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Bachelor Thesis

NFT Art, an Investment Alternative for Everyone?

Submitted on 10 November 2022 by:

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Abstract

Investing, in general, was costly and only accessible to a few people in the past century. Enhanced by the ensemble between art and stock market prices, growing wealth was mostly a privilege for the wealthy. Now, in the era of decentralization and NFTs, investing in art is possible for everyone connected to the internet. This work analyses if investing in affordable NFT art had been profitable in the past. Similar like traditional art investments, risk-return ratios of NFT art is comparable to the ones of common stocks. Historic data of NFT art shows, that such investments can be very attractive, especially in the lower price segment with an initial investment amount of up to $500. It appears that NFT prices, in every price segment, are subject to high volatility. These results do not predict any future NFT prices but rather show similarities to traditional art investing. In conclusion, NFTs can be seen as a tool which can make art suitable for the portfolios of the mass.

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1 Introduction

In the early days of the Internet with Web 1.0, people with Internet access were able to access content in a 'read only' format. Web 2.0 made it possible for the masses to create their own content and make it available on the web through platforms such as Facebook or Google. However, the users are dependent on a few large corporations. With this dependency come advantages, for example a very distinctive technological infrastructure. However, the advantages are offset by major disadvantages such as a lack of transparency, questionable political decisions and high costs, driven by the high margins of the corporations. Web 3.0 wants to counteract these disadvantages by gradually replacing monopolies with decentrally organized projects. Therefore, Web 3.0 is occasionally seen as a kind of revolution. Emerging technologies such as blockchain and smart contracts enable a direct exchange between private computers, thus avoiding the dependency on a few centralized entities. Decentralization is intended to create a completely new type of transparency. By mining or buying cryptocurrencies, so-called tokens, everyone can participate in the networks of projects and influence them. Such projects can also be trading places for art. The decentralized nature in combination with new blockchain-based standards for unique assets enables the general public to trade digital as well as real art. One such example is the ERC-721 standard for non-fungible tokens (NFTs).

In the past, alternative investments like art mainly used to be part of wealthy portfolios. Auctions often took place in big cities like New York or Paris, where you either have to be lucky to get invited, or have to be able to pay the costs to get there. Not only expensive art, where potential investors were directly or indirectly preselected, prevented art from being included in the mainstream portfolios. An easy accessible, affordable and fast marketplace was missing. The problem for such a marketplace was probably not the fault of the ones who tried building it. The question was how to prove ownership of an asset, and how to make that ownership easy transferable. Fungible assets, like common stocks, already have a standard for trading them. Now, with the evolution of the blockchain technology and smart contracts, a new way of trading ownership of non-fungible assets is on its way to the public.

NFTs are on the raise to disrupt the way how people can invest and trade alternative investments like art. Investing in NFT art makes it possible to invest in a unique peace of art and the only thing you need to participate in the auction is a WiFi connection. Of course art is more than just an investment object. This makes it almost impossible to predict future art prices. But before we look into the future of NFT art as an investment alternative, we can try to understand the past.

In the following, the world of these NFTs will first be explained and a brief insight into the traditional art trade will be given, in order to then analyze the key question of whether NFT art represents an investment alternative for everyone. This work is mainly meant for retail investors who are interested in alternative investments, especially art. First we give a brief introduction into the blockchain technology in general. Then we will define what an NFT is and important coherent key words. Next, we take a look into traditional art investing, to be able to compare investing in NFT art with how this kind of alternative investing used to look like. The main part consists of analysing a big data set of NFT trades. We look at the top 100 NFT art collections on of the biggest NFT platforms when it comes to trading volume. The analysis mainly focuses on the achieved profit from the first purchase to the next sale. We will not try to predict future NFT prices. Instead, we check for anomalies in the profits in terms of the initial NFT price and the holding period, the time between the first and second trade of the NFT.

2 Literature Review

2.1 Understanding NFTs

In order to analyse NFTs and their characteristics as an investment alternative, it is essential to first understand the underlying mechanics, such as decentralization. Therefore, the following part will give a brief summary the individual parts of NFT art investing.

2.1.1 Blockchain

Gomber et al. (2017) describe a blockchain as sequence of data packages (blocks) where each block consists of messages containing information about transactions. This sequence is an ever-growing list and is maintained by a decentralized network of servers. This network validates the transactions of a new block using a consensus mechanism. The use of cryptographic hash algorithms make it hardly impossible to manipulate the blockchain. Nakamoto (2008) presented the first concept of a peer-to-peer network for electronic payments using a blockchain, today known as Bitcoin. The presented draft for payment processing using a blockchain made third-parties, like banks, unnecessary. With this new concept, the required mutual trust when making transactions is being replaced by the blockchain. Over the past years, a variety of blockchains evolved. They can differ in purpose, functionality or even in the used hash algorithm. The two blockchains with the largest market caps have been for years, and still are, Bitcoin and Ethereum. Measured in US-Dollar the native tokens of both blockchains have a combined market cap of more than \$500bn.[1]. It is not necessary to fully understand the technical mechanics how those blockchains work, it is important to know that the anyone can see the full contents of the historic blocks of a blockchain (Chen, Cong, and Xiao, 2021, p. 4-5). This is a key feature when it comes to comparing traditional art investing with NFT art investing. Another important fact about blockchains is, that since the individual blocks are build on each other, participants check previous transactions, recognize potentially invalid transactions and thus there is no incentive to validate fraudulent transactions. In order to motivate the network for the validation process and to compensate for the energy costs incurred, they benefit from transaction fees that users of the blockchain have to pay for each transaction on the blockchain (Chen, Cong, and Xiao, 2021, p. 12-13).

[1] according to cryptowat.ch on 20 October 2022

NFTs are typically embedded in such a blockchain, provided the blockchain has the required functionalities. Wang et al. (2021) stated that the concept of NFTs originally comes from the Ethereum blockchain with the aim to distinguish tokens with unique attributes. It is questionable if the concept of NFTs actually emerged from the Ethereum blockchain. The white paper of so-called Colored Coins from Rosenfeld (2012), already presented a similar construct where real-world assets can be embedded in the Bitcoin blockchain, as non-fungible tokens. However, this idea has not caught on in practice.

2.1.2 Token

Since NFTs do without a central instance, decentralized applications are required on the blockchain in order to be able to process transactions without both parties having to trust each other. With the introduction of the Ethereum network Buterin (2014), a platform emerged with built-in Turing-complete programming language, allowing for the creation and execution of a variety of complex smart contracts. This is another reason why Ethereum is the most popular blockchain for decentralized applications such as a decentralized trading platform for NFTs.

