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Verasity – Economic Analysis

Stability Tests of the Verasity Economy

Dr. Christian Jaag

Dr. Michael Funk

Matthias Hafner

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Executive Summary

By regulating money supply, the Verasity Foundation intends to stabilize price levels within the Verasity economy. Money supply may impact inflation directly by making tokens more or less scarce or indirectly through minting tokens that are used to incentivize market participants to engage in transactions. Hence, finding the right policy for regulating the supply of money is key to ensuring long-term price stability and enabling Verasity to become a successful economy.

The Verasity Foundation plans to regulate the supply of money with a deterministic mechanism on the blockchain. The center for cryptoeconomics (cryptecon) was asked to simulate the proposed mechanism and test its influence on the long run-price stability of the Verasity economy.

The Verasity Foundation aims to keep inflation at a moderate rate of 3% per year in order to ensure sufficient liquidity and stable growth of the economy. The minting mechanism is designed to hold prices at a constant growth rate that corresponds to the overall growth of the economy. The mechanism mints tokens so that the increase in money supply matches the expected increase in demand for VERA tokens. The Verasity Foundation plans to use a straightforward and simple to implement method to form expectations about future growth that is based on historic growth rates of the last two periods.

Given the information provided by the Verasity Foundation, our simulations indicate that a simple mechanism, approximating expected demand for VERA tokens with historic price levels, can result in a stable money market. This result even holds when external shocks are introduced.

We find that a moderate positive inflation target performs better than a zero-inflation target, as the latter induces strong reactions by speculators, which may destabilize the economy. Assuming that speculators form adaptive expectations, the simulations show that their strong reactions may destabilize the economy, especially in the initial phase when demand is very volatile. However, if adaptive speculators do not react right away with all their assets, the mechanism is able to produce a stable outcome. Finally, the simulations indicate that shorter backwards-looking periods result in more stable price developments, as they allow for swifter reaction to exogenous shocks.

Based on the information provided by the Verasity Foundation and assumptions about the behavior of speculators, we conclude that the planned mechanism for money supply is capable of creating reasonable price stability. Among the simulated scenarios, the baseline-scenario with a one period backward-looking mechanism, 3% inflation target, and 40% reaction of adaptive speculators performs best.

Content

1 Introduction

The Verasity Foundation intends to launch a next-generation video platform which will enable viewers, content producers and advertisers to exchange services based on a specialized cryptocurrency. Trade between the different players will be facilitated by the VERA token. This allows the Verasity Foundation to develop a decentralized economy in which the different players interact directly without expensive middlemen earning large shares of content producers' revenues. The platform only charges a small transaction fee which is used to finance maintenance.

In contrast to traditional video distributors, the Verasity Foundation will not actively participate in the market. The Foundation is mainly responsible for the design of the decentralized platform which controls the money supply and the allocation of newly minted tokens in the economy. In this capacity, the platform may incentivize different sides of the Verasity platform to participate in the market. Like all governing bodies of economies, the Verasity Foundation should be concerned about the stability of the service as well as the monetary market.

Against this background, the center for cryptoeconomics (cryptecon) was asked to test the planned mechanism for regulating the supply of money provided by the Verasity Foundation. The aim is to gain a better understanding of the behavior of participants (e.g. viewers, content creators) and speculators, and to determine whether the Verasity platform can provide a stable price environment for video distribution, given different assumptions on input parameters and external shocks. Cryptecon has run various simulations for which the Verasity Foundation provided the key inputs and assumptions. The simulations focus on the design of the minting mechanism, the behavior of speculators and the role of inflation targets. This should allow for conclusions concerning the price stability of the Verasity economy in the long run.

The report begins with a short description of the Verasity economy and the minting mechanism (section 2). It then specifies the setup of the simulations and states the main assumptions (section 3). Subsequently, it presents and discusses the results of the simulations (section 4) and finally concludes (section 5).

2 Design of the Verasity Economy

2.1 Basic structure of the economy

The description of the Verasity economy is based on the information provided in the White Paper. There are four different players in the economy:

- **Viewers** consume video content through the Verasity platform. Consumption may be free or require payment in VERA tokens. Viewers can earn VERA tokens by watching advertisement. Viewers can fund new content as stakeholders for which they receive compensation in the form of a share in subsequent revenues.
- **Creators** produce video content to share on their channels in order to generate both views and revenue from their audience. Creators can be supported by publishers. In this document, the roles of creators and publishers are used interchangeably
- **Advertisers** use the Verasity platform for promotional activitiy. Advertisers pay viewers for their attention with VERA tokens, which they can use to watch paid content.
- **Sponsors** pay creators in order to receive attention, e.g. by product placement.

- The **Verasity platform** acts as a central bank that aims to maximize the overall welfare of all participants in the Verasity economy. The platform controls the money supply and can use newly minted tokens to provide incentives for market participants to trade.
- **Speculators** invest in VERA tokens either because they expect the value of VERAs against other currencies to increase (subsequently referred to as adaptive speculators) or because they expect the economy to grow (subsequently referred to as rational speculators).

