THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Do Users of Blockchain IT Infrastructure Value Environmental Sustainability? Evidence from Environmental Impact Disclosures

Presenter: Bruce Si Yuan Jin

Joint work with Allen H. Huang, Kar Yan Tam*, Zitong Li

April 10, 2024

Background

Figure: Centralized Data Platform

Background

Figure: Centralized Data Platform

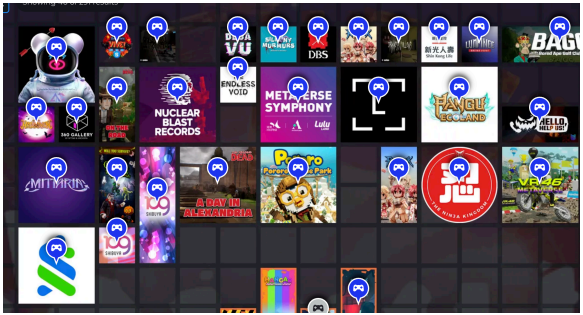


Figure: Decentralized Data Platform

Background

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Definition: Blockchain

Decentralized database (securely and consistently records and verifies data across a decentralized network. (Hua et al., 2019; Sarker et al., 2021))

[1] HKMA establishes a regulatory environment for tokens

Background

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Definition: Blockchain

Decentralized database (securely and consistently records and verifies data across a decentralized network. (Hua et al., 2019; Sarker et al., 2021))

Definiton: Token

Digital ownership of both virtual and physical assets. (Bauer et al., 2022; Ziolkowski et al., 2020)

[1] HKMA establishes a regulatory environment for tokens

Background

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Definition: Blockchain

Decentralized database (securely and consistently records and verifies data across a decentralized network. (Hua et al., 2019; Sarker et al., 2021))

Definiton: Token

Digital ownership of both virtual and physical assets. (Bauer et al., 2022; Ziolkowski et al., 2020)

- **3 trillion** $ token market size in 2021
  - Entrepreneurs
  - governmental entities[1]
  - venture capital

[1] HKMA establishes a regulatory environment for tokens

Foreground

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Token-based Platform

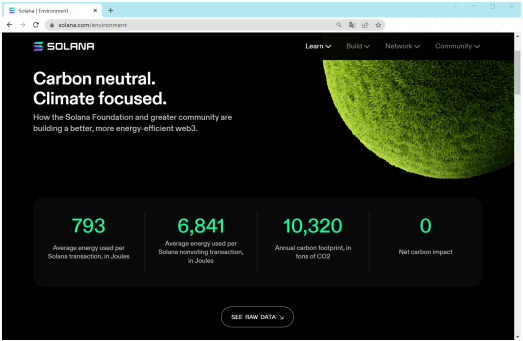
Online platforms that leverage digital tokens as a means to secure asset ownership and facilitate their transactions (Belk et al., 2022; Cong and He, 2019).

- Example: Metaverse. Digital Assets Ownership (token).

What Happened?

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

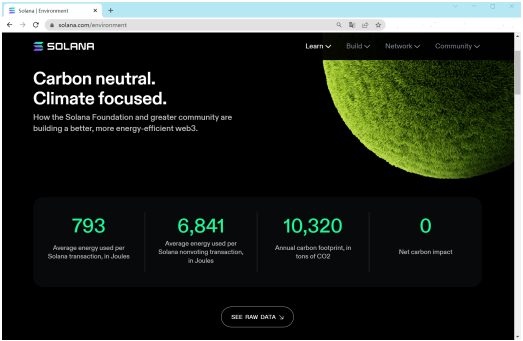
- What: Environmental web pages (Since 2018).



What Happened?

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

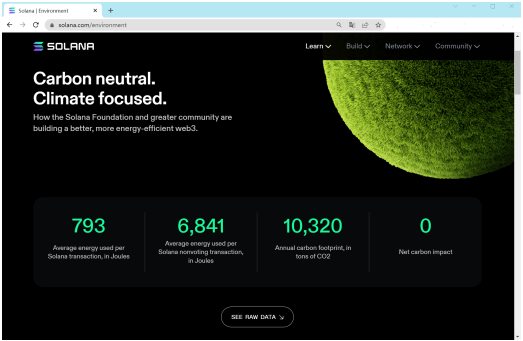
- What: Environmental web pages (Since 2018).
- Who: 40+ token-based platforms (> $300 million).



What Happened?

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- What: Environmental web pages (Since 2018).
- Who: 40+ token-based platforms (> $300 million).
- **However!**
  - 7 in Jan 2018 - Mid 2021
  - 35 in Mid 2021 - Mar 2023



Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:

Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:
  - EU's Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive
  - Private Equity Fund case (Markarian et al., 2023):

Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:
  - EU's Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive
  - Private Equity Fund case (Markarian et al., 2023):
    - approximately 60% do not disclose ESG information
    - another 30% engage in cheap talk.

Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:
  - EU's Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive
  - Private Equity Fund case (Markarian et al., 2023):
    - approximately 60% do not disclose ESG information
    - another 30% engage in cheap talk.

Puzzle 1

Token-based platforms are **not regulated** to disclose environmental information. Why do they disclose that?

Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:
  - EU's Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive
  - Private Equity Fund case (Markarian et al., 2023):
    - approximately 60% do not disclose ESG information
    - another 30% engage in cheap talk.

Puzzle 1

Token-based platforms are **not regulated** to disclose environmental information. Why do they disclose that?

- Disclosure has a low marginal cost.
  - **No additional actions**: (Ziolkowski et al., 2020)
    - Energy information = pre-determined consensus algorithms + the number of participating nodes

Practical Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Regulated security market:
  - EU's Non-Financial Reporting Directive (NFRD), Corporate Sustainability Reporting Directive
  - Private Equity Fund case (Markarian et al., 2023):
    - approximately 60% do not disclose ESG information
    - another 30% engage in cheap talk.

Puzzle 1

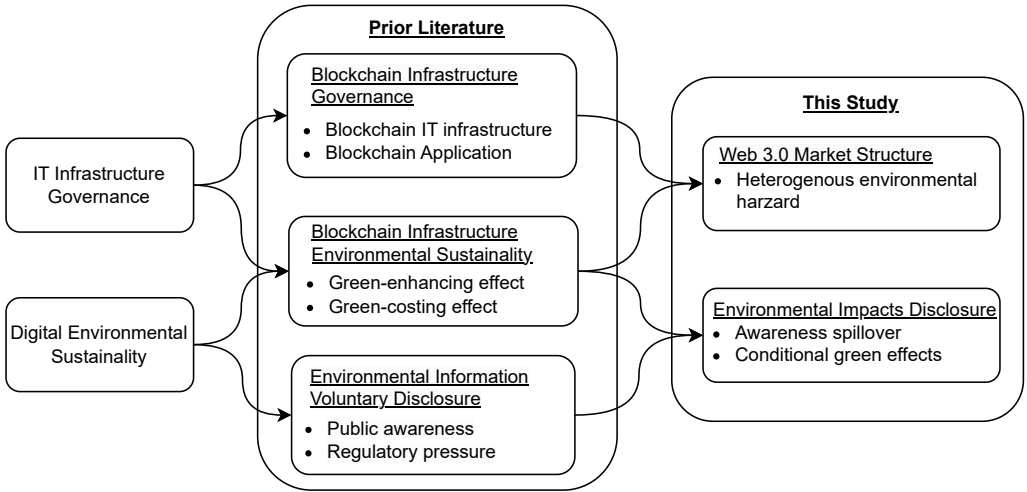
Token-based platforms are **not regulated** to disclose environmental information. Why do they disclose that?

- Disclosure has a low marginal cost.
  - **No additional actions**: (Ziolkowski et al., 2020)
    - Energy information = pre-determined consensus algorithms + the number of participating nodes
  - **No verification**(Christensen et al., 2021).

Puzzle 2

Why do they have time-dependent disclosure behavior?

Literature Motivation



Literature Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

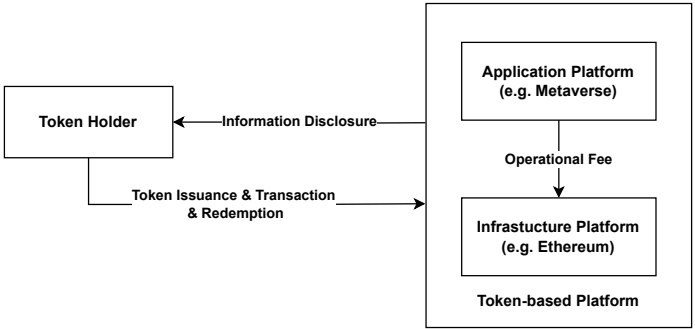
IT Infrastructure Governance

- IT infrastructures underpin applications; governance requires distinct knowledge (Tiwana and Kim, 2015; Xue et al., 2011).
- Traditional IT services separate infrastructure and applications (Xue et al., 2011; Brown and Magill, 1994, 1998).

- However, the literature on discusssing blockchain IT infrastructure and application is scarce.

Conceptual Layered Structure

- **Infrastructure platforms (IPs)**: blockchain network, supporting data recording.
- **Application platforms (APs)**: operate tokens on multiple IPs without their own mining



Literature Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Green Dilemma: Competing views of green effects on platforms' DSGRs.

Green-enhancing Effect

Platforms are incentivized to voluntarily disclose information to reduce information asymmetry (Howell et al., 2020) and improve reputations (Avramov et al., 2022).

Literature Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Green Dilemma: Competing views of green effects on platforms' DSGRs.

