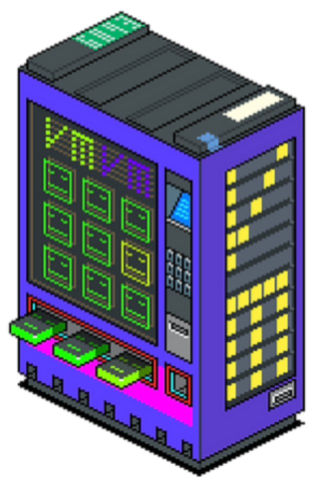
Vote-Bonding Token System
Simulation Report



VENDING MACHINE

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Abstract This simulation report evaluates the economic performance of a proposed vote-bonding token system, focusing on rewards for solvers and vbTOKEN holders who engage with the Protocol clearing layer. Using a digital twin of the token model, the system's evolution is analyzed under various scenarios, incorporating economic assumptions of Protocol and those derived from historical data of similar token designs and technical research. The analysis covers key parameters such as annual TOKEN emission rates, decay rates, and revenue share percentages for vbTOKEN, and assesses their impact on stakeholder rewards and system sustainability. Findings suggest that a 5% annual emission rate strikes a balance between incentivising early solvers and meeting performance benchmarks, while higher emission rates could lead to over-incentivisation and unsustainable long-term growth. A constraint of 10% allocation of total supply for incentives was considered and simulation results indicate sufficiency of economic incentives only in the short term under this constraint. Additionally, vbTOKEN revenue share is analyzed, with a recommendation for 100%. The simulations indicate that alternative methods to reduce solver costs or increase TOKEN token utility will be necessary to sustain the system at higher intent volumes, particularly when the Protocol reward constraints are applied. Key metrics, such as solver rewards and vbTOKEN APR are monitored to ensure the protocol remains robust across a range of market conditions.

1 Introduction

Vending Machine has been partnered with Protocol to develop a comprehensive token system for the upcoming launch of the Protocol protocol, as well as to provide economic simulations to parameterise the system. As part of this effort, the vote-bonding token (vbTOKEN) system was proposed to incentivise solvers who net their intent volume on Protocol, while rewarding vbTOKEN holders who participate in the gauge model to direct incentives and earn a share of protocol revenue.

To rigorously assess the economic viability of this token system, a detailed simulation study was conducted using a digital twin model that replicates the economic assumptions of the Protocol clearing layer. This model allowed for the evaluation of system performance over time under varying market conditions and intent volumes.

The simulation study simulated over 48 million possible states across a wide range of scenarios, providing a comprehensive analysis under various market conditions for the token system. The study focused on key factors such as emission rates, vbTOKEN revenue shares, and solver incentives to determine how well the system could meet performance benchmarks.

Preliminary technical research was undertaken to establish reliable estimates for model assumptions, using historical data from comparable token systems. The simulation aimed to evaluate the impact of different emission rates—ranging from conservative (2.9%) to aggressive (11.8%) on the sustainability of rewards for both solvers and vbTOKEN holders.

In addition to assessing the system's core performance, the study included sensitivity analyses to explore how changes in key environmental variables, such as intent volume distribution across major traffic and long-tail chains, or shifts in locking rates, affect outcomes. This analysis provided insights into the resilience of the token system under varying external conditions and highlighted areas of potential vulnerability.

Stress testing was also conducted to simulate a combination of extreme market scenarios, such as significant price declines and reduced intent volumes, offering a view into how the system might perform under extremely adverse conditions.

The report also provides additional insights for key stakeholders, such as early partners and vbTOKEN holders, as well as the potential for wash trading in the early stages of the protocol. These findings offer a nuanced understanding of the token system's dynamics.

This simulation study provides a rigorous, data-driven foundation for Protocol's strategic decisions regarding the implementation of the vbTOKEN token system. By evaluating a broad range of possible outcomes and stress-testing the system under various conditions, this report ensures that the token system is designed for both initial success and sustainable operation in a rapidly evolving market environment.

2 Recommendations and Key Findings

2.1 TOKEN Annual Emission and Emission Decay Rate

2.1.1 Recommendation 1 - Optimizing Solver Rewards given no Supply Constraint for Incentives

- [redacted] annual emission rate (distributed uniformly per epoch) is recommended.
  - Simulation results show high levels of incentives at the short-term target of $1B monthly intent volume, as well as sufficient incentives at the medium-term target of $4B monthly intent volume for solvers.
  - Provides a high level of solver rewards in the short term to attract intent volume to bootstrap initial growth.
- For a [redacted] starting emission rate, an annual [redacted] decay rate is recommended.
  - Total allocation of supply to fund emissions for 4 years comes to 17.195%; thereafter, token inflation can be used to fund the ongoing emissions if desired.
- This is an ideal level of system incentives to achieve short and medium term volume goals.

2.1.2 Recommendation 2 - Optimizing Solver Rewards given the 10% Supply Constraint for Incentives

- This recommendation considers the current supply allocation available for the gauge system, where a maximum of 10% of the TOKEN token supply is allocated for incentives over a 4-year period.
- [redacted] annual emission rate is recommended under this constraint.
  - Solver rewards in bps are sufficient under the initial intent volume target, although at a reduced level to bootstrap initial incentive volume.
  - Possibility of providing sufficient incentives for solvers is considerably reduced when actual intent volume exceeds the medium-term target of $4B monthly.
- For a [redacted] starting emission rate, an annual [redacted] decay rate is also recommended.
  - Total allocation of supply to fund emissions for 4 years comes to 9.97% and thereafter, token inflation can be used to fund the ongoing emissions if desired.
- Whilst this recommendation meets the current supply allocation constraint, the risk is that the system does not adequately incentivise solvers and therefore reduces the chance to reach the medium and long-term intent volume targets.

2.2 vbTOKEN Revenue Share

- At initial intent volume levels, it is advisable to keep the revenue share percentage to vbTOKEN holders at [redacted] to offer maximum vbTOKEN APR from revenue share.
- The main trade-off of decreasing intent volume revenue share portion to vbTOKEN to fund the DAO treasury reserve is the reduction in vbTOKEN APR, which will be one of the primary incentives for any party to lock their TOKEN tokens.

- Therefore, it should be done with caution, giving sufficient regard to the resulting levels of estimated vbTOKEN revenue share APR and ensuring it is sufficient to make locking TOKEN tokens an attractive action.
- As the Protocol system matures, this revenue share split can be revised to determine a portion of the revenue share that should be allocated towards the DAO treasury.

2.3 Inflation of TOKEN Token Supply

- After 4 years, when the allocation of existing supply will have been depleted.
- If Protocol plans to implement the gauge system for more than 4 years, it is advisable to launch the system with inflation, so that emissions can be fulfilled with new supply and current treasury supply can be used for other growth initiatives.

