Optimal Currency Redemption: Theory and Evidence from a Digital Platform[*]

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August 2025

Abstract

Many currencies are backed by promises of redemption—including historical gold-backed currencies, historical free bank notes, and emerging stablecoins—but little theory or evidence informs the optimal design of currency redemption policy. We study the impact of redemption policy on currency acceptance and steady-state flows using unique transaction data from a digital trading platform. We show in a search-theoretic framework that redeemability can coordinate agents on a monetary equilibrium with zero steady-state redemption costs. However, the evidence is more consistent with a heterogeneous agent model in which redeemability is both costly and necessary for money circulation. A key implication is that optimal policy may impose some degree of redemption friction.

JEL Classification: *E41, E42, G23*

Keywords: *Redemption, Token Adoption, Digital Currency*

[*]First Draft: June 20, 2023. We thank Shiyang Huang, Giorgio Valente, Russell Wong, and Anthony Zhang for their helpful comments and seminar participants at the University of Hong Kong and Hong Kong Monetary Authority. We are grateful to the staff at Bunz for their assistance with the data.

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1 Introduction

Many currencies are backed by promises of *redemption*, including historically dominant gold-backed currencies, historical free bank notes, and emerging digital currencies such as stablecoins. However, little research informs the optimal design of currency *redemption* policy—i.e. policies chosen by currency issuers that determine the difficulty of redemption. Recent studies have characterized optimal adoption subsidies (Alvarez et al. 2023; Crouzet, Gupta, and Mezzanotti 2023) and optimal issuance (Rogoff and You 2023; Rogoff, He, and You 2024). Yet evidence and theory on the impacts of currency redemption policy are rare.

The dearth of research on the impacts of redemption policy is perhaps surprising. The critical importance of redeemability for the function of money as a medium of exchange is starkly illustrated by historical episodes—from the booms and busts of 18th–19th century banknotes (Volta 1893; Hamilton 1946; Gorton 1996; Velde 2007; Friedman and Schwartz 2008; Sanches 2016) to the recent collapse of the stablecoin UST (Liu, Makarov, and Schoar 2023).[1] Currently, large corporations such as Walmart and Amazon are considering issuing their own redeemable digital currencies due to the GENIUS Act of 2025.[2] Given the historical significance and contemporary relevance, a proper understanding of the impacts of currency redemption policy is of first-order importance.

In this paper, we study how redemption policy affects currency acceptance, stability, flows, and the profitability of currency issuers. Empirical progress is made by leveraging a unique transaction dataset with rare cross-sectional and time-series variation in currency redeemability. Theoretical progress is made by developing a simple heterogeneous-agent search-theoretic model of redeemable money to illustrate how and why redemption policy

[1]Anthropologists and historians contend that redemption promises, whether by states or private credit institutions, were instrumental in money's earliest emergence (Mitchell-Innes 1913, 1914; Knapp 1924; Lerner 1947; Humphrey 1985; Wray 2004; Graeber 2011). In modern times, regulators employ tools like reserve requirements, deposit insurance, and surveillance to enforce redemption guarantees.

[2]The Guiding and Establishing National Innovation for U.S. Stablecoins Act (GENIUS Act), is a United States federal law that creates a comprehensive regulatory framework for stablecoins. Stablecoins are a type of cryptocurrency that are backed by reliable assets such as a national currency.

affects currency acceptance, currency flow, trade, and issuer profits. The model not only explains the observed impacts of currency redemption policy, but also enables a characterization of optimal redemption policy.

The unique dataset used in this paper comes from an online trading platform named Bunz, through which a large number of Toronto-based users met in person and traded second-hand items, such as clothing, accessories, plants, and furniture. As previously documented by Wong (2025), the Bunz platform operated a redeemable digital currency, but later discontinued redemption due to cash flow problems. The novelty of the empirical work here is to leverage new cross-sectional variation in redemption convenience to quantify the empirical relationship between token redeemability, acceptance, and flows.

We first document that geographic proximity to redemption opportunities is strongly associated with higher token adoption, inflows, and redemption, but only mildly or insignificantly higher token outflows, issuance, or holdings in the Bunz economy. Tokens therefore on average flowed from users who are far away from redemption opportunities to those who are closer. This finding reveals that the choice by users to accept tokens was not purely driven by strategic complementary in token acceptance—as is the case in many canonical monetary models—it was influenced in part by their proximity to redemption opportunities. We confirm the robustness of this finding using alternative definitions of redemption convenience and a rich set of individual-level control variables.

We then document that the halt in redeemability caused massive drops in token acceptance and flows, even in areas where redemption was comparatively inconvenient. These reductions are orders of magnitude larger than the effects of a one standard deviation increase in the cross-sectional exposure to redemption prior to the halt. Moreover, initial cross-sectional differences in money acceptance and inflows disappeared. This finding suggests that while strategic complementarities in currency acceptance were significant in this real-world setting, they were not sufficient to sustain a monetary equilibrium in the absence of currency redemption.

These empirical findings are theoretically interesting. To our knowledge, existing models of money as a medium of exchange do not consider the impacts of changes in redemption ease. To explain the empirical results, we incorporate redeemability into the Kiyotaki-Wright (1993) model of money as a medium of exchange. The novelty is to allow agents to endogenously choose whether to immediately redeem money for a redemption good that yields a utility ν_R upon receiving money. We then characterize the impact of redeemability on currency circulation. We do so first in a simple model where a set of identical agents face homogeneous redemption utility. We then consider an extended model where redemption utility is heterogeneous across agents.

The baseline model reveals that currency redemption can be a very low cost method for encouraging currency adoption. Specifically, we show that redeemability can coordinate agents on a monetary equilibrium despite *zero* steady-state redemption. The reason is as follows. An increase in the value of ν_R can encourage agents to accept money. This increase in money acceptance, in turn, raises the rate at which agents who accept money find profitable trades. Increased transactions can make holding money more attractive than redeeming it immediately. Therefore, if the probability of single coincidence is sufficiently high and ν_R is sufficiently large but not too large, there exists a unique monetary equilibrium without any realized token redemption.

However, currency redemption also introduces systemic risks. We show that a run equilibrium emerges if ν_R is high relative to a cutoff that increases with the expected share of agents that accept currency. In the run equilibrium, agents redeem until the money stock is depleted. Therefore, both mispricing of the redemption good and a lack of confidence can be disastrous, both for the agents in the economy and for the currency issuer itself.

The extended model reveals that redeemability can become both costly and necessary for sustaining a monetary equilibrium even in the steady state. Specifically, we consider environments where the probability of single coincidence is not high, and redemption utility ν_R varies across agents. We find in this model that money acceptance, in-flows, and redemption all grow with redemption utility ν_R, so money flows from agents with low ν_R to agents with high ν_R. Moreover, redeemability can be necessary for a monetary equilibrium to exist.

Our empirical findings are consistent with the heterogeneous agent model, since we find that (1) currency acceptance and flows increase with redemption ease, and (2) currency acceptance dramatically declined when redemption was halt. We characterize optimal redemption policy in heterogeneous-agent model. We show that the platform should minimize the level of redemption volume, while keeping it high enough to maintain currency circulation. A key implication is that optimal currency redemption restricts redemption to a limited set of agents, and keeps redemption utility only high enough that this set of agent is willing to accept the token, and no higher.

Together, the findings of this paper help to make sense of the prominent role of redeemability in the rise and fall of currencies throughout history. They explain why currency redemption volume is often low, even though redeemability is critical for successful currency circulation. They also help explain why currency issuers often impose redemption frictions, such as restricting redemption to a subset of agents or charging a redemption fee. The results provide useful case evidence and intuitions that can guide the design and operation of emergent digital payment systems. They also highlight the relevance of agent heterogeneity and partial acceptability when analyzing the behavior of real-world currencies.

The rest of the paper is organized as follows. The next subsection discusses related literature. Section 2 presents our conceptual framework. Section 3 provides background on the Bunz economy. Section 4 documents the cross-sectional relationship between redemption convenience and token use. Section 5 reports the heterogeneous impact of reduced redemption. Section 6 concludes.

1.1 Related Literature

The first and main contribution of this paper is to provide empirical evidence on the impacts of currency redemption policy using novel data and empirical strategies. Our work builds on Wong (2025), who introduced the high-frequency and comprehensive transaction-level data that is used in this paper, and provided time-series evidence on the impact of monetary expansion and reduced redeemability in the Bunz economy. The key innovation in this paper is to study the impacts of currency redemption on currency and trade flows using *cross-sectional* variation in redeemability. We establish new empirical findings, interpret using a novel heterogeneous-agent model with endogenous redemption choices, highlight the previously underappreciated role of agent heterogeneity in explaining equilibrium behavior, and explore the economics of optimal redemption policy. To our knowledge, this paper is the first to use cross-sectional variation and transaction-level data to empirically explore how currency redemption policy impacts currency acceptance and steady-state flows.

The second contribution of this paper is theoretical. We formally show how a credible promise of redemption can coordinate agents on a unique monetary equilibrium at *zero steady-state cost*, but introduces the possibility of a run equilibrium. To our knowledge, this paper is the first to study search-theoretic models of redeemable money with *endogenous* redemption choices. Our framework builds on a variants of Kiyotaki and Wright (1993) that consider how platform or government policy affects the existence and uniqueness of monetary equilibria. Two early papers—Aiyagari and Wallace (1997) and Li and Wright (1998)—show that enforcement of a legal mandate to accept tokens among a subset of the population can engender a unique monetary equilibrium (see also Soller Curtis and Waller 2000; Lotz and Rocheteau 2002; Lotz 2004). Selgin (2003) shows that adaptive learning precludes agents from coordinating on a monetary equilibrium. Wong (2025) provides a model where the agents' rate of redemption is *exogenous*, showing that redeemability can help agents coordinate on a monetary equilibrium. Our results follow from allowing agents to make *endogenous* redemption choices.

The third contribution of this paper to show that optimal redemption policy may involve some degree of redemption frictions. To show this, we build on Shevchenko and Wright (2004), who study a version of Kiyotaki and Wright (1993) with agent heterogeneity and partial acceptability. Although more recent literature incorporates agent heterogeneity into the popular Lagos-Wright model (e.g., Rocheteau, Weill, and Wong 2021), the later contributions does not feature partial acceptability, which is needed to fit our evidence.[3] Our key result is that redemption frictions are optimal, since they reduce the cost of steady-state currency outflow, while ensuring that the currency successfully circulates. We show that the evidence is best explained by a model in which optimal redemption is frictional.

In a closely related paper, Ma, Zeng, and Zhang (2025) study stablecoin market structure through the lens of a variant of Diamond and Dybvig (1983). They similarly argue that redemption restrictions may be desirable, but for a different reason: they find that redemption restrictions reduce run risk. A related strand of the literature studies optimal issuance policy for redeemable platform currencies (Rogoff and You 2023; Rogoff, He, and You 2024). Another body of work studies the pricing of digital currencies, but do not consider the role of currency redemption policy (e.g., Cong, Li, and Wang 2022; Sockin and Xiong 2023; Garratt and van Oordt 2024).

Our theoretical results are especially interesting in light of several recent studies that examine optimal subsidies for encouraging currency adoption using technology adoption models. For example, Crouzet, Gupta, and Mezzanotti (2023) study the 2016 Indian demonetization intervention that increased the relative benefit of firms using electronic payment methods instead of cash. Alvarez et al. (2023) show using a technology diffusion model calibrated to transaction-level data on Costa Rica's national electronic payment system "SINPE" to characterize the optimal subsidy. Alvarez, Argente, and Van Patten (2023) documents the failure of Bitcoin's rollout in El Salvador, despite Bitcoin being declared legal tender. A key implication of such models is that a temporary subsidy can led to a persistent and irreversible increase in adoption. Our approach leads to a different set of policy implications. We show that redeemability can encourage currency circulation in a highly cost-effective manner, but it also introduces risks. The promise of redemption followed by a

[3] A related strand of the search-theoretic literature also considers models with bank-issued currencies, but also do not explicitly analyze partial acceptability (e.g. Berentsen, Camera, and Waller 2007; Chiu et al. 2023; Gu et al. 2023; Williamson 2024).

reduction in redeemability can lead to a monetary boom and bust.

2 Conceptual Framework

In this section, we devise a search-theoretic model in which agents endogenously choose whether to accept and redeem money. We begin with a model with identical agents similar to Kiyotaki and Wright (1993). In the model, agents must solve a coordination problem for money to successfully mediate transactions—since it is profitable for agents to accept money only if they expect others to do the same—leading to an equilibrium where money circulates and one where it does not. We show that redemption opportunities guarantees that money circulates. This can be accomplished at very low cost, since there may be zero steady-state redemption volume in equilibrium. However, a run equilibrium may also emerge, depending on redemption good pricing and strategic beliefs.

We then incorporate both heterogeneity in utility for transaction goods and heterogeneity in access to redemption opportunities. Our model builds on Shevchenko and Wright (2004), which, to our knowledge, is the only readily available model for analyzing economies with agent heterogeneity and partial acceptability. We show that agents with greater redemption opportunities are more likely to accept money and engage in sales, leading to a flow of money from agents with low redemption opportunities to those with high redemption opportunities. Moreover, a positive steady-state redemption volume may be necessary for a monetary equilibrium to exist. A key implication is that optimal redemption policy imposes redemption frictions. The development of a divisible money model with agent heterogeneity, partial acceptance, and endogenous redemption is left for future work.

2.1 Model with Identical Agents

A set of agents in the economy is denoted by N, with measure $\mu(N) = 1$. Each agent i can produce a unit of a certain type of goods, G^i, and can consume only one type of goods g^i. Agents cannot consume their own products, so they have to meet and exchange goods with other agents in order to consume. Goods are perishable, and production is instantaneous.

Each agent derives utility $u_C > 0$ from consuming a good, incurs cost $c > 0$ from producing a good, and we assume that $u_C - c > 0$. Each agent discounts future utility with time preference $\beta > 0$.

Time is discrete. In each period, agents meet with probability $\alpha > 0$. The probability that agent i meets another agent whose product i can consume is $P(g^i \in G^j) = x$. Conditional on this, a "double coincidence of needs" has probability $P(g^j \in G^i \mid g^i \in G^j) = y$. To simplify notation, we let $B = \alpha xy(u_C - c)$ denote the expected gain from barter in a period, and $l = \alpha x(1 - y)$ denote the probability of a "single coincidence" meeting.

Money is indivisible, durable, and has zero storage cost. The money supply is denoted by $M > 0$. We assume that one unit of money is always traded for one unit of commodity. This finding matches the fact that there was no observed inflation in the Bunz economy. It can also be rationalized by models with price coordination frictions (e.g., Green and Zhou 1998, 2002; Kamiya and Shimizu 2006, 2007a,b, 2011; Jean, Rabinovich, and Wright 2010).

Agents' decisions. In this model, each agent has two decision variables: acceptance π and redemption ρ. Since agents are fully symmetric in their production and homogeneous on all other aspects, we suppress the index i on the decision variables.

When agents meet in pairs, they barter and consume upon a double coincidence of needs. Upon a single coincidence of needs, the agent with the ability to produce the desired good faces a decision problem of whether to accept money from their transaction partner. We describe this decision with π, the probability of accepting money upon a single coincidence meeting. We allow agents to use mixed strategy in money acceptance, hence $\pi \in [0, 1]$. We use Π to denote each agent's expectation of other agents' probability of accepting money.