Smart contracts are codes that automatically execute the predetermined content of an agreement, such as releasing tokens once the terms of the agreement are met. They also have their own memory and account balance and, once connected to the blockchain, can no longer be changed. Transactions are sent to the contract address, which is unique. After successful validation by the network, the account balance of the contract is updated (Alharby and Moorsel, 2017, p. 127-128). On the Ethereum blockchain, smart contracts hold exchangeable ERC-20 tokens (the standard for tokens that have an identical value and are therefore exchangeable), or the native currency Ether, or non-exchangeable ERC-721 tokens, NFTs.

Ether

The standard for tokens on the Ethereum blockchain that have an identical value and are therefore exchangeable, introduced by Buterin (2014) and further explained by Wood (2022).

ERC-20

The standard for tokens on the Ethereum blockchain that have an identical value and are therefore exchangeable, introduced by Vogelsteller and Buterin (2015).

ERC-721

Equivalent to the ERC-20 standard, but for distinguishable and unique tokens, which are hence not exchangeable, introduced by Entriken et al. (2018). "ERC-721 is a free, open standard that describes how to build non-fungible or unique tokens on the Ethereum blockchain. While most tokens are fungible (every token is the same as every other token), ERC-721 tokens are all unique. Think of them like rare, one-of-a-kind collectables."

2.1.3 Minting

The creation of an NFT is a process known as minting. To mint an NFT, a user—or platform acting on behalf of the user—calls a special function in the smart contract where the NFT will reside. (Some marketplaces have a form of "lazy" minting in which an NFT is minted on the blockchain only when it is first sold or transferred.)

2.1.4 NFT Art

An NFT for an artwork consists of a digital pointer that is publicly and permanently recorded on a digital ledger - specifically on a blockchain. This pointer is an address for the content of the NFT, which usually but not always resides off chain, meaning in a system separate from the blockchain, e.g., a cloud server or a so-called decentralized storage system such as IPFS [31, 107].2 (An NFT may also include a pointer to metadata, e.g., the token name and description.) Recorded in association with an NFT is an account identifier corresponding to its owner. These account identi

ers are (randomized) numerical values, not real-world names, so NFT ownership is pseudonymous by default. Ownership can change, of course: NFTs can be bought and sold or simply transferred to new owners, and thus moved to new accounts. To understand how NFTs work, it's important to be familiar with a few key con- cepts that we now brie y describe: wallets, private keys, minting, and marketplaces. In the next couple of subsections, we provide a little more technical detail on the systems that enable NFTs.

2.1.5 Wallets

Wallets: Because an NFT resides on a blockchain, users must employ blockchain-specific software known as a wallet to buy, sell, create, and maintain possession of NFTs. Wallet software runs on a user device such as a mobile phone or a laptop and provides a graphical interface through which users can perform NFT-related

transactions. As the term wallet suggests, wallets also allow users to obtain and transact in cryptocurrency. Use of cryptocurrency is a requirement for NFT buyers and sellers, as NFTs are usually bought and sold using the cryptocurrency native to the blockchains on which they reside.

2.1.6 Marketplaces

NFTs for sale can be listed on marketplaces, websites that act as front ends for the blockchains on which the NFTs reside. Marketplaces can be viewed in an ordinary browser (even without use of a wallet). In addition to advertising NFTs and intermediating the sale of NFTs, marketplaces also provide technical tools for the creation of NFT smart contracts. In return, they collect commissions on the NFT sales they intermediate. As an example, one of the largest NFT markets today is OpenSea [37]. OpenSea NFTs reside on the Ethereum blockchain, and NFT prices on OpenSea are therefore quoted in Ether (ETH), the native cryptocurrency of Ethereum. (At the time of writing, 1 ETH is worth about $3000, but prices are extremely volatile.) To cre- ate, buy, or sell NFTs, most users interact with OpenSea using a wallet known as Metamask, which is available as a browser plug-in.

Execution within seconds

2.2 Traditional Art Investing

Art Market

Traditional art is typically traded either at auction or from a dealer. One of the major auction houses is Christies.

Market Participants

There are three sources of demand: dealers, museums, and private collectors.

2.2.1 Traditional Art as an Investment

First studies like Anderson (1974) from 1974, have examined paintings as an investment over the period form 1780 to 1970. Their results show that art investments on the one hand can provide positive annual return. But on the other hand compared with other investment alternatives, the risk-adjusted return is less attractive.
Compared to NFTs, which are traded on a blockchain that stores all the owner and price history of the individual asset, traditional art profits can not easily be calculated by comparing the purchase and sale of the asset. I.e.

Π = Profit
p_0 = Asset price at time 0 (initial purchase)
p_1 = Asset price at time 1 (sale after first purchase)

$$\Pi = \frac{p_1}{p_0} - 1$$

As a consequence, the profitability in literature on investments in traditional art, was quantified by setting up an index of art prices.
Anderson (1974) first approximated that following the mean variance approach to portfolio theory the total return must be similar to another equally risky asset. The risk is estimated by applying the Central Limit Theorem on the variance in annual returns of the constructed price indices.
Anderson (1974) came to the conclusion, that the price of a painting depends on the reputation of the artist, the year it was sold and the size of the painting. Risk return ratios of paintings can be compared with those of common stocks. Lower risk return ratios may be due to the consumption value of the art.

This is of course not 100% accurate since it is possible that only art prices one the primary market go up, but investors can not sell their art on the secondary market, or at least not for a profit. This makes the whole comparability of traditional art with the NFT art market less significant. The analysis in this work will therefore also include traditional asset classes like a bond and stock market index.

2.2.2 Art and Money

Further studies like "Art and Money" from Goetzmann, Renneboog, and Spaenjers (2011) were still using a similar approach in 2009, like the from Anderson (1974). Goetzmann, Renneboog, and Spaenjers (2011) investigated the impact of equity markets and top incomes on art prices. They constructed an art index and tested for correlation between the art index, the stock market and wealth of the wealthy. The wealth data used for their analysis rely on income tax data of the top 0.1% income share. Their results "strongly" suggest the existence of a long-term relation between top incomes and part prices. In other words, "it is indeed the wealth of the wealthy that drives art prices".

2.2.3 Buying Beauty: On Prices and Returns in the Art Market

Rennebog and Spaenjers (2012) have studied the investment performance of traditional art with a more recent and larger data set than previous work has done.

Data set ranges from 1957 to 2007

2.2.4 Does it Pay to Invest in Art? A Selection-Corrected Returns Perspective

2.2.5 Alternative Investments in the Fintech Era: The Risk and Return of Non-fungible Token (NFT)

NFTs have higher returns than traditional financial assets but also higher volatility, resulting in a comparable sharpe ratio to the NASDAQ index. NFT prices depend on tokens scarceness (Knappheit) and investor's aesthetic preference.

What are alternative investments: real estate, fine arts, wine and collectible stamps
Used for diversifying portfolios from traditional investments such as stocks, bonds mutual funds etc.
NFT interesting exploding since 2021
Literature on this crypto innovation as an alternative investment class is rather limited.
NFTs are used for proving ownership
In this paper CryptoPunks Collection is used to construct an NFT index, data since 2017
Time period for the crypto market too short.
Unlike this paper states cryptopunks "epitomize" the NFT market, we assume that other more affordable collections should be considered.

