

Non-Fungible Tokens

Anthony Lee Zhang

May 10, 2024



\$1,800,000



\$22,400,000



\$2,800,000

Non-fungible Tokens: Overview

- ▶ Intro and basics
- ▶ “Digital Veblen Goods”
- ▶ Market Design
- ▶ Misc topics

Non-fungible Tokens

- ▶ Non-fungible tokens (NFTs) are digital assets held in blockchain wallets
- ▶ Wallet public address allows verifying ownership
- ▶ Private key allows buying, sending, trading NFTs
- ▶ In contrast to other crypto-assets, NFTs are unique and indivisible

NFT Primary Markets

- ▶ NFTs we study are sold by creators in collections of 5,000-10,000
- ▶ Primary market purchases (referred to as “mints”) coincide with the creation of the NFT on the blockchain
- ▶ Public sales advertised through social media and websites

NFT Trading Platforms

OpenSea

Search items, collections, and accounts

Explore

Stats

Resources

Create

Filter

Status

Buy Now

On Auction

New

Has Offers

Price

\$

United States Dollar (USD)

Min

to

Max

Apply

Collections

Chains

Categories

On Sale In

29,485,870 Items

all items

Sort by

88888_888

2x Basic 300 + 1 common

Price \uparrow 1

9-11 days left

THE PASTORALIST

3 Multibases

Price \uparrow 0.35

9-11 days left

CrystalBones Flower #21702

Price \uparrow 0.043

10-12 days left

Obnoxious Tiger Social Club #4425

Price \uparrow 0.353

9-11 days left

Fungus Assets Penguined fairy #5906

Price \uparrow 0.0396

9-11 days left

Adding Assets Adding Assets! #2742

Price \uparrow 0.02

9-11 days left

dash-Lala GooCat #4385

Price \uparrow 0.01

10-12 days left

Cryptos Prisoner Prisoner #1201

Price \uparrow 0.021

9-11 days left

ICatx ICat #5119

Price \uparrow 0.019

9-11 days left

MOG12388 Unique! # 106

Price \uparrow 0.05

9-11 days left

187 Tgatory Senny #06

Price \uparrow 0.057

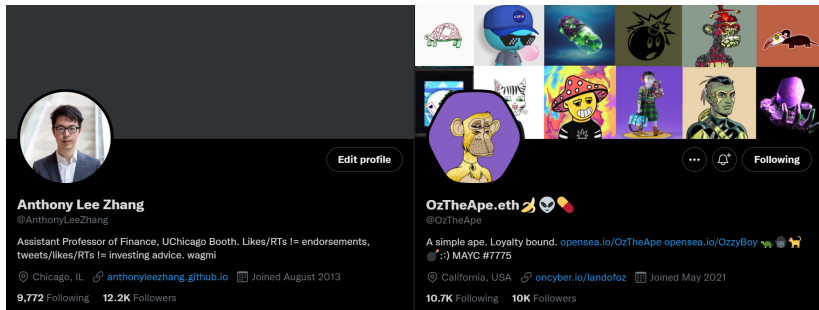
9-11 days left

Cryptos Religious E... Crypto Runes #4038

Price \uparrow 0.01

9-11 days left

Why Do People Buy NFTs?



Why Do People Buy NFTs?

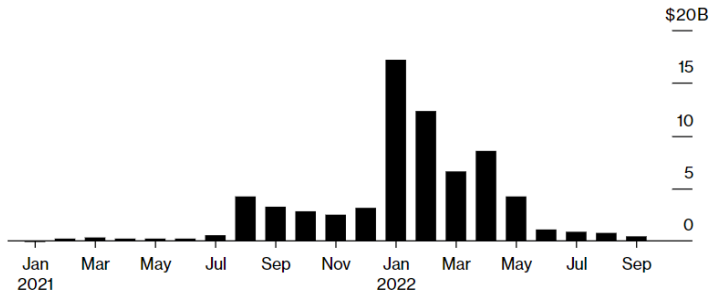
- ▶ NFTs are “art”, and also durable digital status goods
 - ▶ Verifiably signals wealth
 - ▶ Private chat groups for NFT owners
 - ▶ Some convey rights/powers within videogames or virtual “metaverse” worlds
- ▶ Returns have also been very high, so attracts many speculative investors

NFT market growth has been explosive (though volumes fell substantially)

Volume Drop

NFT monthly volume has dropped 97% from 2022 highs

■ Volume



Source: Dune Analytics; Dashboard by @hildobby

Note: Cumulative data from OpenSea, NFTX, LarvaLabs, LooksRare, SuperRare, Rarible, Foundation

Source

Digital Veblen Goods (Oh, Rosen, Zhang 2023)

- ▶ NFTs as “Veblen” goods \implies a large social aspect to their value
- ▶ Key empirical findings confirming model predictions:
 - ▶ NFT primary market outcomes are strikingly bimodal
 - ▶ NFTs are systematically underpriced in primary markets (“mint premium”)
 - ▶ “Scalpers” exploit issuers’ pricing strategies to systematically extract profits
- ▶ Aside: story of this paper...

