**Borrow Interest Rate**

Mitigating liquidity risk through the borrow interest rate model

Aave’s interest rate algorithm is calibrated to manage liquidity risk and optimise utilisation. The borrow interest rates are derived from the [Utilisation Rate](https://github.com/aave/risk-v3/blob/main/liquidity-risk/historical-utilization.md) *U*

.

​*U* is an indicator of the availability of capital within the pool. The interest rate model manages liquidity risk in the protocol through user incentives to support liquidity:

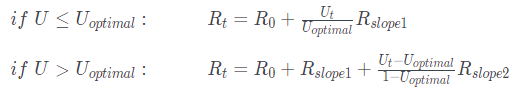
* When capital is available: low interest rates to encourage borrowing.
* When capital is scarce: high interest rates to encourage repayments of debt and additional supplying.

To retrieve the interest rate strategy contract on-chain, see [this section of the developer docs](https://docs.aave.com/developers/core-contracts/pool#getreservedata).

**Interest Rate Model**

Liquidity risk materialises when utilisation is high, and this becomes more problematic as *U* gets closer to 100%. To tailor the model to this constraint, the interest rate curve is split in two parts around an optimal utilisation rate *Uoptimal*​. Before *Uoptimal*​ the slope is small, after it begins rising sharply.

The interest rate *Rt*​ follows the model:

​​ 

In the borrow rate technical implementation, the [calculateCompoundedInterest](https://github.com/aave/aave-v3-core/blob/e46341caf815edc268893f4f9398035f242375d9/contracts/protocol/libraries/math/MathUtils.sol#L51) method relies on an approximation that mostly affects high interest rates. The resulting actual borrow rate is as follows:

​​ 

* When *U*≤*Uoptimal*​ the borrow interest rates increase slowly with utilisation
* When *U*>*Uoptimal*​ the borrow interest rates increase sharply with utilisation to above 50% APY if the liquidity is fully utilised.

Both the variable and stable interest models, are derived from the formula above from the [Whitepaper](https://github.com/aave/aave-protocol/blob/master/docs/Aave_Protocol_Whitepaper_v1_0.pdf) with different parameters for each asset.

Variable debt see their rate constantly evolving with utilisation.

Alternatively, stable debts maintain their interest rate at issuance until the specific rebalancing conditions are met. In V3 interest models are optimised by new rate strategy parameter **Optimal Stable/Total Debt Ratio** to algorithmically manage stable rate.

​

�������<������:��=�0+�����−������1−�����������*ifratio*<*ratioo*​:*Rt*​=*r*0​+1−*ratioo*​*ratio*−*ratioo*​​*Rbase*​

​

**Model Parameters**

First, it’s crucial to distinguish assets that are used predominantly as collateral (i.e., volatile assets), which need liquidity at all times to enable liquidations. Second, the asset’s liquidity on Aave is an important factor as the more liquidity, the more stable the utilisation. The interest rates of assets with lower liquidity levels should be more conservative.

It is also key to consider market conditions (i.e., how can the asset be used in the current market?). Aave’s borrowing costs must be aligned with market yield opportunities, or there would be a rate arbitrage with users incentivized to borrow all the liquidity on Aave to take advantage of higher yield opportunities.

With the rise of liquidity mining, Aave adapted its cost of borrowing by lowering the *Uoptimal* of the assets affected. This increased the borrow costs that are now partially offset by the liquidity reward.

**Variable Interest Rate Model Parameters**

Variable rate parameters:

* ​

��������*Uoptimal*​

​

* Base Variable Borrow Rate
* Variable Rate Slope 1
* Variable Rate Slope 2

**Stable Interest Rate Model Parameters**

Stable rate parameters:

* ​

��������*Uoptimal*​

​

* Base Variable Borrow Rate
* Variable Rate Slope 1
* Variable Rate Slope 2
* Stable to Total Debt Ratio

The stable rate provides predictability for the borrower; however, it comes at a cost, as the interest rates are higher than the variable rate. The rate of a stable loan is fixed until the rebalancing conditions are met:

1. 1.

Utilisation Rate:

��>95%*Ut*​>95%

​

1. 2.

Overall Borrow Rate, the weighed average of all the borrow rates:

��<25%*RO*​<25%

​

The assets that are most exposed to liquidity risk do not offer stable rate borrowing.

The base rate of the stable rate model corresponds to the average market rate of the asset.

**V3 Interest rate Parameters**

The interest rate parameters for V3 markets have been deployed with 3 interest rate strategies calibrated per cluster of assets that share similar risk profiles.

**Rate Strategy Volatile One**

Volatile assets need liquidity at all times and are thus calibrated at a low Optimal Utilisation Ratio

AAVE, BAL, CRV, DPI, GHST, LINK, SUSHI, WAVAX, WBTC, WETH, WFTM, WMATIC, WONE

| Parameters | Value |
| --- | --- |
| Optimal Usage | 45% |
| Base Variable Borrow Rate | 0 |
| Variable Rate Slope 1 | 4% |
| Variable Rate Slope 2 | 300% |
| Base Stable Borrow Rate | 2% |
| Stable Rate Slope 1 | 7% |
| Stable Rate Slope 2 | 300% |
| Optimal Stable to Total Debt Ratio | 20% |

**Rate Strategy Stable One**

Low liquidity stablecoins have lower Optimal Utilisation Ratio than those with higher liquidity.

DAI

| Parameters | Value |
| --- | --- |
| Optimal Usage | 90% |
| Base Variable Borrow Rate | 0 |
| Variable Rate Slope 1 | 4% |
| Variable Rate Slope 2 | 60% |
| Base Stable Borrow Rate | 2% |
| Stable Rate Slope 1 | 0.5% |
| Stable Rate Slope 2 | 60% |
| Optimal Stable to Total Debt Ratio | 20% |

**Rate Strategy Stable Two**

High liquidity stablecoins which are callibrated to lower rates to encourage borrow.

SUSD, USDC, USDT, EURS, JEUR, AGEUR

| Parameters | Value |
| --- | --- |
| Optimal Usage | 80% |
| Base Variable Borrow Rate | 0 |
| Variable Rate Slope 1 | 4% |
| Variable Rate Slope 2 | 75% |
| Base Stable Borrow Rate | 1% |
| Stable Rate Slope 1 | 0.5% |
| Stable Rate Slope 2 | 75% |
| Optimal Stable to Total Debt Ratio | 20% |

When market conditions change, the interest rate parameters must be changed to adapt to utilisation on Aave’s market as well as to incentives across DeFi.

**Supply rate**

The borrow interest rates paid are distributed as yield for aToken holders who have supplied to the protocol, excluding a share of yields sent to the ecosystem reserve defined by the reserve factor. This interest rate is generated on the asset that is borrowed out then shared among all the liquidity providers. The supply APY,

��*Dt*​

, is:

​

��=��(�����+�����)(1−��)*St*​=*Ut*​(*SBt*​*St*​+*VBt*​*Vt*​)(1−*Rt*​)

​

* ​

��*Ut*​

, the utilisation ratio

* ​

���*SBt*​

, the share of stable borrows

* ​

��*St*​

, the average stable rate

* ​

���*VBt*​

, the share of variable borrows

* ​

��*Vt*​

, the variable rate

* ​

��*Rt*​

, the reserve factor

You can view the protocol's deposit APY on the [Aave App](https://app.aave.com/reserve-overview/?underlyingAsset=0xd586e7f844cea2f87f50152665bcbc2c279d8d70&marketName=proto_avalanche_v3) for each asset.

The average Supply APY over a period also includes Flash Loan fees.