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Digital Disruption in Art: A Comprehensive Analysis of AI and NFT Market Dynamics

Keywords: artificial intelligence; NFT; AI-generated art; digital art; cryptocurrency

JEL: O14; N7; O33; Q55; Z11

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Abstract

Theoretical background: The dynamic development of generative artificial intelligence such as ChatGPT has transformed the perception of creative work. In the graphic realm, AI systems like Midjourney, DALL-E, or Adobe Firefly allow the creation of high-quality graphics without the need for artistic skills or hiring a talented designer. Concurrently, the emergence of cryptocurrencies and the associated non-fungible tokens (NFTs) has resulted in radical changes in the creative sector, especially in the art market.

Purpose of the article: The aim of this article is to examine the development pace and impact of AI-generated art and NFTs on the global art market, focusing on market trends, dependency on energy prices, segmentation, and how these changes influence artwork pricing and artists' livelihoods.

Research methods: The author has assessed the popularity and development of the NFT market, as well as the main reasons for its collapse in 2022. The author identified possible scenarios for the development of the art market, pointed out the primary potential threats, and highlighted the key determinants of future digital asset valuation.

Main findings: Despite initial euphoria, buyers depreciate digital goods, especially those generated by artificial intelligence. They are considered inherently inferior and less valuable. Overproduction of works combined with the availability of AI solutions means that the traditional supply and demand mechanism lowers the price

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of assets and thereby forces more and more graphic designers, photographers, and painters to abandon their professions. Competition from artificial intelligence is subject to the same supply and demand mechanisms, which reduces the cost of access to quality graphics for entrepreneurs and individuals. Simultaneously, as the market becomes saturated with synthetic goods, there will be a delineation at the segment level, similar to what has happened with artisanal beers, hand-assembled cars, and furniture, or handmade ceramics. An unwritten, "made by humans" certificate will result in a 300–500% higher price for similar goods made by humans compared to works of artificial intelligence. This situation will resemble the division of the clothing or furniture market into mass-produced goods and designer items. Amid all this, the increasingly prominent role of NFTs will be evident, which will also appreciate in value, but due to the ecological taxation resulting from energy consumption that is 100,000 times higher than that of a regular bank payment.

Introduction

The Fourth Industrial Revolution has ushered in the era of the Internet, digital commerce, and artificial intelligence, leading to the creation of several technologies and products that are transforming production processes and business management. The advent of cryptocurrencies, built on blockchain technology, has facilitated the emergence of digital artworks known as non-fungible tokens (NFTs). Additionally, the evolution of generative artificial intelligence now enables the mass production of diverse goods in various styles. As this digital revolution permeates the arts and crafts sector, it becomes crucial to analyze the ongoing processes and anticipated market changes.

The rapid development of artificial intelligence (AI) and the surge in NFTs within the art market have initiated profound discussions and considerations around the integration of technology with traditional and digital art forms. Simultaneously, the fluctuating energy prices pose unique challenges and opportunities for the burgeoning NFT market, drawing attention to the sustainability and ethical dimensions of digital art transactions. While AI's role in enhancing creativity, streamlining operations, and expanding the accessibility of art is increasingly acknowledged, significant research gaps remain in comprehensively understanding its implications on the art market's dynamics, authenticity, and valuation of artworks.

Furthermore, the implications of energy costs on the sustainability of digital artworks, particularly NFTs, underline a pressing need for holistic investigations into how economic, technological, and environmental factors converge within the art sector. This juncture presents an emergent research gap, where the intersection of AI development, energy economics, and the art market's transformation demands a multifaceted exploration. Such an investigation is crucial for identifying sustainable practices that can support the art market's expansion while addressing ethical considerations and ensuring equitable access to technology.

The aim of this article is to explore the development pace and impact of art generated by Artificial Intelligence (AI) and the NFT market on the global art scene and how it may change in near future. It seeks to identify the main trends, market segmentation, and drivers of change in the AI-art market, and to assess their effects on artwork pricing and the livelihoods of artists.

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This paper aims to delve into this uncharted territory, proposing to examine the nuanced relationships between AI's creative potential, the economic implications of energy consumption in digital art production and distribution, and the evolving landscape of the art market influenced by technological advancements. By identifying and addressing these research gaps, the study seeks to contribute valuable insights into fostering a sustainable, inclusive, and ethically responsible future for the art world in the digital age.

Literature review

The emerging digital economy elevates intangible digital data to a pivotal role, akin to how oil once dictated economic development and competitive advantages. Similarly, the global art market is experiencing a transformation, fueled by digital advancements.

The initial shift occurred in May 2014 when Kevin McCoy sold the first NFT, a short video animation created by his wife. It was registered on the Namecoin blockchain and sold for USD 4 (Cascone, 2021). The subsequent year saw the debut of the first NFT project, Etheria, utilizing the newly established Ethereum blockchain (Matney, 2021). In 2017, the CryptoKitties game introduced a series of tradable NFT cat cards, skyrocketing Ethereum transactions and significantly slowing the network (Wong, 2017).

The NFT market's rapid expansion, primarily among computer gamers, artists, and tech enthusiasts, led to a surge in its value to USD 250 million in 2020 (calculated as turnover value) (Harrison, 2021). By 2021, this value reached USD 25.1 billion and slightly decreased to USD 24.7 billion in 2022. Concurrently, transaction numbers grew from 58.6 million in 2021 to 101 million in 2022 (Hayward, 2023). This growth phase also saw a significant revaluation of individual NFTs, transforming initially niche assets into widely popular ones beyond a narrow circle of tech aficionados. Moreover, the influx of numerous NFT platforms and artworks resulted in a market oversupply relative to the expanding audience.

Understanding the implications of NFTs necessitates a comprehensive grasp of the underlying technology. An NFT, short for non-fungible token, is a unique digital asset, often Ethereum-based.

Cryptocurrencies leverage blockchain technology, which consists of distributed ledgers, a concept introduced by Nakamoto in 2008 (Nakamoto, 2019). Bitcoin, the first cryptocurrency, was developed using an algorithm functioning on a decentralized network. This blockchain algorithm interlinks a distributed database, securing transaction records with cryptographic protocols (Garay et al., 2017). Blockchain addresses the issue of trust in transactions by requiring that a transaction be validated by over 50% of network participants before processing. Such widespread confirmation across nodes ensures the immutability of the archived data, facilitating the traceability of Bitcoin or Ethereum ownership (Wood et al., 2014).

