FORTE

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FORTE

ME 10+ years building technology for games and finance

US building tech & tools supporting the game industry's adoption of blockchain

THIS TALK

1) problem (combinatorial markets, poor price signals)

2) solution (fully collateralized AMMs)

3) design & tools (CAS + control theory + CAD + simulation)

4) SOK (design suitable to games)

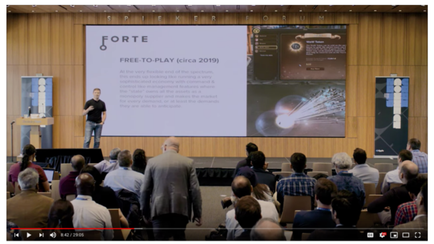
PROBLEM

huge combinatorial space, poor price signals, limited opportunity for fundamental analysis

GAMES

(BACKGROUND)

Brett Seyler - How blockchain can forge the future of gaming (Blockchain Games Next)



Building Games on Blockchain with Brett Seyler of Forte Labs at UBRI Connect 2019

ASSETS

games require all kinds, and in large numbers

	Fungible	Non-fungible
Divisible	 In-game currencies that act as money in a specific game universe are what other in-game items are typically denominated in, and would serve as a medium of exchange between players.	 Non-fungible, yet divisible designs are plentiful in games. Existing specifications include ERC-1155.
Indivisible	 Basic items in games are often fungible, but indivisble, bearing resemblance to commodities. Also referred to as “stackable” items, they solve performance issues arising from inventory management.	 Commonly referred to as “NFTs”, non-fungible tokens are are likely to be implemented for rare items and collectibles. Existing specifications include ERC-721.

MARKETS

design features and market characteristics

DISCRETE

P2P / OTC

- Best when market not fully liquid and supply or demand is limited
- Useful for individually negotiating trades when desired attributes are dynamic
- Can preserve privacy, curb front-running

- Slow to achieve “double coincidence of wants”
- Requires active participation by either party or by intermediary

AUCTIONS

- Useful when supply side controls inventory and wants to sell
- Maximizes price discovery for uniquie, illiquid asset that doesn’t have obvious comparable
- Curbs front-running

- Slow and expensive on-chain
- Usually requires an intermediary to run

CONTINUOUS

LIQUIDITY PROVIDERS

MARKET MAKING

- Opportunity to generate spread and control supply / demand
- When networked, leverages others to bridge liquidity as each MM would only need to hold a few assets

- Broker dealers are intermediaries, creates opportunity to front-run

AUTOMATED MARKET MAKING

- Instant liquidity
- No counterparty necessary
- Can program economic incentives to reward early adopters

- Susceptible to front-running if AMM both prices and settles transactions

ORDER BOOKS

- For highly liquid assets, an efficient way to organize bids and asks and enable matching
- Can be very quick with sufficient liquidity and automatic matching

- No crossing if no liquidity
- Expensive on-chain
- If off-chain, opportunity for relayer to front run

GAMES

market design suitability to game assets

CONTINUOUS

DISCRETE

LIQUIDITY PROVIDERS

P2P / OTC

AUCTIONS

MARKET MAKING

AUTOMATED MARKET MAKING

ORDER BOOKS

THINLY TRADED / ILLIQUID

HIGHLY LIQUID

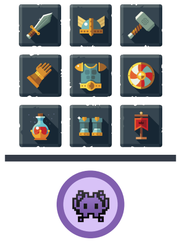
PROBLEM
SUMMARY

huge combinatorial space, poor price signals, limited opportunity for fundamental analysis

- An individual game can have 100M+ players. This is only possible with modern benchmarks for low-friction UX.
- Not everyone is an economist. Not everyone wants to bid in an auction.
- A solution mapping onto modern games needs to “just work”, providing an experience comparable to existing in-game purchases of virtual currencies & items.

SOLUTION

fully collateralized assets + AMMs



Collateralize all game assets with a single underlying game currency.

AUTOMATED MARKET MAKING

Use fully-collateralized AMMs to trade game currencies.

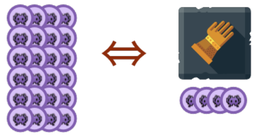
ITEMS

collateral all the way down 

Developer creates a game item by creating a collateral contract with game currency requirements (ERC-1155 compatible).

Players can purchase / mint more of game item using game currency at price set by game / contract rules.

Players can burn / sell game item(s) for game currency via same contract / rules.