Green-enhancing Effect

Platforms are incentivized to voluntarily disclose information to reduce information asymmetry (Howell et al., 2020) and improve reputations (Avramov et al., 2022).

Green-costing Effect

- A waste of resources derived from agency problems between shareholders and managers (Krüger, 2015)
- Diverting attention away from a website's primary content, leading to information overload for token holders (Ghose et al., 2014; Hirshleifer and Teoh, 2003).

Literature Motivation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Green Dilemma: Competing views of green effects on platforms' DSGRs.

Green-enhancing Effect

Platforms are incentivized to voluntarily disclose information to reduce information asymmetry (Howell et al., 2020) and improve reputations (Avramov et al., 2022).

Green-costing Effect

- A waste of resources derived from agency problems between shareholders and managers (Krüger, 2015)
- Diverting attention away from a website's primary content, leading to information overload for token holders (Ghose et al., 2014; Hirshleifer and Teoh, 2003).

- Serafeim (2021) suggest buyers in private markets do not care about firms' ESG performance as long as they maintain cash-generating capabilities.

Research Question

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Question 1:** What drives token-based platforms to disclose environmental information?

Event Shock

- Elon Musk, on 12 May, 2021: Tesla suspended vehicle purchases using Bitcoin due to its environmental impact.

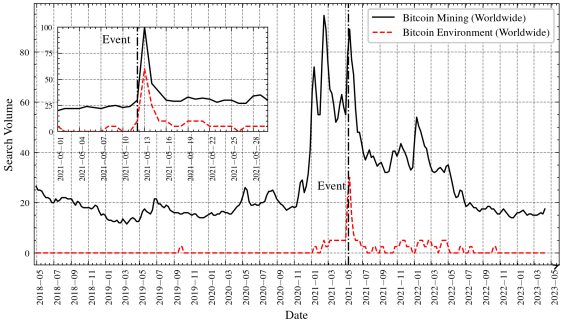
Event Shock

- Elon Musk, on 12 May, 2021: Tesla suspended vehicle purchases using Bitcoin due to its environmental impact.

Event Shock

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Elon Musk, on 12 May, 2021: Tesla suspended vehicle purchases using Bitcoin due to its environmental impact.
- The awareness of Bitcoin mining's environmental impacts (Cacioppo et al., 1986).



Research Question

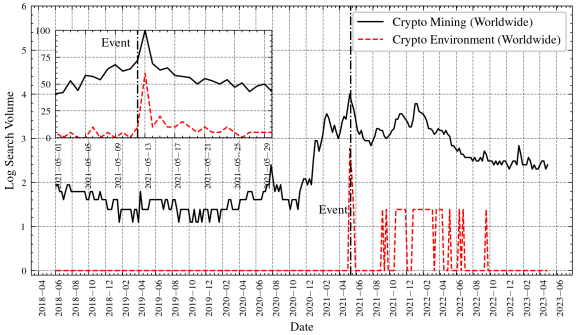
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- What drives token-based platforms to disclose environmental information?
  - The event shock alters the awareness of Bitcoin mining's environmental impacts that mining has severe environmental impacts, and actions are taken by IPs to respond to this change.

Research Question

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- What drives token-based platforms to disclose environmental information?
  - The event shock alters the awareness of Bitcoin mining's environmental impacts that mining has severe environmental impacts, and actions are taken by IPs to respond to this change.
  - **Model-free evidence**:
    - Google search index
    - All 40+ environmental pages were established by IPs.



Research Question (Continued)

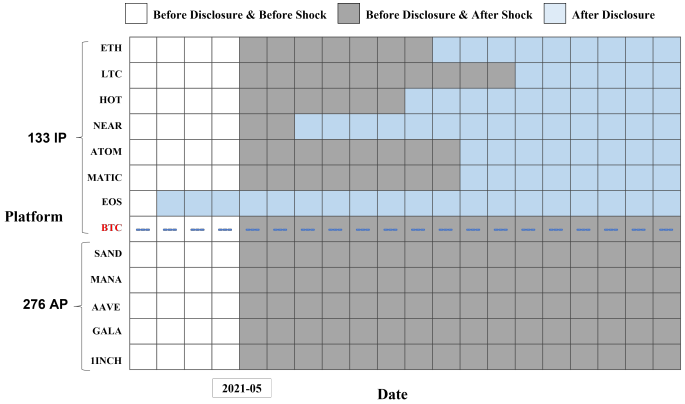
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- How has the awareness of Bitcoin mining's environmental impacts influenced the environmental disclosure of token-based platforms?
- How has the awareness of Bitcoin mining's environmental impacts influenced their daily size growth rates (DSGRs)?
- How has the awareness of Bitcoin mining's environmental impacts influenced the relationship between environmental disclosure and the DSGRs of token-based platforms?