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The demand for computational power, essential for cryptocurrency mining, is met by users contributing their computer's processing capabilities. Consequently, as a currency gains popularity and network activity increases, more computers join the mining efforts to stabilize the network. The primary constraint here is the energy cost required to operate these database-supporting computers.

The maturation of NFTs brings tangible economic advantages. Their integration into the gaming industry has led to the creation of cryptocurrency-based games (such as CryptoKitties, Axie Infinity, or Aviator), where players purchase exclusive virtual items (e.g. imited virtual animals, weapons, accessories, skins, clothes or upgrades), which can later be sold for profit. Game developers and NFT creators (whose authorship is sewn into each token) receive royalties from market sales, benefiting both creators and consumers.

Non-fungible tokens offer a means of "certifying" digital art, enabling authentication and security for various collectibles. Thanks to that it is possible to authenticate and secure collector cards, movies, internet domain names, diamonds, virtual real estate or intellectual property (Wiv, 2021; Superrare, 2023; NBA top shot, 2023; Icecap, 2023; Crypto stamp, 2023). For artists, NFTs facilitate enhanced promotion and the opportunity for passive income. When artists mint their digital creations into NFTs, they can promote them without relinquishing ownership rights, safeguarded by blockchain records. Post-sale, creators can earn royalties from future re-sales (Known origin, 2023; Superrare, 2023).

Furthermore, NFTs bolster the metaverse concept – a shared virtual space for digital asset storage. Blockchain technology fosters this virtual ecosystem, allowing for global cultural and recreational engagement, potentially democratizing access for marginalized groups. The nascent metaverse promises expansive growth, as evidenced by initiatives from major tech corporations. At the same time, the metaverse allows, as in the real world, trade between users and the form of exchange is cryptocurrencies. It is possible to rent offices, raise animals or buy real estate. The meta-world concept is still in the early stages of development, but the activities of Meta (the former Facebook) or Apple's presentation of the VisionPro virtual reality kit in 2023, show that this segment will grow in the coming years.

The transition of NFT usage into tangible realms has been facilitated by blockchain technology, which assures the veracity of cultural event tickets. Traditional ticketing is reliant on the trustworthiness of the vendor, with a persistent risk of fraud. Non-fungible tokens mitigate this risk by enabling secure purchases through a verifiable public transaction ledger and smart contracts. This system of authentication extends to the art world, allowing for the tokenization of physical artworks, thereby preserving their provenance and ownership history (Wang et al., 2021).

The inception of AI is credited to visionaries like John McCarthy and Alan Turing in the 1950s. AI aspires to emulate human cognitive functions. Present-day AI research harnesses neural networks for complex tasks such as analyzing text, images, videos, and speech. Through training on diverse datasets, AI systems

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develop the capability to solve problems, synthesize information, and generate new content.

Generative artificial intelligence has emerged as a transformative technology in recent years, employing neural networks with multiple layers of neurons trained on extensive Big Data sets (Składanek, 2017; Karras et al., 2019). OpenAI's ChatGPT exemplifies this innovation, utilizing large language models (LLM) such as the Generative Pre-trained Transformer. Initiated in 2018, the model has evolved, with its latest iteration, ChatGPT-4.0, released on March 14, 2023, leveraging 100 trillion parameters and trained on 570 GB of data. For comparison first version of the chatbot was pre-trained on 5 GB of data, and the second (GPT2) on 40 GB. Despite data limitations up to 2021, ChatGPT-4.0 processes millions of queries daily, facilitating ongoing learning. The model's development, estimated at USD 12 million, was enabled by Microsoft's backing, incorporating ChatGPT into its Bing, Office, and Azure platforms. Even with its data restrictions, the model provides internet search capabilities to fetch current information (Gratas, 2023).

Building on the foundations of ChatGPT, OpenAI developed DALL-E, an AI for image creation, launched on January 5, 2021, with its second iteration now available as a paid service. Users can purchase tokens to generate images from textual descriptions, termed prompts, with costs as low as USD 0.06 per set of tokens (OpenAI, 2023). Notably, DALL-E 2 allows both private and commercial use of the images it generates, which amounts to around 2 million images daily (Dorrier, 2022).

Midjourney, widely recognized in the visual arts sector for its generative AI, was developed by David Holz on July 12, 2022. This AI, seamlessly integrated with the Discord platform, offers subscription plans ranging from USD 10 to USD 120 per month. The pricing tiers correlate with the speed of image generation and the ability to process multiple prompts simultaneously. A significant feature of all plans is the allowance for commercial usage of the AI-generated images (Midjourney, 2023).

As of March 31, 2023, Adobe's generative AI, Firefly, is in beta. This tool enables users to create high-quality images via text queries. It produces four options per query, from which users can select or further refine (Adobe Firefly, 2023). Currently free during its beta phase, Firefly does not yet permit commercial use of its content. Unique features include customizable styles, composition, lightning and color schemes. Adobe plans to integrate Firefly into its suite of graphic products (Photoshop, Illustrator), suggesting an eventual shift to a commercial offering.

Other notable graphic solutions in the market include Microsoft Designer and Canva. Both platforms offer free services that enable users to create various types of content, including commercial use (Microsoft, 2023; Canva, 2023). These tools are designed for ease of use, allowing even those with minimal graphic design experience to produce professional-quality advertising materials, banners, posters, flyers, and digital content for applications and websites.The widespread accessibility of generative artificial intelligence tools, notable for their affordability and user-friendly interfaces, has catalyzed the production of vast amounts of synthetic data. This digital data, entirely

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crafted by AI algorithms, is derived from existing datasets. Such a surge in synthetic data production offers significant advantages (Dilmegani, 2023; Savage, 2023):

Data Protection and Privacy: Generated data circumvents regulatory restrictions associated with real data. Synthetic data can replicate the essential statistical properties of real data without disclosing sensitive information that falls under such restrictions.

