Firyx: Decentralized Concentrated Liquidity Lending Protocol

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Abstract

The decentralized finance (DeFi) landscape, while innovative, is hampered by significant barriers to entry and systemic inefficiencies. Current lending protocols demand over-collateralization, excluding a vast majority of potential users. Simultaneously, capital often lies idle, liquidity is ephemeral, and the economic incentives between lenders and borrowers are fundamentally misaligned. Firyx introduces a paradigm-shifting protocol that addresses these challenges head-on. By enabling trustless non-collateralized lending, integrating with the Hyperion Concentrated Liquidity Market Maker (CLMM), and pioneering an integrated principal-yield design, Firyx unlocks capital efficiency, ensures sustainable liquidity, and creates a symbiotic relationship where both lenders and borrowers thrive. This paper outlines the core problems in modern DeFi and details Firyx's architectural, conceptual, and economic solutions.

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1 Introduction

1.1 Background

Today's dominant lending protocols, such as Aave and Compound, are built on an over-collateralization model. This requires users to deposit assets of greater value than the amount they wish to borrow, effectively serving only those who are already capital-rich. This model fundamentally blocks access to capital for most retail and institutional users who seek loans for productive means, not just for leverage. While some protocols (e.g., Maple, TrueFi) attempt non-collateralized lending, they revert to centralized, trust-based systems involving whitelists, credit scores, or off-chain legal agreements, thereby sacrificing the core DeFi principles of being trustless and permissionless.

1.2 About Firyx

Firyx pioneers a new model of non-collateralized lending that is truly trustless and permissionless. Instead of disbursing cash-like assets, Firyx issues borrowed funds as liquidity provider (LP) shares within a designated high-yield strategy. This ensures borrowers can only use the capital for a specific, pre-approved, liquidity-generating purpose. This innovative structure achieves two critical goals:

- **Safety for Lenders:** Capital never leaves the protocol's control. It is directly deployed into yield-generating positions, eliminating the risk of borrower default or misuse of funds.
- **Access for Borrowers:** Since the loan is inherently secured by the productive LP asset it creates, there is no need for credit scores, whitelists, or upfront collateral. Borrowers can instantly access capital to yield farm.

2 Formal Definitions

Variable	Description
L, Pool Liquidity	The total current liquidity in the Loan Position.
r, Pool APY/APR	The underlying yield of the LP position from AMM fees.
x, Loan Slot Share	The percentage of the Loan Position that is borrowed.
U, Utilization Rate	The ratio of borrowed capital to total capital (Borrowed/Total).
U_{opt}, Target Utilization	The utilization rate targeted by the model.
APR_0, Base Rate	Constant for $U = 0$.
APR_{borrow}, Loan Rate	The interest rate of the loan.
$slope_1$, Slope below U_{opt}	Scaling of the interest rate when $U < U_{\text{opt}}$.
$slope_2$, Slope above U_{opt}	Scaling of the interest rate when $U \geq U_{\text{opt}}$.
R, Protocol Reserve	An upfront deposit from the Borrower to secure a Loan Slot.

3 Protocol Architecture

Firyx's architecture is composed of three core concepts that work in concert to facilitate its novel lending and liquidity model.

3.1 Loan Position

A Loan Position is the central lending pool that holds the underlying LP position from a CLMM like Hyperion. Lenders deposit their assets (e.g., USDC, ETH) into the Loan Position and, in return, receive shares that represent their claim on the pool's assets and future revenue. The pool automatically compounds all yields, including trading fees from the AMM and interest payments from borrowers, providing a simple, passive investment vehicle for lenders.

3.2 Loan Slot

A Loan Slot is an individual borrowing position created against a Loan Position. When a user borrows, they are essentially creating a Loan Slot that represents their leveraged portion of the underlying LP asset. The protocol tracks the debt associated with each Loan Slot using a dynamic interest accrual system. This allows for compound interest to be calculated efficiently without requiring constant on-chain transactions, saving gas and improving scalability.

3.3 Deposit Slot

A Deposit Slot represents a lender's share in a Loan Position. It acts as a receipt for their deposited liquidity and is the vehicle through which they receive their portion of the pool's automatically compounding yield. The yield distributed to Deposit Slots is derived from the overall performance of the Loan Position, including all fees and interest payments.

4 Economic Model

4.1 Interest Rate Model

Firyx employs a dynamic interest rate model to manage liquidity risk and incentivize equilibrium, closely similar to Aave's formula. The borrowing APR is determined by the pool's utilization rate, U.

$$\mathrm{APR}_{\mathrm{borrow}} = \mathrm{APR}_0 + \mathrm{slope}_1 \cdot U + \mathrm{slope}_2 \cdot (\max(0, U - U_{\mathrm{opt}}))^\gamma$$

This formula creates an interest rate curve that rises gently as utilization increases, then sharply accelerates after the optimal utilization point (U_{opt}) is surpassed. This encourages borrowing when capital is abundant and discourages it when the pool becomes illiquid, maintaining a healthy balance. The exponent γ controls the sharpness and curvature of the interest rate spike after utilization passes the optimal point (U_{opt}).

