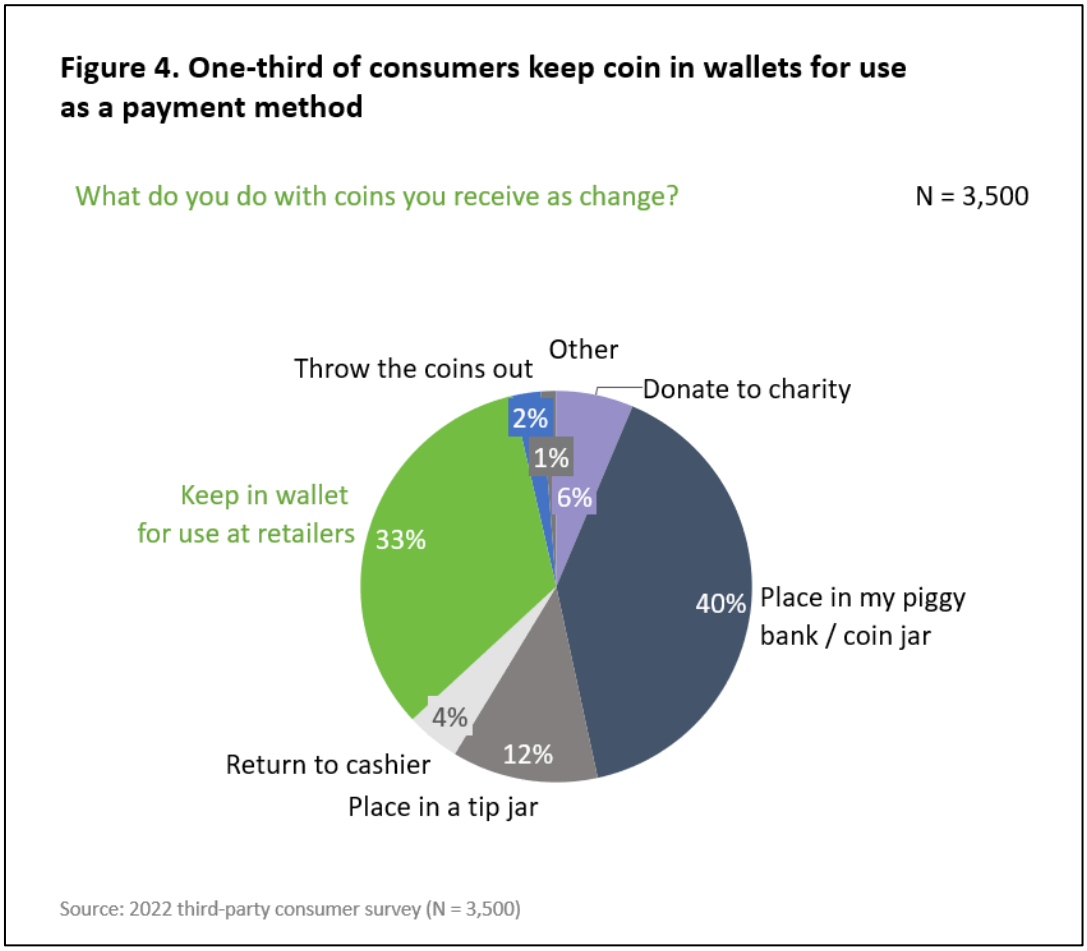
2b: Impacts on the consumer

While circulation pathways declined, consumer coin jars, which were already the largest pocket of actively circulating coin,[31] expanded by as much as 15 – 20%.[32]

This is primarily due to the perceived lack of utility of coin as a payment method. When asked about their planned uses for coin, only one third of consumers stated that they plan to use their coin for payments (**Figure 4)**. This reluctance is partly due to the accelerated growth of digital payments during the pandemic, but also a result of generational inflation that has impacted the value of goods that can be purchased by using coins as a form of payment.

As a result, consumers increasingly hold coin at home, in coin jars. The median household[33] now holds $60 - $90 in coins (the equivalent of one to two 16-ounce cups or a medium-sized piggy bank),[34] a figure that has grown as pathways to recirculate coin have declined. Additionally, when asked why consumers do not redeem their coins more frequently, the most common answer was that it was not worth the effort to do so **(Figure 5)**.

Figure 4. One-third of consumers keep coin in wallets for use as a payment method



Source: 2022 third-party consumer survey (N = 3,500)

