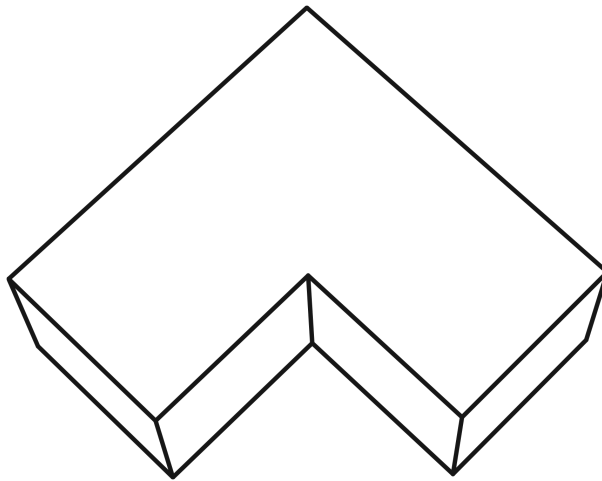# Angle Whitepaper

A Decentralized, Over-Collateralized and Capital Efficient Stablecoin Protocol

Angle Labs Core Team

contact@angle.money

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Abstract

Angle is the first over-collateralized, decentralized and capital-efficient stablecoin protocol. Thanks to the liquidity providers it uses, the protocol proposes full convertibility between stable assets and collateral, meaning that it is possible to swap collateral against stable assets, and stable assets against collateral at oracle value. This makes the protocol not only capital efficient but also highly liquid.

Angle Protocol could be used to issue any stablecoin, and will start at launch on mainnet with a stable Euro. Besides creating the first liquid Euro stablecoin, the goal of Angle is to create stablecoins for almost all Forex currencies, including the US Dollar.

Contents

1 Introduction

Decentralized Finance (DeFi) is expanding, and the market for digital assets and in particular for stablecoins is democratizing by the hour. Unfortunately, up to date, stablecoin protocols remain incomplete in the following ways:

- The stablecoins with the largest market capitalization remain centralized projects (USDT [1], USDC [2]) that require trust in a third party.

- As for decentralized protocols (Maker [3], Synthetix [4]), they rely on complex logistics which make it difficult for basic users to mint and burn stable assets by themselves. It is not within reach of everyone to own and maintain vaults or collateralized debt positions like required by most stablecoins protocols nowadays.

- Besides, full and unrestricted 1:1 convertibility of collateral against stable assets (and conversely) has not been reached yet for any of the over-collateralized decentralized protocols. Besides the fact that the stability therefore mostly depends in these cases on the careful choice of protocols' parameters (stability fee in Maker), it is very capital inefficient to issue these stablecoins.

- Under-collateralized and algorithmic stablecoin protocols tend to be the most capital efficient designs. Yet, in the past, the numerous occurrences (e.g., Basis Cash, Iron Finance's Titan) of bank-run situations and liquidity crises with such stablecoins showed that they are not reliable enough so far.

- There is still no decentralized protocol dedicated mostly to building stable Euros. Some protocols like Mirror [5] or Synthetix enable minting stable Euros but besides their limited and restricted convertibility, they are barely used for that. As a consequence, most lending protocols on which users can lend their stablecoins and earn interests on it do not accept stablecoins pegged to Euro: people willing to receive interests on a stablecoin have to do it through a stable dollar. The problem for people in Europe (or in other countries where USD is not the main currency) is that they are subject to a change risk. They may earn an annual yield of 10% on their stable USDs on Compound but if in the meantime USD crashes with respect to their currency, they could end up with a positive net loss in their currency.

The aim here is to introduce Angle, a protocol that proposes a new approach and tries to make the best of centralized and decentralized protocols, as well as of over-collateralized and under-collateralized approaches. Angle is a decentralized version of centralized protocols allowing swaps at oracle value between synthetic assets and collateral. The protocol issues perpetual futures to remain insured against the volatility of the collateral held in reserves.

The idea with Angle is to enable the spread and democratization of digital stable assets pegged to Euro and other fiat currencies, and to be a building block of tomorrow's DeFi and bankless society.

