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The VIGOR Protocol*

Chester Hedron[1]

***Abstract*— VIGOR is a crypto multi-collateralized and fully decentralized protocol with a low volatility payment token and a utility/governance token on the EOS blockchain.**

I. INTRODUCTION

The VIGOR token is an applied financial engineering innovation with regards to a decentralized low-volatility unit of account. The VIGOR platform mints a multi-collateralized token without any central counterparty by enabling participants to separate and transfer both **volatility risk** and price **event risk** through locking other crypto in open source smart contracts. In particular, VIGOR tokens are minted and loaned out when EOS and other eosio native crypto tokens are locked in the VIGOR smart contracts and further collateralized by insurers. The VIGOR platform introduces a decentralized system of borrowing & lending with only two distinct independent participants:

- **Borrowers**
  - lock EOS native tokens as collateral
  - take VIGOR loans, maintaining collateral level
  - pay premiums in the native VIGOR Protocol utility token, VIG, over time to protect their collateral
- **Lenders (also called Insurers)**
  - lock EOS native tokens to capitalize an insurance pool
  - get VIG rewards based on their contribution to the platforms solvency
  - bailout: takeover/recap undercollateralized loans

A. The Problem

Currently there is no truly decentralized low-volatility token on EOS. Many use cases involving time value of money require this kind of basic functionality. Other platforms suffer the following problems that this platform will attempt to address:

- **Intractable Governance**
  - governance token concentrated to a few whales; suggest a measure of "usage" of the platform should lead to a governance role not just token "holder"
  - voter apathy, voters expected to vote on complex topics for which they have no interest nor specialty; suggest user/voter should delegate to experts
  - Overlapping participant roles and lack of decentralization; we suggest full decentralization and distinct separation of skills: borrower/insurer/custodian
- **Absent financial engineering**
  - arbitrary loan pricing with no financial model nor market price discovery
  - lack of risk modeling and risk budgeting; we suggest risk is a scarce resource that should be modeled and allocated via budgeting
  - participants having no way to know if risk/return is attractive
  - no stress testing is done nor considered
  - underestimate friction/illquidity in market stress
- **Not scalable**
  - inefficient pricing/fees precludes institutional use
  - poor user experience: high txn fee, slow block time
  - solidity not appropriate for financial math models

B. The Solution

The VIGOR protocol is a platform for decentralized secured lending of crypto tokens. The VIGOR token is a low volatility crypto token designed to provide stability in a range

*`Vigor` protocol originates from the many not the few.

[1]Special thanks to genesis custodians.

of use cases from value preservation to market hedging. Users can do the following:

- **Gain Rewards**
  - get rewarded by locking tokens as insurance to protect collateral backing VIGOR token loans;
- **Borrow**
  - Borrow VIGOR token, VIG token, & other cryptos;
- **Leverage**
  - get leveraged exposure to token prices by taking VIGOR loans followed by selling it for other tokens;
- **Hedge**
  - reduce exposure to token prices by taking VIGOR loans followed by hodling VIGOR in savings
- **Short Exposure**
  - take crypto loans backed by VIGOR tokens followed by short selling the proceeds

The design of the VIGOR protocol focuses on the transfer of volatility and price event risk embedded in token prices. The smart contract enables decentralized secured token lending by implementing a risk model based on an insurance regulatory accord, a pricing model based on event derivatives and uses financial product structuring. Deployed on the EOS public blockchain it operates autonomously and with full transparency performing on-chain stress testing in near real time to maintain the stability characteristics of the VIGOR token.

The borrow rates are not dictated but are discovered, determined by users as they interact in a process of risk-based price discovery. Each user transaction is a credit or debit to a risk budget where risk is measured as capital adequacy. As the system risk departs from its risk target, prices adjust to incentive user behavior in an effort to preserve and replenish the risk budget and restore capital adequacy.

There is not one single borrow rate on VIGOR (in contrast to other simplistic platforms which seem to let users borrow at the same rate regardless of whether one loan has more or less collateral than another). On the VIGOR plaftorm an entire pricing curve is discovered using a pricing model as a functional accross collateral ratio (loans with less collateral require purchasing more insurance and are then more expensive). This enables VIGOR users much more efficient pricing per unit risk than other platforms, an important consideration in a competetive landscape.