Innovation: Access to extensive datasets, analogous to real data but unregulated, facilitates the creation of innovative solutions. This is particularly advantageous when developing sophisticated AI algorithms.

Simulation Accuracy: Synthetic data enables more precise simulations due to its approximation to real-world data.

One significant challenge is the reliance on synthetic data that may be less accurate for training AI models. While this approach improves learning efficiency, it can compromise the precision of the AI-generated output. The reliance on synthetic data is expected to increase, with projections suggesting that by 2030, a majority of the global digital content will be the product of AI processes, simulations, and statistical modeling (Gartner, 2021). This raises concerns about the authenticity and reliability of future AI-generated information.

On October 25, 2018, Christie's auctioned the first AI-created artwork for USD 432,500. The piece, titled *Edmond de Belamy*, was a blurred image of a gentleman, the work of Parisian art collective Obvious, which employed the generative adversarial network (GAN). Drawing from 15,000 portraits spanning the 14th to 19th centuries available on WikiArt, the AI was able to craft this piece. Obvious showcased this event as evidence that the creative realm extends beyond human effort (Figure 1).

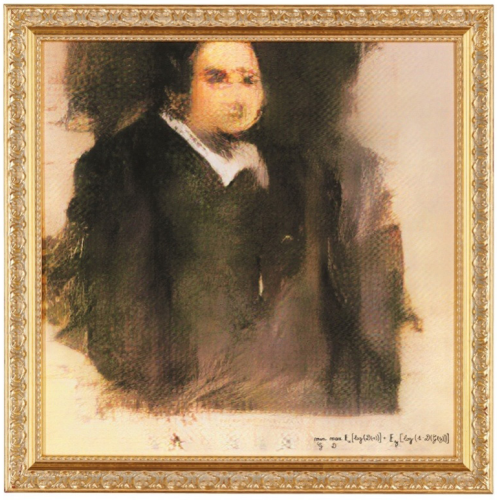


Figure 1. *Edmond de Belamy* – the first AI-created painting sold at auction

Source: (www1).

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This situation opens a new chapter for the art industry. However, the key in this new situation, is to resolve who is the creator of the artwork – the algorithm or the human typing the commands as a prompt?

The issue at hand involves the GAN program used to create the *Edmond de Belamy* painting, and the debate over attribution and royalties. The GAN was created by Robbie Barrat, not the Obvious collective, raising questions about his role and the distribution of credit and profits. The perception of AI's role in the creative process also influences attribution; the more AI is anthropomorphized, or seen as human-like, the more credit is given to the machine rather than the human artist. Despite varying opinions, the consensus tends to favor the artist's rights over those of the technologists or the public contributing prompts to the AI. The lack of a clear framework for assigning responsibility and sharing profits from AI-generated art sales points to the need for recognizing the contributions of both the artist and the programmers (Epstein et al., 2020). This scenario is analogous to Formula One racing, where the driver is primarily celebrated, followed by the team, including designers and mechanics.

This research does not alleviate the concerns of artists, who see AI applications capable of generating thousands of images on demand as a threat. Further complicating matters is the fact that every human-created image uploaded to the Internet may be used to train AI models, enhancing their ability to produce even more advanced graphics (Roose, 2022). The looming threat is the replacement of human graphic designers, actors, and other creatives with AI specialists. This shift could lead to the downsizing of entire creative departments, replaced by a few individuals who manage content creation AI, thereby tilting the balance of profits and losses in favor of companies seeking cost savings and productivity improvements.

A separate issue is the classification of AI-generated images: are they art, or as Coeckelbergh (2017) suggests, merely "machine creativity" related to machine learning? Addressing whether a machine can be creative leads to copyright considerations not only for the software developer but potentially for the program itself (Turner, 2018). This notion is popular among internet users (Lima et al., 2020). Meanwhile, studies show that people often rate AI-generated art differently than that created by humans even though they cannot always discern between the two (Köbis & Mossink, 2021; Gangadharbatla, 2021). This parallels the historical undervaluation of works by women and non-white individuals. With AI art, beyond the lack of "human artistic sensibility", the perceived lesser effort and involvement in creation may diminish its value in human eyes; knowing a work is AI-generated could reduce its perceived worth, as no physical effort or fatigue is involved from the machine (Lima et al., 2021).

Therefore, no matter how advanced artificial intelligence models become, or whether they achieve consciousness, humanity may grapple with "cyberracism", where an average human-created image is valued more than a superior one crafted by AI. The philosophical debate about recognizing AI as sentient is extensive, and its outcomes, likely far in the future, will determine if this tendency to undervalue AI contributions should be contested.

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The review indicates that the art, audiovisual, graphic creation, and copywriting market is undergoing significant change. A new market player, whose role and autonomy are not clearly defined, is emerging. This has sparked a debate on copyright distribution and incited public resistance fueled by job security concerns. Nonetheless, the advent of NFTs alongside generative AI could expand and diversify the art market, similar to how photography expanded but did not extinguish the painting market. With the purchase motives for both NFTs and traditional art aligning (Qian, 2023), the industry ponders whether there is space for both human and AI creations in the digital art realm, or if, like Schumpeter's concept of creative destruction, synthetic art may displace traditional artists.

In recent years, both the development of AI and the dynamic changes in the energy market, along with the growing popularity of NFTs, have started to exert a significant impact on various sectors of the economy, including the art market. Integrating AI into the process of creating and analyzing artworks opens new possibilities for artists and galleries, offering tools for automatic classification of artworks, extraction of artistic features, and creation of art pieces (Cheng, 2022; Cetinic & She, 2021; Yan & Fang, 2021). Furthermore, the use of AI to process and analyze large data sets allows for a deeper understanding of collector behaviors and market trends.

On the other hand, dynamic changes in energy prices are becoming an essential factor affecting the global art market, particularly in the context of the production and distribution of energy-intensive NFTs (Guan et al., 2023;). Rising energy costs may impact the value and availability of NFTs, raising questions about sustainability and ethics in this rapidly evolving sector.