Upon receiving a unit of money, the agent can choose to redeem immediately and enjoy utility flow ν_R, or hold the unit of money in anticipation of using it for a future transaction. We describe this decision with ρ, the probability of redeeming money upon receiving it. Similarly, we allow for mixed strategies and $\rho \in [0, 1]$.

Thus, agents can transition between two states: state 0 of not having money, or state 1 of receiving one unit of money. We denote the measure of agents in state 1 as μ_1. Then, given agents' decision problem, their value functions are characterized by the following equations.

$$V_t^1 = \max_{\rho} \underbrace{B}_{\text{Barter utility}} + \underbrace{\rho\left[\nu_R + \beta V_{t+1}^0\right]}_{\text{redemption utility}} \tag{1}$$
$$+ \underbrace{(1-\rho)\Big[l\Pi(1-\mu_1)u_C + \beta\big(l\Pi(1-\mu_1)V_{t+1}^0 + \big(1 - l\Pi(1-\mu_1)\big)V_{t+1}^1\big)\Big]}_{\text{Transaction utility as buyer}}$$

$$V_t^0 = \max_{\pi} \underbrace{B}_{\text{Barter utility}} \underbrace{-lM\pi c + \beta\big[lM\pi V_{t+1}^1 + (1-lM\pi)V_{t+1}^0\big]}_{\text{Transaction utility as seller}} \tag{2}$$

Solution concept. We solve for the steady state symmetric Nash Equilibrium in π, ρ. In equilibrium, we let $\pi = \Pi$. In addition, the equilibrium measure of agents choosing not to redeem upon receiving one unit of money must be equal to the money supply, hence μ_1 and M satisfy the relation $\mu_1(1-\rho) = M$. Steady state requires that the flows of agents between state 0 and state 1 are equalized, such that

$$\overbrace{\mu_1}^{\text{Prob. of being in S1}} \cdot \underbrace{[\rho + (1-\rho)l\Pi(1-M)]}_{\text{Prob. of transition, S1 to S0}} = \overbrace{(1-\mu_1)}^{\text{Prob. of being in S0}} \cdot \underbrace{lM\pi.}_{\text{Prob. of transition, S0 to S1}} \tag{3}$$

From the agents' point of view, there are two uses of money: redemption and transaction. The value of these two uses depend on ν_R and u_C, respectively. Depending on the parameters, a multiplicity of equilibria may arise. Since the value functions are linear in the decision variables, optimal strategies are corner solutions with $\pi, \rho \in \{0, 1\}$ for most parameter values, except for a measure zero set of knife edge cases. Therefore, we focus on the symmetric pure strategy equilibria.

We define the equilibrium as "Non-monetary" if $\pi^* = 0, \rho^* = 0$, i.e., agents neither accept nor redeem money. We define the equilibrium as "Monetary" if $\pi^* = 1, \rho^* = 0$, i.e., agents accept money and do not redeem. We define an equilibrium as "Run" if $\rho^* = 1$, i.e. agents always redeem. In this case, the steady-state money stock is zero, and there is multiplicity of

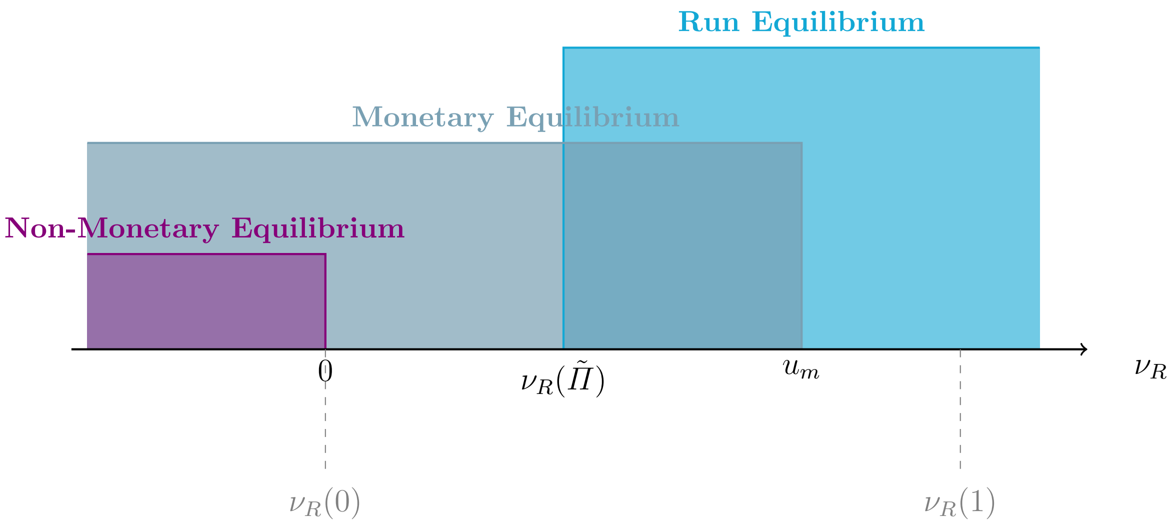


Figure 1. Equilibrium Existence as a Function of ν_R

Notes. This figure illustrates how the existence of different equilibria depends on the value of redemption utility ν_R. The ranges of ν_R that sustain the Non-Monetary equilibrium, Monetary equilibrium, and Run equilibrium are colored in purple, gray and blue respectively.

equilibria with regarding to π, since agents are indifferent between any $\pi \in [0, 1]$. We assume that the agents' expectation that other agents accept money is the same across agents, and denote this expectation as $\tilde{\Pi} \in [0, 1]$, in situations where this belief is not pinned down by the solution concept.

Proposition 1. *Suppose consumption utility $u_C > \underline{u}$ for some $\underline{u} > 0$. Then:*

1. *The Non-Monetary equilibrium exists if and only if $\nu_R \leq 0$.*
2. *The Monetary equilibrium exists if and only if $\nu_R \leq u_m$, where u_m is a cutoff value that is strictly positive.*
3. *The Run equilibrium exists if and only if $\nu_R \geq \nu_R\left(\tilde{\Pi}\right)$, where $\nu_R(\cdot)$ is an increasing function such that $\nu_R(0) = 0 < u_m < \nu_R(1)$.*

Proof. See Appendix. □

Proposition 1 shows that positive redemption utility eliminates the non-monetary equilibrium. When redemption utility $\nu_R \leq 0$, the model features multiple equilibria, with all agents either accepting or not accepting money. With any positive redemption utility $\nu_R > 0$, the non-monetary equilibrium disappears. However, as redemption utility further increases, a run equilibrium emerges. If ν_R becomes sufficiently high, the run equilibrium becomes the unique equilibrium. Figure 1 illustrates this result.

As previously mentioned, a multiplicity arises within the Run Equilibrium because agents are indifferent between whether or not to accept money themselves in a transaction when the money stock is zero. However, agents are *not* indifferent between whether *others* accept money, since their acceptance choices affect the opportunity cost of redemption. If agents believe that others are unlikely to accept money, then the run equilibrium exists even when redemption utility ν_R is low. If instead agents expect that others are likely to accept money, then the run equilibrium exists only when redemption utility ν_R is high.

2.2 Model with Heterogeneous Agents

In this section, we extend the model to incorporate heterogeneity among agents to account for the richness of our empirical setting. Two specific forms of heterogeneity are added. First, agents are heterogeneous in terms of the utility they derive from consuming transacted goods. We denote agent i's consumption utility as u_C^i. For simplicity, we assume that u_C^i is distributed uniformly on a support $[\underline{u}_C, \overline{u}_C]$ across the distribution, where $\underline{u}_C > 0$. Second, the issuer offers heterogeneous redemption utilitys to agents, denoted as $\nu_R^i \geq 0$.

To keep the steady-state money supply constant in the economy, we assume that money is exogenously issued to agents in each period. Specifically, agents who hold no money receive a unit of money with probability σ. This assumption matches the way the Bunz issuer issues money to users via helicopter drops in our empirical setting, and can be altered without significantly changing the intuitions we highlight.

Under these assumptions, the enriched Bellman equations of the agent i are given by

$$V_{1,t}^i = \max_{\rho_t^i} \underbrace{B}_{\text{Barter utility}} + \underbrace{\rho_t^i \left[\nu_R^i + \beta V_{0,t+1}^i\right]}_{\text{Redemption utility}} + \underbrace{(1-\rho_t^i)\Big[lW_t u_C^i + \beta\big(lW_t V_{0,t+1}^i + \big(1-W_t\big)V_{1,t+1}^i\big)\Big]}_{\text{Transaction utility as buyer}} \tag{4}$$

$$V_{0,t}^i = \max_{\pi_t^i} \underbrace{B}_{\text{Barter utility}} \underbrace{-lM_t\pi_t^i c + \beta\big[lM_t\pi_t^i V_{1,t+1}^i + (1-lM_t\pi_t^i)V_{0,t+1}^i\big]}_{\text{Transaction utility as seller}} + \underbrace{\beta\sigma(V_{1,t+1}^i - V_{0,t+1}^i)}_{\text{Issuance value}}. \tag{5}$$

Following the previous section, π_t^i denotes agent i's probability of accepting money in a single-coincidence meeting and ρ_t^i denotes her probability of redeeming money upon receiving it. In addition, μ_t^i denotes the probability that agent i is in state 1 in period t. $M_t = \sum_j \mu_{t-1}^j(1-\rho_{t-1}^j)$ denotes the money stock, while $W_t = \sum_j \pi_{t-1}^j(1-\mu_{t-1}^j)$ is the aggregate probability that agent i meets an agent that accepts money.

Individual state transition follows the law of motion,

$$\mu_{t+1}^i = \mu_t^i(1-\rho_t^i)(1-lW_t) + (1-\mu_t^i)(\pi_t^i lM_t + \sigma). \tag{6}$$

As before, we define a steady state equilibrium where aggregate quantities and individual optimal decisions, $(M, W, \{\mu^i\}_i, \{\pi^i\}_i, \{\rho^i\}_i)$, are constant in time.

We first study agents' optimal individual decisions as a function of their consumption utility u_C^i and redemption utility ν_R^i. We relegate the details of analyses to the Appendix and directly present the structure of optimal decisions in the following Lemma.

Lemma 1. *Given $W, M \in (0,1)$, each agent i's optimal choice (π^i, ρ^i) as a function of (u_C^i, ν_R^i) is given by Figure 2.*

Proof. See Appendix. □

Figure 2 shows that agents accept money if and only if either (a) redemption utility ν_R^i exceeds a certain cutoff $\frac{c}{\beta}(1+\beta\sigma)$, or (b) consumption utility u_C^i is large relative to a cutoff

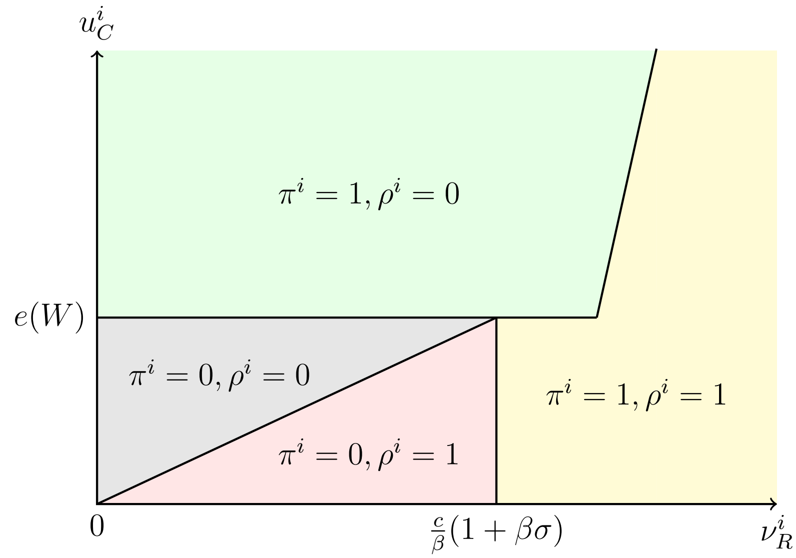


Figure 2. Optimal individual acceptance and redemption

Notes. This figure presents how each agent i's optimal acceptance decision π^i and redemption decision ρ^i depend on u_C^i, ν_R^i. Cutoffs between regions are functions of the aggregate states and primitives.

$e(W) = \frac{c}{\beta}\frac{1+\beta\sigma-\beta(1-lW)}{lW}$, which decreases in lW, the aggregate probability that agent i meets an agent that accepts money. Among these agents, those whose u_C^i is large relative to ν_R^i do not redeem. Agents with both low u_C^i and low ν_R^i do not accept money. However, some may redeem whatever money that they are issued, if ν_R^i high when compared to u_C^i .

The optimal acceptance and redemption choice characterized above imply that money will on average flow from agents who do not redeem towards agents who redeem in steady-state equilibrium. Moreover, as money on average flow towards the redeeming agents, goods accordingly on average flow away from redeeming agents.

To see this formally, let money inflows from peers to agent i be $S^i = lM(1-\mu^i)\pi^i$, i.e., the expected number of transactions in which agent i accepts money in exchange for a produced good. Let money outflows from peers be $P^i = lW\mu^i(1-\rho^i)$, i.e., the expected number of transactions in which agent i uses money to obtain a good.

Proposition 2. *In any steady-state equilibrium, consider any two agents i, j with consumption utility $u_C^i = u_C^j$ and redemption utility $\nu_R^i < \nu_R^j$. Their behaviors satisfy:*

1. *The probability of accepting money increases with redemption utility, i.e.,* $\pi^i \le \pi^j$.

2. *The volume of money inflows from peers increases with redemption utility, i.e.,* $S^i \le S^j$.

3. *The volume of money outflows from peers decreases with redemption utility, i.e.,* $P^i \ge P^j$.

Proof. See Appendix. □

We next examine what types of equilibria exist in the heterogeneous agent model. Here we take the issuer's redemption policy as exogenous. We extend the proof strategy developed in Shevchenko and Wright (2004) to characterize two dimensions of equilibrium choices among a large and heterogeneous population. For tractability, we assume that u_C^i and ν_R^i are distributed independently. We also assume the following:

Assumption 1. $\underline{u}_C < e(1)$ *and* $\overline{u}_C > e(\frac{1}{1+\sigma})$.

This assumption imposes that the dispersion of u_C^i among agents is large. The first cutoff is chosen to ensure that there exist some agents with low enough u_C^i such that they don't accept money for transaction purposes even when all other agents are accepting money, and the second cutoff is chosen to ensure that there exist some agents with high enough u_C^i such that they accept money for transactions even if only a small share, $\frac{1}{1+\sigma}$, of other agents are accepting money. Intuitively, the existence of low u_C^i agents ensures that there *cannot* exist a monetary equilibrium without sufficient redemption, whereas the existence of high u_C^i agents ensures that there *cannot* exist a non-monetary equilibrium when redemption is sufficiently high.

The following Proposition shows that in this case, the economy converges to a unique non-monetary equilibrium if redemption utilities for all agents are below a cutoff value. If instead redemption utilities for all agents are above the same cutoff value, it converges to a unique monetary equilibrium.

