Havven: a stablecoin system
v0.5

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Abstract

There is currently no effective decentralised unit of account; previous attempts to create one have either relied on significant centralisation or have been undermined by their complexity. Havven resolves these issues by creating a decentralised stability market that incorporates clearly defined incentives between participants. It employs a dual-token solution, composed of a stabilised exchange token and the reserve token which backs it. Users requiring price-stability support the system through fees which incentivises collateral holders to maintain the distributed reserve. Because the collateral is encapsulated entirely within the system and distributed among its users, we remove the need for a central authority. Such a stable cryptocurrency, useful for everyday economic purposes, will accelerate the adoption of decentralised systems.

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1 Introduction

1.1 Money and Cryptocurrencies

The technology of money has three key functions: to act as a unit of account, a medium of exchange and a store of value. In addition, money should ideally exhibit durability, portability, divisibility, uniformity, limited supply, and acceptability. As payment technology has advanced in recent years, it has become increasingly invisible and it is often lost upon users of money that, like any technology, it can be improved. Specifically, this means improving the performance of those desirable properties.

Bitcoin is an impressive technological advancement on existing forms of money because it simultaneously improves durability, portability, and divisibility. Further, it does so without requiring centralised control or the enforcement of a nation state from which to derive its value. This fixed monetary policy has protected Bitcoin from debasement and devaluation, allowing it to outperform other forms of money as a store of value. But this has created the potential for short-run volatility as Bitcoin lacks a mechanism to dynamically adjust to changing demand.

Bitcoin has thus tended to be a poor medium of exchange and an even worse unit of account. In order for something to perform these functions it must remain relatively stable against the price of goods and services over the short to medium term.

1.2 Stablecoins

A stablecoin is a cryptocurrency designed for price stability, such that it can function both as a medium of exchange and unit of account. It should ideally be as effective for making payments as fiat currencies like the US Dollar, but still retain the desirable characteristics of Bitcoin, namely transaction immutability, censorship resistance and decentralisation.

Cryptocurrencies that exhibit these characteristics are clearly a far better form of money; but adoption has been hindered by the volatility inherent in the inflexible monetary policies employed by decentralised systems. Thus stability continues to be one of the most valuable yet elusive characteristics for the technology. Clearly, efforts to create dynamic monetary policies within cryptoeconomic systems is still nascent, and significant research into stable monetary frameworks for cryptocurrencies is required.

The interested reader can also find additional discussion of stablecoins, cryptoeconomics, competitors, and other related topics on our blog at `http://blog.havven.io`.

1.3 Havven

Havven is a decentralised stability marketplace, where users requiring stability transact directly with those who provide the collateral to create it. This enables a novel form of representative money in which there is no requirement for a physical asset, thus removing problems of trust and custodianship. The asset used to back the stablecoin is a pool of reserve tokens that collectively represent the system itself; controlling these reserve tokens reflects participation in the Havven system, and they are a proxy for its value. Havven generates fees from users who transact in the stablecoin and distributes them among the holders of the reserve token, compensating them for underpinning the system. Havven therefore rewards those who actively participate in maintaining the stability of the system and charges those who benefit from its utility. These rewards are proportionally applied in response to the active management of the supply of the exchange token such that its price mirrors that of the asset it tracks.

Because we have created a system that generates cash flow for participants, we now have an asset which can be used as the collateral to support the stablecoin with a well-defined market value. The key to this is that the value of the system is measured in US dollars. This allows the system to issue a stablecoin which can be presented and redeemed for a percentage of the collateral tokens valued at $1. Backing a stablecoin in this way is beneficial because such a cryptoeconomic system does not require trust in a centralised party; each participant has full transparency over how many tokens have been issued against the available collateral at all times.

The two linked tokens and the complex of incentives are described below:

Havven

The collateral token, whose supply is static. The capitalisation of the havvens in the market reflects both the system's aggregate value and the reserve which backs the stablecoin. Thus, users who hold havvens take on the role of maintaining stability. Following Bitcoin, the Havven system will appear in upper case and singular; while the havven token will be lower case and may be plural.

Nomin

The exchange token - the stablecoin - whose supply floats. Its price as measured in fiat currency should be relatively stable. Other than price stability, the system should also encourage some adequate level of liquidity for nomins to act as a useful medium of exchange.

Each holder of havvens is able to issue a value of nomins in proportion to the dollar value of the havvens they hold and are willing to place into escrow. If the user wishes to release their escrowed havvens, they must present the system with nomins in order to free their havvens and trade them again. The holders of this token provide both collateral and liquidity, and in so doing assume some level of risk. To compensate this risk, such nomin-issuers will be rewarded with fees the system levies automatically as part of its normal operation.