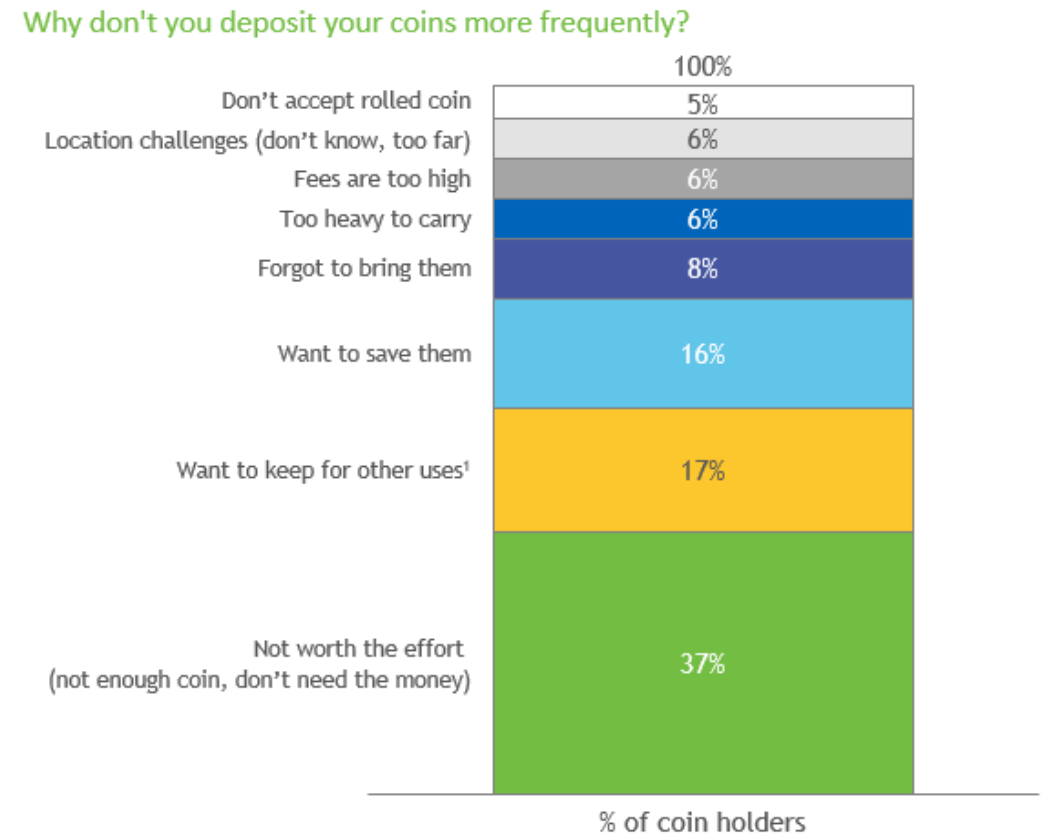
[31] "Actively circulating" coin refers to coin that has not entirely dropped from the U.S. financial system or consumer utility (e.g., lost, destroyed, exported to a foreign country). Some of this coin may only circulate every few years, but it still eventually recirculates through the financial system

[32] Per analysis completed in partnership with the third-party consultant on the size and growth of coin jars and actively circulating coin

[33] Assuming 122MM households per the U.S. Census

[34] Third-party consumer survey findings

Figure 5. The primary driver for not depositing coins more frequently is a lack of perceived value in doing so

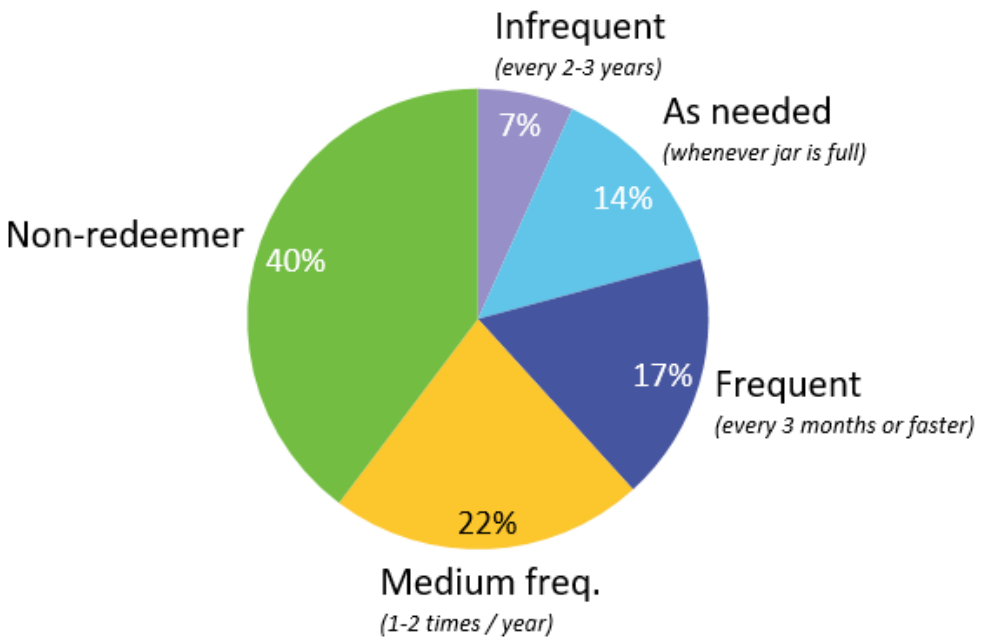


1. Other uses include gifting and purchases
Source: 2022 third-party consumer survey

In the context of the current coin circulation challenge, the growth of consumer coin jars poses an obstacle to improving coin circulation. While retailers and FIs struggle to meet coin demand (given that retailers provide more change than they receive), most coin is sitting in coin jars across the country. Currently, more than 60% ($10-$14 billion) of actively circulating coin sits in coin jars. During the pandemic, up to $2 billion may have been added to coin jars as coin-intensive payments and coin deposits rapidly declined. Notably, almost half of coin jar value is held by non-redeemers and infrequent redeemers of coin (**Figure 6**),[35] adding to the challenge of revitalizing coin circulation.