2.4 Other Key Findings

- Early partners will be whitelisted solvers, and therefore their rewards are likely to be higher than estimated in the modelling, as the same rewards will be distributed over a smaller pool of intent volume.
- Wash trading intent volume is expected at the initial stages after launch when solver TOKEN rewards in bps exceed average solver costs.
  - The severity of wash trading will depend on how much wash traders will be able to re-balance their own intent volume. It is improbable that this will hold true in practice, and the presence of wash trading volume may increase the organic netting percentage on Protocol.

3 Model Configuration

3.1 Model Assumptions

3.1.1 System assumptions

Table 1: Epoch Length Parameter and Rationale

Parameter	Value	Rationale
Epoch length (in days)	14	Governance epoch from Protocol's team feedback

3.1.2 TOKEN assumptions

Table 2: TOKEN Token Parameters

Parameter	Value
TOKEN initial price	[redacted]
TOKEN total supply	[redacted]
TOKEN initial circulating supply	[redacted]
TOKEN supply schedule	Time-series of TOKEN unlock schedule

3.1.3 vbTOKEN assumptions

Technical research was conducted into historical data of similar token designs to obtain the following estimates for parameters relating to locking and early exit behaviour applied to the TOKEN token system.

Table 3: vbTOKEN Parameters and Rationale

Parameter	Value	Rationale
vbTOKEN early unlock rate (daily)	0.0426%	Data obtained through research across different protocols (Yearn Finance and Radiant)
vbTOKEN early exit tax rate	27.31%	Based on initial estimates of minimum and maximum exit tax rates (20% and 80%, respectively), as well as the TOKEN to vbTOKEN conversion rate and technical research into historical early exit data
TOKEN to vbTOKEN conversion rate	0.8808	Data obtained through research on locking duration distribution across different protocols (Curve and Balancer)

3.1.4 Pricing assumptions

The following pricing assumptions were obtained from Protocol team's research into pricing dynamics for both major traffic and long-tail chains, where aggregate values were extracted and used in the model.

Table 4: Pricing Assumptions

Parameter	Value
Major traffic chain network fee per intent volume	[redacted] bps
Major traffic chain DAO fee per intent volume	[redacted] bps
Major traffic chain arbitrageur discount per intent volume	[redacted] bps
Long-tail chain network fee per intent volume	[redacted] bps
Long-tail chain DAO fee per intent volume	[redacted] bps
Long-tail chain arbitrageur discount per intent volume	[redacted] bps

3.2 Parameters to Set

3.2.1 TOKEN Emission Rate Per Year

Annual emission of TOKEN tokens will be distributed uniformly across the year for each epoch, directed to spoke contracts as solver incentives.

3.2.2 Annual TOKEN Emission Decay Rate

This will be applied yearly to reduce the TOKEN emission rate for the following year. The decay rate is proposed to reduce the pressure on the protocol to emit incentives to its stakeholders over time, after achieving sufficient scale and growth in the initial phase. Furthermore, should the system need to inflate the total supply to fund ongoing emissions to solvers, an annual decay rate in emissions will reduce the inflationary pressure on the TOKEN token supply.

3.2.3 vbTOKEN Revenue Share Percentage

The split of protocol fees collected on intent volume, which will be directed to vbTOKEN token holders as economic incentives.

3.3 Environmental Variables

3.3.1 TOKEN Price

Geometric Brownian Motion (GBM) was used to simulate the stochastic trend of TOKEN price for each simulation run.

Drift and diffusion parameters were obtained by retrofitting the GBM distribution to the historical TOKEN price as well as CRV token price 1 year after its launch.

Our study substituted the standard *Wiener process* in the GBM for randomness at each time point with a *Student's t-distribution* with 8 degrees of freedom to allow for a greater incidence of extreme values i.e. fatter tails of the bell curve.

Price scenarios tested:

Table 5: Price Scenarios and Descriptions

	Price Scenario Description
1	Increasing price trend based on CRV token price trend in the first year after launch
2	Decreasing price trend based on CRV token price trend in the first year after launch
3	Increasing price trend based on half of CRV token price trend in the first year after launch
4	Decreasing price trend based on half of CRV token price trend in the first year after launch
5	Zero price drift with high volatility
6	Rapid price decrease for the first 2 months, followed by a steady increase for the remaining period
7	Rapid price increase for the first 2 months, followed by a very small increase for the remaining period
8	Rapid price increase for the first 2 months, followed by a steady decrease for the remaining period

3.3.2 Intent Volume

4 different levels of intent volume scenarios were tested across all price scenarios to understand the performance of the system under different adoption levels of Protocol.

Table 6: Monthly Intent Volume and Descriptions

	Monthly Intent Volume	Description
1	$500M	A pessimistic scenario where only 50% of the best-estimate monthly intent volume
2	$1B	Best estimate target volume for Protocol at launch, used as the medium case in simulations (1-month internal target)
3	$5B	Optimistic scenario, halfway between best-estimate and mature-state intent volume targets (4-month internal target: $4B)
4	$10B	Target intent volume per month in the mature state of the protocol (12-month internal target)

3.3.3 Locking Rates

Locking behaviour of TOKEN token was obtained via technical research into historical data for comparable token locking designs such as Curve, Balancer and Camelot.

To remove noise from the gathered data, daily net locking rates were calculated by averaging the locking rates from 3 different historical datasets.

All scenarios in the initial simulation runs used average locking rates without adjustment and sensitivity of the metrics to the changes in locking rates is highlighted under Sensitivity Analysis.

3.4 Simulation Configuration

This simulation study employs Monte Carlo simulations to simulate potential future scenarios given a configuration of a stochastic nature. Therefore, each simulation run result is different from the next.

The results from each simulation are aggregated and metrics are computed on the aggregate results, which are then compared to the benchmarks.

Table 7: Simulation Parameters

Number of runs per scenario	10,000
Number of timesteps (epochs)	48

10,000 simulations were chosen as the distribution of randomly generated numbers according to a Student's t-distribution with 8 degrees of freedom fit the assumed distribution satisfactorily, with Mean Squared Error (MSE) of 3.94e-06.

48 timesteps were determined given an epoch length of 2 weeks and a total simulation duration of 24 months.

3.5 Metrics

Below we highlight the metrics that were computed for each simulation run, which signalled the strength of economic incentives for solvers and vbTOKEN holders.

All of the metrics will be calculated for each simulation run and then averaged for different time periods to represent the mean figure.

