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Cryptoasset Valuation…

for designers.

silicon valley ethereum meetup

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Introduction

- Cryptoassets, like financial assets before them, constitute a social and institutional ***design space***.
- They have meaningful existence solely in the context of ***games we construct***, populated by communities of interacting players.
- Typically, cryptoassets are intended to be ***exchangeable*** for other financial and cryptographic assets, which implies they have "***value***" in financial terms.
- The purpose of this talk is to help you think about how to ***design*** assets whose values, which are likely to change over time, offer the ***valuations and exposures*** you desire.
- ***Valuability*** should be a design goal.

Sculpting an asset

Source: http://cultura.biografieonline.it/david-di-michelangelo/

Sculpting an asset

- A sculpture begins as a block of stone, a flexible medium from which many things, but not anything, can be constructed. It has its characteristics and affordances.

- Our stone will be ***game-theoretic***, a continuous space of prices at which our players can agree to transact. ***Every price and many sequences of prices over time form potential Nash equilibria*** for a community of players who will buy and sell our assets for reasons that are application dependent. At what prices will they transact? How stable will those equilibria be?

Sculpting an asset

- Our coarsest chisels will be ***redemption*** and ***issuance***, which put a floor beneath and a ceiling above price respectively.

- An artist's goal is not to give form to stone, but to affect the soul of the human who gazes upon the stone. The form is only a means to an end.

- An asset designer's goal is not to constrain price, but to affect the behavior of the communities who trade our asset in ways that enable and incentivize activities and collaborations we consider desirable. Constraining the price is just a means to an end.

Constraining prices

Constraining prices

∞

really unconstrained price space

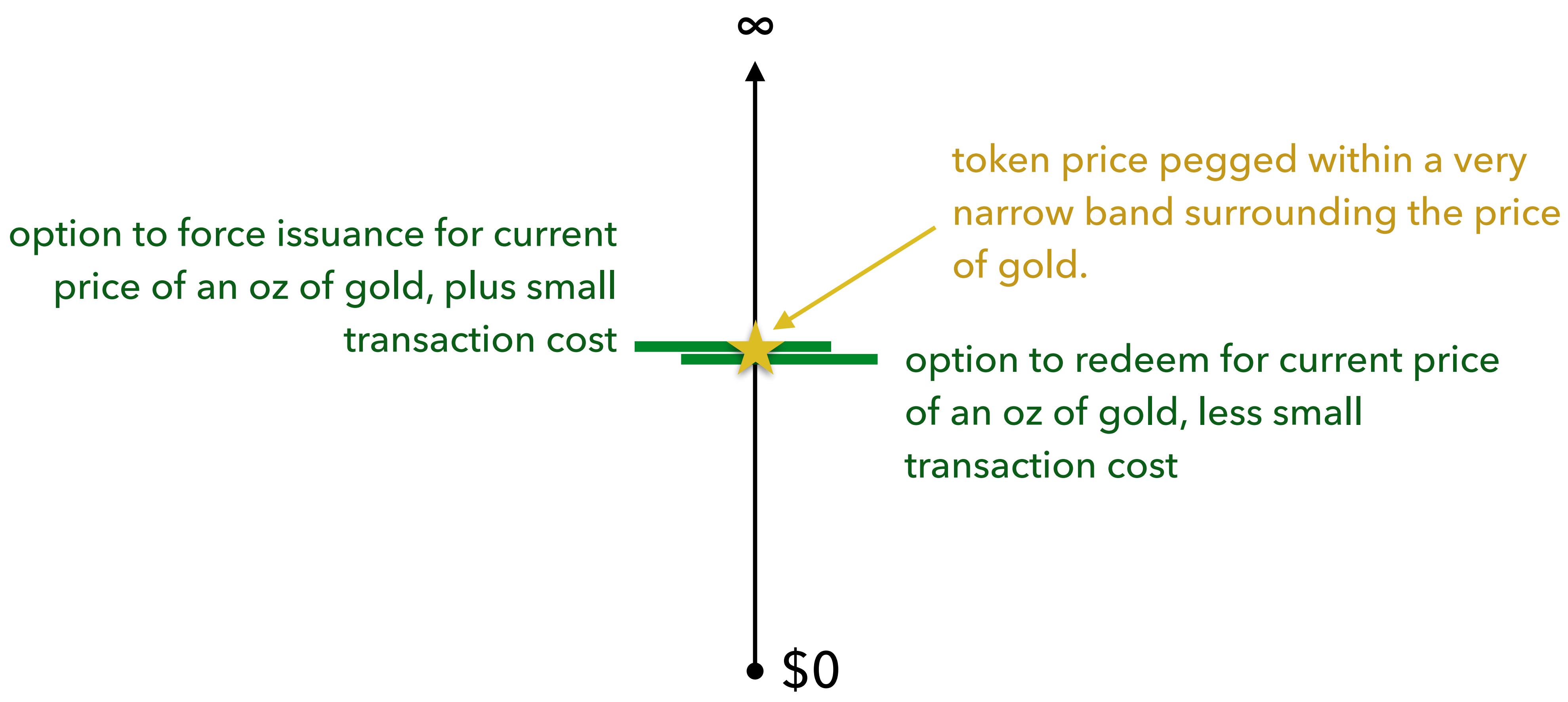
-∞

Did you notice the * in the previous slide? The so-called “unconstrained price” was in fact ***constrained by a presumed ability to dispose, i.e. to redeem at $0 with no further liability.***

Many financial instruments can have negative values. You literally have to pay to get rid of them. If this sounds exotic, check your credit card statement!

With systems like ethereum, cryptographic tokens can represent liabilities as well as assets against some escrowed collateral. ***Negative redemption values can be meaningful!***

Example: gold-tracking ETF



(This is close to how ETFs like GLD actually work, but there's a wrinkle. In order to ensure that redemption requests can always be met, the redemption price must drift downward over time to cover the cost of storing gold, which can be sold when redemptions are demanded. The issue price follows the redemption price down. The ETF perfectly tracks the *return* of holding gold less storage and administration fees. But the price diverges from it's original 0.1 oz fix. The price of a cryptoasset without storage or administration fees can be tracked perfectly.)

