



BARNBRIDGE

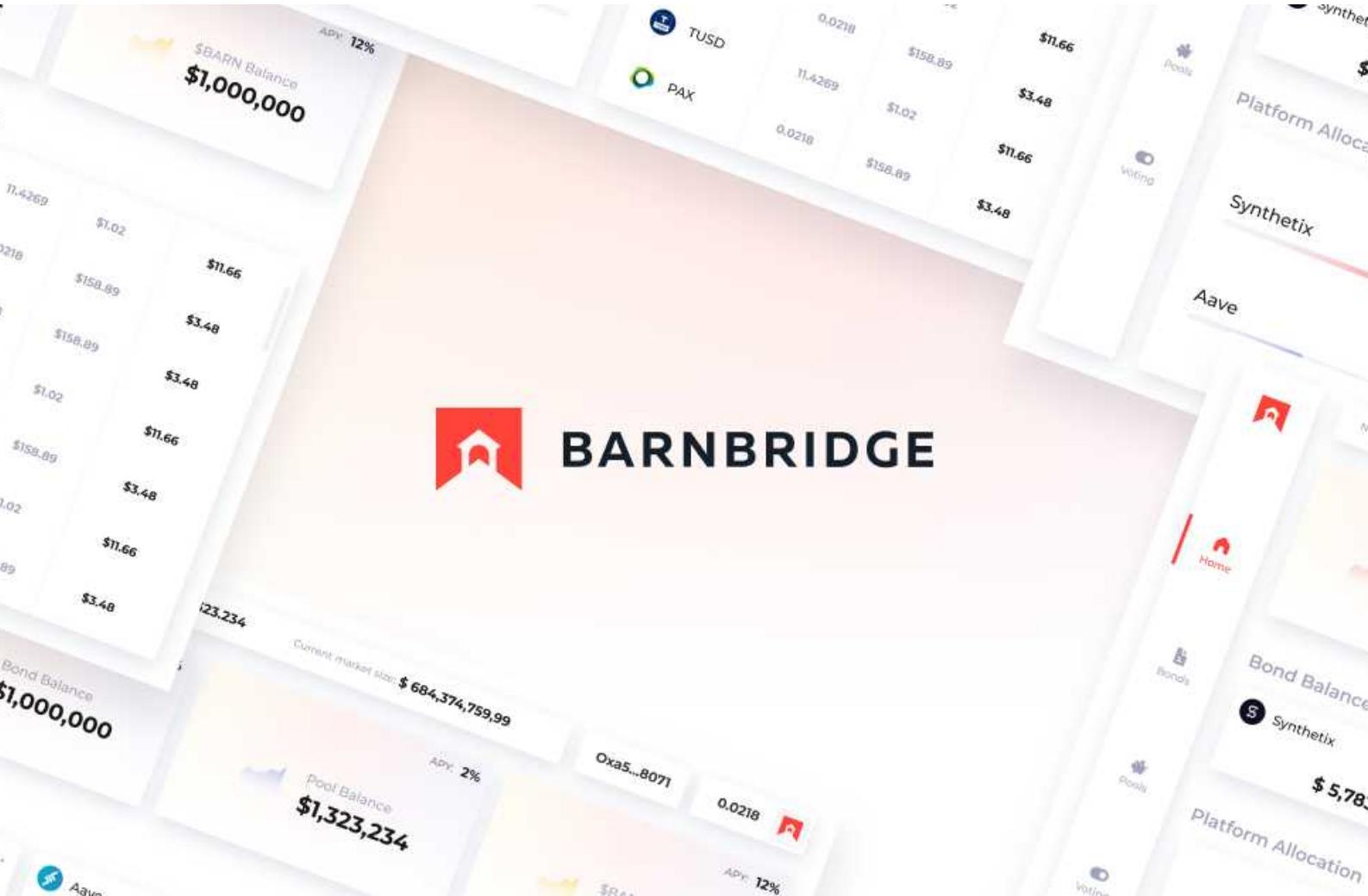
Introduction to **SMART Yield**



SMART Yield is the first fixed income product from BarnBridge, a risk tokenizing protocol. By introducing an elegant yield sharing mechanism, SMART Yield is able to offer the first structured products in decentralized finance (DeFi) that mirror the safety and security of highly-rated debt instruments offered by traditional finance (TradFi) while still providing the outsized return. In this document, we will dive into the details and mechanisms behind how SMART Yield is delivering tranched risk, fixed income products, and guaranteed risk-adjusted returns to capital-conscious investors.

Before we dive into SMART Yield, it is worth introducing BarnBridge and the important role it plays in bringing to DeFi the products that were once esoteric to TradFi alone. BarnBridge is a risk tokenizing protocol. It allows users to hedge factors like yield sensitivity and price volatility by accessing debt pools on other DeFi protocols, and transforming single pools into multiple assets with varying risk/return characteristics.

BarnBridge was originally conceived in Q2 2019 and started getting built a year later, in May 2020. It was officially introduced in September 2020. BarnBridge aims to facilitate the transition to a decentralized financial system addressing some key aspects of institutional activity, such as risk management and access to fixed income instruments.



Overview

What is SMART Yield

SMART Yield allows users to mitigate the variable yield volatility of other projects, such as Aave, Compound, or Yearn Finance, by introducing senior and junior tranche derivatives.

Users are able to mint junior or senior tokens which represent accordingly-tranches deposits into the underlying protocol. Junior token holders provide the liquidity necessary for senior bond investors to be able to receive fixed yield. The risk present is that, should the underlying variable rate annuities fall below the level necessary to meet senior debt obligations, junior yields and potentially even principals would be algorithmically reallocated to cover.

At the same time, juniors will benefit from the extra yield generated by senior deposits in cases where the variable rate of the underlying debt pool (including any associated token subsidy rewards) are higher than the weighted average guaranteed yields of current seniors. It is expected that the junior positions will have more capital in a given pool than the senior ones.

