

# Is decentralized finance actually decentralized? A social network analysis of the Aave protocol on the Ethereum blockchain

COMP7860 Project Final Presentation

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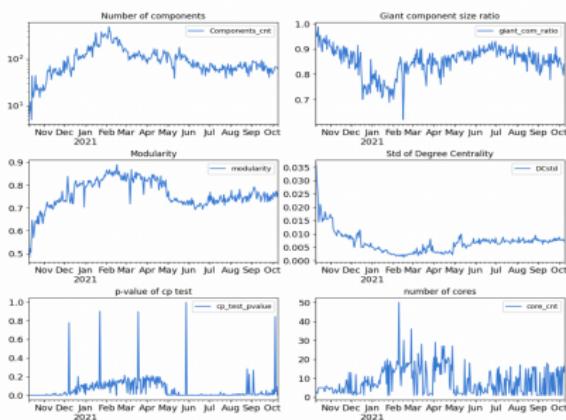
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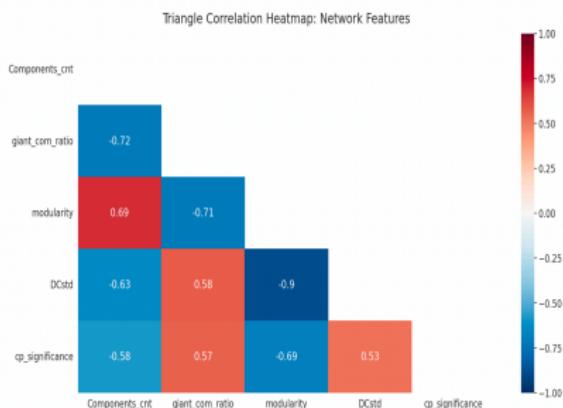
# Replication of Original Work

## Replication of Result 1:

Result 1: Defining decentralization via network measures	Replication
1. Correlation Heatmap of network features	<b>Result holds</b>
2. Time-series Plots of network features	<b>Result holds</b>



(a) Time-series Plots of network features

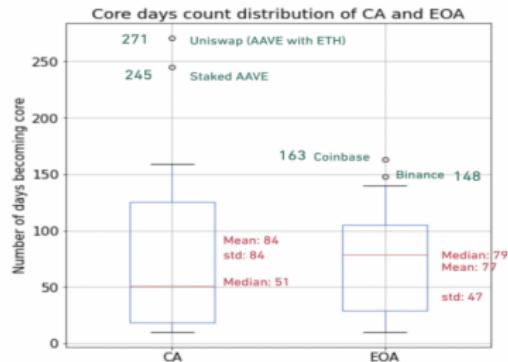


(b) Correlation Heatmap of network features

# Replication of Original Work Cont.

## Replication of Result 2:

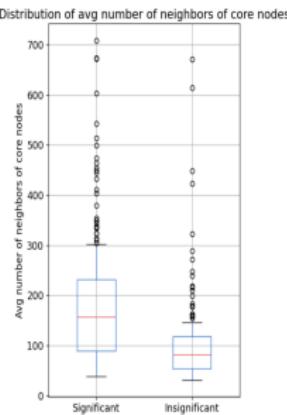
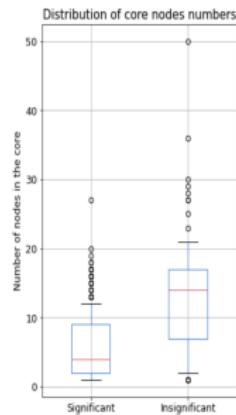
Result 2: Core Periphery Structure	Replication
1.Core days count distribution of CA and EOA	Result holds
2.Distribution of core nodes number	Result holds
3.Distribution of avg number of neighbors of core nodes	Result holds
4.Network graphs on significant and insignificant day	Result holds