VIGOR delivers unique functionality enabling both sides of the collateralized lending equation: lock something risky to borrow something relatively stable, and its compliment, lock something relatively stable to borrow something risky. The VIGOR platform is then complete with a dual symbiotic feature set enabled by a single shared token pool also having a dual purpose: a source of tokens for lending and to insure collateral.

VIGOR introduces ”bailouts” as a distinct departure from the naive and risky approach of holding debt auctions (ie users auctioning collateral related to failed loans during distressed markets). The VIGOR bailout mechanism is low friction and does not require auctions but rather the insurers stand ready to take responsibility for the remaining collateral and debt of failed loans, recapitalizing them. The illiquidity risk is offloaded to lenders who are compensated to take this risk.

VIGOR is built initially for eosio blockchains, and is deployed on the EOS mainnet. This chain offers very fast block times (0.5 sec) with zero transaction fees and a fully featured multisignature permission system. The user experience is second to none. The code is written in C++ which is high performance and is the most common, most respected language for financial modeling worldwide. The VIGOR contracts were professionaly audited by Sentnl.io.

VIGOR is built to use many collateral token types and treats them with portfolio analytics to enable users to borrow against a basket of tokens and to take advantage of diversification. It is built to consume collateral tokens, and can onboard many tokens popular within the different factions and tribes in the crypto landscape.

VIGOR is meant to be a smart contract platform enabling a user friendly and entertaining experience for a community of borrowers and lenders where the borrow rates are discovered by user interaction.

VIGOR’s Governance is structured as a decentralized autonomous community (DAC) for the advantages this governance structure provides: the DAC structure incentivises an open and decentralized build community, it casts a large net, attracts many self-starters, those with initiative, pragmatism, and enables this talent to rise as top contributors and to have a sense of endowment. Custodians are elected daily from a pool of approximately 200+ and growing Candidates, and are generally experts in their respective fields. Multisignature access is required to update the VIGOR smart contracts code, the keys reside with the Custodians.

The Utility token of the VIGOR Protocol is called VIG. Its utility is to provide access to the system, to be used as a fee token, to be used as a final reserve and also to act as a Governance token via a staking mechanic. Any VIG holder can stake a certain amount of VIG to become a Candidate and if garnish enough votes can themselves cast votes to elect Custodians.

VIG tokens are paid-in by borrowers to the protocol and are used to reward insurers/lenders. A small portion of this transaction is withheld by the system to be used as final reserve, to hedge against Black Swan events. A portion of fees is also taken to cover the costs of the community building the protocol.

The VIGOR protocol was designed to have solid financial engineering specification and make use of standards in regulatory risk management. The smart contract implementation focuses heavily on duality:

- **Pricing**: valuation model & price discovery
- **Risk**: risk framework, stress model, & capital adequacy

The result is a self-sustaining ecosystem balanced by borrowers and lenders which is robust to extreme price events. VIGOR is a decentralized finance token lending protocol

having relatively tractable governance, higher leverage capability for borrowers, and higher adoption/scalability than has ever been possible.

II. Risk Framework

A. Credit Enhancement

Two types of credit enhancement are used which enables prudent lending:

- **Overcollateralization** (margin or haircut) refers to crypto tokens held by a borrower (collateral) having value that exceeds the value of their loan (borrowed tokens). As collateral values fluctuate with the market, an excess amount of a collateral is required as a buffer.
- **Insurance/Lending** is a collection of crypto tokens held by insurers/lenders, available to the system to protect borrower collateral value against catastrophic price events and price declines related to price diffusion/normal volatility; it is a backstop, a means for recapitalizing bad debt (loans having collateral value less than outstanding debt), and also serves as the source of availablility of tokens to be loaned out to borrowers.
  - Borrowers effectively protect their collateral by paying premium protection payments over time on a Token Event Swap (TES) an innovative smart contract which triggers bail-out if a price event occurs in exchange for premium payments.
  - Insurers/lenders take on risk to get the premium (rewards) and provide backing for loans by locking crypto tokens into the insurance/lending pool.

B. Solvency

VIGOR token should exhibit low-volatility to the extent that loans either have excess collateral or that the lending pool is sufficiently capitalized. Therefore the smart contract models the capitalization of the lending pool with critical importance. The system mimicks the Solvency II risk framework used by insurance regulators in the EU.