3.5.1 Solver Reward in bps Per Epoch

Solver metrics were calculated in bps per epoch to align with the costing assumptions for solver activity, thus aligning with the conventional way of comprehending solver economics.

$$R_t^S = \frac{\text{TOKEN emissions} \times \text{TOKEN price in epoch t}}{\text{solver intent volume in epoch t}}$$

3.5.2 Solver Net Cost in bps Per Epoch

$$C_t^S = \frac{\text{network cost} + \text{protocol cost} + \text{arbitrageur discount}}{\text{solver intent volume}}$$

$$NC_t^S = C_t^S - R_t^S$$

3.5.3 Additional Intent Volume (%) as Profitable Wash Trading

$$PWT_t = \frac{R_t^S}{C_t^S} - 1$$

This metric relies on the assumption that wash traders are able to settle 100% of their own intent flow and receive an average allocation of TOKEN emissions from the spoke contracts for the chain on which they have been active.

3.5.4 vbTOKEN Revenue Share APR

$$r_t^{VB} = \frac{\text{revenue share of protocol fee in epoch } t}{\text{vbTOKEN supply} \times \text{TOKEN price}} \times \frac{365}{\text{epoch length in days}}$$

3.5.5 vbTOKEN Early Exit Tax Redistribution APR

$$p_t^{VB} = \frac{\text{tax applied on early exits}}{\text{remaining vbTOKEN supply}} \times \frac{365}{\text{epoch length in days}}$$

3.5.6 vbTOKEN Total APR

$$R_t^{VB} = r_t^{VB} + p_t^{VB}$$

3.6 Benchmarks

3.6.1 Solver Reward in bps Per Epoch

Strict requirement

Solver reward in bps $\geq$ average discount cost for solvers in bps.

- TOKEN token rewards subsidise the cost of discounts given to arbitrageurs to effectively make the system achieve equivalent price savings as if 100% organic netting occurred.

Weak requirement

Solver reward in bps $\geq$ solver cost in bps $\rightarrow$ solver net cost in bps ≤ 0.

- Solvers are not incurring a cost for netting on Protocol.
- This will increase the attractiveness for solvers to be netted using the Protocol network, attracting more solver intent volume, and igniting the flywheel over time by:
  - Improving the efficiency of Protocol's clearing layer.
  - Potentially reducing the fixed costs incurred by solvers.

The table below summarises the benchmarks for solver reward in bps by split of intent volume between major traffic vs long-tail chains.

Table 8: Major Traffic and Long-tail Chain Splits

	85:15 split	**70:30 split**
Strict requirement	1.99 bps	2.91 bps
Weak requirement	3.14 bps	4.21 bps

Wash trading will be profitable if the weak benchmark is met and unprofitable if solver rewards are below the weak benchmark.

3.6.2 vbTOKEN Total APR

No benchmark has been set for this APR, as the primary objective of the parameter setting is to determine the suitable TOKEN emission rate for solvers.

vbTOKEN APR will be determined primarily by the experience of monthly intent volume on the Protocol clearing layer, and thus the total fees accrued for revenue share.

3.6.3 Wash Trading

No benchmark was set for additional volume as profitable wash trading, given the rewards and costs for solvers in bps per epoch.

The primary reason for not setting a benchmark for this metric is that, unlike other DeFi protocols where wash trading to farm rewards is a net-negative behaviour for the protocol and its users, wash trading on Protocol could contribute to more efficient netting and long-term cost reduction, benefiting the users of Protocol.

4 Simulation Results

4.1 Summary by Parameter to be Optimised

4.1.1 Summary of TOKEN Emission Rate

Based on the simulation result findings, the performance of each emission rate has been rated on a scale of 0 - 5 for each of the key considerations.

Table 9: Emission Rate Benchmarks and Descriptions

Initial emission rate	**Benchmarks on short-term target intent volume ($1B) (0-5)**	**Benchmarks on med-term target intent volume ($5B) (0-5)**	**Benchmarks on mature state target intent volume ($10B) (0-5)**	**Sustainability of emission from allocated supply (0-5)**	**Over-incentivisation of solvers & wash trading profitability (0-5)**	**Short term reward metrics for early partners (0-5)**
2.9%	5: Strict and Weak benchmarks satisfied under high and medium likelihood scenarios	1: Weak benchmark satisfied only under one high likelihood scenario	0: Neither strict nor weak benchmarks met under any scenarios	5: 10% of total allocation used for emissions in 4 years	5: High volume of wash trading can be suspected at low intent volume levels, but expected to disappear as real intent volume grows.	3: 3.42 - 6.09 bps at $1B monthly intent volume, 1.14 - 1.54 bps at $5B monthly intent volume
5%	5: Strict and Weak benchmarks satisfied under high and medium likelihood scenarios	3: Weak benchmarks satisfied under high and medium likelihood scenarios	1: Weak benchmark satisfied only under one high likelihood scenario	2: 17.20% of total allocation used for emissions in 4 years	2: Wash trading still profitable until medium term target intent volume is reached	4: 7.06 - 12.57 bps at $1B monthly intent volume, 2.36 - 3.19 bps at $5B monthly intent volume

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Table 9: Emission Rate Benchmarks and Descriptions (Continued)

11.8%	5: Strict and Weak benchmarks satisfied under high and medium likelihood scenarios	5: Strict and Weak benchmarks satisfied under high and medium likelihood scenarios	4: Weak benchmarks satisfied under high and medium likelihood scenarios	0: can fund 1.8 years worth of emissions using initial allocation of 21%	0: Wash trading will be very profitable as solver rewards are significantly higher at all intent volume levels	5: 15.62 - 27.72 bps at $1B monthly intent volume, 5.54 - 7.49 bps at $5B monthly intent volume

4.1.2 Summary of vbTOKEN Revenue Share Percentage

Based on the simulation result findings, the performance of each revenue share percentage has been rated on a scale of 0 - 5 for each of the key considerations.

Table 10: vbTOKEN Revenue Share and DAO Treasury Reserve Projections

Revenue share percentage	**vbTOKEN revenue share APR (0-5)**	**Projected DAO treasury reserve (0-5)**
50%	2: 4.18 - 8.91 at high likelihood price scenarios and initial target intent volume; 5: 16.84 - 22.06 at medium-term target volume	5: $256,430 after 1 year at initial target intent volume, $1,282,151 after 1 year at medium-term target, $2,564,302 at mature state target intent volume
80%	4: 6.7 - 14.26 at high likelihood price scenarios and initial target intent volume; 5: 26.95 - 35.34 at medium-term target volume	2: $102,572 after 1 year at initial target intent volume, $512,860 after 1 year at medium-term target, $1,025,721 at mature state target intent volume
100%	5: 8.37 - 17.83 at high likelihood price scenarios and initial target intent volume; 5: 33.68 - 44.18 at medium-term target volume	0: $0

4.2 TOKEN Emission Rate

4.2.1 11.8% Emission Rate

The minimum level of TOKEN emissions required to meet the benchmarks under all tested intent volume levels is 11.8%, but this is not a feasible or a sustainable recommendation.

This highlights that once the Protocol protocol reaches its mature state target intent volume of $10B per month, TOKEN emissions alone may not sufficiently incentivise solvers to net using the Protocol clearing layer.