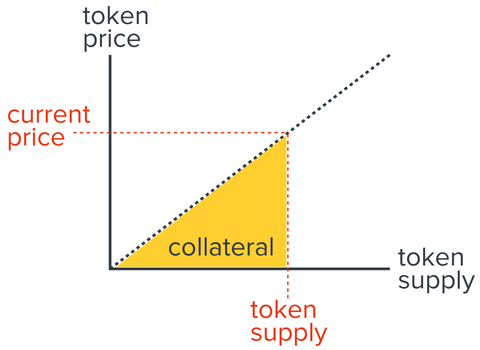
Players can also trade directly with other players on their own terms, with at least a floor on the price signal via the item contract (AMM).

AMM
FOR GAMES

continuously available price discovery + immediate liquidity

AUTOMATED MARKET MAKING

AMMs have extensive and formally verified constructions. Hanson's logarithmic market scoring rule (LMSR) and Othman's liquidity sensitive extensions of LMSR offer sound reference for AMM design.

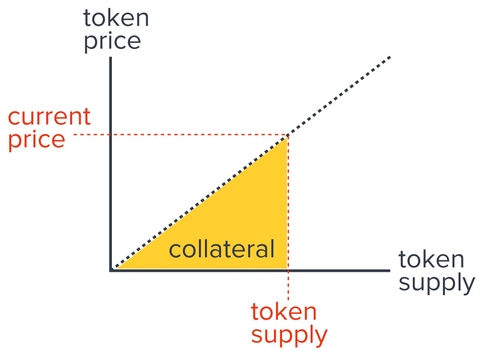


Token bonding curves (TBCs) are a widely deployed fully collateralized AMM design in crypto and can be constructed to respond to market dynamics in a wide variety of ways. In current form, we believe there are important limitations to overcome and generalize to satisfy our use case in games.