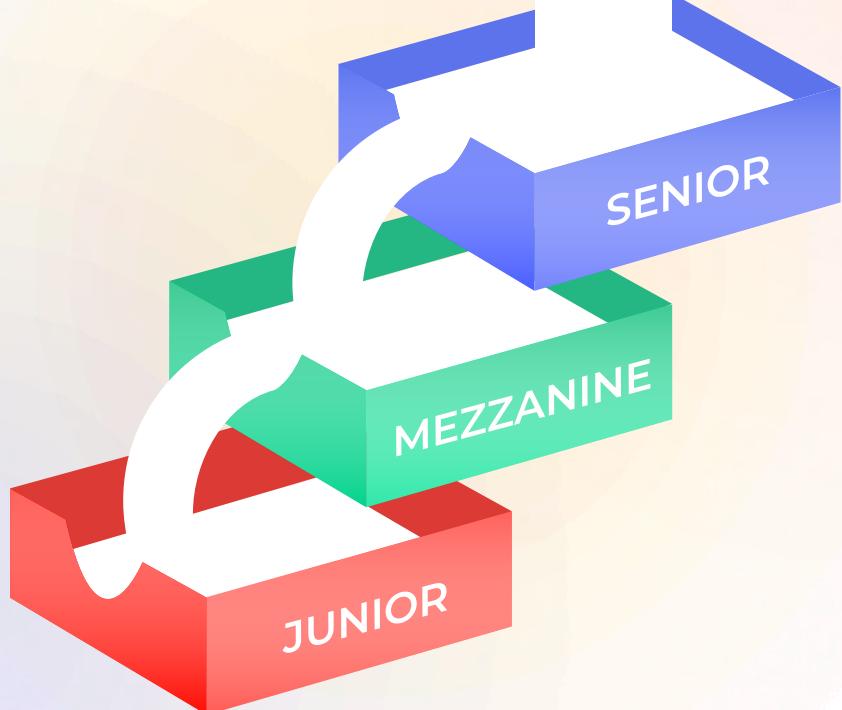


Why It is Different

SMART Yield differs from traditional structured debt products in a number of ways. At a high level, SMART Yield products allow for users to tranche out the available yield from the debt pools or other products to normalize the risk curve by creating derivatives for risk mitigation. As such, the risk profiles and associated returns of each tranche are determined by the depth and liquidity of the subordinate securitizing tranches beneath it coupled with the available cost of capital in the decentralized lending markets, rather than the composition and character of the underlying debt upon which their traditional counterparts rely.

To better illustrate this, let's take a look at a simple residential mortgage-backed security (RMBS) trashed out into senior and subordinate bonds. A RMBS is created when a large group of many residential mortgages are combined into one larger debt pool, which cash flows are then subdivided into a number of fixed-income securities that are sold to investors at various levels of risk and return with the senior-most bonds receiving the lowest interest rate - or "coupon" - in exchange for getting the first claim on incoming cash flows. Each subordinate bond is then given a slightly higher coupon in exchange for taking on more risk by occupying a place further down the cash flow waterfall.