- **Solvency Ratio** measures lenders ability to bail-out undercollateralized loans, see Figure 1.
  - **Own Funds** is the amount of crypto collateral in the insurance/lending which exceeds the sum total market value of all TES protection purchased by borrowers.
  - **Solvency Capital Requirement (SCR)**. The SCR is the amount of capital needed for the system to be adequately capitalized in the event of market stress, for a given tolerance of certainty.
  - **Solvency Ratio** is the risk measure used to indicate if the current state of the system at any time meets the capital requirement. A target solvency level which exceeds or is below the requirement is a reflection of risk appetite.

SCR is obtained as shown in Figure 2 as the change in Own Funds between normal and stressed markets. To arrive at SCR the core operation is to conduct a stress test per Solvency II which provides information about the

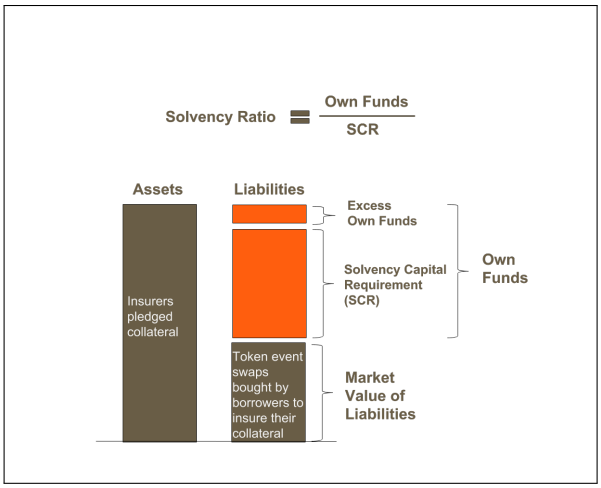

Fig. 1. Economic Balance Sheet

required quantity of crypto collateral that should be locked by lenders to maintain solvency. For this stress test the platform implements a TES pricing model to provide a best estimate for market value of the TES liabilities in normal conditions and a stress model for what their shocked value might be (given varying levels of certainty). Own Funds equals the amount of crypto collateral pledged by lenders minus the best estimate **normal** market value of the TES contracts. Stressed Own Funds equals the **stressed** value of crypto collateral pledged by lenders minus the best estimate **stressed** value of the TES contracts. Finally, SCR is the change in Own funds due to stressed markets and **Solvency Ratio** is the ratio of Own Funds to SCR.

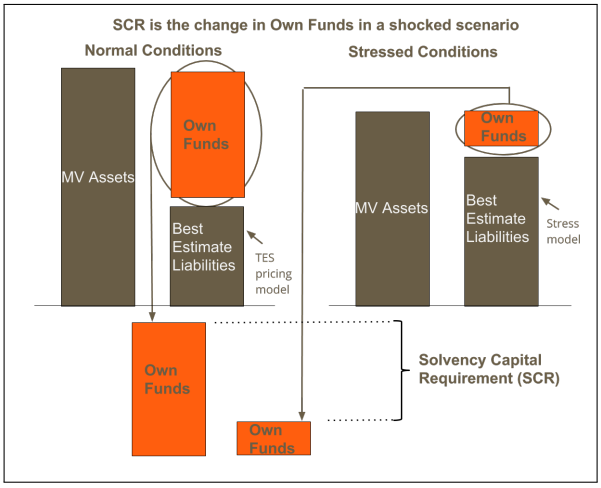

Fig. 2. Solvency Capital Requirement (SCR)

C. Stress Model

The stress test is based on the coherent risk model, portfolio based, historical-parametric Conditional Value at Risk and utilizes the payoff function of the pricing model, see subsection III-A. It considers both standalone risk as measured by historical Exponentially Weighed Moving Average Volatility with decay, averaged from several different frequencies, and

considers the correlation structure. To visualize a typical portfolio loss distribution in the context of VIGOR protocol, see Figure 3. There are three categories of loss: expected loss which is insured by overcollateralization, unexpected loss which is insured by insurers/lenders, and stress loss which is backed by VIG final reserves (see subsection II-F). Key inputs to this model are volatility, correlation, alpha level of the test, and Collateral Ratio. This stress model is used primarily to obtain SCR and Solvency Ratio but also provides a measure of capital efficiency and risk concentration (Risk Adjusted Return on Capital and contribution to RAROC) to indicate system health.

