

NON-FUNGIBLE TOKENS (NFTS): SUSTAINABLE GROWTH OR DESTINED TO DISAPPEAR?

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Abstract. *The paper aims to analyze the new technology of non-fungible tokens (NFTs) to understand whether there is a basis for sustainable growth or whether these tokens will disappear over time. The key issues analyzed include economic, environmental, legal, and accessibility aspects. NFTs are an innovation that has emerged in recent years and have attracted huge and growing interest worldwide. They represent a type of cryptographic token that serves as a deed and certificate of authenticity for a single asset on the Blockchain. In order to do so, the methodology consists of analyses of existing literature and various information sources. What emerged is that NFT technology is to be considered as the future of online property and is destined to revolutionize, to some extent, the way the internet is used. In addition, it is an important product and process innovation for many companies, regardless of their industry. However, sustainable growth will only be possible if several environmental, legal, and economic changes occur. It must therefore be in everyone's interest to preserve and exploit the potential of non-fungible tokens, and to invest in and commit to making them environmentally sustainable and secure.*

Keywords: *Blockchain; Environmental impact; Non-fungible tokens; Sustainable growth; Technology.*

Introduction

Non-fungible tokens (NFTs) are a type of cryptographic token representing a unique asset's deed and authenticity certificate written on the Blockchain (Chohan, 2021; Kugler, 2021). Non-fungible tokens are distinguished by the fact that they are not interchangeable with one another. NFTs are an innovation that has emerged in recent years and have attracted huge and growing interest worldwide.

The motivation behind developing this topic, both on a practical and academic level, is the incredible innovation power that NFT technology is proposing. NFT can be applied to new companies and products and to the transformation or improvement of existing

products and processes. Attention to environmental impact and possible applications to safeguard the environment is also closely linked to technology.

This paper aims to study the longevity of the NFT technology, observing its pros and cons and all its possible applications (Wilson, Karg, & Ghaderi, 2021). In particular, the focus will be on understanding whether NFTs can have sustainable growth or are destined to disappear. The key issues analyzed include economic, environmental, legal, and accessibility aspects. Sustainable growth is therefore understood as a form of development that safeguards the environment first and foremost, but also the economic and legal security of users.

The approach used in this paper is a compilation approach, implemented by collecting information from many sources and studies.

The paper is structured as follows: the first paragraph will deal specifically with NFTs, starting with the blockchain technology underpinning these tokens and ending with the various non-fungible tokens. The second paragraph will focus on market analysis, value, trends, and fluctuations. The third paragraph is the heart of the study, highlighting all aspects of whether NFTs will have sustainable growth or fade away in the future. As mentioned above, the paragraph will deal with the controversy surrounding the speculative bubble status of the market, the environmental impact of NFTs, legal and regulatory aspects, and the current accessibility issues of non-fungible tokens.

Blockchain and NFT: a literature review

There is a category of blockchain-based virtual assets known as non-fungible tokens (NFTs), which have garnered incredible investor interest in a very recent and short period (Bao, & Roubaud, 2022; Dowling, 2022a). To adequately deal with the world of NFTs, it is, therefore, necessary to take a step back and tackle the topic of blockchain technology (Chevet, 2018; Karandikar et al., 2021).

Blockchain technology (Di Pierro, 2017) is defined as a decentralized, distributed ledger that records the provenance of a digital asset (Nofer et al., 2017). The data on a blockchain cannot be changed by design, making it a real disruptor in industries like payments, cybersecurity, and healthcare. The blockchain, derived from the phrases block and chain, is a decentralized distributed database structured as a chain of blocks holding transactions. Those are chronologically correlated, and a system assures the integrity of cryptographic methods and rules. Once the data has been inserted into the blocks, it can no longer be updated retroactively without invalidating all subsequent operations, which would suggest that most of the system agrees. Every record is saved to include a portion of the information they refer to previously; this relationship makes it very hard to make changes without them being immediately accessible to the whole network. The blocks to be added to the chain are then submitted to a validation procedure based on the idea of distributed consent, which assures the chain's legitimacy by making the figure of a superfluous. The blockchain is a decentralized ledger based on the distributed trust concept that, according to its unique configuration, does not require the intervention of a third party to ensure its incorruptibility because it is designed to do so.

