arts

Article

The Cyber Turn of the Contemporary Art Market

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Abstract: The paper addresses the issue of digitalization of the contemporary art market. It analyzes key features of today's online art market and discusses three technological innovations—cryptocurrency, blockchain, and artificial intelligence—that have the potential to contribute to the further development and growth of online art trade. The paper demonstrates that whereas cyberspace attracts new talent and great business ideas intended to make global art commerce more versatile and efficient, online art market players alongside with providers of online art market data and analytics offer interesting avenues of future research in this sector.

Keywords: online art market; cryptocurrency; blockchain; artificial intelligence (AI)

1. Introduction

Academic research on art markets heavily depends on surviving guild records, inventory studies, financial statements, and legal documents (McNulty 2014). One of the pioneering books on the history of art markets, Gerald Reitlinger's trilogy *The Economics of Taste* was published back in 1961. Since then, there has been a steady increase in the number of scholars working on multiple issues of the economics of art. As the majority of art market operations still take place offline, contemporary art market researchers do not pay too much attention to the phenomenon of the Internet as a powerful art market disruptive innovation and treat cyberspace as a mere supportive tool to boost art sales. As the art market scholars of the DALMI (Duke Art, Law & Markets Initiative) research consortium Van Miegroet, Alexander, and Leunissen suggest in their paper *Imperfect Data, Art Markets and Internet Research*, also published in this special issue, "it is hard to predict the future of online art markets, though it is obvious that over the past ten years online market platforms have been gaining in importance". Our paper, while totally agreeing with Van Miegroet, Alexander, and Leunissen's findings, offers a more "optimistic" view on the cyber turn of the contemporary art market. Whereas DALMI's researchers focus on some crucial methodological constraints related to Internet data-driven art market research, we, in turn, explore the conceptual transformation of the contemporary art market under the influence of new digital technologies. We argue that the Internet has turned from an art-marketing instrument to an apart-standing art market segment with its unique features and development patterns. To support this argument, we first analyze the evolution and the current state of the online art market and then examine three particular technologies that have the potential to contribute to the future expansion of the online art trade. Methodologically, our research is complicated by two issues. On the one hand, due to the academic novelty of the topic under consideration, we have to deal with the lack of statistical data, which makes it quite difficult to develop a comprehensive retrospective narrative on the given topic without sounding avant-garde and futuristic. On the other hand, due to the marginal presence of the online art market segment in the overall contemporary art market, we have to anticipate the skepticism about our research on the part of the "conservative" art community that does not recognize the issue of the online art market as worthy of separate analysis.

2. Evolution and the Current State of the Online Art Market

The development of information and communication technologies has fueled the digital economy by accelerating the production, delivery, and consumption of goods and services. The Internet has left no economic field untouched, the visual arts being no exception. Whereas various art market players increasingly embrace new technologies to display, promote, and conserve artworks, artists engage with innovative media to intensify cultural branding in the digital age and to give birth to new art forms that push the boundaries of the contemporary art canon. Moreover, information and communication technologies have intensified the globalization of art. As a result, art currently develops in two tiers: "As local avant-gardes at the fringes of the many art sectors, and as a global commodity disseminated instantly across institutional and national boundaries" (Hackforth-Jones and Robertson 2016, pp. 165–66). As for the art-market relation in particular, new technologies progressively lead to the paradigm shift in art trade and mediation, as well as stimulate the emergence of "novel structures for art businesses, which are supported by the new interdependencies between art, technology and commerce" (Hackforth-Jones and Robertson 2016, p. 171). In fact, the idea of the online art market is not quite new. The very first art sales websites were launched during the dot-com-economy boom back in the late 1990s. However, most of them collapsed "in the spectacular bust of 2000, sometimes with astonishing rapidity" (Adam 2014, p. 121). In spite of the economic fiasco of the first-generation online art startups, the belief that the Internet is the future for art commerce in the era of globalization has not gone away, and a whole new generation of online art businesses are currently battling for attention. Moreover, the issue of online art trade appears more and more frequently in the academic literature on the future of art markets (e.g., Meyer and Even 2002; Moulin 2003; Horowitz 2011; Zorloni 2013; Adam 2014; Schmitt and Dubrulle 2014; Velthuis and Curioni 2015; Flynn 2016; Schneider 2017; Winkleman 2017, etc.).