Therefore, alternative methods to incentivise solver activity, such as reducing solver net cost or introducing additional TOKEN token utility, will need to be explored.

Analysis of 1 year metrics at 85:15 intent volume split between major traffic vs long-tail chains

Table 11: Benchmarks at 11.8% emission

Monthly intent volume	Strict Benchmark	Weak Benchmark
$500M	Satisfied under all high and medium likelihood price scenarios.	Satisfied under all high and medium likelihood price scenarios.
$1B	Satisfied under all high and medium likelihood price scenarios.	Satisfied under all high and medium likelihood price scenarios.
$5B	Satisfied under all high and medium likelihood price scenarios.	Satisfied under all high and medium likelihood price scenarios.
$10B	Satisfied under all high likelihood price scenarios.	Satisfied under all high likelihood price scenarios.

4.2.2 5% Emission Rate

Analysis of 1 year metrics at 85:15 intent volume split between major traffic vs long-tail chains

Table 12: Benchmarks at 5% emission

Monthly intent volume	Strict Benchmark	Weak Benchmark
$500M	Satisfied under all price scenarios.	Satisfied under all price scenarios.
$1B	Satisfied under all price scenarios.	Satisfied under all price scenarios.
$5B	Only satisfied under monotonically increasing price scenarios.	Only satisfied under strictly increasing price scenarios.
$10B	Only satisfied under the highest price scenario.	Not met under any price scenario.

4.2.3 2.9% Emission Rate

Analysis of 1 year metrics at 85:15 intent volume split between major traffic vs long-tail chains

Table 13: Benchmarks at 2.9% emission

Monthly intent volume	Strict Benchmark	Weak Benchmark
$500M	Satisfied under all price scenarios.	Satisfied under all price scenarios.
$1B	Satisfied under all price scenarios.	Satisfied under the vast majority of price scenarios.
$5B	Only satisfied under large increasing price scenario.	Not met under any price scenario.
$10B	Not met under any price scenario.	Not met under any price scenario.

4.3 vbTOKEN Revenue Share

Further experiments were conducted across various combinations of intent volume and price scenarios with different splits of revenue share between vbTOKEN holders and the DAO treasury reserve. These experiments aimed to understand the impact on vbTOKEN revenue share APR and to approximate the cumulative values of the DAO treasury reserve over time.

20% to DAO treasury reserve (80% to vbTOKEN holders)
This leads to a reduction in vbTOKEN revenue share APR by 20% (relative).

Table 14: DAO Treasury Reserve Projections under 20% revenue share

DAO treasury reserve	$500M monthly intent volume	$1B monthly intent volume	$5B monthly intent volume	$10B monthly intent volume
6 months	$29,455	$58,911	$294,555	$589,109
12 months	$51,286	$102,572	$512,860	$1,025,721
24 months	$110,746	$221,493	$1,107,464	$2,214,929

50% to DAO treasury reserve (50% to vbTOKEN holders)
This leads to a reduction in vbTOKEN revenue share APR by 50% (relative).

Table 15: DAO Treasury Reserve Projections under 50% revenue share

DAO treasury reserve	$500M monthly intent volume	$1B monthly intent volume	$5B monthly intent volume	$10B monthly intent volume

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Table 15: DAO Treasury Reserve Projections under 50% revenue share (Continued)

6 months	$73,639	$147,277	$736,386	$1,472,
12 months	$128,215	$256,430	$1,282,151	$2,564,
24 months	$276,866	$553,732	$2,768,661	$5,537,

5 Sensitivity Analysis

5.1 Split of Intent Volume to Major Traffic vs Long-tail Chains

After running the simulations for the scenarios above, we further studied the sensitivity of the solver economics to the split of intent volume across major traffic vs long-tail chains.

Given the aggregate costing assumptions for solvers, the average solver cost for re-balancing can be expressed via:

$$C_t^S = x \times TC^M + (1 - x) \times TC^{LT}$$

where:

- x = percentage of total intent volume from major traffic chain
- TC^M = total re-balancing cost on major traffic chain
- TC^{LT} = total re-balancing cost on long-tail chain

$$\implies C_t^S = 2.0706x + (1 - x) \times 9.215 = 9.215 - 7.1444x$$

Therefore, the total average cost per solver decreases by 0.71444 bps as intent volume from major traffic chains increases by 10% on average.

Given that the protocol fees is also lower for major traffic chains, vbTOKEN APR via revenue share can also be expected to decrease should the intent volume from major traffic chains increases.

5.1.1 Simulation Results

The simulation tested intent volume splits of 85:15 and 70:30 between major traffic and long-tail chains, highlighting the impact on solver costs and vbTOKEN APR:

- **85:15 Split:**
  - Cost per solver volume: 3.14 bps
  - Average protocol fee for revenue share: 0.405 bps
- **70:30 Split:**
  - Cost per solver volume: 4.21 bps
  - Average protocol fee for revenue share: 0.51 bps

The 85:15 split results in a 1.07 bps lower net cost for solvers, while vbTOKEN APR is projected to be 25.93% (relative) lower in the 70:30 split.

5.2 Net Locking Rates of TOKEN Tokens

An increase in the net locking rate of TOKEN tokens is expected to have negative impact of the resulting vbTOKEN APR, as the same rewards will be diluted over a greater base of vbTOKEN supply.

5.2.1 Simulation Results

The simulation tested the same price and intent volume scenarios under different net locking rate conditions:

- Baseline net locking rate (average of Curve, Balancer, and Camelot).
- 10% increase in net locking rate from baseline.
- 20% increase in net locking rate from baseline.

10% Increase in Net Locking Rate from Baseline

- Resulted in an average 5.65% reduction in vbTOKEN revenue share APR.

20% Increase in Net Locking Rate from Baseline

- Resulted in an average 14.90% reduction in vbTOKEN revenue share APR.

From this analysis, it can be inferred that the vbTOKEN revenue share APR is expected to decrease at a faster-than-1:1 rate as the locking rate of TOKEN increases.

Additionally, the increase in vbTOKEN early exit tax redistribution APR is proportional to the increase in the net locking rate.

6 Stress Testing

The goal of the stress testing is to observe system performance under a scenario where multiple environmental variables enter an extremely adverse state.

6.1 Scenario Setup

- Since the TOKEN token system relies heavily on initial solver volume to ignite flywheel effects, this stress test simulates a scenario where only 10% of the initial intent volume target is achieved, leading to $100M monthly intent volume.
- A sharp decline in the TOKEN token price is simulated, with a 90% drop in the first month followed by a gradual decrease throughout the simulation period.
- Average solver costs in bps are expected to increase due to the higher proportion of intent volume from long-tail chains, with a 50:50 split between major traffic and long-tail chains assumed.
- The net locking rate assumptions for TOKEN tokens were increased by 50%, diluting the revenue share and further reducing vbTOKEN APRs.
- To simulate higher degrees of extreme price movements, the degrees of freedom in the Student's t-distribution feeding into the GBM of TOKEN price were reduced from 8 to 6.
- An annual TOKEN emission rate of 2.9% was used to amplify the impact of adverse market conditions.