Blockchain can be classified into three kinds based on how the ledger is maintained: public blockchain (Bitcoin and Ethereum), consortium blockchain (The Hyperledger Fabric consortium blockchain), and private blockchain, respectively.

Blockchain (Belotti et al., 2019) has some general components. Generally, blockchain architecture can be organized into five tiers: data layer, network layer, consensus layer, incentive layer, and application layer.

A token is a digital asset that may be transferred between two parties on a blockchain platform without an intermediary. In other words, it represents a value related to an item, service, or property right (Bamakan et al., 2022). Tokens have the following characteristics:

1. liquidity: it can be easily transformed into current currency or cryptocurrency
2. divisibility: allows the subdivision of the value into even minimal units
3. exchangeability: allows you to make trades
4. immutability: once digital information is entered on the blockchain it will no longer be changed.

The tokenization (Li et al., 2019; Freni et al., 2020) process entails converting a good/rights service into a digital token registered on the blockchain, with the real good and the token linked by a smart contract. Tokenizing is the process of generating and tying a token to a tangible object through a smart contract on a blockchain network. The smart contract converts a contract into code that can automatically verify the fulfillment of conditions and perform actions or make provisions in this regard. Technically, it is based on scripts that read the various provisions of the contract as well as the operating conditions under which they must be maintained. It is self-activated when the data referring to real-life situations match the data relating to the established contractual requirements.

A non-fungible token can be seen as a unit of digital information (token) stored on a blockchain and is not inherently interchangeable with other digital assets (non-fungible). The term “fungible” derives from the economic and accounting literature and is defined as anything that is interchangeable with an identical or similar object. Traditional forms of currency, whether equivalent sums of paper money or identical units of precious metals, are fungible objects, which helps them serve as mediums of exchange, because they are understood to be of equal value. According to Nash (2017): “Fungibility is, essentially, a characteristic of an asset or a token in this case, that determines whether items or quantities of the same or similar type can be completely interchangeable during exchange or utility”.

Value, Trends, and fluctuations of NFTs

At the end of November 2021, the total US dollars spent on completed sales for NFT amounted to approximately 20 billion. The comparison with the previous quarter (with an amount of approximately 1.8 billion) shows a difference of 18.2 billion dollars. Statista, in a study updated in October 2021, reports the market size of NFTs. Specifically, the data highlighted cover many topics, starting from the general market to the various sectors of application of non-fungible tokens. The market capitalization of transactions globally involving a non-fungible token shows strong growth, with 40.96 million US dollars in 2018, and with 141.56 in 2019, reaching 338.04 in 2020. The

exponential growth is demonstrated by the percentages, with an increase of 245.61% between the first and second year and 725.29% between 2018 and 2020. The sharp rise in interest in NFTs is also demonstrated by the world's most expensive non-fungible token sale in March 2021. "Beeple Everyday: The First 5000 Days" sold on March 11 for \$ 69.3 million, followed by "CryptoPunk 3100" (7.58 M) and "CryptoPunk 7804" (7.57 M) sold on the same date. Currently, the top 15 most valuable sales were made in 2021.

Non-fungible tokens are often traded in a marketplace within the platforms that issue the NFT. However, there are external sites where the users can sell and buy tokens. OpenSea is an NFT marketplace founded in New York in 2017 by Devin Finzer and Alex Atallah. On the platform users can generate NFTs for free and offer them for direct purchase or auction. OpenSea is based on the Ethereum ERC-721 standard. A crypto wallet such as B. Bitski or MetaMask needed. OpenSea has a total volume of \$ 10.39 billion, with 639,121 traders and an average of \$ 873.04 per transaction. The second in terms of volumes is Axie Infinity.

The data collected highlights the exorbitant value that some single NFTs are reaching. This type of token is therefore inaccessible to the wallets of most users and therefore one of the directions that the NFT world is taking is that of fractionalized NFTs. This type of NFT allows individual investors to spend a small amount by purchasing fractional ownership of a high-value asset.

