MIRROR:
REFLECTING ASSET VALUE ON-CHAIN

Abstract. Traditional asset classes have yet to enter the transparent, censorship resistant and globally accessible universe of public blockchains. Geographical barriers, high transaction costs and liquidity constraints make it hard for the average person to invest a small amount in assets like stocks and real estate. Asset tokenization has the potential to break down many of those barriers via blockchain reflections of traditional assets that are globally accessible, infinitely divisible and cheap to transact in. We present Mirror, a protocol that allows anyone to issue and trade synthetic assets that track the price of arbitrary real world assets without physical backing. Mirror enables two markets with well-balanced incentives: a market for minters to safely issue overcollateralized synthetic assets, and a market for traders to gain exposure to them. Mirror has the potential to democratize finance by making assets of all shapes and forms accessible to anyone, anywhere in the world.

1. Introduction

Blockchain technology has been adopted in a wide variety of industries thanks to its core properties of accessibility, transparency and immutability. Public blockchains, meaning those accessible by virtually anyone with an internet connection, have enabled unprecedented access to capital and to non-sovereign assets such as Bitcoin. Despite those developments, the financial industry remains closed and inaccessible, only experimenting with private blockchains which restrict access to specific parties. Indeed, access to financial assets such as stocks, bonds and derivatives remains a challenge for most of the world outside of America and Europe. We believe that a necessary requirement for an open financial system is open, unfettered access to financial assets.

In this paper we discuss how asset tokenization can be an avenue for democratization of financial assets and propose an implementation via synthetic tokens – tokens that track the prices of real-world assets without physical backing. We present Mirror, a protocol that allows anyone to issue synthetic assets that track arbitrary real-world assets using public blockchain technology. In the latter half of the paper we discuss the core mechanisms that enable Mirror and argue that the protocol will play a crucial role in expanding the audience of traditional finance.

2. Asset Tokenization

2.1. **Motivation.** Let us first consider a simple problem where an individual wants to invest in a piece of real estate but only has a portion of the total required capital necessary to make the purchase. It may be in the investor's best interest to invest a portion of the total amount every month (known as dollar cost averaging) and slowly build up the investment capital. However, this would be an unusual concept in the real estate industry as it does not make sense to buy, say $10m^2$ of a piece of property. In a similar vein, the reverse scenario where an individual would like to

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procure $50,000 worth of liquidity but only has a piece of real estate worth $100,000 must necessarily sell the whole piece of real estate. It would be absurd to only sell half the house. However, we can view this as capital inefficiency as the individual would be left with an excess of $50,000 if they were to sell the entire house.

2.2. **Tokenization on a Public Ledger.** An elegant solution to the above problem would be to introduce **asset tokenization**. To put it simply, we would convert the ownership rights, an asset, into a digital token. We can arbitrarily say that our $100,000 property converts to 100,000 "tokens", each corresponding to an equal share of ownership. If an individual seeks to control 50% of property ownership, it would be necessary and sufficient to purchase 50,000 of those tokens.
A requirement for this solution to work is agreement among all parties on a point of reference for assessing the current state of ownership division. The introduction of blockchain to this framework provides a public ledger where ownership is verifiable by all parties and cannot be forged nor revoked. Users can transfer rights through explicit contractual agreements that are publicly verifiable and are free of counterparty risk. Blockchains are by design a natural fit for asset tokenization.

2.3. **"Tokenizable" Assets.** While almost anything is "tokenizable" in theory, we expect the main tokenization demand drivers to be the following categories of assets:

- **Physical Assets** - This would include types of goods such as real estate, commodities, precious metals, famous paintings and a long tail of illiquid assets.

- **Abstract Assets** - This would include the majority of investment asset classes such as stocks, bonds, investment funds, derivatives etc.

We review the advantages of tokenizing those types of assets in the following section.

2.4. **Advantages of Asset Tokenization.**

(1) **Reduced Geographical Barriers** - As all the relevant information and records of previous transactions are stored on a permissionless blockchain, individuals can transact from anywhere in the world.

(2) **Reduced Reliance on Middlemen** - The traditional need of a middleman trusted by involved parties to validate and facilitate transactions is eliminated thanks to the blockchain's immutability and transparency.

