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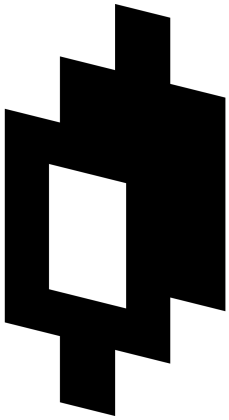
The Standard For Synthetic Assets: Mirror

DeFi's 1-To-N Opportunity



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Executive Summary

The emerging world of synthetic assets is one of DeFi's most powerful bridges into traditional financial markets. With the backdrop of macro change accelerated by COVID-19, we argue that synthetic assets can create a gravitational pull on capital, as investor appetite moves deeper into the risk spectrum. Notably, we examine the growing international demand for US equities and the challenges faced by investors in the existing e-brokerage model.

This context leads us into the primary focus of the report, Mirror: a new protocol for synthetic asset creation. Mirror synthesizes the primary innovations of DeFi – including Automated Market Makers (AMMs), oracles, stablecoins and liquidity mining – to enable permissionless minting and trading of traditional assets. Mirror is uniquely positioned as a capital efficient system using stablecoins, reducing collateralization requirements to only 150%, a vast improvement over comparable systems which are typically collateralized upwards of 300-400%.

Mirror will launch with support for a select number of US equities, and will decentralize ownership of its native governance token MIR via a community-first distribution strategy.

Contents

1 DeFi + TradFi: The 1-To-N Opportunity

The Birth of DeFi

2020 will be remembered as a year of unprecedented financial repurposing. Old systems unravelled and the world reimagined capital markets overnight. This story applies to everything from central bank intervention to the corporate treasurer's search for hard assets. Crypto's great repurposing centers on the rise of DeFi, where decentralized infrastructure transformed into rails for a new, permissionless financial system.

This boom in Decentralized Finance (DeFi) leveraged existing crypto-networks and liquidity. Promising permissionless, protocol-level primitives to rival legacy institutions, the narrative is very different to other FinTech innovations. DeFi does not simply improve the user experience of banking; it dismantles it altogether. Rather than repackaging finance, DeFi repurposes finance; competing directly with the legacy financial system through new settlement layers that are equipped with their own units of account.

Despite a tumultuous ride, DeFi's boom-bust cycle has delivered beyond promise alone. The growth in decentralized liquidity is undeniable: in just under a year, DeFi's Total Value Locked (TVL) has risen from a mere $675 million to over $14 billion (December 2020)[1]. Secured by growing trust in Ether as primary collateral, this rise represents one of the few "0-to-1" innovations in cryptocurrency, perhaps second to the invention of Bitcoin. By spurring the invention of protocols for trustless lending, borrowing, exchange, stablecoins, yield and insurance, it is not a question of "if" DeFi will approach escape velocity, but "when" and "how".

The Broader Context

In parallel to this crypto-native transformation, the macro environment has forced the world into uncharted monetary waters. Central banks have voyaged into no-man's land and it is not clear if or when they re-emerge. This journey includes everything from negative rates to quantitative easing and yield curve control.

These experiments have almost universally increased risk appetite. The purchasing power of the uninvested is in perpetual decay. Real inflation measures at 1-2% annually[2], yet 10 year government bonds lag behind[3]. From retail to institutional, this reality has led to a flight into risk, particularly in the form of US equities.

TradDeFi

Peter Thiel's notion of the "0-to-1" invention is vertical: it creates something new. A "1-to-N" application is horizontal, scaling what has been created[4]. DeFi's foundations are 0-1, but what are the applications that scale Total Value Locked to hundreds of billions or even trillions in value?

We believe the merging of Traditional Finance (TradFi) and DeFi – "TradDeFi" – is one of the most compelling 1-to-N opportunities. This will take many forms. In this report, we will focus on one application: crypto-synthetic assets. These assets are one of DeFi's most obvious Trojan Horses into legacy

[1] URL: https://defipulse.com/.

[2] URL: https://www.bls.gov/news.release/cpi.nr0.htm.

[3] URL: https://www.treasury.gov/resource-center/data-chart-center/interest-rates/pages/textview.aspx?data=yield.

[4] Peter Thiel. *Zero to One. Notes on Startups, or How to Build the Future.* The Crown Publishing Group, 2014. URL: http://www.zerotoonebook.com/.

markets, leveraging the openness of crypto while feeding on the insatiable demand for markets like US equities.

Mirror: Tokenizing Synthetic Assets

In this report, we present the fundamental case for synthetic assets in terms of demand and technological innovation. What is the latent demand for assets? Why is DeFi uniquely suited as a platform for synthetics?

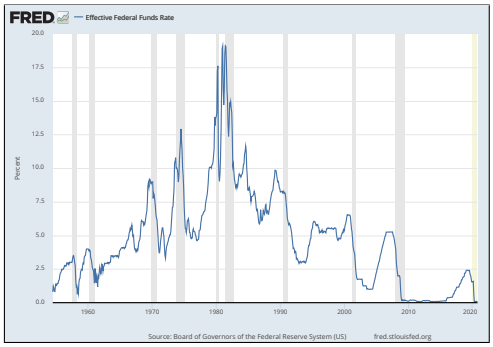
Once we lay this fundamental groundwork, we will then analyze Mirror, a DeFi protocol built on the Terra blockchain, designed for permissionless and capital efficient minting and exchange of synthetics.