We suggest that the cyber art trade has turned over time from just a mere art-marketing instrument to an apart-standing art market phenomenon with its unique features and development patterns. What we observe nowadays is "the restructuring of the Hows, Wheres and Whos that shaped the art world until now" (An and Cerasi 2017, p. 121). Today's online art market is an autonomous segment of the contemporary art market that offers alternative ways to buy and sell art. It differs from the offline art market in two respects. On the one hand, due to its capacity to spread information about art and artists instantly and worldwide, the art market connected to the Internet can "reach manifold new buyers and grow the market colossally" (Adam 2014, p. 121). On the other hand, while existing in the virtual cyberspace beyond national borders and continental divides, the online art market can "be held by any number of vendors around the world but displayed on a single site", which makes it accessible to a larger number of potential customers who "would be hesitant about entering an art gallery to browse and educate themselves before buying, from the comfort of their homes" (Adam 2014, p. 122). Assessing the size of today's online art market is rather tricky. Different analytical reports present various statistical data. Thus, according to the Hiscox Online Trade Report 2019, the online art market has grown 9.8% in aggregate to $4.64 billion, marking a slowdown from the 12% growth experienced in 2017 (Hiscox 2019, p. 2). In contrast, according to The Art Market 2019 Report, in 2018, although global sales in the online art market accounted only for 9% of the value of global art sales, they reached $6 billion, which was 11% higher than in 2017 (The Art Market 2019, pp. 258–62). The TEFAF (The European Fine Art Fair) Art Market Report Online Focus 2017, in turn, has revealed that the size of the online art market depends on the definition and price range of artworks. As the report writes, in 2017, online art sales reached at least $3.1 billion, where $1 billion accounted for the online trade of art and antiques over $500, $1.6 billion comprised the online trade of art, antiques, and collectibles over $500, and between $0.5 and $2 billion corresponded to the online trade of art, antiques, and collectibles under $500 (TEFAF 2017, pp. 38–39).

As for the structure of the contemporary online art market, it is possible to distinguish between "hybrid" online–offline art businesses and "pure" online art enterprises. Online–offline companies present on the contemporary online art market are traditional primary (galleries) and secondary (auction

houses) art market players that operate both online and offline. They use cyberspace to increase sales and create new marketing channels. According to The Art Market 2019 Report, "brick-and-mortar auction companies continued a strong trajectory of online sales in 2018, making up one of the largest segments of the online art market by value" (The Art Market 2019, p. 272). To be more precise, at Christie's, total online sales reached $250 million in 2018, compared to $214 million in 2017 (The Art Market 2019, p. 272). At Sotheby's, in turn, total online sales reached $220.4 million in 2018, a 24% increase from 2017 (The Art Market 2019, p. 273). The statistics of the dealer sector in 2018 show that the online channel represented 6% of total sales, 4% of which were made through dealers' own internal online channels, such as a website or an e-mail, and the remaining 2% were arranged through third-party platforms, like Artsy, 1stdibs, and Artnet (The Art Market 2019, p. 292). In contrast to brick-and-mortar art galleries and auction houses, online-only art businesses exist exclusively in the virtual space. There are three main types of online art enterprises currently functioning in the art market—online auctions, online galleries, and online marketplaces. Online auctions (e.g., Auctionaftersale, Barnebys, Birdsquare, Heritage Auction, Hihey, Invaluable, Liveauctioneers, Thesaleroom, Paddle8, etc.) give their customers the "chance to bid for art from the comfort of their own home, taking away the social barriers of bidding at traditional auction houses, where you often have to be of a certain status and wealth" (Le Journal de ArtmarketGuru 2018). Online galleries (e.g., Artgallery, Degreeart, Ideelart, Newbloodart, Upriseart, Weng Contemporary, Zatista, etc.) are virtual "showrooms" intended for the display and sale of artworks. They attract art dealers who do not want to spend money on renting physical gallery spaces because their new-generation clients are not used to conventional offline art viewing and art buying norms. Online marketplaces (e.g., 1stdibs, Artnet, Artsy, Artandcollect, Artviatic, Saatchiart, etc.) are non-auction online art platforms that let buyers immediately purchase art using a "click-to-buy" function. They act as an entry point for new art collectors and, unlike online auctions, ensure direct communication between artists, art dealers, and prospective art buyers. Since the structure of the online art market is constantly evolving, we should expect the emergence of new online art market players in the nearest future. Most importantly, we should anticipate the increasing influence of social media in online art trade (a.k.a. social media art market). According to Hiscox 2019, 80% of art buyers use social media to discover new artists and 89% of art galleries use social media to attract new customers (Hiscox 2019, p. 9). As for The Art Market 2019 estimates, social media remain a strategic tool to build trust and brand awareness, as well as to facilitate sales and convert more social media users into active buyers (The Art Market 2019, p. 287).