Game theory and behavior

- Remember, our ultimate goal is not to shape a price, but to condition the behavior of the community that trades our assets.

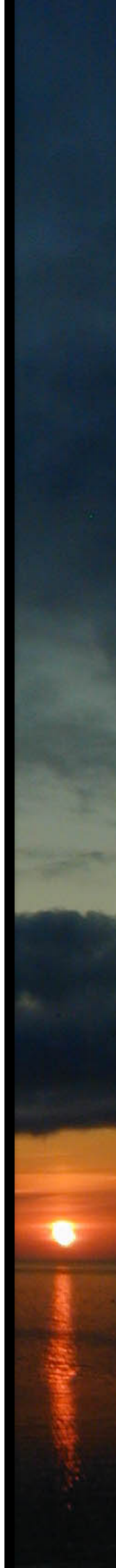
- Tools as trivial as a redemption price can profoundly shape the behavior of institutions and communities. We'll need to do some game theory to understand how.

- Let's review.

What is a Nash Equilibrium?

- A ***Nash equilibrium*** refers to a circumstance in which every agent is pursing her best strategy given the strategies other agents are pursuing.
- Equivalently, under a Nash equilibrium, no single agent can improve her outcome with a unilateral change of strategy. Any improvements would require ***trusted or enforced coordination***.
- A stable Nash Equilibrium is like a kind of ***social habit***.

prisoners' dilemma (of course)



Example: Prisoners' Dilemma

Alice \ Bob	Keep Quiet	Confess
Keep Quiet	Alice -1 / Bob -1	Alice -4 / Bob 0
Confess	Alice 0 / Bob -4	Alice -3 / Bob -3

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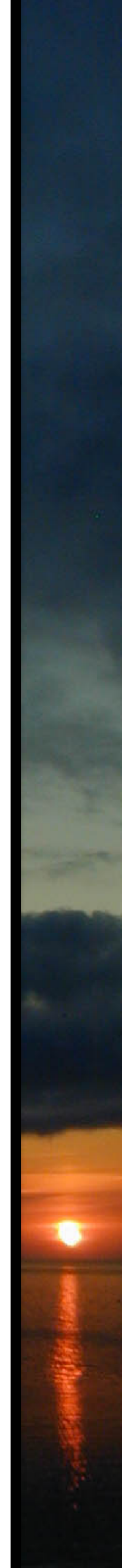
stag hunt



Example: Stag Hunt

Alice \ Bob	Hunt	Chill
Hunt	Alice 3 / Bob 3	Alice -2 / Bob 0
Chill	Alice 0 / Bob -2	Alice 0 / Bob 0

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Example: Stabilizing a fractional reserve bank

- Clients prefer to hold deposits in a bank rather than cash is a shoebox, because of payment convenience and reduced security costs / risks. A dollar in the bank is worth $1 in payment use-value and an additional .2¢ in added convenience.
- Unfortunately, the bank is “fractional reserve” meaning if both Alice and Bob simultaneously try to withdraw cash, the bank will have to sell assets in a “fire sale” and will only be able to pay $0.50 on each dollar deposited.
- This sets up a “stag hunt” game.

Example: Stabilizing a fractional reserve bank

- An unguaranteed bank

Alice \ Bob	Hold in Bank	Run
Hold in Bank	Alice 1.02 / Bob 1.02	Alice 0 / Bob 1
Run	Alice 1 / Bob 0	Alice 0.5 / Bob 0.5

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- Redemption guarantee eliminates “bad” equilibrium

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Example: Stabilizing a fractional reserve bank

- Note that in this example, the redemption guarantee profoundly alters the institutional outcomes even though no player ever makes use of it!

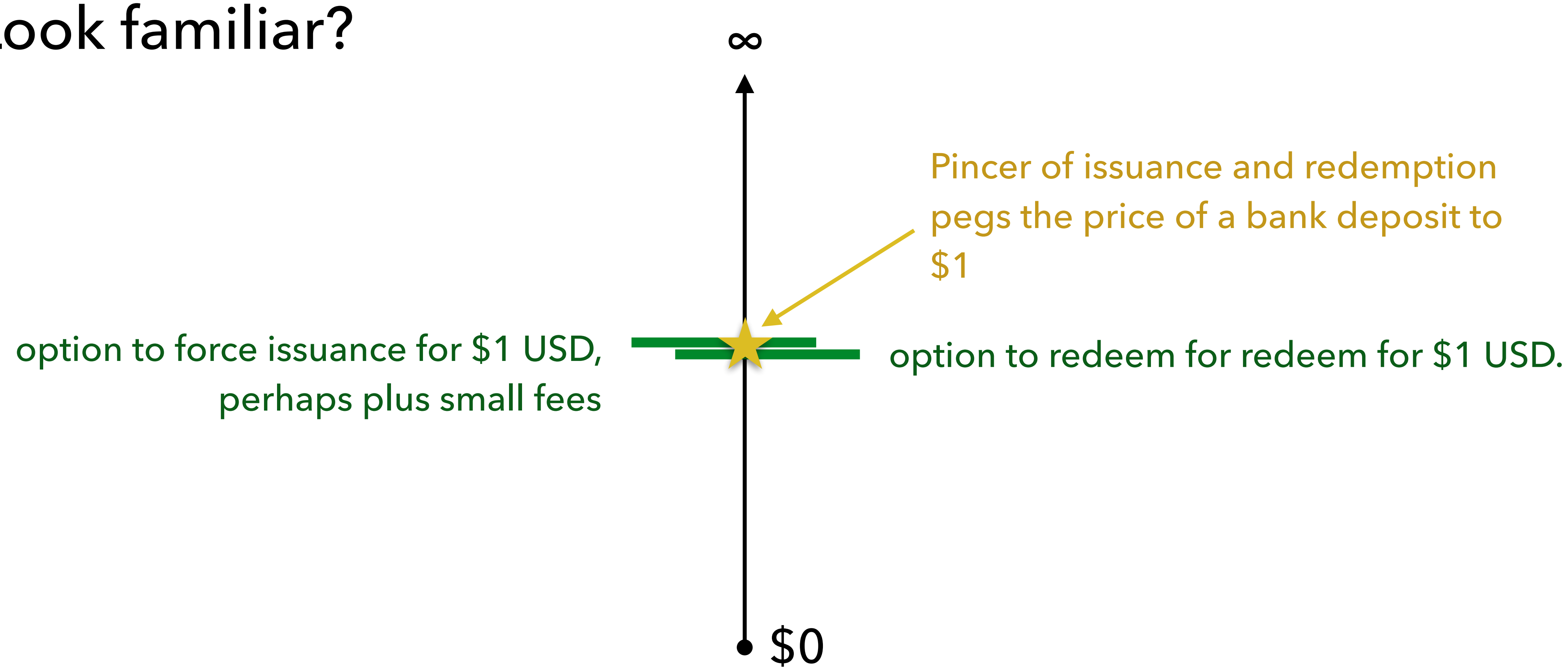
- So a sufficiently credible bluff would do the same thing. There is a reason why banks were built of thick, solid marble and opulently appointed prior to the guarantees now offered by the Fed and the FDIC.