Graphs depicting circulating supply of TOKEN, vbTOKEN supply and prices for the stress test scenario are included in Appendix **??**.

6.2 Results

6.2.1 Simulation Run Metrics for Stress Test Scenario

Table 16: Solver Metrics Over Time

	Solver CLEAR rewards (bps)	**Solver net cost (bps)**	**vbCLEAR rev share APR**	**Profitable wash trade volume (%)**
6 months	4.23	1.41	14.72	17.64
12 months	3.40	2.24	36.47	15.26
24 months	2.03	3.61	423.72	8.50

6.2.2 Key Takeaways

- Strict and weak benchmarks for solver TOKEN rewards in bps are met in the first 6 months, but performance of incentives degrades over time under adverse market conditions, falling short of the benchmarks in the 2-year period.
- However, solver TOKEN rewards are still expected to offset a considerable portion of solver costs.

- Some level of wash trading can still be expected under this stress scenario, as solver rewards will exceed solver net costs.
- vbTOKEN revenue share will be relatively strong due to the downward trajectory of the TOKEN price, which offsets the revenue share collected from low incentive volumes.
- Given the downward trajectory of TOKEN price, vbTOKEN APR over 2 years becomes extremely large, potentially providing price support for TOKEN as economic incentives to buy and lock TOKEN tokens for revenue share remain high.

7 Other Insights

7.1 Incentives for Early Partners

- Early partners will be whitelisted solvers, and therefore their rewards are likely to be higher than estimated in the modelling, as the same rewards will be distributed over a smaller pool of intent volume.
- TOKEN tokens should be distributed retroactively or regularly to early partners in proportion to the chosen annual emission rate, to achieve the results indicated by the modelling.
- **85:15 intent volume split between major traffic vs long-tail chains.**

Below is the table outlining the range of average solver rewards in bps in the first 6 months of protocol launch under each intent volume scenario and the most probable price scenarios.

Table 17: Range for solver rewards in bps in first 6 months

Monthly intent volume	**2.90% emission rate**	**5% emission rate**	**11.80% emission rate**
\$500M	5.9 - 7.74	10.36 - 13.58	23.83 - 31.23
\$1B	3.98 - 7.08	7.06 - 12.57	15.62 - 27.72
\$5B	1.42 - 1.92	2.36 - 3.19	5.54 - 7.49
\$10B	0.69 - 0.93	1.2 - 1.62	2.77 - 3.75

7.2 vbTOKEN Total APR

- TOKEN lockers will not earn the modelled revenue share APR until the gauge system is live and revenue share begins to flow to vbTOKEN holders.
- The average vbTOKEN APR estimate is significantly high during early periods after launch due to the relatively low base value of vbTOKEN holdings compared to the revenue share collected from intent volume.
- Over time, vbTOKEN APR averages out as the base value of vbTOKEN holdings increases.
- The APR a TOKEN token holder can receive from vbTOKEN will depend on the duration that the TOKEN token is locked. At maximum lock duration, 100% of vbTOKEN APR will be attainable by the TOKEN token holder.

7.3 Early Exit Tax

Given the formula for the expected APR from early exits, given an average tax rate applied on early exits, the calculation of APR can be approximated:

$$p_t^{VB} = \frac{\text{tax applied on early exits}}{\text{remaining vbTOKEN supply}} \times \frac{365}{\text{epoch length in days}}$$

$$\Longrightarrow p_t^{VB} = \frac{\text{average tax rate} \times \text{early exits}}{\text{remaining vbTOKEN supply}} \times \frac{365}{\text{epoch length in days}}$$

$$\implies p_t^{VB} = \frac{\text{average tax rate} \times \text{early exit rate} \times \text{vbTOKEN supply}}{(1 - \text{early exit rate}) \times \text{vbTOKEN supply}} \times \frac{365}{\text{epoch length in days}}$$

$$\implies p_t^{VB} \approx \frac{\text{average tax rate} \times \text{early exit rate}}{(1 - \text{early exit rate})} \times \frac{365}{\text{epoch length in days}}$$

- The observed average tax rate on early exits was 27.31%, based on technical research.
- Given the average locking duration as a percentage of the maximum lock, the average APR for remaining vbTOKEN holders is around 4.27%.

7.4 Wash Trading

- A healthy system benefits from higher intent volumes and moderate price scenarios (both increasing and decreasing).
- Unlike wash trading activity on trading or lending protocols, the presence of wash trading on Protocol is not purely net-negative, as it is not guaranteed that wash traders will be able to net out their own intent flow, making reward capture uncertain.
- The presence of wash trading on Protocol may increase the percentage of natural netting, thereby improving the experience for other solvers and reducing costs.
- Wash trading profitability is likely to exist during the initial period after protocol launch until actual monthly intent volume becomes large enough to make TOKEN rewards lower than the total costs incurred by solvers.
- Fully mitigating wash trading profitability during the initial phases comes with a significant opportunity cost, as it would reduce the high levels of initial incentives intended to attract solvers.
- A peak of around 20% average profitable wash trading occurs during the most intense increasing price scenario with the lowest intent volume. The lowest levels of wash trading are expected at medium-term and mature-state intent volumes.

7.5 TOKEN Price

- The trajectory of TOKEN price will likely be driven by the APR that vbTOKEN token holders expect to earn from revenue share.
- If growth in intent volume on Protocol exceeds expected levels, TOKEN price could increase, as demand for TOKEN tokens rises.
- The TOKEN token price will also be subject to overall market sentiment in the cryptocurrency industry, and it may follow general short-term price trends in the market.

8 Conclusion

8.1 Key Takeaways

- A 5% annual emission rate is recommended as it balances early solver incentives with long-term sustainability. This rate satisfies the benchmarks in high and medium-likelihood scenarios, making it ideal for initial growth.
  - The protocol can provide sufficient economic incentives in the short and medium term, but at mature intent volume targets ($10B per month), alternative strategies beyond emission-based rewards (such as further token utility or solver cost savings) will be necessary to maintain solver participation.
- The 2.9% emission rate minimizes incentives but risks reduced early volume growth and failing to meet benchmarks under higher volume scenarios, especially if the protocol grows faster than expected.
- Keeping vbTOKEN revenue share at 100% initially maximizes early returns for vbTOKEN holders, attracting TOKEN holders to lock their tokens.
- Some degree of wash trading is expected during the initial phases when solver TOKEN rewards exceed solver costs. However, incentivising wash trading should not be considered a sustainable long-term approach.
- Under adverse market conditions, such as low intent volume and sharp price declines, the economic incentives will remain robust in the short term but cannot be sustained beyond 1 year.