(3) **Enhanced Accessibility through Fractional Ownership** - Tokenization allows assets to be divided into as many units (tokens) as desired, thereby enabling wider investment participation for high-value assets such as real estate and expensive stocks. While fractional ownership for stocks is becoming increasingly popular in brokerages, it comes with operational overhead that does not exist with tokenized stocks.

(4) **Improved Asset Liquidity** - Assets that are hard to transfer/trade tend to suffer in terms of liquidity. The use of blockchain to track and transfer ownership substantially reduces friction and therefore permits higher liquidity.

(5) **Increased Transaction Efficiency** - Blockchain transactions can dramatically improve efficiency of traditional settlements by reducing time and cost. Complex transactions can be automated via smart contracts, thereby reducing legal and operational costs and minimizing the risk of disputes.

(6) **Expanded Investor Base** - Flexible fractional ownership improves access to investment opportunities by allowing investors to partake in transactions that were previously inaccessible to them due to capital or liquidity constraints.

The above is undoubtedly only a subset of the vast advantages of asset tokenization.

2.5. **Implementations of Asset Tokenization.** We present the two primary implementations of asset tokenization and discuss the advantages of each:

(1) **Asset-backed tokens** are tokens which are backed one-to-one by the the physical or abstract good that they represent. For instance, an asset-backed gold token representing 1 ounce of gold would need to be backed by 1 ounce of physical gold stored in a vault.

(2) **Synthetic tokens** are tokens that provide "synthetic" exposure to the physical or abstract good that they represent without requiring one-to-one backing. For instance, a synthetic gold token representing 1 ounce of gold would be exchangeable for the price of 1 ounce of physical gold. Synthetic tokens can be issued either by a centralized party, e.g. a bank whose credit "backs" the token, or a decentralized network whose incentives guarantee that the synthetic token is always exchangeable for the price of the asset it represents.

The primary advantage of asset-backed tokens is **simplicity**: the design is easy for anyone to understand, and risk is limited to the custodian – if they are trustworthy then the token should be safe to hold. Synthetic tokens can be more complicated to implement. We see a number of important advantages of synthetic vs asset-backed tokens. First, the **accessibility** afforded by tokenization is typically wider for synthetic tokens: while anybody with an internet connection can access synthetic tokens on a public blockchain, asset-backed tokens may face restrictions imposed by the custodians backing them. Second, synthetic tokens tend to be **more affordable to hold** as they typically charge no holding fee. Custodians for asset-backed tokens will typically charge custody fees which can be high, particularly for physical assets such as gold or oil. Third, synthetic tokens provide complete **censorship resistance** which asset-backed tokens often cannot due to restrictions faced by custodians.
We see a market developing for both asset-backed tokens and synthetic tokens. Asset-backed tokens will certainly increase the transparency and liquidity of assets held by custodians, and we believe will become increasingly common. In the following section we introduce a protocol for **synthetic asset tokenization**, as we believe it has greater potential to democratize access to financial assets for a global audience.

3. The Mirror Protocol

Mirror is a protocol that allows anyone to issue and trade **synthetic assets** that track the price of real world assets – everything from traditional equities to real estate.

Mirror unleashes the full power of asset tokenization to offer globally accessible, transparent and affordable access to financial assets.

3.1. **Basic Operations.** A synthetic asset issued on Mirror is said to be an mAsset. For instance, a synthetic version of real-world asset X would be called mX. The following are the main operations enabled by the Mirror Protocol:

- **Mint:** Anyone can mint an mAsset by locking up collateral, either in the form of a stablecoin or a different mAsset. The required collateral is at least a minimum multiple of the asset's value (150% for stablecoin collateral, 200% for mAsset collateral). For instance, if stock X is reported to be trading at $100, minting 1 mX would require at least $150 in stablecoin, or $200 in a different mAsset.

- **Burn:** To burn an mAsset, the issuer must burn the amount initially issued to receive the locked stablecoin collateral.

- **Trade:** mAssets are tradable on automated market makers (AMMs) on public blockchains like Terra and Ethereum, making it easy for issuers as well as investors to buy and sell them.