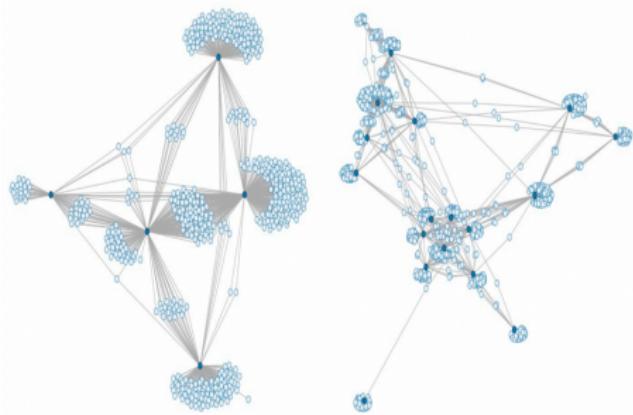
(c) Core days count distribution of CA and EOA

# Replication of Original Work Cont.

## Replication of Result 2:



(d) Core days count distribution of CA and EOA



(e) Network graphs on 2020-10-12 (left) and 2021-02-22 (right)

# Replication of Original Work Cont.

## Replication of Result 3:

Result 3: Counterfactual impact evaluation	Replication
1. Results of the token market returns (USD)	Result holds
2. Results of the 30-day volatility growth rate	Result holds

Table 1: Results of the token market returns (USD)

Time horizon	t, t+1	t, t+7	t, t+14	t, t+21	t, t+28	t, t+35	t, t+42	t, t+49	t, t+56	t, t+90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ component cnt	-0.015	0.113	0.281**	0.423***	0.342***	0.318***	0.261**	0.293**	0.320**	0.258**
R <sup>2</sup>	0	0.007	0.029	0.047	0.037	0.033	0.021	0.025	0.025	0.017
Residual Std. Error	(0.129)	(0.132)	(0.163)	(0.192)	(0.178)	(0.177)	(0.185)	(0.192)	(0.213)	(0.221)
Δ giant com ratio	0.024	-0.028	-0.086	-0.188*	-0.212*	-0.144	-0.176	-0.377**	-0.442***	-0.332***
R <sup>2</sup>	0	0.001	0.003	0.012	0.017	0.008	0.011	0.049	0.056	0.032
Residual Std. Error	(0.129)	(0.132)	(0.165)	(0.195)	(0.180)	(0.179)	(0.186)	(0.190)	(0.209)	(0.219)
Δ log(modularity)	0.011	0.059	0.089	0.278***	0.288***	0.212**	0.239**	0.351***	0.368**	0.592***
R <sup>2</sup>	0	0.003	0.004	0.027	0.039	0.019	0.023	0.046	0.041	0.108
Residual Std. Error	(0.129)	(0.132)	(0.165)	(0.194)	(0.179)	(0.178)	(0.185)	(0.190)	(0.211)	(0.211)
Δ log(Dstd)	0.018	0.005	-0.082	-0.217***	-0.268***	-0.220***	-0.220***	-0.267**	-0.257*	-0.337***
R <sup>2</sup>	0	0	0.004	0.021	0.037	0.026	0.025	0.034	0.026	0.046
Residual Std. Error	(0.129)	(0.132)	(0.165)	(0.195)	(0.178)	(0.178)	(0.185)	(0.191)	(0.212)	(0.218)
cp significance	-0.014	-0.090**	-0.163***	-0.278***	-0.322***	-0.324**	-0.314*	-0.188	0.056	1.834***
R <sup>2</sup>	0.007	0.031	0.039	0.061	0.049	0.028	0.018	0.005	0	0.124
Residual Std. Error	(0.080)	(0.242)	(0.391)	(0.528)	(0.718)	(0.931)	(1.138)	(1.269)	(1.351)	(2.432)
PCA component1	0.024	0.047*	0.063**	0.097***	0.076**	0.059*	0.045	0.018	-0.033	-0.236***
PCA component2	-0.015	-0.117	-0.196	-0.401***	-0.332***	-0.279***	-0.266**	-0.249**	-0.256**	-0.651***
PCA component3	0.056	0.228***	0.400***	0.575**	0.487***	0.438***	0.435***	0.459**	0.469***	0.561***
R <sup>2</sup>	0.011	0.107	0.194	0.3	0.252	0.202	0.177	0.172	0.146	0.42
Residual Std. Error	(0.129)	(0.126)	(0.149)	(0.165)	(0.158)	(0.161)	(0.170)	(0.178)	(0.200)	(0.170)

Note: This table reports the results of predicting the future market return (USD) using the 7-day moving average of network variables (except cp significance). Columns [1]-[10] represent one day, one week to eight weeks, and 90 days respectively. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels. The data frequency is daily. The residual standard errors are reported in parentheses.