A Note on Restaurant Pricing and Other Examples of Social Influences on Price

Gary S. Becker

University of Chicago

This note tries to explain why many successful restaurants, plays, sporting events, and other activities do not raise prices even with persistent excess demand. My approach assumes that demand by a typical consumer is positively related to quantities demanded by other consumers. This can explain not only the puzzle about prices but also why consumer demand is often fickle, why it is much easier to go from being “in” to being “out” than from “out” to “in,” and why supply does not increase to reduce the excess demand.

Bank Runs, Veblen Goods, and “Strategic Complementarities” in Economics and Finance

- ▶ Recall how bank runs work:
 - ▶ If no one withdraws, everything is good. If everyone withdraws, the bank is insolvent
 - ▶ Diamond: “Fear of fear itself”. Fear is a self-fulfilling prophecy: if everyone thinks everyone else will withdraw, everyone wants to withdraw
- ▶ “Social goods” are similar – but in reverse!
 - ▶ If nobody buys bored apes, they’re uncool, and nobody wants to buy them
 - ▶ If everyone buys, I want to buy too! Demand begets demand!
 - ▶ Here, success is a self-fulfilling prophecy: if everyone thinks everyone else will buy, everyone will buy. . .

Aside: “Strategic Complementarities” in Economics and Finance

- ▶ Markets, generically, are settings with strategic substitutes
 - ▶ When lots of people want to ski, ticket prices go up, so I’m less likely to ski
 - ▶ When lots of people study finance, wages go down. . .
- ▶ Substitutes naturally lead to unique equilibria

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- ▶ Substitutes naturally lead to unique equilibria
- ▶ Bank runs, and Veblen goods, display strategic complementarity
 - ▶ When everyone withdraws, I want to withdraw
 - ▶ When everyone buys an NFT/Hermes bag/Rolux, it's cool and I want one too

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 - ▶ Banks with equal fundamentals can be solvent, or run on
 - ▶ “A Rolux by any other name. . .”

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 - ▶ “A Rolux by any other name. . .”
- ▶ What are other examples of strategic complementarities?

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 - ▶ “A Rolux by any other name. . .”
- ▶ What are other examples of strategic complementarities?
- ▶ Is blockchain adoption, on the whole, more strategic substitutes or complements? Why?

Testing the Social Goods Hypothesis

How would we test the hypothesis that “social effects” are important in NFT markets?

1. **Bimodal outcomes**

- ▶ With social effects, something can be “in” or “out”, but not in-between
- ▶ We should see collections either sell very well, or very poorly, but few in between!

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2. Underpricing in primary markets

- ▶ With social effects, demand is fragile: if an “in” collection collapses to “out”, it’ll go from crowded to empty!
- ▶ Hermes/Rolux purposefully sets prices “too low”, so items are “overdemanded” in primary markets
- ▶ This is never optimal if there aren’t social effects

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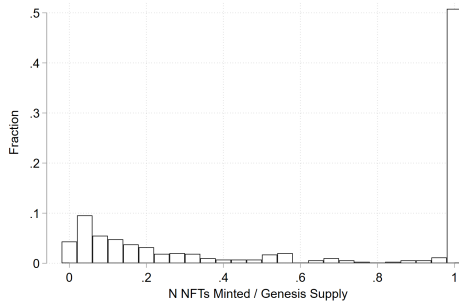
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3. Scalping

- ▶ Due to underpricing, even if you don’t want an Hermes bag, if you get one at retail, you can flip it for profits
- ▶ If we see underpricing, we should also see “scalpers” try to exploit issuers’ underpricing

Prediction 1: Outcomes are Bimodal

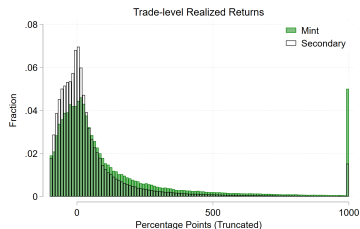
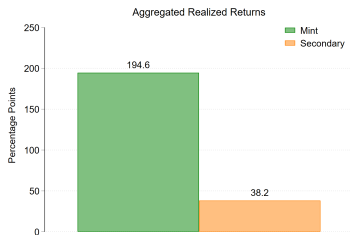