Proposition 3. *Suppose that* u_C^i *and* ν_R^i *are independently distributed. Then, there exists* $\overline{\nu} > \frac{c}{\beta} + \sigma$ *such that:*

1. *Suppose the issuer assigns redemption utility* $\nu_R^i < \frac{c}{\beta} + \sigma$ *to all agents. Then there exists a unique* non-monetary *equilibrium in which all agents optimally play* $\left(\pi^i = 0, \rho^i = 1\right)$*, the aggregate money acceptance probability is* $W^* = 0$*, and the aggregate money stock is* $M^* = 0$*.*

2. *Suppose the issuer assigns redemption utility* $\nu_R^i \in [\frac{c}{\beta} + \sigma, \overline{\nu}]$ *to all agents. Then there exists a unique* monetary *equilibrium in which agents optimally play either* $\left(\pi^i = 1, \rho^i = 0\right)$ *or* $\left(\pi^i = 1, \rho^i = 1\right)$*, both strategies are played by positive shares of agents, and the aggregate states* $W^*, M^* > 0$*. The fraction of agents playing each strategy and the values of* W^*, M^* *depend on the exact distribution of* ν_R^i*.*

Proof. See Appendix. □

Proposition 3 shows that there is instead only a non-monetary equilibrium when redemption utilities are zero. This result contrasts with Proposition 1, which showed that there exists both a monetary equilibrium and a non-monetary equilibrium when redemption utility is zero. Assumption 1 is critical for this difference. Since the dispersion in u_C^i is large, the presence of agents who actively redeem from the issuer is now *necessary* for the existence of the monetary equilibrium. In other words, steady-state redemption volume is now necessary for sustaining money circulation.

2.3 Optimal Redemption Policy

We now consider the optimal redemption policy from the perspective of the currency issuer. Our key finding is that it may be optimal for the currency issuer to restrict redemption. To show this, we consider the following game. First, the currency issuer chooses redemption utility ν_R^i for each agent i. We assume that issuance σ is chosen such that the money stock

M is in steady state. Second, agents simultaneously choose π_i and ρ_i to maximize steady-state payoffs. We assume that the currency issuer knows the distribution of u_C^i, but does not observe each agent's individual u_C^i.

We focus on redemption policies where the issuer randomly assigns a share s of agents a positive redemption utility given by $\nu_R = \frac{c}{\beta}(1+\sigma\beta)+\epsilon$, where ϵ is a small positive number indicating that the utility is just above the cutoff value $\frac{c}{\beta}(1+\sigma\beta)$. The remaining share $1-s$ of agents receive zero redemption utility. As discussed in Lemma 1 and illustrated in Figure 2, agents are guaranteed to accept money—that is, to take action $\pi = 1$—if and only if they are assigned a redemption utility of at least $\frac{c}{\beta}(1+\sigma\beta)$. Conditional on accepting money, further increases in redemption utility lead to a higher likelihood that the agent will redeem the money, i.e., take action $\rho = 1$, which in turn raises the redemption cost. Randomization is without loss, since the issuer does not know the individual u_c^i of agents.

The issuer's objective function is given by

$$\max_s \underbrace{\tau l M W}_{\text{Revenue}} - \underbrace{\int \mu^i \rho^i \nu_R^i di}_{\text{Redemption cost}} \tag{7}$$

where τ is the dollar revenue the issuer earns per monetary transaction. By substituting in the definitions of W, M, and Equation (6), the equilibrium conditions are given by

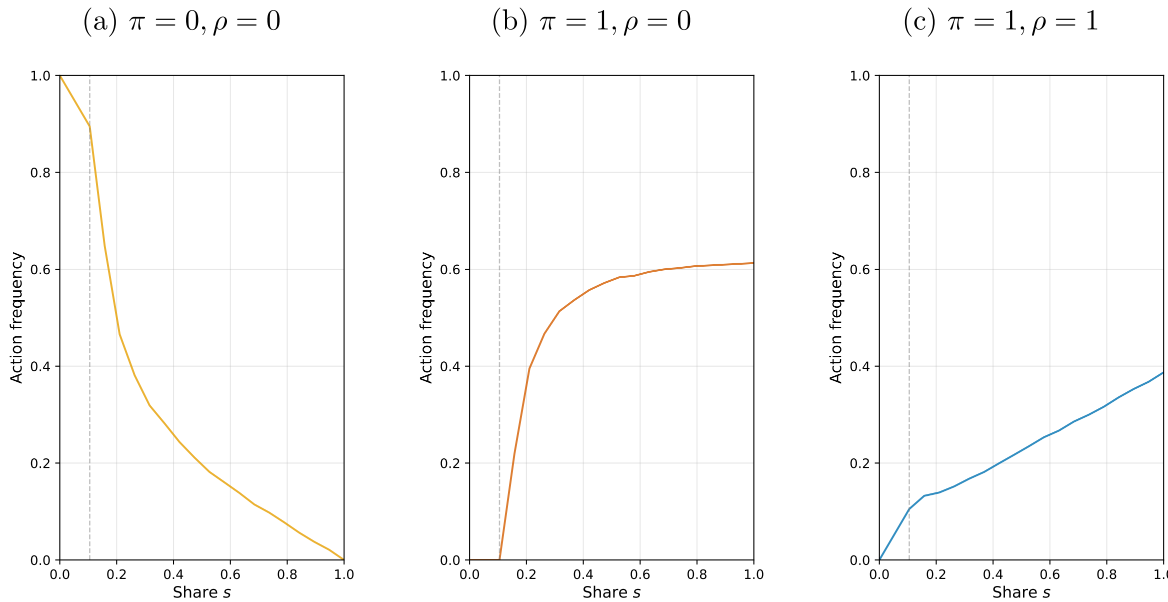
$$W = \frac{lM+\sigma}{lM+\sigma+1} s Pr(u_c^i < e(W)) + \frac{lM+\sigma}{lM+\sigma+lW} Pr(u_c^i > e(W)) \tag{8}$$

$$M = \frac{\sigma}{\sigma+lW}(1-s) Pr(u_c^i < e(W)) + \frac{lM+\sigma}{lM+\sigma+lW} Pr(u_c^i > e(W)). \tag{9}$$

The solutions to these fixed-point equations determine the issuer's steady-state revenue, which is given by $\tau l M W$. The issuer's redemption cost is

$$\text{Redemption cost} = \int \mu^i \rho^i \nu_R^i di = s\nu_R \frac{lM+\sigma}{lM+\sigma+1} Pr(u_c^i < e(W)). \tag{10}$$

Figure 3. Action frequency vs. share of agents given redemption opportunity



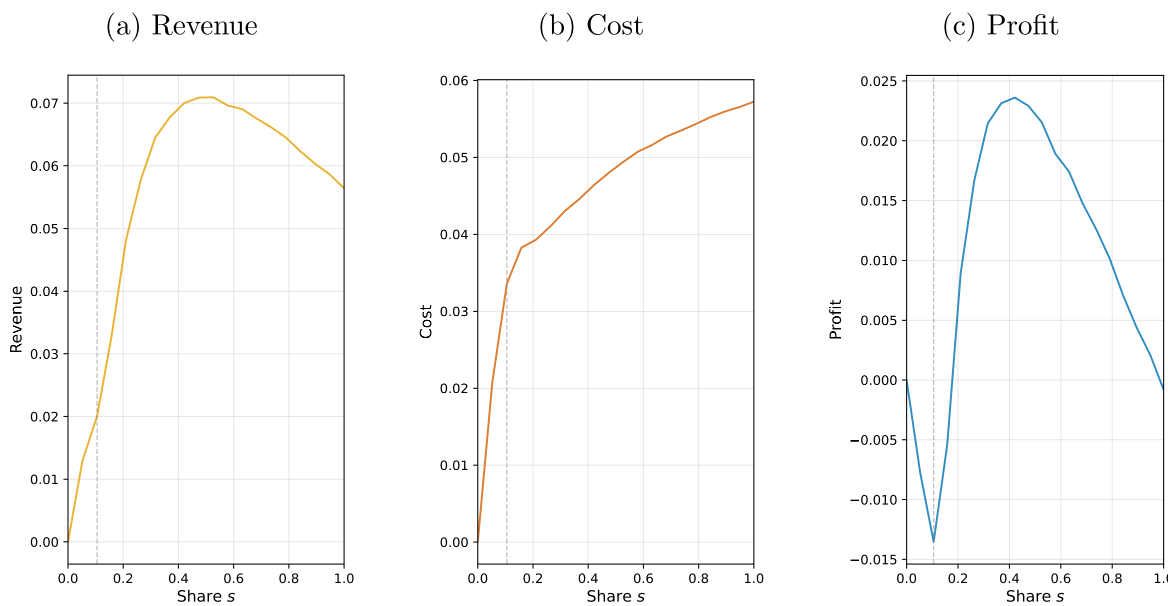
Notes. This figure shows the equilibrium action frequencies as a function of the redemption assignment share s. The dashed line indicates the cutoff s that induces positive action frequency for $\pi = 1, \rho = 0$. The action frequency of $\pi = 0, \rho = 1$ is a constant 0 and hence omitted from the figure. The parameters used in simulation are $\tau = 1$, $l = 0.5$, $\beta = 0.9$, $c = 1$, $\sigma = 0.05$, $u_C \in [0, 4]$, $\nu_R = 1.39 = \frac{c}{\beta}(1 + \beta\sigma) \times 120\%$.

Although we do not have an analytical proof of equilibrium uniqueness, our simulations using multiple initial guesses suggest that the solution is unique under plausible parameter values.

Our main finding is that issuer profits may be non-monotone in redemption share s. To see this, consider how agent action profiles change as the redemption share s increases. When $s = 0$, there is a unique non-monetary equilibrium, in which all agents choose $\pi = 0, \rho = 0$ (i.e., don't accept, don't redeem), as previously shown in Proposition 3. As the issuer increases s, agents begin to accept money for the purpose of redemption, leading them to choose $\pi = 1, \rho = 1$ (i.e., accept and redeem). As s continue to increase, the measure of agents willing to accept money may exceed a critical mass, such that the transaction value of money is sufficient to motivate agents with high u_C^i to accept money purely for transaction purposes, so some agents begin to choose $\pi = 1, \rho = 0$ (i.e., accept and don't redeem).

Figure 3 uses a numerical simulation to illustrate how the share of agents with different

Figure 4. Revenue, cost, profit vs. share of agents given redemption opportunity



Notes. This figure shows the equilibrium revenue, cost, and profit as a function of the redemption assignment share s. The dashed line indicates the cutoff s that induces positive action frequency for $\pi = 1, \rho = 0$. The parameters used in simulation are $\tau = 1$, $l = 0.5$, $\beta = 0.9$, $c = 1$, $\sigma = 0.05$, $u_C \in [0, 4]$, $\nu_R = 1.39 = \frac{c}{\beta}(1 + \beta\sigma) \times 120\%$.

action profiles varies with redemption share s. Panel (a) shows that the share of agents who neither accept nor redeem decreases as the redemption share s increases. Panel (b) shows that the share of agents who accept but don't redeem is initially zero when s is small, but starts to rapidly rise once s exceeds a threshold. The cutoff in s corresponds to the point at which the measure of accepting agents W exceeds the critical mass needed to incentivize the agent with the highest u_C^i to accept money for transaction purposes. Panel (c) shows that the share of agents who accept and redeem starts at zero and increases steadily with s.[4]

Figure 4 shows how revenue, cost, and profit vary with s. Panel (a) shows that revenue initially increases with s but eventually declines. Panel (b) shows that cost rises with s, but the marginal cost falls around the critical threshold where the frequency of $\pi = 1, \rho = 0$

[4]Figure 3 omits the action frequency of $\pi = 1, \rho = 0$ because it remains constant at 0, given that the redemption utility we calibrate is $\nu_R^i \equiv \frac{c}{\beta} + \sigma + \epsilon$.

becomes positive. Panel (c) shows that the profit-maximizing redemption share s is interior.

The intuition for Figure 4 comes directly from the action profiles. As s increases from zero, revenue-generating transactions are initially driven entirely by agents with action profiles $\pi = 1, \rho = 1$—those who accept money solely for the purpose of immediate redemption—resulting in high marginal costs for the issuer. Once s exceeds the critical threshold, the frequency of the action $\pi = 1, \rho = 0$ begins to rise, which increases marginal revenue and reduces marginal cost, pushing the issuer toward its profit-maximizing share. However, as s continues to increase, the frequency of $\pi = 1, \rho = 0$ plateaus, while the frequency of $\pi = 1, \rho = 1$ continues to rise, leading to higher costs and ultimately lower revenue and profits.

2.4 Testable Predictions

Note that optimal redemption policy is frictional only in the heterogeneous-agent model. Moreover, the heterogeneous-agent model has two empirical predictions that are not available in the homogeneous agent model:

Prediction 1. *In any monetary equilibrium, money acceptance and in-flows increases with redemption utility v_R in the cross-section.*

Prediction 2. *If there is sufficient dispersion in consumption utility u_C, then redeemability may be necessary for money circulation. In this case, there is a transition from a monetary equilibrium to a non-monetary equilibrium if redemption is halted.*

These two predictions will be tested in the remainder of the paper. Our results reveal the empirical relevance of a heterogeneous-agent model, confirming that optimal redemption may be frictional.

3 Empirical Setting: Bunz Platform

To test the predictions of our theory, we turn to unique transaction-level data from Bunz. The Bunz community was founded in 2013 and consisted primarily of young millennial adults in Toronto who arranged to trade second-hand items such as clothing, accessories, plants, and groceries through a mobile app platform. The community's founder forbade cash transactions, so the platform's roughly ten thousand daily active users, who were largely strangers meeting bilaterally in a decentralized manner, initially had to barter.[5]

In April 2018, the Bunz platform introduced a redeemable digital token, BTZ. Each user was endowed with 1000 BTZ upon digital wallet activation. Users could then send BTZ to other users and earn BTZ from the app by answering a survey, inviting friends to join the app, or posting new items. To promote the token, Bunz operated a token redemption program, which allowed users to purchase goods using BTZ at partner local stores at a fixed exchange rate of 100 BTZ to 1 Canadian dollar (CAD).[6] After accepting BTZ payments, the owners of local stores would then receive cash from Bunz HQ at the same fixed exchange rate. The platform did not buy or sell tokens apart from direct issuance to users and redemption at partner stores.

Bunz users can receive BTZ in two ways. First, users receive BTZ from the Bunz Platform by registration, completing specific tasks.[7] Second, users can sell items to other users for BTZ tokens. As for the token outflow, users can either send BTZ to other users to buy their products or redeem the BTZ tokens at merchants cooperating with the Bunz platform to get goods such as coffee, beer, daily necessities, etc. The Bunz Platform will then send these merchants CAD to buy back the BTZ that the merchants hold. Figure A1 illustrates how the token moves between users, merchants, and the Bunz platform.