2 An Insatiable Thirst For Risk

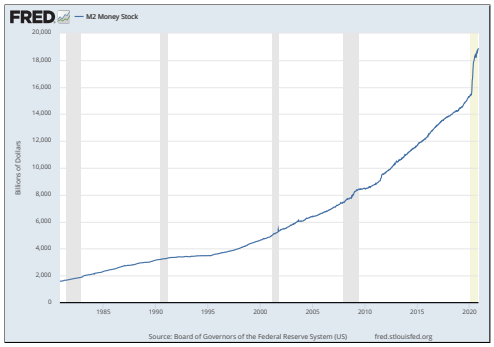
The world is tumbling toward risk assets at every turn. In this section, we discuss how the macro landscape is driving retail and institutional investors toward US equities and derivatives.

2.1 The Evolving Macro Landscape

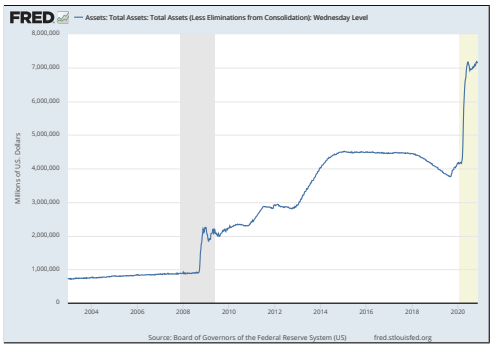
In response to COVID-19, central banks embraced sweeping changes to monetary policy. Across the globe, central banks cut interest rates and followed these measures with creative support packages. The scale of monetary intervention, in many cases, rivals the response following 2008's Great Financial Crisis.



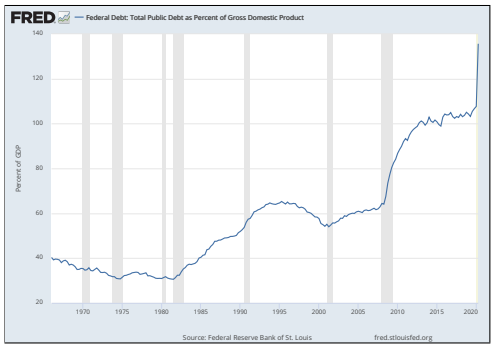
(a) Federal Funds Rate from the early 1960s[5].



(b) M2 Money Stock from the early 1980s[6].



(c) Federal Reserve balance sheet from the early 2000s[7].



(d) Federal Debt to GDP ratio from the mid 1960s[8].

Figure 1: Historical US macroeconomic factors.
↓ interest rates, ↑ money supply, ↑ balance sheet and ↑ public debt.

In the United States alone, monetary policy has ranged from:

- Reducing the effective federal funds rate target to a range of 0% to 0.25%, effectively instituting a Zero Interest Rate Policy (ZIRP). While the Federal Reserve has committed to avoiding negative rates, it remains to be seen if this position will be maintained into the future, as other central banks consider and adopt negative rates (e.g. the Bank of England[9] and European Central Bank[10]).

[5] URL: https://fred.stlouisfed.org/series/FEDFUNDS.
[6] URL: https://fred.stlouisfed.org/series/M2.
[7] URL: https://fred.stlouisfed.org/series/WALCL.
[8] URL: https://fred.stlouisfed.org/series/GFDEGDQ188S.
[9] URL: https://www.reuters.com/article/britain-boe-rates-idUSKBN27L08Z.
[10] URL: https://www.ecb.europa.eu/pub/economic-bulletin/articles/2020/html/ecb.ebart202003_02~4768be84e7.en.html.

- Slashing the reserve requirement ratio for all depository institutions to 0%, allowing for "infinite" lending leverage[11].
- Announcing an ongoing $700 billion quantitative easing package to repurchase US Treasury's and mortgage backed securities[12].

The implications of these policies are evident in the historical charts in Figure 1: interest rates stand near the zero-lower-bound, the M2 money supply has grown by approximately 22% in 2020 and the Federal Reserve's balance sheet has almost doubled from $4 trillion to $7 trillion.

Central bankers were not alone in these efforts. Governments complemented these policies with an aggressive fiscal response. Record stimulus bills pervaded the European Union[13] and the United States[14], each passing packages exceeding $2 trillion. In the US today, total public debt as a percentage of Gross Domestic Product stands at 135%, rising 28% in a single quarter.

While many remain astounded at the disconnect between 2020's productivity slump and booming financial markets, the answer lives in this monetary expansion. Central banks have forced the investor's hand. In the face of $17 trillion of negative yielding bonds[15], investors have found refuge in risky investments across a range of asset classes.

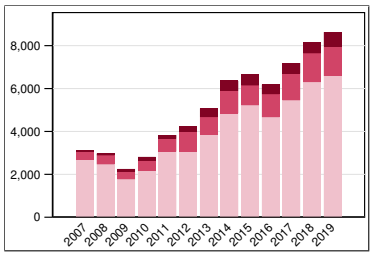
2.2 Global Black Hole: US Foreign Direct Investment (FDI)

Amidst a backdrop of global easing and investor desperation, the US remains the strongest global recipient of Foreign Direct Investment (FDI), as per Figure 2. As of 2019, foreign holdings of US equities amounted to $8.6 trillion[16], representing 10% year-on-year growth from 2018. In the same period, the US received the largest FDI inflows of all countries, followed by China and Singapore.