The market we see evolving today is a market that is growing at an exponential rate, with unprecedented liquidity but also it is even more of a speculative and volatile market than ever before. One of the first indicators that has caught our attention is that of the resale rate being sold at a loss. Several collections are starting to show significant resale rates at a loss.

If this trend is confirmed, it could reflect the beginning of the deflation of the speculative bubble around certain types of NFT (notably Collectibles). In any case, the current growth context requires all investors and NFT stakeholders to pay extra attention. Triple digit growth necessarily goes hand in hand with market instability, unrealistic expectations, and potential disappointments.

The topic highlighted by NonFungible fully represents the fluctuations mentioned above. In fact, although in the previous paragraphs the data collected told of an unprecedented unstoppable expansion, the reality may be thornier to face. The fact that many collectors are making losses after the sale of their collections shows that the value of NFTs is strongly linked to risk. In fact, having the possibility of varying strongly (both increasing and decreasing) in value, these are assets that require particular attention in the purchase and sale. Since the interest is currently huge and NFTs are accessible even to fundamentally inexperienced or uninformed users, the necessary attention is very often absent. One of the terms used by NonFungible in its conclusions on the third quarter of 2021 is the speculative bubble.

NFTs: a sustainable growth?

The previous paragraph collected and analysed economic data relating to NFTs and their fluctuations in value. To understand whether NFTs are destined to disappear or have the scope for sustainable growth, it is not enough to simply observe the data collected.

What is, therefore, necessary is to start by taking into consideration the disputes that exist on this topic. This also allows us to observe the negative sides of this world, detaching ourselves from the glitter of the phenomenal economic data described, to understand, with a critical eye, the potential, and the future of NFTs.

The first useful source to study the presence of a bubble state is the study carried out by Maouchi, Charfeddine and El Montasser (2022). Within their paper, done in collaboration between the College of Business and Economics (Qatar University) and the ESCT school of Tunis (University of Manouba), the scholars used a sample of 9 DeFi tokens, 3 NFT, Bitcoin and Ethereum, trying to detect different bubbles that can overlap the cryptocurrencies examined. Specifically, the nine DeFi considered are Chainlink [LINK], Maker [MKR], 0x [ZRX], Ren [REN], Terra [LUNA], Synthetix [SNX], Fantom [FTM], Reserve Rights [RSR], THORChain [RUNE]. The three NFTs are THETA [THETA], Enjin Coin [ENJ] and Decentraland [MANA]. Finally, they consider Bitcoin [BTC] and Ethereum [ETH], as they are the two cryptocurrencies with the largest market. The inclusion of the two cryptocurrencies is prompted by Bitcoin's dominance of the cryptoassets markets and its status as one of their primary drivers, as well as Ethereum's role as the backbone of DeFi and NFTs protocols.

The starting concept of the study is that the rate and extent of capital flows to DeFi and NFT are reminiscent of cryptocurrencies and the creation of bubbles observed in these markets in the study by Kyriazisa et al. (2020). The study method applied is the "real-time bubble detection method" proposed by Phillips and Shi, which has the advantage of circumventing the problems of unconditional heteroscedasticity and multiplicity that other bubble identification methods have. They looked at potential bubble predictions by considering both internal and external aspects in cryptocurrencies markets (Dowling, 2022b). They employed four univariate models: logit, probit, tobit, and linear regression. While the last three models are used for the robustness of the results, logit is the most relevant for the study. The dependent variable in logit and probit models is a dichotomous variable that takes the value 1 (Bubble = 1) if the estimated PSt statistic is greater than the bootstrap critical value, and 0 otherwise. Inside, the logit model considers the variables: traded volume, TVL, COVID-19 pandemic proxied by the global number of total cases, VIX, gold, Google Trend searches, EPU index, and Brent prices. The result of the bubble detection is described by a graph for each of the three NFT, which shows in the highlighted parts the presence of speculative bubbles detected by the PS algorithm.

Taking into consideration the entire year 2021 and comparing it with previous years, one conclusion that can be made is that the entire year can be considered a single bubble. However, given its possible applications, NFT technology is only at the beginning of its rise and 2021 could be just the beginning of an even more disproportionate increase in sales, operations, and users.