### (f) Results of the token market returns (USD)

Table 2: Results of the 30-day volatility growth rate

Time horizon	t, t+1	t, t+7	t, t+14	t, t+21	t, t+28	t, t+35	t, t+42	t, t+49	t, t+56	t, t+90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ component cnt	0.062	0.300***	0.294**	0.349**	0.348**	0.223	0.164	0.155	0.045	-0.279**
R <sup>2</sup>	0.005	0.04	0.026	0.025	0.021	0.008	0.005	0.005	0	0.022
Residual Std. Error	(0.085)	(0.151)	(0.185)	(0.226)	(0.253)	(0.264)	(0.237)	(0.246)	(0.219)	(0.221)
Δ giant com ratio	-0.022	-0.041	-0.017	0.01	-0.043	-0.034	-0.061	-0.106	-0.079	0.049
R <sup>2</sup>	0.000	0.003	0	0	0	0	0.001	0.003	0.001	0.001
Residual Std. Error	(0.085)	(0.154)	(0.187)	(0.229)	(0.255)	(0.265)	(0.238)	(0.237)	(0.246)	(0.221)
Δ log(modularity)	-0.013	-0.036	-0.128	-0.277**	-0.280*	-0.338**	-0.249**	-0.137	-0.131	-0.082
R <sup>2</sup>	0	0.001	0.008	0.024	0.02	0.027	0.018	0.006	0.005	0.003
Residual Std. Error	(0.085)	(0.151)	(0.187)	(0.226)	(0.253)	(0.262)	(0.238)	(0.237)	(0.245)	(0.221)
Δ log(Dstd)	-0.041	-0.162*	0.016	0.128	0.16	0.232	0.153	-0.036	-0.022	0.2
R <sup>2</sup>	0.004	0.018	0	0.005	0.007	0.013	0.007	0	0	0.017
Residual Std. Error	(0.085)	(0.152)	(0.187)	(0.228)	(0.254)	(0.263)	(0.237)	(0.237)	(0.246)	(0.219)
cp significance	-0.002	-0.028	-0.056**	-0.122**	-0.210***	-0.294***	-0.364***	-0.412***	-0.425***	-0.431***
R <sup>2</sup>	0.000	0.01	0.02	0.038	0.068	0.103	0.131	0.152	0.152	0.191
Residual Std. Error	(0.043)	(0.137)	(0.233)	(0.315)	(0.384)	(0.432)	(0.467)	(0.485)	(0.500)	(0.444)
PCA component1	0.007	0.03	0.036	0.072*	0.136**	0.191***	0.217**	0.252***	0.267***	0.307***
PCA component2	0.035	-0.004	-0.196	-0.271	-0.286	-0.280*	-0.141	-0.019	0.009	0.441***
PCA component3	0.025	0.132*	0.220**	0.202*	0.066	-0.109	-0.291*	-0.468***	-0.573***	-0.831***
R <sup>2</sup>	0.008	0.031	0.044	0.05	0.076	0.124	0.184	0.257	0.299	0.508
Residual Std. Error	(0.085)	(0.152)	(0.184)	(0.224)	(0.246)	(0.249)	(0.215)	(0.205)	(0.207)	(0.156)

Note: This table reports the results of predicting the 30-day volatility growth rate using the 7-days moving average of network variables (except cp significance). Columns [1]-[10] represent one day, one week to eight weeks, and 90 days respectively. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels. The data frequency is daily. The residual standard errors are reported in parentheses.