1.4 Design Rationale

This issuance mechanism allows nomins to act as a form of representative money, where each nomin represents a share in the havven value held in reserve. Nomins derive value insofar as they provide a superior medium of exchange, and are effectively redeemable for a constant value of the denominating asset. In this paper, we use US dollars as this asset, but this could be any external and appropriately fungible asset, such as a commodity or a fiat currency. The system incentivises the issuance and destruction of nomins in response to changes in demand, to maintain a constant price.

In order to issue a nomin, there must be a greater value of havvens escrowed in the system. Overcollateralisation in this way provides confidence that nomins can be redeemed for their face value, even if there is a reduction in the value of the locked havvens. For example, if the collateralisation ratio is set to 100:1 then the price of havvens would need to fall 99% for the nomin to no longer be overcollateralised. On the other hand, the ratio could be set to 1:1, but any decrease in havven price would mean the currency was no longer overcollateralised. In this situation, it would not be possible for all nomins to be redeemed for their face value, which may cause confidence in the system to drop.

While overcollateralisation strongly supports a stable nomin price, it simultaneously reduces the efficiency of the system by limiting the utility of the nomin. A ratio of 1:1 provides far greater utility than 100:1, with respect to both the effiicency of the collateral and the revenue generated from transaction fees. There is clearly a trade-off between efficiency and resilience in Havven, which means the collateralisation incentives must therefore not only promote nomin price stability. They must also allow the system to operate as efficiently as possible, whilst maintaining resilience to reduction in the value of the collateral. The design of these incentives is described in detail in section 2.

Due to denominating the value of the stablecoin in an external fiat currency stability is relative only to that currency. In the future the system may support additional flavours of stablecoin that are denominated in other currencies such as the Euro. Denominating the stablecoin in a fiat currency removes the need to respond to macroeconomic conditions, as it benefits from the stabilisation efforts of large institutions acting in fiat markets.

2 System Description

Havven is a dual-token system that, combined with a set of novel incentive mechanisms, stabilises the price of the nomin with respect to an external asset. Users of the nomin token pay the owners of the havven token for collateralising and stabilising the system.

The havven token incentivises those who hold it to fulfil two functions:

- To provide the system with collateral.
- To participate in the stabilisation of the nomin price.

Collateralisation

Confidence in the stability of the nomin begins with overcollateralisation, so that the value of escrowed havvens is greater than the value of nomins in circulation. As long as the ratio of total nomin value to total havven value remains favourable, there is sufficient backing in the underlying collateral pool to ensure that nomins can be redeemed for their face value. The redeemability of a nomin for the havvens against which it was issued strongly supports a stable price.

Stabilisation Incentives

Havven rewards those that have issued nomins. These rewards are derived from transaction fees and are distributed in proportion with how well each issuer maintains the correct nomin supply. The system monitors the nomin price, and responds by adjusting its targeted global supply, which individual issuers are incentivised to move towards.

Where volatility persists, stronger stabilisation mechanisms may be applied, for example automated collateral recovery. Where a significant portion of nomins are being used for hedging, (and hence not generating transaction fees) a charge can be applied to ensure that the cost of utility for hedging is not being solely borne by transactions.

2.1 Equilibrium Nomin Price

We first introduce the core system variables:

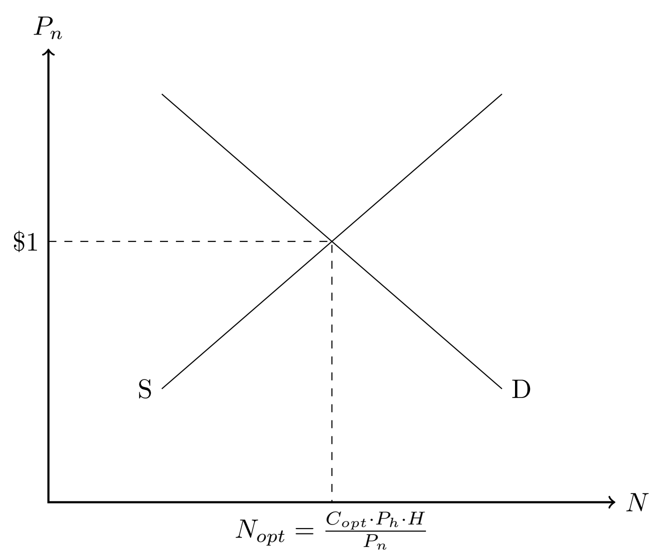
H	havven quantity	N	nomin quantity
P_h	havven price	P_n	nomin price

All havven tokens are created at initialisation, so H is constant. The quantity of nomins floats, responding to the issuance actions of havven holders. The Havven system needs to incentivise issuers to maintain N such that the nomin price P_n, is stable at \$1. As we proceed, we may subscript variables with t to indicate the value of that variable at a given time. Any variable lacking such a subscript indicates the value of the quantity it represents at the current time.