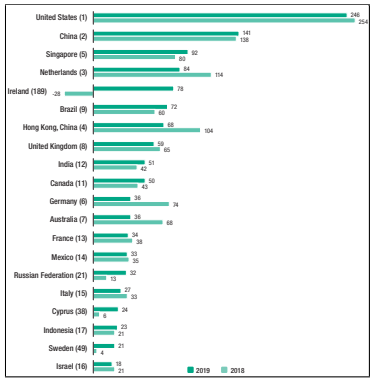
This trend accelerated rapidly during the pandemic. As of the end of March 2020, Figure 3 shows international investors composed 16% of the corporate equity market, with net inflows into US equities exceeding $187 billion during Q1 2020[19]. This trend continued into May, with foreign inflows into US equities amounting to $79.7 billion[20], an all time high.

As per Figure 4, the largest sources of FDI are developed countries, including Japan, Canada, Germany, the UK, Ireland and South Korea. Notably, the fastest growing sources of FDI are less developed and developing nations, including Kuwait, Thailand, Chile, Brazil and Turkey.

[11] URL: https://www.federalreserve.gov/monetarypolicy/reservereq.htm.
[12] URL: https://www.federalreserve.gov/newsevents/pressreleases/monetary20200315a.htm.
[13] URL: https://ec.europa.eu/info/strategy/recovery-plan-europe_en.
[14] URL: https://home.treasury.gov/policy-issues/cares.
[15] URL: https://www.bloomberg.com/news/articles/2020-11-06/negative-yielding-debt-hits-record-17-trillion-on-bond-rally.
[16] *Foreign Portfolio Holdings of U.S. Securities as of June 28, 2019.* Department of the Treasury, Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System, 2020. URL: https://ticdata.treasury.gov/Publish/shl2019r.pdf.
[17] *Foreign Portfolio Holdings of U.S. Securities as of June 28, 2019.* Department of the Treasury, Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System, 2020. URL: https://ticdata.treasury.gov/Publish/shl2019r.pdf.
[18] United Nations Conference on Trade and Development (UNCTAD). *World Investment Report 2020.* United Nations, 2020. URL: https://unctad.org/system/files/official-document/wir2020_en.pdf.
[19] URL: https://www.foxbusiness.com/markets/foreigners-biggest-buyers-u-s-stocks-2020-goldman-sachs.
[20] URL: https://www.reuters.com/article/us-usa-treasury-securities-idUSKCN24H3AT.
[21] Goldman Sachs.
[22] URL: https://www.selectusa.gov/servlet/servlet.FileDownload?file=015t00000003D9M.



(a) Total US FDI inflows from the early 2000s (billions)[17].



(b) FDI inflows across the top 20 host economies, 2018 and 2019 (billions)[18]. The US remains the largest recipient of FDI.

Figure 2: Historical US Foreign Direct Investment statistics.

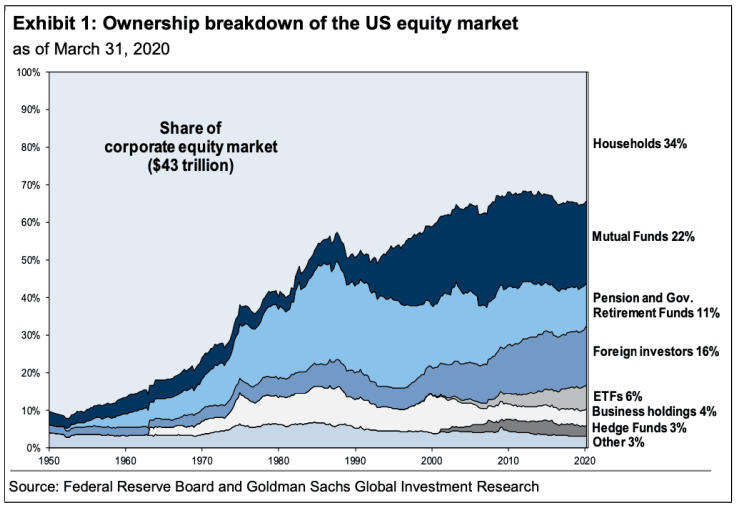


Figure 3: Ownership breakdown of the US equity market[21].
Foreign investor ownership has grown from under 1% in the early 1950s to 16% today.

It's hard to overstate the gravitational pull of US assets in the current paradigm. Foreign inflows have continued pouring in over a decade and accelerated during a global pandemic and monetary transformation.

In the end, loose money and unbridled stimulus is not a US-centric theme. It is worldwide, and in many cases, US assets are the best available hedge on interventionist excess. Investors continue to seek Dollar-denominated investments, pessimistically as a hedge on inflation and optimistically as a bet on the US' pioneering role in technological progress.

Rank	Market	2019 Position In USD millions	Share of total
1	Japan	$644,727	14.5%
2	Canada	$580,752	13.0%
3	Germany	$521,979	11.7%
4	United Kingdom	$446,179	10.0%
5	Ireland	$343,538	7.7%
6	France	$310,743	7.0%
7	Netherlands	$290,429	6.5%
8	Switzerland	$224,368	5.0%
9	Australia	$86,537	1.9%
10	Spain	$84,338	1.9%
11	Bermuda	$77,140	1.7%
12	Belgium	$70,073	1.6%
13	Sweden	$61,316	1.4%
14	South Korea	$61,135	1.4%
15	Singapore	$60,138	1.3%

(a) Largest sources of FDI in the US.

Rank	Market	2019 Position In USD millions	CAGR 2014-2019
1	Kuwait	$1,820	41.8%
2	Thailand	$1,684	26.7%
3	Chile	$3,431	21.7%
4	Ireland	$343,538	20.3%
5	Brazil	$45,273	19.6%
6	Bermuda	$77,140	19.1%
7	Netherlands	$290,429	17.1%
8	New Zealand	$2,619	16.7%
9	Turkey	$2,346	16.6%
10	Austria	$6,250	15.3%
11	China	$59,043	15.2%
12	Colombia	$4,080	13.9%
13	Luxembourg	$22,760	13.5%
14	Singapore	$60,138	12.3%
15	Denmark	$23,541	12.3%

(b) Fastest growing sources of FDI in the US.