2.2.6 A Digression on Wealth

This be able to answer the question of this work, if NFT art is an alternative investment for everyone, we must know something about the individual financial ability to invest in alternative products. Not everybody is able to investment millions for one NFT. In order to find some Investment boundaries we take a look at the Capgemini World Wealth Report 2022.
The report states directly: "NFTs are cryptographic assets on a blockchain with unique identification codes and metadata that distinguish them from each other. They cannot be traded or exchanged at equivalency.
Amundi, Europe's largest asset manager announced in early 2022 that it would launch NFT products allowing clients to invest in companies operating in this space or directly in NFTs. [Fnlondon, "Amundi sets sights on booming NFT market;" February 16, 2022]

Wave Financial and Criptonite Asset Mangament have launched NFT fund for qualified investors in Switzerland. The fund features NFT collectibles, platforms, and protocols, with around 70% of allocations to the thriving digital art and collectibles space." [Hedgeweek, "Wave Financial and Criptonite Asset Management launch NFT fund for qualified investors in Switzerland;"March 28 2022]

2.3 Alternative Investment: NFT Art

NFT artwork can be treated as digital wealth, much like cryptocurrency, in that it can be valuable and quickly transferable irrespective of buyer and seller geographies. These features have already led to the use of NFT artworks as collateral for loans [35], financial derivatives [11], and NFT artwork price prediction markets [116]. As a valuable asset, NFT artwork will also spur the growth of related industries, like insurance companies with the technological knowledge to offer NFT artwork insurance for theft or loss and NFT artwork experts to advise wealthy buyers.

2.3.1 NFT Boom

The year of 2020 marked the beginning of mainstream artists publishing their work in the form of NFTs. The sale of 10 NFTs for $6 million in December of 2020 by the Canadian musician Grimes was a landmark event in the music community [143]. By early 2021, Rolling Stone declared that music NFTs had gone mainstream, noting that Kings of Leon became the first band to a release a new album as a non-fungible token (NFT) in March 2021—with great success [124]. In summer 2021, prominent traditional artist Damien Hirst [8] announced the sale of a series of 10,000 hand-painted dot-covered works on paper entitled The Currency. He gave buyers the option of receiving the physical work or having it destroyed and represented as an NFT. Well-known auction houses such as Sotheby's [70], Christie's [54], Phillips [109], and others also started to conduct NFT sales [139] as NFTs caught the eye of in- fluential artists. One prominent example of the burgeoning acceptance of NFTs in the art community was the $69 million sale by Christie's of the NFT art piece "Everydays" [67, 135] by digital artist Mike Winkelmann [48] (artist name Beeple). This sale propelled NFTs into the media spotlight and Beeple to fame outside the cryptocurrency-art circles in which he was previously known. In the next section, Section 5, we examine the most recent past year of NFT history, and discuss the current shape of the NFT ecosystem.

2.3.2 NFT Market Today

Just as technology development for cryptocurrencies is advancing at a breakneck pace, so too are technologies and fads in the world of NFTs. A description of what purports to be the current state of the NFT ecosystem would no longer be current after a few months. Therefore we instead offer a snapshot of the NFT landscape in early 2022, spotlighting what we view as the most significant emerging and popular forms of NFTs, with an emphasis on art and collectables. We organize this snapshot of the state of the NFT industry into three separate pillars: Section 5.1 deals with who the market participants are, Section 5.2 considers what types of NFTs they interact with, and Section 5.3 discusses the places where these market participants interact.

2.3.3 Categories

Category	Collection
Fine Art	Art Blocks, Fidenza, Damien Hirst's Currency
Profile Picture Collections	CryptoPunks, Bored Ape Yacht
Collectibles	Club Parallel Cards, NBA Top Shot
Crowdfunding Media Production	Treeverse, ETH-MEN, Shibuya
Grassroots Community Building	Loot, n project
Fractional Ownership	Fractional.art, SharkDAO, Founders DAO
Identity Tokens	Proof of Attendance Protocol (PoAP)

Table 1 Taxonomy of popular NFTs

2.3.4 NFTs as a Crowdfunding Mechanism

NFTs as a Crowdfunding Mechanism: Many projects in the NFT ecosystem use the sales of collections of art NFTs as a means of selling the intellectual prop- erty rights to a character or participant in a soon-to-be-developed media collection (like a comic, movie, television show or game). The proceeds then bankroll further development of the media project, in a manner akin to crowdfunding sites like Kickstarter or GoFundMe. In the existing ecosystem, these NFT projects tend to focus on building ecosystems of intellectual property, stories and artwork associated with the NFT collection, slowly growing an entire media franchise centered around the NFTs. Examples of this kind of crowdfunding NFT in gaming include Treeverse [105] and Colony Online [56], both of which sold NFTs to raise money for development of Massively Multiplayer Online Role Playing Game (MMORPG)-style video games. For example, Treeverse sold NFTs that were meant to be used in the upcoming game as private homes for owners of plots of land. In Colony Online's case, the NFTs

represent animal characters meant to be used as the sprite, that is, the avatar, of the owner while interacting in the game-world. Comic-startup companies have also used NFTs as a means to bootstrap a project: Both PixelVault PUNKS Comics [90] and ETH-MEN [65] sell NFTs for tokenized comic books such that access to read the comic is restricted to people that have purchased the token. The PUNKS Comics project uses NFTs in a novel way. That project promises that in the future, a physical comic book they create will be mailed only to people who participate in a "burning" event in which users render their tokens unusable by transferring them to a special address that no one controls [90]. NFTs have also bled into video media. For example, the Forgotten Runes Wizards Cult [72] project used proceeds from the sale of a group of 10,000 wizard-picture NFTs to fund a partnership with the animation studio Titmouse to produce an animated television show about the lives of the wizards in the NFT collection itself [6]. The Shibuya.xyz project [98] is producing an Anime television show. The team behind the project sells "episode" NFTs on a regular basis that allow the person who purchases the NFT to vote on the trajectory that the episode will take, similar to the decision points in a choose-your-own-adventure game [99].

2.3.5 Market Participants

Creators (Artists and Developers)

Artists and smart contract developers cre- ate the art and infrastructure that support the NFT ecosystem. Many of them come to acquire NFTs, not infrequently as gifts from friends or fellow artists. As such, they constitute a special class of collectors and tastemakers. While there have been examples of famous artists who were or are also collectors (e.g., Damien Hirst [8]), the ease with which relationships can be formed and NFTs can be transferred has made interactions among creators especially vibrant within the NFT community. For instance, creators will partner to host digital events. Creators in the traditional art world have held co-hosted events as well, but the speed and geo-diversity of Internet culture means artists can hold digital events more often and more easily than events at a gallery. For example, the prominent cryptoartist Farokh [68] holds weekly podcasts with other NFT artists, which are accessible to anyone with an internet connection, in contrast to the exclusive events held by traditional galleries in the physical world [95, 96]. Another prominent NFT artist, FVCKRender [76] is well known in the community for being an avid collector as well as artist. His OpenSea profile, for example, shows that he owns over 1500 NFTs created by other artists [75].