Empirical Setting

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- May 12, 2021: Elon Musk's statement, discontinuing Tesla's acceptance of Bitcoin due to environmental concerns linked to Bitcoin mining.
- The shock is related to IPs rather than APs, as only IPs are directly related to mining.



Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Treatment group**: IPs
- **Control group**: APs
- **Measurement**: platform daily size growth rate (DSGR), an indicator of platform daily performance (Clementi and Hopenhayn, 2006; Evans, 1987).
- As the community's attitude has become that mining has negative environmental impacts:

Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Treatment group**: IPs
- **Control group**: APs
- **Measurement**: platform daily size growth rate (DSGR), an indicator of platform daily performance (Clementi and Hopenhayn, 2006; Evans, 1987).
- As the community's attitude has become that mining has negative environmental impacts:

Hypothesis

The the awareness of Bitcoin mining's environmental impacts led to the decreased DSGRs of IPs, but not APs.

Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- To **alleviate concerns** about mining and meet the expectations of token holders (Cho and Patten, 2007), (Clementi and Hopenhayn, 2006; Evans, 1987), only IPs should disclose relevant information.

Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- To **alleviate concerns** about mining and meet the expectations of token holders (Cho and Patten, 2007), (Clementi and Hopenhayn, 2006; Evans, 1987), only IPs should disclose relevant information.

Hypothesis

The awareness of Bitcoin mining's environmental impacts led IPs, but not APs, to disclose environmental information via web pages.

Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Green-enhancing effect after the change**: As suggested by Hypothesis 1, IPs underwent a decrease in DSGRs due to their environmental impacts.
- **Green-costing effect before the change**: environmental disclosure may have been viewed as unprofitable actions (Krüger, 2015), as
  - Only a few platforms disclosed environmental information

Hypothesis Development

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Green-enhancing effect after the change**: As suggested by Hypothesis 1, IPs underwent a decrease in DSGRs due to their environmental impacts.
- **Green-costing effect before the change**: environmental disclosure may have been viewed as unprofitable actions (Krüger, 2015), as
  - Only a few platforms disclosed environmental information

Hypothesis

The awareness of Bitcoin mining's environmental impacts moderates the association between IPs' environmental disclosures and their DSGRs such that the association is negative (positive) before (after) the change.

Event Data

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Financial data**: Coinmarketcap.
- **Selection**: platforms with a market size of at least $100 million, starting from the first day a platform achieved this threshold and continuing until March 1, 2023.

Event Data

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Financial data**: Coinmarketcap.
- **Selection**: platforms with a market size of at least $100 million, starting from the first day a platform achieved this threshold and continuing until March 1, 2023.
- **Baseline data**: 409 distinct platforms, totaling 23,570 platform-day observations. Timeframe: April 12, 2021, to June 12, 2021,

Data Exclusion

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Bitcoin**: its direct association with Elon Musk's announcement
  - Bitcoin's decreased payment utility vs. its environmental implications

Data Exclusion

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Bitcoin**: its direct association with Elon Musk's announcement
  - Bitcoin's decreased payment utility vs. its environmental implications
- **Stablecoin**: part of APs, facilitate services based on IPs.
  - A bridge between fiat currencies and digital tokens, including IPs' tokens and APs' tokens.
  - Both IPs and APs' performance influence stablecoin platforms, leading to endogenous concerns.

Statistical Summary

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Dependent variable: DSGR - the daily percentage change in platform size.

Baseline Sample	Count	Mean	Std	Min	Median	Max
Dependent Variable						
DSGR	23,570	-0.01	0.13	-3.38	-0.01	3.39
Explanatory Variables						
Post Shock	23,570	0.54	0.50	0.00	1.00	1.00
IP	23,570	0.33	0.47	0.00	0.00	1.00
Time Series Controls						
Prior Size (million)	23,570	2,372.21	17,668.40	0.96	207.43	482,881.90
Prior AllMktcap Change	23,570	-0.00	0.06	-0.26	-0.00	0.16
Prior Week Return	23,570	-0.06	0.26	-3.48	-0.05	3.43
Prior Month Return	23,570	-0.14	0.51	-4.18	-0.18	3.81
Prior 3-Month Return	23,570	0.69	0.96	-2.37	0.59	8.33
Supply (million)	23,570	6,913.43	42,605.23	0.0	246.12	766,307.71
Prior Close	23,570	812.14	6,048.65	0.00	1.00	82,745.19

Awareness and DSGR

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Method**: A DID approach with APs as the control group and IPs as the treatment group.