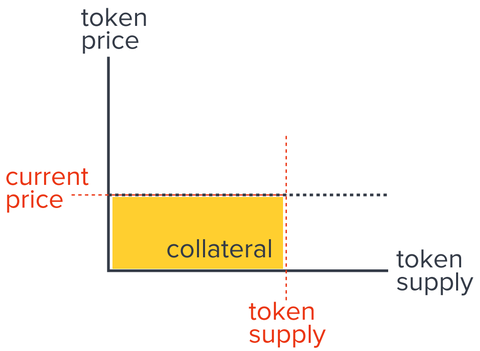
AMM
PARAMETERS

sample of TBC forms & parameters

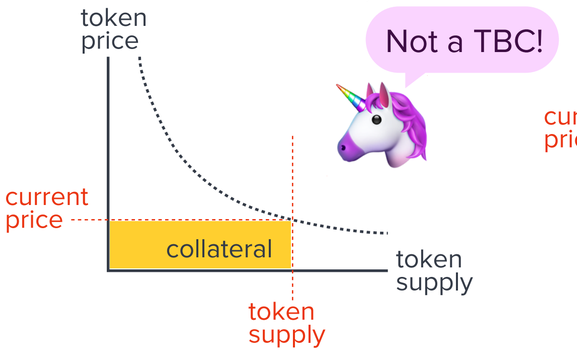
$$y = kx$$



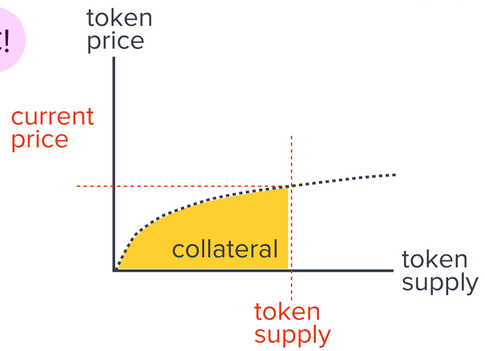
$$y = k$$

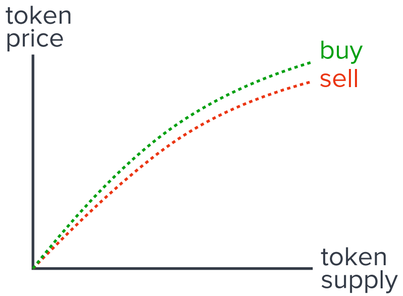


$$y = k/x$$

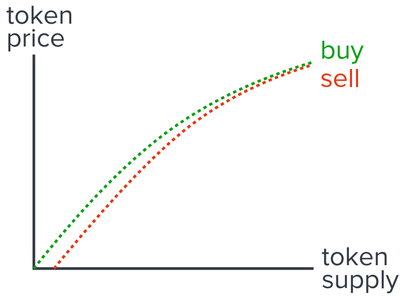


$$y = k*log(x)$$

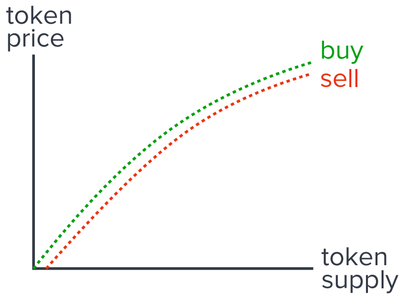




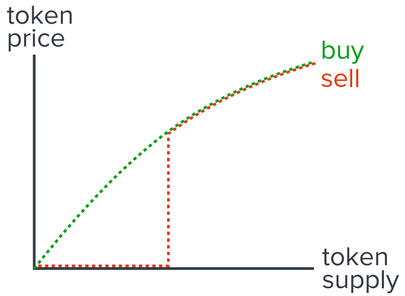
% spread



fundraising



fixed fee



redemption limit

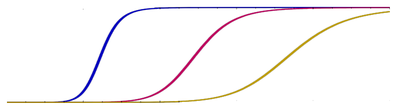
AMM

FUNCTIONAL FORMS

which functional form is suitable to games?

Hyperbolic and exponential TBCs suffer accelerating price volatility as demand increases.

Linear and logarthmic TBCs bound price range (unless token supply is infinite).



Sigmoidal TBCs are often cited as the most natural form. They follow natural growth dynamics seen with network effects.

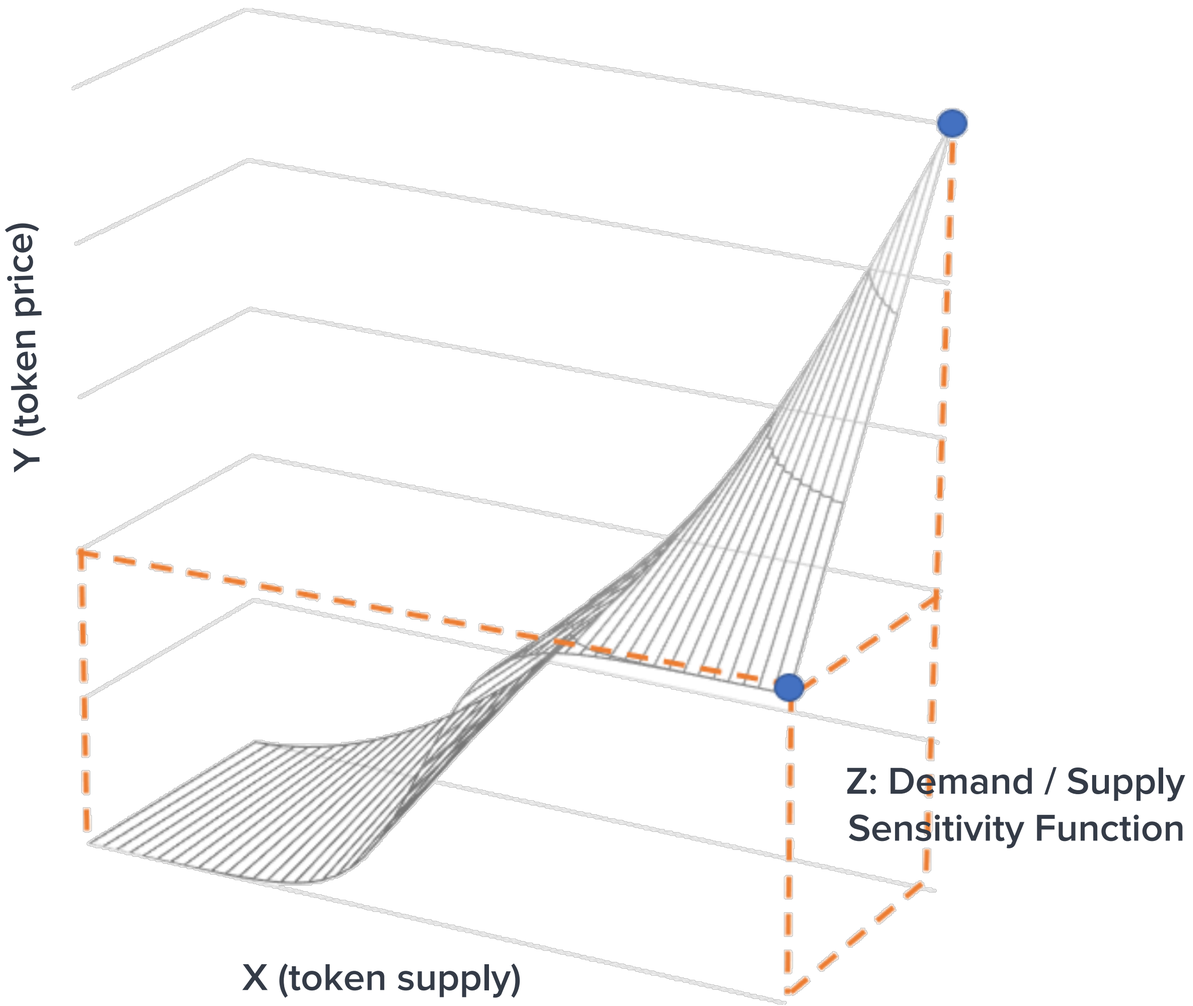
Early sub-linear growth followed by superlinear exponential-like growth.