Prediction 2: Mint Underpricing

- ▶ Goal: show that NFTs are systematically underpriced at mints
- ▶ Implication: mint trades earn higher profits than secondary market trades
- ▶ Realized returns:

$$r_{i,j,c,t,\tau}^{realized} \equiv \frac{Price_{i,j,c,t}^{Sold} - Fees_{i,j,c,t} - Price_{i,j,c,\tau}^{Purch} - Gas_{i,j,c,\tau}}{Price_{i,j,c,\tau}^{Purch} + Gas_{i,j,c,\tau}}$$

Prediction 2: Mint Underpricing



- ▶ Aggregated returns from mints substantially higher
- ▶ Within the distributions of returns, substantially more mass at larger returns for mints compared to secondary market trades

Prediction 2: Mint Underpricing

$$r_{i,j,c,t,\tau}^{realized} = \beta \times IsMint_{it} + \gamma X_{i,j,c,t,\tau} + \epsilon_{i,j,c,t,\tau}$$

	(1)	(2)	(3)	(4)	(5)	(6)
Last Trade Was Mint Dummy	1.138*** (230.70)	1.970*** (355.83)	2.227*** (368.80)	1.520*** (216.55)	2.029*** (239.76)	1.017*** (197.85)
ln(Days to Realize)			0.213*** (208.77)		0.260*** (151.81)	
Collection FE	No	Yes	Yes	No	No	No
NFT FE	No	No	No	Yes	Yes	No
BuyDate-SellDate FE	No	No	No	No	No	Yes
R ²	0.022	0.205	0.222	0.399	0.415	0.337
N	2,131,225	2,131,218	2,131,216	1,424,834	1,424,832	2,123,630

- ▶ Mints over 100% more profitable than secondary market trades!
- ▶ Primary market returns systematically exceed secondary market returns \implies systematic underpricing in primary markets as model predicts

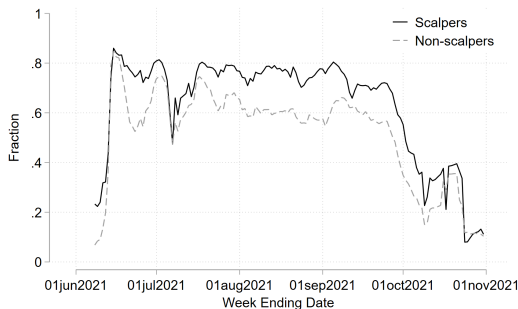
Prediction 3: Existence of Scalpers

- ▶ “Scalpers”: no fundamental utility for holding NFTs but purchase in primary markets to profit from underpricing
- ▶ We identify traders in the data that behave like “scalpers”
 - ▶ More likely to trade in primary markets
 - ▶ Short holding periods after minting
 - ▶ Higher returns explained by minting propensity \implies no preferential access or superior information

Defining “Scalpers”

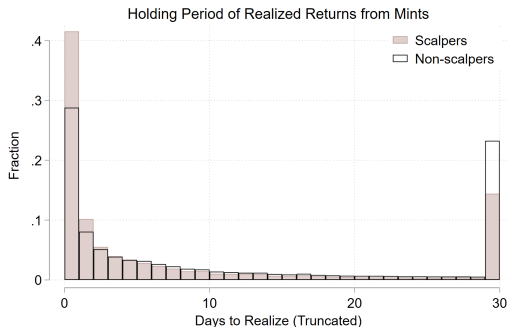
- ▶ $\approx 540,000$ unique wallets in our GC-based sample
- ▶ Minting/trading activity is very concentrated:
 - ▶ $\approx 50\%$ of txns by wallets with $99 +$ txns
- ▶ **Scalpers:** wallets above 50% cutoff prior to given date
 - ▶ As-of prior date \implies time-varying, backwards-looking classification
 - ▶ Using full sample, $\approx 13,000$ (2.4%) of wallets are “scalpers”