Figure 4: US FDI statistics for 2019, segmented by country of origin[22].

2.3 The Equity Derivatives Monster

Size and Scope

The insatiable demand for US assets is the first leg of this crypto-synthetics story. The second is the size and scope of equity derivatives more broadly. Exchange-traded equity derivatives are a rapidly growing market around the world. In 2019, equity derivatives volumes saw a year-on-year increase of 18.4%, with the single largest annual volume since 2010, as per Figure 5. This surpassed growth across all other derivative types (commodity, interest rate, currency etc.).

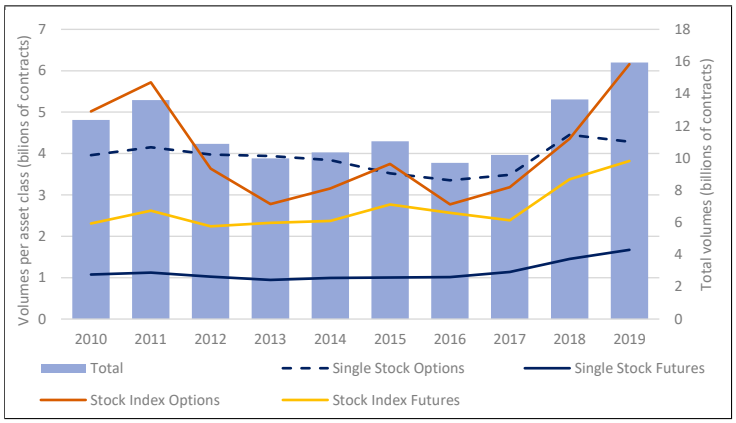


Figure 5: Total global volume of equity derivatives contracts[23].

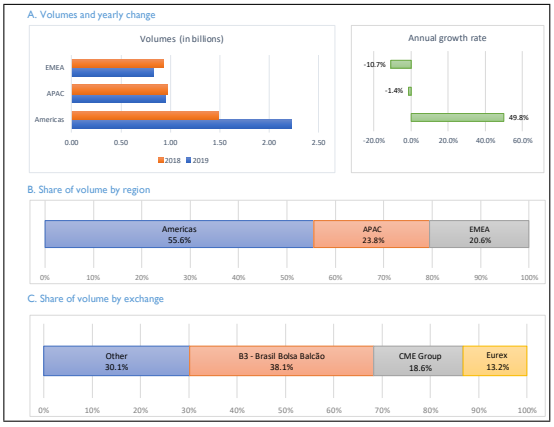
Figure 6 illustrates the vast majority of growth stems from a focus on stock index futures and single stock futures:

- Stock index futures volumes achieved 18.6% growth, accounting for 24.8% of overall equity deriva-

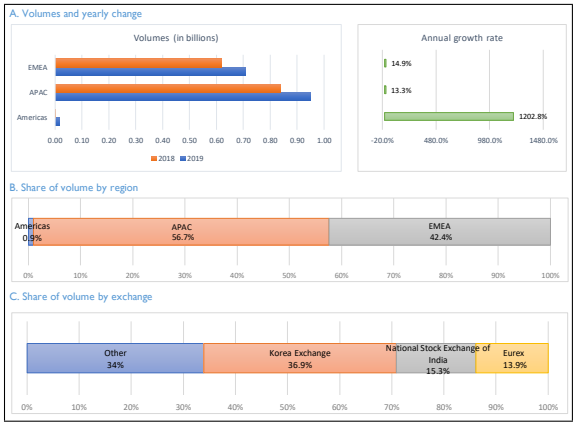
[23] *The WFE's Derivatives Report 2019*. World Federation of Exchanges, 2020. URL: https://www.world-exchanges.org/storage/app/media/IOMA%202020/FH1.2019%20IOMA%20report_%20v13.pdf.

tives volume. The Americas were the largest contributor, accounting for 49.8% of the expansion.

- Single stock futures lagged closely behind at 16.2%, accounting for 10.5% of equity derivatives volume. In this case, the Asia-Pacific region was the key contributor, accounting for 56.7% of the growth, with the Korea Exchange, National Indian Stock Exchange of Index and Eurex Exchange processing 66.1% of all volumes.



(a) Stock index futures.



(b) Single stock futures.

Figure 6: Global equity derivatives statistics[24].

Retail Mania

The retail investor is at the centre of this growing demand for US equities and global equity derivatives. The stock market is no longer the exclusive purview of Wall Street's suits, whether in New York, London or Tokyo. The growth in Main Street's role is best captured by the post-pandemic boom in retail trading, a pattern demonstrated in Figure 7. Yet, arguably, this was simply the acceleration of a secular trend, one that was foreshadowed by the 2019 growth statistics in stock index and single stock futures.

In Q1 2020 alone, the average number of revenue generating trades (DARTs) increased between 72-144% across electronic brokers including Charles Schwab, TD Ameritrade, E-Trade and Interactive Brokers[25].

Accelerated by an industry-wide trend toward zero-commissions trading, retail demand for US equities drove over 1.2 million new users to Fidelity in Q1[27] and a further 3 million users to Robinhood in the first four months of 2020[28]. In an ironic twist, the retail trader may have outsmarted the typical hedge fund manager[29], ignoring gloomy sentiment and rushing to the market after a +30% drawdown in the S&P500 and NASDAQ.