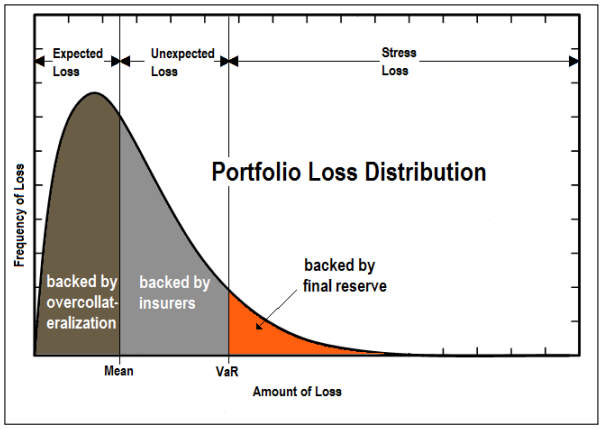

Fig. 3. Stress Model: Portfolio Loss Distribution

D. Structured Feature

All TES lending pool contracts written to protect collateral are taken together as a basket of TES to form an aggregated lending premium. Lenders take the other side by selling protection on notional amounts of a basket TES (a single TES written on a basket of collateral), see Figure 4. The basket TES may be tranched in later releases.

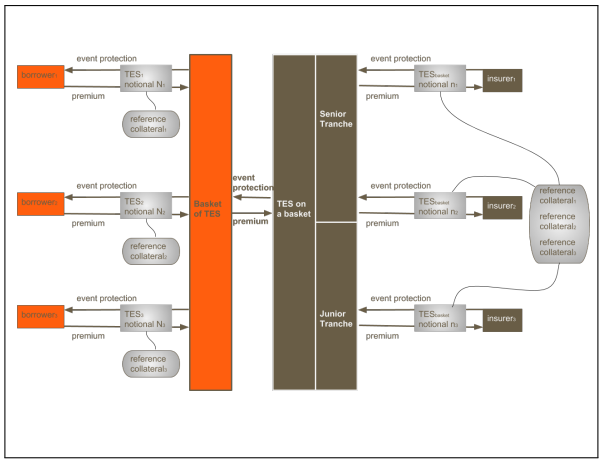

Fig. 4. Structured Feature: transferring risk with a basket of token event swaps (TES) and a single TES written on a basket of collateral

E. Bail Outs

A TES is triggered for bail-out if collateral value falls below the value of debt for a given loan. If a TES is triggered then the basket TES protection sellers (Lenders) would immediately take-over and recap the undercollateralized loan realizing a loss. Gains and losses of the lending pool is shared accross lenders. Participation is commensurate with **contribution to solvency** defined as the change in Solvency Ratio resulting from a given TES seller escrowing tokens into the lenders pool. Handling bail-outs does not require auctioning collateral into distressed markets Rather, the basket TES is both funded and physically settled. This means that the insurers lock tokens ahead of time to be available to accept bailouts and recap the system instantly and with no friction.

F. Final Reserve

Premiums paid-in by borrowers is required to be de-nominated in VIG utility tokens and must be posted prior to drawing loans; insufficient maintenance of VIG balance triggers bail-out of the loan with borrower retaining any excess collateral. The VIGOR protocol has an automated VIG debt function that, should the borrower run out of VIG tokens, issues the borrower additional VIG debt to cover premiums for a limited duration (days). The automated VIG debt feature helps minimize the occurence of bailouts due to insufficient VIG balance. Insurers are rewarded in VIG when locking EOS and other supported crypto, or in VIGOR when locking VIG.

The system stores a cut of VIG premiums as final reserves after making VIG payment to lenders. VIG **final reserves** is used recap the system if at any time the lending pool is depleted, covering the so-called stress losses as depicted in Figure 3.

III. Pricing Framework

A. Pricing Model

The **token event swap TES** contract delivers a protection payment (the cost to bail-out an undercollateralized loan) at the time of the triggering event, defined as the token price declining below a pre-specified triggering barrier level (value of collateral falling below the value of debt). In exchange the TES protection buyer makes periodic premium payments at the TES rate up to the triggering event. The model implemented to acheive those characteristics is a modified version of a cash-or-nothing digital. The pricing model was inspired by the works of the following: [1], [2], and [3].