Mint Propensity



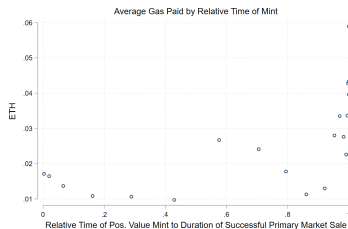
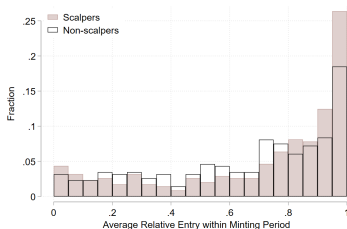
- ▶ Scalpers perform a substantially larger fraction of trades in primary markets compared to non-scalpers throughout our sample

Differences in Holding Period from Mint



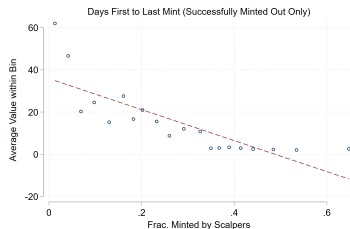
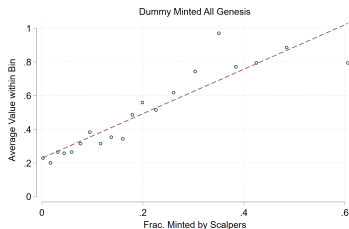
- Scalpers flip their mints in secondary market at higher rate

Mint Entry Timing



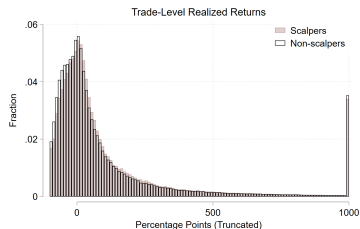
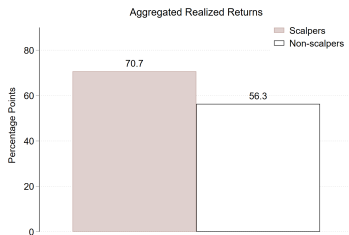
- ▶ Scalpers tend to purchase later in minting period
- ▶ Relatively late mints have much higher gas fees

Scalper Participation and Mint Success



- ▶ Scalpers appear to pick more successful collections: more likely to mint out, and mint out faster
- ▶ However, don't actually do better on mints!

Scalper Return Outperformance



- ▶ In aggregate, scalpers earned higher realized returns
- ▶ Scalpers appear to earn higher realized returns at trade level on average

Scalper Return Premia

$$r_{i,j,c,t,\tau}^{realized} = \delta \times Scalper_{i,t} + \gamma X_{i,j,c,t,\tau} + \epsilon_{i,j,c,t,\tau}$$

	Return Including Fees			Return Before Fees		
	(1)	(2)	(3)	(4)	(5)	(6)
Scalper Seller Dummy	0.056*** (9.87)	0.186*** (32.17)	0.128*** (26.18)	0.474*** (57.41)	0.535*** (63.12)	0.417*** (56.72)
ln(Days to Realize)		0.136*** (133.11)			0.064*** (42.17)	
BuyDate-SellDate FE	No	No	Yes	No	No	Yes
R ²	0.000	0.008	0.324	0.002	0.002	0.293
N	2,131,225	2,131,223	2,123,630	2,131,225	2,131,223	2,123,630

- ▶ Controlling for buy/sell date FEs, scalpers attain **12.8pp higher returns** per trade
- ▶ Outperformance similar when controlling for holding period vs buydate-selldate FEs

Role of Mints in Scalper Performance

$$r_{i,j,c,t,\tau} = \delta \times Scalper_{i,t} + \beta \times IsMint_{i,t} + \gamma X_{i,j,c,t,\tau} + \epsilon_{i,j,c,t,\tau}$$

	(1) All	(2) All	(3) All	(4) Mints	(5) Secondary
Scalper Seller Dummy	0.186*** (32.17)	-0.042*** (-7.27)	-0.006 (-1.16)	-0.025*** (-3.81)	0.055*** (9.73)
Last Trade Was Mint Dummy		1.355*** (248.70)	1.028*** (196.28)		
ln(Days to Realize)	0.136*** (133.11)	0.187*** (173.10)	0.111*** (45.10)	0.108*** (30.06)	0.032*** (14.89)
BuyDate-SellDate FE	No	No	Yes	Yes	Yes
R ²	0.008	0.037	0.337	0.407	0.324
N	2,131,223	2,131,223	2,123,628	1,193,226	924,271

- ▶ Mints fully explain scalper premia: controlling for mint dummy and holding period, scalper premium is zero
- ▶ Underperform 2.5pp in mints, outperform 5.5pp in secondary markets