- In real life, we are interested in many player games, not two player arrangements between Alice and Bob.

- With discontinuous equilibria (like our original case), idiosyncratic, random behavior is unlikely to cause a shift. ***Phase changes happen when something coordinates and biases participant behavior.*** If we want stability, we must design to discourage correlated shifts. Bluff well.

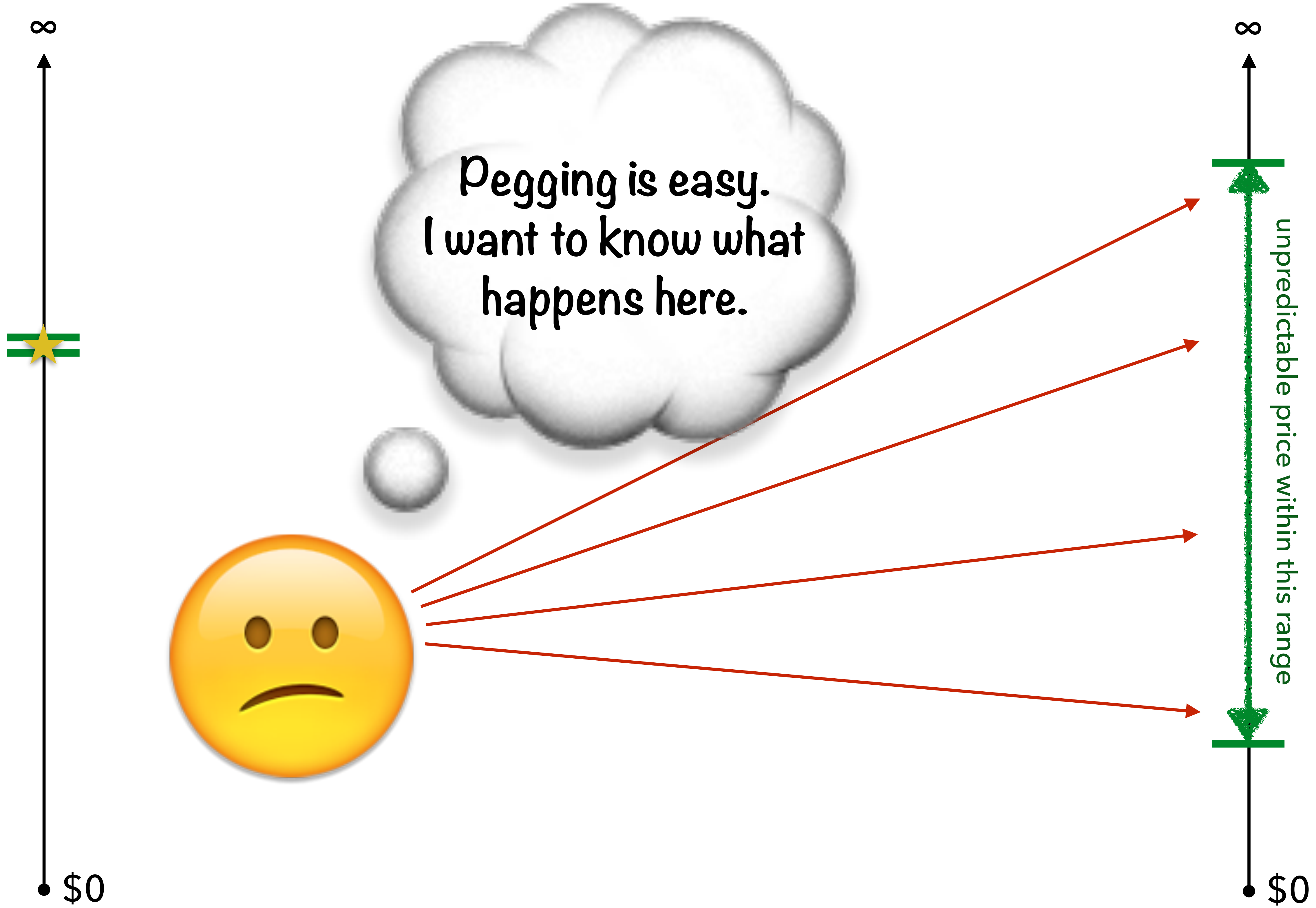
Example: Stabilizing a fractional reserve bank

- Look familiar?