8.2 Potential Roadmap Items for Protocol

- **Monitor Solver TOKEN Rewards:**
  - Continuously monitor both the average cost and rewards on Protocol to ensure that benchmark levels are met.
  - Additional refinement of benchmarks for solver rewards may be needed based on actual experience once Protocol is live.
- **Monitor Wash Trading Behaviour:**
  - Analyse the intent volumes netted out by solvers, focusing on similar sizes, flows, and timing.
  - Monitor the concentration of intent volume in spoke contracts where the majority of emissions are directed.
- **Monitor vbTOKEN Revenue Share APR:**
  - As intent volume grows and the TOKEN token supply schedule progresses, it will be imperative to monitor the levels of vbTOKEN revenue share APR to determine the appropriate time to switch on revenue share to the DAO.
- **Investigate Cost-Saving Measures for Solvers at High Intent Volumes:**

  - As intent volume grows, finding cost-saving measures for solvers will be key to enhancing the economic incentive to use the Protocol clearing layer, particularly when emissions alone are no longer sufficient.

- **Ideate Further Incentives for Solvers:**
  - At high levels of intent volume, pure TOKEN token emissions may become insufficient. Therefore, exploring further economic incentives for solvers or additional token utility for TOKEN tokens will be crucial.

9 Limitations

This section highlights the limitations of the model used for simulations and, by extension, the recommendations made.

- **Solver Cost Assumptions:**
  - Aggregate costing assumptions for solvers on major traffic and long-tail chains were used, based on prior research by the Protocol team.
  - The model does not explicitly account for organic netting and arbitrageurs' netting throughout epochs, and thus cannot be used to make specific recommendations regarding these dynamics.
- **Individual Spoke Contracts:**
  - The model does not include specific spoke contracts, meaning solver TOKEN rewards in bps from simulations represent an average across all solvers, regardless of their destination chains.
- **Interaction Between Protocol Metrics and TOKEN Price:**
  - Back-testing was performed under specific adverse scenarios (e.g., low intent volume and declining TOKEN price), but the model does not outline the impact of protocol metrics on TOKEN price or vice versa.
- **Second-Order Impacts of Circulating Supply of TOKEN on TOKEN Price:**
  - The model does not define a relationship between the circulating supply of TOKEN tokens and the token price. This omission was intentional to avoid incorporating spurious assumptions and to prevent over-fitting the model with predefined relationships.
- **Time Period Granularity:**
  - Since the model measures time in epochs (14-day intervals), it is effective at predicting the macro functions of the system over time. However, it does not capture intra-epoch trends or micro-economic functions.
- **Scenarios Tested:**
  - The figures and results demonstrated in this report are outputs from the underlying scenarios that were tested during the simulations. Should the actual market conditions differ from the scenarios that are tested, it is expected that the results will deviate from the results in this report.
- **Smart Contract Risk:**
  - The model does not account for smart contract risk or any associated events. As a result, actual economic metrics could deviate from the simulated results if such risks materialise.

10 Disclaimer

This token design documentation is provided by Vending Machine, a token design firm, for informational purposes only. The information contained herein is based on a modified version of a modelling based systems engineering process and is intended solely for the use of Protocol. Vending Machine makes no representation or warranty, express or implied, for the information contained in this documentation.

The comments in this document are made in relation to the currently proposed system design by the core team. Therefore the information provided is only relevant given the current circumstances of the protocol and may become outdated.