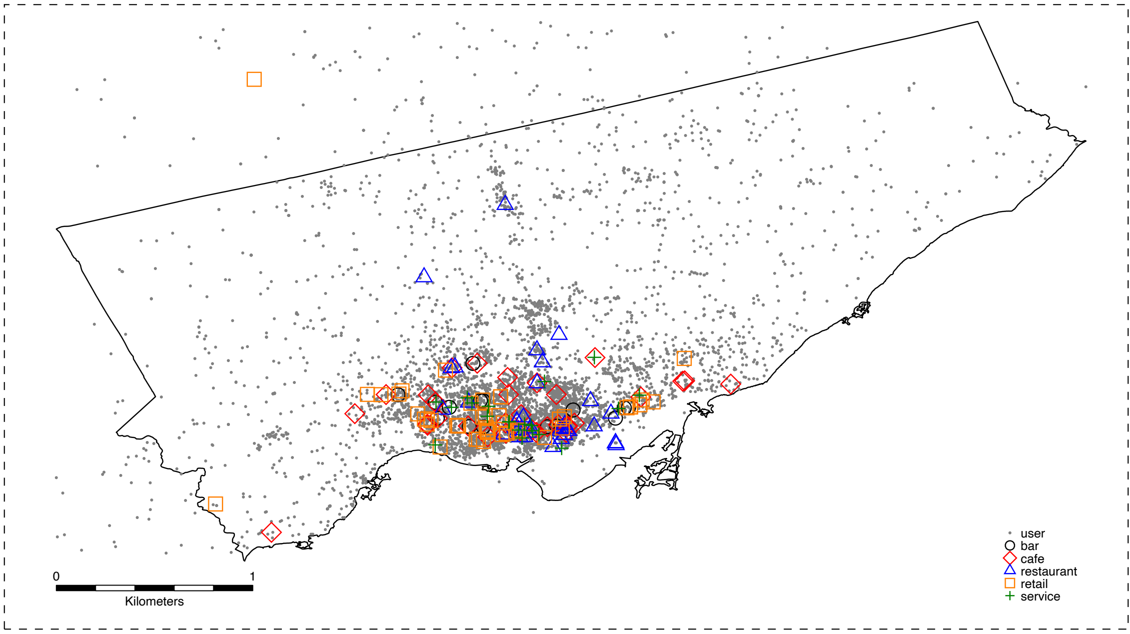
Bunz provided timestamped data for the universe of items posted, messages sent, BTZ transactions, and user ratings after transactions. A unique feature of the data provided by the Bunz platform is that user activity with and without BTZ are both observed at high frequency. The geolocation of a large subset of users is also known. For these reasons, we can

[5] The platform enforced this ban on cash by removing any items asking for cash from the mobile app. Further details are provided in Wong (2025).

[6] In 2018, the average exchange rate was 1 CAD to 0.77 USD.

[7] Bunz may offer BTZ token for watching a video or advertisement, answering questions provided by Bunz, visiting the webpage of a third party such as a Bunz sponsor, and remaining there for a specified time, or other actions or circumstances Bunz may designate from time to time. See https://bunz.com/terms

Figure 5. Map of users and redemption store locations

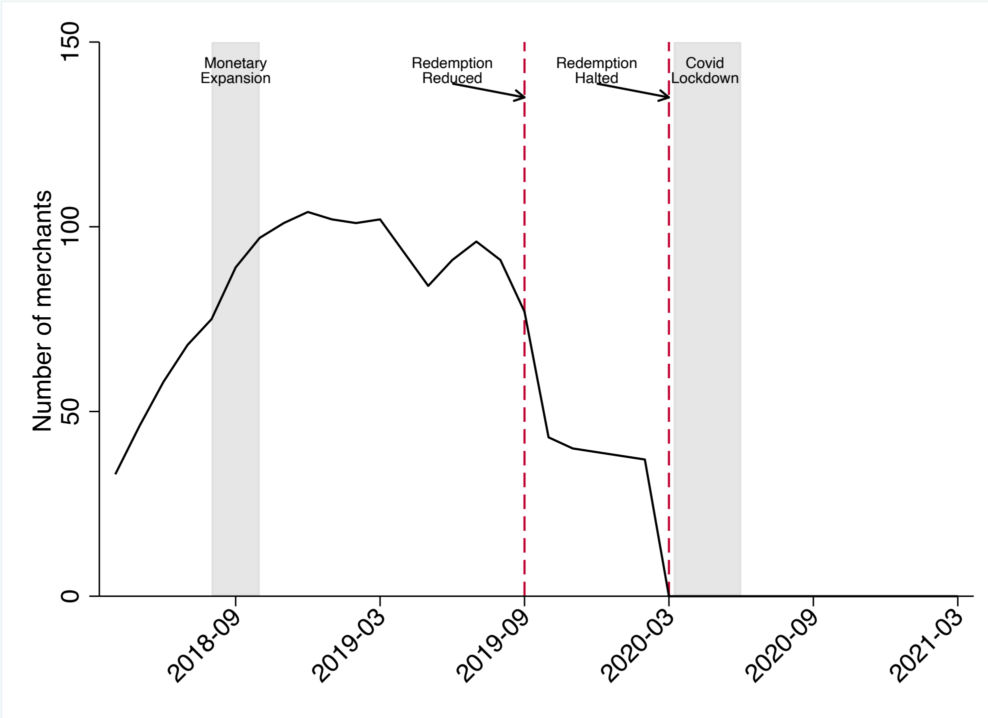


Notes: The map presents the location of the frequent users and redemption stores. Frequent users are defined as users with 20 item posts from April 2018 to August 2019. The users and redemption stores are in an area with a longitude between 79.11524° W and 79.63926° W and a latitude between 43.58100° N and 43.85546° N. This area includes Toronto and parts of its neighborhood.

study how the adoption of digital money depends on a given user's proximity to redemption opportunities.

Figure 5 shows the location of the merchants and active users located in Toronto. As shown in the gray dots on the map, most active users live in the city center of Toronto. Other users live sporadically in Toronto. As for the merchants, in total, 216 merchants at some point accepted BTZ as the payment method, and 155 of the merchants were located in Toronto. These merchants included 50 retail shops, 34 restaurants, 33 cafes, 20 service merchants, 15 bars, 2 beauty merchants, and 1 gallery in Toronto. Most of the merchants in Toronto also locate in the city center of Toronto. Generally, users located in the city center

Figure 6. Total number of merchants over time



Notes: Figure plots the number of active merchants that accept BTZ payments over time. Merchants are defined as active at the month of opening. If merchants no longer have redemption transactions after a specific month, these merchants will be excluded from active merchants.

have higher redemption network exposure than user located in other areas.[8] Section 4 studies the cross-sectional relationship between token use and redemption convenience during the period when the BTZ redemption program was in operation.

Figure 6 shows the number of active merchants over time. We define merchants as active when they start to accept BTZ payments. Merchants do not accept BTZ redemption after a specific month. In that case excluded after that month. From April 2018 to December 2018, the number of active merchants increased continuously. Bunz also expanded the monetary supply from August 2018 to October 2018, after which the introduction of merchants stabilized. On September 10, 2019, Bunz halted on redemption at retail and service-providing

[8]Between September and November 2018, Bunz dramatically increased the supply of BTZ through helicopter drops to users in an attempt to drive user traffic. As documented by Wong (2025), the monetary expansion caused large and persistent increases in transaction volume and items posted on the platform among existing users, but did not detectably alter token acceptance patterns.

stores without giving any prior notice, causing some users to stop accepting BTZ and rush to the remaining merchants to redeem their BTZ. On February 26, 2020, Bunz completely halted the Shop Local program but called it a temporary pause.

In prior work, Wong (2025) showed that the BTZ price of posted items remained highly stable throughout the observable period. The lack of price adjustment likely reflects the difficulty of coordinating prices without a centralized currency exchange.

4 Effects of Redemption Convenience on Token Usage

In this section, we estimate the effects of proximity to redemption opportunities—as measured by the number of nearby redemption merchants—on user token acceptance, flows, and holdings. The estimates provide an empirical test of Prediction 1, according to which token acceptance and inflows increase with redemption utility ν_R^i.

4.1 Methodology

To measure user-level exposure to redemption opportunities, we leverage the fact that a large number of users provide their geolocation to the platform, so their physical distance to redemption merchants can be calculated. We focus on the period between April 2018 and August 2019, when the redemption program was at its full extent. We focus on frequent users, defined as those who posted 20 or more items during this period, and exclude users who posted more than 70 percent of their items in a single month. Since geolocation is not available for all users, we focus on users for whom an exact geolocation within Toronto is observed.[9] This leaves 7,162 users. This sample accounts for 53 percent of token redemption, 60 percent of ratings, 47 percent of token inflows, and 57 percent of token outflows (see Appendix Tables B1 and B2).

We define user-level *redemption exposure* as the average number of redemption merchants within 1 km of users from April 2018 to September 2019. This variable captures the number

[9] 32.94 percent of users provide only their city of residence, rather than a specific geolocation within the city.

of redemption stores that the users easily access on foot. We then measure how redemption exposure affects user behavior using the following regression specification:

$$y_i = \beta \times Exposure_i + \gamma X_i + \epsilon_i, \tag{11}$$

where y_i represents outcomes including token redemption, acceptance, flows, and holdings of user i. β is the estimated relationship between the number of merchants within 1 km of users and users' behavior related to tokens. X_i is the demographic characteristics, activeness, and the distance to the city center of users. The demographic data includes the age, income, and education level.[10] The measurements of activeness include the number of item posts and the number of completed trades — measured by the number of ratings sent to other users[11]. The main threat to causal identification is the fact that users closer to redemption stores may be selected. Since the estimates are highly similar even when additional controls are added, it is likely that the estimates partly capture a causal effect.

4.2 Results

The estimates reveal that token acceptance, inflows from peers, and redemption strongly increases with proximity to redemption opportunities. Meanwhile, token outflows to peers, issuance, and holdings had weak relationships with redemption exposure. In other words, tokens on average flowed from users who were farther away from redemption opportunities towards those who were close. This finding is consistent with the heterogeneous-agent model, wherein acceptance does not purely depend on strategic complementarities between agents, but also on proximity to redemption opportunities.

Table 1. Effect of redemption exposure on token acceptance

	Dependent variable: Token acceptance				
	(1)	(2)	(3)	(4)	(5)
# Nearby redemption merchant	0.003*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003** (0.001)
Demographic controls		X			X
User activeness controls			X		X
Distance to city center				X	X
# Obs	7,162	2,204	7,162	7,162	2,204

Notes: Table shows the effect of redemption exposure on token acceptance. The nearby redemption merchant is defined as the number of merchants within 1 km of users. The baseline mean is the average token acceptance of users with zero redemption exposure. The analysis period is from April 2018 to August 2019. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Redemption exposure strongly increased token acceptance.

Table 1 reports the main result of this section—namely, that redemption exposure increased token acceptance. We measure token acceptance as the proportion of items a user lists with a BTZ-denominated price, which signals the user's willingness to transact in tokens. Column (1) indicates that having one additional merchant within a 1-kilometer radius is associated with a statistically significant 0.3 percentage-point increase in token acceptance. Columns (2) through (5) show that this positive relationship is robust to additional control variables.

Redemption exposure strongly increased token inflows, but not outflows.

Panel A of Table 2 reports the effects of redemption exposure on token inflows (i.e., the number of tokens received by the user from other users). Consistent with increased acceptance, Column (1) shows that an additional nearby merchant is associated with a statistically significant 2.6 percent increase in token inflows. The economic magnitude and statistical significance of this effect is similar across Columns (2)-(5), as control variables are

[10] As the demographic data is the survey data of Bunz, we only have 2,204 users who have completed these surveys.

[11] Upon completion of a transaction, both parties may rate each other. If neither party submits a rating, the system will automatically assign a default rating.

Table 2. Effect of redemption exposure on token inflows and outflows

	Panel A: Asinh token inflow				
	(1)	(2)	(3)	(4)	(5)
# Nearby redemption merchant	0.026*** (0.005)	0.030*** (0.008)	0.023*** (0.003)	0.026*** (0.006)	0.039*** (0.007)
	Panel B: Asinh token outflow				
# Nearby redemption merchant	0.002 (0.004)	-0.007 (0.008)	-0.002 (0.003)	0.003 (0.006)	0.011* (0.006)
Demographic controls		X			X
User activeness controls			X		X
Distance to city center				X	X
# Obs	7,162	2,204	7,162	7,162	2,204

Notes: Table shows the effect of redemption exposure on asinh ($asinh(x) = ln(x + \sqrt{x^2 + 1})$) amount of token inflow and outflow. The nearby redemption merchant is defined as the number of merchants within 1 km of users. The baseline mean is the average token inflows and outflows of users with zero redemption exposure. The analysis period is from April 2018 to August 2019. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

added. Appendix Table B3 reports the effects of redemption exposure on extensive margin measures of token inflow, revealing that users with higher redemption exposure have a greater number of inflow transactions and are more likely to have at least one inflow transaction.

Table 2 Panel B reports the effects of redemption exposure on token outflows (i.e., the number of tokens sent by the user to other users). Column (1) shows that an additional merchant within 1 km is associated with a statistically insignificant 0.2 percent reduction in token outflows. Columns (2) - (4) shows that the estimated effect remains stable when controlling for user demographics, activity levels, and distance to city center. Column (5) reveals a marginally significant positive effect after adding all controls. Appendix Table B4 reports the effects of redemption exposure on extensive margin measures of token outflows, showing similarly limited differences in either the frequency or likelihood of token outflows across users with varying merchant exposure.

Table 3. Effect of redemption exposure on token redemption and issuance

	Panel A: Asinh token redeemed				
	(1)	(2)	(3)	(4)	(5)
# Nearby redemption merchant	0.029*** (0.003)	0.044*** (0.007)	0.029*** (0.003)	0.023*** (0.004)	0.031*** (0.008)
	Panel B: Asinh token issuance				
# Nearby redemption merchant	0.004 (0.004)	-0.004 (0.004)	0.002 (0.003)	0.015*** (0.005)	0.007* (0.004)
User demographic controls		X			X
User activeness controls			X		X
Distance to city center				X	X
# Obs	7,162	2,204	7,162	7,162	2,204

Notes: Table shows the effect of redemption exposure on asinh amount of token redeemed and issuance. The nearby redemption merchant is defined as the number of merchants within 1 km of users. The baseline mean is the average token redemption and issuance of users with zero redemption exposure. The analysis period is from April 2018 to August 2019. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Redemption exposure strongly increases token redemption, but not issuance.

Panel A of Table 3 reports the effects of redemption exposure on actual redemption volume (i.e., the number of tokens accepted by the platform from the user). Column (1) shows that an additional merchant within 1 km is associated with a statistically significant 6.9 percent increase in tokens redeemed. Columns (2) - (5) shows that this positive association is robust to additional controls. Appendix Table B5 reports the effects of redemption exposure on extensive margin measures of redemption, showing that redemption exposure increases both the number of redemption transactions and the probability of redeeming tokens.

Panel B of Table 3 reports the effect of redemption exposure on token issued by the Bunz platform to the user (i.e. the number of token transferred from Bunz to users in response to user actions such as filling out surveys on the app).[12] Column (1) shows an economically small and statistically insignificant effect (0.4 percent increase) of additional merchants on tokens issued. Columns (2) and (3) show that this null result persists when controlling for

[12]Bunz distributes tokens for various user actions, including watching videos or advertisements, completing surveys, visiting sponsor webpages, or other designated activities. See https://bunz.com/terms for details.

Table 4. Effect of redemption exposure on token holdings

	Dependent variable: Asinh token holding				
	(1)	(2)	(3)	(4)	(5)
# Nearby redemption merchant	0.003 (0.004)	0.004 (0.005)	0.001 (0.004)	0.014** (0.006)	0.017*** (0.006)
Demographic controls		X			X
User activeness controls			X		X
Distance to city center				X	X
# Obs	7,162	2,204	7,162	7,162	2,204

Notes: Table shows the effect of redemption exposure on asinh amount of token holdings. The nearby redemption merchant is defined as the number of merchants within 1 km of users. The baseline mean is the average token holdings of users with zero redemption exposure. The analysis period is from April 2018 to August 2019. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

demographics and user activity. However, Columns (4) and (5) account for distance to city center, reveal statistically significant effects of 1.5 percent and 0.7 percent, respectively, which remain substantially smaller than the effects of redemption exposure on token redeemed. Appendix Table B6 reports the effects of redemption exposure on extensive margin measures of token issuance, showing similarly limited differences in either the frequency or likelihood of token issuance across users with varying merchant exposure.

Redemption exposure not strongly correlated with token holdings.