In this whitepaper, Angle's main aspects will be introduced. The objective is to present the main innovations and key takeaways of Angle. More implementation details can be found in the documentation of the protocol.

2 Stable Holders and Seekers - Unrestricted Convertibility

The goal of Angle's protocol is to mint stable assets tradable on the blockchain. For the purpose of the examples, this paper will consider a stablecoin pegged to the Euro (€) called `agEUR` available on Ethereum ([6]) under the `ERC-20` standard and using `ETH` as collateral.

Angle lets stable seekers (i.e. people wanting stablecoins) buy `agEUR` with the collateral of their choice (among a whitelist of collaterals) at oracle value and with as little fees as possible. Similarly, owners of `agEUR` are able with Angle to exchange it seamlessly at anytime with the collateral of their choice and with small fees.

The experience of issuing the stablecoins with collateral and burning the stablecoins for collateral is hence similar to that of a swap from a user perspective.

2.1 Mint and Burn Transactions

To generate a stable asset, a user just has to send to the protocol a whitelisted collateral. An oracle then determines how many stablecoins need to be minted and sent to the user.

> **EXAMPLE 2.1**
>
> If the oracle price for a `ETH` is 1000€, and if the transaction fees are 0.3% of the transaction, then a user giving Angle 1 `ETH` will receive 997 `agEUR` newly minted by the protocol.

The same procedure works when users are willing to cash out: they just have to send to the protocol their stable assets, specify the collateral they want, and they receive in return the chosen collateral in an amount depending on the collateral price specified by the oracle and on the transaction fees. The stablecoins received by the protocol are then burnt.

> **EXAMPLE 2.2**
>
> If the oracle price for `ETH` is 1000€, and if the transaction fees are 0.3%, then a user giving Angle 1000 `agEUR` will receive in exchange 0.997 `ETH`. The 1000 `agEUR` received are then burnt by the protocol.

In all cases, mint and burn transactions are executed without slippage on the price, regardless of the size of the transaction.

Note that if there are fees in this protocol, it is to remunerate LPs which guarantee the robustness of the system, to prevent front-running and flash loan attacks and to deter new users from coming in when the protocol may be at risk. This will make more meaning later in this whitepaper but transaction fees depend on the collateral from users that is "insured" by perpetual futures.

2.2 Stability

The convertibility as described above is what makes the tokens minted stable. Direct arbitrage opportunities arise whenever the token trades at a price different from its peg.

> **EXAMPLE 2.3**
>
> Let's say that 1 `agEUR` trades at a price above 1€. The incentive is to mint `agEUR` for 1€ worth of collateral and then sell these newly minted `agEUR` for more than 1€ on the market. This reduces the price closer to €1.

Opportunities for arbitrage are however reduced when there are transaction fees. With a 5% transaction fee, it is no longer profitable to do arbitrage for price deviations of less than 5%.

2.3 Main difference with other stable assets

In Maker, when people mint `DAI`, they still own the `ETH` they put as collateral. Besides they have to pay interests for the `DAI` they minted. People typically use `DAI` to get leverage on their collateral, and Maker can be viewed as a cheap way to borrow money in order to get leverage.

In the case of Angle (and in the case of `USDT` or `USDC` too), when someone gives collateral to mint stablecoins, as in a swap, this collateral no longer belongs to the person. When you are a stable seeker, you simply use Angle to convert your collateral to a stable asset.

2.4 The Need for Over-Collateralization

To be always able to swap collateral against stablecoins and stablecoins against collateral, the protocol needs to remain over-collateralized regardless of the variations of the price of the collateral.

EXAMPLE 2.4

Imagine there is 1 `ETH` in the protocol worth 1000€, and 1000 `agEUR` minted, the collateral ratio is 100%. If the price of `ETH` decreases to 500€, the collateral ratio is now 50%. Then, someone could come with 500 `agEUR` and get 1 `ETH` in exchange leaving no collateral left for the owners of the 500 remaining `agEUR`. The intrinsic value of these tokens is then no longer 1€.

Like most decentralized stablecoin protocols, to keep the trust in the protocol and to be able to sustain convertibility, Angle aims for over-collateralization.