　　Online art sales channels are in high demand in the contemporary art market for two reasons: They make art trade more convenient and more comfortable. The convenience of online art sales channels consists of the relative easiness to find wanted artworks. Experienced art collectors can search for the necessary artworks much faster online than they could otherwise "by randomly visiting many physical spaces" (Winkleman 2017). The comfort of online art sales channels presupposes instant access to demanded artworks without placing customers on a waiting list. This second feature is especially important for younger art collectors who feel intimidated "by the legendarily icy reception or arcane rituals" (Winkleman 2017) typical to physical galleries and high-profile auction houses. In spite of being convenient and accessible, online art sales channels struggle a lot to establish trust among the influential clientele of older generations. As Hiscox 2019 suggests, building consumer trust is the biggest challenge for all online art businesses: In 2018, 60% of them admitted that "difficulties establishing the reputation of the seller was a key obstacle" (Hiscox 2019, p. 22). Among other problems that online art sales channels currently face are the issues of authenticity and physical inspection of artworks. In 2018, 62% of online art customers said that they were afraid of buying online "a fake or an object which is not what it purports to be" and 74% of online art customers complained that they were unable to inspect the artwork ahead of a purchase (Hiscox 2019, p. 22). Although online art sales channels are not perfect, they maintain a positive rate of growth and have bright development prospects. Online buying in the art market has become more mainstream. As The Art Market 2019 Report points out, the expectations of traditional offline art dealers, surveyed in 2018, were that online

art sales would increase over the next five years, with 70% of them expecting online art trade to increase significantly and a further 24% predicting online art trade to remain at about the same level (The Art Market 2019, p. 294).

By and large, the cyber turn of the contemporary art market exerts an enormous influence on the modalities of trading and valuing art. On the one hand, online art market transactions "robotize" art commerce, as they involve "a minimal amount of personal contact between the buying and selling practices because of distance and the way in which the sale is conducted" (Vickers 2005, p. 198). On the other hand, gradual diversification of online art market players and practices educates a new breed of art collectors who, instead of valuing artworks in the "traditional" terms of money, power, and beauty (Findlay 2012), "evaluate digital images, conduct price comparison surveys, and pay electronically from the comfort of home" (Vickers 2005, p. 198). Besides, from a scholarly perspective, the digitalization of the contemporary art market has contributed to the emergence of Art History 2.0 (Bailey and Gardiner 2010; Rodriguez-Ortega 2019) as a separate academic field. The acceptance of technological innovations as applied to online art market research has resulted in the creation of new methods of analysis and visualization of online art market data (Bentkowska-Kafel et al. 2005; Hai-Jew 2017; Flanders and Jannidis 2019) and the establishment of digital archiving as a socially engaging and responsive practice of documentation of online art commerce (Bentkowska-Kafel et al. 2009; Hatchwell et al. 2019; Jaskot 2019).

3. Technologies Used to Expand the Online Art Market

Although academic research on the online art market remains at the outskirts of art historians' attention and does not attract any significant number of sociologists of art and culture, art market analysts take this issue seriously and offer innovative approaches to study the quickly developing patterns of online art commerce. The most respectful analytical art market reports, such as The Art Market Report and The Hiscox Online Trade Report, distinguish between three cyber phenomena—namely, cryptocurrency, blockchain, and artificial intelligence—that hold big promises for the future development and expansion of online art trade. In this paragraph, we explore these three digital technologies under consideration and analyze their potential to further transform the organizational and functional underpinnings of the virtual art marketplace. It is worth mentioning at once that our attempt to research the issues of cryptocurrency, blockchain, and artificial intelligence in connection with online art market research is experimental, as these issues have so far been raised exclusively by art market analysts and practitioners, whereas scholarly research on art markets is still silent about this emergent aspects of online art trade.

3.1. Cryptocurrency and Blockchain

There has recently been a noticeable increase in art-and-cryptocurrency/blockchain-related news in the mass media, and a number of conferences have been held for art professionals dedicated to the subject. For example, on 11–12 May 2018, the experimental software development company ConsenSys hosted the Ethereal Summit, an international conference about blockchain held annually in New York, that placed special emphasis on the contemporary art market, even concluding the event with a live charity auction for the benefit of The Foundation for Art & Blockchain. On 19 July 2018, the London-based auction house Christie's organized the Art + Tech Summit that discussed, among other topics, the potential of blockchain and cryptocurrency to create decentralized, secure, and trustworthy channels of online art market operations. In September—October 2018, the Paris-based innovation hub ERM Développement mounted the innovative art show Bitcoin Art (R)evolution dedicated to the role of cryptocurrency in the contemporary art market. The show presented a new artistic movement called CryptoArt and demonstrated the ideas of several living artists about the influence of cryptocurrency on artistic creativity. Moreover, all the artworks on display were offered for sale exclusively for bitcoins, whereas physical money was not accepted at all.