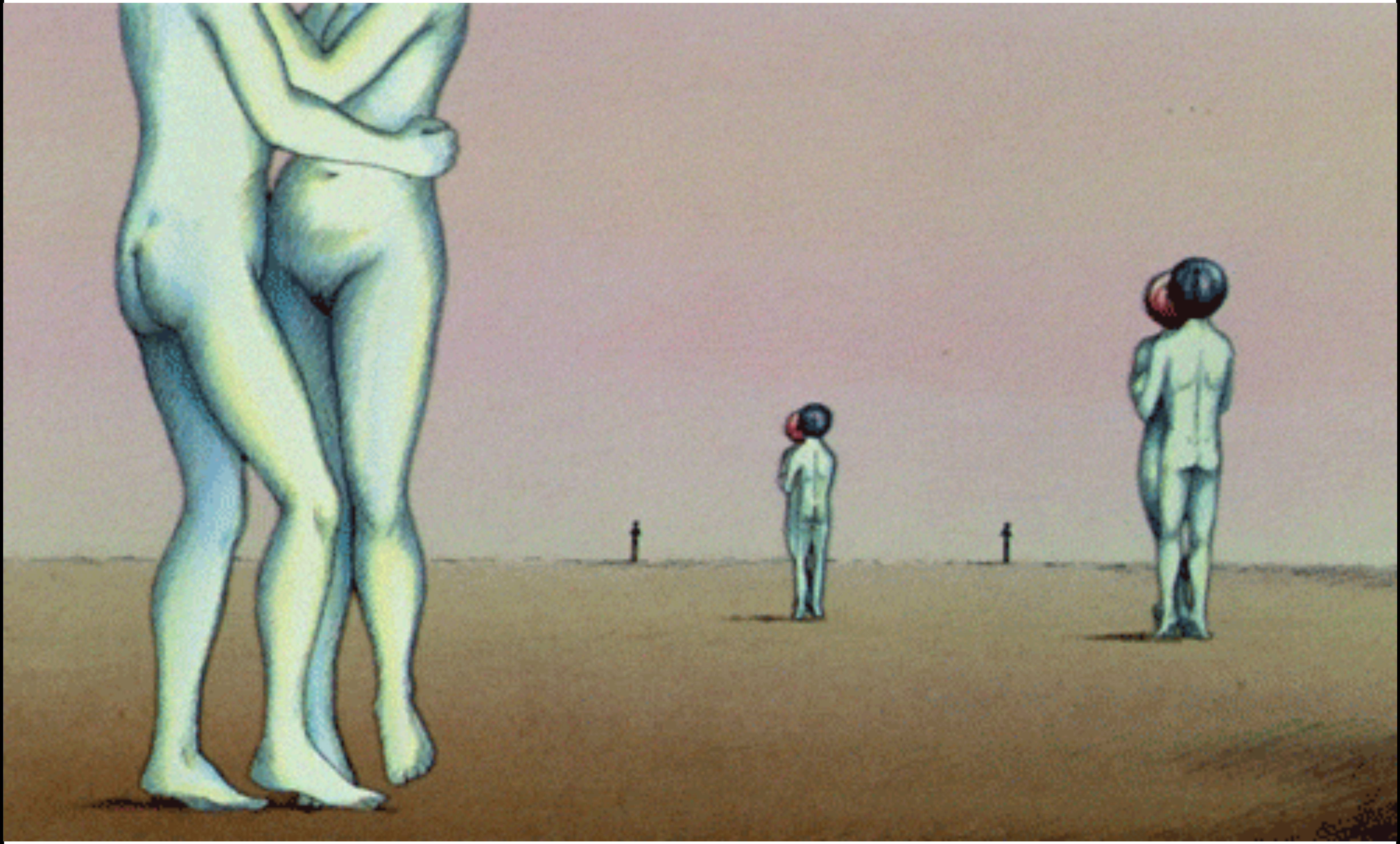


For much of US history, each "dollar" deposit or note from private banks traded at prices less than a dollar of US currency. "Parity", in the lingo, of bank deposits and currency, was a big deal, and is much of the purpose of the modern, Federal Reserve centered banking system. Bank deposits are literally pegged to US dollars, just like an ETF might peg gold. Rather than bearing storage costs to insure redeemability (which would force a negative downward drift like with GLD), banks invest for positive return and let the regulatory state guarantee redemption.

Beyond pegging...



Fantastic Planet *(aka repeated games)*



Source: Film – *Fantastic Planet* (1973), GIF – http://giphy.com/gifs/animation-film-dancing-XCYQ725hhVvJS

Fantastic Planet ***(aka repeated games)***

- Buying and selling your asset represents a repeated game, for which there are a potentially infinite array of Nash Equilibria that your transactors might hit upon, for a while.
- A Nash Equilibrium can be coordinated around any price.
- The price space is effectively continuous, which means equilibria are likely to drift and be unstable.
- More complicated equilibria, including conventions like "greater fool" may arise.
  - Greater fool gets a bum rap, but it is not always an unreasonable game!

Example: Repeated Prisoners' Dilemma

- **Simplifying assumptions:**
  - Discount rate of 0% (we value the future like the present)
  - Credible self-commitment (but no trust required of others)
- **Our players adopt a "grim trigger" strategy**
  - They agree upon a plan in advance
  - If either player ever deviates, forever after the betrayed party foregoes its own welfare to make the betrayer's life as miserable as possible.
  - This is referred to as a "minimax strategy", the betrayed minimizes the maximum achievable welfare of the betrayer.
  - This is an existence proof, not a claim that "grim trigger" is a likely strategy

Example: Repeated Prisoners' Dilemma

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Repeated Prisoners' Dilemma

- All four boxes can contribute to Nash Equilibria:
  - The players can agree never to confess (the optimal outcome)
  - The players can agree to oscillate w.r.t. who confesses
  - The players can not agree at all, or agree then deviate, in which case they then always confess
- Lessons:
  - Repeated games can make almost any "convention" a Nash Equilibrium, if the breakdown of the convention will (by its nature or via credible commitment of other players) leave the deviator much worse off in future rounds.
  - Nothing guarantees the "best" Nash Equilibrium will become conventional!