In Havven, the measure of the value of nomins against the value of havvens is called the collateralisation ratio:

$$C = \frac{P_n \cdot N}{P_h \cdot H} \tag{1}$$

From the law of supply and demand, there exists some supply of nomins N_{opt}, where the related level of demand yields an equilibrium price of \$1. This quantity is associated with an optimal collateralisation ratio C_{opt}. We visualise this equilibrium below with a hypothetical demand and supply curve.



The system is unable to influence the demand for nomins. We assume that some level of demand exists given the utility of nomins as a stable cryptocurrency. Although demand cannot be manipulated, the supply of nomins is controlled by havven holders, whose issuance incentives are in turn controlled by the system. It follows that as we require a fixed price $P_n = \$1$ and are unable to control either P_h or H, we must manipulate C_{opt} such that $N = N_{opt}$ in order to satisfy our requirement.

2.2 Issuance and Collateralisation

Havven's goal is to remain overcollateralised. In order to do so, the system defines a collateralisation target:

$$0 < C_{opt} < 1 \tag{2}$$

It is necessary at this point to distinguish, for an account i, between the nomins it contains N_i (equity) and the nomins it has issued $\check{N}_i$ (debt). Note that globally, $\sum_i N_i = \sum_i \check{N}_i$, as all nomins were issued by some account. However, a given account may have a balance different from its issuance debt. Hence we can define the collateralisation ratio for an individual account i in terms of its issuance debt:

$$C_i = \frac{P_n \cdot \check{N}_i}{P_h \cdot H_i} \tag{3}$$

The system provides incentives for individual issuers to bring their C_i closer to C_{opt} while maintaining C_{opt} itself at a level that stabilises the price.

Nomin Issuance

The nomin issuance mechanism allows Havven to reach its collateralisation target. Issuing nomins escrows some quantity of havvens, which cannot be moved until they are unescrowed. The quantity of havvens $\check{H}_i$ locked in generating $\check{N}_i$ nomins is:

$$\check{H}_i = \frac{P_n \cdot \check{N}_i}{P_h \cdot C_{max}} \tag{4}$$

Under equilibrium conditions, there is some $\check{H}_i \leq H_i$ when C_i coincides with C_{opt}, which the issuer is incentivised to target. These incentives are provided in the form of transaction fees, discussed in section 2.4. It is important to note that the issuer may voluntarily increase their C_i up to the limit of C_{max}; for example if they anticipate a positive movement in C_{opt}.

On the other hand, an issuer may not issue a quantity of nomins that would lock more than H_i havvens. Consequently, C_i may never exceed C_{max}, except by price fluctuations, and in such circumstances, issuers are rewarded for bringing

C_i back under C_{max}.

After generating the nomins, the system places a **limit sell** order with a price of \$1 on a decentralised exchange. This means that the nomins will be sold at the current market price, down to a minimum price of \$1. If we assume implementation on Ethereum, then the nomins are sold for an equivalent value in ether, with the proceeds of the sale remitted to the issuer.

Nomin Destruction

In order to access the havvens that have been escrowed, the system must destroy the same number of nomins that were originally issued. When the issuer indicates the intention to retrieve their havvens, the system places a **limit buy** order on a decentralised exchange, up to a maximum price of \$1. The system places this order on behalf of the issuer and upon completion, the nomins are immediately destroyed.

2.3 Transaction Fees

Havven needs a direct incentive mechanism that can correct the global collateralisation ratio, C, in response to changes in the price of havvens or nomins. In order to target the correct price, the system adjusts the fees it pays to havven holders as according to their effectiveness in stabilising the price.