The stability of the Verasity economy will crucially depend on the platform's capability to balance supply and demand for VERA token. If supply surpasses demand, the economy will witness inflation. If demand surpasses supply, there will be deflation. The Verasity Foundation aims for a moderate inflation rate of 3% per year in order to guarantee the economy's liquidity.

After the initial coin offering, the Verasity Foundation seeks to mint additional tokens in order to balance supply and demand for VERA tokens in the economy. Newly minted VERA tokens are added to the reward pool. The tokens in the Reward Pool are then redistributed to viewers and content creators.[1] Additionally, the Verasity Foundation can use the transaction fee which is due for each transaction.

Figure 1: Structure of the Verasity economy

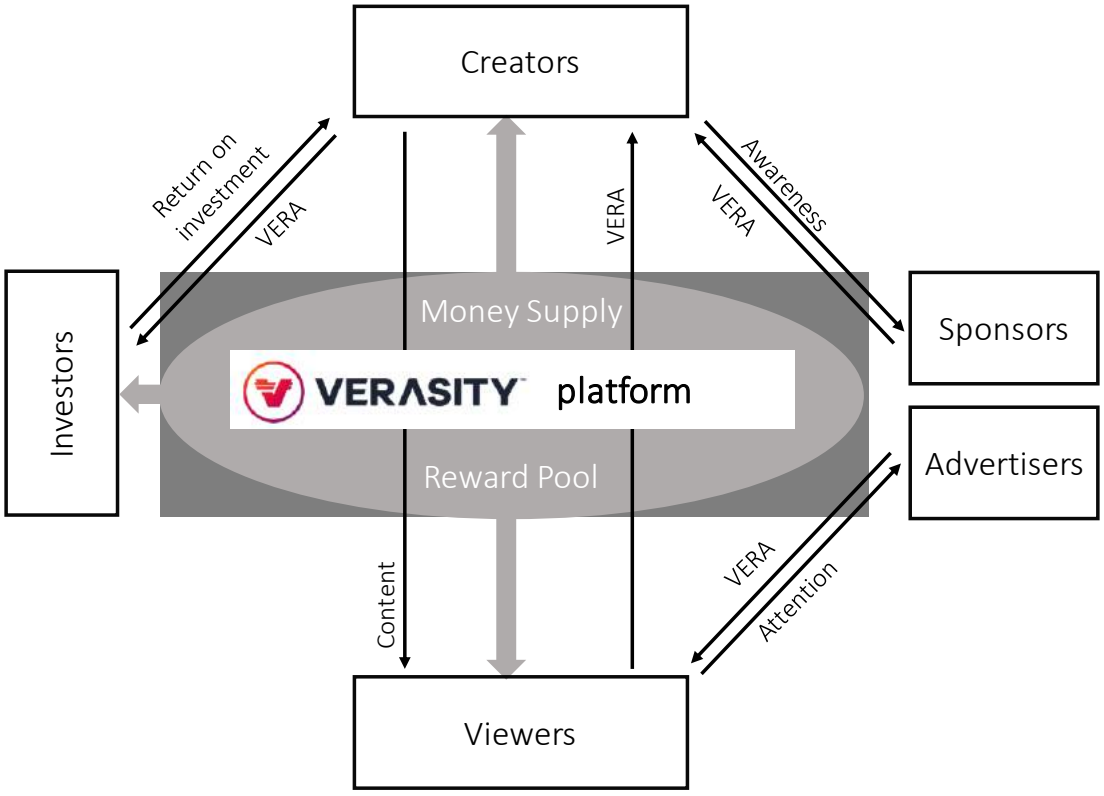


Figure: cryptecon

In order to balance supply and demand for content, the Verasity Foundation can incentivize different players using the tokens in the reward pool. From this perspective, the Verasity

[1] A portion of the reward pool is also use to reward participating in the creation of new blocks on the Verasity Blockchain, the so-called VERAfiers.

platform constitutes a multi-sided market (different player groups using the same platform), where the platform enables transactions between the different market sides.

The Verasity Foundation's aim is to maximize the welfare of the platform participants. To that end it will use mechanisms from monetary as well as fiscal policy.

- **Monetary Policy**: The Verasity Foundation implements the mechanism which regulates money supply. An algorithm within the blockchain automatically regulates the supply of money. For example, supply may be expanded by releasing more tokens into circulation either through increased minting or through reducing the number of tokens not in circulation. In order to provide the market with enough liquidity and the necessary stability, the Verasity Foundation chooses a moderate inflation target.
- **Fiscal Policy**: The Verasity Foundation allocates newly minted VERA tokens to different players in order to reward participation (e.g. active viewers and creators). In addition to the intrinsic value of trade, the platform can therefore further incentivize different market sides to participate in the economy. This may be desirable since the platform constitutes a multi-sided market (with different customer groups on each side), in which the participation of each side creates value for the other sides (positive externalities) and therefore increases the overall value of the platform.