Table 4 reports the effects of redemption exposure on user token holdings. Column (1) shows that an additional merchant within a 1 km radius of users corresponds to a statistically insignificant 0.3 percent increase in token holdings. Columns (2) and (3) further confirm the lack of significance after controlling for users' demographic characteristics and activeness, respectively. However, Columns (4) and (5) reveal a statistically significant positive relationship: an additional merchant is associated with a 1.4 percent and 1.7 percent increase in token holdings after controlling for distance to the city center.

Robustness.

Additional checks confirm that the estimates are not specific to early users, attributable to differences in user activity profiles, or specific to the chosen redemption exposure measure. Appendix Table B7 re-estimates the effects of redemption exposure using a restricted sample of users who posted at least 20 items prior to token introduction, showing that the results are qualitatively unchanged. Appendix Table B8 estimates Equation (11) with the number of item posts and completed trades as the outcome variables, showing that the number of item posts and completed trades are not correlated with redemption exposure even after controlling for demographic characteristics and distance to city center. Appendix Table B9 estimates Equation (11) using alternative measures for redemption exposure, showing that our main findings regarding token activities highly similar.

5 The Heterogeneous Effects of Redemption Halt

In this section, we estimate the effect of the unanticipated halt in redemption on user-level outcomes using an interrupted time-series design. The novelty here is to examine whether the effects were different for users who were once closer to redemption opportunities than for those who were farther. The estimates provide an empirical test of Prediction 2, according to which redeemability is necessary for money circulation in the presence of sufficient dispersion in the utility for transacted goods across agents.

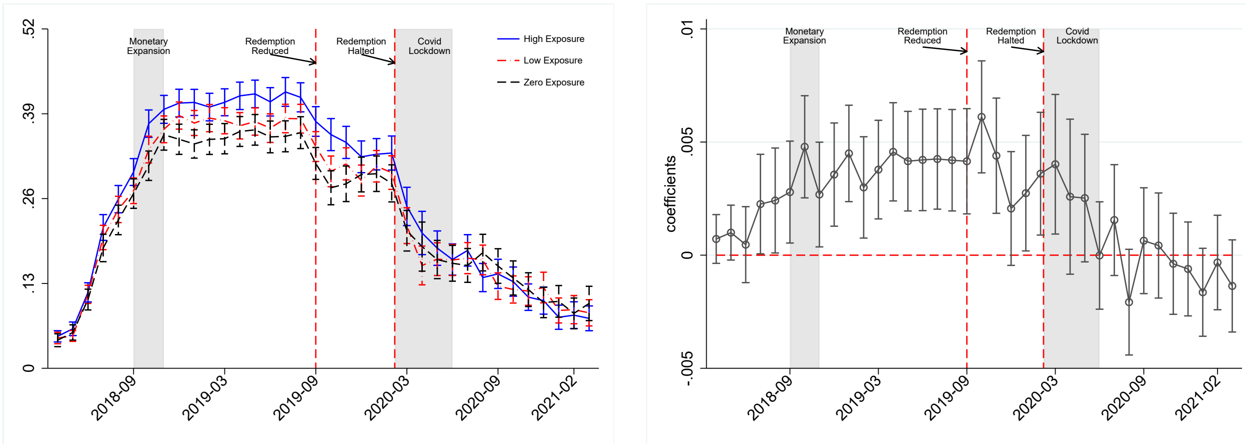
5.1 Methodology

To visualize the effect of redemption halt, we first plot the trend of the token acceptance and flows of frequent users with high, low, and zero initial redemption exposure, as measured by average number of nearby merchants from April 2018 to March 2021. Users with zero initial redemption exposure are those without merchants within 1 km. Users with high (low) initial redemption exposure are those with above (below) median average merchants within 1 km, excluding those with zero redemption exposure. Appendix Figure C1 plots

Figure 7. Token acceptance over time, by redemption exposure

Panel A: Mean acceptance by exposure

Panel B: Partial correlation over time



Notes: The figure shows the average token acceptance by exposure and regression coefficients β_t, with the 95 percent confidence intervals, estimated by Equation (12) over time.

the distribution of redemption exposure, showing that the majority of users do not have any redemption stores within 1km, but the extent of redemption exposure is quite widely dispersed otherwise.

To quantify how the correlation between initial redemption exposure and token activities changed over time, we estimate the following cross-sectional regression equation for each month t:

$$y_{it} = \beta_t \times Exposure_i + \epsilon_{it}, \tag{12}$$

where y_{it} represents outcomes of user i in month t, including token redemption, acceptance, flows, and holdings. β_t are the estimated effects of redemption exposure on the token use behavior. In the Appendix, we supplement with difference-in-difference estimates of the effects of redemption halt interacted with initial redemption exposure, estimated on the same user sample, but with data starting only six months before the redemption halt.

5.2 Results

We find that the halt in redemption caused token use to decline throughout the platform. The decline was much larger than the initial cross-sectional difference in token acceptance and flows due to differences in redemption convenience. This finding suggests that the halt triggered a transition from a monetary equilibrium to a non-monetary one, as predicted in the heterogeneous-agent model.

Redemption halt reduced token acceptance, eliminating initial differences.

Figure 7 displays the main result of this section—namely, that token acceptance dramatically fell following redemption halt, eliminating initial differences. Panel A shows that the end of redemption caused token acceptance—as measured by the share of item posts with a BTZ price—to immediately decline from roughly 30 p.p to roughly 23 p.p.. It also shows that the initial difference among users in different groups disappeared after the redemption halt. Panel B confirms that an additional nearby merchant was initially associated with a statistically significant increase in token acceptance in February 2020, but this relationship became statistically insignificant after March 2021 when redemption haltd. Appendix Table C1 reports difference-in-difference estimates, with Column (1) showing that that redemption halt had an negative impact on token acceptance and eliminated reduced differences.

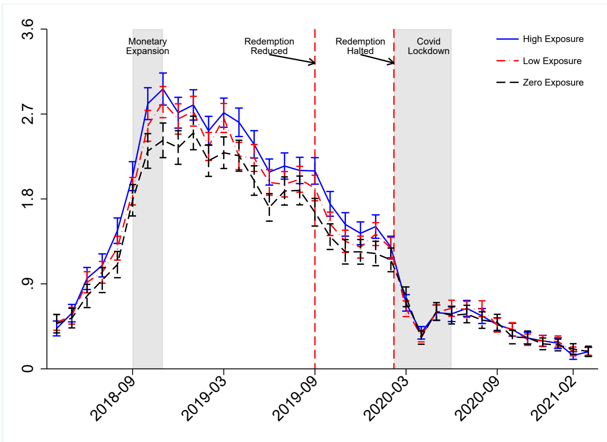
Redemption halt also reduced token flows, eliminating initial differences.

Redemption halt not only reduced acceptance, but also affected token flows in the Bunz economy. Panel A1 of Figure 8 shows that token inflow drops by more than 50 percent following the redemption halt. The previously observed difference among the three exposure groups approximately narrows to zero. Panel A2 shows the partial correlation between redemption exposure and token inflow over time, revealing a statistically significant correlation prior to the redemption, and statistical insignificance immediately thereafter. Appendix Table C1 Column (2) shows the same finding using a difference-in-difference specification. Appendix Table C2 reports similar results a difference-in-difference specification using extensive margin

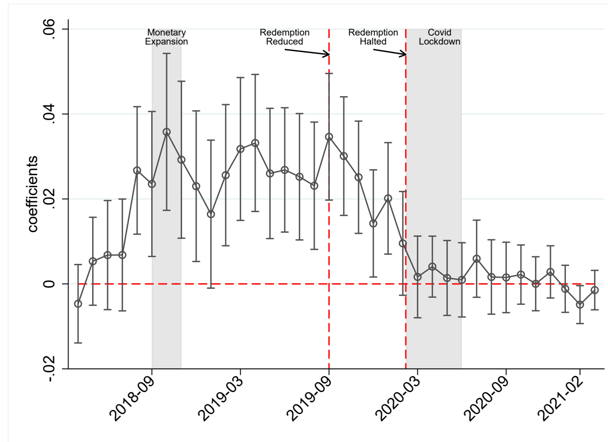
Figure 8. Token inflows and outflows over time, mean and regression coefficients

Panel A: Token inflow

Panel A1: Mean inflow by exposure

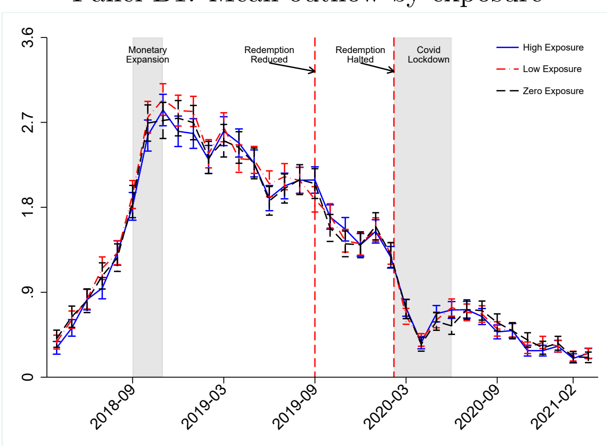


Panel A2: Partial correlation over time

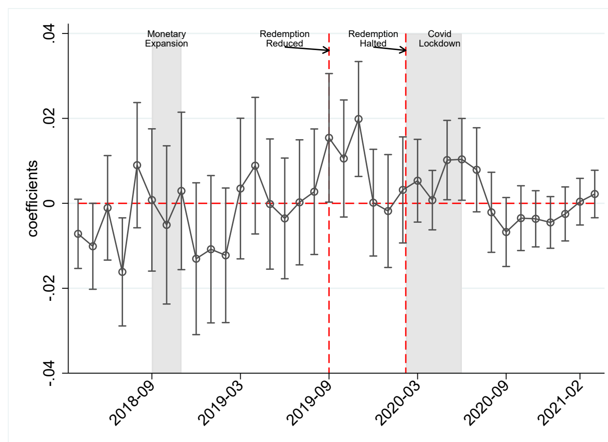


Panel B: Token outflow

Panel B1: Mean outflow by exposure



Panel B2: Partial correlation over time



Notes: The figure shows the average asinh amount of token inflows and outflows by exposure and regression coefficients β_t, with the 95 percent confidence intervals, estimated by Equation (12) over time.

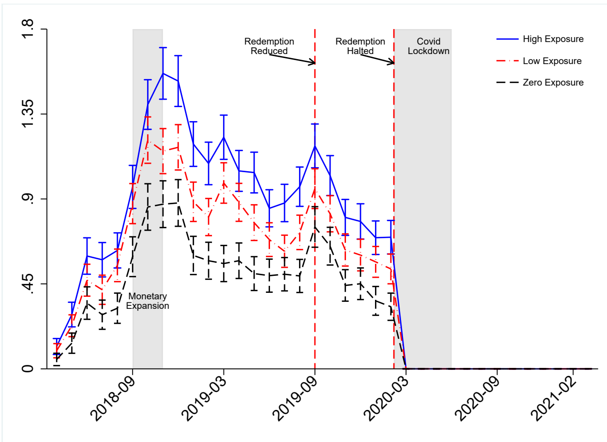
measures of token inflow.

Panel B1 of Figure 8 shows a very large reduction in token outflows (i.e. the amount of tokens sent to other users) after redemption halts, between February 2021 and March 2021. Panel B2 shows that token outflow does not vary with redemption exposure in almost all months, both before and after redemption halt. Appendix Table C1 Column (4) shows that similar results are found using a difference-in-difference estimations. Appendix Table C3

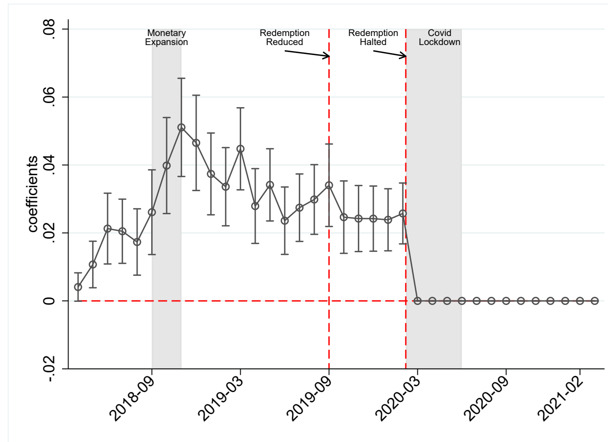
Figure 9. Token redemption and issuance over time, mean and regression coefficients

Panel A: Token redemption

Panel A1: Mean redemption by exposure

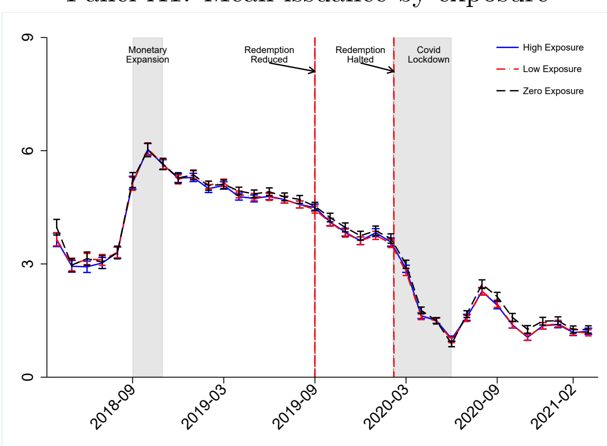


Panel A2: Partial correlation over time

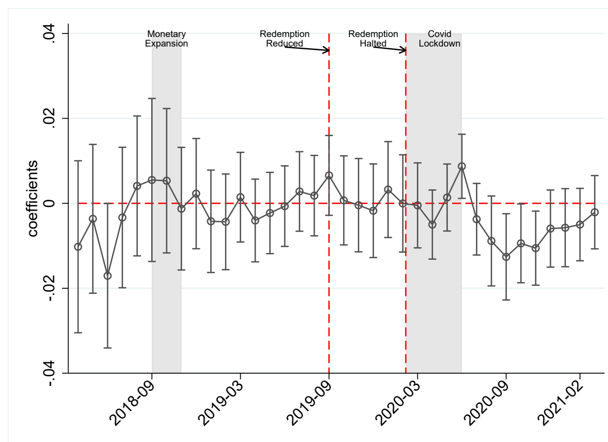


Panel B: Token issuance

Panel A1: Mean issuance by exposure



Panel A2: Partial correlation over time



Notes: The figure shows the average asinh amount of token redeemed and issued by exposure and regression coefficients β_t, with the 95 percent confidence intervals, estimated by Equation (12) over time.

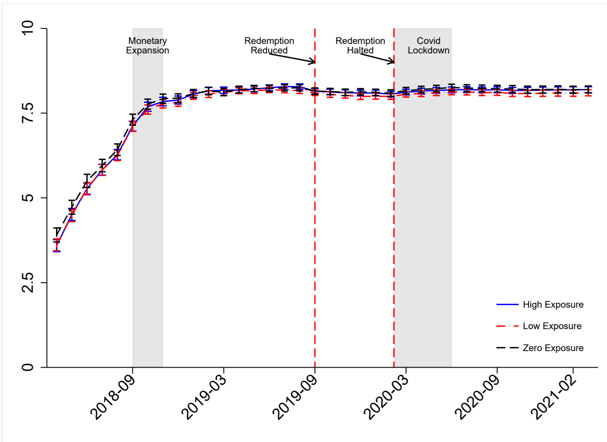
shows similar results for extensive margin measures of token outflows.

Token redemption and issuance both fell.