Awareness and DSGR

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Method**: A DID approach with APs as the control group and IPs as the treatment group.
- **Endogenous concern** from the layered structure
  - APs necessitate the payment of fees to function on the IPs

Awareness and DSGR

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Method**: A DID approach with APs as the control group and IPs as the treatment group.
- **Endogenous concern** from the layered structure
  - APs necessitate the payment of fees to function on the IPs
- To make them comparable, we incorporate the price and total supply amount of IPs' tokens as control variables because they are directly correlated with the operational costs of the APs:

$$Y_{it} = \alpha_i + \delta_t + \beta \times Post_t \times IP_i + Control_{i,t-1} + \epsilon_{i,t} \quad (1)$$

Awareness and DSGR Results

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)	(5)	(6)
Post Shock:IP	-0.0053**	-0.0147***	-0.0144***	-0.0053**	-0.0147***	-0.0144***
	(0.0026)	(0.0029)	(0.0029)	(0.0022)	(0.0031)	(0.0049)
Fee Control	No	Yes	Yes	No	Yes	Yes
Size Control	No	No	Yes	No	No	Yes
Effects	Entity	Entity	Entity	Entity	Entity	Entity
	Time	Time	Time	Time	Time	Time
No. Observations	23,570	23,570	23,570	23,570	23,570	23,570
Cov. Est.	Robust	Robust	Robust	Clustered	Clustered	Clustered
R-squared	0.0002	0.0052	0.0348	0.0002	0.0052	0.0348

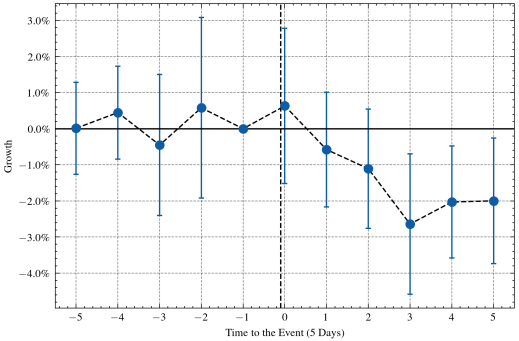
Result 1

After the shock, IPs' DSGRs decrease more than that of APs'.

Event Study

- **Concern**: The APs and IPs may not be comparable entities.
- **Method**: Parallel trend assumption checking with the event study:

$$Y_{it} = \alpha_i + \delta_t + \sum_{k=-5, k\neq -1}^{5} \beta_{k(t)} \times IP_i + Control_{i,t-1} + \epsilon_{i,t} \quad (2)$$



After-Event Environmental Disclosure Data

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Sample**: Top 200 token-based platforms as of April 1, 2023.

After-Event Environmental Disclosure Data

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Sample**: Top 200 token-based platforms as of April 1, 2023.
- **Exclusion**: Excluding Stablecoin platforms, bitcoin, and 5 platforms that published an environmental web page before May 12, 2021.

After-Event Environmental Disclosure Data

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Sample**: Top 200 token-based platforms as of April 1, 2023.
- **Exclusion**: Excluding Stablecoin platforms, bitcoin, and 5 platforms that published an environmental web page before May 12, 2021.
- **Final Panel data**: 85 IPs, of which 41 had published an environmental web page. Final panel data: 40,768 observations from May 12, 2021, to March 1, 2023.

Symbol	Web Page	Launch Date
EOS	https://eosauthority.com/green/	2018-11-25
XRP	https://xrpl.org/carbon-calculator.html	2020-10-21
NEAR	https://near.org/blog/near-climate-neutral-product/	2021-04-15
ALGO	https://algorand.com/about/sustainability	2021-04-22
CSPR	https://blog.casperlabs.io/new-power-usage-report-shows-the-casper-networks-impressive-energy-efficiency-relative-to-other-blockchain-protocols/	2021-05-04
HOT	https://www.holochain.org/projects/#energy_project	2021-05-05
MOB	https://mobilecoin.com/blog/mobilecoin-saves-on-environmental-footprint	2021-05-11
CRO	https://crypto.com/company-news/crypto-coms-climate-commitment-2	2021-05-27
...	...	...

Awareness and Env Disclosure

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

To examine the impact of the awareness of Bitcoin mining's environmental impacts on the adoption of web page environmental disclosures:

Awareness and Env Disclosure

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

To examine the impact of the awareness of Bitcoin mining's environmental impacts on the adoption of web page environmental disclosures:

- **Method**: Chi-square test to assess the statistical significance of the change in the number of such disclosures during the pre and after-shock periods.

IP	Published	Not Published	Total
Before Change	7	78	85
After Change	34	51	85
Total	41	130	170

AP	Published	Not Published	Total
Before Change	0	105	105
After Change	0	105	105
Total	0	210	210

$$\chi^2 = \frac{(7-16.65)^2}{16.65} + \frac{(78-68.35)^2}{68.35} + \frac{(34-24.35)^2}{24.35} + \frac{(51-60.65)^2}{60.65} = 8.36.$$

Awareness and Env Disclosure

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

To examine the impact of the awareness of Bitcoin mining's environmental impacts on the adoption of web page environmental disclosures:

- **Method**: Chi-square test to assess the statistical significance of the change in the number of such disclosures during the pre and after-shock periods.