2.2 Demand for VERA tokens

The demand for VERA tokens depends foremost on the number of transactions between viewers and creators and the price level within the VERA economy. Some demand may also derive from the sponsors who invest in the content market in order to achieve a return on investment. Both, the tokens used for transactions and the tokens used for investment in the content market, are floating in the market. Total demand for VERA tokens within the economy therefore depends on the size of the economy's demand for transactions (T_t), and the price level (P). Another factor which influences demand for money is the velocity of money (V). The faster money circulates, the less money is needed in the economy (holding everything constant).

Demand for VERA tokens may also derive from speculators who aim for currency gains. It is likely that speculators will put considerable deflationary pressure on the value of VERA in the short term and this may not be entirely possible to mitigate. However, the stability of the economy depends on sufficient money supply available for transactions. Demand for speculative money (S) depends on expected inflation rates and the opportunity cost of holding VERA tokens. It will increase if investors expect deflation and decrease otherwise.[2]

The demand for VERA tokens can therefore be written as:

$$M^D = P * \left(\frac{T}{V} + S\right) \quad (1)$$

[2] Note, in a traditional economy the demand for money also depends on the interest rate. Individuals choose between holding money and holding productive assets. Two opposing effects then determine the demand for money. On the one hand, opportunity costs of holding liquidity in the form of missed earnings from assets imply that money demand is decreasing in the nominal interest rate. However, since Verasity does not intend to pay any interests for holdings VERA tokens, this part of money supply does not apply.

2.3 Supply of VERA tokens

The mechanism to supply VERA tokens to the economy is determined and locked from the start of the economy. It is the most important instrument to ensure the stability of the Verasity economy and its implementation is one of the main responsibilities of the Verasity Foundation.

In order to create a stable economy, demand and supply of tokens have to be in stable equilibrium. In an traditional economy, the money market is in equilibrium when the real money supply (M/P) meets the demand for money ($L(i,Y)$), which depends on output (Y) und the nominal interest rate:

$$\frac{M}{P} = L(i, Y) \tag{2}$$

Without the leverage of interest rates, the Verasity Foundation may regulate money supply directly, either by minting new tokens or withdrawing (and burning) tokens. The Verasity Foundation aims for a sufficiently high inflation rate that incentivizes VERA holders to participate in the economy and prevents deflation, which could destabilize the economy. However, the inflation target must be sufficiently low to not discourage market participants to acquire VERA tokens. In order to provide the economy with a sufficient amount of tokens and reach the inflation target, the Verasity Foundation has to form an expectation on future money demand. The supply of VERA tokens therefore depends on expected demand, which again is deduced from past demand and the expected growth of the economy.

2.4 The minting mechanism

The minting mechanism is designed to hold demand and supply at a constant growth rate. The mechanism mints tokens such that any expected growth of demand for money will be matched by an increase in money supply. Under the assumptions that the expected growth can be approximated correctly, the mechanism aims to prevent deflation. Furthermore, the mechanism mints additional tokens such that the Verasity economy supports a moderate inflation target.

The envisaged mechanism works according to the following principle:

Demand for money at each point in time (t) is derived by the price level (P_t), demand for transactions (T_t), the velocity of money for participants of the economy (V_t) and by the demand from speculators (S_t):

$$M_t^D = P_t * \left(\frac{T_t}{V_t} + S_t\right) \tag{3}$$

For simplicity, we define the term in the brackets as real demand for money (demand for money adjusted by the price level):

$$M_t^{Dr} = \frac{M_t^D}{P_t} = \left(\frac{T_t}{V_t} + S_t\right) \tag{4}$$

At each point in time supply must equal demand in equilibrium:

$$M_t^S = M_t^D \tag{5}$$

Using real demand for money, this results in:

$$M_t^S = P_t * M_t^{Dr} \tag{6}$$

A stable inflation target implies that growth between the price levels and the periods remains stable. Inflation is derived by:

$$inflation = \frac{P_{t+1}}{P_t} - 1 \quad (7)$$

Rearranging equation (6) to

$$P_t = \frac{M_t^S}{M_t^{Dr}} \quad (8)$$

and plugging into (7) results in:

$$1 + inflation = \frac{M_{t+1}^S}{M_{t+1}^{Dr}} * \frac{M_t^{Dr}}{M_t^S} = \frac{M_{t+1}^S}{M_t^S} * \frac{M_t^{Dr}}{M_{t+1}^{Dr}} \quad (9)$$

$$(1 + inflation) * (1 + g) = \frac{M_{t+1}^S}{M_t^S} \quad (10)$$

with g = $\frac{M_{t+1}^{Dr}}{M_t^{Dr}} - 1$ being the growth rate of real money demand.

For a given inflation target, the mechanism must therefore set money supply (M_{t+1}^S) such that:

$$M_{t+1}^S = (1 + inflation\ target) * (1 + g) * M_t^S \quad (11)$$

As the growth rate g is unknown ex ante, the mechanism must form an expectation about the future development of money demand ($E[g]$). The Verasity Foundation plans to use a straight forward and simple to implement method to form expectations about future growth that is based on historic growth rates of the recent past.