With SMART Yield products, the underlying debt is replaced by the yields made available by lending in the debt pools of other projects, such as Compound, Aave, Cream or Yearn Finance. The combined collateral provided by SMART Yield investors is deployed via smart contract to generate the highest return on capital across these various projects. As these yields themselves are variable in nature, SMART Yield employs a creative and elegant strategy to recreate the guaranteed rate of return by creating two distinct assets: senior sBONDS and junior jTokens.



How It Works

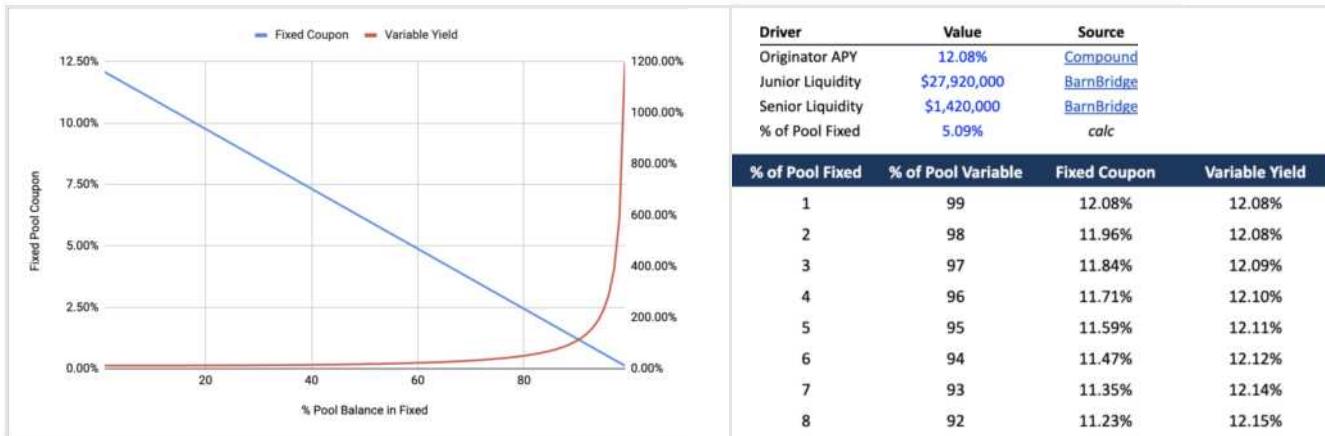
SMART Yield's innovation lies in the elegant way it transfers risk from investors looking to achieve stable, capital-conscious returns to those willing to bear the additional risk in exchange for any excess gains realized over the lifespan of the "bond". By removing the reliance upon flawed third party intermediaries and using the subordinate junior pool to effectively ensure the returns of the senior instrument, SMART Yield is able to offer guaranteed returns with a level of security greater than that of even AAA-rated securities in traditional markets. This is because smart contracts can guarantee coupon delivery at maturity.