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Appendices

A Differential Specification of Protocol Model used for Simulations

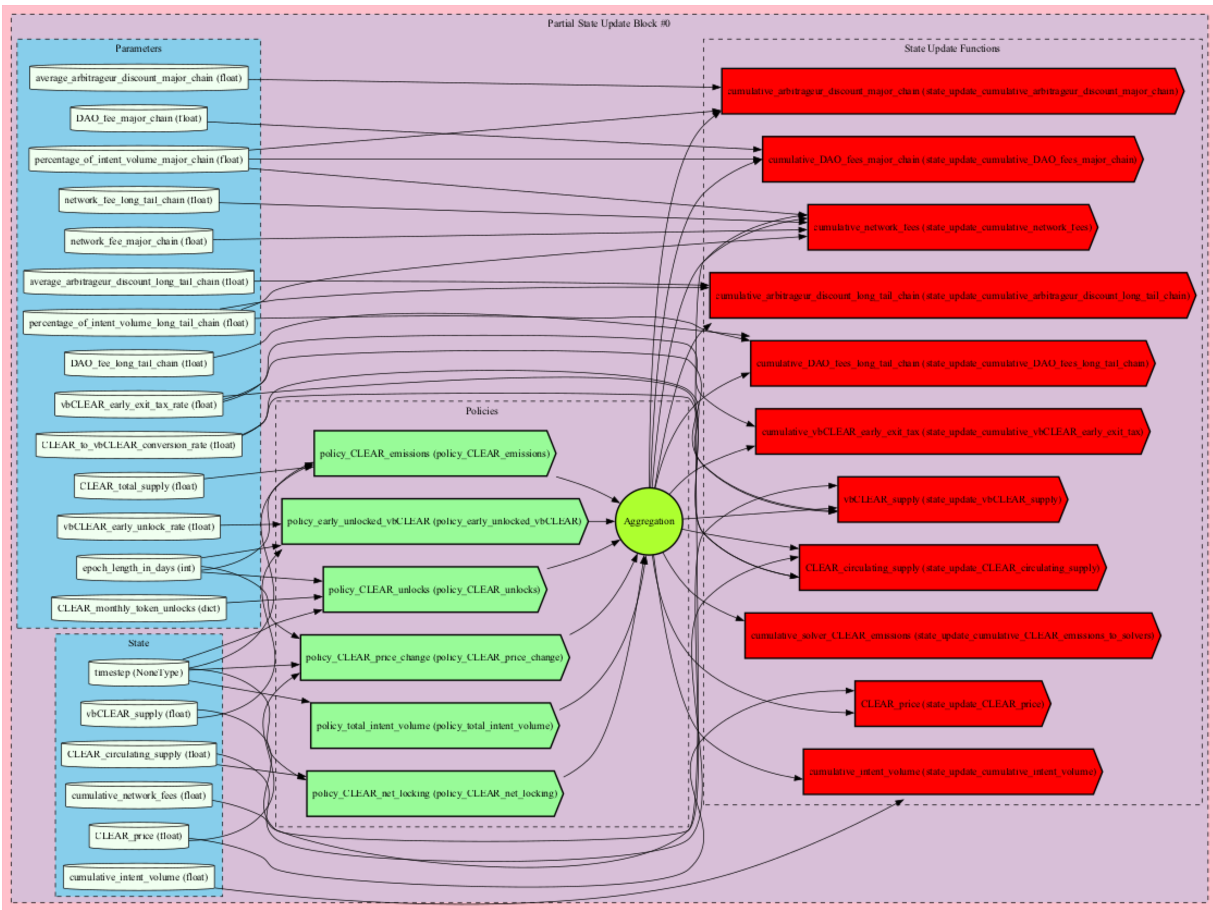

Figure 1: Differential Specification of Model used for Protocol Simulations

B Additional plots for Simulation Results using 2.9% emission rate

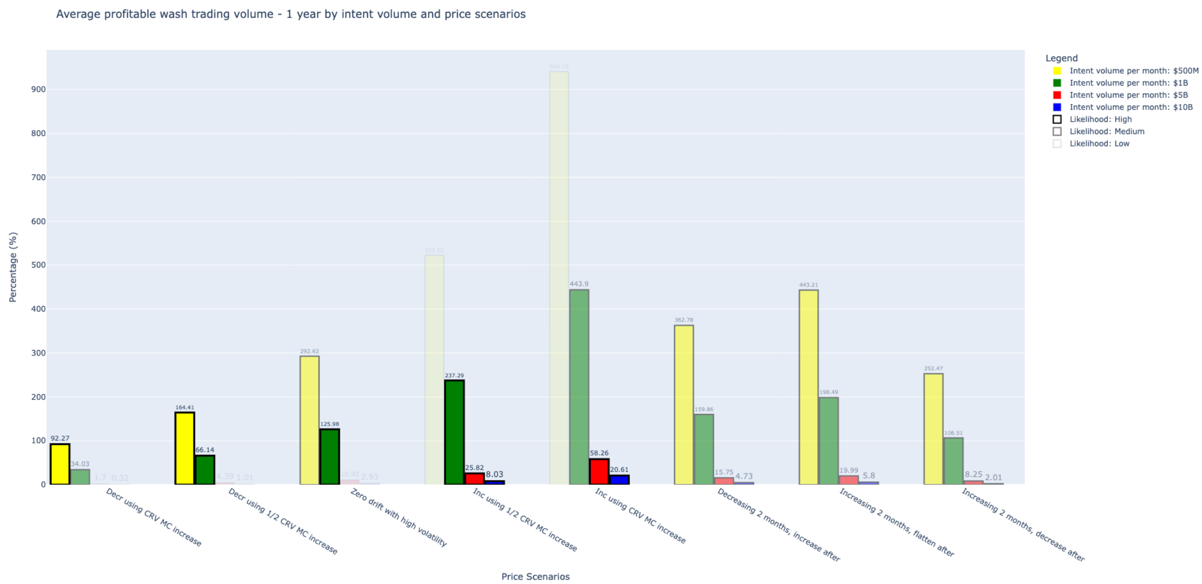

Figure 2: Average profitable wash trade volume over 1 year at 2.9% emission rate

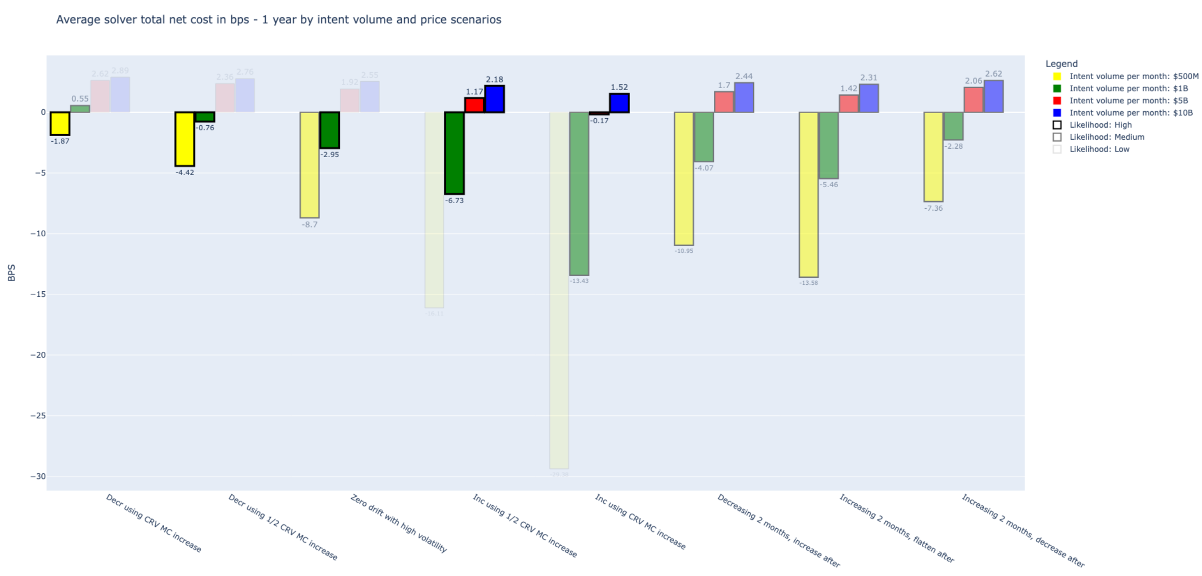

Figure 3: Average solver net cost in bps over 1 year at 2.9% emission rate