The phenomena of cryptocurrency and blockchain are rather new to online art market research and practice. From an economic point of view, cryptocurrency is a digital asset used as a medium of exchange and based on the principle of decentralized control that enables users to send payments without passing through a central authority, such as a bank or a payment gateway (Rosenberger 2018, p. 9). It uses the mechanism of strong cryptography to secure the execution of financial transactions and control the creation of new units of "virtual" money. Bitcoin, which appeared as an open-source software written by Satoshi Nakamoto in 2009, is the most frequently used cryptocurrency in today's world, generally speaking. Bitcoins represent a specific form of "virtual" money that are given as a reward for the process called mining, which stands for a record-keeping operation executed through the use of computer processing power (Antonopoulos 2017, p. 15). Financial transactions conducted with the use of bitcoins are verified and recorded in a publicly distributed ledger called a blockchain, which is a type of payment rail that secures the protocol of peer-to-peer network communication embedded in the algorithm of creation and verification of operations with a specific cryptocurrency (Furneaux 2018, p. 39).

Due to the absence of relevant data that would allow us to conduct an in-depth retrospective study on the virtues and perils of both cryptocurrency and blockchain for the contemporary art market, the overwhelming majority of art market scholars prefer to omit these two issues from their analysis of emerging art market trends. Despite this persisting academic skepticism, art market professionals treat cryptocurrency and blockchain as two most salient technological innovations able to transform the online art market in the nearest future. Since 2018, the influential Art Market Report published annually by the Art Basel art fair in cooperation with the UBS bank has recognized blockchain and cryptocurrency as one of the most important developments that happened on the global art market in the previous year. The 2018 Art Market Report introduced three key advantages of the application of blockchain in art market operations; namely, the potential to improve authentication and provenance of artworks, the potential to protect privacy of art collectors, and the potential of traceability of art sales and commissions. At the same time, the same report emphasized the risks of introducing cryptocurrency in art market transactions. In particular, the report mentioned that "while blockchain technologies could help reduce fraud in some sectors, cryptocurrencies could also create a black market of dubious transactions that could worsen the reputation of the online market with new buyers" (The Art Market 2018, p. 249). The 2019 Art Market Report continued the discussion about the modalities of integration of blockchain and cryptocurrency in the contemporary art market. Most importantly, this report introduced the phenomenon of the tokenization of art, which puts forward the idea of fractional ownership of art. The report provided as example the tokenization of Andy Warhol's painting *14 Small Electric Chairs* (1980) undertaken by the online art investment platform Maecenas in July 2018. In fact, Maecenas has issued more than 6 million ART tokens, each of which offering a small "virtual share" in Warhol's work. As a result of this unusual auction, 49% of *14 Small Electric Chairs* has achieved "a reported value of $6.5 million", whereas the original owners of the artwork have retained the remaining 51% of the artwork (The Art Market 2019, p. 295).

In addition to the inclusion of the phenomena of blockchain and cryptocurrency in art market analytics, we can observe two major applications of cryptocurrency and its accompanying blockchain technology in today's art market. On the one hand, cryptocurrency represents a new form of money with which art can be bought and sold. It is rather curious that both public and private art institutions are eager to acquire artworks with cryptocurrency instead of real money. Both online and offline art businesses gradually turn to bitcoins and other cryptomoney as an alternative payment method to reach a global audience and attract more customers. The London-based Moniker Art Fair that specializes in street art was the first among all European art fairs to introduce "virtual" money into art business. The also London-based Dadiani Fine Art was the first European art gallery to have completely shifted, since 2017, to making art market transactions in cryptocurrency. Today, the most "crypto-active" online art trading platforms include Cointemporary, Whitestone Coin, and Maecenas. Unlike art market players, public museums, in turn, do not have an established practice of using cryptocurrency because

of the absence of a precisely defined legal framework on this issue. Nevertheless, a limited number of world museums are gradually engaging in activities with cryptomoney. The first European museum to buy art for bitcoins was MAK Wien (Museum of Applied Arts in Vienna). In 2015, it purchased Harm van den Dorpel's *Event Listeners* for a particular amount of bitcoins (the sum was not revealed to the public). In addition to the development of art trade in cryptocurrency, contemporary art market players have turned to blockchain technology as a means of protection of the artwork's ownership rights. In particular, blockchain is already widely used to prove the authenticity of works of art. The code can be either directly encrypted in the artwork by the artist himself or can be purchased as a separate certificate. Presently, such ownership certificates generated through blockchain are offered by the online art platforms AllPublicArt and Seezart. In addition to the verification of the authenticity of art, blockchain has the potential to become an innovative methodological tool in provenance research. For example, the art startup Arte Questa applies blockchain to trace the provenance of artworks stolen from Jews during World War II. Like cryptocurrency, blockchain is an Internet-based technological innovation but can serve different commercial needs of both online and offline art market players.