3 Simulation Setup

3.1 Simulation Goals

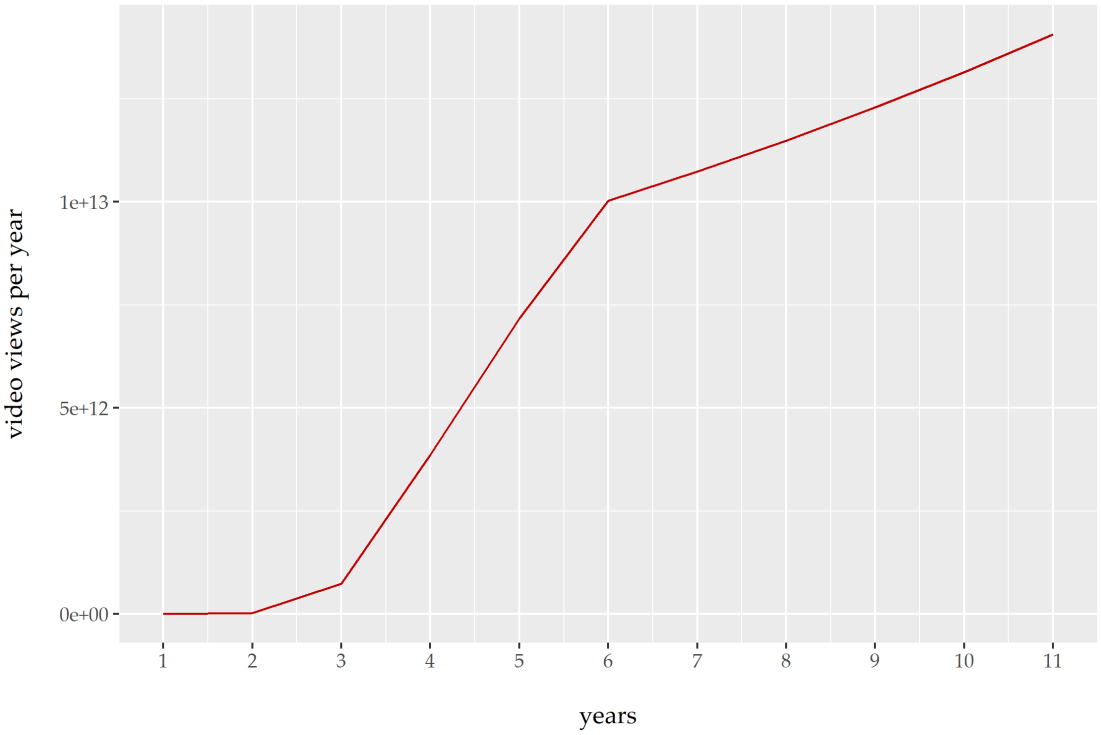
The goal of the simulations is to test whether the proposed mechanism for money supply can produce a stable inflation pattern under the assumptions given by the Verasity Foundation. For this end we expose the economy to external shocks and analyze how the mechanism performs. In order to study how inflation develops over time, we implement different growth patterns, which are based on the expected number of total views per year and random deviations. In addition, we modify some assumptions of the economy and parameters of the mechanism to determine their impact on stability.

3.2 Main assumptions

The simulations are conducted using the following assumptions provided by the Verasity Foundation:

- The mechanism implemented by the Verasity Foundation is deterministic and no one can change it subsequently. If not stated otherwise, the players react instantly.
- The increase in number of transactions (T) over time constitutes the economy's growth. The expected growth rate of the economy is based on the expected number of videos watched, which is provided by the Veracity Foundation. It is assumed that, on average, a transaction is made (including both advertisers and viewers) for every video watched.

Figure 2: Expected number of video views



Source: Verasity

- The number of transactions T follows a stochastic process; that is, the growth rate as provided by the Verasity Foundation is modified by a random deviation, simulating unforeseen changes of the demand for videos. In the first five years, this deviation is expected to be rather large (+/-0.5%). Subsequently, when the economy is more stable, this volatility decreases (+/- 0.25% and later +/-0.1%). This adjustment is justified because demand for video content is expected to be much more uncertain initially than when the economy has entered a mature state.[3]
- The velocity of money (V) is exogeneous. The Verasity Foundation expects a yearly velocity of money of 120, meaning every token is roughly traded every third day.
- The Verasity Foundation assumes that from the initial coin sales, 20% are used for transaction in the economy. The remaining 80% is held by speculators.
- Speculators invest in the tokens in order to sell them later at a higher price. It is reasonable to assume that in the Verasity economy, the inflation rate is strongly linked to the exchange rates for other currencies. Hence, speculators invest if they expect deflation in the future and disinvest otherwise. However, speculators may differ in the way they form their expectations about future inflation:
  - Adaptive speculators form expectations by looking at past patterns i.e. inflation in previous periods induces them to divest and deflation in previous periods induces them to invest. Speculators may differ with regard to how many periods they use to form their expectations and how they calculate expected inflation from past information.

[3] The simulations have also been conducted assuming other rules regarding the stochastic process. The results do not differ significantly.