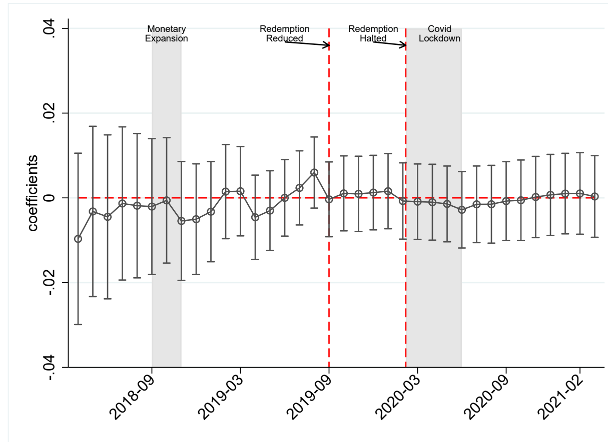
Panel A1 of Figure 9 shows that users with greater exposure on average redeem substantially more tokens before the redemption halt. Moreover, token redemption plummeted to zero in all groups immediately following the redemption halt. Panel A2 reports the partial correlation between initial redemption exposure and token redemption, showing users with

Figure 10. Token holdings over time, mean and regression coefficients

Panel A: Mean holdings by exposure



Panel B: Partial correlation over time



Notes: The figure shows the average asinh token holdings by exposure and regression coefficients β_t, with the 95 percent confidence intervals, estimated by Equation (12) over time.

greater redemption exposure had statistically significantly higher token redemption prior to February 2020, but not thereafter.

Panel B1 of Figure 9 shows that token issuance more than halved following the redemption halt. Panel B2 reports the partial correlation between initial redemption exposure and token issuance, indicating that users with greater redemption exposure did not have higher token issuance throughout. Appendix Table C1 Column (3) confirms this result using difference-in-differences estimates. Appendix Table C4 show similar results for extensive margin measures of token issuance.

Token holdings were unchanged.

Panel A of Figure 10 shows that user token holdings experienced minimal immediate change following the redemption halt. Panel B shows that redemption exposure had negligible effects on token accumulation, with estimated coefficients ranging from -0.009 to 0.005 across different user groups. This pattern of limited differential effects is statistically confirmed in Column (5) of Appendix Table C1.

Robustness.

The results are highly similar when estimated on a restricted sample of long-lasting users and are not explained by changes in user activeness, measured by the number of item posts and the number of completed trades. Appendix Table C5 estimates the effects of redemption halt, using a restricted sample of users who posted at least 20 items prior to token introduction, showing that the results are qualitatively unchanged. Appendix Figure C2 documents the effects of redemption halt on user activeness, showing a significant decline in new item posts following the redemption halt, but with no discernible differences across exposure groups, thereby ruling out the possibility that users closer to redemption opportunities became differentially less active after redemption halt.

6 Conclusion

Redemption is central to the successful circulation of many currencies and payment tools. However, rigorous economic analysis of the impact of currency redemption policy has been rare, partly because of the lack of appropriate data. This paper leverages both cross-sectional and time-series variation in redemption convenience from the Bunz setting to estimate the impacts of redemption policy. Our key finding is that redemption promises serve as more than an implicit backing for the value of a currency; they affect the cross-sectional distribution of money acceptance as well as money and good flows. We find that redemption convenience increases users' desire to accept a new currency, leading token to flows on average towards those closer to redemption opportunities. We also find that the removal of redeemability triggered a collapse in token acceptance everywhere, providing clear evidence of strategic complementarity in token acceptance.

We interpret these results through the lens of a search-theoretic model with endogenous redemption choices. We show that a credible promise of redemption can coordinate agents on a unique monetary equilibrium at *zero steady-state cost*, even as it introduces the possibility of a run equilibrium. We also show in a heterogeneous-agent model with partial acceptability—which better explains the evidence—that optimal redemption policy involves some degree of redemption frictions. These findings can help inform the design and roll-out of new digital currencies. Since prior studies have largely focused on optimal adoption subsidies and issuance policies, a better understanding of optimal currency redemption policy helps to maximize efficiency and mitigate systemic risks.

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A Proofs

Proof of Proposition 1. The proof strategy follows the framework of Kiyotaki and Wright (1993). To fully solve for equilibrium, we rearrange the Bellman equations and write them in terms of steady state values.

$$V_1 = \max_{\rho} B + \beta V_0 + u_R + (1-\rho)\left(l\Pi(1-\mu_1)u_C - u_R + \beta(1 - l\Pi(1-\mu_1))(V_1 - V_0)\right) \quad (13)$$

$$V_0 = \max_{\pi} B + \beta V_0 + \pi l M \left(\beta(V_1 - V_0) - c\right) \quad (14)$$

Let $\Delta = V_1 - V_0$. Since the objective functions are linear in ρ, π, from an individual agent's perspective, $\rho = 0$ is optimal iff $\Delta > \frac{u_R - l\Pi(1-\mu_1)u_C}{\beta(1-l\Pi(1-\mu_1))}$, note here that $\mu_1 = M$; $\pi = 1$ is optimal iff $\Delta > \frac{c}{\beta}$. Combining the Bellman equations result in

$$\Delta = \frac{\rho u_R + (1-\rho)(l\Pi(1-\mu_1)u_C) + \pi l M c}{1 - (1-\rho)\beta(1 - l\Pi(1-\mu_1)) + \pi l M \beta}. \quad (15)$$

Let us first consider the "monetary equilibrium" where $\pi = 1, \rho = 0$. In this equilibrium, $\Delta = \frac{l(1-\mu_1)u_C + lMc}{1-\beta(1-l(1-\mu_1)) + lM\beta}$. Optimality of $\pi = 1, \rho = 0$ requires that $\Delta > \frac{u_R - l(1-\mu_1)u_C}{\beta(1-l(1-\mu_1))}$ and $\Delta > \frac{c}{\beta}$. These conditions are satisfied if and only if $u_C > \underline{u}$ and $u_R < u_m$, where $\underline{u} = \frac{1}{l(1-\mu_1)}\left(\frac{c(1-\beta+\beta l)}{\beta} - lMc\right)$ and $u_m = Au_C + B$ with $A = \frac{l(1+lMc)(1-\mu_1)}{1-\beta+\beta l-\beta l\mu_1+lMc}$, $B = \frac{lMc\beta(1-l(1-\mu_1))}{1-\beta+\beta l-\beta l\mu_1+lMc}$.

Next we consider the "non-monetary equilibrium" where $\pi = 0, \rho = 0$. In this equilibrium, $\Delta = 0$, and optimality of $\pi = 0, \rho = 0$ requires $\frac{c}{\beta} > \Delta > \frac{u_R}{\beta}$. These conditions are satisfied if and only if $c > 0 > u_R$.

Finally we consider the "currency run equilibrium" $\rho = 1, M = 0$. In this case, $\Delta = u_R$. In order to guarantee individual optimality of $\rho = 1$, the condition $\Delta < \frac{u_R - l\Pi(1-\mu_1)u_C}{\beta(1-l\Pi(1-\mu_1))}$ where $\mu_1 = 0$ must hold. Given that the steady state $M = 0$, the individual action of π is undetermined. Additionally assume that agents' belief of others' probability of accepting money is given by $\Pi = \tilde{\pi} \in (0,1]$. Then, the optimality condition of $\rho = 1$ can be rewritten as $u_R > u_r$ where $u_r = \frac{l\tilde{\pi}u_C}{1-\beta(1-l\tilde{\pi})}$.

Finally, it only remains to observe that when $\tilde{\pi} = 0$, we have $u_r(0) = 0$, and when $\tilde{\pi} = 1$, we have $u_r(1) = \frac{lu_C}{1-\beta(1-l)}$. Note that in this case, we have $u_r(1) > u_m$. To see this, note that the $u_r(1)$ is linear in u_C with a slope of $\frac{l}{1-\beta(1-l)} > A$. In this case, there exists $\underline{u}$ such that when $u_C > \underline{u}$, we have $u_r(1) > u_m$.

Proof of Lemma 1. To be fully transparent with assumptions embedded in the transition dynamics, we let agents' individual expectations satisfy $E[V^i_{k,t+1}] = V^i_{k,t}$ for $k \in \{0,1\}, i \in \mathcal{I}$. In equilibrium, this assumption doesn't impose any additional restrictions. The economy initializes with individual and aggregate states $\{\mu^i_1\}_i, W_1, M_1$. At the beginning of period t, agents observe the strategy profiles in period $t-1$, which is equivalent to observing $\{\mu^i_t\}_i, M_t, W_t$. More concretely, the dynamic path is iterated forward as the following. Initializes with $\{\mu^i_1\}_i, W_1, M_1$. Agents best respond and generates $\{\pi^i_1\}_i, \{\rho^i_1\}_i$. Individual and aggregate states are updated overnight and results in $\{\mu^i_2\}_i, W_2, M_2$. Agents best respond and generates $\{\pi^i_2\}_i, \{\rho^i_2\}_i$. So on so forth.

Based on the Bellman equations, first order conditions of π_t^i, ρ_t^i are given by

$$FOC_{\pi_t^i} = lM_t \left(\beta(V_{1,t}^i - V_{0,t}^i) - c\right)$$

$$FOC_{\rho_t^i} = \nu_R^i - lW_t u_C^i - \beta(1 - lW_t)(V_{1,t}^i - V_{0,t}^i)$$

Optimal decisions are corner solutions in $\{0, 1\}$ depending on the sign of the first order condition. We specify the following tie-breaking rules. If $FOC_{\pi_t^i} = 0$, then the optimal $\pi_t^i = 1$. If $FOC_{\rho_t^i} = 0$, then the optimal $\rho_t^i = 0$.

Hence we can characterize the optimal decision rule as the following. Let

$$\Delta_t^i = V_{1,t}^i - V_{0,t}^i = \frac{\rho_t^i \nu_R^i + (1 - \rho_t^i) lW_t u_C^i + \pi_t^i lM_t c}{1 - \beta(1 - \rho_t^i)(1 - lW_t) + \beta\pi_t^i lM_t + \beta\sigma} \tag{16}$$

and $\pi_t^i = 1$ iff $\Delta_t^i \geq \frac{c}{\beta}$, $\rho_t^i = 1$ iff $\Delta_t^i < \frac{\nu_R^i - lW_t u_C^i}{\beta(1 - lW_t)}$. The parametric ranges for the four possible pairs of optimal solutions are given by the following.

Equilibrium	Δ_t^i	Conditions	Simplified
$\pi_t^i = 0, \rho_t^i = 0$	$\Delta_t^i = \frac{lW_t u_C}{1-\beta(1-lW_t)+\beta\sigma}$	$\frac{\nu_R^i - lW_t u_C}{\beta(1 - lW_t)} \leq \frac{lW_t u_C}{1 - \beta(1 - lW_t) + \beta\sigma}$ (17) $\frac{lW_t u_C}{1 - \beta(1 - lW_t) + \beta\sigma} < \frac{c}{\beta}$ (18)	$\frac{\nu_R^i}{1 + \sigma\beta} \leq \boxed{u}$ (19) $\boxed{u} < \frac{c}{\beta}$ (20)
$\pi_t^i = 1, \rho_t^i = 0$	$\Delta_t^i = \frac{lW_t u_C + lM_t c}{1-\beta(1-lW_t)+\beta lM_t+\beta\sigma}$	$\frac{\nu_R^i - lW_t u_C}{\beta(1 - lW_t)} \leq \frac{lW_t u_C + lM_t c}{1 - \beta(1 - lW_t) + \beta lM_t + \beta\sigma}$ (21) $\frac{c}{\beta} \leq \frac{lW_t u_C + lM_t c}{1 - \beta(1 - lW_t) + \beta lM_t + \beta\sigma}$ (22)	$\nu_R^i \leq \textcircled{u}$ (23) $\frac{c}{\beta} \leq \boxed{u}$ (24)
$\pi_t^i = 0, \rho_t^i = 1$	$\Delta_t^i = \frac{\nu_R^i}{1+\beta\sigma}$	$\frac{\nu_R^i}{1 + \beta\sigma} < \frac{\nu_R^i - lW_t u_C}{\beta(1 - lW_t)}$ (25) $\frac{\nu_R^i}{1 + \beta\sigma} < \frac{c}{\beta}$ (26)	$\boxed{u} < \frac{\nu_R^i}{1 + \beta\sigma}$ (27) $\frac{\nu_R^i}{1 + \beta\sigma} < \frac{c}{\beta}$ (28)
$\pi_t^i = 1, \rho_t^i = 1$	$\Delta_t^i = \frac{\nu_R^i + lM_t c}{1+\beta lM_t+\beta\sigma}$	$\frac{\nu_R^i + lM_t c}{1 + \beta lM_t + \beta\sigma} < \frac{\nu_R^i - lW_t u_C}{\beta(1 - lW_t)}$ (29) $\frac{c}{\beta} \leq \frac{\nu_R^i + lM_t c}{1 + \beta lM_t + \beta\sigma}$ (30)	$\textcircled{u} < \nu_R^i$ (31) $\frac{c}{\beta} \leq \frac{\nu_R^i}{1 + \beta\sigma}$ (32)

Table 1. Characterization of Individually Optimal Solutions [updated]

Our goal is to fully characterize the optimal solution π_t^i, ρ_t^i as a function of ν_R^i, u_C^i. The above table might be a lot to take in. We proceed with the following key observations.

Observation 1. Given W_t, M_t and parameters β, l, c, Equations (R1.2) and Equations (R2.2) are mutually exclusive. To simplify notation, let us denote $\boxed{u} = \frac{lW_t u_C}{1-\beta(1-lW_t)+\beta\sigma}$.

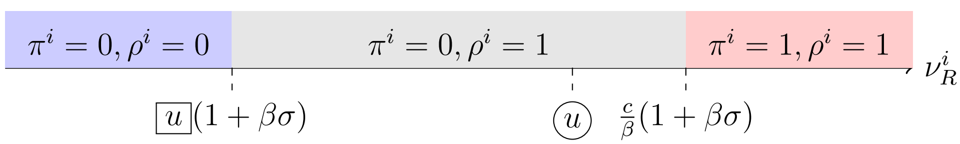
Then, Equation (R1.2), row 1 second equation, is equivalent to $\boxed{u} < \frac{c}{\beta}$ and Equation (R2.2) is equivalent to $\frac{c}{\beta} \leq \boxed{u}$. The intuition is straight forward: If the agent is not redeeming, then the decision to accept solely depends on consumption utility u_C. If consumption utility is high, we have (R2.2) and $\pi = 1$, otherwise we have (R1.2) and $\pi = 0$. These two cases are mutually exclusive. We will separately discuss the two cases.

Observation 2. Equation (2.1) is equivalent to $\nu_R^i \leq \frac{\beta(1-lW_t)lM_t c+(1+\beta lM_t+\beta\sigma)lW_t u_C}{1-\beta(1-lM_t-lW_t)}$. We denote $\textcircled{u} = \frac{\beta(1-lW_t)lM_t c+(1+\beta lM_t+\beta\sigma)lW_t u_C}{1-\beta(1-lM_t-lW_t)}$. In addition, $\textcircled{u}$ has the following property: if $\boxed{u} < \frac{c}{\beta}$, then $\frac{\textcircled{u}}{1+\beta\sigma} < \frac{c}{\beta}$, and if $\boxed{u} \geq \frac{c}{\beta}$, then $\frac{\textcircled{u}}{1+\beta\sigma} \geq \frac{c}{\beta}$.

Given the two observations, we separately discuss two possible cases of the agent.