2.3.6 Real-World Interaction Tokens and Identity Tokens

One last NFT col- lectable trend in the current ecosystem are identity tokens that serve as both as collectibles and as tokens that prove some sort of fact about a human being. One example of this is the Proof of Attendance Protocol (PoAP) ecosystem [91]. PoAP NFT tokens are intended to be given out by organizers at conferences as conference swag, like stickers or tee shirts. Often these tokens will have a corresponding piece of art for that year's conference attached to the token. Later, anyone can verify own- ership of a PoAP token, and view the list of tokens for attendance to each unique event. These tokens can then be used by groups that want to only interact with people that attended certain conferences or real-world events. PoAP tokens are subvertible, in the sense that cheating conference organizers can distribute fake credentials. For higher quality identity NFTs, the Proof of Humanity (PoH) [92] project grants NFT tokens to Ethereum users who prove they're a human. The PoH system requires submitting video evidence answering a list of questions, and it also utilizes a system in which people must have other people "vouch" for their humanness and the uniqueness of their asserted identity. Today, identity NFTs are not widely used. Their use has been limited to gating access to NFT-related parties or to opportunities to purchase new NFTs [53, 142]. We believe, however, that identity NFTs will assume a much larger role in the NFT ecosystem in the future. We discuss this idea in Section 6.

2.3.7 NFT Communities

Some discussion and interaction among NFT market par- ticipants occurs on sites like Instagram, Facebook, and Tik-Tok, but the majority happens on two social media networks: Twitter and the Discord chat application. Typically an NFT community will create a Discord server (a chat server) for community members, with gated chat channels only accessible to members that have proven ownership of an NFT in the associated collection. The largest of these communities tend to include tens of thousands of users. For example, as of March 2022, the Bored Ape Yacht Club has 148,000 Discord users, and the Larva Labs (the company behind CryptoPunks, Autoglyphs, and Meebits) Discord has 56,000 registered users. Twitter too serves as a platform for discussions among influencers, thought lead- ers, and regular users. Commentary on Twitter is more public than Discord, since all Tweets are fed into one central timeline, as opposed to the segmented chat servers of Discord. Unlike the case in many industries, in the NFT space many influencers on Twitter have dedicated pseudonymous accounts that discuss only NFTs and dis- play expensive collections. Examples include Cozomo de Medici (confirmed to be the famous rapper

musician Snoop Dogg), who as of March 2022 has 214.3K fol- lowers [57] and Punk 6259 who has 285.4K followers [40]. Traditional "influencers" also take part: Artists and celebrities such as Steve Aoki [44], Logan Paul [32], and DeadMau5 [24] partner with different NFT collections, promote them on Twitter, and even release their own NFTs. Twitter has embraced the NFT community, even offering a feature in its paid Twitter Blue subscription service that allows users to distinguish their NFTs as their profile pictures with hexagonal portraits, as opposed to the usual circular portraits of non-NFT users. The service validates that the NFTs are actually stored on-chain, but does not limit which NFT collections are allowed to be used or validate that the NFT collection itself is legitimate or fake in any way.

Investors

Another category of NFT buyer is those who seek to earn a profit over the long term based on astute anticipation of the NFT community's evolving tastes and market dynamics. Some of these investors, both individuals and institutional investors, re- semble those in traditional art markets, as discussed in Section 3. Ex- amples of the latter include Three Arrows Capital [103, 104]. They are known for collecting com- puter generated digital art pieces from a well-known curated online NFT Art gallery called Art Blocks [49] and describe themselves as "a hedge fund established in 2012 and focused on providing superior risk-adjusted returns." Smart contracts, however, have also given rise to NFT investors for whom coun- terparts in the traditional art world are rare or non-existent. For example, many NFT investors invest in fractional ownership or shares of high-value works of art, a rela- tively unpopular practice in traditional art markets. For example, fractional.art [73] allows any owner to frac- tionalize her or his NFT in a smart contract vault, which issues partial shares of the NFT that can then be traded and sold. This practice allows investors to gain expo- sure to NFTs they could not afford to own in their entirety. Some investors invest in NFTs by way of Decentralized Autonomous Organiza- tions (DAOs), smart con- tracts that realize institutional investment with governance rules enforced by code. For example, members of SharkDAO [97] use a DAO to fractionalize Nouns [86], an expensive variety of NFT. There are many similar DAOs for other high-value NFTs, e.g., CryptoPunks, Bored Apes, etc. (See Section 5.2 for further discussion of DAOs for NFTs.)

Flippers

The last category of participant in the NFT ecosystem are flippers: a special class of investor who hold NFTs for very short periods of time. As discussed in Section 3, flipping is frowned upon and discouraged in traditional art markets. In NFT markets,

it is a common practice, however (although it can be and sometimes is prevented by having smart contracts enforce minimum holding periods on NFTs). Many NFT flippers exhibit behaviors like those of arbitragers in traditional finan- cial markets: They employ technically sophisticated strategies to exploit arbitrage opportunities between different marketplace platforms, gain priority access to NFTs before the general public to sell at a higher price (frontrunning [115]), and so forth. Indeed, some prominent arbitragers such as MEVCollector [81, 82] and SneakyN- injaPants [100, 101] publicly discuss and arbitrage both cryptocurrency and NFT transactions in search of profit.

2.3.8 Measuring Profitability

Top profits driving traditional art prices already indicate a restriction for people having an yearly investment budget of less than, for example, $1000.

2.3.9 Who Should Buy and Own NFTs?

The ability to create, buy, and trade NFTs at present is more open than in traditional art markets. NFT artists must only have access to a cryptocurrency wallet application, make an account on a platform like Opensea, and be able to pay transaction fees to mint their NFTs. NFT buyers have the same technical requirements. Although access to traditional fine art markets is limited by gallerists and auction houses, which often exclude unknown buyers or those with a reputation for reselling works, the traditional art market is still notorious for money laundering [117]. Without gate-keeping by gallerists and auction houses, anyone with the resources can participate in the NFT market. This openness could lead to a more democratized art market, however, it raises regulatory concerns. Identity verification standards to purchase and trade NFTs are not universally enforced. In the broader cryptocurrency ecosystem, identity verification and en- forcement against money laundering and the financing of terrorism has been left to exchanges, the companies that allow trading of cryptocurrency for government-issued currencies and vice versa. With identity verification completed as a separate step at the discretion of private companies for many cryptocurrency-to-cryptocurrency transactions, legal enforcement against criminal users can be challenging. As NFTs embody large amounts of value, their use for illicit purposes as an alternate form of digital wealth to cryptocurrency will raise challenges for national financial law en- forcement agencies. One potential solution would be to require identity verification using a centralized or decentralized identity system before an individual can interact with NFT trading platforms. As with know-your-customer (KYC) / anti-money- laundering (AML) systems in the traditional

financial system, sanctions lists could arise for users who have engaged in criminal activity.