- Rational speculators form their expectations by looking at long run inflation. They realize how the minting mechanism supplies money in times of deflation and burns money when inflation prevails (as it aims for a stable inflation target). Therefore, they will not blindly follow any short-term trends and act to some extent against the behavior of adaptive speculators. Instead of aiming for short run currency gains, rational speculators base their investment decision on the expected overall development of the economy.

For the simulations, we assume that adaptive speculators solely base their expectations on the average inflation rate of past periods, whereas rational speculators also consider the overall growth of the economy. It is assumed that the share of rational speculators is 50%.

- We run the simulation for a period of 20 years. However, the players expect the economy to last longer and that the platform is able to mint or burn tokens at all points in time.

3.3 Limitation of the analyses

The main limitation of any analysis of such an economy is that actual demand is unknown. Therefore, the simulation has to rely on strong assumptions regarding the number of videos viewed, the velocity of money and the behavior of speculators.

Another limitation is that in reality, money supply does not have an immediate effect on the price level. Rather, we would expect a gradual adaption over time since demand and supply will not shift to a new equilibrium instantly.

A distinct feature of the Verasity economy is that the minting of new tokens (and therefore the size of the reward pool) is directly linked to the growth of the economy. Hence, monetary stability and short-run platform growth are interconnected. Though potential trade-offs were taken into account when creating the mechanism and determine the parameters, it is not part of the simulation. In our analysis the demand for money is assumed to be based on the expected growth rate of the whole economy, and not on the strategic behaviour of the different actors in the Verasity economy.

3.4 Tested factors and parameters

The simulation has been conducted using different parameters to test the stability of the Verasity economy when demand experiences exogenous shocks. For this purpose, monthly numbers of video views have been calculated by using the yearly growth pattern provided by the Veracity Foundation.

- **The inflation target's influence:** The inflation target may have an impact on the stability of the economy and the number of tokens needed. We tested the model for six different inflation targets between 0% and 10%.
- **Behavior of speculators:** Underlying the simulation runs are varying assumptions on the extent to which speculators react to past inflation and deflation rates. That is, how they adjust their demand for VERA tokens by a certain factor (k) of their previous demand level. We use factors between 0% and plus/minus 100%. In addition, we assume that present demand will never fall below the initial demand from adaptive speculators.

  Formally, the demand for money of adaptive speculators (S_t^A) is calculated as follows:

$$S_t^A = \begin{cases} S_{t-1}^A * (1+k), & \emptyset\, inflation < 0 \\ S_{t-1}^A, & \emptyset\, inflation = 0 \\ S_{t-1}^A * (1-k), & \emptyset\, inflation > 0 \end{cases} \quad (12)$$

  with

$$\emptyset\ inflation = \frac{1}{i} * \left(\sum_{a=t-1}^{t-i} inflation_a\right) \qquad (13)$$

Where *i* describes the number of periods (i.e. months) that the adaptive speculators take into account.

- **Different backward-looking rules:** The minting mechanism supplies or withdraws tokens based on expected growth of demand (E[g]). For the formation of the expectations they may consider different periods of time. Holding everything else constant, a longer period smoothens the expected growth of demand. However, the effect on the economy of extreme values from the stochastic process lasts longer. In our simulations, we look at time spans from one to eleven periods (i.e. months).

  Formally, the mechanism calculates the expected growth of demand by the compound growth rate between the last few periods:

$$\mathrm{E}[g] = \sqrt[i]{\frac{M_t^{Dr}}{M_{t-i}^{Dr}}} - 1 \qquad (14)$$

  Where *i* describes the number of periods that the mechanism takes into account.

  For the one period (i.e. one month) backward-looking mechanism this is the same as the simple average growth rate between the last two periods:

$$\mathrm{E}[g] = \frac{M_t^{Dr}}{M_{t-i}^{Dr}} - 1 \qquad (15)$$

4 Results

4.1 Baseline Scenario

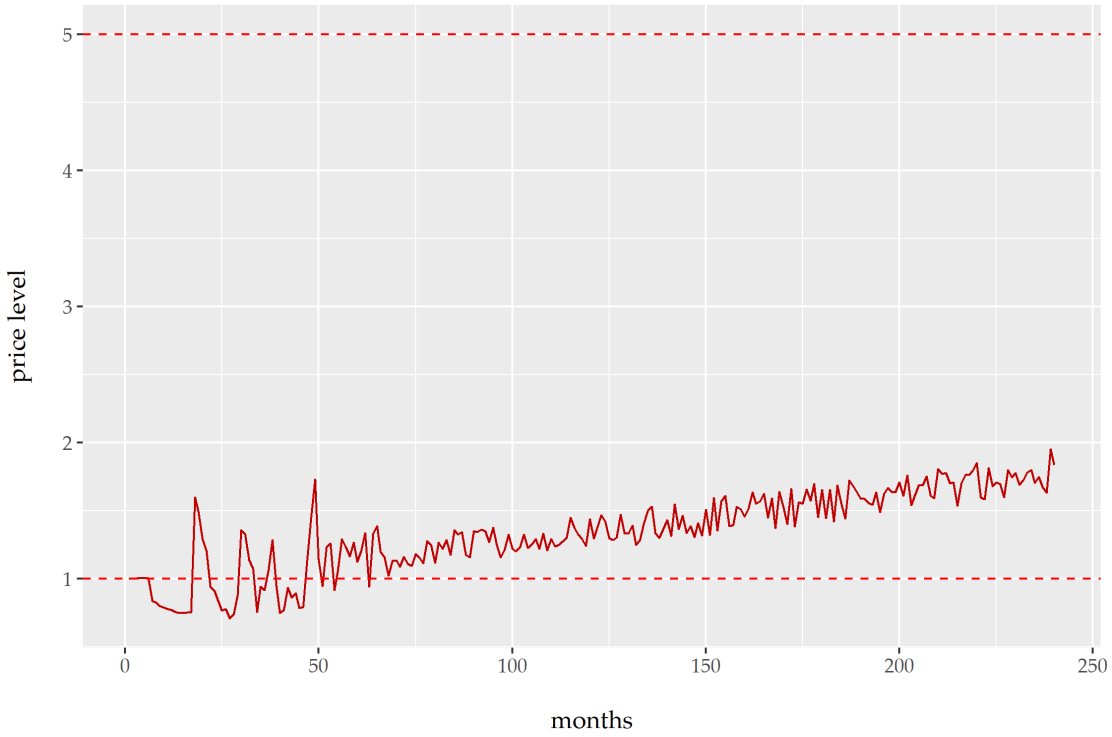
We start by describing the baseline scenario, which serves as the starting point for our analysis. Afterwards, individual parameters will be modified in order to test the stability of the economy. We focus our attention on the development of inflation, which is defined by the change in the price level over time. To assess monetary stability, we look at the long-run development of price levels in the Verasity economy (and not only over two periods).

A simulation consists of several runs of the same calculations using different growth patterns, which are drawn from a random distribution. The results presented below, show a representative illustration for each setting of the model. However, every single run of the model produces a slightly different pattern.

For the baseline scenario we use the following parameters:

- 1 period backward-looking mechanism (see equation 14 and 15)
- 3% inflation target (see equation 11)
- 40% reaction of adaptive speculators; 3 periods backward-looking (see equation 12 and 13)

Figure 3: Baseline Scenario



Source: cryptecon

As a general pattern, inflation is very volatile at the beginning, but smoothens after the initial phase (see figure Figure 3). This is due to the stochastic process, which produces stronger shocks at the beginning. The price level is normalized to one at the start. The strong reactions at the beginning reflect the uncertainty about demand and potential external shocks. However, the mechanism is capable of bringing the economy back to a stable growth path. In the long run the mechanism can attain the 3% inflation target and result in a reasonably stable development of the price level.

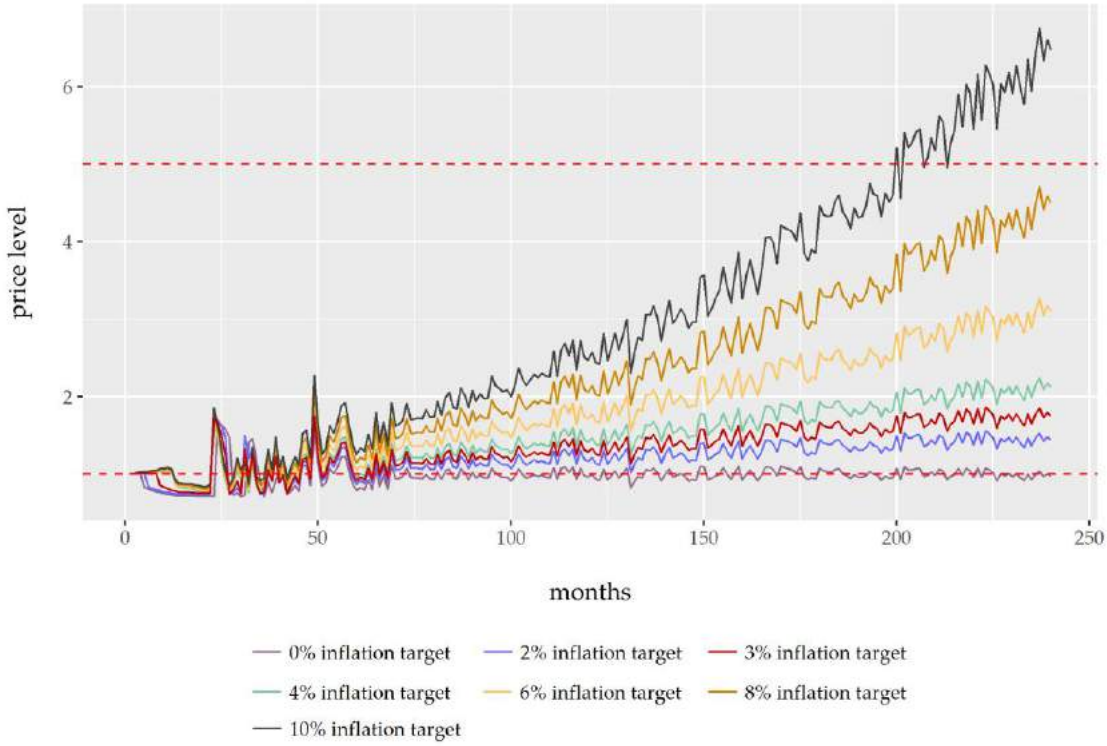
In the following figures, the baseline scenario is represented by the red line.