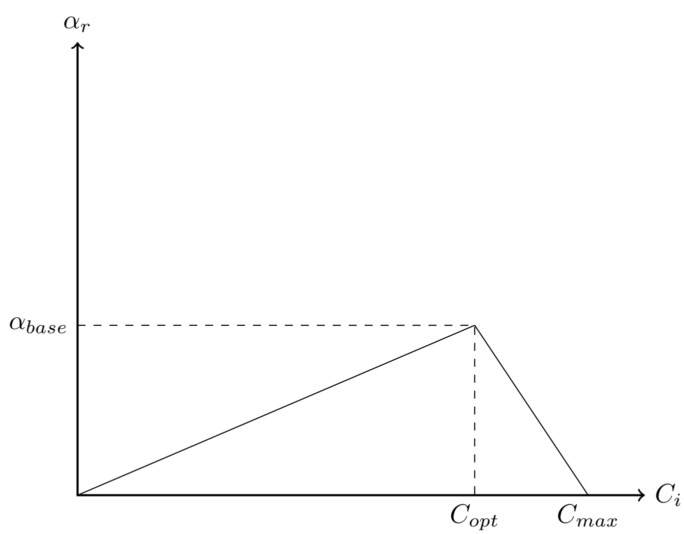
2.3.1 Fees Received by Havven Holders

The fee rate paid to a havven holder that has escrowed is α_r. The actual fee they receive is $\check{H}_i \cdot \alpha_r$, being proportional with the value they escrow. This rate changes with respect their unique collateralisation ratio, C_i. It increases linearly to a maximum α_{base} at the optimal collateralisation ratio C_{opt}, before quickly diminishing as C_i approaches the maximum collateralisation ratio C_{max}.

This function is designed to encourage havven holders to constantly target the optimal collateralisation ratio, by rewarding them with greater fees if they bring their C_i into alignment with C_{opt}.

$$\alpha_{r,i} = \alpha_{base} \cdot \mathcal{F}_i(C_i, C_{opt}, C_{max}) \tag{5}$$

$$\mathcal{F}_i(C_i, C_{opt}, C_{max}) = \begin{cases} \frac{C_i}{C_{opt}} & \text{when } C_i \leq C_{opt} \\ \frac{C_{max}-C_i}{C_{max}-C_{opt}} & \text{when } C_{opt} \leq C_i \leq C_{max} \\ 0 & \text{otherwise} \end{cases} \tag{6}$$



2.3.2 Nomin Transaction Fees

Every time a nomin transaction occurs, the Havven system charges a small transaction fee. Transaction fees allow the system to generate revenue, which it can distribute to havven holders as an incentive to maintain nomin supply at N_{opt}.

The fee rate charged on nomin transactions is α_c. It is constant and will be sufficiently small that it provides little to no friction for the user. We may then express the total fees collected in the last period, F, as a function of the velocity of nomins v and the total nomin supply N:

$$F = v \cdot \alpha_c \cdot N \tag{7}$$

2.3.3 Base Fee Rate

Let us define the total fees paid to havven holders F_r:

$$F_r = \sum_i \check{H}_i \cdot \alpha_{r,i} \tag{8}$$

Havven requires that the total fees collected from users has to be equal to the total amount of fees paid to the havven holders, so that $F_r = F$. Substituting our earlier definition (5) for $\alpha_{r,i}$ and solving for α_{base}:

$$\alpha_{base} = \frac{F}{\sum_i \check{H}_i \cdot \mathcal{F}_i(C_i, C_{opt}, C_{max})} \tag{9}$$

We have now defined the maximum fee rate, α_{base}, in terms of the fees collected, F. This rate should be achieved when an individual's C_i is at C_{opt}.

The definition of C_{opt} must therefore provide the following incentive. If $P_n > \$1$ then the system must encourage more nomins to be issued. However, if $P_n < \$1$, the system must encourage nomins to be burned.

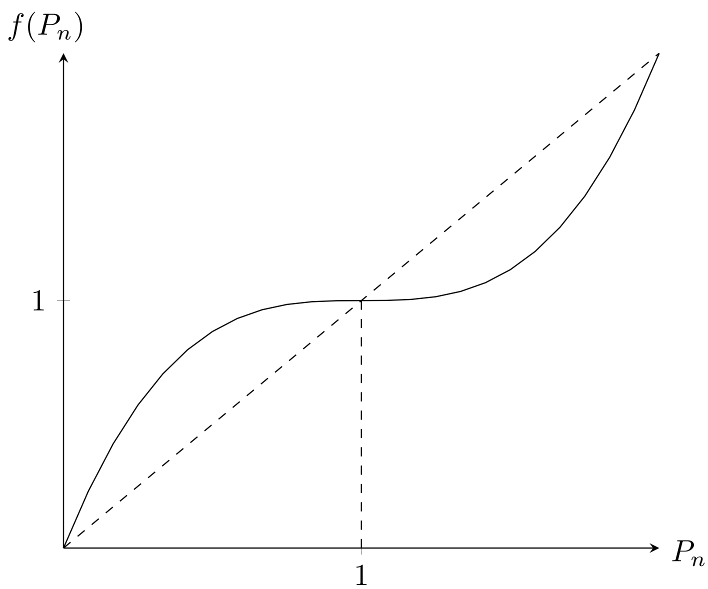
2.4 Collateralisation Ratio

2.4.1 Optimal Collateralisation Ratio

The optimal collateralisation ratio C_{opt} is a target for havven holders to reach in order to maximise the amount of fees they receive. C_{opt} is defined in terms of the nomin price P_n, such that its value directly tracks changes in the nomin price; a havven holder wishing to maximise their fees will target C_{opt} by issuing or destroying nomins.