The technology of non-fungible tokens is at the centre of debates concerning not only the economic aspect analysed in the previous section. The impact that the creation and exchange of NFTs has on the environment is another topic of controversy (Truby et al., 2022). In order to study this counter-bias we need to start from the study by Valeonti et al., (2021), which aims to understand whether NFTs provide a fundraising opportunity for galleries, libraries, archives and museums (GLAM) by selling ownership of digital copies of their collections. To understand this, the paper examines the environmental

issue, giving a clear view of the current situation. Academics introduce the topic by explaining how the most contentious issue concerning non-fungible tokens is the significant energy consumption connected with the Ethereum blockchain, which is where most NFTs are traded. Ethereum's annual energy consumption is anticipated to be 48.7 Tera-Watt Hours (TWh) as of May 2021, the same as Malta's annual energy consumption. As a result, environmentalists have been harsh in their criticism of NFTs. Precisely for this reason, many newspapers have moved to address the environmental impact of NFTs and their future sustainability.

Energy-efficient NFTs, in parallel to Ethereum, already exist and are traded on a regular basis. One of them is Whitworth Gallery NFT is registered and sold on the low-energy Tezos network. Many other blockchains, such as Cardano and Algorand, use the Proof-of-Stake mechanism for transaction verification, with energy costs comparable to operating traditional servers in a centralized application. Furthermore, Cardano, a project based on academic research, is fully operational by the end of summer 2021. Due to its pioneering, peer-reviewed Proof-of-Stake implementation, Cardano promises to be "The Most Environmentally Sustainable Blockchain Protocol," while its scalability, interoperability, and sustainability characteristics make it a contender to challenge Ethereum's dominance.

Although the mechanism guarantees significantly lower energy consumption than Ethereum's one, the Proof-of-Stake technology has nevertheless received criticism from environmentalists. PoS blockchains have been accused of "granting power to the already powerful" (the more coins a node operator holds, the more transactions they are allowed to verify with their coins held as collateral) and "that [this] is also a climate issue," because "climate justice is social justice". Regarding this criticism in the study, the academics take a clear position, explaining that the current subsidies (referring to museums, but it's applicable to other contexts) coming from the banking system consume much more than if NFT were used.

Lastly, aside from PoS adoption, other measures are being used to reduce the carbon footprint of NFTs, albeit with a lesser impact. These measures include so-called Layer 2 solutions (in which the number of transactions that must be registered on the blockchain is reduced to a minimum) and the use of renewable energy for mining.

The conclusion on the environmental issue from the study by Valeonti et al. (2021) is that, despite the various criticisms, the financial potential of non-fungible tokens is substantial. The problem they identified is attributable to the Ethereum blockchain, on which NFTs were first built, which consumes a lot of energy, and this is the most serious criticism made against them. Most NFTs are still traded on the Ethereum blockchain, which consumes a lot of energy, even though energy efficient NFTs already exist. The expectation is therefore that the world of NFTs will increasingly turn (as does Ethereum) towards sustainability and ever lower consumption.

Non-fungible tokens, due to the energy consumption required by the blockchain to validate the transaction, have been and still are objectively harmful to the environment. Moreover, the cause of this immense energy consumption is mainly due to Ethereum and the fact that most of the transactions take place on its blockchain. What has emerged, however, is that there is hope for NFTs and that a process is already underway to solve this problem. In fact, the channels that have been activated to reduce energy

consumption and make NFTs more environmentally friendly are mainly two: the first concerns the blockchain technology itself and the second the origin of the energy consumed to bring operations to life.

The change in blockchain is also divided into two possibilities. The first is to move away from Ethereum (based on the Proof-of-Work method of transaction validation) and make room for blockchains based on the Proof-of-Stake method. This option has already entered the mainstream, thanks to blockchains such as Cardano and Algorand, which use the Proof-of-Stake mechanism for transaction verification, with energy costs comparable to running traditional servers in a centralised application. The second possibility is to apply the project to improve Ethereum's technology, without therefore having to radically change the reference blockchain. In this case the innovation would be brought about by using the single blockchain to contain multiple NFTs. In the case of the approach launched by StarkWare a single block would be able to contain millions of NFTs, but the project of the two Israeli founders Eli Ben-Sasson and Uri Kolodny is not the only one already in place to have as its objective to increase the efficiency of the Ethereum blockchain. It is also necessary to remember that Ethereum itself has for years declared its commitment to making its technology more sustainable. The second channel concerns the use of renewable energy sources to power the NFT world. On the positive side, NFT and cryptocurrencies go hand in hand, as they are both based on the same technology. This means that both are interested in making progress about energy consumption. Again, the journey has already begun (currently renewable energy sources account for around 39% of bitcoin mining) and projects such as CurrencyWorks (there are many in the pipeline), which turns rubbish into energy, are one of the keys to the future survival of NFTs.