- If $\gamma < 1$: The cost of borrowing when the pool is nearly empty becomes progressively weaker. This creates a significant risk that the pool's utilization could hit 100%, leaving zero liquidity available. Not used in practice.

- If $\gamma = 1$: The rate would increase in a straight, steep line after the kink. It would be a linear increase.

- If $\gamma > 1$: The rate increases exponentially. The curve gets steeper and steeper. This means the difference in APR between 90% and 91% utilization is small, but the difference between 98% and 99% is massive.

4.2 Protocol Reserve

Instead of a traditional collateral requirement, the borrower must transfer a deposit, R, to the Pool as reserve to acquire a Loan Slot. This deposit is calculated to be slightly larger than the total expected interest payment, acting as a security for the lender. A key innovation of Firyx is that this deposit does not sit idle; it is added to the Loan Position's liquidity, generating additional yield for the entire pool. The required deposit is a multiple (α) of the total borrow fee:

$$R = \alpha \cdot x \cdot L \cdot \text{APR}_{\text{borrow}}$$

Where α is a protocol-defined reserve factor and x is the loan slot share. At the end of the loan term, the borrow fee is subtracted from R and paid to the Lender. The remainder of the deposit is returned to the Borrower.

$$\text{borrow\_fee} = x \cdot L \cdot \text{APR}_{\text{borrow}}$$

4.3 Yield Generation Formulas

The yields for lenders and borrowers are directly linked, creating the core of Firyx's incentive alignment.

- **Pool Yield from AMM APR:**

$$\text{Yield}_{\text{AMM}} = (L + R) \cdot r$$

- **Borrower's Yield:**

$$\text{Yield}_{\text{Borrower}} = x \cdot \text{Yield}_{\text{AMM}} + R - \text{borrow\_fee}$$

  The borrower earns the yield from the leveraged portion of the pool ($x \cdot \text{Yield}_{\text{AMM}}$) and receives the deposit refund, but pays an interest fee.

- **Lender's Total Yield:**

$$\text{Yield}_{\text{Lender}} = (1 - x) \cdot \text{Yield}_{\text{AMM}} + \text{borrow\_fee}$$

  The lender earns the yield from their non-leveraged capital plus the interest fee paid by the borrower, resulting in an enhanced return.

5 Crunching Some Numbers

5.1 Standard Case

Let us compare the outcomes for a lender and a borrower in Firyx versus a standard DeFi protocol.

Assumptions:

- A Lender provides $10,000 USDC as the capital for a Loan Position.
- A Borrower takes a loan of $4,000 USDC.
- The underlying Hyperion LP position generates an AMM APR (r) of 10%.
- Utilization Rate (U) is $4,000 / $10,000 = 40%.
- The loan slot share (x) is also 40%.
- Interest rate parameters: $\text{APR}_0 = 0$, $\text{slope}_1 = 7\%$, $U_{\text{opt}} = 80\%$.
- Deposit multiplier (α) is 1.25 (implying a 25% buffer).

Calculations:

- Borrow APR: $\text{APR}_{\text{borrow}} = 7\% \cdot 40\% = 2.8\%$
- Borrow Fee (Annual): $\text{borrow\_fee} = x \cdot L \cdot \text{APR}_{\text{borrow}} = \$4,000 \cdot 2.8\% = \$112$.
- Required Borrower Deposit (R): $R = \alpha \cdot \text{borrow\_fee} = 1.25 \cdot \$112 = \$140$.
- Total Yield-Earning Capital: $\text{Total Capital} = \$10,000 + \$140 = \$10,140$.
- Total AMM Yield (Annual): $\text{Yield}_{\text{AMM}} = \$10,140 \cdot 10\% = \$1,014$.

Outcome Analysis:

- **Lender's Annual Return:** The lender receives their share (60%) of the total AMM yield, plus the borrow fee from the borrower.

$$\begin{aligned}\text{Lender Yield} &= (1-x) \cdot \text{Yield}_{\text{AMM}} + \text{borrow\_fee} \\ &= 0.60 \cdot \$1,014 + \$112 \\ &= \$608.40 + \$112 \\ &= \$720.40\end{aligned}$$

  If the AMM APR were to drop to 1%:

$$\text{Yield}_{\text{AMM}} = \$10,140 \cdot 1\% = \$101.40$$

$$\begin{aligned}\text{Lender Yield} &= 0.60 \cdot \$101.40 + \$112 \\ &= \$60.84 + \$112 \\ &= \$172.84\end{aligned}$$

  Compared to the staking yield of $\$10,000 \cdot 1\% = \$100$, the lender enjoyed a +$72.84 increased profit.