[24] *The WFE's Derivatives Report 2019*. World Federation of Exchanges, 2020. URL: https://www.world-exchanges.org/storage/app/media/IOMA%202020/FH1.2019%20IOMA%20report_%20v13.pdf.

[25] URL: https://www.cnbc.com/2020/05/13/trading-volume-for-electronic-brokers-doubled-last-quarter-and-shows-no-signs-of-letting-up.html.

[26] URL: https://www.bloombergquint.com/businessweek/how-robinhood-s-addictive-app-made-trading-a-covid-pandemic-pastime.

[27] URL: https://www.cnbc.com/2020/06/17/robinhood-drives-retail-trading-renaissance-during-markets-wild-ride.html.

[28] URL: https://www.cnbc.com/2020/08/21/robinhood-is-having-a-moment-users-should-be-careful.html.

[29] URL: https://www.cnbc.com/video/2020/06/08/why-stanley-druckenmiller-says-hes-been-humbled-by-the-market-comeback.html.

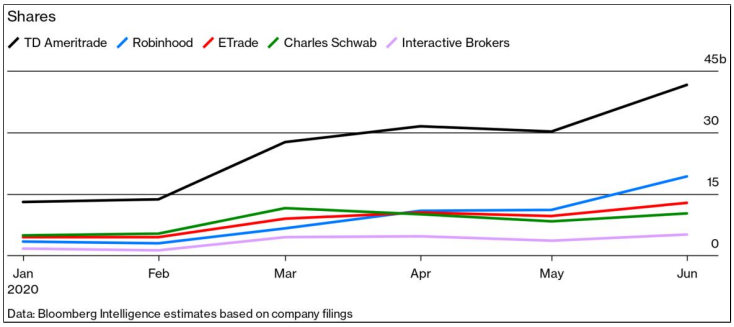


Figure 7: Retail equity trading volume[26].

Bringing Equities to Crypto

In light of this retail mania, cryptocurrency exchanges have also begun their foray into equity offerings. Building a bridge between crypto and traditional assets, FTX recently launched the trading of tokenized US stocks[30]. These tokens are:

- Fully reserved and redeemable on request, representing a claim on the underlying asset.
- Custodied by the licensed German financial institution CM-Equity.
- Traded on spot markets against US dollar stablecoins.
- Traded on leveraged futures markets, marked against the spot pair with unrestricted collateral (including BTC or ETH).
- Restricted to a set of popular technology stocks.
- Tradeable 24/7.

While not the first attempt at bridging the crypto-equity divide (1Broker[31] and Abra[32] were first to market, but experienced major regulatory challenges), we are eager to monitor trading volumes and open interest over the coming year. The success or failure of FTX's offering may signal the level of latent demand for equities within crypto alone.

[30] URL: https://help.ftx.com/hc/en-us/articles/360051229472-Tokenized-Stocks.
[31] URL: https://www.sec.gov/news/press-release/2018-218.
[32] URL: https://www.sec.gov/news/press-release/2020-153.

3 The Promise of DeFi Synthetics

The E-Broker Sleight of Hand

The current landscape for electronic brokerage is relatively concentrated. There are five to six major players, including the likes of Robinhood, TD Ameritrade and Charles Schwab. Many of these giants have come under criticism for opaque and non-transparent order flow.

The industry-wide trend of eliminating trade commissions is not a free lunch. While alluring marketing for retail investors, zero commissions simply shift fee extraction down the value chain. Instead of charging fees on trades, e-brokers now sell order flow directly to market makers who then profit from the bid-ask spread.

Incentives have become muddled. Brokers would once focus on guaranteeing best execution for their clients, but is today simply a race to offload order flow to the highest bidder? Notably, platforms which can attract the least sophisticated investors are likely to sell their order flow for a higher price. Currently, Robinhood charges the most for its order flow on equity and options markets, as per Figure 8. What does this imply about the sophistication of the Robinhood user base?

		Q1 2020		Q2 2020	
Broker	Trade	Payment for Orders	Rate/100 Shares	Payment for Orders	Rate/100 Shares
Robinhood	Equity	$31,116,950	$0.24	$69,116,307	$0.17
	Option	$59,802,125	$0.48	$111,148,089	$0.58
	Total	$90,919,076	$0.36	$180,264,395	$0.30
Charles Schwab	Equity	$25,447,153	$0.11	$32,396,842	$0.11
	Option	$28,517,592	$0.36	$33,745,172	$0.37
	Total	$53,964,745	$0.18	$66,142,014	$0.18
E-Trade	Equity	$29,822,204	$0.16	$50,210,044	$0.15
	Option	$49,829,545	$0.45	$60,117,332	$0.46
	Total	$79,651,749	$0.27	$110,327,376	$0.18
TD Ameritrade	Equity	$72,782,936	$0.15	$144,219,349	$0.15
	Option	$129,597,189	$0.53	$179,991,996	$0.58
	Total	$202,380,125	$0.28	$324,211,345	$0.25

SOURCE: Piper Sandler, SEC filings

Figure 8: Payment for order flow from major retail brokers[33].

Transparency of DeFi

DeFi's emergence presents an opportunity to disrupt the legacy e-broker and expand traditional market exposure to anyone capable of using crypto.

A decentralized and permissionless system to trade equities has a number of advantages over the e-broker model:

- *24/7 Trading* – The ability to trade synthetic assets at any time of the day, regardless of market open or close.
- *Decentralized Exchange* – The ability to trade synthetic assets via on-chain DEXs, with the liquidity benefits of Automated Market Makers (AMMs).