3.2. **Mirror Participants.** We expect Mirror to enable two types of markets involving different participants:

- **Minters:** Minters are those who mint mAssets and effectively take the opposite position of the asset's natural direction. For instance, an issuer of mXAU (gold) is effectively taking a short position on XAU. The minter's counterparty is the system itself.

- **Traders:** Traders are those who buy and sell mAssets on the decentralized exchanges supported by Mirror. Virtually anyone with an internet connection can gain exposure to mAssets via a Mirror-supported decentralized exchange.

The Mirror protocol creates incentives for minters to mint assets and provide liquidity for traders. We discuss those incentives in the following section.

3.3. **Liquidity, Governance and the Mirror Token.** The Mirror protocol utilizes AMMs (automated market makers) to facilitate mAsset trading against stablecoins. For instance, trading against an mXAU/UST pool on Uniswap would be the easiest way for a trader to get access to XAU.
Minting and liquidity provision are essential services without which Mirror would not be able to function. It would therefore be natural for traders to compensate liquidity providers. To incentivize minting and liquidity provision, the Mirror protocol rewards liquidity providers with:

- **Trading Fees:** All mAsset trades that go through the AMM pay a small commission to that mAsset's liquidity providers.

- **The native Mirror Token:** Mirror defines a native token with a deterministic inflation schedule that rewards mAsset liquidity providers.

In addition to providing liquidity incentives, the Mirror Token has a core governance role for the Mirror protocol. Mirror Token holders stake their tokens to vote on key issues including:

- **Whitelisting Assets:** Enabling/disabling assets that can be minted.
- **Key Parameter Changes:** Changing key protocol parameters such as the minimum collateral ratio and trading fees.

The Mirror Token is therefore foundational for the Mirror protocol, acting as both an incentive for liquidity providers and the primary governance vehicle.

3.4. **Oracles, Liquidations and Peg Incentives.** A critical function of the Mirror protocol is the ingestion of asset price data external to the blockchain. This is necessary for determining the amount of collateral required for minting an mAsset, and for assessing whether or not sufficient collateral is locked for existing mAssets. The protocol achieves this via an on-chain oracle similar in design to Terra's: Mirror Token holders submit votes on each asset, which the protocol aggregates to compute a median weighted by each holder's Mirror Token stake. The Mirror oracle submits prices at a high frequency to accommodate real-time pricing of exchange-traded assets.

The Mirror oracle facilitates solvency of mAssets by triggering collateral liquidations whenever the collateral ratio of an mAsset (collateral value/asset value) drops below the governance-mandated minimum. For instance, if $150 worth of stablecoin have been locked by a minter to issue an mAsset worth $90, and the minimum collateral ratio is 150%, an increase in the asset's value to $101 would trigger a liquidation. When the collateral ratio drops below the minimum, the Mirror protocol needs a way to retrieve and burn the respective mAssets. It does so by seizing a portion of the collateral and initiating an auction at a discount for anyone willing to sell the mAsset in exchange. This process is performed recursively until the collateral ratio is above the minimum threshold. The liquidation procedure implemented by Mirror for mAssets is similar to the procedure Maker implements for CDPs.

In addition, the Mirror oracle facilitates a key property of mAssets: that their on-chain price is pegged to the price of the real-world assets they represent, as supplied by the oracle. This is achieved by incentives naturally created by the Mirror protocol. In particular, if the price of an mAsset trades at a discount to the oracle price, minters are incentivized to purchase and burn it, thereby profiting by paying back their debt at a discount. Conversely, if the price of an mAsset trades at a premium to the oracle price, market participants are incentivized to mint and sell it at the premium price, thereby profiting from the difference. In both cases, a drift of the mAsset's price away from the price of the real-world asset creates arbitrage that market participants will exploit until the peg is restored.

4. Conclusion

Asset tokenization on public permissionless blockchains has the potential to break down the financial and geographic barriers that hold back traditional asset classes from global accessibility. Mirror is a protocol that allows anyone to issue and trade

synthetic assets that track the price of arbitrary real world assets. Mirror's well-calibrated system of incentives creates a market for minters to safely issue synthetic assets and for traders to gain exposure to them from anywhere in the world. Mirror unleashes the full power of asset tokenization to democratize access to financial assets of all shapes and forms.

References

[1] Maker DAO. (2017). *The Dai Stablecoin System* [White Paper].