2.3.10 New Financial Instruments with NFT Artworks

An NFT artwork can be easily fractionalized and owned by groups of collectors using a smart contract that custodies the work and parcels out ownership shares. These ownership shares can be publicly viewed, ownership can be proven, and shares can be resold or further fractionalized. Buyers of NFTs have in some cases achieved massive and rapid price appreciation by fractionalizing ownership and selling shares. (Their approach is analogous to real estate developers who buy parcels of land and carve them into lots.) For example, DOGE, an NFT of an image of a dog, sold for a total of 11,000 ETH once fractionalized after its initial purchase for 1,696.9 ETH [137]. Protection against fractionalization using price caps by artists hoping to discourage price speculation for their work can be found in Section 6.1. Art funds in traditional markets have not become popular. In contrast, there has been a significant growth of funds where investors buy re-sellable shares of a selec- tion of NFTs from successful collections. These funds are roughly like index funds, allowing investment in a portfolio of NFT artwork that is broadly representative of a segment of the NFT market. While the reason for the popularity of such funds in the NFT community is unclear, it no doubt helps that NFT artworks can be bought and sold quickly, without the hassle of transporting and securing valuable physical objects. NFT funds typically operate in a decentralized manner as DAOs (see Section 5.2). DAOs enable funds with no managers, only stakeholders, and could revolutionize collective ownership of fine art [14]. Similarly, one could imagine NFT art museums operating as DAOs, with patrons guiding acquisitions and exhibitions.

2.3.11 The Bot Art Market

A future is conceivable in which machines shape or even dictate tastes in art markets. Machine learning can be used to create NFT artwork and also to purchase it. Thus the principles of taste that govern the desirability of NFTs may deviate from human taste. While this seems to be a futurist prediction, machine learning is already used to generate NFT artwork. For instance, an algorithm called Botto generates art and each week mints a piece as an NFT based on votes from the Botto community [15]. The Gan Apes [30], a series of NFT artworks, are created by feeding existing NFT artworks called the Bored Apes into a machine learning system called a Generative Adversarial Network (GAN). What is created is an image generally recognizable as a version of a Bored Ape, but differing in form, color, and style. Machine learning has

another role to play in NFT markets as well. NFTs more closely resemble traditional financial instruments than traditional works of fine arts, as discussed in Section 6.2. Financial trading firms commonly use machine learning to craft trading strategies. NFT trading is a natural application of machine learning algorithms, one that will inevitably arise if it hasn't already. An interesting twist, however, is that such algorithms may take as input not just data on market dynamics, but also characterization of the style of NFTs, i.e., trade in part based on NFT styles. Beyond prediction of NFT market movements to devise profitable strategies, ma- chine learning algorithms could also discover ways to manipulating art markets, i.e., strategies to influence the trading behavior of market participants. The result would be use of machine learning algorithms not just to predict market movements, but to influence them for profit.

3 Analysis

The previous chapters gave a introduction into the world of NFTs, traditional art investing and finally, the combination of both: NFT art investing. This chapter puts the theory into practise. By analysing historic NFT art investments, this analysis provides insights, which are especially relevant for potential investors considering to enter the NFT art market. The analysis begins with describing the available data, and preparing it for deeper analysis. In the next step, the profitability is broken down in detail. By comparing contiguous transactions, the analysed profitability represents realised returns by actual trades and thus ensures practical relevance. At the end of the analysis part, the from the data induced advantages and disadvantages will be faced.
Note: data gathering, data clean-up, and the analysis was all performed using python. The according code can be found on github.com/vfcapital/bachelor-thesis.

3.1 Data

This section describes the data which was used for analysing the profitability of NFT art investments. First, it needs to be decided which NFTs are being included in the analysis. As as basis, this work chose the top 100 art collections from opensea.io.[2] Opensea.io is one of the major exchanges, when it comes to minting and trading ERC-721 tokens on the Ethereum blockchain.[3] The top 100 collections ranking is selected by all time trade volume measured in the ethereum native currency ether (ETH), and filtered by the NFT subcategory "art". For the time span of retrieving the data, this work chose the 01 January 2019 until 03 October 2022. This might seem like an extraordinary short period of time when comparing to data sets of traditional art, where typically several centuries of history investment transactions can be analysed. As in the previous chapter mentioned, NFTs and its ERC-721 standard was first published in 2018. Hence, much longer time spans are just not possible. Looking at the finally retrieved data in the following section of the actual analysis, one will notice that most of the NFT art trades took place in late 2021, see figure 1.

Plainly looking at the transaction distribution, the analysed data set raises questions of potential selection issues. An argument against potential selection is the fact, that the selected top 100 collections are composed by all time transaction volume and the collection in the data set with the lowest transaction volume is called "SUPER-PLASTIC: SUPERGUCCI" with an total volume of $14,695.95. This relatively low