Simultaneously, research gaps are emerging regarding the impact of AI on the authenticity, originality, and value of artworks in the digital era. There is a need for further research on how these technologies are changing the perception and value of art in the eyes of collectors and affecting decision-making processes related to purchases (Cheng, 2022). In the context of energy, it is crucial to understand how price fluctuations can affect the NFT market and the broader art economy, especially regarding long-term sustainability and ethical considerations related to energy consumption (Alexander et al., 2023).

Additionally, it is necessary to investigate how the development of AI and rising energy prices influence the accessibility and distribution of art across different regions of the world. This requires interdisciplinary research that combines knowledge from the fields of art economics, information technology, and sustainable development (Lean & Lee, 2022; Knez et al., 2022). Such a holistic review will allow for a better understanding and prediction of future trends in the art market, providing insight into how new technologies may shape the future of artistic creativity and investment.

Based on the performed study, the author proposes the following hypotheses:

1. The growth of NFTs and AI-generated art remains a niche, subject to high price volatility and potential speculative bubbles.

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2. AI-generated art might reduce inclusivity by marginalizing local cultures and dialects.

3. Electricity costs are a significant determinant of NFT prices, likely to remain a key factor in price fluctuations as the market matures.

4. AI technology may lead to a decrease in artwork prices and potentially push artists with minimal digital skills out of the profession.

Research methods

A bibliometric analysis was conducted to assess the popularity of different facets of the AI art market. This study involved examining the number of publications that included relevant keywords in the Scopus scientific database, spanning the years 2010 to 2022.

To evaluate the art market's size, including the NFT market and sales volume of NFT art (AI-generated art included), market analyses and statistics from the six leading digital art trading platforms were utilized. These statistics also helped in identifying trends and shifts within the cultural industry, including art. Data from Eurostat, pertaining to the European Union's economy, were used to determine export volumes and employment structures in the handicraft-related sector.

Digital exclusion among artists due to generative AI is assessed by analyzing the contribution of various languages to online content, which is crucial for neural network training. Artificial intelligence algorithms learn from Big Data datasets, predominantly sourced from web materials. Consequently, a language's prevalence online directly influences its effectiveness in interfacing with AI and capturing linguistic nuances.

Forecasting the NFT market's future values utilized linear regression and a complementary survey. The regression model, based on 2022–2023 data, predicted global NFT sales through 2030, correlating natural gas prices with NFT sales and extrapolating based on projected gas prices. The survey, targeting an economically savvy YouTube community, comprised three single-choice questions related to economics and business. The anonymous survey, conducted over seven days, garnered responses of 838, 639, and 736, respectively, and can be found at YouTube Community Survey.[1] This survey provides valuable insights, enriching the study with perspectives from informed participants in the AI-art and NFT market. Time period during which answers were gained was 7 days. Incorporating a survey in this study offers essential firsthand data from active participants in the AI-art and NFT space, lending a practical dimension to the theoretical and statistical analyses presented. This approach not only bolsters the research with real-world insights but also aligns the theoretical perspectives with current market realities and trends, enhancing the paper's relevance and applicability.

[1] (www2).

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Results

Popularity of AI NFT and blockchain

Initially, the author sought to gauge the popularity of digital art. This was accomplished through a bibliometric analysis using the Scopus database. The study focused on identifying the number of scientific articles published from 2010 to 2022, which included the keywords "NFT", "AI", or "blockchain" in their title, keywords, or abstract. The findings from this research are illustrated in the subsequent charts.

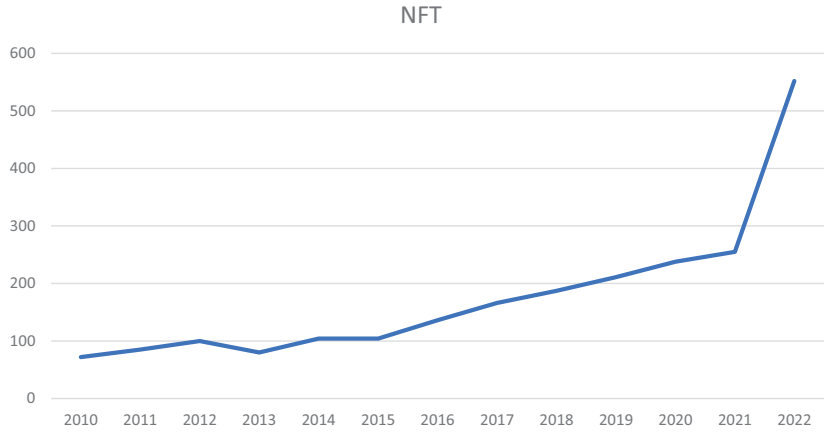


Figure 2. Number of publication regarding NFT in Scopus database (2010–2022)

Source: Author's own study based on the Scopus database.

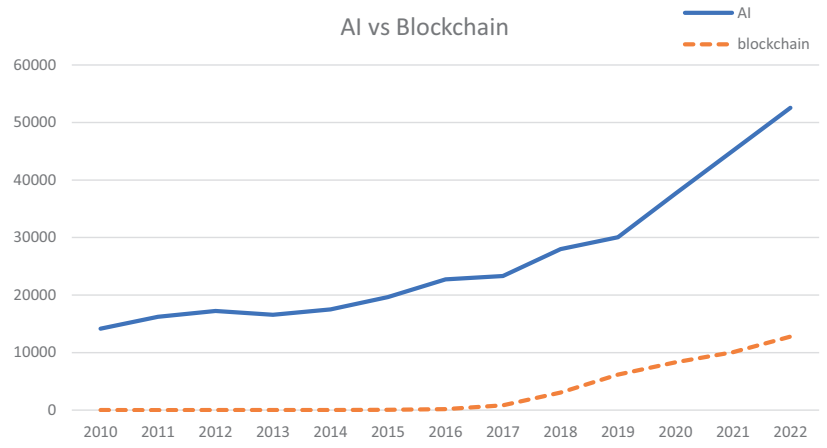


Figure 3. Number of publication regarding blockchain and artificial intelligence in Scopus database

Source: Author's own study based on the Scopus database.