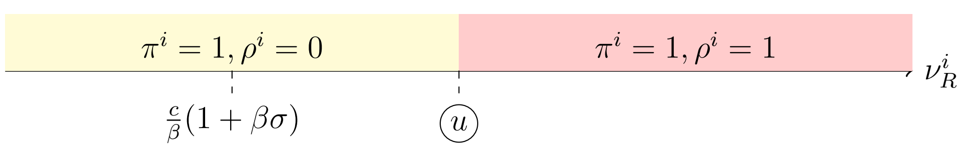
- First, suppose $\boxed{u} < \frac{c}{\beta}$, equivalently $u_C < e(W) = \frac{c}{\beta}\frac{1+\beta\sigma-\beta(1-lW)}{lW}$ indicating that transaction value of money alone is insufficient for agents to accept money.

  By Observation 1, the possible optimal actions for any given agent i includes ($\pi = 0, \rho = 0$), ($\pi = 0, \rho = 1$), and ($\pi = 1, \rho = 1$). By Observation 2, $\textcircled{u} < \frac{c}{\beta}(1+\beta\sigma)$. Thus, the cross-sectional distribution of actions are characterized by the following.



- Second, suppose $\boxed{u} \geq \frac{c}{\beta}$, equivalently $u_C \geq e(W)$, indicating that transaction value of money alone is high enough for agents to accept money.

  By Observation 1, the possible optimal action for any given agent i cannot be ($\pi = 0, \rho_i = 0$). In addition, in the case of $\boxed{u} \geq \frac{c}{\beta}$, the region that supports ($\pi = 0, \rho_i = 1$) as optimal action is empty. Hence the possible actions are ($\pi = 1, \rho = 0$) and ($\pi = 1, \rho = 1$). By Observation 2, $\textcircled{u} \geq \frac{c}{\beta}(1+\beta\sigma)$. Thus, the cross-sectional distribution of actions are characterized by the following.



Combining the two cases produces exactly the result presented in Lemma 1.

Proof of Proposition 2 (1) is a direct result of Lemma 1. (2) and (3) directly follows from

$$S^i = lM\pi^i \frac{\rho^i + (1-\rho^i)}{\pi^i lM + \sigma + \rho^i + (1-\rho^i)} \tag{33}$$

$$P^i = lW(1-\rho^i)\frac{\pi^i lM + \sigma}{\pi^i lM + \sigma + \rho^i + (1-\rho^i)}. \tag{34}$$

Note that for S^i, P^i are pinned down by the optimal decisions π^i, ρ^i. Hence, for agents i, j with $u_C^i = u_C^j, \nu_R^i < \nu_R^j$, it is straightforward to enumerate the different possibilities of their optimal decisions based on Lemma 1 and find that $S^i \leq S^j$ and $P^i \geq P^j$.

Proof of Proposition 3 This proof builds upon the proof of Lemma 1. Recall that the aggregate states are determined by

$$W_{t+1} = \int \pi_t^j (1 - \mu_t^j) dj = W_t \tag{35}$$

$$M_{t+1} = \int \mu_t^j (1 - \rho_t^j) dj = M_t \tag{36}$$

and

$$\mu_{t+1}^i = \mu_t^i (1 - \rho_t^i)(1 - lW_t) + (1 - \mu_t^i)(\pi_t^i l M_t + \sigma) = \mu_t \tag{37}$$

which can be rearranged as $\mu_t^i = \frac{\pi_t^i l M_t + \sigma}{\pi_t^i l M_t + \sigma + \rho_t^i + (1-\rho_t^i) l W_t}$.

Recall

$$e(W) = \frac{c}{\beta} \frac{1 + \beta\sigma - \beta(1 - lW)}{lW} \tag{38}$$

we know

$$e'(W) = -\frac{c}{\beta} \frac{1 - \beta(1 - \sigma)}{lW^2} < 0, \quad e''(W) = \frac{2c(1 - \beta(1 - \sigma))}{\beta l W^3} > 0 \tag{39}$$

and $e(0) = +\infty$, $e(1) = \frac{c(1-\beta(1-\sigma)+\beta l)}{\beta l}$.

Recall $u_C^i \sim U([\underline{u}_C, \overline{u}_C])$. Additionally we denote $\overline{W}$ s.t. $\overline{u}_C = e(\overline{W})$ and $\underline{W}$ s.t. $\underline{u}_C = e(\underline{W})$. Since e is monotonically decreasing in W, we know that $\overline{W} < \underline{W}$.

Recall **Assumption 1**. The first part assumes that $\underline{W} > 1$, equivalently, $e(1) > \underline{u}_C$ or $\underline{u}_C < \frac{c\left(1+\beta\sigma-\beta(1-l)\right)}{l\beta}$. Note that this is an assumption on primitives. The intuition is that we want there to be at least some people with low u_C that doesn't want to accept money for transaction's sake even if $W = 1$. This suggests that unless they have redemption utility, they won't join. This is important for eliminating the monetary equilibrium in the low-redemption regime. The second part assumes that $\overline{W} < \frac{1}{1+\sigma}$, equivalently $e(\frac{1}{1+\sigma}) < \overline{u}_C$. The intuition is that we want at least some people with high u_C such that they are happy to accept money for transaction's sake even if only $\frac{1}{1+\sigma}$ share of the population can accept their money.

Claim 1. If redemption is distributed as $\nu_R^i < \frac{c}{\beta} + \sigma$, the only equilibrium is $\pi^* = 0, \rho^* = 1$ for all agents, and aggregate $W^*, M^* = 0$.

Proof. Since $\nu_R^i < \frac{c}{\beta} + \sigma$, we can disaggregate our equilibrium condition to be

$$W = \frac{lW}{lM + \sigma + lW} P\left(u_C^i > e(W)\right) \tag{40}$$

$$M = \frac{lM + \sigma}{lM + \sigma + lW} P\left(u_C^i > e(W)\right) + \frac{\sigma}{\sigma + lW} P\left(u_C^i \leq e(W), \nu_R^i < \boxed{u}^i(1 + \beta\sigma)\right) \tag{41}$$

Observe immediately that $W^* = 0, M^* = 0$ satisfies the conditions and we have $e(0) = \infty$ meaning that $\pi^* = 0$ for everyone, which is consistent with the aggregates. We next show that there cannot be $W^* \in (0, 1)$ that solves the system.

Suppose $W \neq 0$, then we can simplify the W condition to be

$$\frac{1}{l} = \frac{1}{lM + \sigma + lW} P\Big(u_C^i > e(W)\Big) \tag{42}$$

by plugging this into the M condition, we obtain

$$0 = \frac{\sigma}{l} + \frac{\sigma}{\sigma + lW} P\Big(u_C^i \le e(W), \nu_R^i < \boxed{u}^i (1 + \beta\sigma)\Big) > \frac{\sigma}{l} \tag{43}$$

which is a contradiction. This concludes the proof of Proposition 3 Part (1).

We next show a more general statement than Proposition 3 Part (2).

Claim 2. Under the following redemption regimes $\{\nu_R^i\}$, there exists a unique monetary equilibrium where all agents play $\pi^* = 1, \rho^* = 0$ or $\pi^* = 1, \rho^* = 1$, aggregate quantities satisfy $W^* \in (\overline{W}, \frac{1}{1+\sigma})$ and $M^* = 1 - (1 + \sigma)W^*$. The redemption regime must satisfy:

(1) $\nu_R^i \ge \frac{c}{\beta}(1 + \sigma\beta)$ for all i. This condition ensures that there is enough redemption incentive to encourage acceptance.

(2) $\nu_R^i \le \max\big\{\frac{(1+\beta\sigma)l\overline{W}u_C^i}{1-\beta+l}, \frac{c}{\beta}(1 + \sigma\beta)\big\}$ for each i. This condition guarantees that a positive-measure set of agents play $(\pi^i = 1, \rho^i = 0)$ in equilibrium. It suggests that the platform should not allow people to redeem too much, especially should restrict redemption utility of those agents with high u_C^i, since they would have accepted money anyway.

It is straightforward to see that Proposition 3 Part (2) is a direct corollary of this claim, where we choose $\overline{\nu} = \frac{(1+\beta\sigma)l\overline{W}\overline{u}_C}{1-\beta+l}$.

Proof. Immediately note that any $W \le \overline{W}$ cannot be an equilibrium given the redemption regimes. If $W \le \overline{W}$, the redemption regimes guarantee that we shall have $u_C^i \le e(W), \nu_R^i \ge \frac{c}{\beta}(1 + \sigma\beta)$ for all agents. Then, they optimally chooses $\pi = 1, \rho = 1$ and this results in aggregate $W' = \int \pi(1 - \mu) = \frac{1}{1+\sigma} > \overline{W}$ which is a contradiction.

Next, we want to show that there is a unique $W^* \in (\overline{W}, \frac{1}{1+\sigma})$ that solves the system.

We begin with the following observation. The maximal redemption bound given in the claim satisfies the following property, that is, for any i and for any potential equilibrium aggregates $W \in (\overline{W}, 1), M \in [0, 1]$, we have

$$\frac{(1 + \beta\sigma)l\overline{W}u_C^i}{1 - \beta + l} \le \circled{u}^i = \frac{\beta(1 - lW_t)lM_t c + (1 + \beta lM_t + \beta\sigma)lW_t u_C^i}{1 - \beta(1 - lM_t - lW_t)} \tag{44}$$

which means that under the redemption regime, all agents have $\frac{c}{\beta}(1+\sigma\beta) \le \nu_R^i \le \max\{\circled{u}^i, \frac{c}{\beta}(1+\sigma\beta)\}$ for all agents.

In this case, there can only be two optimal actions in equilibrium, either $\pi = 1, \rho = 0$ for agents with $u_C^i > e(W)$ because we know $\nu_R^i < \circled{u}^i$; or $\pi = 1, \rho = 1$ for agents with $u_C^i < e(W)$ because we know $\nu_R^i > \frac{c}{\beta}(1 + \sigma\beta)$.

Now our equilibrium conditions are given by

$$W = \frac{lW}{lM+\sigma+lW} P\Big(u_C^i > e(W)\Big) + \frac{1}{lM+\sigma+1}\Big(1 - P\Big(u_C^i > e(W)\Big)\Big) \tag{45}$$

$$M = \frac{lM+\sigma}{lM+\sigma+lW} P\Big(u_C^i > e(W)\Big) \tag{46}$$

They can equivalently can be written as

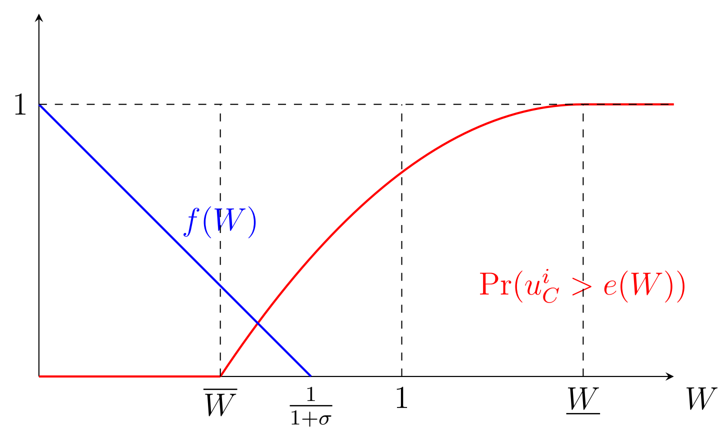
$$\frac{lM}{lM+\sigma} W + M = P\Big(u_C^i > e(W)\Big) \tag{47}$$

$$W = \frac{1-M}{1+\sigma} \tag{48}$$

It's easy to see that the first condition comes from the equation in M. The second condition can be obtained from taking the two equations in M, W and concentrating out the probability term.

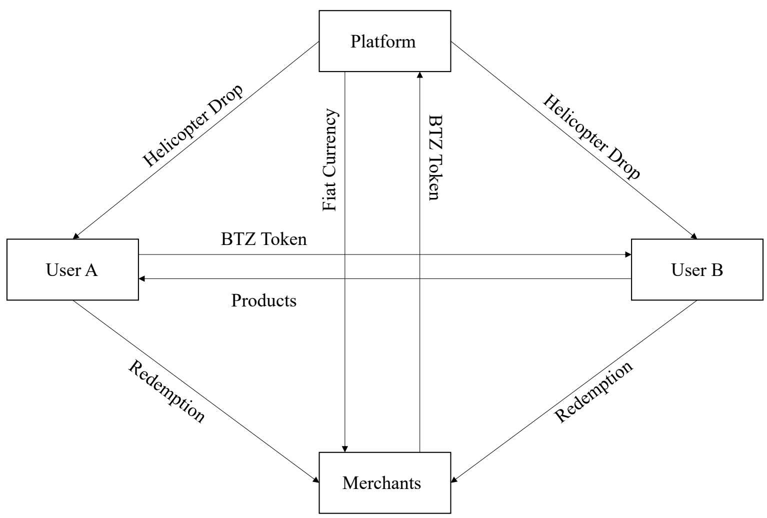
It is obvious that the second equation specifies a one-to-one mapping between equilibrium W^*, M^*, we plug this into the first eqation and simplifies the system to a single equation

$$f(W) \equiv -\sigma \frac{(W - \frac{1}{\sigma+1})(W - \frac{\sigma+l}{\sigma l})}{(W - \frac{\sigma+l}{(\sigma+1)l})} = P\Big(u_C^i > e(W)\Big). \tag{49}$$



A few additional observations regarding the left hand side function $f(W)$ yields our result. First note that the $\frac{1}{\sigma+1} < 1 < \frac{\sigma+l}{\sigma l} < \frac{\sigma+l}{(\sigma+1)l}$ and that $f(0) = 1$, $f(\frac{1}{\sigma+1}) = 0$. We also note that on the support $W \in [0,1]$, $f(W)$ is non-negative only on $[0, \frac{1}{1+\sigma}]$ and that on this region $f'(W) < 0$. Therefore we are guaranteed a unique solution to the equation such that $W \in (\overline{W}, \frac{1}{1+\sigma})$.

Figure A1. Token circulation within Bunz community



Notes: The figure plots the BTZ circulation in the BUNZ community.

Table B1. Redemption activity, full sample vs. analysis sample

Merchant Type	Redemption Volume (Percentage of Toal)	Redemption Transaction (Percentage of Toal)	Amount Per Transaction (CAD)	# Transactions Per Merchant
	Panel A: All users			
Cafes	19%	38%	7.92	46.2
Retail Shop	41%	21%	31.76	15.7
Bars	8%	13%	10.25	28.1
Restaurants	23%	25%	15.25	33.9
Service Shop	9%	4%	37.78	8.2
Total	1,134,767 CAD	70,439	16.11	26.4
	Panel B: Analysis sample			
Cafes	15%	32%	8.74	17.4
Retail Shop	47%	27%	33.49	9.0
Bars	5%	9%	11.04	9.0
Restaurants	23%	27%	16.50	16.8
Service Shop	10%	5%	39.51	4.4
Total	600,250 CAD	31,388	19.12	11.8

Notes: The table provides a comprehensive overview of the redemption patterns of all users and frequent users. Only users and redemption stores located in an area with a longitude between 79.11524° W and 79.63926° W and a latitude between 43.58100° N and 43.85546° N are included. Frequent users are defined as users with 20 item posts from April 2018 to August 2019.