[2] as of 01 October 2022, 11:00 am CET
[3] erc721.org

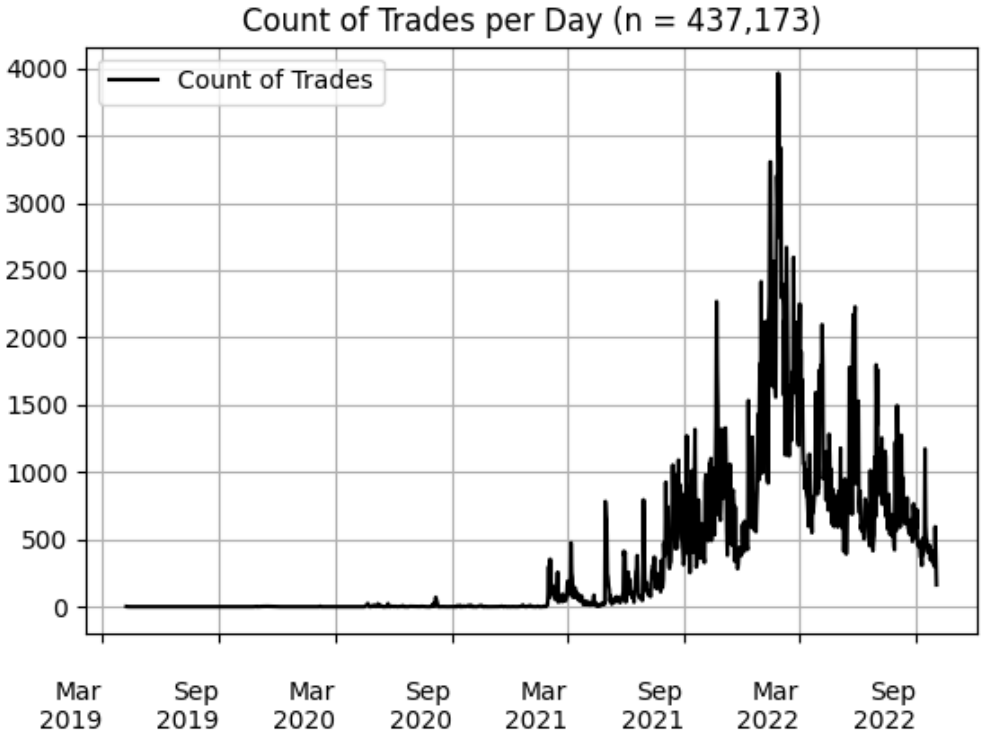

Figure 1 Transactions per Day

all time transaction volume indicates that the most important NFT art collections are included in the data set. For comparison, the collection with the highest overall transaction volume is "BoredApeYachtClub" with a total of $967,988,903.95. More metrics on the data can be extracted from table 2. At this point it needs to be noted, that the data on the one hand contains primary as well as secondary market transactions, since both types are possible on the opensea.io exchange. On the other hand, the data contains only actual successfully settled trades. The data from etherscan.io comes directly from the Ethereum blockchain, ensuring a high data quality. Additionally, in the next steps, the clean-up process of the data will be described in a shortly manner. It turns out that after the data set clean-up only 89 of the initial 100 retrieved collections remain in the data set. A final count of remaining 437,173 transactions within the past 3.5 years can still be seen as a well representation of the overall NFT art market.

While retrieving the data of each collection for this work, a strong pattern has been occurring for a majority of collections. Most of the transactions of each collection happened on the first days of launching the collection. This pattern matches the in the previous chapter mentioned behavior of NFT investors always looking for the next hyped collection. This can also be shown in numbers. Across all collections, 5%

Count of Collections	89
Count of NFTs	164,195
Count of Transactions	437,173
Median Transaction Count per Collection	4,443
Median NFT Count per Collection	1,814
Min. Total Volume per Collection	$14,695.95
Median Volume per Collection	$5,921,004.73
Mean Volume per Collection	$21,092,742.05
Max. Volume per Collection	$967,988,903.95

Table 2 Total Transaction Volumes per Collection

of all transactions happen on the first day after the first trade was made. 51.30% of all transactions happen within the first 10 days. Having the majority of trades within the first trading days displays a cluster risk in terms of liquidity. This issue will be caught up on in the discussion part. Another potential issue with the data set could be survivorship could cause upwards bias in the analaysis, as Goetzmann, Brown, et al. (1992) exemplified. This potential issue is countered by the nature of how a blockchain works. Every transaction settled on the blockchain stays on the blockchain and can not be reverted. As long as opensea.io did not manually remove any collection from the top 100 art collections of all time transaction volume, the list is complete. Even NFT collections which are not being traded anymore and lost their complete attraction to investors, are included in the analysis.

As already mentioned and table 2 also shows, only 89 of the initial 100 NFT art collections remain for the final analysis. This is caused by the clean-up process. This process is important to for achieving reliable results and avoiding unnecessary errors in the calculation. The clean-up is required for the profit analysis of all initially fetched 775,592 transactions. This work starts with a table which contains the following columns:
Transaction Hash, Timestamp (inclusive milliseconds), Transaction Action Type, Buyer Wallet Address, Collection Name, Token ID, NFT Type, Quantity, Price and Market Place
First, a unique NFT identifier is created by merging the collection name with the collection specific token id. Since the token id is not a unique identifier, merging both columns into one makes further calculation easier. Next, checks are being run on the data to ensure that the market place is for all the same opensea.io. Similar to the market place, a check ensures the NFT type to equal the Ethereum standard ERC-721. The transaction action type has to be "bought". This excludes some included transactions where the investor won the auction but the trade did not settle. In the next step, all transactions having a buy price of $0 are excluded from the

data set. This might seem controversial to some. The background of $0 buy prices are typically a marketing strategy for some selected investors, made by some collections. Potential investors can not rely on such special treatments, and the resulting profits from such transactions would bias the final results by increasing the mean profits significantly. The amount of such transactions is still low, compared to the total count of transactions. The following step cleans out a much higher number of transactions. In order to calculate realised profits of NFT art transactions, at least two transactions are required per unique NFT id. Every transaction of unique NFTs only having exactly one transaction in the whole data set will be excluded for the profit analysis. Additionally, all duplicated transactions are excluded from the data set. It is possible having multiple transactions with the same transaction id. This happens on opensea.io when an investor buys multiple NFTs and pays them in one payment.

Compared to traditional art price indices, there can't be survivorship bias in the art market. Since all trades, even those with a total loss, are included on the blockchain..... resale, Goetzmann, Brown, et al. (1992) Goetzmann (1992) shows that survivorship issues can put a significant upward bias on estimated returns. Goetzmann, Renneboog, and Spaenjers (2011): It is a more pressing issue when solely focusing on the performance of art as an investment.)

hedonic approach for analysing returns?

To get an estimate of the index over T periods based on N repeated sales observations, we follow the Bayes formulation of a repeat sales regression, which imposes some additional restrictions on the estimation, outlined in Goetzmann (1992, 1993):

where X again is a N x T matrix of dummy variables indicating the holding period for each object, the weights in are the times between sales, and R is the N-dimensional vector of logged returns. Additionally, J is a matrix of ones, and is a constant that divides the variance of the residual error by the variance of the index:

The Bayes formulation avoids spurious negative autocorrelation in the estimated return series, and leads to a much more accurate estimator when the number of observations is relatively small (Goetzmann, 1992).

A good approximation of the annual arithmetic returns is then given by the cross-sectional variance of the return can be estimated in the second stage of the Case-Shiller repeat- sales regression under the assumption that it is constant over time (Goetzmann, 1992). This specification

corrects for a downward bias of the arithmetic mean that is due to the log transformation of the art prices. The return estimates can then be used to build a price index over the period of interest.

3.2 Analysing NFT Art Trades

Pedregosa et al. (2011)

3.3 Discussion on Profitability

3.3.1 Disadvantages

Cluster risk of liquidity. 51.30% of all trades happen within the first 10 days of trading of each collection.

3.3.2 Advantages

3.3.3 Costs

Costs are even for an NFT costing half a million US-Dollar very low. and always below $1.