The solution proposed by Angle to get over-collateralized is to resort to Liquidity Providers (LPs), that is extra agents that bring collateral to the protocol and help it manage its risk. Angle introduces two different types of LPs: Hedging Agents (HAs) and Standard Liquidity Providers (SLPs).

3 Hedging Agents (HAs) - Perpetual Futures to Insure the Protocol Against the Volatility of the Collateral

Hedging Agents are the most important type of liquidity provider for Angle protocol.

3.1 Principle and Need

As detailed above, when a stable seeker gives 1 `ETH` to the protocol, the protocol is subject to the volatility of this `ETH`. While surges in collateral prices can be beneficial to the protocol in this case, drops are less desirable as the protocol gets under-collateralized. To insure the protocol against the volatility of the collateral used to back stablecoins, Angle created a way to transfer the volatility to other actors willing to get leverage on collateral: the Hedging Agents (HAs).

These people get perpetual futures from the protocol. By doing so, from their perspective, they just get leveraged on the evolution of the price of the collateral with respect to that of the asset the stablecoin is pegged to. But, from a protocol perspective, they insure the system against drops in collateral price, making sure that the protocol has always enough reserves to reimburse stable holders.

3.2 Perpetual Futures

The flow for HAs is that they come to Angle, bring some collateral and choose the amount of collateral from stable seekers they want to cover. With their initial investment they take all the volatility of the larger amount they are back-

ing, earning a lot in case of a price increase, but incurring significant losses when price goes down.

If there is y ETH that were brought to get stablecoins by a stable seeker, Hedging Agents can come to Angle, bring collateral (like x ETH) and choose to cover these y ETH (hence getting a $\frac{x+y}{x}$ leverage multiplier). This means that this person gets the capital gains or has to pay for the loss she would have made if she had owned these y ETH from the beginning.

At any point in time, she will therefore be entitled to get from the protocol:

$$x + y \cdot \left(1 - \frac{\texttt{initial price}}{\texttt{current price}}\right)$$

The HA gets however liquidated if the value of the position drops below zero and hence if the price drops to:

$$\texttt{current price} = \frac{y}{x+y} \cdot \texttt{initial price}$$

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EXAMPLE 3.1

If 1 ETH is worth 1000€, if there is a HA with $x = 10$ and $y = 50$, this HA takes the variation of 50 ETH besides her 10 ETH. So if the price goes to 1200 : 1, the HA will earn a leveraged return of $10 + 50(1 - 10/12) = 18.33$ ETH. On the opposite, if the price for one ETH drops to $\frac{50}{60}1000 = 833$, the HA will have lost her investment, which will be absorbed by the protocol to stay collateralized.

</div>

HAs will never be able to back up an amount superior to the collateral that was brought by users (see 7). For instance, if users gave 10 ETH to mint agEUR, HAs can only take the volatility of up to 10 ETH.

HAs are therefore in a win-win cooperation with the protocol. They are just long traders that have a risky but interesting leveraged investment. In return, they reduce the exposition of Angle to price variations, which can seize their money in case of collateral price drops. In some occasions, governance of the protocol can also decide to distribute them governance tokens to incentivize them to come.

3.3 Implementation Details

Within Angle, Hedging Agents have to pay small transaction fees when they come in and when they exit the protocol. There is however no funding rate like in centralized exchanges.
Entry and exit costs depend on coverage curves (equivalent to the utilization curve on Compound), that define the transaction fees as a function of the coverage ratio that is the proportion of the collateral from users to cover that is actually covered by HAs. The more is covered, the more expensive it gets to become a HA, but the less expensive it is to exit a HA position.

HAs positions are encoded within Angle protocol as NFTs: they can be transferred from one address to another, but the amount covered by a position cannot be modified. A single address can own multiple HAs' positions within a same pool or within different pools of the protocol.

To prevent HAs from taking advantage of potential oracle failures or insiders' advantages, there is a one hour lock after each update in the position of a HA: someone becoming a HA will never be able to exit in the hour following her entrance in the protocol.

3.4 Imbalances Between Offer and Demand For Volatility

If HAs were covering at all times the collateral brought by stable seekers, the protocol would remain perfectly collateralized, and convertibility could always be maintained regardless of the variations of collateral price. In such a case, the protocol would be a perfect marketplace between people willing to get stability and people willing to get volatility and getting the volatility of the collateral brought by people who wanted stability.