The function for C_{opt} given below provides our dynamic target for havven holders based on the price of nomins:

$$\begin{aligned} C_{opt} &= f(P_n) \cdot C \\ f(P_n) &= max(\sigma \cdot (P_n - 1)^{\phi} + 1, 0) \\ \sigma & \quad \text{price sensitivity parameter } (\sigma > 0) \\ \phi & \quad \text{flattening parameter } (\phi \in \mathbb{N},\ \phi \nmid 2) \end{aligned} \tag{10}$$

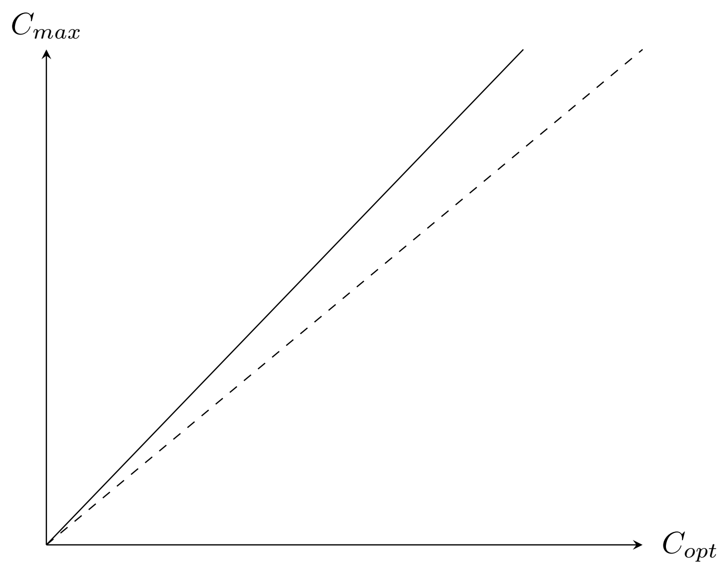


When P_n is at \$1, $C_{opt} = C$ and there is no incentive given to move away from the current global collateralisation level. However, if $P_n <$ \$1, then $C_{opt} < C$, incentivising issuers to burn nomins, thereby raising the price. The $P_n >$ \$1 case is symmetric. Notice that when the P_n is close to \$1, $f'(P_n)$ is small. However, the further it diverges from \$1, the larger the slope becomes, providing a stronger incentive, in the form of potential fees, for a havven holder to move toward C_{opt}.

2.4.2 Maximum Collateralisation Ratio

Havven seeks to maintain $C \leq C_{opt} < C_{max} < 1$, in order to retain sufficient overcollateralisation. It might seem intuitive that C_{max} should be a static value. However, since C_{opt} varies linearly with P_n and inversely with P_h, there are situations where C_{max} may need to change. Below we define C_{max} in terms of C_{opt}.

$$\begin{aligned} C_{max} &= a \cdot C_{opt} \\ a &\geq 1 \end{aligned} \tag{11}$$



The value of C_{max} determines how overcollateralised each nomin is at issuance. The higher its value, the more nomins can be generated for the same quantity of havvens. In contrast, if C_{max} is low, the system has a greater capacity to absorb negative shocks in the havven price before it becomes undercollateralised. The value of C_{max} therefore represents a tradeoff between *efficiency* and *resilience*. By defining C_{max} as a function of C_{opt}, Havven finds the optimal balance in this dilemma. This ensures that like C_{opt}, C_{max} only changes as a consequence of instability in the nomin price.

It should be noted that $C_{max} > 1$ corresponds to a fractional reserve monetary system, where a greater value of nomins can be issued against each havven. In Havven, this situation is unsustainable because it would cause simultaneous appreciation of havvens (up to at least the value of nomins issuable against a havven) and depreciation of nomins, immediately diminishing C, C_{opt} and C_{max}, bringing them back under 1.

2.5 Nomin Demand and Havven Value

Being freely-tradable ERC20 tokens, havvens will have a market price which, like the nomin price, can be measured with an oracle. Initially, while nomin demand is low, we will use a seven day rolling average of the market price for both havvens and nomins. This rolling average is designed to smooth out fluctuations in the market price and increase the cost of attacking the system.

However, once nomin transaction volume is sufficiently high, we may instead consider internally estimating the value of a havven by the fees it is likely to accrue in the future. This value, which implicitly measures nomin volume, would allow issuance incentives to directly reflect changes in nomin demand. By using this value instead of the havven market price, the system can avoid the influence of speculation, since the permitted nomin supply would expand and contract in line with how much nomins are actually being used.