Mints: Decomposing Returns

- To decompose performance, estimate:

$$\log(Y_{i,j,c,t}) = \beta \times Scalper_{i,t} + X_{i,j,c,t}\gamma + \epsilon_{i,j,c,t}$$

- $\log(Y_{i,j,c,t})$: mint price, gas fees, sale price, or sale fees
- Scalpers pay higher gas fees on average \implies lower returns

	ln(Mint Price)		ln(Gas from Mint)		ln(Sale Price)		ln(Fees from Sale)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Scalper Seller Dummy	-0.003*** (-16.17)	-0.003*** (-19.20)	0.067*** (62.28)	0.004*** (5.14)	-0.035*** (-20.47)	-0.006*** (-4.80)	-0.041*** (-24.00)	-0.012*** (-10.38)
Collection FE	Yes	No	Yes	No	Yes	No	Yes	No
Collection-BuyDate FE	No	Yes	No	Yes	No	No	No	No
Collection-SellDate FE	No	No	No	No	No	Yes	No	Yes
R ²	0.963	0.981	0.804	0.883	0.553	0.820	0.569	0.831
N	1,199,924	1,198,701	1,199,722	1,198,499	1,199,924	1,184,704	1,199,924	1,184,704

Summary of Scalper Returns in Primary Markets

- ▶ No evidence of preferential access OR private information
- ▶ If scalpers had preferential access to or private information about collections in primary markets, why do they follow lower-return strategy of entering enter mints later and paying higher gas fees?
- ▶ We cannot prove that scalpers do not have access advantages in primary markets: our results only suggest that preferential access does not appear to be a quantitatively large driver of scalpers' excess returns

Secondary Markets

- ▶ Scalpers outperform in secondary markets both before and after fees
- ▶ Consistent with earning spreads from market making

	Return from Secondary Before Fees			Return from Secondary Including Fees		
	(1)	(2)	(3)	(4)	(5)	(6)
Scalper Seller Dummy	0.061*** (8.17)	0.061*** (8.57)	0.051*** (8.33)	0.055*** (9.62)	0.047*** (8.65)	0.041*** (8.97)
BuyDate-SellDate FE	Yes	Yes	No	Yes	Yes	No
Collection FE	No	Yes	No	No	Yes	No
BuyDate-SellDate-Collection FE	No	No	Yes	No	No	Yes
R ²	0.308	0.383	0.786	0.324	0.410	0.801
N	924,273	924,235	710,453	924,273	924,235	710,453

Secondary Markets: Better Execution

- ▶ To test execution, consider “synthetic returns”:

$$\frac{\text{Sold}}{\text{Paid}}, \frac{\text{Sold}}{\text{Index}}, \frac{\text{Index}}{\text{Paid}}, \frac{\text{Index}}{\text{Index}}$$

- ▶ Scalpers buy at slightly higher prices, sell at even higher prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sold/Paid	Sold/Index	Index/Paid	Index/Index	ln(Sold b4 Fees)	ln(Fees in Sale)	ln(Paid b4 Fees)	ln(Gas in Purchase)
Scalper Seller Dummy	0.041*** (8.97)	0.088*** (16.43)	-0.030*** (-11.80)	0.000 (0.00)	0.036*** (22.32)	0.023*** (14.73)	0.016*** (11.61)	0.032*** (34.15)
BuyDate-GC FE	No	No	No	No	Yes	Yes	No	No
SellDate-GC FE	No	No	No	No	No	No	Yes	Yes
BuyDate-SellDate-GC FE	Yes	Yes	Yes	Yes	No	No	No	No
R ²	0.801	0.767	0.869	1.000	0.860	0.854	0.872	0.743
N	710,453	710,453	710,453	710,453	920,551	920,551	923,301	923,301

Implications: Market Design

- ▶ Some authors' explanation for “underpricing”:
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 - ▶ NFT issuers don't run auctions for the same reason Rolex/Hermes doesn't!
 - ▶ Auctions don't work for social goods: "demand begets demand"
 - ▶ The appearance of scarcity is necessary, to create demand for the assets!

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 - ▶ Auctions don't work for social goods: "demand begets demand"
 - ▶ The appearance of scarcity is necessary, to create demand for the assets!
- ▶ What do you think?

Implications: Asset Pricing

- ▶ Many papers look at trading data, and seem to show returns on NFTs are very high. . .
- ▶ But this is the same as saying the return on buying Hermes bags is high! Social goods are underpriced by design
- ▶ Sure, the trading strategy is profitable: but you can't necessarily do it, because you can't guarantee winning the mints
- ▶ Beware of crypto folks telling you about sure-win trading strategies!