Yet, at a given point in time, specially after new users come in, or HAs exit, there may be mismatches. Not all users' positions may be covered and there may not be a full demand for the protocol's offer in volatility taking the form of perpetual futures. A new type of liquidity providers is therefore needed to account for these temporary imbalances and to serve as a buffer between users and HAs: they are called Standard Liquidity Providers.

4 Standard Liquidity Providers (SLPs) - Insurance of the Insurance

4.1 Description

Standard Liquidity Providers (SLPs) are the buffer for the moments when Hedging Agents do not fully cover the collateral that was brought by users, and when the protocol's reserves are not fully insured.

They entrust Angle with their liquidity and like liquidity providers in other protocols (Compound, Uniswap, Aave), they automatically accrue interests on the assets they brought. The risk for them is to incur a slippage when the protocol is not well collateralized and they want to cash out.

4.2 Incentives for SLPs

When lending money to over-collateralize the protocol, SLPs are taking a small risk. They should be incentivized for taking this risk:

- A fraction of the transaction fees obtained when minting or burning stablecoins are redistributed to SLPs in proportion to how much they contribute to the protocol.

- SLPs will also be able in some conditions to stake their positions to receive governance tokens.

- At each point in time, the protocol owns reserves which are only useful when redeemed by a user, a SLP or a HA. Part of the reserves can then automatically be transferred to strategies (like Yearn strategies) responsible for getting yield on it by for instance lending to protocols like Compound [7] or Aave [8]. In this case, SLPs end up earning interests not only on the collateral they lent but also on the collateral brought by stable seekers.

> EXAMPLE 4.1
>
> Suppose the protocol owns 1.5 ETH out of which 1 comes from users who minted and 0.5 comes from LPs. If all the money of the protocol is put in lending strategies, LPs will be receiving interests on 1.5 ETH although they just brought 0.5 ETH: they receive 3 times more interests than they would get by lending directly to other protocols.

Because of the multiplier effect described above, the protocol is able to guarantee higher yield to SLPs than other lending platforms. In general, the less SLPs there are, the more a single SLP, for a similar amount invested, can receive transaction fees, governance tokens, and interests. This mechanism thus incentivizes SLPs to re-collateralize the protocol when it is not collateralized enough because of a lack of SLPs.

Note however that all transaction fees and lending returns are not given to SLPs: the rest goes directly to the surplus of the protocol.

4.3   sanTokens

When contributing to a collateral pool as a Standard Liquidity Provider, a SLP receives a token marking her belonging in the pool, just like a lender on Compound would receive a `cToken`. A SLP bringing `ETH` to the protocol for the Euro stablecoin would receive `sanETH-EUR` tokens based on the current exchange rate between `sanETH-EUR` and `ETH`.

By issuing `sanTokens`, SLPs earn interests and rewards through the underlying token exchange rate, which increases in value relative to the underlying asset as transaction fees arrive in that pool and as interests from collateral being lent are collected.

SLPs only receives transaction fees from transactions which concern the pool they contribute to. Transaction fees from a mint transaction affecting the `USDC` liquidity pool will not go to SLPs which contributed to the `ETH` liquidity pool.

4.4   Risks for SLPs

Although there can be big rewards and great incentives for being a SLP in the protocol, there are also some risks associated with it. SLPs are here to ensure the collateralization of the protocol in the situations when there are no perfect matches between users and HAs. If the protocol is not collateralized enough, they are at risk of not being able to get all their money back: there will be a slippage when the protocol is not enough collateralized.

EXAMPLE 4.2

Let's say that 10000 `agEUR` were minted with 10 `ETH` backing it. First say 1 `ETH` is worth 1000 `agEUR`, so the protocol is fully collateralized. Then a SLP brings 1 `ETH` to the protocol. She will earn the fees and the yield rate of the whole 11 `ETH` available plus the transaction fees accruing in the meantime. But if in the future 1 `ETH` is only worth 800 `agEUR`, the protocol is under-collateralized and the SLP will not be able to get all her money back when exiting. If the slippage at this point is 90%, then the SLP willing to cash out 1 `ETH` will only be able to get 0.9 `ETH`.