While the system cannot perfectly determine future fee returns and hence nomin demand, it is possible to estimate as a function of the transaction fees that the system has recently generated. This computation is designed not to be vulnerable to instantaneous volume spikes, while taking the most recent transaction volumes to be the most highly-correlated with future volumes:

$$V_t \;=\; \sum_{t'=1}^{t} \frac{F_{t-t'}}{(1+r)^{t'}} \tag{12}$$

with

V_t	the system's valuation of a havven in period t
F_t	the total fees collected in period t
r	a falloff term

This can be computed efficiently, because $V_{t+1} = \frac{V_t + F_t}{r}$. Further, if it is assumed that the average fee take is approximated by F_t, and t is large, then:

$$V_t \;\approx\; \sum_{t'=1}^{\infty} \frac{F_t}{(1+r)^{t'}} \;=\; \frac{F_t}{H \cdot r} \tag{13}$$

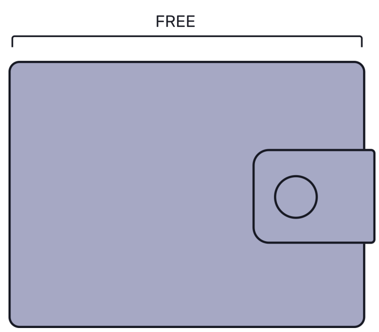
Consequently, $\frac{1}{r}$ approximates the number of periods for a havven to yield a fee return of V_t. A judicious choice of r can then yield a V_t which underestimates the market price of havvens (which also incorporates, for example, capital gains), while not unduly constraining nomin supply.

2.6 Issuance Case Study

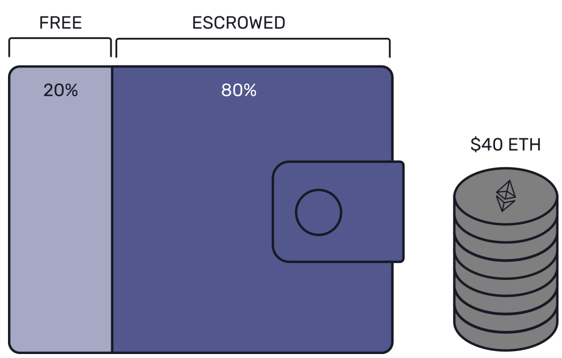
Bob decides to purchase 100 havvens at $1 each. Consider the following initial conditions:

$$
\begin{array}{ccc}
C_{max} = 0.5 & C_{opt} = 0.4 & C = 0.4 \\
P_n = 1 & P_h = 1 & H_i = 100 \\
\sigma = 50 & \phi = 3 & a = 1.25
\end{array}
$$

The system is in price equilibrium, with the global collateralisation ratio C equal to the optimal collateralisation ratio C_{opt}. Initially, Bob's wallet contains only free havvens.



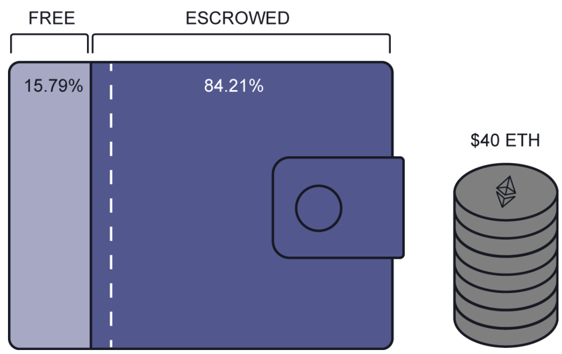
Bob wants to earn the maximum possible fees, so he issues nomins up to C_{opt}. The system generates 40 nomins and escrows 80 of his havvens, locking $80 worth of value in the system. The nomins are sold for $40 worth of ether and the proceeds are transferred to Bob's account.



Nomin Price Change This example shows how the system incentivises havven holders to correct instability in the nomin price.

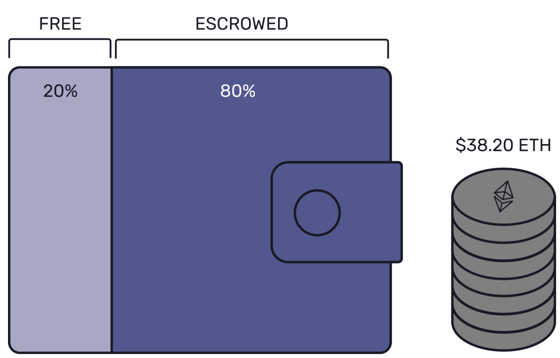
1. As a consequence of reduced demand in decentralised trading markets, the nomin price P_n drops to $0.90. The system needs to incentivise havven holders to reduce the supply of nomins so that the price returns to $1.00.