### (g) Results of the 30-day volatility growth rate

# Summary of Replication

- Source code is not complete for all required results
- GitHub repository does not have any instructions on package version and programming environment details

# Construction of New Data

- **Transaction Data:** Kaggle's public dataset BigQuery integration

The screenshot shows a Kaggle notebook interface. At the top, there is a navigation bar with a profile icon, the text "GOOGLE BIGQUERY AND 2 COLLABORATORS · UPDATED 4 YEARS AGO", a progress bar indicating "189", a "New Notebook" button, and three more icons. Below the header, the title "Ethereum Blockchain" is displayed in a large, bold, dark font. A subtitle "Complete live historical Ethereum blockchain data (BigQuery)" follows. To the right of the title is a small image of two Ethereum coins. The main content area contains a table with columns "Data", "Code (39)", and "Discussion (8)".

## About Dataset

### Context

Bitcoin and other cryptocurrencies have captured the imagination of technologists, financiers, and economists. Digital currencies are only one application of the underlying blockchain technology. Like its predecessor, Bitcoin, the Ethereum blockchain can be described as an immutable distributed ledger. However, creator Vitalik Buterin also extended the set of capabilities by including a virtual machine that can execute arbitrary code stored on the blockchain as smart contracts.

### Usability

7.06

### License

CC0: Public Domain

### Expected update frequency

Not specified

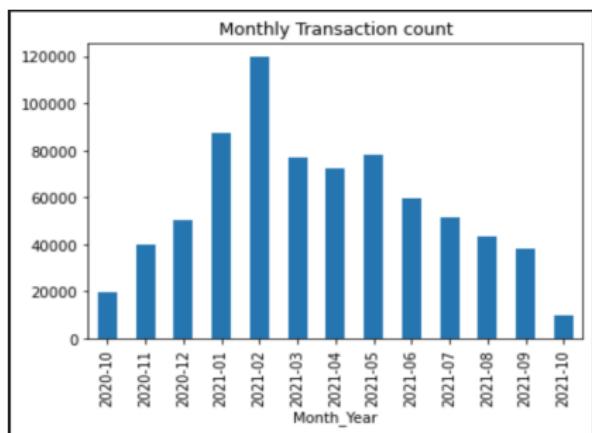
## (h) Ethereum Blockchain Token Transaction Data

\*\*The time period of existing data is 10/10/2020 - 09/10/2021, the period of new data will be 10/07/2021 - 09/07/2022

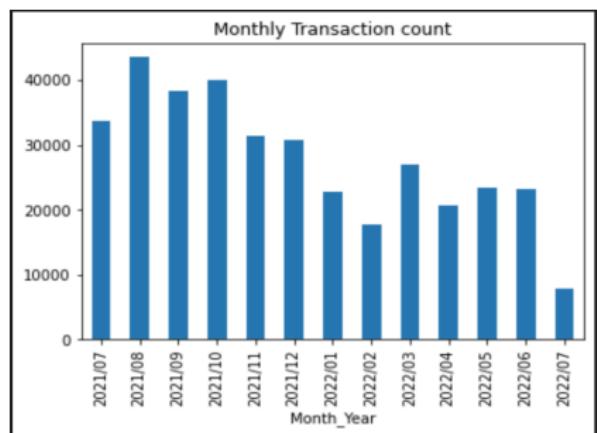


# Analysis results using New Datasets

## Monthly Transaction Comparison between Existing and New Datasets



(j) Monthly transaction count on existing datasets



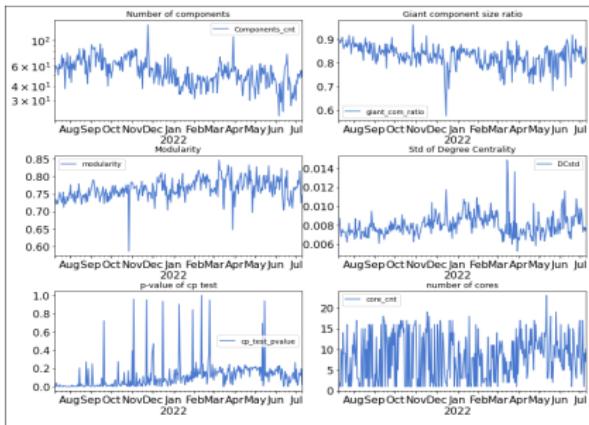
(k) Monthly transaction count on new datasets