Biasing chaos:
Fine-grained sculpting of the valuation space

- “Fundamental value” as fuzzy redeemability

1. Suppose our token cannot be redeemed at will, but it confers some sort of benefit on its holder

2. Potential benefits include
   – use value
   – claims to future flows of cash or value
   – claims to assets following some triggering event
   – capacity to extinguish debts, fees, or taxes
   – control rights
   – liquidity benefits

3. If these benefits could be converted to “cash” at will (where cash is whatever currency or numeraire we are measuring value in), we would have simple redemption.

Biasing chaos:
Fine-grained sculpting of the valuation space

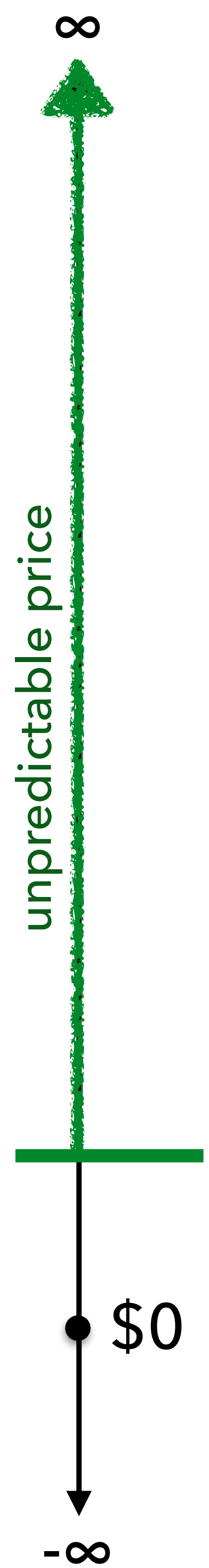
- "Fundamental value" as fuzzy redeemability

4. Typically they cannot be, but they put a kind of fuzzy floor on token values, because no one would sell a token for a price less than the value they put on the nonmarketable bundle of benefits that accompany it.
5. This introduces a ***"meta-valuation" problem***, as to understand the level of the floor, we have to put a value on the bundled sources of value.
6. But since these bundles are not directly marketable, there will be no one, unique valuation. Different people will value them differently, and individuals will have a probabilistic rather than point-estimate understanding of fundamental value.

Note: *A simple redemption option is just an unusually sharp special case of fundamental value!*

Biasing chaos:

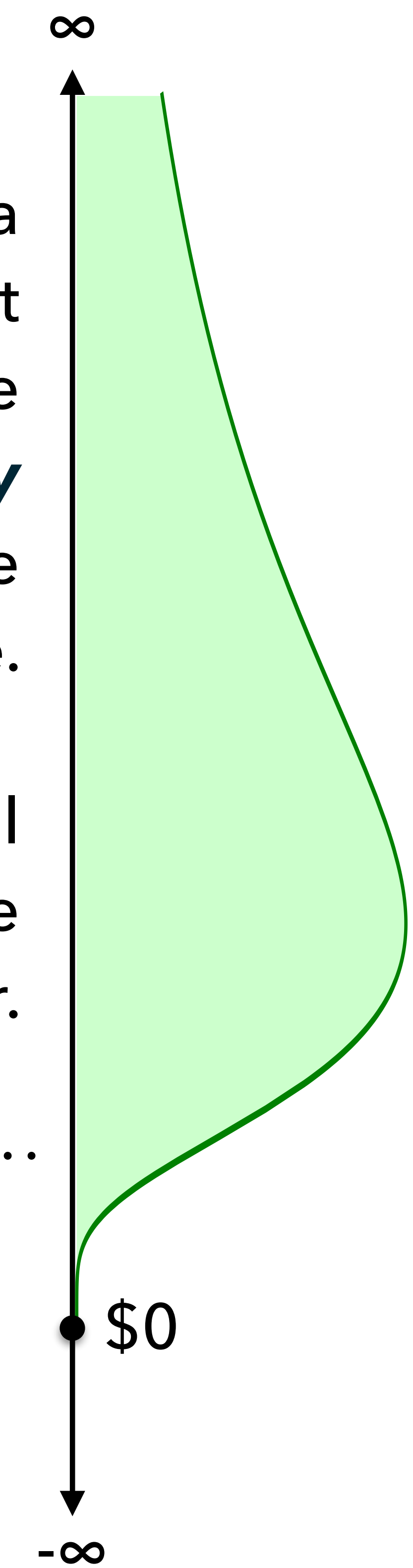
Fine-grained sculpting of the valuation space



Fundamental value puts a "fuzzy" floor beneath asset value, imposes a bias, in the form of a ***probability distribution***, on an otherwise chaotic valuation space.

The greater the fundamental value, the higher the expected floor.

option to **redeem** for $10 becomes a "fuzzy floor" · · · · ·



Sources of fundamental value

- ***Use Value*** – Perhaps tokens can be “redeemed” not for money, but for goods and services offered by the issuing application or entity.

- ***Claims to Future Flows of Cash or Value*** – Perhaps tokens pay interest over time, or dividends that depend upon the success of an application or entity. Payments might be in some other cryptoasset, in traditional fiat, or in “use”, goods and services offered by the issuing application or entity.

- ***Claims to Assets Following Some Triggering Event*** – Perhaps after an activity financed by the cryptoasset has completed, the product of the activity gets distributed *pro rata* to tokenholders. Perhaps in the event of a dissolution or disbanding of an application, unencumbered assets formerly controlled by the application will be distributed to tokenholders.

Sources of fundamental value

- ***Control Rights*** – Perhaps tokens confer a right to vote or participate in control of some application or entity whose behavior is consequencial to potential holders of the asset.

- ***Liquidity benefits*** – Perhaps the asset itself is useful as collateral or in trade, and so reduces costs of borrowing and exchange to its holders.

- ***Capacity to Extinguish Debts, Fees, or Taxes*** – Perhaps by virtue of use of or participation within an application, users incur fee or tax liabilities. Perhaps to exploit Use Value, participants lend and borrow to one another. Perhaps the application imposes consequences that are unpleasant (inability to use, loss of data, exile from the community, meatspace legal enforcement).

  The existence of debtors and unpleasant consequences of nonpayment creates exchange value, since debtors may offer other assets, goods, or services in exchange for the tokens they need to evade the unpleasantness.