[35] Third-party consumer survey findings

Figure 6. Non-redeemers and infrequent redeemers hold almost half of consumer coin holdings



1. Total consumer coin jars range between $10-$14B across variety of analyses conducted
Source: 2022 third-party consumer survey (N = 3,500)

2c: Frictions at Financial Institutions

As described above, decreasing deposits of coin, caused by the erosion of consumer pathways to use coin, together with persistent demand for coin, created challenges for FIs. Furthermore, allocation limits imposed by the FRB, which were intended to distribute a scarce supply of coin in the most equitable fashion possible (and did so, given the currently limited data on true demand available to the FRB),[36] prevented many FIs from receiving sufficient coin to compensate fully for any difference between their own deposits and orders. Moreover, although the U.S. Mint and FRB could probably have increased their contingency inventory of coin by five billion pieces or more to provide a buffer for such a black swan event, given the magnitude of the circulation gap (around 15 to 25 billion pieces per year) they would still have had to impose allocation limits at some point.

As a result, some FIs maintained or increased their coin inventory levels in an effort to maintain a sufficient safety stock of coin for their customers. Total FI inventory declined slightly in 2020 and 2021 but rose in the first quarter of 2022 (**Figure 7**).[37]

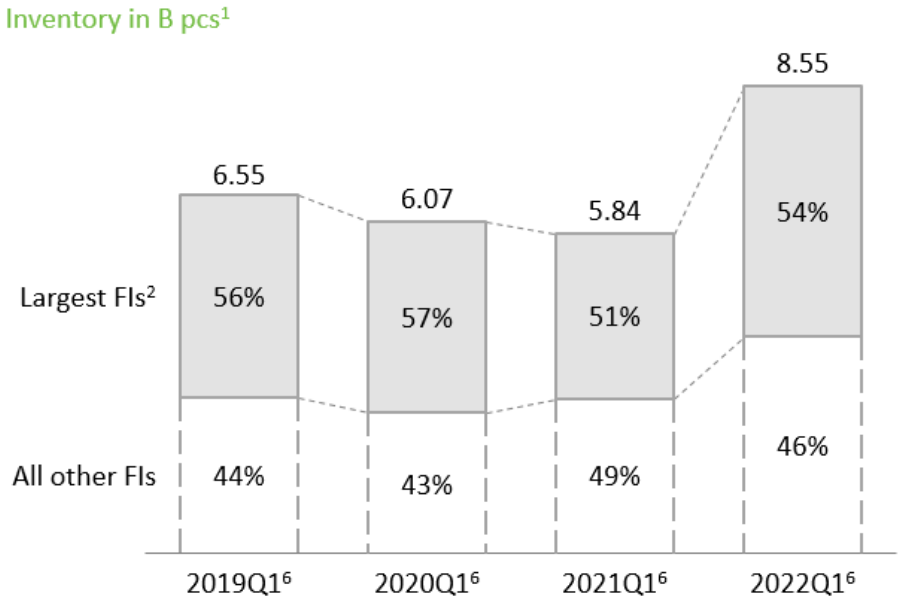
These inventory trends were also affected by regional imbalances. As coin availability tightened, regional imbalances between coin supply and demand at FIs also emerged. In addition to the FRB efforts to transfer and balance inventories across locations, many FIs faced challenges in moving inventory to balance

[36] Per analysis of FRB and ecosystem data

[37] Per analysis completed by the third-party consultant based on data shared by coin ecosystem participants

increased demand in one region with excess supply in another. Since coin is physically cumbersome to transport, regional imbalances became more difficult to resolve as a result of limited visibility into local inventory, the lack of availability of trucks and labor to move inventory, and price increases for transportation. These factors created inherent friction in supply chains, leading to trapped regional inventory that could not be readily deployed to meet demand.

Figure 7. FI coin inventories were flat through 1Q'21, but have grown in 1Q'22



1. Estimate of inventories based on data from 3 major CITs with assumed CIT coin market share of 80% across all three
2. FI size split based on data from two major CITs and extrapolated across remainder of CIT coin holdings

Implications for coin velocity and inventory management at Financial Institutions

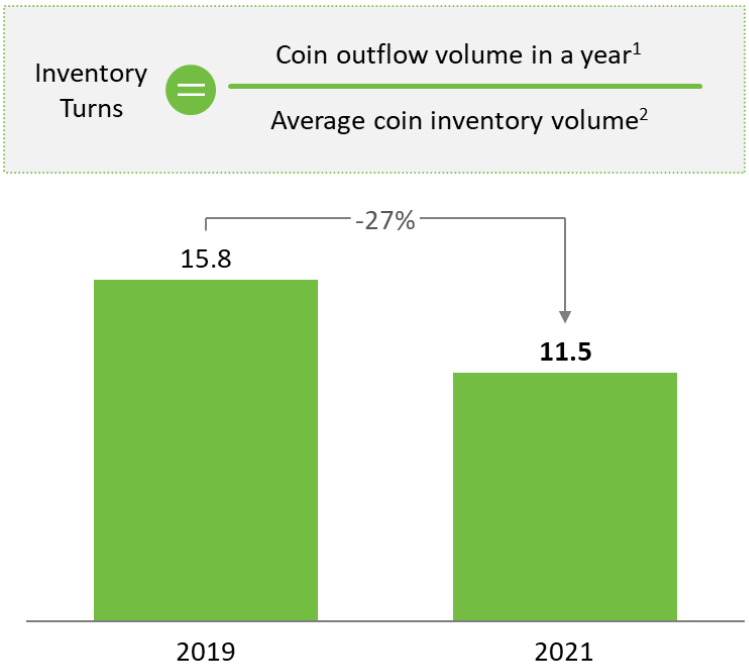
As FIs continued to receive less coin from their consumer and commercial clients, their ability to move coin rapidly through their supply chain (velocity) declined. From 2019 to 2021, the number of inventory turns (outflows / average inventory)[38] of coin at FIs fell by approximately 30% (**Figure 8**).[39]