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The analysis of the data suggests that during the period studied, NFT was the most niche research topic. This could be attributed to its narrower scope compared to AI, which had significantly more articles. Blockchain publications were fewer than NFT articles until 2015. Since 2017, there has been a marked increase in interest in cryptocurrencies, growing from 3.5% of the interest level in AI to 24.3% in 2022. In 2022, NFT-related interest constituted 4% of blockchain and 1% of AI interest (Figure 2 and 3). The significant rise in NFT interest was only evident in 2022, indicating the need for a longer time series to confirm if this trend of increasing NFT popularity will persist.

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The literature review section discusses the principle of operation and technologies related to NFT and synthetic art. Analysis of bibliometric values using Pearson's correlation coefficient yielded the following results (Table 1):

Table 1. Pearson correlation values for AI, blockchain and NFT

Variables	Correlation index value	*p*-value
AI & NFT	0.887	2.31e-05
AI & blockchain	0.969	1.25e-08
Blockchain & NFT	0.895	1.50e-05

Source: Author's own study

In all instances, there is a high correlation, signifying a strong relation between digital technologies. Also all of the above correlations are statistically significant. Although AI is not a prerequisite for NFT development, the evident correlation of increased interest among researchers, governments, and companies in staying at the forefront of innovation – currently centered around robotization and algorithmization – is notable.

NFT's share of the art market

The global art market (excluding NFTs) was USD 67.8 billion in 2022. This value has been relatively stable since 2007 (Figure 4).

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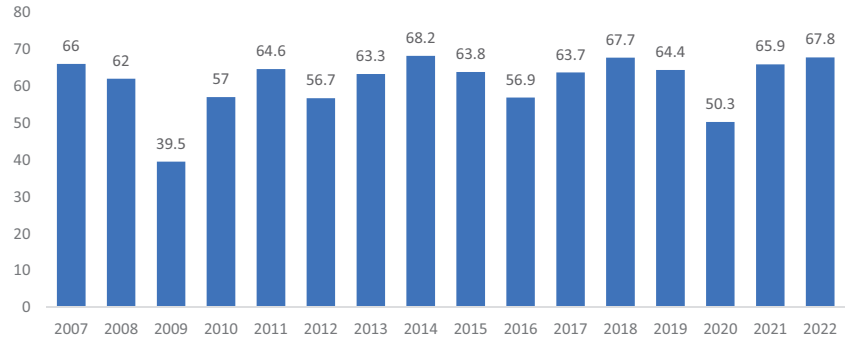


Figure 4. Global art market sales volume (in billion USD)

Source: (Statista, 2023b).

At the same time, the global NFT market – understood as the sale of blockchain-based art and collectibles worldwide – was USD 4.6 million in 2019. The year 2020 gave an increase of 552% (to USD 30 million), 2021 – by 43.674% (to USD 13.1 billion), and 2022 – by 1.3% (to USD 13.3 billion).

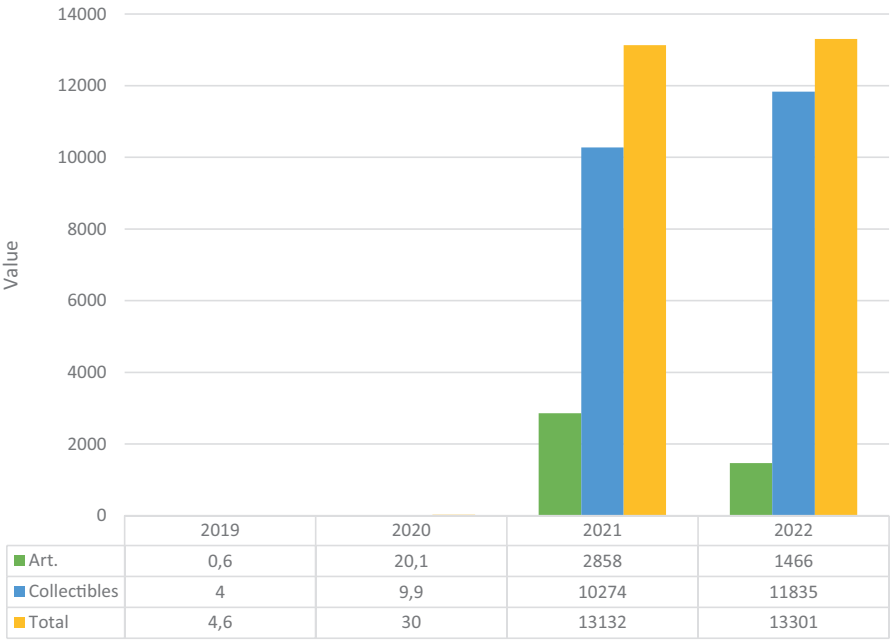


Figure 5. NFT annual sales volume globally

Source: (Statista, 2023c).

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In 2020, NFT art saw a sales value surpassing that of collectors' items, accounting for 67% of the total sales volume in art goods. However, in 2019, 2021, and 2022, art's share fluctuated between 11 and 22%. This pattern indicates that NFTs remain predominantly linked to the gaming and entertainment sector, where collectibles lacking artistic value are significant contributors to the overall turnover (Figure 5).

The comparison between the global NFT art market and the traditional art market shows a growing significance of NFTs. In 2019, NFT art sales were a mere 0.001% of traditional art sales, but this figure increased to 4.3% in 2021 and then to 2.2% in 2022. Meanwhile, the entire NFT market's value, including art and collectibles, rose from 0.007% in 2019 to 19.62% in 2022. Notably, the NFT art market experienced a 49% value decline between 2021 and 2022, possibly due to speculative activities by certain cryptocurrency firms.

Analyzing the sales values of NFT art and traditional art through Pearson's correlation coefficient reveals a correlation of 0.58. Conversely, this coefficient for the relationship between traditional art sales and the entire NFT market is slightly higher at 0.686. This suggests a linkage between the two markets, supporting the notion of considering generative art and NFT as legitimate forms of art.

The dynamic growth of the NFT market was stopped in the middle of 2022. This is particularly evident from the monthly sold value of the global NFT market in Figure 6. The data comes from the 6 largest NFT trading platforms: Blur, OpenSea, Magic Eden, x2y2, CryptoPunks, LooksRare and the values are expressed in dollars (left scale). They are juxtaposed with average global natural gas prices for the month (in USD, right scale). Natural gas represents changes in the price of energy, as it is responsible for 25% of energy generated globally (IEA, 2023).