# Analysis results using New Datasets

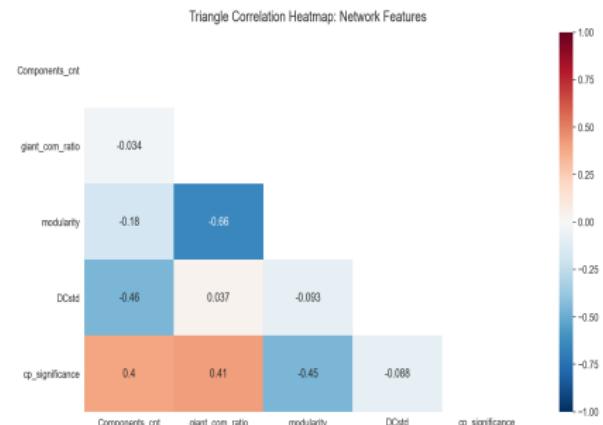
## Result 1 on New Datasets:

### Result 1: Defining decentralization via network measures

1. Correlation Heatmap of network features
2. Time-series Plots of network features



(l) Time-series Plots of network features



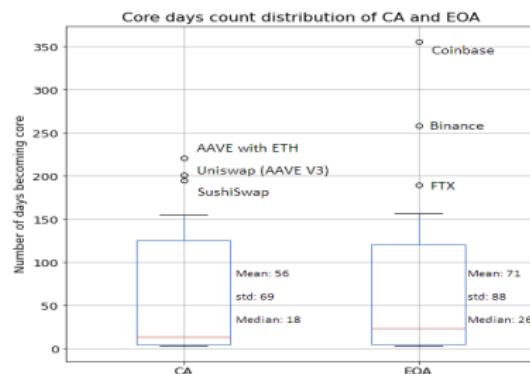
(m) Correlation Heatmap of network features

# Analysis results using New Datasets Cont.

## Result 2 on New Datasets

### Result 2: Core Periphery Structure

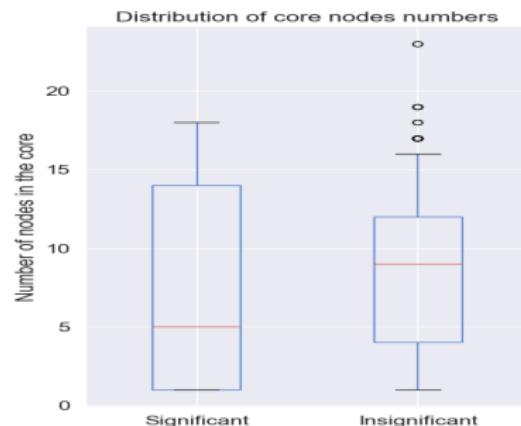
- 1.Core days count distribution of CA and EOA
- 2.Distribution of core nodes number
- 3.Distribution of avg number of neighbors of core nodes
- 4.Network graphs on significant and insignificant day



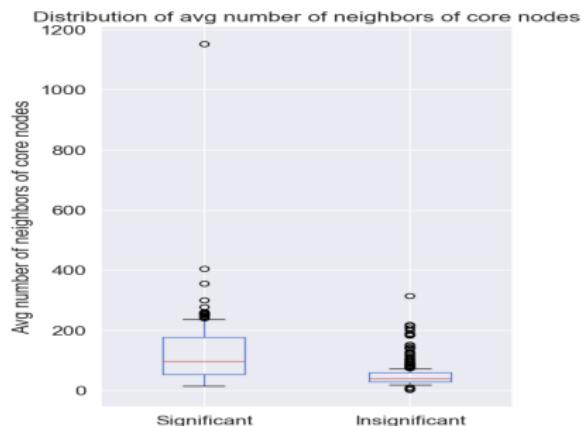
(n) Core days count distribution of CA and EOA