Conventional modeling of fundamental value

- Financial assets are generally valued by estimating the cash flows they are expected to produce over time, and summing them, with future cash flows summed at a discount that accounts for time and risk.

$$V = \sum_{t=0}^{\infty} \frac{\mathrm{CF}_i}{(1+r)^t}$$

$$P = \frac{\mathrm{CF}}{r} \qquad P_{\mathrm{growing}} = \frac{\mathrm{CF}_1}{r-g}$$

Conventional modeling of fundamental value

- To the degree that the value provided can be expressed in your valuation numeraire (the currency you want to express your value in), discounted cash flow techniques can be applied to estimating *use value*, *claims to future cash flows or value*, and *claims to assets following triggering events*.

- Conceptually, the ***cryptoequity of a decentralized autonomous corporation is just equity.*** Nothing sexy or new needs to be invented to value it.

- But the techniques that are unsexy and old are imprecise. They leave lots of room for analysts or assetholders to disagree, except for instruments like safe bonds with very predictable cash flows.

- And cryptoassets carry with them some new institutional detail.

Conventional modeling of fundamental value

Cryptoasset valuation will be unusually challenging for the forseeable future:

1. "Cash flows" will often take the form of goods and services or other cryptoassets, which themselves will need to be valued.

2. Most traditional financial assets can be modeled as pure cash-flow sources. The control rights embedded in a share of stock and other institutional details affect the pricing for acquirers and purchasers of large blocks, but are negligible day to day. Many cryptoassets will (hopefully!) entangle assetholding with deep participation in organizations and communities. These aspects of the asset will be hard to value.

3. For institutional and regulatory reasons, it is very difficult to use most traditional financial assets directly for transfers and payments. Cryptoassets can be easily used this way. Liquidity premia are difficult to value. They rely on sometimes faddish and unstable coordination equilibria. This will complicate valuation.

4. Cryptoasset values may be affected by parties trying to settle liabilities which must be settled with the asset rather than "cash settled". Experience with "physically settled" credit default swaps and theories of tax- or debt-driven money suggest this may meaningfully support prices, and contribute to volatility if settlement dates are correlated. There has been very little modeling of these phenomena.

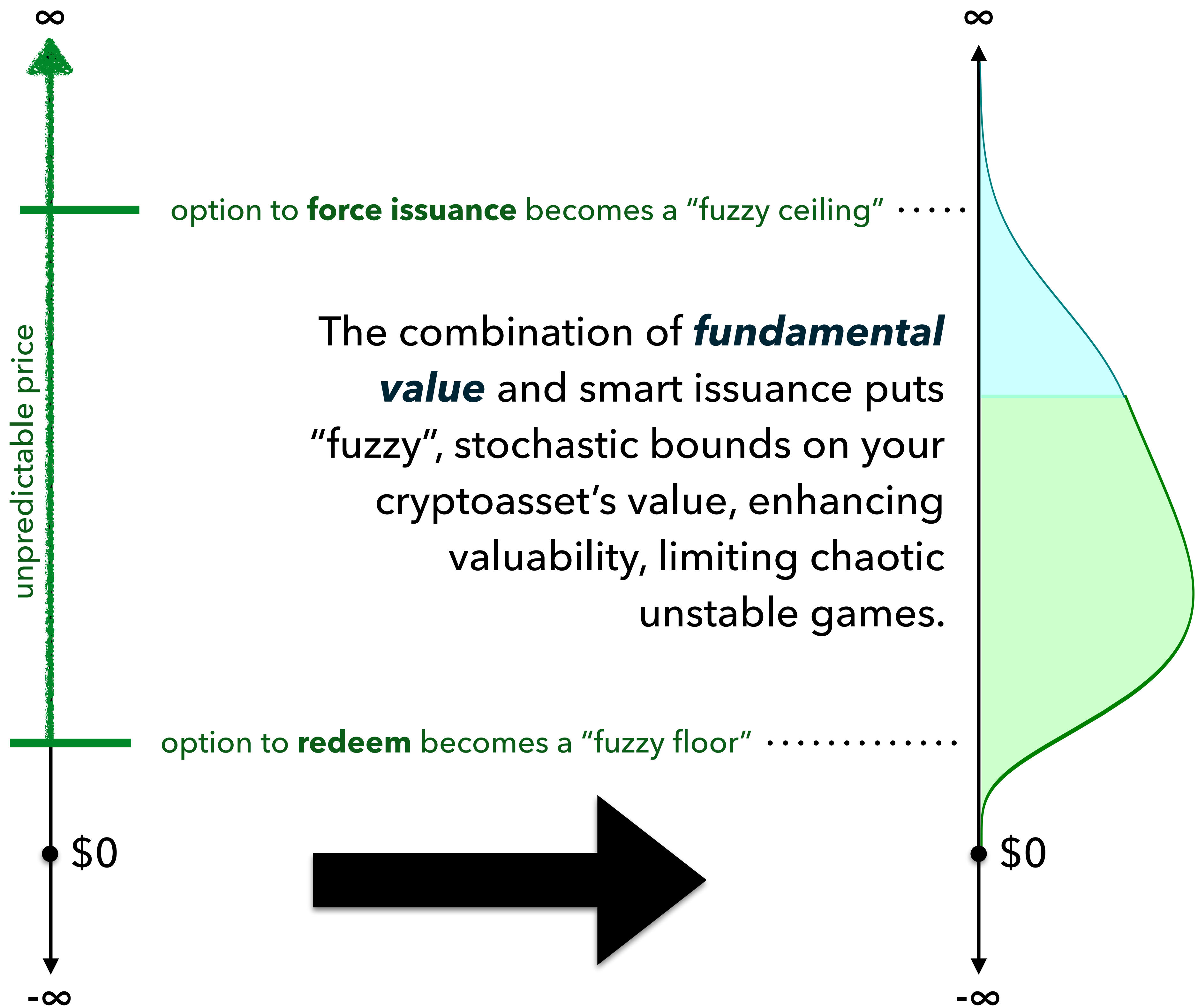
Biasing chaos:
Discretionary or (stochastic) algorithmic issuance

- **Good assets issue when their value grows too high! The sky should not be the limit. If game-theoretic chaos and greater-fool games make an asset too valuable, the asset should issue.**
  - Bubbles and "greater-fool" phenomena can be understood as indefinite-term repeated-game Nash equilibria. Once they arise, it can be perfectly reasonable to participate. They last indefinitely but not infinitely. They always end, with winners and losers. When they do, their collapse usually harms the ecosystem or application in which they arose.