Let's take a quick look at how this works with some real-world numbers. Below you will find a snapshot of the current rates available in the Compound SMART Yield pools.

Token Name	Senior Liquidity	Senior APY	Junior Liquidity	Junior APY	Originator APY	Token conversion rate	Wallet balance	
 USDC USD Coin	1.42M USDC \$1.42M	4.85%	54.56M USDC \$54.56M	4.82% +42.97%	4.93%	1 bb_cUSDC ≈ 1.0324 USDC	0 USDC \$0.00	Details
 DAI Dai Stablecoin	0 DAI \$0.00	6.72%	41.18K DAI \$41.18K	6.62%	6.62%	1 bb_cDAI ≈ 1.0023 DAI	0 DAI \$0.00	Details



We can see the source of yield, in this case the USDC debt pool on Compound Finance, is currently yielding 12.08% APY to depositors (quoted above under “originator APY”). We are also able to see the relative pool weights with nearly \$28m of junior pool collateral securitizing the \$1.4m of capital invested into the senior tranche. By visiting the rate curves, we are able to see how the originator APY is divided across the two pools.



At approximately 5% of the total liquidity committed to the senior “fixed” pool, SMART Yield is able to offer a fixed coupon of 11.61% for any investor that wants to commit new capital to the senior tranche, at maturities of up to one year. This coupon is then ensured by the collateral provided by participants in the junior “variable” pool. In exchange for providing this insurance, the junior pool investors receive the residual 0.47% of the originator APY not claimed by the senior pool investors. Additionally, as shown in the SMART Yield



screen capture above, junior pool participants are further incentivized with rewards in the form of BOND, the native governance token of the BarnBridge protocol.

Important for investors to understand is how exactly the junior tranche position effectively “insures” the returns of the senior tranche. When a user commits capital to the junior pool, a certain portion of that capital is held in reserve to ensure that the senior pool participants receive their quoted coupon. As stated earlier, the willingness to take on this additional risk is compensated in the form of claims on all residual cash flows as well as protocol incentives. Let’s continue with the above example to see how this works:

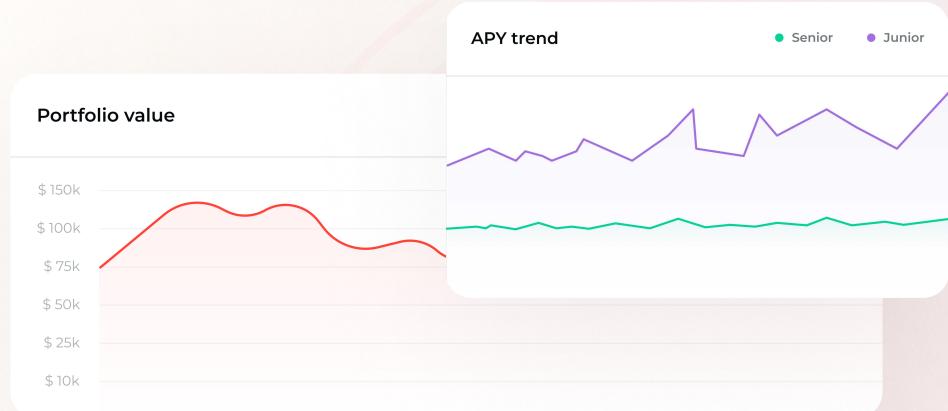
For simplicity's sake, we will assume a homogeneous composition of the senior pool with weighted-average maturity and coupon of 1 year and 11.61%, respectively. At \$1.42m of principal, we can expect that the collective senior pool will receive an additional \$164,862 at maturity. In order to guarantee this return, \$164,862 of the collateral provided by the junior pool will be held in reserve until these returns are realized by the senior pool investors. This amounts to 0.59% of the committed capital in the junior pool. Any junior pool participant that wishes to redeem their position must either sacrifice a commensurate percentage of their original investment

if they wish to do so immediately, or defer redemption until the associated seniors reach maturity.