This decrease in inventory turns resulted from a significant decrease in coin outflows from FIs despite relatively similar aggregate inventory levels between 2019 and 2021. Although this may suggest that FIs are holding relatively more inventory than they used to hold when serving their customers' pre-pandemic needs, there are multiple complexities that led to the relatively higher inventory levels versus outflows.

[38] Inventory turns are defined as the outflow of inventory in a given time period normalized by the average inventory level. For the purpose of this study, the total number of pieces of coin that financial institutions distributed in a given year divided by the average number of pieces held by financial institutions were measured.

[39] Per analysis of coin ecosystem data shared with the third-party consultant

Figure 8. Financial Institution Inventory Turns



1. Estimated total outflows by leveraging data collected from FIs, developing archetypes by size and coin flow and extrapolating across total FI ecosystem
2. Total addressable FI inventory is primarily held with 3rd party CIT vendors. Midpoint of analysis CIT held FI inventories shown

2d: Structural challenges impacting the health of the coin ecosystem:

In addition to the secular decline in deposits via consumer pathways, and changing circulation patterns of coin through FIs, there were also key structural challenges that affected the health of the U.S. coin ecosystem. These challenges existed prior to the pandemic, and greatly exacerbated the impact of the circulation challenge in the U.S. in comparison with other developed, highly digitized countries. When analyzed, four key factors emerged in the U.S. coin ecosystem relative to other peer countries:

- **The U.S. has a much higher percentage of unbanked and underbanked individuals relative to peer countries,**[40] leading to a greater dependence on cash and coin as a method of payment.
- **A less transparent coin ecosystem:** Many other countries (such as UK, Canada, and India) have greater transparency into coin demand, circulation, and inventory. This results from central bank, mint, and FI participation in centrally managed demand forecasting and inventory management systems.
- **A large percentage of U.S. coin production is dedicated to low-value denominations** (for example, more than 50% of 2021 U.S. circulating coin produced was pennies), which have been phased out in many other countries. Given limitations in current capacity, this makes it difficult for the mint to increase production of higher denominations.[41]
- **A more fragmented financial institution landscape** exists in the U.S. versus many other developed countries. For example, there are more than 10,000 financial institutions in the U.S.[42] compared to 100+ in other highly developed countries. Collaboration and

[40] Per official government databases: U.S. unbanked population is ~6% (20MM individuals), vs. 1-3% (1-3MM) in UK, Canada, and others

[41] For example, Canada rationalized the penny, which freed up Mint production capacity to focus on higher denominations

[42] Per the Federal Reserve Bank of St. Louis

communication across the ecosystem are inherently more challenging as a consequence.[43]

Key takeaways:

Although there have been many contributing factors to the U.S. circulation challenge, the key root causes are:

1. **The accelerating shift to digital payments among net-coin-depositing merchants** (such as mass transit, laundromats, tolls, casinos). This is a secular trend, and therefore unlikely to reverse to any significant degree.
2. **The persistence of cash transactions that require settlement with coins.** Although the number of cash transactions, and therefore demand for coin as a method of settlement, declined during COVID,[44] it fell much more slowly than the supply of recirculated coin.
3. **Challenging, pre-existing structural factors in the U.S. coin ecosystem**. Some of these factors stem from policy or macroeconomics (such as the unbanked and underbanked population, and the fragmented financial institution landscape), while others are caused by sustained underinvestment in coin infrastructure (for example, the lack of transparency with regard to coin circulation and inventory).

Figure 9. COVID-19 accelerated ongoing secular trends

Participant	Secular trend	COVID-induced effects	Impact on coin circulation
Financial Institutions	Digital focus; Change in branch footprints / formats	Accelerated secular trends	Reduced consumer deposit options
Commercial / Retail	Digital shift among coin-intensive services & retailers[1]; Growth of self-checkout[2] & in-store financial services	Accelerated shift to digital payments; Rapidly changing channel use (e.g., omni-channel)	Persistent demand for coin; Flowback drop from coin-intensive service providers
Consumer	Growing preference for digital payments; Persistent cash use in some segments	Accelerated digital spending; Shift to remote work	Coin jar growth; Less convenient to deposit / use coin

1. Coin-intensive service providers represent those service providers (not solely private-sector merchants) for whom coin served as a primary vehicle for settling cash transactions (e.g., laundromats, mass transit, tolls)
2. Self-checkout machines require up to 3-times more coin inventory to operate

[43] A small number of FIs in Canada and the United Kingdom are involved in coin circulation, and many of these FIs share demand data with the Mint

[44] Per third-party proprietary data



Chapter 3: Potential solutions and implications for the path ahead

Overview of solutions that address root causes

We have seen that several interconnected root causes underpin the ongoing disruption in the coin supply chain that emerged during the COVID-19 pandemic. Given the complexity and scope of the problem, solving the circulation challenge is too great a task for any one stakeholder or stakeholder group, and there are no rapid, low-cost, or simple solutions that would have a meaningful impact on the crisis.