The slippage factor will be a piecewise linear function of the collateral ratio to make the risk predictable for SLPs while still incentivizing them to stay in the protocol. Having a continuous function is also necessary to limit front-running effects. The smaller the collateral ratio, the bigger the slippage. Above a certain collateral ratio (for instance 120%), no slippage will be set for SLPs.

5   Summary

- Angle is a decentralized protocol designed to create truly-stable crypto-assets in a capital efficient way. It tries to improve over centralized designs as well as over over-collateralized and under-collateralized decentralized designs.

- Angle innovates by proposing full convertibility at a `1:1` rate between stable assets and collateral. Collateral can always be swapped against stablecoins, and stablecoins can always be swapped against collateral at oracle value.

- The protocol involves 3 groups which all benefit from Angle: Stable Seekers and Holders who issue and use stable assets, Hedging Agents, who get perpetual futures from the protocol while insuring it against the variability of the collaterals' prices and Standard Liquidity Providers, who help the protocol have enough liquidity at all times, even when the protocol is not fully covered by HAs.

6 Other Protocol Modules and Details

6.1 Oracles

Oracles to get access to price feeds are crucial for Angle Protocol. Given that the protocol allows swaps between collateral and stable assets at oracle value, it is subject to a front-running risk due to on-chain oracle latency.

To eliminate this risk, the protocol relies on Uniswap V3 Time-Weighted Average Price (TWAP) oracles with a 5 minute time window and on Chainlink price feeds. For a feed like `ETH-USD`, the protocol will compare the value obtained with Chainlink with that of Uniswap V3 (using `USDC` pools for `USD`) and keep the one that is most at its advantage.

> EXAMPLE 6.1
>
> If the two oracles give two different values for the `USD` price of `ETH` (1000$ and 1100$), for a mint transaction the protocol will use the lowest oracle value to compute the amount of stablecoins to issue based on the collateral. For a burn transaction the protocol will use the highest value to convert a stablecoin amount to an `ETH` amount.

6.2 Strategies

Lending part of the reserves of the protocol to other lending platforms is part of what can make the protocol attractive to SLPs. By lending reserves, the protocol can on the one hand propose interesting yield to SLPs and on the other hand accumulate some surplus.

The design of that has been heavily inspired by what Yearn does. Angle relies on strategies, that handle Lender contracts interacting with lending and other yield farming protocols l. Just like on Yearn, new strategies to get some yield on the protocol's collateral can be added along the way by governance votes. Each strategy can also support multiple lending platforms or protocols.

The first strategy implemented will simply consist in optimizing lending between Compound and Aave and pick the one with the best APY.

6.3 Keepers

Some actions needed for the protocol to function are not performed automatically because they would require too much gas if they were done at each transaction. The protocol relies on external incentivized actors called keepers to perform these actions regularly.
Keepers are mostly useful for:

- HAs: HAs positions, also called perpetuals or vaults, need to be liquidated if their value gets too low or unhealthy, or cashed-out if there are too many HAs. Keepers should monitor HAs in the protocol and take action in case of. When taking action on a HA perpetual, they are incentivized by getting part of the fees that were paid at perpetual opening.

- Transaction Fees & Parameters: Some parameters of the protocol like the slippage for SLPs depend on the collateral ratio of the protocol which is too expensive to compute at each transaction. Keepers are needed to compute the collateral ratio and accordingly update the parameters once in a while.

- Strategies: Like Yearn, the protocol needs to interact with keepers to make the lending strategies work effectively.

- Staking: To distribute governance tokens based on the parameters set by governance.

- Arbitrage: To make the stablecoins stable, keepers are required.

6.4 Generalization to Other Stablecoins

Angle aims to be a protocol that lets users mint the synthetic pegged to the asset of their choice (among a whitelist of assets) with the collateral of their choice. To this extent, Angle will not just deploy a stable Euro (`agEUR`), other synthetics like `agUSD` are for instance going to be launched soon after the launch of the Euro stablecoin.