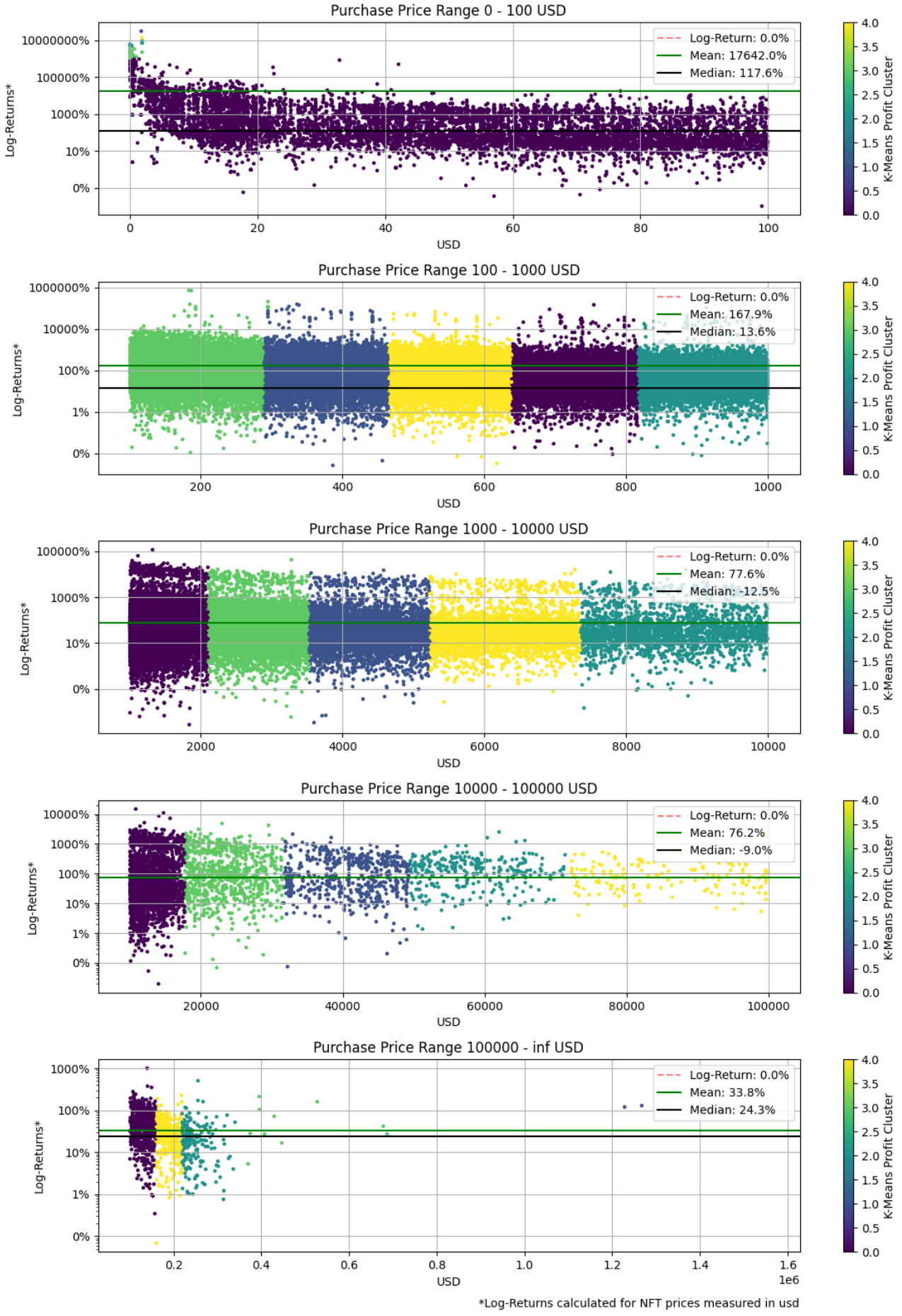

Figure 2 NFT trade returns per purchase price in ETH (1/2)

Source: Own calculation. NFT data from etherscan.io, accessed on 02 October 2022

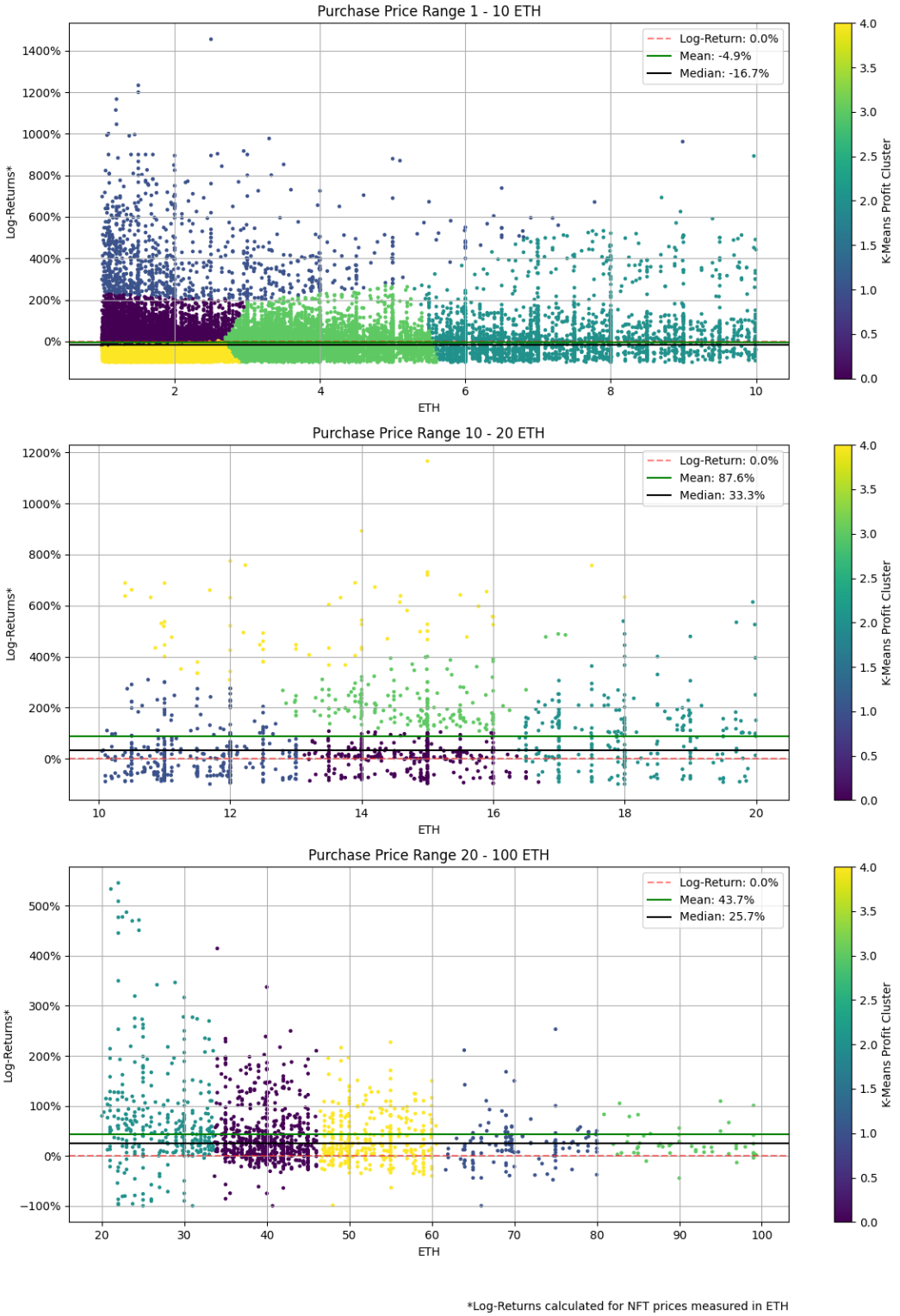

Figure 3 NFT trade returns per purchase price in ETH (2/2)