Furthermore, the disruption has now persisted for two years, and analysis suggests that it is unlikely to solve itself. The structural factors that exacerbated the severity of the circulation challenge still exist, such as the lack of transparency due to chronic underinvestment in coin infrastructure and will continue to be a major source of risk.

Given these conditions, solutions must reflect a landscape for physical coin that is likely to have been permanently altered by secular trends. This changed landscape also leads to significant costs and frictions for ecosystem participants. For example, many retailers have had to round transactions to the nearest five cent increment (or in some cases to 10, 25 or dollar increments), reallocate labor (or in some cases hire employees), develop the new IT solutions necessary to manage the alternatives to providing change at point of sale, and pay incremental fees to purchase coin from private suppliers.

Due to the magnitude and persistence of the challenge, the FRB and U.S. Mint, in partnership with the third-party consultant, took a holistic look at potential solutions. First, an unconstrained view[45] of potential solutions was developed based on inputs from:

- Learnings from peer Central Banks
- Solutions proposed by several stakeholders across the ecosystem
- Case studies from other industries that have addressed similar challenges

Through these sources, 33 potential solutions were identified that span both traditional initiatives (such as boosting consumer awareness or increasing transparency within the supply chain) and newer potential interventions (such as creating mobile loose coin deposit locations or promoting greater private competition and ownership). In partnership with the third-party consultant, this unconstrained list of solutions was subsequently evaluated through an impact and feasibility analysis.

As there has been no single cause of the circulation challenge, there is no single solution. After the prioritization process, a shortlist of solution options was identified across four key pillars that combine to form a holistic solution approach, summarized below:

- Pillar #1: Increased transparency
- Pillar #2: Improved inventory management
- Pillar #3: Denomination shifts
- Pillar #4: Reinforced consumer pathways

Pillar #1: Increased transparency

Prior to the coin circulation challenge, most ecosystem stakeholders did not have visibility into the overall flow and inventory of coins at an ecosystem level, and some even had challenges tracking these same metrics at a detailed level within their own footprints. Moreover, there was no clear central authority for ecosystem-wide data. This prevented ecosystem stakeholders from rapidly diagnosing the root causes of the circulation challenge and added friction to ecosystem stakeholders' ability to efficiently match coin supply with demand. Improved ecosystem data and transparency would have also enabled the FRB to improve their allocation approach via real-time demand analysis.

In order to improve ecosystem-wide transparency and optimize the distribution of coin, the coin ecosystem could launch a Control Tower (a data management and analysis system)[46] for coin inventory, flows, and demand. This Control Tower would operate by using data shared by participants throughout the ecosystem (such as the Federal Reserve / U.S. Mint, FIs, and CITs).[47] In an initial phase, the Control Tower could undergo a pilot test using manually submitted data on coin stocks and flows shared by FIs and CITs with the Federal Reserve. The Control Tower could then be automated and enhanced with advanced analytical tools to boost visibility considerably.

The launch and success of the Control Tower would require the support and participation of a broad set of ecosystem participants (such as the data from FIs and CITs)[48], but at the same time could improve the participants' ability to manage coin efficiently (in preliminary discussions, many of these parties indicated they would be willing to support such an effort). For example, the Control Tower would mean that:

- The Federal Reserve could ensure supply and demand are better matched with available coin supplies

[45] An unconstrained view of the solution space reflects all major solutions identified, even if not subsequently prioritized upon assessment for feasibility and impact

[46] Control Tower is defined as a system that ingests, analyzes and visualizes data and business metrics to provide a multi-layered and multi-component view of the value chain, enabling improved inventory management and demand forecasting

[47] For example, the Control Tower could source inventory data from CITs, order and deposit data from FIs, new coin production data from the U.S. Mint, FRB circulation data from the Federal Reserve, and additional consumer data from aggregators

[48] For example, new data sharing agreements between FIs, CITs, and the Federal Reserve / U.S. Mint may need to be developed.

- The Mint could improve the efficiency of the production process to meet total demand and demand by denomination
- CITs could manage inventory in greater pools in a considered way, leading to lower costs
- FIs and retailers could understand and manage true coin demand, leading to improved efficiency and better service

The free flow of data, active participation in Control Tower pilots, and investments in data and reporting among ecosystem participants, would enable the Control Tower to have a greater impact in improving coin circulation. The Control Tower could also be extended to adjacent products (such as cash) to build future-proofing into the circulation of other forms of money issued by the central bank, and reduce the risk of black swan circulation shocks such as those that occurred with coin.

