Stochastic Properties of EIP-1559

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ABSTRACT EIP-1559 is a new proposed pricing mechanism for the Ethereum protocol developed to bring stability to fluctuating gas prices. To properly understand this as a stochastic process, it is necessary to develop the mathematical foundations to understand under what conditions does the base fee gas price outcomes behave as a stationary process, and when it does not. This understanding these mathematical under pinnings critical to properly engineering a stable system.

INDEX TERMS EIP 1559, Stochastic Processes, Stationarity

I. INTRODUCTION

Syscoin 4.0 builds upon Syscoin 3.0 with additional implementation of an Ethereum Bridge, Offers/Escrow, Lightening Networks, and Decentralized Identity. As previously featured, anything pertaining to the market place (eg, digital sales, auctions, marketplace modification, etc.) has been deprecated. The full release will included the Syscoin Network-Enhanced Virtual Machine (NEVM) which will utilize the Ethereum Virtual Machine (EVM) together with a Zero Knowledge Proof (ZKP) system to build scalable applications and the introduction of a decentralized cost model around Ethereum Gas fees (Table **??**).

II. EIP 1559 PRICING MECHANISM

Bitcoin was the first to attempt to offer a practical outcome in the General's Dilemma using Crypto Economic rationale and incentives. Ethereum was the first to abstract the concept of turing completeness within similar frameworks assumed by Bitcoin. What Syscoin presents is a combination of both Bitcoin and Ethereum with intuitions built on top to achieve a more efficient financial computing platform which leverages coordination to achieve consensus using Crypto Economic rationale and incentives. We propose a four-layer tech stack using Syscoin as the base (host) layer, which provides an efficient (ie, low gas cost per transaction) platform. Some of the main advantages include building scalable decentralized applications, the introduction of a decentralized cost model around Ethereum Gas fees. This new model proposes stateless parallelized execution and verification models while taking advantage of the security offered by the Bitcoin protocol. We may also refer to this as Web 3.0.

III. SIMULATE GAS DEMAND

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IV. SIMULATE GAS DEMAND

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Simulation	ADF Statistic	p-value	Outcome
1	-1.506	0.531	not stationary
2	-1.260	0.647	not stationary
3	-2.170	0.217	not stationary
4	-2.432	0.133	not stationary
5	-1.844	0.359	not stationary
6	-1.323	0.618	not stationary
7	-1.645	0.459	not stationary
8	-1.662	0.451	not stationary
9	-1.124	0.705	not stationary
10	-1.930	0.318	not stationary

TABLE 1: Comparing PoW to PoS consensus mechanism; plus sign (+) indicates vulnerability; see [**?**]. As shown, PoW system has the least number of vulnerabilities

V. ANALYZE STATIONARITY

Definition: A time series X_t is called strictly stationary if the random vectors $(X_1, ..., X_N)^T$ and $(X_{1+\tau}, ..., X_{N+\tau})^T$ have the same joint distribution for all sets of indices $t_1, ..., t_n$ and for all integers τ and $n > 0$. It is written as

$$(X_1, ..., X_N)^T \stackrel{D}{=} (X_{1+\tau}, ..., X_{N+\tau})^T, \tag{1}$$

where $\stackrel{D}{=}$ means equal in distribution.

A. AUGMENTED DICKEY FULLER TEST

Given the following higher-order autoregressive processes:

$$\delta y_t = \alpha y_{t-1} + \theta_1 \delta Y_{t-1} + ... + \theta_p \delta Y_{t-p} + \epsilon_t, \tag{1}$$

the Augmented Dickey Fuller (ADF) test checks the existence of a unit root $\alpha = 1$ (ie, H0: $\alpha = 1$) where the null hypothesis is non-stationary. The unit root in (3) is characteristic of a time series that makes it non-stationary.