IP	Published	Not Published	Total
Before Change	7	78	85
After Change	34	51	85
Total	41	130	170

AP	Published	Not Published	Total
Before Change	0	105	105
After Change	0	105	105
Total	0	210	210

$$\chi^2 = \frac{(7-16.65)^2}{16.65} + \frac{(78-68.35)^2}{68.35} + \frac{(34-24.35)^2}{24.35} + \frac{(51-60.65)^2}{60.65} = 8.36.$$

Result 2

A significant increase in the number of IPs, not APs, that published environmental pages.

Statistical Summary

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

IP Panel Data	Count	Mean	Std	Min	Median	Max
Dependent Variable						
DSGR	40,768	-0.00	0.07	-1.44	0.00	1.50
Explanatory Variables						
Post	40,768	0.06	0.24	0.00	0.00	1.00
E	40,768	0.33	0.47	0.00	0.00	1.00
Time Series Controls						
Prior Size (million)	40,768	7,486.35	35,054.28	14.73	1,073.44	569,094.33
Prior AllMktcap Change	40,768	-0.00	0.04	-0.26	0.00	0.16
Prior Week Return	40,768	-0.02	0.24	-13.54	-0.01	2.30
Prior Month Return	40,768	-0.08	0.53	-13.70	-0.07	2.46
Prior 3-Month Return	40,768	-0.22	0.92	-14.42	-0.20	3.83
Prior Close	40,768	57.88	314.22	0.00	1.04	23,147.35
Supply	40,768	280,233.23	2,126,310.56	2.42	875.25	19,320,892.17
Heterogeneous Effects						
Address	40,768	0.41	0.49	0.00	0.00	1.00
Registration	40,768	0.44	0.50	0.00	0.00	1.00

Environmental Disclosure and IPs' DSGRs

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Staggered adoption of environmental web pages
- **Method**: a staggered adoption DID method to test the effects of web page environmental disclosure. Our model is as follows:

$$Y_{it} = \alpha_i + \delta_t + \beta \times Post_{it} + Control_{i,t-1} + \epsilon_{i,t} \tag{3}$$

where Y_{it} represents DSGRs of platform i in day t. $Post_{it}$ represents the web page launch dummy variable for platform i on day t. We incorporate both platform-level fixed effects α_i and year-by-month-by-day fixed effects δ_t.

Environmental Disclosure and IPs' DSGRs

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**
	(0.0012)	(0.0012)	(0.0012)	(0.0014)	(0.0014)	(0.0014)
Size Control	Yes	Yes	Yes	Yes	Yes	Yes
Effects	Entity	Entity	Entity	Entity	Entity	Entity
	Time	Time	Time	Time	Time	Time
No. Observations	40,768	40,768	40,768	40,768	40,768	40,768
Cov. Est.	Robust	Robust	Robust	Clustered	Clustered	Clustered
R-squared	0.0045	0.0045	0.0050	0.0050	0.0077	0.0077

Result 3

IPs' DSGRs increase after the environmental disclosure.

Environmental Disclosure and IPs' DSGRs

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**
	(0.0012)	(0.0012)	(0.0012)	(0.0014)	(0.0014)	(0.0014)
Size Control	Yes	Yes	Yes	Yes	Yes	Yes
Effects	Entity	Entity	Entity	Entity	Entity	Entity
	Time	Time	Time	Time	Time	Time
No. Observations	40,768	40,768	40,768	40,768	40,768	40,768
Cov. Est.	Robust	Robust	Robust	Clustered	Clustered	Clustered
R-squared	0.0045	0.0045	0.0050	0.0050	0.0077	0.0077

Result 3

IPs' DSGRs increase after the environmental disclosure.

- **Falsification Test (Pass):**
  - **Concern**: Any web page may lead to an increased DSGR anyway.

Environmental Disclosure and IPs' DSGRs

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**	0.0029**
	(0.0012)	(0.0012)	(0.0012)	(0.0014)	(0.0014)	(0.0014)
Size Control	Yes	Yes	Yes	Yes	Yes	Yes
Effects	Entity	Entity	Entity	Entity	Entity	Entity
	Time	Time	Time	Time	Time	Time
No. Observations	40,768	40,768	40,768	40,768	40,768	40,768
Cov. Est.	Robust	Robust	Robust	Clustered	Clustered	Clustered
R-squared	0.0045	0.0045	0.0050	0.0050	0.0077	0.0077

Result 3

IPs' DSGRs increase after the environmental disclosure.

- **Falsification Test (Pass):**
  - **Concern**: Any web page may lead to an increased DSGR anyway.
  - **Method**: Social pages as a comparison.