Pillar #2: Inventory Management

Low ecosystem transparency has been a persistent challenge in the coin ecosystem and made it more difficult to diagnose and resolve the coin circulation challenge. The low level of transparency can in part be explained by the fact that coin is a lower priority for many ecosystem stakeholders, and that little significant investment is therefore devoted to inventory and demand management tools. Along with greater visibility, improved inventory management processes (stemming from that visibility) would enable ecosystem stakeholders to improve the way they tackle regional imbalances in coin supply and demand and operate with more efficient coin inventories. Looking at best practices from other industries that have widely distributed inventory and large recycling components (such as healthcare and bottling), three potential opportunities to improve coin ecosystem inventory management were identified:

1. **Multi-nodal inventory management:** Initially, ecosystem participants could adopt multi-nodal inventory management practices. In a multi-nodal approach, ecosystem participants would work to increase visibility into inventories and demand across operational nodes (such as third-party coin vaults and bank branches) through more robust internal inventory management tools and possibly greater data sharing across institutions. This data would then be utilized to manage inventories through a coordinated approach across nodes. In certain cases, ecosystem participants could collaborate to manage inventories jointly, or these inventory management practices could be codified through updates to operating circulars, coin terminal agreements or other policies. These solutions would allow for greater efficiency, speed, and flexibility in meeting customer demand, potentially also leading to reduced regional imbalances.

2. **Kanban methodology:**[49] Ecosystem participants could also improve inventory management by implementing inventory control systems that better align orders to coin demand. For example, participants could apply the Kanban methodology, through which participants could track production and quickly identify when coin stocks are running low. Through this methodology, ecosystem participants would order according to their immediate, predicted demand. This could limit the buildup of excess inventory and reduce inefficiencies and cost as a result of shipping coin to locations where there may be limited demand. This methodology would be predicated on a holistic understanding of coin demand and the consistent availability of supply to meet coin demand.

3. **Refined allocation methodology:** Lastly, with better data sharing across the ecosystem, the Federal Reserve could refine the allocation methodology to reflect true demand for coin from clients of FIs more accurately (the key constraint in the current allocation methodology). Allocations would be refined by utilizing coin inventory and circulation data collected as part of a Control Tower pilot, thus improving the Federal Reserve's visibility into coin demand. By partnering closely, the Federal Reserve and FIs could also test the removal or loosening of allocation limits in certain regions.

Each of these solutions could be enabled by data sharing and coordination through a Control Tower designed to improve visibility into inventories and demand. For example, an automated Control Tower

[49] Kanban is a methodology that is used to operate supply chains in extremely lean fashion by relying on 'pull' to deliver inventory. For coin, this would mean that a client would order coin only when they have demand and carry minimal buffer stock.

would use advanced analytics to refine demand forecasts for ecosystem participants.

Overall, improvements in inventory management would have a significant impact on coin circulation, with ongoing efficiency gains in meeting demand and likely leading to a lower total ecosystem cost. However, such improvements will depend on broad participation and data sharing from the ecosystem if meaningful value is to be created.

Pillar #3: Denomination shifts

Given the persistent demand for coin and declining recirculation, producing coin at a level that would fill the gap between demand and recirculated coin has become a significant challenge for the Mint. Without changes in current circulation patterns, the volume of coin required to meet demand is currently above the U.S. Mint's production capacity (and currently limited raw material supplies) of around 14.5 billion coins per year. One possible option would be to follow the lead of many other countries and reduce production of lower denomination coins.[50] In addition to high production volume of the penny, it also has other societal challenges, including a high cost to produce[51] and circulate.[52]

The Federal Reserve and Mint could explore changing the mix of denominations, for example, by reducing penny production and shifting that capacity to higher denominations. This measure could help meet coin demand more efficiently, thus addressing the above capacity constraints without the need for a new Mint facility. Changing the mix of new coin production could also reduce the total number of pieces that other ecosystem participants must store, handle, and transport, likely reducing total ecosystem costs.

This shift in production would be carried out over a multi-year period with data-backed stage gates, and a test-and-learn approach, to ensure that no negative ramifications ensue within the coin ecosystem (such as the risk of overwhelming flowback). By using a data-backed approach to shifting production over time, the U.S. Mint can shift capacity in a considered manner in order to align with any future changes in demand.

In the near term, the coin ecosystem could also explore the impact of a larger shift in penny production through a series of data-backed discussions and studies on rounding, total cost to circulate, and market incentives (such as pricing and fees). This would ensure that any future planning with regard to significant shifts in the denomination mix is based on a comprehensive body of facts. Data from existing studies could be used as a starting point, and then augmented with additional research where it is thought to be needed. Insights from these studies should be communicated to ecosystem stakeholders and policymakers.

Moreover, learnings from other countries that have implemented rounding (such as Canada and Ireland) should be studied to understand the impacts that rounding had on retailers, consumers, and the macroeconomy.

- **The current cost of circulating the penny through the coin ecosystem:** While it is well known that pennies cost more than two cents to manufacture, there is less clarity on the current ecosystem-wide costs of penny circulation (which have also risen considerably due to fuel costs and labor inflation). Two key questions to consider might be:
  - What are the ecosystem-wide costs in recirculating a penny, and do they exceed the face value of the penny?
  - What are the environmental impacts of continuing to produce and circulate pennies (for example, raw materials extraction, carbon emissions, fuel used during transport)?

This data could then be used to facilitate a series of cross-industry discussions on the economics of the penny.

- **Market incentives** (such as charging a fee on orders of new coins) could also be explored as a means to reduce demand incrementally. A study should consider the impacts of market incentives on coin demand, retailer costs, as well as the impacts for consumers and other ecosystem participants.