B. PROBLEM STATEMENT

For sake of comparison, let's look at stationarity for an AR(1) process:

Consider a standard first-order auto-regressive process defined by the recursive equation:

$$x_t = \mu + \alpha(x_{t-1} - \mu) + \epsilon_{t-1} \qquad \epsilon_t \sim IID\ N(0, \sigma^2) \quad (3)$$

The above process is stationary when $|\alpha|<1$ so that this has a single root $1/\alpha$ outside the unit circle. It can be shown that if $sigma>0$, then this process has the asymptotic stationary distribution:

$$x_\infty \sim N(\mu, \frac{\sigma^2}{1-\alpha^2}) \quad (4)$$

Considering the (state space like) simularities to the AR(1) process; the question is what are the constraints (if any) that time varying process δ_t must meet to ensure stationary outcomes for the basefees?

C. RANDOM COEFFICIENT AUTOREGRESSIVE MODELS

EIP 1559 (1) fits into the framework of a Random Coefficient Autoregressive (RCA) Model, which essentially introduces a random coefficients to the AR model in (3). RCA(1) model is given by:

$$x_k = \alpha + \beta_k x_{k-1} + \epsilon_k, \quad (5)$$

where ϵ_k is an independent sequence of random variables with 0 mean and variance $\sigma^2 > 0$; β_k is an independent sequence of random variables with mean μ_β and variance σ^2_β of the random coefficient β_k, and variance σ^2 of the error ϵ_k. Given (3) and (4) it is obvious that when $\sigma^2_\beta = 0$, the RCA(1) in (5) becomes a AR series, and becomes a random walk when $\mu_\beta = 1$ and $\sigma^2_\beta = 0$, hence non-stationary.

Theorem Consider RCA(1) model (5) with β_k, ϵ_k, which is identically normally distributed. Then the sufficient condition for the existence of a strictly stationary and ergodic solution is that:

$$\ln(\sigma^2_\beta) < \varsigma + \ln(2) - 2\int_0^1 \frac{1-\exp[-\lambda(1-w^2)]}{1-w^2}dw, \quad (6)$$

where $\varsigma \approx 0.57721$, denotes Euler's constant and $\lambda = \mu^2_\beta / 2\sigma^2_\beta$

Proof: See Theorem 2 in [1]

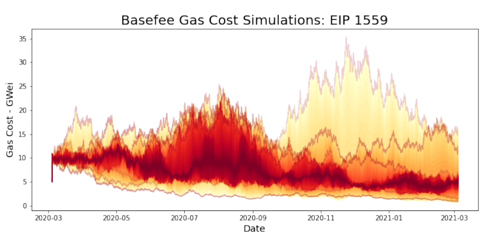

FIGURE 1: Basefee simulations

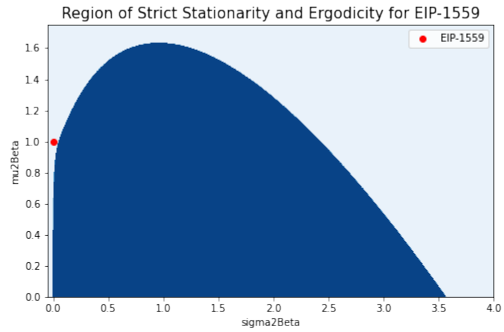

FIGURE 2: Strict stationarity

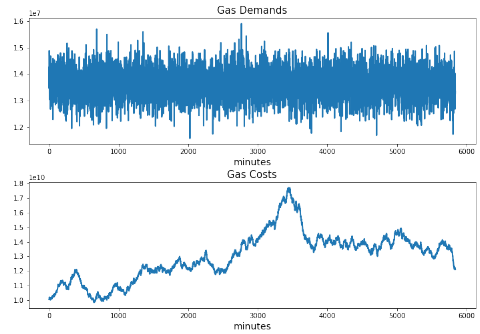

FIGURE 3: Gas and demand simulations

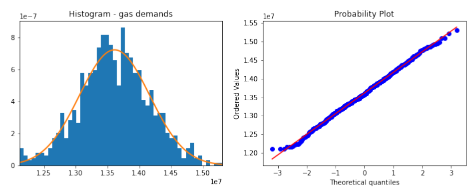

FIGURE 4: Analysis of Normality of Gas Demands

VI. CONCLUSION

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