Despite the important steps being taken towards environmental protection, there is still a long way to go. The rise in interest in NFTs also represents an increase in energy consumption, which makes it more important to move quickly in the direction of environmental protection. Precisely for this reason, projects that aim to make the reality of NFTs less polluting are in clear growth, thanks also to the awareness that non-fungible tokens can represent the future of online ownership and that the enormous media visibility that the problem of environmental impact it has received could cause its disappearance.

Non-fungible tokens are still a novelty and as such not all the necessary steps have been taken to regulate the market (Fairfield, 2022). This means that legal and regulatory aspects are still to be defined or in the process of being defined. Currently, as legal regimes differ from country to country, the creation of a global standard for NFTs must consider local legislation. According to Jordanoska (2021), most NFTs would fall into the category of unregulated tokens, and hence outside of the regulatory perimeter, unless they exhibit features of e-money or security tokens in terms of providing additional rights. Investing in unregulated tokens, such as NFTs, is exempt from the standards for fair, unambiguous, and non-misleading advertisements. Moreover, regulatory protections are likewise unlikely to be available to investors.

A clear example of consideration of the regulation of NFTs came from the UK's Financial Conduct (FCA). The consultation acknowledged that NFTs might be used as a medium of trade or for speculative and high-risk purchases. It decided, however, that they are not easily replaceable and hence do not constitute a significant enough risk to consumers to warrant regulatory intervention. The FCA's abilities to interfere in the NFT market for

consumer protection would be restricted in this regard, consisting primarily of consumer education and warnings about crypto investment scams. The FCA is already working in this direction, for example, by launching a £11 million digital marketing effort to raise awareness of the risks of cryptocurrencies. The outcome of the consultation is still awaiting, however due to the fast-paced innovation in the sector and the continual creation of new ways to integrate NFT features, the stance may need to be reconsidered in the future. As in the UK, other states will move to issue their own NFT regulations, seeking to clarify the “rules of the game”.

Conclusions

The paper began by asking whether non-fungible tokens can have sustainable growth or are destined to disappear over time. Sustainable growth means that technology can be oriented towards both profit and economic return, as well as social and environmental development. The prerequisite was therefore to find out whether in the future there is room and feasibility for an environmentally friendly, user-safe, and clearly regulated use of NFTs.

All aspects that determine whether sustainable growth is possible were analysed. First, the NFT market and the possibility that it is in a state of speculative bubble were considered. Observing this aspect was useful to understand whether the market is driven by hype, by irrational and unjustified drives, and therefore destined to collapse, or whether it is reliable and developing. Since this is a rapidly changing reality, and since it is difficult to realise that you are in a speculative bubble when you are in one, it is impossible to establish with certainty the reliability of the market. The values recorded and the studies considered suggest that there may be a general bubble state, although it cannot be ruled out that it may have already burst. As a result, NFTs are a reality that should be approached with caution and vigilance by both potential investors (especially those who are inexperienced) and regulators (Chohan, & Paschen, 2021). The section on the possible applications of NFT technology was useful to show that, although there is still some uncertainty about the reliability of the market, the potential of non-fungible tokens is vast. This means that, as a means of product and process innovation for many companies, NFTs can in effect become a constantly used medium, thereby stabilising the market. As time progresses and NFTs move beyond the stage where they are a novelty, the occasional users who are only attracted by easy profit (even in a fraudulent way) could be displaced and the correct uses of these virtual assets could be increasingly implemented.