This balancing mechanism serves to not only guarantee the returns of the senior tranche investors, but also stabilize the inflow and outflow of capital into the junior pool and therefore, allowing the smart contract to more efficiently and effectively deploy the capital across yield-optimized strategies.

How to Use It

[Read Documentation](#)



Technical Details

Introducing sBONDS

SMART Yield senior tranches are represented by ERC-721 non-fungible tokens (sBONDS) that have a guaranteed yield for the lifespan of the bond. Senior tranches have fixed APY and are less risky compared to junior tranches.

The set of features that a senior bond has is:

- principal - the amount deposited in the bond;
- gain - the amount of token that will be gained (this is used to determine the APY);
- issuedAt - the issuance date;
- maturesAt - the maturity date;
- liquidated - a flag used to determine if the senior bond was redeemed or not.



Senior Tranche APY

Senior APY determines the annual percentage for senior bonds at the current time.

It can be derived for any and all senior bonds in existence by annualizing the percentage difference between the deposited value and the gained value using the following formula:

```
((gain/principal) / (maturesAt - issuedAt)) * 365 * 100
```

The screenshot shows the SMART Yield platform interface. At the top, there's a sidebar with icons for Home, Markets, Portfolio, Pools, and a search bar. The main header says "SMART Yield" and has a "Connect Wallet" button. Below the header, there are tabs for "Markets" (which is selected), "Portfolio", and "Pools". There are three cards: "Compound Markets" (selected), "Aave Coming soon", and "Yearn Finance Coming soon". A summary section shows "Compound total liquidity" of \$56,007,744.02. The main table displays two rows of data:

Token Name	Senior Liquidity	Senior APY	Junior Liquidity	Junior APY	Originator APY	Token conversion rate
USDC USD Coin	1.42M USDC \$1.42M	5.65%	54.55M USDC \$54.55M	10.66% +4.87%	10.63%	1 bb_cUSDC = 1.0324 USDC
DAI Dai Stablecoin	0 DAI \$0.00	6.77%	41.18K DAI \$41.18K	6.68%	6.68%	1 bb_cDAI = 1.0023 DAI

Each row has a "Details" button on the right. The "Senior APY" column for both rows is highlighted with a red border.



The SMART Yield ABOND

In order to provide the best UX for juniors and encourage them to participate in our SMART Yield pools, we want the system to allow them to join the pool at any time. Moreover, we want the possibility of instant withdrawal of at least part of their funds, without affecting the integrity of the system and keeping the guarantees.

To do that, we have to be able to calculate the profits and losses of the pool very efficiently. We do that by averaging all existing senior bonds into one "weighted average" aBOND with the following properties:

- Principal locked (sum) -> ABOND.principal
- Guaranteed rewards (sum) -> ABOND.gain
- Start timestamp -> ABOND.issuedAt
- Weighted average end timestamp -> ABOND.maturesAt

The aggregate sBOND (aBOND) represents the current senior pool and will help us calculate its health at an instant. If the rewards generated by the senior pool so far exceed the guaranteed rewards at this time (abond.paid), the extra reward can be considered profit for the junior pool (and loss if it's negative).

aBOND parameters are recalculated each time new senior bonds are purchased.



Introducing jTokens

Positions in a junior tranche are represented by fungible ERC-20 tokens (jTokens) which provide liquidity and buy risk from senior bond investors, in exchange for ensuring the APY/coupon of the senior tranche position holders. Junior tranches have variable APY and are more risky than senior tranches.