4.2 Inflation target

The Verasity Foundation may choose different inflation targets. In order to analyse the impact of the inflation target, we rerun the simulation using different values for the inflation target ranging between 0% and 10% (see equation 11).

- Baseline scenario of 3%
- Different inflation targets between 0% and 10%

Figure 4: Different inflation targets



Source: cryptecon

The results in figure Figure 4 show that a reasonably (positive) inflation target can lead to a stable price level in the long run. By contrast, an inflation target of 0% is more prone to strong reactions of speculators and therefore unstable.

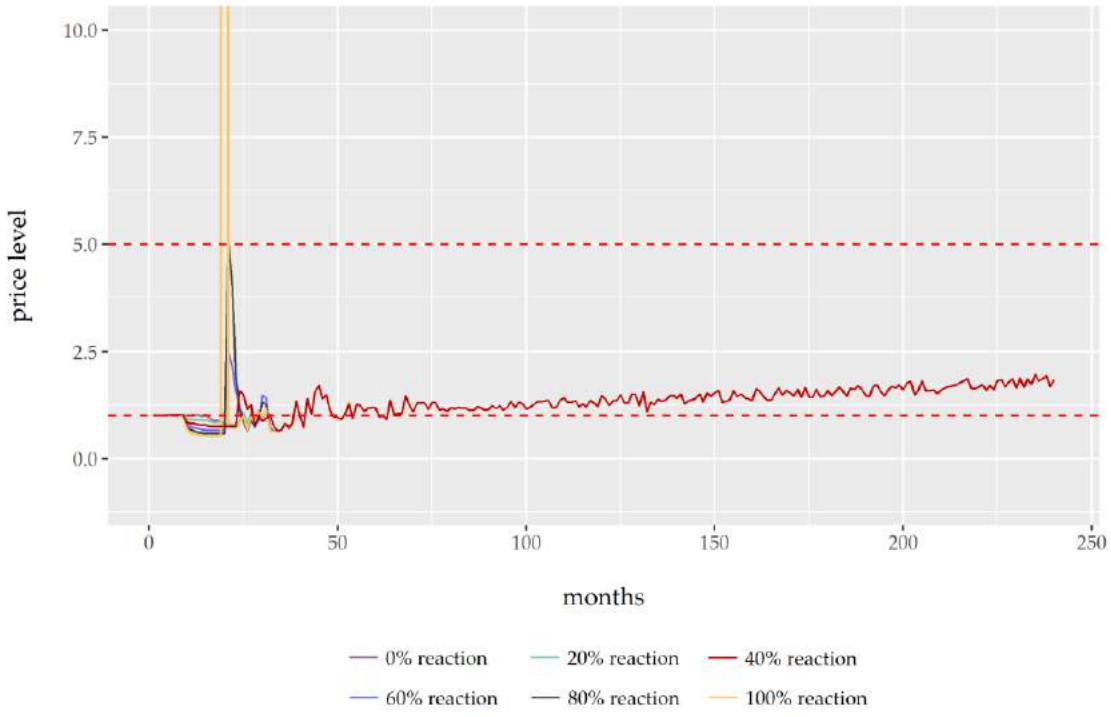
The inflation target of the baseline scenario (3%) is represented by the red line.

4.3 Reaction of adaptive investors

In this section, we test different reactions of adaptive investors. As described in section 3.4, the investment decision of adaptive speculators is expressed as a percentage of their previous demand. Their demand for VERA tokens decreases with expected inflation and increases with expected deflation. We use values for the adaptation factor (k) between 0% and plus/minus 100% (see equation 12).

- Baseline scenario 40%
- Reaction to expected inflation ranging between 0% and plus/minus 100%

Figure 5: Different reaction from adaptive speculators



Source: cryptecon

The simulation shows that a stronger reaction of adaptive speculators may destabilize the economy, especially in the initial phase when demand volatility is strong (Figure 5). However, when a reasonable proportion of previous demand is used for speculation, the mechanism is able to produce a stable outcome.