The awareness of Bitcoin mining's environme

- Staggered adoption DID regression model with a heterogeneous time variable $Before_t$:

$$Y_{it} = \alpha_i + \delta_t + \beta \times Before_t \times Post_{it} + \gamma_1 \times Post_{it} + Control_{i,t-1} + \epsilon_{i,t} \quad (4)$$

where Y_{it} is the DSGR for platform i on day t. $Before_t$ is a dummy indicator showing whether the time is before the shock. $Post_{it}$ is a dummy variable indicating whether platform i has launched its web page by day t. we incorporate both platform-level fixed effects α_i and year-by-month-by-day fixed effects δ_t. $Before_t$ is absorbed by the fixed effects as it is unit-invariant.

Effects with Different the awareness of Bitc environmental impacts

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)	(5)	(6)
Post:Before	-0.0102**	-0.0102***	-0.0098**	-0.0098***	-0.0097**	-0.0097***
	(0.0044)	(0.0023)	(0.0044)	(0.0021)	(0.0044)	(0.0021)
Post	0.0030***	0.0030***	0.0029***	0.0029***	0.0029***	0.0029***
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Effects	Entity	Entity	Entity	Entity	Entity	Entity
	Time	Time	Time	Time	Time	Time
No. Observations	67,330	67,330	67,330	67,330	67,330	67,330
Cov. Est.	Robust	Clustered	Robust	Clustered	Robust	Clustered
R-squared	0.0025	0.0025	0.0028	0.0028	0.0031	0.0031

Result 3

The awareness of Bitcoin mining's environmental impacts **increases the effect of web page environmental disclosures** as IPs' DSGRs decrease more during the before-shock period than the after-shock period.

Regulatory Risk

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- The token market is **not regulated** in terms of environmental disclosure.
  - In loosely regulated markets, investors tend to **disregard regulatory risks** (Ilhan et al., 2021; Avramov et al., 2022).
  - Otherwise, platforms subject to stricter regulation would benefit more from such disclosures because of their **increased regulatory risks** (Avramov et al., 2022).
- **Regulatory Indicator**:
  - *Registration*: whether a platform is officially recognized as a legal entity in a particular country
  - *Address* - whether a platform is officially registered with a full address for its organization.
- A staggered adoption DID with different levels of regulation degree:

$$Y_{it} = \alpha_i + \delta_t + \beta \times Registration_i \times Post_{it} + \gamma_1 \times Post_{it} + Control_{i,t-1} + \epsilon_{i,t} \quad (5)$$

Heterogeneous Regulation

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DV: DSGR	(1)	(2)	(3)	(4)
Post:Registration	-2.259e-05	-2.259e-05		
	(0.0024)	(0.0027)		
Post:Address			0.0016	0.0016
			(0.0024)	(0.0025)
Post	0.0029*	0.0029*	0.0022	0.0022
	(0.0016)	(0.0017)	(0.0017)	(0.0014)
Effects	Entity	Entity	Entity	Entity
	Time	Time	Time	Time
No. Observations	40,768	40,768	40,768	40,768
Cov. Est.	Robust	Clustered	Robust	Clustered
R-squared	0.0077	0.0077	0.0077	0.0077

Regulation Concern

Different levels of regulation degree **do not lead to a significant difference** in the effect of environmental disclosures on IPs' DSGRs.

Conclusion

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Three hypothesises are valid:

- **Heterogeneity** of token-based platforms in the setting of **environmental disclosures** and find a **layered structure** and its connection with mining's environmental impacts.

Conclusion

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Three hypothesises are valid:

- **Heterogeneity** of token-based platforms in the setting of **environmental disclosures** and find a **layered structure** and its connection with mining's environmental impacts.

Conceptual Layered Structure

- **Infrastructure platforms (IPs)**: blockchain network, supporting data recording.
- **Application platforms (APs)**: operate tokens on multiple IPs without their own mining

Conclusion

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Three hypothesises are valid:

- **Heterogeneity** of token-based platforms in the setting of **environmental disclosures** and find a **layered structure** and its connection with mining's environmental impacts.

Conceptual Layered Structure

- **Infrastructure platforms (IPs)**: blockchain network, supporting data recording.
- **Application platforms (APs)**: operate tokens on multiple IPs without their own mining

Results: After the awareness change

- IPs' DSGRs decrease more than that of APs'.
- A significant increase in the number of IPs, not APs, that published environmental pages.
- **The effect of web page environmental disclosures increases**.

Contribution

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Information Systems (IS) literature** : heterogeneity of token-based platforms and IT environmental impacts.

Contribution

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Information Systems (IS) literature** : heterogeneity of token-based platforms and IT environmental impacts.
- **Empirical token studies literature**: omitted variables to make IPs and APs comparable.

Contribution

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Information Systems (IS) literature** : heterogeneity of token-based platforms and IT environmental impacts.
- **Empirical token studies literature**: omitted variables to make IPs and APs comparable.
- **ESG literature**: a new empirical perspective on the trade-off between green-costing and green-enhancing effects in the token market.