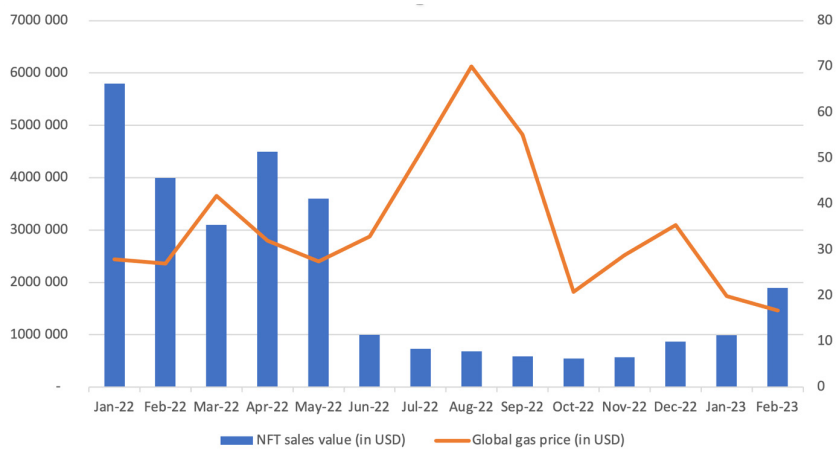


Figure 6. Monthly NFT sales volume globally and global gas prices

Source: https://www.coingecko.com/research/publications/nft-trading-volume and International Monetary Fund (2023).

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The contrasting relationship between energy prices and the volume of NFT market transactions becomes evident. This correlation is linked to the implementation of the 6th package of EU sanctions and restrictions on the supply of natural gas and oil to Europe, specifically in response to Russian sanctions (Kardaś, 2022). The process of validating NFT transactions involves powering the entire blockchain network, demanding substantial computational resources. This computation primarily relies on graphics cards, which are one of the most energy-intensive components of modern computers. Each transaction necessitates confirmation at multiple nodes within the network. Figure 7 provides a comparison of electricity consumption by NFT, Bitcoin, payment cards, and household payments.

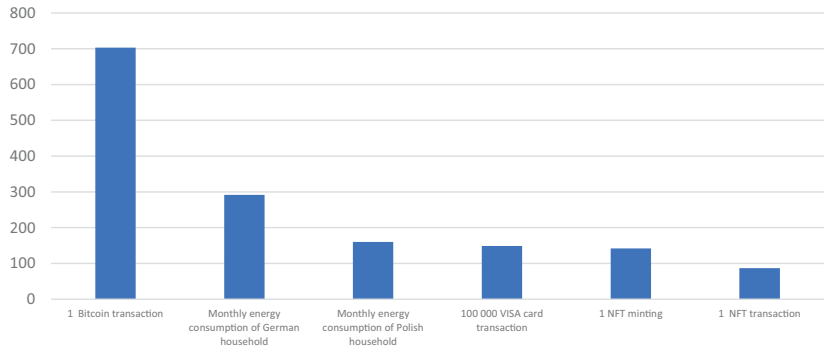


Figure 7. Energy consumption per type of usage (in kWh)

Source: Author's own study.

One cryptocurrency transaction in Bitcoin consumes as much energy as 469,000 VISA payment card transactions (Statista, 2023a). An NFT transaction each time consumes 87 kWh, while minting one NFT is 142 kWh (Hedera, 2023).[2] In comparison, the average monthly energy consumption of a household in Poland is 160 kWh (Cire.pl, 2021), and in Germany, it is 292 kWh (Wehrmann, 2023). This means that each NFT created consumes similar amounts of energy as a Polish family, and at least for daily transactions, cryptocurrencies will not replace regular traditional currencies due to extremely inefficient energy management. An additional problem for the development of NFTs and cryptocurrencies turned out to be the war in Ukraine caused by Russian aggression. It has entailed a series of events, among which the most important are:

– sanctions limiting the supply of Russian raw materials to Europe, mainly oil and gas,

[2] Indicated energy consumption refers to the period when ETH remained with proof of work as a method of reaching consensus in transactions.

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– imports of liquefied natural gas (LNG) into Europe from Middle Eastern countries and the US,

– U.S. sanctions on China, resulting in a ban on the sale of advanced U.S. processors to the Chinese market, and a ban on U.S. technology professionals from working for Chinese companies under the threat of losing citizenship (McMorrow, 2022).

These dynamic events are causing changes in the globalized world by radically raising energy prices in European high-growth countries, increasing fuel prices in global markets, and disrupting supply chains in the production of microprocessors necessary for the development of artificial intelligence and blockchain networks. All of these issues, coupled with efforts by the European Union and the United States to transition toward green energy, are leading to significant investments in energy development and a reduction in the energy intensity of the economy.

Cultural exclusion

ChatGPT and other artificial intelligence language models are developed using English, which is the dominant programming language in the world. Subsequently, they are trained on extensive Big Data comprised of online databases. Consequently, the prominence of a specific language on the Internet directly influences the quality of service and communication in the human-AI interaction in that language. Therefore, an analysis of the most prevalent languages on the Internet reveals which languages facilitate the most effective collaboration with AI (Table 2).

Table 2. Language's contribution to the Internet

No.	Language	Share (%)
1	English	25.9
2	Chinese	19.4
3	Spanish	7.9
4	Arabic	5.2
5	Indonesian	4.3
6	Portuguese	3.7
7	French	3.3
8	Japanese	2.6
9	Russian	2.5
10	German	2.0

Source: (Internet world stats, n.d.).

These languages collectively constitute 76.9% of the content available on the Internet. Furthermore, communities that speak these languages account for 68% of the world's population. As for the remaining communities, they are often compelled to acquire proficiency in a foreign language, preferably English, when initiating interactions with AI in order to enhance productivity. Historically, this situation has been

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less pronounced in office settings, with specialized software initially being developed in English and gradually introducing localized versions. Consequently, individuals who do not possess fluency in foreign languages or find it challenging to acquire such proficiency have encountered limited or weaker support for their native languages. This deficiency manifests as a lack of features like error correction and text style improvement (which are essential for enhancing the quality of marketing content, books, or documentation) and the ability to generate reviews on specific topics (with a reduced understanding of local community references). Nevertheless, from the perspective of this study, the primary concern lies in the marginalization of speakers of niche languages and dialects. While ChatGPT supports 95 languages, it demonstrates varying degrees of proficiency in understanding and responding to different languages.