Issuance in the face of overvaluation need not mean "inflation" or "debasing the asset". On the contrary, smart issuance can be value-maximizing for incumbent assetholders.

Biasing chaos:

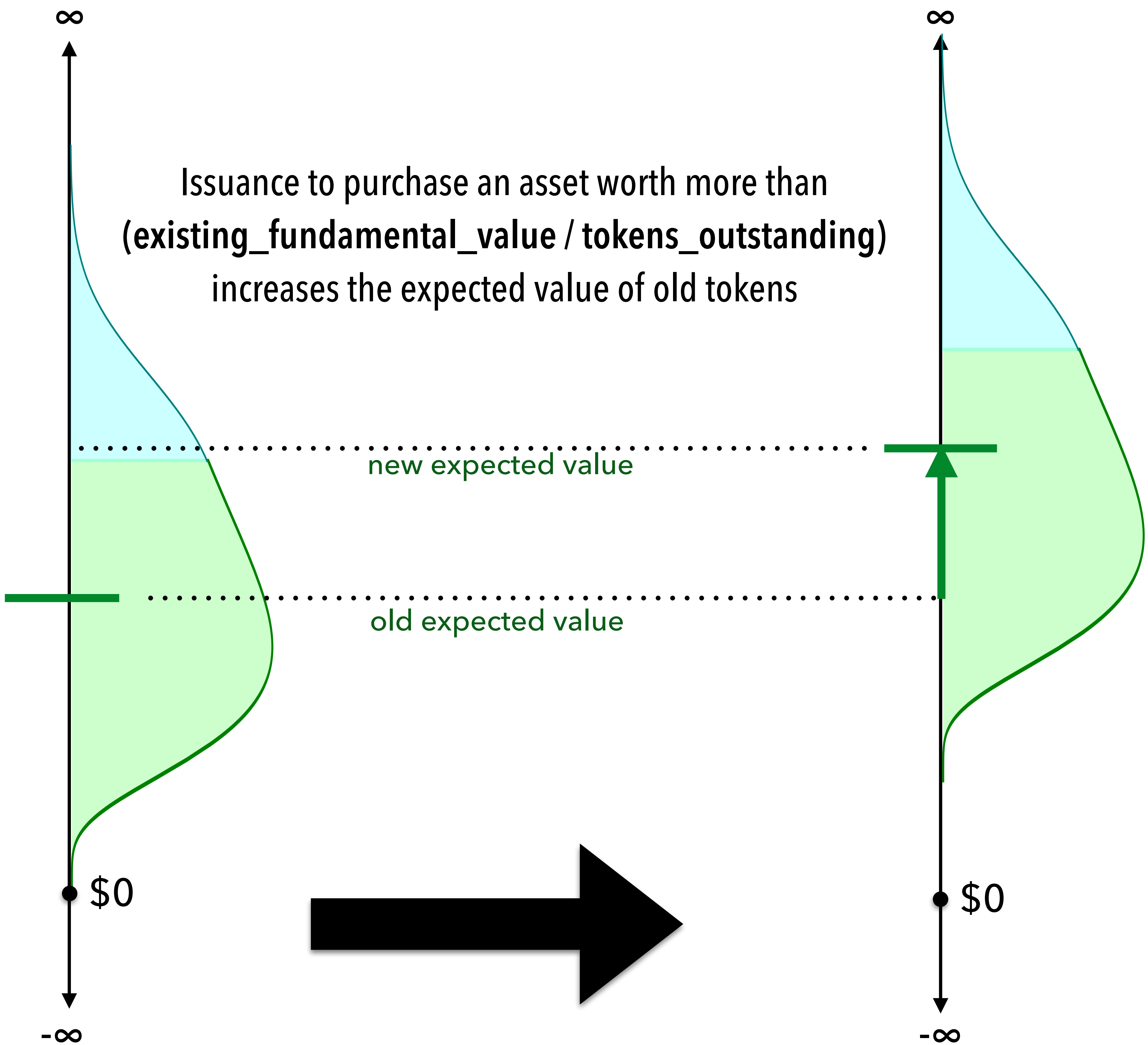
Discretionary or (stochastic) algorithmic issuance



Smart issuance: To whom, for what?

- An issuance policy is desirable to constrain endogenous volatility of the asset price.
- ***Probability of issuance should be a function of price!***
- But issuing claims for nothing to particular parties amounts to extraction of value from the remaining community of assetholders.
- Issuance should either pay for goods that benefit all holders, or intentionally punish particular holders.
- ***If the application or decentralized entity that issues the tokens holds assets or requires services, newly issued tokens should be sold to purchase assets and services whenever doing so is likely to increase the fundamental value of the tokens.***
- If an application requires ongoing participation and maintenance by the community it comprises, issuance to "active" community members for free is a means of punishing those deemed to have undercontributed.
  - *Be sure you mean to punish the people that you punish! They will probably leave if they can!*

Smart issuance: To whom, for what?



An old trick: Think in balance sheets!

- *Every* cryptoasset can be understood as a liability or equity claim against a decentralized organization.

- The right-hand side of a cryptoasset balance sheet is very easy to construct!

- The left-hand side is very difficult to construct, because the sources and quantities of fundamental value must be characterized, and those can usually only be estimated.
  - "Assets" of a DAO may be intangible and have no cost basis

- Nevertheless, the exercise helps us to frame questions of valuation and decisions about issuance.