2. First, consider that both C and Bob's C_i have decreased to 0.36. Since the nomin price has changed, C_{opt} is recalculated to 0.342, which is smaller than both C_i and C. Consequently, C_{max} also changes to 0.4275. This increases the percentage of Bob's havvens that are locked.



3. Bob now has a higher dollar value of locked havvens and his $C_i > C_{opt}$. This means that he is no longer receiving the maximum fee rate α_{base}. In order to return to α_{base} he must lower his C_i back to C_{opt} by burning some nomins. He needs to work out how many to burn.

4. He should burn 2 nomins so that he has 38 total issued, which will cost $1.80. When the system completes this process, his locked havvens will reduce back to 80. In addition, his C_i is equal to C_{opt} at 0.342, which means he is once again receiving the maximum fee rate.

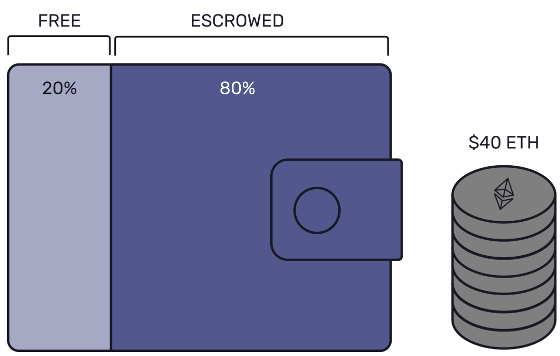


5. Bob has taken the correct actions to raise the low nomin price. By electing to burn nomins, the system performed a limit buy order on his behalf, putting upward pressure on the nomin price. As compensation for doing so, he is rewarded with the optimal fee rate α_{base}.

Havven Price Change (Market Price) This example illustrates how the system maintains the dollar value of the underlying collateral by adjusting the quantity of a user's escrowed havvens when the havven price changes. Consider the same initial conditions as before:

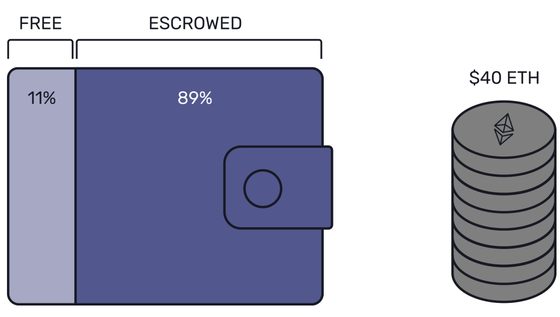
$$
\begin{aligned}
C_{max} &= 0.5 & C_{opt} &= 0.4 & C &= 0.4 \\
P_n &= 1 & P_h &= 1 & H_i &= 100 \\
\sigma &= 50 & \phi &= 3 & a &= 1.25
\end{aligned}
$$

1. Like before, Bob elects to issue up to C_{opt} in order to maximise fees.



2. The havven price P_h drops to \$0.90, which means the value of Bob's wallet has decreased to \$90. Both C and Bob's C_i have increased to 0.44. Since the nomin price has not changed, the system does not need to incentivise issuance or burning. This is reflected in the new value of C_{opt}, which changes to 0.44, matching C and C_i.

3. However, the system needs to escrow more of Bob's havvens to maintain the dollar value of the locked collateral. The system has now locked around 89% of Bob's havvens, to maintain \$80 of locked collateral.



2.7 Fee Evasion

Being based on Ethereum, Havven is potentially vulnerable to its tokens being wrapped by another smart contract which takes deposits, and replicates all exchange functionality on redeemable IOU tokens it issues. These wrapped tokens could then be exchanged without incurring fees. We consider this situation unlikely for a number of reasons.

First, the fees are designed to be low enough that most users shouldn't notice them, so users will not in general be strongly motivated to switch to a marginal and less trustworthy alternative.

Second, network effects are tremendously important for currencies; in order to have utility a token must be accepted for exchange in the marketplace. This is challenging enough in itself, but a wrapped token must do this to the extent that it displaces its own perfect substitute: the token it wraps. In Havven's case, this would undermine its built-in stabilisation mechanisms, which become more powerful with increased transaction volume. Consequently, as a wrapped nomin parasitises more of the nomin market, it destroys the basis of its own utility, which is that nomins themselves are stable.

Finally, it is unlikely that a token wrapper will be credible, not having been publicly and expensively audited, while its primary function undermines the trustworthiness of its authors.

Even as this may appear unlikely, it's a simple matter to implement a democratic remedy, weighted by havven balance, by which havven holders can freeze or confiscate the balance of any contract that wraps assets. Those havven holders are incentivised not to abuse this system for the same reason that bitcoin mining pools do not form cartels to double-spend: because abuse of this power would undermine the value of the system, and thus devalue their own holdings.