Simultaneously, individuals who generate content using the most widely recognized languages will experience faster business growth and improved communication with generative artificial intelligences relying on language models. Consequently, English-speaking artists hold an advantage over those who communicate in German, Russian, and less commonly spoken languages, including Lithuanian, Slovak, and Serbian.

Handicrafts and cultural goods

Handmade works demand specific manual skills as well as a sense of aesthetics and artistic sensibility. In 2022, the European Union's cultural sector, which encompasses the production of handicrafts, employed 7.7 million individuals, constituting 3.8% of the workforce (Eurostat, 2023a). Eurostat's classification of the cultural sector includes cultural heritage, archives, libraries, books, magazines, visual arts (photography, design), performing arts (dance, theater), audiovisual arts (film, radio, television, music, graphics), architecture, advertising, handicrafts, and more. Artificial intelligence is enhancing and transforming all these aspects, with a particular impact on handicrafts. Handicrafts alone represented 3.8% of EU-wide exports of cultural goods in 2021, while works of art accounted for 13.8% (Eurostat, 2023b).

The decline of artisanal professions, which was observed during the development of modern industry, is not a looming threat to artists. The dynamic changes in the art market triggered by cryptocurrencies, NFTs, and AI have not led to a collapse in employment. In fact, between 2021 and 2022, there has been an increase in employment in the creative, arts, and entertainment sector, which, if there were a collapse of art professions, would have been most affected. From 2013 to 2022, employment in the cultural sector has risen from 6.8 million to 7.7 million, marking a 13% increase (Figure 8). Additionally, exports have increased from EUR 2.1 billion to EUR 2.9 billion, reflecting a 40% growth (Eurostat, 2023a).

A review of the most popular auction portals, such as eBay, OLX, Allegro, and Sotheby's, reveals significant variation in the prices of art goods. Handmade tables

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are priced 250–300% higher than mass-produced ones. The "handmade" markup for jewelry ranges from 100 to 500%, for clothing it is between 50 and 200%, and for ceramics, it is 50–300%. It is important to note that these goods are new and lack historical value that would influence the price. The key factors determining these price differences, based on the review conducted, include materials, design, craftsmanship, uniqueness, and the reputation of the creator.

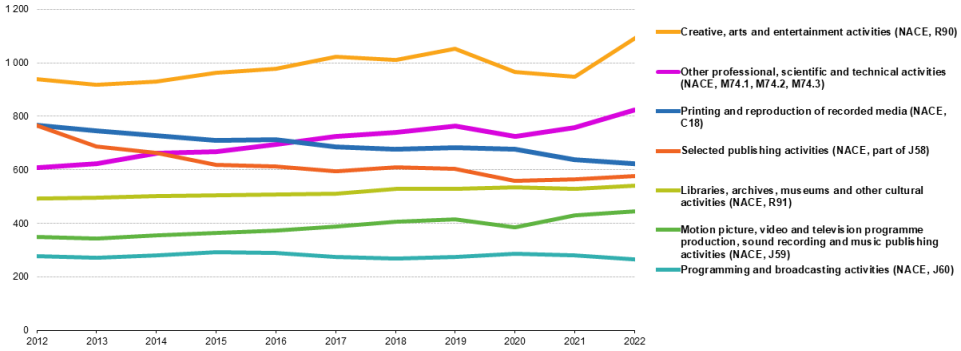


Figure 8. Evolution of cultural employment in EU in 2012–2022 (in thousands)

Source: (Eurostat, 2023a).

In the case of AI-generated works, there are currently no widespread auctions. However, it can be assumed that creators using algorithms to generate art may conceal this fact, as they do not want to devalue their work. Therefore, there is pressure from regulators to make it mandatory to label AI-generated works in the online space.

NFT market forecast to 2030

Future NFT prices and the value of the overall market will heavily depend on the price of energy carriers. Available analyses indicate that natural gas prices will decline by 2030. According to Fitch, Dutch gas prices will fall by 50% by 2026, while Deloitte assumes a 36% drop by 2030 (Cochintu, 2023). Averaging these values, the author assumes that average natural gas prices in 2030 will fall by 43% relative to 2022. Thus, the average price will decrease from USD 27.89 to USD 15.9 in 2030, reaching prices similar to those in 2008 and 2021.

To estimate the energy price as mentioned, the author projected the value of global NFT sales by 2030 using multiple linear regression. The dependent variable was NFT sales, and the independent variables were time (in months) and energy prices (in USD).

In the first step, using linear regression, the coefficient for the gas price was -34,853.71, and the intercept was 3,274,887.51. This means that each unit increase

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in the gas price leads to a decrease in NFT sales of USD 34,853.71. For this regression model, the coefficient of determination R^2 reached 0.086, indicating the level of statistical significance.

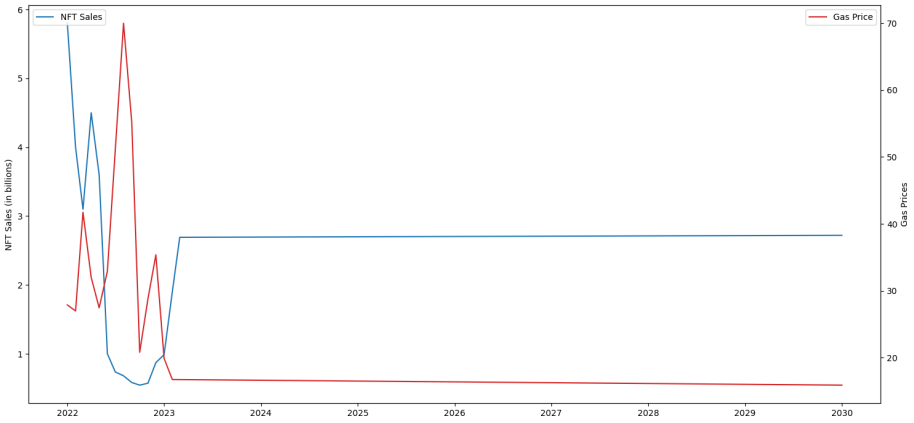


Figure 9. Forecast of NFT sales and gas prices (2022–2030)

Source: Author's own study.