At a certain scale, the network approaches saturation and stabilizes.

AMM

DESIGN SPACE

fully collateralized, market responsive AMM



AMM
CLEARINGHOUSE

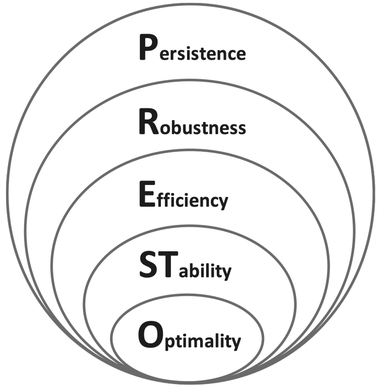
curb front-running by separating order pricing and settlment

Bonding curves might be used only for price before relaying orders to a clearinghouse settlement function. As in traditional exchanges, the clearinghouse smart contract would ensure only valid transactions clear.

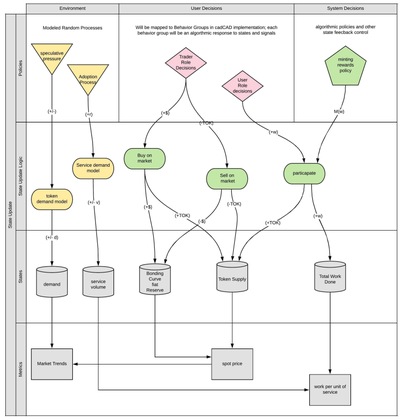
- Automates circuit breaker actions, halting transactions when precommitted conditions are triggered (e.g. market runs)
- Verifies transacted price comports with pricing function / TBC
- Optionally validates KYC / AML for both parties (oracles today, on-chain ID in future)
- Optionally prevents or reduces unwanted market participants (e.g. cooldowns and limits for those with little stake or history.)
- Separates price quote from settlement ordering and clearing, mitigating front-running attack vectors.

DESIGN

frameworks and tools suitable to AMM & mechanism design



A decentralized economic protocol network suitable to open participation by players and creators is a vast, complex system vulnerable to system risk. Mechanisms designed to create a balance of incentives for network participants and result in any desirable equilibia is a tall order.

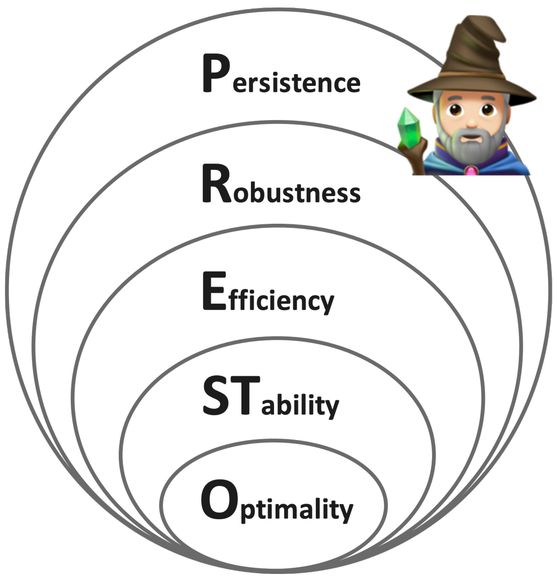


Furthermore, formally validating that such a network and its mechanisms achieve design goals is untenable. Given the large state space, control theory & simulation tools are likely the weapons of choice for both game item creators and mechanism designers.