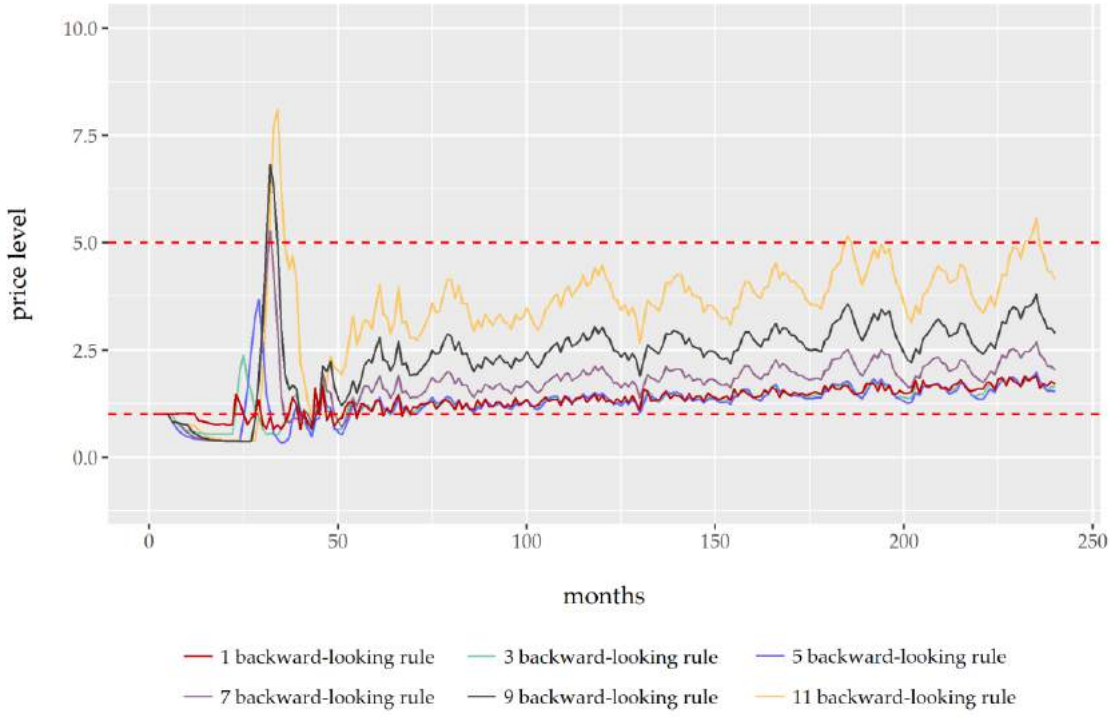
The value of the baseline scenario (40%) is represented by the red line.

4.4 Different backward-looking mechanisms

Finally, we simulate different settings for the money minting mechanism, which vary with regard to the number of past periods that are taken into account (see equation 14 and 15).

- Baseline scenario 1 period
- Different backward-looking mechanisms taking into account 1 to 11 periods

Figure 6: Different backward-looking mechanisms



Source: cryptecon

The simulation demonstrates that a longer backwards looking period results (everything else constant) in stronger volatility and a higher price level (Figure 6). This is due to the fact that a longer period prevents the mechanism to react instantly to exogenous shocks. Therefore, the mechanism will encounter exogenous shocks later and they will impact the economy for longer.

The value of the baseline scenario (one period backward-looking) is represented by the red line.

5 Conclusions

The Verasity Foundation is planning to launch a next-generation video platform, which enables the exchange of video content supported by blockchain technology. To that end, the Verasity Foundation creates a specialized economy, in which all transactions are based on a newly created VERA token. The Verasity Foundation plans to regulate money supply in the economy with a deterministic mechanism on the blockchain. cryptecon was asked to simulate the mechanism and test its influence on the long run price stability of the economy.

The Verasity Foundation aims for a moderate inflation target in order ensure sufficient liquidity and stable growth of the economy. In order to simulate the economy, the Verasity Foundation provided cryptecon with information concerning the design of the mechanism as well as the expected demand for video content and VERA tokens. The information included the expected numbers of videos viewed over time and the velocity of money in the economy. To implement the simulation, cryptecon had to formulate additional assumptions, especially concerning the behavior of speculators and the development over time.

Given the information provided by the Verasity Foundation, the simulations indicate that a simple mechanism, which bases the expected demand for VERA tokens on observed price levels in the past, can provide a stable money market. This holds even when faced with external shocks. More specifically, we find that a moderate inflation target preforms better than a zero-inflation target, because the latter induces strong reactions by speculators, which may destabilize the economy. With regard to the behavior of speculators, the simulations show how a strong reaction of adaptive speculators may destabilize the economy, especially in the initial phase when demand is very volatile. However, when adaptive speculators do not react right away with all their assets, the mechanism is able to produce a stable outcome. Finally, the simulation indicated that a shorter backwards-looking period results in a more stable price development, because it can react instantly to exogenous shocks.

Based on the information provided by the Verasity Foundation we conclude therefore that the mechanism for money supply is capable to create reasonable price stability. With regard to the parameters, the baseline scenario with a one period backward-looking mechanism, 3% inflation target, and 40% reaction of adaptive speculators performs best.

It is important to note that these results rely on strong assumptions, especially regarding the ex-ante unknown demand for video content and money. The simulations provide only a static and deterministic reflection of the reality. In reality, the players in an economy interact strategically, which may enhance or weaken the stability of the economy. This aspect is not captured by the current simulations since it would require the formulation of a full game theoretic model.

cryptecon
center for cryptoeconomics

cryptecon
Abeggweg 15
8057 Zurich
Switzerland

T: +41 (0)44 500 56 20
F: +41 (0)44 500 56 21

info@cryptecon.org
www.cryptecon.org