# Analysis results using New Datasets Cont.

## Result 2 on New Datasets Cont.



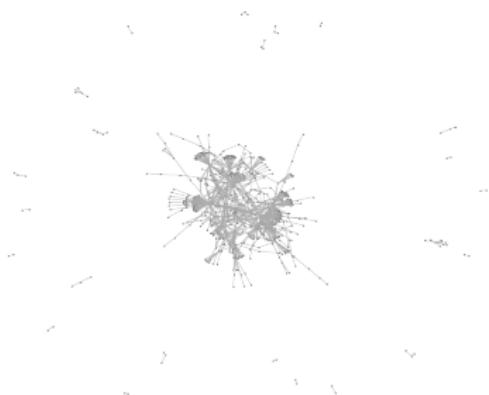
(o) Distribution of core nodes numbers



(p) Distribution of average number of neighbors of core nodes

# Analysis results using New Datasets Cont.

## Result 2 on New Datasets Cont.



(q) Network graph on 2021-08-08 (left)



(r) Network graph on 2022-03-14 (left)

# Analysis results using New Datasets Cont.

## Result 3 on New Datasets Cont.

### Result 3: Counterfactual impact evaluation

1. Results of the token market returns (USD)
2. Results of the 30-day volatility growth rate

Table 1: Results of the token market returns (USD)

Time horizon	t, t+1	t, t+7	t, t+14	t, t+21	t, t+28	t, t+35	t, t+42	t, t+49	t, t+56	t, t+90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ component cnt	-0.066	0.141	0.092	0.172	0.139	0.126	0.015	-0.015	0.107	0
R <sup>2</sup>	0.003	0.007	0.003	0.01	0.006	0.004	0	0	0.003	0
Residual Std. Error	[0.126]	[0.172]	[0.181]	[0.177]	[0.185]	[0.202]	[0.195]	[0.204]	[0.191]	[0.201]
Δ giant com ratio	0.065	-0.107	-0.162	-0.132	-0.124	-0.17	-0.021	-0.13	-0.216*	-0.199*
R <sup>2</sup>	0.003	0.005	0.01	0.007	0.005	0.008	0	0.005	0.015	0.011
Residual Std. Error	[0.126]	[0.173]	[0.181]	[0.177]	[0.185]	[0.202]	[0.195]	[0.203]	[0.190]	[0.200]
Δ log(modularity)	-0.076	0.109	0.152	0.164	0.052	0.025	0.045	0.053	0.144	0.223
R <sup>2</sup>	0.003	0.003	0.006	0.007	0.001	0	0	0.001	0.005	0.011
Residual Std. Error	[0.126]	[0.173]	[0.181]	[0.177]	[0.185]	[0.203]	[0.195]	[0.204]	[0.191]	[0.200]
Δ log(DCstd)	0.073	-0.063	-0.034	-0.068	-0.237	-0.042	0.009	-0.01	-0.087	-0.015
R <sup>2</sup>	0.003	0.001	0	0.001	0.016	0	0	0	0.002	0
Residual Std. Error	[0.126]	[0.173]	[0.181]	[0.178]	[0.184]	[0.203]	[0.195]	[0.204]	[0.192]	[0.201]
cp significance	0.007	0.038*	0.072**	0.099***	0.103**	0.099**	0.108**	0.071*	0.051	0.056
R <sup>2</sup>	0.003	0.011	0.022	0.028	0.027	0.026	0.027	0.015	0.008	0.016
Residual Std. Error	[0.064]	[0.176]	[0.237]	[0.291]	[0.304]	[0.301]	[0.296]	[0.285]	[0.278]	[0.221]
PCA component1	0.019	0.046*	0.060**	0.063**	0.060*	0.060*	0.059*	0.038	0.023	0.046
PCA component2	0.04	-0.103	-0.088	-0.079	-0.018	0.124	0.164	0.127	0.133	0.358***
PCA component3	0.017	0.13	0.152	0.074	0.004	0.143	0.174	0.199	0.156	-0.042
R <sup>2</sup>	0.006	0.025	0.031	0.028	0.019	0.028	0.038	0.024	0.015	0.07
Residual Std. Error	[0.127]	[0.171]	[0.179]	[0.176]	[0.184]	[0.201]	[0.192]	[0.202]	[0.191]	[0.195]