The credible threat of such a system existing is enough to discourage token wrappers from being used, even if they are written, since any user who does so risks losing their entire wrapped balance.

3 System Analysis

While, the simplicity of the Havven mechanism makes it feel intuitively viable, we take the view that falsification is vital in validating a proposed cryptoeconomic system. The more resilient a given system is to hypothetical attacks, the more trust can be put in its viability.

Ultimately this must done empirically, but it is also important to model Havven extensively before launch. Therefore in our quantitative analysis we seek above all to identify its failure modes, and also to characterise its stability under a range of conditions.

In our quantitative analysis, we take three distinct approaches in modelling the system:

Analytical

By expressing our system in the language of game theory and microeconomics, we seek to gain insight into Havven's incentive structure and the resulting price equilibria. Examining the problem from this direction can lead us to concise and mathematically robust conclusions.

Simulationist

We implement a broad range of strategies as AI agents, and examine how the market responds under different initial conditions, with different constituent populations, and in response to external shocks. This approach allows us to examine situations which are analytically intractable.

Empirical

The initial release of the Havven system utilising ether-backed nomins will be invaluable in testing our assumptions. Observation of real market behaviour will allow us to better understand how the it responds in different situations, and therefore how to choose appropriate values for system variables.

The results of these investigations will be published as they are completed.

3.1 Agent-based modelling

It has been observed that analytic methods are often difficult to apply in the complex and dynamic setting of a market. One suggested solution to this problem is *agent-based modelling*. Under this paradigm, we proceed by first defining rational agent behaviour and then simulating the interplay of those strategies over time. We seek to develop a more effective method of characterising market behaviour and equilibrium prices than pure analytic reasoning.

Such simulations also provide an immediate means of measuring quantities of interest. Simply by observing the model, we can discover how varying input parameters affect system outputs in an experimental fashion. One important corollary is that this is a way of extracting reasonable settings for system parameters (such as fee levels) that might be difficult to reason about *a priori*. These systems, reactive as they are, also provide a method for testing proposed remedies for any identified failure modes, and are a platform to simulate the conclusions of any antecedent game-theoretic reasoning.

3.2 Expected Market Players

Here we outline some of the players anticipated in the market. These represent only some of the agents that our modelling and simulations are predicated upon.

Havven Holders

A havven holder provides the collateral and liquidity for the system. It is assumed that havven holders primarily seek fee revenues, and escrow most of their havvens, adjusting their issuance to track Havven's moving fee incentives. While these incentives make sense if havvens are relatively stable in the long term, Havven will also provide incentives for correcting the nomin price in in the short term. Returns for these actors are primarily realised in fees, seignorage, and the appreciation of havvens resulting from their constrained supply.

Nomin Users

These are the market participants who will make up the base demand for any stablecoin, chasing its superior utility as a medium of exchange or as as means of hedging against other forms of value. The users of nomins may include merchants, consumers, service providers, cryptocurrency market actors such as exchanges.

The transaction volume these users provide is necessary for fees to exist. They may be disincentivised from using the system in low liquidity situations or with excessive volatility in the price of nomins.

Speculators

Speculators may tend to magnify price corrections, and are a significant vector by which to introduce exogenous shocks to the system. In our modelling we induce volatility by simulating modes of interest such as large capital flows in response to breaking news and the like.

Speculators also produce an important stabilisation force. When the market believes that the price is being stabilised, upward price shifts induce sell pressure, and downward price shifts induce buy pressure. This strategy is profitable on the assumption that the price will return to the equilibrium point. This neutral stabilisation force is a self-sustaining negative feedback loop which operates independently of other incentives; preliminary simulations and observations of other systems have verified the efficacy of this corrective pressure.

Buyer of Last Resort

While the system is designed to work without intervention, the Havven foundation will have capital reserves with which to intervene in the market to stabilise nomin prices in extreme situations.

The advantage that such a market participant confers, given that a very large market entity is willing to underwrite the stability of the coin, is that profit strategies predicated upon the stability of the token become less risky and so more feasible. As a result, any such presence, even if it rarely intervenes in the market, enhances the aforementioned neutral stabilisation force. In our modelling, the Havven foundation in this capacity takes on the role of providing confidence.

Modelling results will inform the need of such an actor in the ecosystem.

Arbitrageurs and Market Makers

The arbitrage force allows us to assume that the havven/nomin, havven/fiat, nomin/fiat prices are properly in alignment or will soon become aligned. Market-making activities allow us in our modelling to neglect the bid/ask spread, and situations where there is insufficient liquidity for players to transact.

Please visit `http://research.havven.io` for an alpha version of our model, and `http://blog.havven.io` for further discussion of stablecoins and cryptoeconomics.