As collateral price and volatility change over time the premium charged to the borrowers (pricing) is adjusted using the TES pricing model; borrowers actually pay a floating premium rate. Premiums adjust inversely proportional to collateralization levels and proportional to level of collateral token volatility. The basket TES is priced as a weighted average basket of TES prices.

B. Price Discovery

The borrow rate is found through an innovative method named here as ”risk-based price discovery”. Every user transaction is a credit or debit to the risk budget as measured by solvency ratio. When solvency is below/above the target,

borrow rates are increased/decreased by applying a scale factor to the input of the pricing model in an effort to drive risk to target. The "right" price is representative of the balance between the supply and demand of lending. The role of the pricing model is simply for relative pricing, to be a deterministic functional that relates price, volatility and moneyness (i.e. collateral ratio) so that the entire borrow rate curve is discoverable with just one single factor (the pricing scale factor).

C. Stability

The VIGOR token is designed to exhibit low price volatility using the following five pillars of stability:

1) **Crypto-overcollateralized**
   Stability depends firstly on the level of overcollateralization which covers expected losses. The system prices the collateral in USD, and overcollateralization is defined as USD value of collateral minus number of VIGOR debt.
2) **Collateral is "protected"**
   Event risk and volatility risk of the collateral is transferred to insurers. Stability then also depends on the level of capital adequacy or solvency of the insurance/lending pool . The system scales pricing through implied paramaters in the pricing model to drive Solvency Ratio to the target set by Custodian vote.
3) **Final Reserve**
   The insurance/lending pool represents insurance to cover unexpected losses estimated by the stress model to a degree of certainty specified by Custodians. Actual losses may prove worse than estimated due to model risk. So the VIG final reserve protects the insurance pool as a lender of last resort covering these so-called stress losses.
4) **Solvency target**
   Custodians set the target solvency giving them the power to run the Vigor protocol from conservative to aggressive.
5) **Saving**
   Savings are incorporated to provide additional downside risk stability. VIGOR protocol users can lock VIGOR tokens and be rewarded with VIG tokens. Saving reward rates change based on the total amount in savings and based on VIGOR price. In the extremely unlikely case of a total system collapse, with full depletion even of the final reserve, the VIGOR Protocol will then use also VIGOR Savings to rebalance the system.

IV. Governance

The fully open and decentralized VIGOR Protocol is partially developed, guided, supported and maintained by a decentralized autonomous community (DAC) run by daily elected Custodians voted in by Candidates, who are VIG holders that stake a certain amount of VIG to participate in the DAC Governance. Custodians vote on all issues concerning the running of the DAC and the support, development and maintainance of the VIGOR Protocol and Smart Contracts.

V. Other Token Lending

A key feature of the VIGOR protocol is that it enables the second half of the lending equation, lending risky tokens using the VIGOR low-volatility token as collateral. This is accomplished through the use of an upside TES and an implied zero cost collar. A lender locks crypto tokens for lending and gets rewarded in VIG tokens for taking exposure to bail out risk of upside price events. A crypto token borrower locks VIGOR low-volatility tokens as collateral and pays upside TES lending premiums as they borrow crypto tokens and take the other side of the collar. This is distinctly different than token lending/leasing platforms that lend the token resources or utility. The VIGOR protocol enables lending the complete token including exposure to price volatility and price event risk (in other words potential capital gains/losses not just resource lending/leasing).

VI. VIG Token Utility and Allocation

The utility token VIG has the following utility aspects in the system:

- **fee token** VIGOR borrowers must pay VIG premiums; insurers are rewarded in VIG when locking other crypto/tokens;
- **final reserve** for absorbing stress losses, the final reserve continuously accumulates VIG from its share of the fees. Tokens in the final reserve stay in the final reserve. Even if the reserve is assigned bailout, the tokens stay in the reserve as it is final, and hence VIG is deflationary.
- **access and reputation score** users need VIG to access the system and their reputation score is a function of their VIG paid in over time, and their VIG rewards received over time. Reputation measures VIG "usage" and all users are ranked relative to each other to identify real users to award discounts and such.
- **governance** VIG holders can stake a certain amount of VIG to become Candidates. Candidates are eligible to receive votes and if garnish enough votes can themselves cast votes to elect daily Custodians of the VIGOR DAC.

The VIG token has a fixed supply of 1 billion tokens with 0% annual inflation rate.

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