Note: This table reports the results of predicting the future market return (USD) using the 7-day moving average of network variables (except cp significance). Columns (1)-(10) represent one day, one week to eight weeks, and 90 days respectively. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels. The data frequency is daily. The residual standard errors are reported in

Table 2: Results of the 30-day volatility growth rate

Time horizon	t, t+1	t, t+7	t, t+14	t, t+21	t, t+28	t, t+35	t, t+42	t, t+49	t, t+56	t, t+90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ component cnt	-0.001	0.075	-0.076	0.021	0.07	0.024	0.088	-0.028	-0.025	-0.061
R <sup>2</sup>	0	0.002	0.002	0	0	0.001	0	0.002	0	0.001
Residual Std. Error	[0.094]	[0.183]	[0.192]	[0.227]	[0.220]	[0.217]	[0.206]	[0.202]	[0.209]	[0.223]
Δ giant com ratio	0.041	-0.109	0.032	0.066	0.018	-0.021	-0.026	-0.019	0.05	0.066
R <sup>2</sup>	0.002	0.004	0	0.001	0	0	0	0.001	0	0.001
Residual Std. Error	[0.094]	[0.183]	[0.192]	[0.227]	[0.221]	[0.217]	[0.207]	[0.202]	[0.209]	[0.223]
Δ log(modularity)	-0.015	0.057	-0.026	-0.003	-0.007	0.077	0.055	0.012	-0.034	-0.023
R <sup>2</sup>	0	0.001	0	0	0	0.001	0.001	0	0	0
Residual Std. Error	[0.094]	[0.183]	[0.192]	[0.227]	[0.221]	[0.217]	[0.207]	[0.202]	[0.209]	[0.223]
Δ log(DCstd)	-0.093	-0.231**	-0.033	-0.051	-0.049	0.008	0.042	-0.017	0.001	-0.061
R <sup>2</sup>	0.009	0.015	0	0	0	0	0	0	0	0.001
Residual Std. Error	[0.094]	[0.182]	[0.192]	[0.227]	[0.220]	[0.217]	[0.207]	[0.202]	[0.209]	[0.223]
cp significance	0	-0.030*	-0.051*	-0.055	-0.059	-0.068	-0.068	-0.088	-0.095*	-0.211***
R <sup>2</sup>	0	0.012	0.014	0.01	0.008	0.008	0.007	0.009	0.012	0.065
Residual Std. Error	[0.047]	[0.133]	[0.210]	[0.275]	[0.331]	[0.367]	[0.395]	[0.421]	[0.427]	[0.401]
PCA component1	0	-0.044	-0.044	-0.039	-0.035	-0.035	-0.027	-0.034	-0.04	-0.130***
PCA component2	-0.001	-0.159**	-0.105	-0.226**	-0.251**	-0.247**	-0.161*	-0.151	-0.137	
PCA component3	0.016	0.03	0.017	0.04	0.086	0.133	0.079	0.039	0.039	0.342*
R <sup>2</sup>	0.001	0.025	0.015	0.025	0.031	0.032	0.023	0.017	0.017	0.088
Residual Std. Error	[0.095]	[0.181]	[0.191]	[0.225]	[0.218]	[0.214]	[0.205]	[0.200]	[0.208]	[0.214]

Note: This table reports the results of predicting the 30-day volatility growth rate using the 7-days moving average of network variables (except cp significance). Columns (1)-(10) represent one day, one week to eight weeks, and 90 days respectively. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels. The data frequency is daily. The residual standard errors are reported in parentheses.

- (s) Results of the token market returns (USD)
- (t) Results of the 30-day volatility growth rate

# References

[1].

- [1] Ziqiao Ao, Gergely Horvath, and Luyao Zhang. Are decentralized finance really decentralized? a social network analysis of the aave protocol on the ethereum blockchain, 2022.

# Thank you!