If these studies show substantial evidence in favor of reducing the production of new pennies, then a more

[50] Over half of all circulating coins minted in 2021 were pennies

[51] Per the U.S. Mint 2021 Annual Report, the 2021 unit cost of production for the penny was 2.1 cents

[52] Initial analysis shows that the societal cost (costs to consumers, retailers, FIs, and other ecosystem participants) to recirculate an existing penny may be higher than its face value

significant shift in future production could be considered (such as drastically reducing or ending the production of the penny). This would require broad support from the ecosystem. It would also require a detailed change management and communications plan, with multiple data-backed stage gates to reduce execution risk. One key risk from a larger shift in penny production is a significant flowback of coin from consumers and businesses seeking to turn in their pennies. This risk can be carefully managed by extending the duration of the shift over a multi-year period, by ensuring there is transparency in the ecosystem to mitigate excess build-up, and by developing a robust plan to store, transport and recycle returned pennies. However, given its potential magnitude, this risk must also be studied further through a cross-industry working group to ensure appropriate mitigation planning is in place.

As well as solving the circulation challenge, a reduction in penny production could save up to $100 million per year for the U.S. Mint.[53]

The Mint has also researched alternative metals to modify the metallic composition of circulating coins. The goals of the research have been the reduction of costs and/or an increase in suppliers. Factors considered in the research include maintaining the same diameter and weight as current coinage, ensuring that the coins will work interchangeably in most coin acceptors using electromagnetic signature technology, and have as minimal an adverse impact as possible on the public and stakeholders. The Mint continues to research new metallic materials or technologies for the production of circulating coinage to enhance coin supply and operations. However, the Mint does not currently have authority to change the composition of the coins without new legislative authority. Should such legislation be enacted, the Mint could reasonably consider a transition to revised compositions for the five-cent, ten-cent, and quarter-dollar coin denominations and continue development of other potentially seamless alternatives, which could result in increased raw material supply, reduced manufacturing costs and increased seigniorage. Such a transition could occur within a few years after enactment of legislation. The term "seamless" indicates that these alternatives would require no or minimal changes to coin-accepting equipment. This would save stakeholders from having to make significantly costly financial and capital investment in altered or new equipment.

Pillar #4: Reinforced consumer pathways

As discussed previously, the COVID-19 pandemic changed consumer behavior with respect to circulating coin, while consumers at the same time increased their home coin holdings. However, given U.S. Mint capacity constraints, moves to increase coin production to fill the coin gap would present challenges and generate significant long-term environmental and social concerns.

The ecosystem must first consider rebuilding circulation pathways and encouraging consumers to return their coins before embarking on investment in new production capacity. These efforts would include a large consumer awareness campaign, including a call to action, and new pathways to deposit loose coin. The first steps would likely involve pilots to test awareness campaigns, and small-scale loose-coin depositing partnerships.

An awareness campaign would need a broad scope and national reach in order to exert a meaningful impact on circulation,[54] as well as targeted regional, digital, and partnership marketing efforts. This awareness campaign should be executed through multiple channels, such as social media, mass media, and partnerships, and via both mass market and precision targeting methodologies. Partnerships with non-profits, technology companies, retailers, and sports teams or large events could be used to boost awareness and provide temporary deposit options for redeeming coin.

In order to refine the ecosystem's view of consumer behaviors and drivers, an effective consumer awareness campaign would need to be grounded in rigorous consumer research. Multiple campaign pilots should be deployed to gather preliminary data on the approaches that would achieve the best return on

[53] Third-party analysis of U.S. Mint financial data. Based on the negative seigniorage earned on all existing penny production.

[54] Media campaigns often have low conversion rates and thus benefit from an increased reach. A broader campaign reach would also be beneficial because consumers coin jars exist nationwide

investment. For example, focusing investments on areas with high large, easily activated coin jars or low coin circulation should be considered. The impact of pilots could be measured, and learnings could then be used to refine campaign strategy, assets, and targeting. For this initiative to be successful, it will require sophisticated marketing capabilities, either in partnership with a marketing firm or using coin ecosystem assets, and a likely media expenditure in the tens of millions of dollars.[55]

The coin ecosystem could also collaborate to increase the coin deposit pathways available to consumers. This could be done through the addition of new loose coin deposit machines at FI branches in various communities. Importantly, such an effort would run counter to the trend toward bank branch consolidation and a shift to smaller branch formats. This initiative would require working with FIs to manage any concerns they have concerning the potential liability and operational risk of installing coin pouring machines, both of which have historically been barriers for FIs in this regard. The inclusion of new coin deposit machines in bank branches would offer a scalable avenue for increasing coin deposit pathways.

To test this avenue, a set of regional pilots could be conducted in partnership with interested FIs. Data and learnings from the pilots could be used to create a scaled campaign with more FI partners. To explore more coin deposit pathways, additional pilots could place coin deposit machines at non-FI locations, such as retailers or government-owned buildings.

In order to maximize impact, creating new coin deposit pathways should be combined with the consumer awareness campaign discussed above. This would build awareness about newly introduced coin deposit options, driving greater redemptions. It could also create opportunities to introduce and promote novel campaigns, such as charity donation events, or introducing new partnerships with aggregators.

Key enablers of solution roadmap

Five key enablers can support the solution pillars discussed in this chapter:

- A joint operating model between the solution leaders and ecosystem
- Key technology assets
- Data, marketing, and public relations talent
- Thought leadership on denomination shifts
- Change management planning

Each enabler is briefly discussed in the following paragraphs.