A further aspect observed to understand the future growth of NFTs is the legal and regulatory one, establishing that currently there are still some uncertainties, in regulation, hovering around this world. Nonetheless, the conclusion is that NFTs, like any other breakthrough that generates a lot of hype, will take some time to become established. The regulation is, in fact, temporary adaptations of current rules that may or may not apply to non-fungible tokens. As a result, individual states and higher institutions will progressively regulate the market and NFTs themselves, both legally and fiscally. Furthermore, the presence of intermediaries (as banks have historically been for money management) cannot be ruled out, albeit this would go against the blockchain's core principle of decentralization.

Accessibility is another factor influencing the future growth of NFTs. There are currently barriers to entry, represented by the lack of information on non-fungible tokens and the

myth that, being based on the blockchain, they are considered cryptocurrencies. Another barrier to entry is the high fees associated with transactions on the blockchain. It follows that for NFTs to grow effectively, platforms and states themselves must move to provide more information to users, combined with a reduction in the fees to be paid for each transaction. As most transactions are still carried out on the Ethereum blockchain, which currently has very high fees, one solution could be to use alternative blockchains.

Once outlined the economic, legal, regulatory and accessibility factors, and established that although there are some aspects to change, improve or overcome, NFTs can have an important path of growth, it's necessary to get to the environmental factor. In this way the picture is complete, and it is possible to establish whether sustainable growth is possible. The conclusion about the environmental impact of NFTs that emerges is consistent across all the sources examined. The first realization, which should be obvious to everyone, is that non-fungible tokens have been and continue to be objectively destructive to the environment due to the energy consumption required by the blockchain to validate the transaction. Furthermore, Ethereum and the fact that most transactions take place on its blockchain are the primary causes of this massive energy use. What has emerged, however, is that there is hope for NFTs, and that a process to fix the problem is currently starting. Indeed, there are primarily two channels that have been triggered to cut energy consumption and make NFTs more environmentally friendly: the first concerns blockchain technology itself, and the second concerns the source of the energy used to bring activities to life. Change in blockchain can also be separated into two categories. The first is to abandon Ethereum (which uses the Proof-of-Work technique of transaction validation) in favor of blockchains that use the Proof-of-Stake method of transaction validation. The second option is to use the project to improve Ethereum's technology without having to update the reference blockchain drastically.

Despite the important achievements gained in the direction of environmental conservation, there is still much work to be done. Increased interest in NFTs also means increased energy consumption, making it even more critical to act fast in the direction of environmental preservation. Precisely because of this, projects aimed at making the reality of non-fungible tokens less polluting are on the rise, owing to a growing awareness that non-fungible tokens can represent the future of online ownership, and that the enormous media attention that the issue of environmental impact has received could lead to their extinction. Another important aspect observed is that it should not be overlooked that some types of NFT can be beneficial to the environment, either by preserving it directly or by helping it in other ways.

The result that is reached by combining all the assumptions concerning the factors considered is that NFT can have sustainable growth, but only with a major evolution in many aspects. NFT technology has proven to be very flexible and applicable in a wide range of contexts, making it a candidate for future introduction in many companies. Although this innovation may revolutionize both the product offered and the process of offering it, the world of non-fungible tokens is still immature and needs to take steps forward to survive. First, the environmental aspect must be resolved, as the world environmental situation is so delicate nowadays and it is not acceptable that a new technology, even if revolutionary, is so polluting. NFT is a technology that many people are interested in preserving and in fact the results show that progress is being made to

solve the problem of environmental impact. The premise of sustainable growth therefore lies in how quickly blockchain, and consequently non-fungible tokens, become an environmentally sustainable technology.

The economics are equally important for growth (Borri, Liu, & Tsyvinski, 2022), and while the limitation of this paper is that it is not possible to determine with certainty whether the NFT market is in a state of speculative bubble, the path that non-fungible tokens are taking does not seem to have a stop in sight. Another conclusion to be drawn from the study of the market is that it will have to be constantly observed carefully, especially by regulators. Legal and regulatory aspects are essential for sustainable growth, both to guarantee security for users and to establish guidelines and penalties for environmental protection. Finally, simplified access to NFTs and correct information from institutions will also be essential to remove barriers to entry for this promising technology, both for users and companies.

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