[33] URL: https://www.cnbc.com/2020/08/13/how-robinhood-makes-money-on-customer-trades-despite-making-it-free.html.

- *Protocol Composability* – The ability to leverage/lend synthetic assets as collateral in onchain lending/borrowing protocols.
- *Transparent Fees* – Understand exactly how fees are charged on trading and execution.
- *No Counterparty Risk* – Assuming correct protocol and oracle function, maintain exposure to an asset without centralised exchange risk.

4 Mirror: The Standard For Tokenized Crypto Synthetics

In this section, we now introduce Mirror, a protocol for the creation and exchange of permissionless synthetic assets, built on the Terra blockchain. We will do this by first mapping out the critical protocol considerations for any crypto-synthetics product and Mirror's proposed solutions.

We believe Mirror will bring the vision of crypto-synthetics to life. It is one of the few capital-efficient crypto economic systems bridging traditional markets with DeFi, building on the TradDeFi paradigm.

4.1 Protocol Considerations

Mirror allows users to issue synthetic assets that track the price of real world assets. Building this type of system requires an intricate economic foundation. Since the system is inherently leveraged, there are several key considerations to ensure it remains sufficiently collateralized and thus solvent:

- *Collateralization* – What is the appropriate collateral to back these synthetic assets? What is a safe, yet efficient leverage ratio?
- *Synthetic Creation / Closure Dynamics* – How are synthetic assets minted or burned?
- *Risk Management* – Is risk pooled or segregated amongst different types of synthetic assets? How does the protocol liquidate undercollateralized positions?
- *Price Oracle* – How does the protocol source a robust, decentralized price feed?
- *Decentralized Exchange* – How are synthetic assets traded? How are long or short positions expressed?
- *Governance Token & Liquidity Incentives* – What is the purpose of the native system token? How is system liquidity and market depth bootstrapped? What is the appropriate protocol fee? How is value distributed and accrued to protocol stakeholders?

4.2 Mirror Mechanism Design

In the following sections, we describe the Mirror protocol with respect to the considerations above.

4.2.1 Collateralization

Mirror's objective is to allow users to gain price exposure to real world assets while:

- Maximizing capital efficiency (i.e. minimising the collateralization ratio).
- Maintaining system solvency (i.e. ensuring the value of minted synthetic assets does not surpass the value of underlying collateral).

Collateral Type

Collateral selection is the key to achieving these two objectives. Users seek exposure to volatile assets like US technology stocks. If the underlying collateral is more (or even as half as) volatile than the synthetic, the system must be vastly overcollateralized in order to avoid bankruptcy. Put simply: if a crypto-synthetics platform is collateralized by a highly volatile collateral like a floating-price crypto-asset, then the system itself is at the whim of collateral fluctuations. This can jeopardize the system's efficacy,

since ***users seek capital efficient exposure to the synthetic asset itself***, not the underlying collateral.

In the ideal case, the collateral asset should:

- Exhibit a low standard deviation in price over long time frames.
- Trade in a relatively liquid market that can absorb sudden market orders without significant slippage.

Given these considerations, Mirror opts for stablecoin as the collateral type, initially TerraUSD (UST), generated by the Terra blockchain. While TerraUSD is new to Terra, its Korean Won counterpart TerraKRW (KRT) has traded for over a year under high demand conditions. Namely, TerraKRW today powers Chai, one of the largest e-commerce wallets in Korea, which hosts over 2 million users and generates $1.2 billion in annualized transaction volume[34]. Figure 9 shows KRT has demonstrated price stability over its history, with a mean of 0.99 KRW per KRT and a standard deviation of 0.006 since mid-2019. TerraKRW currently trades with approximately $1 million of daily volume, and we expect TerraUST to achieve similar traction as a US dollar pegged stablecoin.

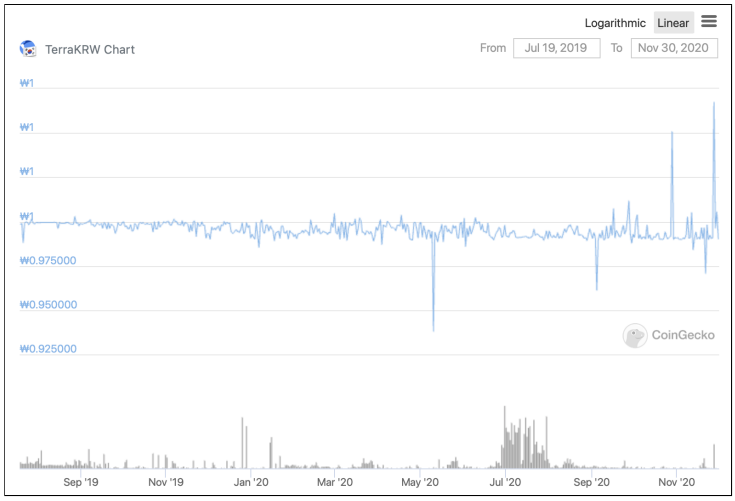


Figure 9: Historical KRTKRW price from mid-2019[35].

Collateralization Ratio

Mirror opts for a minimum collateralization ratio of 150%. In other words, for every $1 of collateral, users can mint a maximum of $0.67 worth of synthetics. Stablecoin collateral unlocks this degree of capital efficiency, contrasting systems that rely on crypto-assets as collateral.

Leveraged Trading: Synthetic Assets As Collateral

In Mirror, users can also use the synthetic assets themselves as collateral for further minting. This allows for leveraged trades. If a synthetic is used as collateral, the minimum collateralization ratio rises to 200%.