C Additional plots for Simulation Results using 5% emission rate

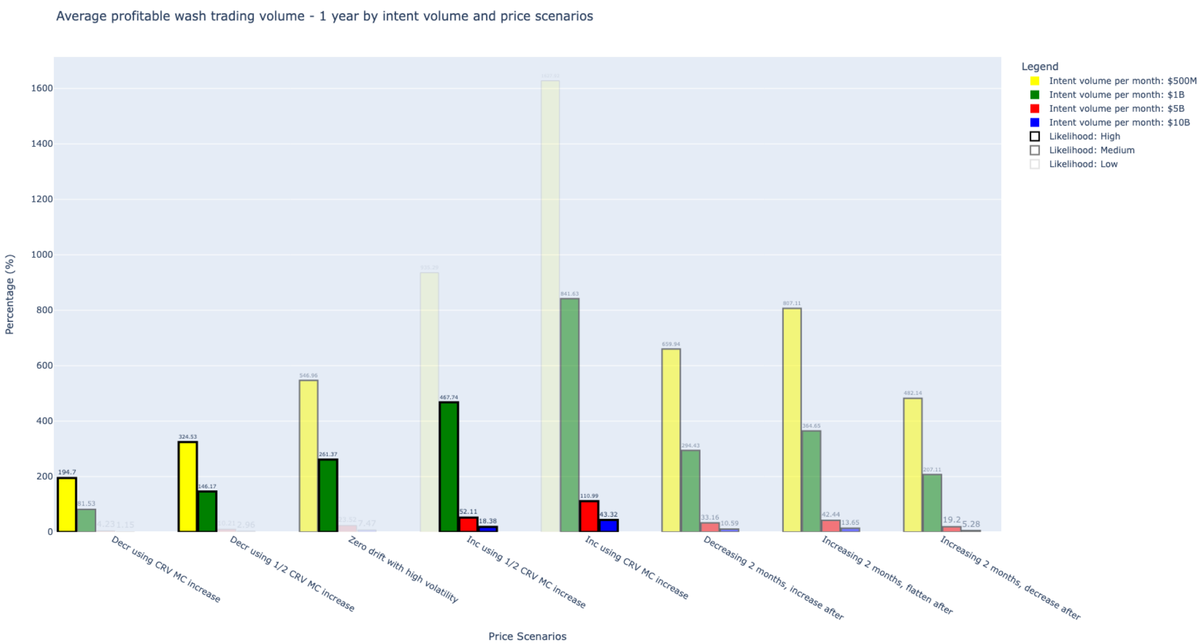

Figure 4: Average profitable wash trade volume over 1 year at 5% emission rate

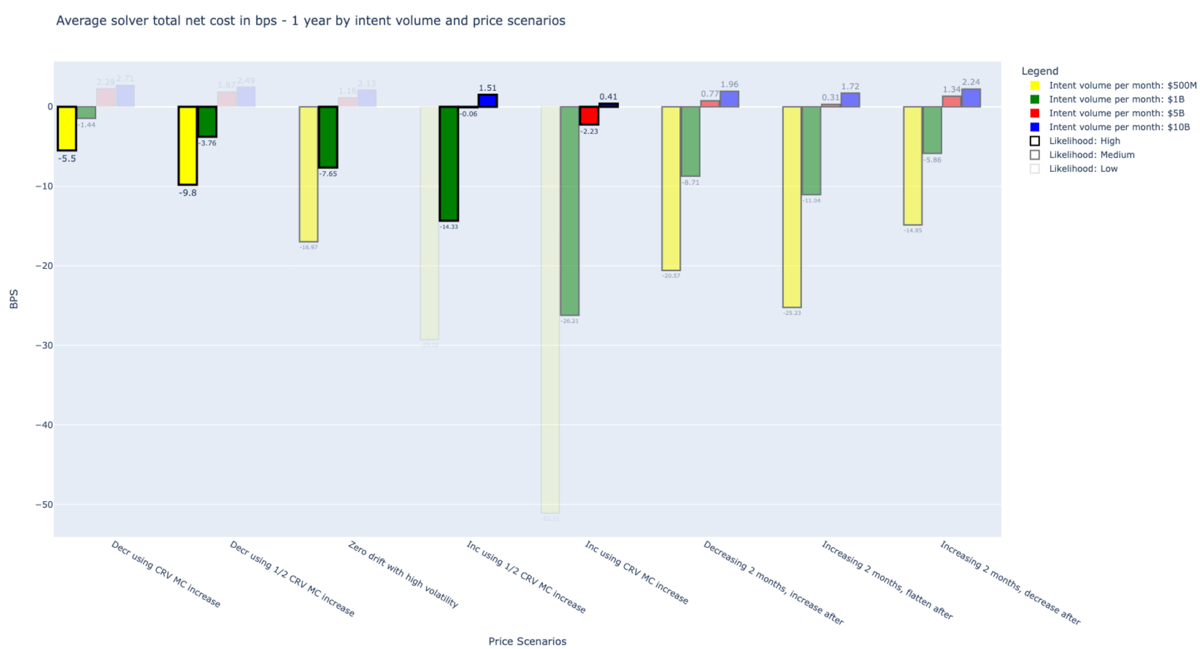

Figure 5: Average solver net cost in bps over 1 year at 5% emission rate

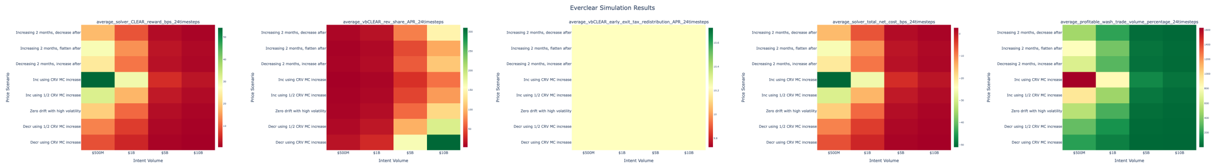

Figure 6: Heatmap of all metrics across scenarios r at 5% emission rate

D Additional plots for Simulation Results using 11.8% emission rate

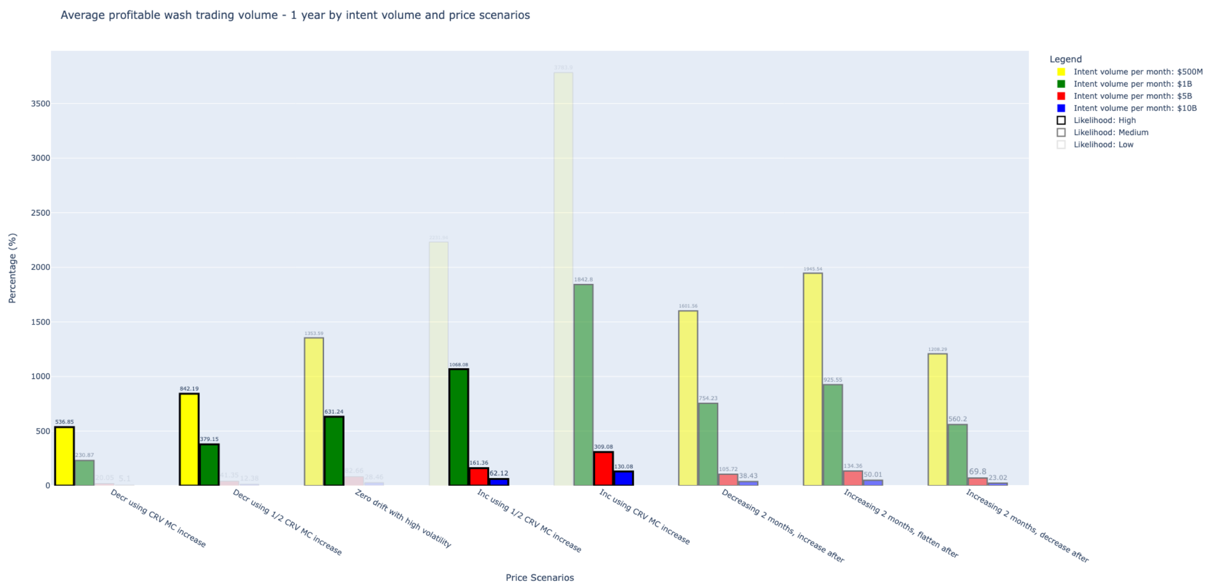

Figure 7: Average profitable wash trade volume over 1 year at 11.8% emission rate