Source: Own calculation. NFT data from etherscan.io, accessed on 02 October 2022

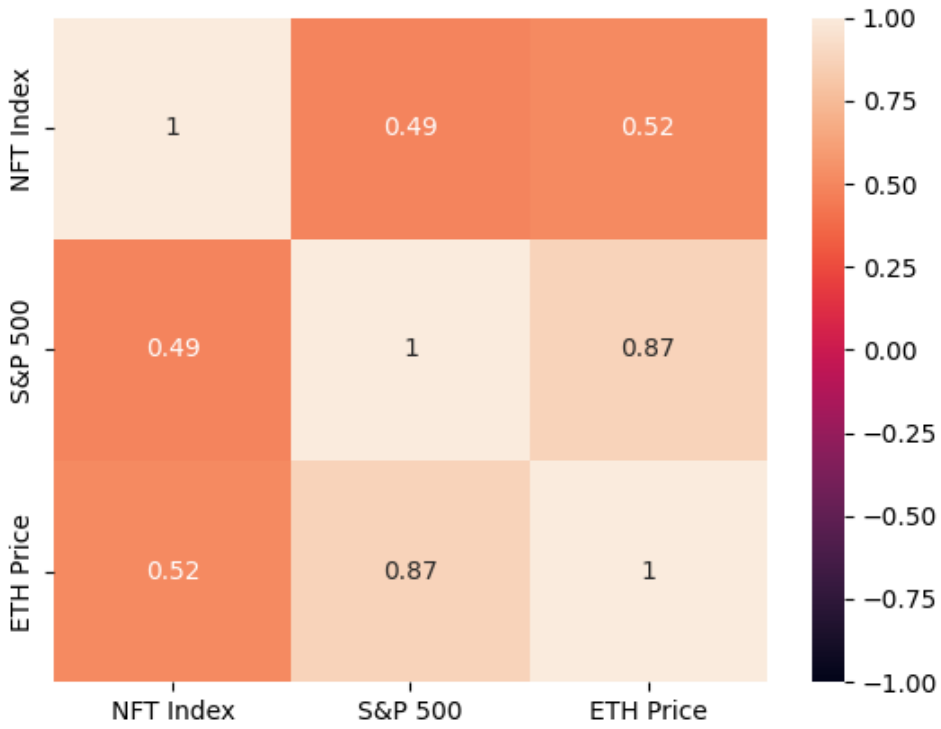

Figure 4 Correlation Heatmap

Source: Own calculation. NFT data from etherscan.io, accessed on 02 October 2022

4 Conclusion

NFTs themselves and the markets created to buy and sell them are new and do not carry the centuries of tradition, norms, legal frameworks, and community practices that surround the traditional art market. NFT artworks can rapidly benefit from innovations in their creation and purchase and sale. They may also emerge as a new frontier for tech-savvy criminals.

costing less than $500, resulted in positive sharpe ratios and medians of more than 30% with an average holding period of X days. This also applies to NFT art in the higher price segment, but the opposite in the mid price segment like $1,000 to $50,000 initial purchase price. It appears that NFT art collections have their best times right after the release

Financial Return + Consumption Value of Art vs. Risk (i.e. total loss)

4.0.1 The Future of NFTs for Art and Collectables

As discussed in earlier sections, the NFT art market sits at the crossroads of cutting edge technology (Section 2) and the traditional art market (Section 3). This collision has created a unique digital culture and a digitally realized marketplace (Section 4 and Section 5), results that have the potential to empower artists by adjusting the balance of market power in their favor. We foresee multiple potential paths for the future for the NFT art market. The first would empower artists with unprecedented control of the sale and resale of their work, facilitate the creation of high-tech work, and grant access to profits in previously impossible ways. The other is a picture of dysfunction: bots snapping up pieces and excluding most attempted market participants, artists unable to execute more control over the sale of their work due to lack of technical knowledge, and undetectable art-related crime. The true future of the NFT art market is likely to contain features from both visions, so we discuss elements of both.

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A Appendix

A.1 Collections

0xmons.xyz	Killer GF
10KTF	Kitty Crypto Gang
3Landers	KnownOriginDigitalAsset
8SIAN	Lil Heroes
AIMoonbirds	Lives of Asuna
AVASTAR Token	Lost Poets
Anatomy Science Ape Club	MAX PAIN AND FRENS OPEN EDITION BY XCOPY
ArtAI	MOAR by Joan Cornella
Async Art	Meta Eagle Club
Autoglyphs	MidnightBreeze
Avid Lines	Mindblowon
Beeings	Murakami.Flowers
Beeple Round 2 Open Edition	Mutant Garden Seeder
Black Box	NFTBoxes
Bloot	Noodles
Boki	OGCR
Boonji Project	PeopleInThePlaceTheyLove
BoredApeYachtClub	Phanta Bear
C-01 Official Collection	Pop Art Cats
Cold Blooded Creepz	QQL Mint Pass
Corruptions	RareApepeYachtClub
Crypto Coven	Rarible
CryptoArte	Rektguy
CryptoJanky	Reptile Armoury
Cypher	SUPERPLASTIC: SUPERGUCCI
Deafbeef	Sneaky Vampire Syndicate
Desperate ApeWives	Squishiverse
Dippies	Super Cool World
Divine Anarchy	SuperRare
Elemental	TRAITORS by XCOPY
Fat Ape Club	Terraforms
Feline Fiendz	The Art of Seasons
First	The Surreals
Fishy Fam	TheCurrency
ForgottenRunesWizardsCult	Tubby Cats
Fragments By James Jean	Voxies
GODA Mint Pass	Waifus
Generativemasks	Weirdo Ghost Gang
Gh0stlyGh0sts	Women Rise
God Hates NFTees	Women and Weapons
Hashmasks	WonderPals
Hello, i'm Victor FEWOCiOUS And This is My Life!	YOLO
Incognito	inbetweeners
Karafuru Gachapon	merge.
Karafuru	

Statutory Declaration

I hereby declare that, to the best of my knowledge and belief, this thesis titled *NFT Art, an Investment Alternative for Everyone?* is my own, independent work. I confirm that each significant contribution to and quotation in this thesis that originates from the work or works of others is indicated by proper use of citation and references; this also holds for tables and graphical works.

Frankfurt am Main, 10.11.2022

Viktor Fendesak