

The ‘D’ in DAO? We’ve All Been Getting It Wrong.

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Popular notions of DAO decentralization have left DAO projects flying blind.

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Introduction

Decentralized Autonomous Organizations, or DAOs, promise to revolutionize the ways that communities collaborate. The ‘D’ in DAO — the decentralization — is the critical ingredient. But the way most people in the Web3 community reason about DAO decentralization today is flawed. It fails to point the way toward sound DAO governance.

Today, people commonly view decentralization in DAOs — and other Web3 projects — entirely in terms of how tokens are distributed among addresses

. The [Gini coefficient](#) and [similar measures](#) of wealth inequality — such as entropy of token holdings

— are popular metrics for this purpose. A high Gini coefficient over addresses in a DAO is “bad”: It means high concentration — dominant control by whales and other large holders. A low Gini coefficient, on the other hand, is “good,” indicating even distribution of tokens.

[Our new research](#) shows that there are gaping blind spots in this view of DAO decentralization. Happily, we also show that it’s possible to do better.

Problems With the Gini View of Addresses

Consider two hypothetical DAOs, called MinnowDAO and WhaleDAO. Both have issued a total of 100 tokens. In MinnowDAO, 100 addresses each hold 1 token apiece. In WhaleDAO, 5 addresses each hold 20 tokens. Which DAO is more decentralized?

You’d probably say MinnowDAO. After all, its tokens are more widely distributed among addresses than those in WhaleDAO (and its Gini coefficient is lower). But that may be wrong.

On any blockchain, a single owner

can control multiple addresses

. So it’s possible that most or all of MinnowDAO’s tokens are actually controlled by one big whale. MinnowDAO might have a low Gini coefficient but be entirely centralized.

Even if MinnowDAO really does have 100 distinct token-holders, that still doesn’t mean that it’s truly decentralized. For example, suppose MinnowDAO does majority voting with no minimum participation, but 99 voters in MinnowDAO never vote. A single voter

in MinnowDAO can then pass a proposal. Again, there’s a low Gini coefficient — apparently equality — but the DAO is largely centralized.

A Fresh Perspective

Our research introduces a new measurement of DAO decentralization called voting-bloc entropy

(VBE, pronounced “vibe”).

Imagine that users in a DAO are clustered into groups of like-minded voters, often called voting blocs

. You can think of them as “virtual” political parties. Informally, VBE measures how token holdings are concentrated among voting blocs, instead of across individual accounts. Conceptually, it’s like the Gini coefficient, but it takes voting blocs into account.

Clustering voters into blocs gives a more accurate perspective on voting power distribution. For instance, if there’s a hidden

whale, as in our first example, that amounts to one big centralized voting block. VBE tells us that the DAO has poor decentralization.

In more detail, VBE is underpinned by two key ingredients: (1) a clustering function

, which specifies how the set of token holders are partitioned into voting blocs; and (2) an entropy metric

, which then measures how “evenly distributed” tokens are across said blocs, and thus what the total VBE of the system is. Importantly, VBE is, in fact, a framework: it is agnostic to a specific choice of clustering and entropy functions, and can be instantiated with any suitable choice.

To partition players into blocs, the clustering step is based on the utility functions

of the token holders, which formalizes the notion of like-minded voters described above. Utility functions are latent variables — conceptually important, but not always directly measurable — and consequently VBE is as well. However, latent VBE

serves as a conceptual tool to reason about the directional influence of policy choices in decentralization

. Further, it can be measured indirectly

, via observable variables

that do lend themselves to direct measurement — such as historical voting data — which yields what we refer to as “observable” VBE (oVBE); unlike its latent counterpart, oVBE is

directly measurable.

Different variants of VBE will correlate better or worse with oVBE. In our paper, we propose one concrete instantiation of our framework, for which oVBE is a very good estimate of the “true” VBE of the system. Towards this, we define a bespoke clustering function that, roughly, assigns token holders to the same cluster if, for every election in some period of time, they both preferred the same outcome (or both were apathetic), i.e., if their utilities for that election were both positive, negative, or close to zero. Then, we combine this clustering function with min-entropy

, to yield our instantiation of VBE. Assuming that players are rational actors, it follows then that clustering based on historical voter data (oVBE) is essentially equivalent to clustering based on preferences (VBE), since a casted vote is a good indicator of the direction of a voter’s utility.

We hope that this variant (or a similar one, for which oVBE is a good estimate) will form the basis for new standards within the DAO community

.

Three Surprising Lessons About DAOs

With its deeper perspective on DAO decentralization, VBE offers counterintuitive new insights that don’t surface if you only consider token holdings. Three lessons stand out.

Lesson 1: DAOs should enable private voting

: Today, DAO votes are often [public](#): It’s possible to tell how someone voted. But DAO members [worry about reputation](#) and consequently tend to vote in alignment with whales or the community as a whole, causing higher centralization. Making ballots [private](#) reduces the reputational concerns, supporting decentralization.

Lesson 2: DAOs should support delegation.

Many people argue that delegation is [bad for decentralization](#), because it makes whales bigger. But in most DAOs today, voters [tend not to vote](#). They form an “inactivity whale” that may be bigger than the actual whales in the DAO. A VBE-informed perspective shows that delegation can break up this inactivity whale, actually improving

decentralization. So unless DAO voters are unusually active, delegation is helpful.

Lesson 3: DAOs need to worry about vote-buying.

When a DAO is highly centralized, a few whales call the shots. That’s generally the case today. But as DAOs become more heavily decentralized, the outcome of a vote may depend on a large number of smallholders. This is good, but our research through the lens of VBE shows that it raises the specter of systemic vote-buying

, especially through [Dark DAOs](#).

Conclusion

It’s early days for DAOs. The vast majority today are controlled by whales and exhibit [low decentralization](#), whatever metric you use. But the landscape is improving and decentralization in many DAOs is increasing. VBE is far from the be-all and

end-all of decentralization metrics, but it points a way forward with concrete guidance around governance. As researchers continue to probe the meaning of decentralization, we hope to see DAOs embrace the resulting lessons about how they can truly earn their 'D.'

We'll be following up soon with a second blog post on Dark DAOs.

To learn more, see our recently released paper, "[DAO Decentralization: Voting-Bloc Entropy, Bribery, and Dark DAOs](<https://arxiv.org/abs/2311.03530>)."

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