[34] URL: https://medium.com/terra-money/announcing-terrausd-ust-the-interchain-stablecoin-53eab0f8f0ac.
[35] URL: https://www.coingecko.com/en/coins/terra-krw.

4.2.2 Synthetic Creation / Closure Dynamics

On Mirror, any user can propose new markets. Once approved by holders of the native governance token (discussed in Section 4.4), the market will open for collateral deposits and synthetic asset creation via Collateralized Debt Positions (CDPs).

As discussed in Section 4.2.1, assets minted on Mirror with stablecoin collateral have a minimum collateralization ratio of 150%:

$$\text{CR} = \frac{\text{SC}}{\text{SAV}} \geq 150\%$$

$$\begin{aligned} \text{where CR} &= \text{Collateralization Ratio} \\ \text{SC} &= \text{Stablecoin Collateral} \\ \text{SAV} &= \text{Synthetic Asset Value} \end{aligned}$$

Given the stability of the underlying collateral, the collateralization ratio is inversely proportional to the Synthetic Asset Value. Considering a CDP with a CR of 150%:

- If the value of the synthetic rises, then the position becomes undercollateralized
- If the value of the synthetic falls, then the position becomes overcollateralized.

In other words, minting on the Mirror protocol via stablecoins represents a short position on the synthetic, unless the synthetic itself is used as minting collateral (which represents a leveraged long position on the synthetic). Minting operations with stablecoin collateral may become the domain of short sellers or sophisticated market makers, as well as yield farmers who accrue trading fees while hedging this net short exposure elsewhere.

Once minted, synthetic assets are freely transferable on the Terra blockchain. Synthetic assets can be burned at any time, redeeming the underlying collateral. Minting and burning is the equivalent of increasing or decreasing the total "open interest" on the synthetic.

4.2.3 Risk Management

If a CDP falls below the minimum collateralization ratio, the system auctions off the collateral at a 20% discount to anyone able to cover the CDPs synthetic asset. This liquidation auction mechanism incentivises sophisticated participants to mint – or purchase on the market via Terraswap (discussed in Section 4.2.5) – the required synthetic and redeem the discounted collateral. System solvency relies on the proper functioning of this mechanism over time.

Mirror segregates risk management. Collateral in one market is only available to that particular market. The protocol can thus support assets with differing volatility profiles without exposing the entire system to insolvency risk.

If Mirror took a pooled risk approach instead – where all synthetic assets were issued against a single reserve of stablecoins – then the collateralization ratio would have to be calibrated to the highest volatility asset. This again reduces capital efficiency and creates unnecessary burdens on the system.

In our view, pooled collateral is suboptimal. Why should the collateral requirements be the same between US 30 Year Treasury Bonds and US West Texas Intermediate Oil?

The tradeoff with Mirror's segregated approach is that liquidity cannot be aggregated and each synthetic market must independently accrue market depth.

4.2.4 Price Oracle

The price oracle is one of the most important components of the system, providing mark-to-market pricing for all synthetic assets and ultimately determining a position's solvency. In Mirror, the system uses an onchain oracle provided by Band Protocol[36]. The oracle posts prices every 6 seconds, roughly the block time of the Terra blockchain.

4.2.5 Decentralized Exchange

Mirror implements a Constant-Function Automated Market Maker (CFMM) – Terraswap – as a decentralized exchange mechanism for trading synthetic assets against stablecoins. This is equivalent to simply transferring ownership to another party, since there is no change in CDP status and total open interest does not change (unlike minting or burning).

The CFMM employs a constant-product function, like Uniswap, based on the equation $x \times y = k$. Each market is by default a 50:50 pair between the synthetic asset and the TerraUSD stablecoin. One important difference is that each pair can be optimised to the volatility of its particular synthetic asset, allowing for the customization of minimum and maximum spreads as well as commissions.

4.3 Architecture

Mirror is deployed on Terra, a high performance blockchain that powers a family of algorithmic stablecoins. Terra provides both the technical infrastructure as well as the economic primitives at the core of Mirror.

4.3.1 Technical Infrastructure

Terra is built on Tendermint[37], a delegated-proof-of-stake consensus technology utilized by the Cosmos ecosystem. The Tendermint blockchain is capable of over 1,000 transactions per second, with sub-10 second blocktimes. The latest upgrade to the Columbus-4 MainNet integrated CosmWasm[38], enabling Terra to embed a WebAssembly runtime environment and facilitate expressive smart contracts.

These characteristics make it a strong fit for a leveraged synthetic asset protocol like Mirror:

- Oracle updates can occur every $\approx$ 6 seconds, approximately the block time. Compared to other platforms, the higher poll rate translates into greater protocol safety, as the system can regularly confirm CDP solvency.
- High throughput translates into high certainty in trade execution. This is critical during liquidation events, where auction participants bid on discounted collateral and have short windows to execute on arbitrage opportunities.

[36] URL: https://bandprotocol.com.
[37] URL: https://tendermint.com.
[38] URL: https://agora.terra.money/t/col-4-upgrade-governance-proposal/246.

4.3.2 Economic Primitives

Beyond these technical foundations, Terra's stablecoin system underpins Mirror collateral. While a full discussion of Terra is beyond the scope of this paper, it is important to outline the basic operation.

The economic foundations of Terra are similar to today's central bank monetary policy[39]. Using the US as an illustrative example:

1. **During economic booms**, the economy expands, driving demand for the US Dollar. The Federal Reserve responds by raising rates, and/or auctioning off new US Treasury Debt (bonds). Both of these have the effect of reducing the supply of the US Dollar, and "slowing down" the economy.
2. **During economic busts**, the economy contracts, reducing demand for the US Dollar. The Fed responds by dropping rates, and/or buying back US Treasury Debt from the market (Quantitative Easing, Yield Curve Control etc.). Both of these have the effect of increasing the supply of the US Dollar, "stimulating" the economy.