Conclusion

- ▶ New framework for understanding NFT market: NFTs as “Veblen” goods
- ▶ Key empirical findings confirming model predictions:
 - ▶ NFT primary market outcomes are strikingly bimodal
 - ▶ NFTs are systematically underpriced in primary markets
 - ▶ “Scalpers” exploit issuers’ pricing strategies to systematically extract profits
- ▶ Contributions to the literature:
 - ▶ Explain NFT markets from a social goods perspective
 - ▶ Empirical evidence for mint premium and scalper returns
 - ▶ Empirical evidence supporting Becker (1991)

Ownership and royalties

- ▶ NFT collections often pay a “royalty”: % of all secondary market sale revenue goes to artist
- ▶ This is good!
 - ▶ Equity: artist makes profit if work blows up
 - ▶ Efficiency: artist/launcher has a stake in making collection continue to do well
- ▶ However, way that it's implemented discourages sale
- ▶ Solution: royalty paid regardless of whether sale occurs!
 - ▶ Each month, bidders bid in an auction to trade the NFT
 - ▶ Highest bidder wins, artist gets 2% of auction price, even if original owner keeps the NFT!
- ▶ See my paper on [Depreciating Licenses](#)

Other things

A few other NFT topics (all good topics for projects!):

- ▶ NFTs outside web3
- ▶ Fractionalization/financialization
- ▶ Rights management
- ▶ Ticketing
- ▶ Luxury goods

Adidas sold more than \$22 million in NFTs, but it hit a few snags along the way

Adidas just did it

By Jay Peters | @jayspeters | Dec 17, 2021, 8:38pm EST

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INTO THE METAVERSE

All 30,000 NFTs have now been minted.

[LEARN MORE](#) [OPENSEA](#)

2022 ALL-STAR

NBA and Dapper Labs to launch 1st-ever NFT Auction on NBA Top Shot

The auction will include 30 unique NFTs, each complete with a VIP pass for the next 5 NBA All-Stars.

Official release

NEW YORK – The National Basketball Association (NBA) and Dapper Labs, the company behind NBA Top Shot and the creators of the Flow blockchain, today announced the launch of the NBA All-Star VIP Pass NFT Auction and Giveaway. Hosted on NBA Top Shot, the auction will include 30 unique NFTs, one-of-one digital collectibles representing every NBA team that grant each owner a VIP pass for the ultimate fan experience at the next five NBA All-Stars. One lucky NBA fan will win an additional All-Star VIP Pass NFT, representing the NBA, through a giveaway that tips off today.

British Museum banks on Turner NFTs after Hokusai initiative

Prices for Ultra Rare editions start at €4,999 but museum sales percentage remains under wraps



AO releases exclusive NFT's to celebrate iconic moments in history

[ausopen.com](#)

17 January 2022

The Australian Open has teamed up with NFT and Digital Collectible platform [Rarible](#) to release the **AO Decades Collection**, featuring six commemorative NFT collections celebrating the iconic decades of the AO.

NFT Fractionalization and Financialization

- ▶ Efforts to “fractionalize” NFTs
 - ▶ Fractional
 - ▶ Paradigm, a VC fund, introduced RICKS and Mortys
- ▶ Like “NFT REITs” in a sense
- ▶ Allows hedging NFT portfolio values
- ▶ I’m personally not very excited about these efforts
 - ▶ Much of the value is in ownership
 - ▶ Would you buy a REIT that invested in Ferraris?

NFTs for Rights Management

- ▶ Music rights
- ▶ For example: **rights and book release party**
- ▶ Generalized “oracle” problems (or, “right-click-save-as” problem)
- ▶ How to tie off-chain usage to the NFT?

NFT Ticketing

- ▶ NFTs seem like a perfect solution for event tickets!
 - ▶ Undercut the very high fees Ticketmaster, etc. charge...
- ▶ An older player is **GET protocol**
- ▶ A newer one is **TravelX**
- ▶ My view: not quite wide-scale adoption yet, but very promising
- ▶ However, entrenchment of the incumbents is a big issue

Digital ownership for luxury goods

- ▶ Idea I've had: what if Gucci/Ferrari/etc minted NFTs with their bags/cars?
- ▶ NFT could be verified and linkable to Instagram
- ▶ Essentially kills the secondary market: if you buy a used Ferrari, people on your IG can tell!
- ▶ Doesn't seem to exist yet, but I'm optimistic