To keep the system resilient, the different stablecoins from the system will all be independent. This implies that the collateral pools for the various stablecoins will be different. If there are two stablecoins supported `agEUR` and `agUSD`, there will be two `ETH` collateral pools: one for the `agEUR` and one for the `agUSD` stablecoin.

6.5 Governance of the Angle Protocol

6.5.1 Design

A core principle of Angle Protocol is its decentralized nature and the DAO that will work on it from the beginning. This DAO is responsible for using Angle protocol at its full potential and to improve it in order to make it a building block of the DeFi space in the end.

The DAO will be responsible for parameters tuning, for deploying new stablecoins, for accepting new collateral for a given stablecoin, for protocol upgrades and integrations. It is forked from the Compound Governor Beta and Timelock.

The long term goal is however to minimize the need for an active governance. Ideally, Angle will be a self-running machine which does not need any human input other than oracles and which will work completely algorithmically.

6.5.2 Governance Token

The governance token of the protocol is the `MUR` token. The idea with Angle's governance token is to make its ownership decentralized and to distribute it to actors in the community which use the protocol or collateralize it as SLPs or HAs.

The exact token distribution is likely to change. Among other things, more than 60% is going to be distributed through staking contracts and through a bonding curve letting people buy governance tokens using the protocol's stablecoins. The price at which governance tokens are sold is an increasing function of the number of tokens already sold through this mechanism. The bonding curve is a cheap way to increase the collateral ratio of the protocol.

Governance token distribution will be used to incentivize people to contribute more to one people than another. It may not be directly activated at protocol launch.

The only situation in which the total supply is likely to inflate is where governance needs to be able to sell more tokens through the bonding curve to recollateralize the protocol.

6.6 Emergency Modules

As any stablecoin protocol, the protocol's main risk is to be unable to maintain the convertibility between stablecoins and collateral in which case governance might have to deter exits with high fees, or to freeze transactions. As long as the protocol remains over-collateralized there is no risk that it happens. The protocol may start to be under-collateralized if at a given point in time the protocol is not covered enough by HAs, if there are not enough SLPs and if the protocol has not accumulated a sufficient surplus from transaction fees and lending yield, from the sales of governance tokens, or from collateral price increases.

The protocol has a set of actions it can take in case of distress, that is generally in case of decreasing demand for leverage by HAs combined with a drop in all collateral types prices.

Responses include elements already explored like the automatic decrease of fees for HAs coming in, distribution of governance tokens to incentivize new HAs and SLPs to come, slippage to prevent SLPs from exiting, dynamic transaction fees for users minting and burning.

Governance can choose to use the bonding curve to make burning stablecoins against the protocol's governance tokens cheaper hence enabling the protocol to recollateralize itself.

Then there is a collateral settlement process that freezes transactions as well as oracle value affecting a collateral and lets stable holders, SLPs, and HAs claim the collateral that's owed to them. More details are given about it in the documentation of the protocol. An important point is that governance token holders are treated preferably in case of collateral settlement.

7 Appendix - Hedging Agents Coverage

Let's do a more complete example to understand the role of HAs. Assume the initial state of the protocol is the following:

	initial price: p
Collateral brought by Users	x
Collateral brought by SLPs	y
Collateral backed up by HAs	z

Table 1: Initial state of the protocol

Then, assume that at a second point in time, Stable Holders and HAs want to cash out.

	current price: q
Amount due to Users	$x \cdot \frac{p}{q}$
Amount due to HAs	$z(1 - \frac{p}{q})$
Fees and returns accumulated for SLPs	r

Table 2: Current state of the protocol

After this cash out, Angle will be left with:

$$y + r + (x - z)(1 - \frac{p}{\hat{p}})$$

Therefore, in case of a price increase, the protocol will have a surplus proportional to $(x - z)$, and in case of a price drop, the risk of not being able to reimburse SLPs is significantly reduced if $x - z$ is close to 0, so if all the funds are backed by HAs.

Remember that HAs will never be able to back up an amount superior to the collateral that was brought by users: hence Angle will always have $z \leq x$. To enforce this bound, the protocol has to check the amount of collateral not backed by HA when one wants to enter the protocol. It also needs to cash out HAs when users burn an amount that makes $z > x$. This feature does not change HAs returns, as their positions are updated and then cleared from the protocol.

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