Contribution

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- **Information Systems (IS) literature** : heterogeneity of token-based platforms and IT environmental impacts.
- **Empirical token studies literature**: omitted variables to make IPs and APs comparable.
- **ESG literature**: a new empirical perspective on the trade-off between green-costing and green-enhancing effects in the token market.
- **CSR Literature**: social pressure itself can influence environmental disclosure decisions even in the absence of potential regulatory requirements.

Implications

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Policymakers: educational campaigns to enhance environmentally conscious practices.

Implications

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Policymakers: educational campaigns to enhance environmentally conscious practices.
- Token-based platforms: timing for disclosing environmental information.

Implications

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

- Policymakers: educational campaigns to enhance environmentally conscious practices.
- Token-based platforms: timing for disclosing environmental information.
- Token holders: the awareness of Bitcoin mining's environmental impacts and integrate them into their investment strategies.

The End

References

Avramov, D., Cheng, S., Lioui, A., and Tarelli, A. (2022). Sustainable investing with ESG rating uncertainty. *Journal of Financial Economics*, 145(2):642–664.

Bauer, I., Parra-Moyano, J., Schmedders, K., and Schwabe, G. (2022). Multi-party certification on blockchain and its impact in the market for lemons. *Journal of Management Information Systems*, 39(2):395–425.

Belk, R., Humayun, M., and Brouard, M. (2022). Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets. *Journal of Business Research*, 153:198–205.

Brown, C. V. and Magill, S. L. (1994). Alignment of the is functions with the enterprise: Toward a model of antecedents. *MIS Quarterly*, 18(4):371–403.

Brown, C. V. and Magill, S. L. (1998). Reconceptualizing the context-design issue for the information systems function. *Organization Science*, 9(2):176–194.

Cacioppo, J. T., Petty, R. E., Kao, C. F., and Rodriguez, R. (1986). Central and peripheral routes to persuasion: An individual difference perspective. *Journal of personality and social psychology*, 51(5):1032.

Cho, C. H. and Patten, D. M. (2007). The role of environmental disclosures as tools of legitimacy: A research note. *Accounting, Organizations and Society*, 32(7-8):639–647.

Christensen, H. B., Hail, L., and Leuz, C. (2021). Mandatory CSR and sustainability reporting: Economic analysis and literature review. *Review of Accounting Studies*, 26(3):1176–1248.

Clementi, G. L. and Hopenhayn, H. A. (2006). A theory of financing constraints and firm dynamics. *The Quarterly Journal of Economics*, 121(1):229–265.

Cong, L. W. and He, Z. (2019). Blockchain disruption and smart contracts. *The Review of Financial Studies*, 32(5):1754–1797.

Evans, D. S. (1987). Tests of alternative theories of firm growth. *J. Pol. Econ.*, 95(4):657–674.

Ghose, A., Ipeirotis, P. G., and Li, B. (2014). Examining the impact of ranking on consumer behavior and search engine revenue. *Management Science*, 60(7):1632–1654.

Hirshleifer, D. and Teoh, S. H. (2003). Limited attention, information disclosure, and financial reporting. *Journal of Accounting and Economics*, 36(1-3):337–386.

Howell, S. T., Niessner, M., and Yermack, D. (2020). Initial coin offerings: Financing growth with cryptocurrency token sales. *The Review of Financial Studies*, 33(9):3925–3974.

Hua, S. Y. H., Langenheldt, K., Harlev, M., Mukkamala, R. R., and Vatrapu, R. (2019). Regulating cryptocurrencies: A supervised machine learning approach to de-anonymizing the bitcoin blockchain. *Journal of Management Information Systems*, 36(1):37–73.

Ilhan, E., Sautner, Z., and Vilkov, G. (2021). Carbon tail risk. *The Review of Financial Studies*, 34(3):1540–1571.

Krüger, P. (2015). Corporate goodness and shareholder wealth. *Journal of Financial Economics*, 115(2):304–329.

Markarian, G., Rakotobe, C., and Semionov, A. (2023). Esg in the top 100 us private equity firms. Preprint, submitted 17 Jul 2023.

Sarker, S., Henningsson, S., Jensen, T., and Hedman, J. (2021). The use of blockchain as a resource for combating corruption in global shipping: an interpretive case study. *Journal of Management Information Systems*, 38(2):338–373.

Serafeim, G. (2021). ESG: Hyperboles and reality. Working paper, Harvard Business School.

Tiwana, A. and Kim, S. K. (2015). Discriminating it governance. *Information Systems Research*, 26(4):656–674.

Xue, L., Ray, G., and Gu, B. (2011). Environmental uncertainty and IT infrastructure governance: A curvilinear relationship. *Information Systems Research*, 22(2):389–399.

Ziolkowski, R., Miscione, G., and Schwabe, G. (2020). Decision problems in blockchain governance: Old wine in new bottles or walking in someone else's shoes? *Journal of*