Junior tranche position holders will benefit from the extra rewards generated by liquidity locked in sBONDs by seniors in situations where the variable APY of Compound (including the COMP rewards) is higher than the guaranteed yields of current sBONDs. On the other hand, in the event of falling rewards from Compound, the returns of juniors are diminished. If necessary, their locked funds will be used to pay for the guaranteed returns of sBONDs.

In order to provide the best UX for juniors and encourage them to participate in SMART Yield pools, the system will allow them to join the pool at any time. Moreover, they will have a possibility of instant withdrawal of at least part of their funds, without affecting the integrity of the system and keeping the guarantees.

To do that, we calculate the profits and losses of the pool very efficiently. We do that by averaging all existing sBONDs into one “weighted average” sBOND.



Junior Tranche APY

The junior tranche APY determines the annual percentage yield for junior tokens at the current time. The APY for your junior position is realized when selling your junior tokens for their respective underlying tokens, at whatever the current ratio is. The conversion rate of junior tokens starts at 1:1, and slowly grows (or drops) when interest accrues. Depending on the annualized difference between your purchase and sell price you can calculate your APY.

Whenever senior positions have to be filled by junior funds (in the case that the underlying lending protocol offers lower rates than current seniors get), the price drops.

Otherwise, whenever yield accrues to junior positions that leverage senior funds, the conversion rate increases.

The screenshot shows the SMART Yield platform interface. At the top, there are navigation links for Markets (highlighted in red), Portfolio, and Pools. Below this, there are three cards: Compound Markets (selected), Aave (Coming soon), and Yearn Finance (Coming soon). The main section displays Compound total liquidity: \$56,007,744.02. Below this, a table compares liquidity and APY for USDC and DAI:

Token Name	Senior Liquidity	Senior APY	Junior Liquidity	Junior APY	Originator APY	Token conversion rate
USDC USD Coin	1.42M USDC \$1.42M	5.65%	54.55M USDC \$54.55M	10.66% +43.87%	10.63%	1 bb_cUSDC = 1.0324 USDC
DAI Dai Stablecoin	0 DAI \$0.00	6.77%	41.18K DAI \$41.18K	6.68%	6.68%	1 bb_cDAI = 1.0023 DAI



Junior Bonds

The junior bonds are represented by ERC-721 non-fungible tokens (NFTs) that have a value denominated in junior tokens (jTokens), and a maturity date equal to that of the aBOND. These special types of bonds are issued as part of the 2-step withdrawal process.

A junior tranche position is subject to senior tranche risk. For a jToken holder to exit the pool, the current sBONDS need to mature. Because it is computationally intensive and gas inefficient to track each and every sBOND with each tx, we opt to use the Aggregated Bond (aBOND) as an approximation for the senior tranche.



SMART Yield at Work

Scenario 1



Scenario 2



In order to illustrate the mechanisms behind SMART Yield, let's examine a hypothetical sequence of events extrapolated from a sample composition of senior and junior liquidity within SMART Yield. The characteristics at our starting point are as follows:

- TVL: \$1.43M in senior + \$32.82M in junior = \$34.26M TVL (4.17% senior vs. 95.83% junior)
 - Senior pool: \$1.43M volume, 10.52% APY
 - Junior pool: \$32.83M volume, 10.94% APY



Let's also define some key variables and acronyms:

- Senior Dominance: % of total liquidity (senior pool + junior pool) in senior pool
- Committed Pool APY: Weighted average APY of all senior bonds outstanding
- Weighted Average Maturity ("WAM"): Weighted average maturity of all senior bonds outstanding
- Interest Owed: Aggregate interest owed to collective senior holders
- Required Reserves: Amount of junior collateral locked up as safety net to guarantee all outstanding seniors are paid out in full (principal + committed pool APY) at maturity
- % Locked Up: Required Reserves / Total Junior Liquidity



Now let's consider a 10-event sequence - found in the 'Event Schedule Example' tab of the [attached model](#) - and examine the impact/outcome of the events:

Want to see our models?