- **Borrower's Annual Return:** The borrower receives their share (40%) of the total AMM yield, pays the borrow fee, and receives a refund from their initial deposit.

$$\text{Gross Yield} = x \cdot \text{Yield}_{\text{AMM}} = 0.40 \cdot \$1,014 = \$405.60.$$

$$\begin{aligned}\text{Borrower Yield} &= R + \text{Gross Yield} - \text{borrow\_fee} \\ &= \$140 + \$405.60 - \$112 \\ &= \$433.60.\end{aligned}$$

The borrower invested \$140 upfront and yielded \$433.60.

$$\text{Borrower's ROI} = (\$433.60/\$140) \cdot 100\% \approx 309.7\%.$$

If the AMM APR were to drop to 1%:

$$\text{Gross Yield} = x \cdot \text{Yield}_{\text{AMM}} = 0.40 \cdot \$101.40 = \$40.56.$$
$$\text{Net Yield} = R + \text{Gross Yield} - \text{borrow\_fee} = \$140 + \$40.56 - \$112 = \$68.56.$$

Here the borrower suffers a loss of \$140 − \$68.56 = \$71.44 (∼51%) because of the sudden drop of the AMM APR.

5.2 Partial-sum versus Lump-sum

If we consider the hypothetical where the borrower stakes \$4,000 as a partial-sum, depositing \$333.33 every month, we can calculate the total yield earned at the end of the year:

$$\text{Yield} = \sum_{m=1}^{12} P\left(1 + \frac{r}{12}\right)^m = \sum_{m=1}^{12} \$333.33 \cdot \left(1 + \frac{10\%}{12}\right)^m \approx \$4223$$
$$\text{Profit} = \$4223 - \$4000 = \$223$$

By using the Firyx Protocol, the borrower enjoyed an increased profit of \$433.60 − \$223 = \$210.60 (+94.4%), while only needing to deposit a much smaller initial capital.

5.3 Extreme Over-utilization

Let us consider the situation where $U > U_{\text{opt}}$.

Assumptions:

- Lenders deposit \$40,000 USDC into a Firyx Loan Position.
- A Borrower takes a non-collateralized loan of \$36,000 USDC from this position.
- The underlying Hyperion LP position generates an AMM APR (r) of 10%.
- The Utilization Rate (U) is \$36,000 / \$40,000 = 90%.
- Interest rate parameters: $\text{APR}_0 = 0$, $\text{slope}_1 = 7\%$, $\text{slope}_2 = 300\%$, $\gamma = 1.5$, $U_{\text{opt}} = 80\%$.
- Deposit multiplier (α) is 1.25.

Calculations:

$$\text{APR}_{\text{borrow}} = \text{slope}_1 \cdot U + \text{slope}_2 \cdot (U - U_{opt})^\gamma = 7\% \cdot 90\% + 300\% \cdot (90\% - 80\%)^{1.5} \approx 15.79\%$$

$$R = \alpha \cdot x \cdot L \cdot \text{APR}_{\text{borrow}} = 1.25 \cdot 0.9 \cdot \$40,000 \cdot 15.79\% = \$7,105.50$$
$$\text{borrow\_fee} = x \cdot L \cdot \text{APR}_{\text{borrow}} = 0.9 \cdot \$40,000 \cdot 15.79\% = \$5,684.40$$
$$\text{Yield}_{\text{AMM}} = (L + R) \cdot r = (\$40,000 + \$7,105.50) \cdot 10\% = \$4,710.55$$

$$
\begin{aligned}
\text{Lender Yield} &= (1 - x) \cdot \text{Yield}_{\text{AMM}} + \text{borrow\_fee} \\
&= (1 - 0.9) \cdot \$4,710.55 + \$5,684.40 \\
&= \$471.05 + \$5,684.40 \\
&= \$6,155.45
\end{aligned}
$$

$$
\begin{aligned}
\text{Borrower Yield} &= x \cdot \text{Yield}_{\text{AMM}} + R - \text{borrow\_fee} \\
&= 0.9 \cdot \$4,710.55 + \$7,105.50 - \$5,684.40 \\
&= \$4,239.50 + \$7,105.50 - \$5,684.40 \\
&= \$5,660.60
\end{aligned}
$$

Outcome Analysis:

- **For the Borrower:** The situation is immediately and severely unprofitable. They are paying a 15.79% interest rate to earn a 10% yield, resulting in a net annual loss of $\$5,660.60 - \$7,105.50 = -\$1,444.90$ (-20.3%). This makes the position economically infeasible and forces them to close it quickly.
- **For the Lender:** The scenario is extremely profitable. The massive, temporary yield acts as a powerful magnet, attracting new liquidity to the pool, which in turn helps drive the utilization rate back down to a healthy level.

6 Conclusion

Firyx introduces a trustless, incentive-aligned model for non-collateralized lending. By channeling borrowed funds directly into productive liquidity positions, combining CLMM-based capital efficiency, and applying a principal–yield separation framework, Firyx addresses the four major weaknesses of current DeFi lending: access, capital efficiency, liquidity sustainability, and incentive alignment. This design lays the foundation for a sustainable, scalable, and inclusive decentralized credit market.

References

[1] Hyperion Concentrated Liquidity Market Maker. `https://docs.hyperion.xyz/product-features/concentrated-liquidity`

[2] Aave Protocol Whitepaper. `https://github.com/aave/aave-protocol/blob/master/docs/Aave_Protocol_Whitepaper_v1_0.pdf`