Next, a linear regression model trained on data from January 2022 to February 2023 was used to forecast the value of NFT sales based on the gas prices estimated in the previous part of the article (for the period 2023–2030) (Figure 9). By the end of the current decade, with the average price of natural gas at USD 15.9, the sales value of the global NFT market is projected to be USD 2.72 billion in January 2030. For the entire year of 2029, the sales value would be USD 32.621 billion, representing a 145% increase from 2022.

In addition to the energy issue, it is important for the NFT and AI market to attract enough interested individuals. The author conducted a survey consisting of 3 questions regarding the perception of the value of AI art. These questions pertain to respect for AI-created works, willingness to pay the same amount for generated and handmade works, and belief in the future growth of the value of AI-made artwork (Table 3).

Table 3. Survey response structure

Question	Yes	No	No opinion
1. Do you think AI-generated art should be treated on par with art created by humans?	13%	79%	8%
2. Are you willing to pay the same amount of money for AI-generated art that you would pay for a man-made work?	11%	79%	10%
3. Do you think AI-generated art has the potential to gain value over time?	59%	27%	14%

Source: Author's own study.

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The responses indicate that the vast majority of respondents (79%) believe that AI-generated art is not treated equally to human-made art, and consequently, individual valuation is also lower. People assign a higher value to things made by human hands because it involves the use of talent, skills, and time spent. In the case of AI, people do not see the valuable resources used, thus lowering the value of the images created by it.

Surprisingly, considering this background, are the results of the third question regarding belief in the future high value of AI art. 59% of respondents believe that AI art will increase in value over time.

Conclusions

NFTs are addressed in the scientific literature far less frequently than blockchain technologies and AI. The analyses conducted show that they have initiated the transformation of the art industry, a process that will accelerate with the further development of generative artificial intelligence.

The energy-intensive nature of NFTs and generative artificial intelligence raises the need to create an environmental tax that will compensate for the negative externalities of the technology. It will pass on to the customer the cost of maintaining computing power, which will reduce the use of cryptocurrencies for payments and focus on other functions like authentication and ownership. An environmental tax on NFTs will, therefore, have the effect of increasing the value of AI.

In turn, the overproduction of art, due to the ease of use and speed of generative AI, will reduce the average value of artworks. Currently, the average price of an NFT image is USD 150, while that of a typical physical image is USD 760 (Prnewswire, 2023). The market will seek a new equilibrium point adjusted to the oversupply of art, according to Marshall's theory. This will benefit entrepreneurs who could not afford to hire a graphic designer and those without artistic skills. AI combined with 3D printing in the sculpture industry could cause a similar revolution. Since only 4% of Americans currently own an NFT (Molenaar, 2023), and about 30% have ever bought a piece of art (Saber, 2014), it is possible that market penetration for NFT and AI art will increase more than 7-fold as it becomes popularized.

The number of jobs for artists is not at risk at this point. The past decade has seen growth in both exports of handicrafts and cultural works and a 13% increase in employment in the sector. However, due to the dominance of English on the Internet (almost 26%), artists and entrepreneurs who do not speak it or other widely spoken languages will be at a disadvantage in terms of using artificial intelligence tools, including generative AI. There will be a marginalization of local cultures with increasing pressure to learn English in place of dialects.

Among those surveyed, there is an apparent disregard for AI art, assigning them less value, but at the same time, the works are expected to gain value over time.

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A good solution is to create a "human-made" certificate with an appropriate scale adequate to the human (AI) participation in the creation of a given work or commodity. The greater the human participation, the more expensive a given commodity will be, which coincides with current differences in pricing of craft goods, where the difference in price is often 300 to 500%.

Analysis by linear regression indicates that each unit increase in the price of the energy carrier causes a decrease in the value of global NFT sales by USD 34.9 thousand. The further spread of generative AI and the expansion of NFT trading mean an increase in the number of transactions and revenues, which is reflected in the projected value of the global NFT market in 2030. According to the forecast, it will be 2.45 times larger than in 2022. However, the author expects a qualitative shift similar to the automotive, ceramics, jewelry, or furniture industries. Declining unit prices of artworks will force some artists to change professions, but the rest, having acquired high digital competence, will be able to count on higher salaries and royalties. At the same time, AI art for the traditional art market may become a complement rather than a replacement, just as photography is for painting.

This study acknowledges certain limitations, primarily its focus on gas prices as the sole energy cost variable, excluding oil or renewable energy sources. Recognizing the potential for a more comprehensive approach, future research might benefit from considering the average cost of a broader range of energy carriers. This paper presents a simplified model, and further studies incorporating diverse energy prices are recommended. It also acknowledges the omission of significant factors like national regulatory frameworks and taxation issues, which can notably influence NFT demand. Additionally, while this research provides insights into the European market's unique characteristics, it does not encompass the distinctive features prevalent in other global regions, suggesting a need for more geographically diverse investigations in the future.

In comparison with existing studies, the findings of this analysis regarding the impact of NFTs and AI on the art market underscore a unique approach to environmental issues and market changes prompted by these technologies. The proposal to introduce an environmental tax to mitigate the negative externalities produced by the energy intensity of NFTs and AI relates to concerns raised in the literature about the carbon footprint of blockchain technology, calling for more energy-efficient solutions.

Observations on the overproduction of art indicate a potential decrease in the average value of artworks, reflecting discussions on digital dissemination and its impact on artistic value. The forecasted significant growth of the NFT and AI art market highlights the transformative potential of these technologies, albeit with caution regarding implications for pricing and market saturation.

Comparisons of this study's findings with existing research underscore the complex challenges and opportunities presented by the integration of NFTs and AI into the art market. They highlight the need for further research, particularly concerning sustainability, market dynamics, cultural inclusivity, and the evolving criteria for artistic value.

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