- **A joint operating model:** In order to ensure accountability and a cohesive approach to driving change, the owners of the solution roadmap should develop a joint operating and governance model. This model would require engagement and input from all ecosystem stakeholders but require clear and cohesive leadership from the ultimate solution owner(s).
- **Key technology assets:** There are two key technology assets: a Control Tower to create transparency for stocks, flows and demand for coin and a marketing technology stack (the tools and software required to run and measure the impact of advertising campaigns). The Control Tower would enable more efficient inventory management and demand forecasting, while the marketing technology stack would support more impactful and efficient pilots and consumer awareness campaigns (such as through tracking impact and collecting feedback, enabling rapid adaptation in response).
- **Data, marketing, and public relations talent:** Skilled talent would be required to drive key initiatives across the roadmap. Data and analytics staff would be needed to support a Control Tower. Specialized marketing talent would be needed to execute consumer awareness initiatives. Finally, public relations talent would be required to communicate changes and insights across the ecosystem, with policy makers and with consumers.
- **Thought leadership on denomination shifts:** There is currently a limited body of data-backed analysis that could improve the understanding of the impact of shifting low-value denominations out of circulation. In order to attain such an understanding, the ecosystem must jointly

[55] Some of the cost could potentially be offset by thoughtful use of U.S. Government public relations assets, channels and leveraging key officials to amplify messaging

undertake and communicate studies to quantify the impacts of rounding, the societal cost of penny circulation, and the effects of market incentives (such as pricing). Insights from these studies, as well as any other thought leadership (such as outcomes of pilots), should be broadly communicated across the ecosystem, to policy makers and to the public. This will ensure that all parties can make fact-based decisions that are in their best interests and in the best interests of the American public.

- **Change management and public relations planning:** A change management function would be required to manage communication and ensure execution across the solution pillars. This office could lead coordination across pillars, centralizing strategic planning and operations. This function would also be responsible for managing the risk from any large-scale initiatives (such as moving away from the penny) and ensuring open and consistent communication among ecosystem stakeholders by partnering with public relations assets to develop and implement cohesive internal and external communications.

Success drivers of solutions roadmap

In addition, there are four critical principles that will underpin the success of any coin ecosystem transformation, as follows:

- **Open communication between ecosystem participants** is vital in order to ensure alignment and coordinate where necessary. This should include a willingness to share data (see Control Tower) in the knowledge that this will help to ease the overall circulation challenge and develop a more resilient, transparent, and efficient coin ecosystem.
- **Support from ecosystem participants.** Ecosystem support is critical throughout the solution lifecycle, including in the selection of high-impact solutions, solution design, and joint investment (where required). The circulation challenge is larger than any single institution, and all parties must work together to solve the issue.
- **Transparency of data and information** (for example via a Control Tower) helps to target solutions and improves visibility into the impacts of solutions on coin circulation and on each ecosystem participant.
- **Adoption of a test-and-learn philosophy** across all solution pillars will offer ecosystem participants the flexibility to refine or adjust solutions, and also reduce the long-term risk resulting from the implementation.

Near-term support from ecosystem participants

By working together to build transformative change, the coin ecosystem has the opportunity to build a better future. To facilitate this coordinated effort, many participants will need to play a role in the development and execution of solutions. A strong foundation of transparent data shared across ecosystem participants will aid this process. A few specific data contributions could be especially valuable in the near term to promote greater transparency:

- **FI and CIT data sharing on coin inventories and flows**. Even if shared via manual file transmission, this data could enable the ecosystem to create a rapid and cohesive view of the coin supply, improving the distribution of coin and reducing coin shortages.
- **Shadow orders:** Shadow order data, presenting an unconstrained view of demand, could provide a more complete view of coin demand in the ecosystem relative to current orders, which are constrained by allocations (both at FRB and FI levels). This more comprehensive view could enable upstream ecosystem participants to improve demand forecasting and hence the way they manage production, circulation, and inventories.

A bold opportunity for the future

While the coin circulation challenge is a complex problem with few rapid or simple solutions, it also presents an opportunity for the coin ecosystem to invest in a transformative future. Together with the support of the coin ecosystem, the U.S. Mint and the Federal Reserve are committed to creating meaningful change to solve the circulation challenge and move toward the vision of a more transparent, resilient, and efficient ecosystem. In doing so, the ecosystem can:

- Ensure equitable access to central bank money and therefore better serve the needs of millions of U.S. consumers who use cash and coin on a regular basis.

- Build a template to improve the management of future shocks and build resilience in the ecosystem.
- Enhance the efficiency and reduce the societal costs of circulating coin.
- Engender long-term trust within the coin ecosystem and with the American public.
- Develop best-in-breed capabilities for coin management among global financial systems.

Acknowledgements

The U.S. Mint and the Federal Reserve extend our appreciation for the ecosystem-wide engagement that enabled this report. As part of this study, stakeholders across FIs, retailers, armored carriers, aggregators, the U.S. Mint, and the Federal Reserve Banks all devoted time and careful consideration to support the insights and analysis completed by the third-party consultant described herein. In particular, we thank cash and coin supply managers and their teams who invested time to develop datasets required for this study and sat down for multiple interviews to advance the evolution of this study's findings.