DESIGN

FITNESS FRAMEWORK

PRESTO (Chia, et. al.) offers a useful framework for evaluating network design



Optimality: Does the protocol solve the problem it is designed to address? Does it maximize the outcomes for participants following it?

STability: Will self-interested actors adhere to the protocol consistently? (i.e does the protocol create equilibria? How many, what type?)

Efficiency: How efficiently does the protocol utilize its resources in achieving Optimality and Stability?

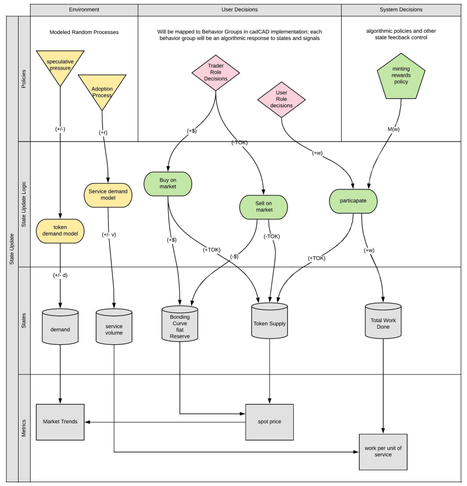
Robustness: Strong under attack / perturbation (e.g. coalitions, competitor attacks, irrationality / panics)?

Persistence: If the protocol is forced out of equilibrium, does it recover? How?

DESIGN

CAD TOOLS

Modeling & simulation using CAD tools are likely essential to establish network fitness



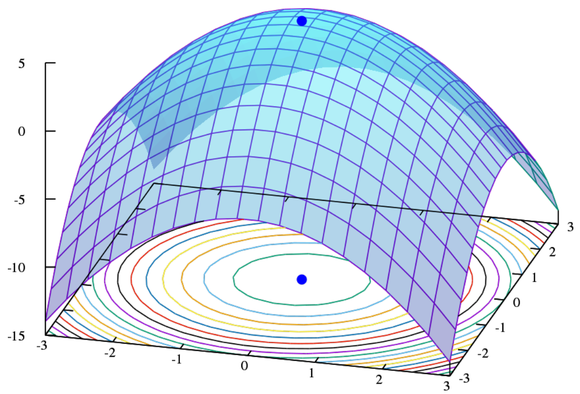
Through complex adaptive systems (CAS) lens, mechanism design focusing on equilibria can be untenable to verify with real world confidence. Randomness and unpredictable agent behavior often force systems out of equilibria without guarantee of timely recovery.

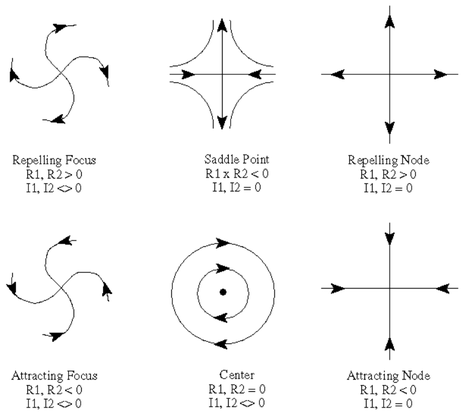
A CAS approach assuming only rules & mechanisms capable of preserving network objectives (“reference states”) without respect to agent behavior may achieve **R**obustness and **P**ersistence objectives from PRESTO more reliably.

DESIGN

OPTIMAL CONTROL

control theory: from useful to provably optimal





Fully collateralized front-running resistant AMMs could provide a valuable stepping stone for game designers wanting to create peer-to-peer economic games.

What steps can we take to ensure AMMs and mechanisms are well designed?

Control theory offers decades of research & tooling that can be brought to bear, modeled, and simulated. Many parameters available to control such a system can be made dynamic and informed / updated by the system state.

Even very complex systems (with a large state space) are likely to benefit from application of these tools.

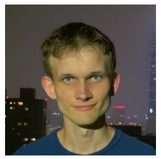
REFERENCES

AND THANKS 🙏🏻

folks from the community whose work that informed our own (in no particular order)

Dan Boneh

Tarun Chitra



Vitalik Buterin

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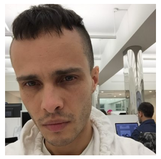
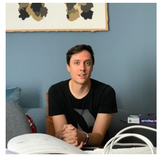
Michael Zargham



Slava Balasanov

Billy Rennekamp



Simon de la Rouviere

Vincent Chia (et. al.)

Emin Gün Sirer

Philip Daian

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THANKS! 🙏🏼

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