[View Model](#)

\$1M added to senior pool with a 60 day term

- Infusion of capital to the senior pool increases senior dominance - thereby increasing the aggregate Interest owed to seniors & required reserves to ensure the seniors get paid out in full + interest
- WAM decreases since this contribution to the senior pool with an earlier maturity (60 days) than the starting WAM (168 days); drawing down the weighted average
- Base APY for the junior pool increases to reflect the added risk being taken on by increased % of Junior liquidity locked up (moves directly with reserve requirement) to secure the senior yield. Rewards APY remains unchanged as no new capital has entered the junior pool



\$2.5M added to the junior pool

- Additional inflow of capital to Junior pool decreases junior rewards APY (fixed 10k weekly rewards distributed across cross larger capital pool)
- Similarly, junior risk is reduced as less % of capital is locked up to cover senior yield - derisking the junior positions and bringing junior base APY closer to originator APY (reducing premium)

A couple weeks later, demand on Compound has fallen (reducing originator APY) and \$5.75M is removed from junior pool

- When the liquidity is removed, the removing user is given one of two withdrawal options: immediate or delayed. They differ in the following ways:
 - Immediate withdrawal: because the junior pool effectively guarantees the coupon due to the committed senior positions, a small portion of the Junior pool is held in reserve to ensure these coupons are paid out. In this example, at the time of withdrawal, 0.22% of the junior pool is locked up to ensure the Outstanding senior pool coupon commitments.



As such, the true withdrawal amount is -\$5,737,291, not counting any accrued interest, rewards or gains. Existing senior positions maintain pre-existing APY

- Delayed withdrawal: a user wishing to withdraw liquidity is also given the option to receive their entire position amount if they are willing to defer the withdrawal event by a number of days equal to the weighted average maturity of the existing senior obligations. In this case, if the user were to choose this option his or her withdrawal would be delayed by 107.75 days, the WAM at the time.
- Quoted rate for new seniors at more of a discount relative to originator APY while quoted rate for juniors at more of a premium relative to originator APY (though still lower nominally due to reduced originator APY) since the % locked up is now higher, meaning higher risk for juniors



\$1M of senior added in event 1 expires and is paid out

- The original principal (\$1M) plus interest (11.48% committed APY * (365/60 duration)) is paid out to the senior holder
- Senior dominance falls, required reserves decrease, and the junior positions are de-risked; Junior quoted APY converges with originator APY while quoted rate for new seniors becomes more attractive relatively

\$3.5M added to senior pool with a 365 day term

- This capital infusion to the senior pool, larger in size and duration than that seen in Event 1, causes more pronounced effects: senior dominance now spikes to 14.3% while also more than doubling WAM
- The senior pool rate drops to its lowest (relative to originator APY) due to relative lack of junior liquidity on the other side to cover risk



In order to summarize, we can observe the trends of Smart Yield's mechanism design:

As senior liquidity enters, required reserves increase to ensure these users are paid in full at maturity (calculated as weighted avg of maturity*weighted avg locked). Since senior APY is necessarily below the Originator APY, this drives up junior APY, incentivizing new contributions to the junior pool. Equal amounts of liquidity added to the senior pool for a longer duration has a more significant impact on % of junior pool locked as the longer time to maturity equates to a more substantial increase in reserve requirements (APY on contributed capital applied over a longer duration) - this can be observed by the impacts of Event 1 (60 day lock) vs. Event 5 (365 day lock).

As junior liquidity enters and the junior pool volume increases relative to that of the senior pool, the required reserve to pay the seniors is spread across a larger pool of junior liquidity, decreasing the % of the junior pool locked up to cover the required reserves.



Resources



Website



Launch app



Discord



Twitter



Medium



YouTube



GitHub



SY Models



Let's stay in touch!

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