The Terra Protocol functions in a similar way to the "Central Bank Protocol" described above, instead the central bank is replaced by the supply of the native token LUNA and the currency is replaced with TerraUSD:

1. **When the Terra Protocol economy is growing**, demand for TerraUSD rises, causing the stablecoin to trade at a premium. The Terra Protocol responds by minting TerraUSD and buying back LUNA. This increases the supply of TerraUSD and thus restores the peg back down to parity. The LUNA "bought back" by the protocol is called seigniorage, the value captured by printing and selling a currency at zero cost. The seigniorage gains are partially burnt, making LUNA scarcer, and the remaining portion is sent to the protocol treasury.
2. **When the Terra Protocol economy is contracting**, demand for TerraUSD falls, causing the stablecoin to trade at a discount. The Terra Protocol responds by minting LUNA and selling for TerraUSD. This has the effect of decreasing the supply of TerraUSD, restoring the peg back up to parity. In this case, all the repurchased TerraUSD is burnt, and none is sent to the treasury.

This economic design is a simple yet elegant adaptation of modern monetary policy. It creates the foundation for permissionless stablecoins, and is validated by TerraKRW, which has historically traded extremely close to parity. Mirror is launching with support for TerraUSD, but is likely to support the entire family of Terra stablecoins in the future.

4.4 Distributing Ownership: MIR Governance Token

The Mirror governance token (MIR) is the native asset of the protocol. The token governs system parameters, including minimum collateralisation ratios, supported collateral and supported synthetic assets. Users must stake MIR to participate in protocol voting.

To incentivise liquidity for Mirror assets, MIR will be rewarded to Terraswap LPs who provide liquidity in Terraswap pools. This will encourage the minting of synthetic assets and bootstrap initial liquidity for users seeking long exposure to synthetics.

MIR's value accrual extends beyond qualitative governance benefits. From initial launch, two mechanisms will directly tie protocol usage to the MIR token, providing a benchmark for valuation and sustainable

[39] *Terra Money: Stability and Adoption*. Terraform Labs, 2019. URL: https://terra.money/Terra_White_paper.pdf.

incentives for ongoing liquidity provision:

- *Trading Fees* – Terraswap fees are configured to 0.3% of trading volume, where 0.25% is redistributed to pool LPs and the remaining 0.05% to MIR token stakers. These fees will enabled post launch once Terraswap achieves sufficient liquidity and volume
- *CDP Closure* – CDP closure incurs a 1% fee on stablecoin collateral. This fee is aggregated daily and used to repurchase MIR tokens on Terraswap. Purchased tokens are redistributed to LPs who provide liquidity to the MIR pair on Terraswap. These fees are enabled immediately from launch.

In line with Table 1, Mirror takes a community first approach to governance, adopting a token distribution strategy which rewards both Mirror protocol contributors and broader DeFi participants. There is no team controlled pre-mine, and all tokens are allocated as AMM liquidity mining rewards, as well as an airdrop to token holders in the Uniswap and Terra ecosystems.

Table 1: MIR token allocation.

Category	**Distribution**	**Percentage (of the Year 1 Supply)**	**Description**
Airdrop	UNI Holders	5%	Distributed at genesis to UNI holders.
	LUNA Stakers	15%	5% distributed at genesis to LUNA stakers, followed by 10% distributed block-by-block to LUNA stakers over 1 year.
Synthetic Asset LP Rewards*	Uniswap	5.625%	Distributed over 1 year to Uniswap Synthetic-UST LP token stakers.
	Terraswap	24.375%	Distributed over 1 year to Terraswap Synthetic-UST LP token stakers.
MIR LP Rewards*	Uniswap	5.625%	Distributed over 1 year to Uniswap MIR-UST LP token stakes.
	Terraswap	24.375%	Distributed over 1 year to Uniswap MIR-UST LP token stakes.
Community Development Fund**		20%	Onchain treasury governed by MIR token holders, requiring a minimum 50% voting quorum to be spent. Used to fund the developer ecosystem and establish future liquidity incentive programs.

*LP rewards will continue for an additional 3 years through inflation. Rewards for years 2, 3 and 4 decay at a rate of 50% of the previous year.
**The Community Development Fund will be replenished for an additional 3 years through inflation. The rate of growth will be 10%, 20% and 20% of the Year 1 Supply in years 2, 3 and 4 respectively.

5 Conclusion: The Future of TradDeFi

Today's uncharted monetary landscape is matched only by the radical experiments in DeFi. We believe that synthetic asset creation is one of the most compelling opportunities for these two worlds to come together. Synthetic assets are DeFi's "1-to-N" opportunity to absorb capital seeking a home in global and diverse markets without permission from gatekeepers.

Mirror is Terra's answer to synthetic assets, leveraging a performant blockchain and economic model to invent a protocol where any asset can be "mirrored" on-chain. It represents a unique alternative to centralised exchanges and e-brokerage platforms, with 24/7, on-chain, capital efficient minting, settlement and trading of US equities. In the future, almost any asset will be tradeable on Mirror.

DeFi will continue to flourish and inevitably charge its way into the corridors of traditional finance with open and transparent financial systems. Synthetic assets are at the heart of this quest to reimagine, among other things, financial markets. We are excited to watch Mirror's economic and technical vision come to life and ultimately set the standard for synthetic asset creation and trading.