Case study: Bitcoin

Balance Sheet

Assets		Liabilities + Equity	
			[redacted]
Network for liquidity provision	**$1,830,000,000**	**[redacted]**	**[redacted],806,932,000**
[redacted]		[redacted]	**[redacted]976,932,000**
Tota[redacted]	[redacted]	[redacted]	**[redacted]30,000,000**

THIS IS AN EXERCISE.
IT INCLUDES SIMPLIFICATIONS AND WILDLY QUESTIONABLE ASSUMPTIONS.

DATA WAS CULLED FROM QUESTIONABLE SOURCES. IT IS UNLIKELY TO BE ACCURATE. IT IS JUST AN EXERCISE!

- BT[redacted]at $23[redacted]
  - B[redacted]o ceiling.
  - B[redacted] wi[redacted]
  - Ig[redacted] ma[redacted]
  - At a[redacted]
  - At th[redacted] the v[redacted]
  - BTC i[redacted], paying for nonimproving mainte[redacted]of its holders. For nonminers, **~14% flow growth**[redacted]**be required to justify price @ 8%.** No recent history of that kind of growth
  - An issuance algorithm that sold new BTC for assets attributable to all BTC holders would likely enhance value at current BTC prices.

Case study: Bitcoin

Balance Sheet

Assets		Liabilities + Equity			
			Quantity	**Value**	
Network for liquidity provision	**$1,830,000,000**	**BTC Outstanding**	13,900,000	$273.88	**$3,806,932,000**
		Overvaluation		-$142.23	**-$1,976,932,000**
Total Assets	**$1,830,000,000**	**Liabilities + Equity**		$131.65	**$1,830,000,000**

- BTC has a market cap of $3.8B, with each token currently trading at $233.88. What supports that value?
  - BTC is not redeemable, it has no hard floor. It offers no option to force issuance, so no ceiling.
  - BTC holders enjoy liquidity services, transacting ~$4M per day with counterparties **outside the network** = **$1.46B per year**
  - ***It is very hard to value an asset whose only "fundamental value" source is potentially unstable liquidity provision.***
  - **Ignoring electricity costs**, using **Western-Union-ish order of magnitude market value (10%)** of annual liquidity services flow: **$146M**
  - Presuming stabilty, at an 8% discount rate, no growth, fundamental value is **$1.83B**
  - At the same **8%** hurdle rate with an annual growth rate of **4.2%** the valuation would be justified
  - BTC issues currently at a rate of roughly 10% p.a., paying for nonimproving maintenance to a small subset of its holders. For nonminers, **~14% flow growth would be required to justify price @ 8%.** No recent history of that kind of growth
  - An issuance algorithm that sold new BTC for assets attributable to all BTC holders would likely enhance value at current BTC prices.

Case study: Ethereum

Balance Sheet

Assets		Liabilities + Equity			
			Quantity	**Value**	
Network for trusted computation services	???	**ETH Outstanding**	60,102,216	$0.31	**$18,439,000**
Network for liquidity provision	???				
Total Assets	**???**	**Liabilities + Equity**		$0.31	**$18,439,000**

- ETH has a (time of sale) market cap of $18M, with each token valued at $0.31. What supports that value?
  - ETH is not redeemable for tradable assets, it has no hard floor.
  - ETH offers no option to force issuance, so no ceiling.
  - ETH will provide use value, it will be exchangeable for trusted computation services.
  - ETH can potentially be used as a token for exchange or as collateral, so it may offer liquidity provision services.
  - There is presently insufficient information to make any kind of estimate of the value of these services.
  - ETH will not pay interest or dividends, will not payout to holders on liquidation or other trigger events, is not likely to create or engender in-kind, costly-to-default liabilities, and confers no meaningful control rights on holders. Use value and liquidity provision are the sole sources of value.
  - ETH has no price-sensitive issuance model. It may suffer bubbles and crashes. The application will not be able to capitalize on overvaluation on behalf of incumbent token holders.

Conclusion

- BTC and ETH are not, in fact, very interesting assets to value. Much more interesting will be the tokens people build on top of platforms like Ethereum, tokens whose ***economic valuation must create incentives that coordinate the behavior of decentralized applications and organizations.***

- ***Cryptoasset valuation is not an analytic topic, but matter of design.*** We must design assets which, in the context of the games our participants will play, will take on valuations consistent with the kinds of collaborations we hope our applications will inspire.

Conclusion

- Without constraint, tokens are susceptible to random drift between transiently conventional prices and "greater fool" games that lead to bubbles and crashes. These kinds of assets are ***ultimately "invaluable"***, in the sense that their valuation is path dependent, potentially chaotic, and resistant to prediction or analysis.

- We can "sculpt" the valuation space by imposing constraints on valuation.

- Simple, hard constraints include offering options to purchasers to force new asset issuance at some (potentially variable) price, which imposes a hard ***price ceiling***, and providing a standing offer to redeem assets at a price, which imposes a hard ***price floor***.

Conclusion

- A "soft" price floor can be imposed by endowing assets with "fundamental value" which serves as a kind of fuzzy redeemability. Sources of fundamental value include
  - use value
  - claims to future flows of cash or value
  - claims to assets following some triggering event
  - capacity to extinguish debts, fees, or taxes
  - control rights
  - liquidity benefits We can "sculpt" the valuation space by imposing constraints on valuation
  - redeemability itself
- A soft price ceiling can be imposed by adopting policies, algorithmic or discretionary, that provoke issuance of new assets as prices rise too far into the chaotic space far above reasonable estimates of fundamental value.

Conclusion

- Issuance of new assets, if done smartly, need not imply “inflation” or “debasement”, even from the perspective of existing holders of the asset.
- Every cryptoasset implicitly defines a decentralized organization that can be characterized by balance sheets. The ease and certainty with which a balance sheet can be written provides clues as to how “valuable” – able to be coherently valued – a token is.
- Balance sheets whose asset side value estimates are stubbornly below the market cap of outstanding tokens indicate overvaluation, and suggests that issuing new tokens at market prices to purchase assets or services for the organization will be supportive of value for existing token holders.