Table B2. User activity, full sample vs. analysis sample

	Full Sample	Analysis Sample	Percentage
Number of users	193,989	7,162	3.69%
Total items posted (2018/04-2019/08)	1,044,234	834,194	79.89%
Total ratings received	772,328	466,050	60.34%
Total BTZ sent	390,282,261	221,650,823	56.79%
Total BTZ received	555,008,838	262,127,349	47.23%
Total BTZ holding	393,724,786	40,476,526	10.28%

Notes: The table provides a comprehensive comparison between the full sample users and analysis sample users. Full sample users are defined as users located in an area with a longitude between 79.11524° W and 79.63926° W and a latitude between 43.58100° N and 43.85546° N. Analysis sample users are defined as users with 20 item posts from April 2018 to August 2019.

Table B3. Effect of redemption exposure on token inflow, intensive vs. extensive margins

	(1) Asinh token inflow	(2) Asinh inflow transactions	(3) Any inflow transaction
Exposure	0.043***	0.006***	0.003***
	(0.006)	(0.001)	(0.001)
Baseline mean	5.169	0.482	0.237
# Obs	7,162	7,162	7,162

Notes: This table reports the effect of redemption exposure on token inflow. Columns (1) and (2) report the asinh ($asinh(x) = ln(x + \sqrt{x^2 + 1})$) amount of token inflow and number of transactions with token inflow, respectively. The analysis period is from April 2018 to August 2019. Robust standard deviations are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B4. Effect of redemption exposure on token outflow, intensive vs. extensive margins

	(1) Asinh token outflow	(2) Asinh outflow transactions	(3) Any outflow transaction
Exposure	-0.003	0.001	0.0003
	(0.007)	(0.001)	(0.001)
Baseline mean	5.534	0.463	0.250
# Obs	7,162	7,162	7,162

Notes: This table reports the effect of redemption exposure on token outflow. Columns (1) and (2) report the asinh ($asinh(x) = ln(x + \sqrt{x^2 + 1})$) amount of token outflow and number of transactions with token outflow, respectively. The analysis period is from April 2018 to August 2019. Robust standard deviations are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B5. Effect of redemption exposure on token redemption, intensive vs. extensive margins

	(1) Asinh token redeemed	(2) Asinh redemption transactions	(3) Any redemption transaction
Exposure	0.069*** (0.007)	0.007*** (0.001)	0.003*** (0.000)
Baseline mean	2.020	1.03	0.060
# Obs	7,162	7,162	7,162

Notes: This table reports the effect of redemption exposure on token redemption. Columns (1) and (2) report the asinh ($asinh(x) = ln(x + \sqrt{x^2 + 1})$) amount of token redeemed and number of redemption transactions, respectively. The analysis period is from April 2018 to August 2019. Robust standard deviations are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B6. Effect of redemption exposure on token issuance, intensive vs. extensive margins

	(1) Asinh token issued	(2) Asinh issuance transactions	(3) Any issuance transactions
Exposure	0.001 (0.003)	-0.0003 (0.002)	0.001 (0.001)
Baseline mean	6.560	3.460	0.745
# Obs	7,162	7,162	7,162

Notes: This table reports the effect of redemption exposure on token issuance. Columns (1) and (2) report the asinh ($asinh(x) = ln(x + \sqrt{x^2 + 1})$) amount of token issued and number of transactions with token inflow from Bunz, respectively. The analysis period is from April 2018 to August 2019. Robust standard deviations are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B7. Effect of redemption exposure on token activity, restricted sample

	(1) Token acceptance	(2) Asinh token holdings	(3) Asinh token inflow	(4) Asinh token outflow	(5) Asinh token redeemed	(6) Asinh token issuance
# Nearby redemption merchant	0.003*** (0.001)	0.007 (0.007)	0.085*** (0.013)	0.002 (0.005)	0.046*** (0.011)	-0.001 (0.011)
Baseline mean	0.250	7.801	5.159	5.697	2.216	6.717
# Obs	2,824	2,824	2,824	2,824	2,824	2,824

Notes: This table reports the impact of redemption exposure on token activity of the active users who also post at least 20 items before token introduction. The redemption exposure is defined as the number of merchants within 1 km of users. The analysis period is from April 2018 to August 2019. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B8. Effect of redemption exposure on user activeness

	(1) Asinh # item posts	(2) Asinh # item posts	(3) Asinh # ratings	(4) Asinh # ratings
Exposure	-0.003 (0.007)	0.005 (0.008)	-0.009* (0.005)	-0.013 (0.008)
Demographic	N	Y	N	Y
Distance	N	Y	N	Y
# Obs	7,162	2,204	7,162	2,204

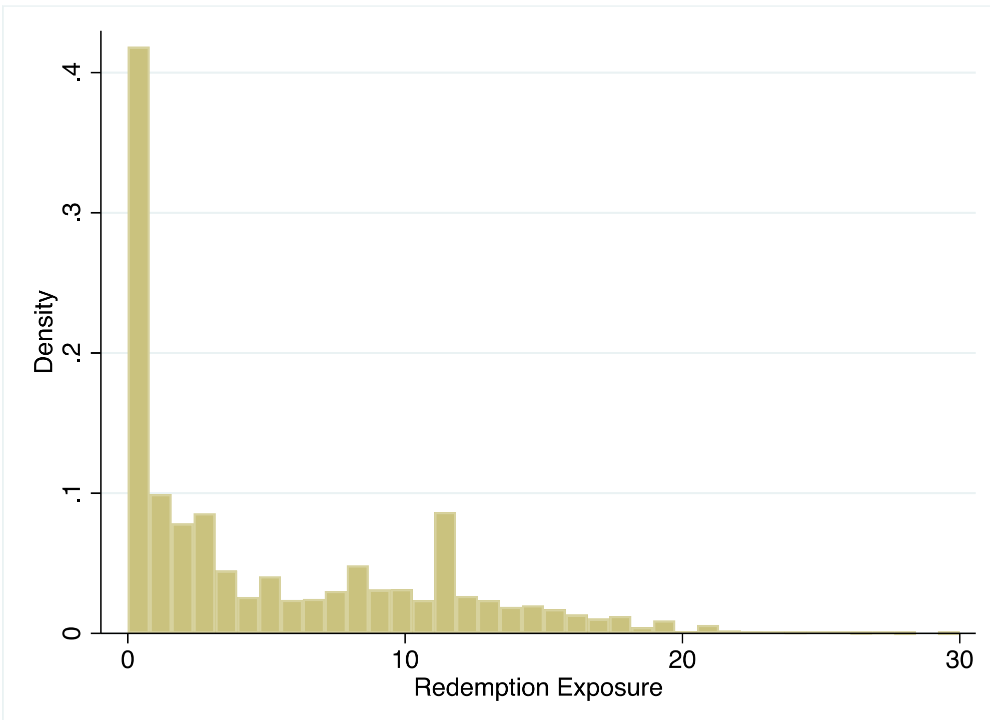
Notes: Table shows the effect of redemption exposure on the activeness of users. The redemption exposure is defined as the number of merchants within 1 km of users. Columns (2) and (4) further controls the demographic characteristics, including the age, income, and education of users and the distance between users' location and city center. The analysis period is from April 2018 to August 2019.

Table B9. Effect of redemption exposure on token activity, alternative redemption exposure measurement

	Independent Variable					
Dependent Variable	# merchants within 1 km	asinh # merchants within 1 km	asinh average BTZ redeemed within 1 km	asinh average redemption transactions within 1 km	asinh average distance from merchants	asinh average distance from merchants weighted by redemption volume
Token acceptance	0.003***	0.015***	0.002***	0.005***	-0.030***	-0.031***
	(0.001)	(0.003)	(0.001)	(0.001)	(0.006)	(0.006)
R^2	0.005	0.004	0.002	0.002	0.003	0.003
Asinh token inflow	0.026***	0.094***	0.015***	0.034***	-0.153***	-0.167***
	(0.005)	(0.019)	(0.004)	(0.008)	(0.043)	(0.044)
R^2	0.005	0.003	0.002	0.002	0.002	0.002
Asinh token redeemed	0.026***	0.128***	0.023***	0.047***	-0.243***	-0.241***
	(0.003)	(0.011)	(0.002)	(0.004)	(0.024)	(0.025)
R^2	0.014	0.018	0.013	0.013	0.012	0.011
Asinh token holdings	0.003	-0.006	-0.007*	-0.011	0.114**	0.107**
	(0.004)	(0.019)	(0.004)	(0.008)	(0.046)	(0.047)
R^2	0.000	0.000	0.000	0.000	0.001	0.001
Asinh token issued	0.003	-0.010	-0.006*	-0.010	0.098***	0.090**
	(0.004)	(0.015)	(0.003)	(0.007)	(0.036)	(0.037)
R^2	0.000	-0.000	0.000	0.000	0.001	0.001
Asinh token outflow	0.002	-0.012	0.000	0.002	0.026	0.011
	(0.004)	(0.018)	(0.004)	(0.008)	(0.043)	(0.044)
R^2	0.000	0.000	0.000	0.000	0.000	0.000

Notes: This table reports the effect of redemption exposure on token related behavior using alternative redemption exposure measurement. The analysis period is from April 2018 to August 2019. Robust standard deviations are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure C1. Distribution of redemption exposure



Notes: The figure plots the distribution of the average number of merchants within 1 km of active users from April 2018 to August 2019.

Table C1. Effects of redemption collapse on token activity

	(1) Token Acceptance	(2) Asinh token inflow	(3) Asinh token issued	(4) Asinh token outflow	(5) Asinh token holdings
Post	-0.145***	-0.939***	-2.301***	-1.059***	0.081***
	(0.010)	(0.092)	(0.193)	(0.103)	(0.020)
$Exposure \times Post$	-0.003***	-0.021***	-0.006	-0.007	-0.001
	(0.001)	(0.005)	(0.004)	(0.005)	(0.002)
Idividual FE	Y	Y	Y	Y	Y
# Obs	38,459	13,6078	13,6078	13,6078	13,6078

Notes: This table reports the DID analysis of redemption collapse on token related behavior using the following equation:

$$y_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where $y_{i,t}$ is the measurements for behavior related to tokens of user i at month t, $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C2. Effects of redemption collapse on token inflows, intensive vs. extensive margins

	(1) Asinh token inflow	(2) Asinh transactions with token inflow	(3) Any transactions with token inflow
Post	-0.939***	-0.165***	-0.116***
	(0.092)	(0.017)	(0.011)
Exposure × *Post*	-0.021***	-0.004***	-0.002***
	(0.005)	(0.001)	(0.001)
Idividual FE	Y	Y	Y
# Obs	136,078	136,078	136,078

Notes: This table reports the DID analysis of redemption collapse on token inflows using the following equation:

$$Inflow_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C3. Effects of redemption collapse on token outflows, intensive vs. extensive margins

	(1) Asinh token outflow	(2) Asinh transactions with token outflow	(3) Any transactions with token outflow
Post	-1.059***	-0.172***	-0.131***
	(0.103)	(0.017)	(0.012)
Exposure × *Post*	-0.007	-0.001	-0.001
	(0.005)	(0.001)	(0.001)
Idividual FE	Y	Y	Y
# Obs	136,078	136,078	136,078

Notes: This table reports the DID analysis of redemption collapse on token outflows using the following equation:

$$Outflow_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C4. Effects of redemption collapse on token issuance, intensive vs. extensive margins

	(1) Asinh token issued	(2) Asinh issuance transactions	(3) Any issuance transactions
Post	-2.301***	-1.599***	-0.350***
	(0.193)	(0.147)	(0.040)
Exposure × *Post*	-0.006	-0.002	-0.002**
	(0.004)	(0.003)	(0.001)
Idividual FE	Y	Y	Y
# Obs	136,078	136,078	136,078

Notes: This table reports the DID analysis of redemption collapse on token issuance using the following equation:

$$Issuance_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C5. Effects of redemption collapse on token activity, restricted sample

	(1) Token Acceptance	(2) Asinh token inflow	(3) Asinh token issued	(4) Asinh token outflow	(5) Asinh token holdings
Post	-0.141***	-1.062***	-2.309***	-1.185***	0.066**
	(0.012)	(0.099)	(0.191)	(0.108)	(0.028)
Exposure × *Post*	-0.002	-0.017**	-0.004	-0.004	0.001
	(0.001)	(0.007)	(0.007)	(0.007)	(0.003)
Idividual FE	Y	Y	Y	Y	Y
# Obs	19,274	53,656	53,656	53,656	53,656

Notes: This table reports the DID analysis of redemption collapse on token related behavior using the following equation using the users who post at least 20 posts before the token introduction:

$$y_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where y_i is the measurements for users' behavior related to tokens, $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C6. Effects of redemption collapse on token activeness, full vs. restricted sample

	(1) Asinh item posts	(2) Asinh item posts	(3) Asinh ratings	(4) Asinh ratings
Post	-0.374***	-0.416***	-0.266***	-0.294***
	(0.045)	(0.051)	(0.032)	(0.033)
Exposure × *Post*	0.0001	0.003	-0.001	0.002
	(0.002)	(0.003)	(0.001)	(0.002)
Idividual FE	Y	Y	Y	Y
# Obs	136,078	53,656	136,078	53,656

Notes: This table reports the DID analysis of redemption collapse on token related behavior using the following equation using the users who post at least 20 posts before the token introduction:

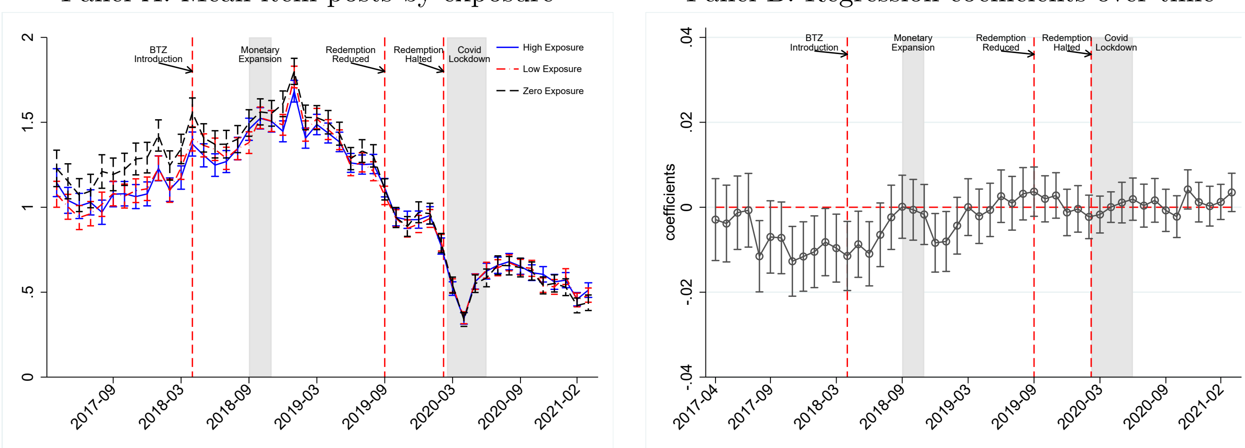
$$Actigveness_{i,t} = \beta_1 Post + \beta_2 Exposure_i \times Post + \gamma_i + \epsilon_{i,t}$$

where $Actigveness_{i,t}$ is the asinh number of item posts and completed trades measured by asinh rating counts, $Exposure_i$ is the number of merchants within 1 km of users i, and γ_i is the individual fixed effects. The analysis period is from September 2019 to February 2021 and the redemption system collapse on February 26th, 2020. Robust standard deviations are two-way clustered at individual and month levels and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure C2. Time series trend of item posts by exposure

Panel A: Mean item posts by exposure

Panel B: Regression coefficients over time



Notes: The figure shows the average asinh number of item posts by exposure and regression coefficients β_t, with the 95% confidence intervals, estimated by Equation (12) over time.