The growing presence of cryptocurrency and blockchain in the contemporary art market has several vital implications for art market research. Thus, the introduction of "virtual" money in art trade affects the principles of art banking. Most importantly, cryptocurrency has the potential to change the norms of art-based lending. Currently, the contemporary art market employs two categories of art-based lending services—loans to galleries to "give dealers an available lien of working capital" (McAndrew 2010, p. 121) and loans to individuals to help art collectors "monetize their art holdings" (McAndrew 2010, p. 122). These loans come from either banking institutions or non-banking boutique lenders and major auction houses. With the introduction of "virtual" money in art trade, it is not clear anymore how art-based lending services will evolve in the future. On the one hand, this technological innovation could diversify art finance by means of offering alternative mechanisms and procedures of art patronage. On the other hand, cryptomoney may result in further consolidation of online art-based lending services around one single large tech company that would dominate cross-border digital art finance. Under such circumstances, online art financial services are likely to be expected to "boom in value and economic importance" (MacDonald-Korth 2018, p. 20). The application of blockchain in art market operations, in turn, has created new sources for the study of art market history. In this respect, the information recorded in the blockchain-based registrar can be considered as both digital-born art market data and an Internet-generated archival database. With the development of new technologies, the data sources available to art market scholars have become ever more diversified. Prior to the advent of the digital age, most sources on art trade were available only in print and only in select research and museum libraries. Moreover, the vast majority of these sources were not properly indexed, making the search for sought-after information a daunting prospect. Numerous digitalization projects that have been undertaken over the past decade "have gone a long way toward not only making these rare research tools accessible, but also, and perhaps more importantly, making them usable" (McNulty 2014, p. 261). With blockchain, the quest towards the digitalization and comprehensive catalogization of art market data can go much further. In particular, this technology can make art market data accessible to a larger number of scholars and practitioners and solve the problem of bulky archival storage of physical art market historical records. At the same time, blockchain makes art market data more dependent on virtual reality. In other words, to access the art market data stored on blockchain, a researcher needs to have a stable and unlimited online connection guaranteed by the Internet provider and the country-specific online traffic regulations, which are different across the globe.

3.2. Artificial Intelligence

Most recently, Christie's became the first auction house in the world to trade art created with artificial intelligence (AI) technology. On 23–25 October 2018, as part of the Print and Multiples auction, it offered for sale the portrait painting of *Edmond de Belamy*. The artwork was produced by the

Paris-based art collectible Obvious with the machine-learning algorithm GAN (Generative Adversarial Network), which was, in turn, written by the American computer scientist Ian Goodfellow. A canvas print of the AI-generated portrait of a fictional character (Belamy is, in fact, a direct French translation of Goodfellow's surname and it literally means a "bel ami", or a "good fellow") was sold for $432,000, which was more than forty times the estimated selling price of $7000 (Hitti 2018). In fact, *Edmond de Belamy* is not the only example of artworks generated by AI, nor is Obvious the only art collective that deals with the creation of art by means of AI. The algorithm-made art started to gain ground a while ago but appeared on the art market only recently. Thus, back in 1981, Peter Kugel published one of the earliest articles dedicated to the power of computers to be universal symbol-processing symbols. In his article, Kugel (1981) claimed that algorithmic programs could serve as models of artistic processes going on the outside of a human brain. In 2015, computer scientists Babak Saleh and Ahmed Elgammal of the Art and Artificial Intelligence Laboratory at Rutgers University published an article in which they presented the machine-learning algorithm CAN (Creative Adversarial Network) that was able to generate artworks representing a particular artistic style. Saleh and Elgammal (2015) findings represent the only comprehensive academic research project conducted on the issue of AI-generated art so far. Apart from academia, art museums and art galleries have also attempted to present their views on the issue of the creative potential of machine-produced art. For example, in early 2018, Le Grand Palais in Paris organized the exhibition *Artists and Robots* that critically assessed the interaction between the human mind and the immersive digital world in an ever more robotic society. The exhibition offered a gateway to an immersive and interactive digital world that subverted the human notions of time and space through the augmented body sensory experience. In late 2018, the Natura Morte art gallery based in New Delhi mounted an exceptional group show, *Gradient Descent*, featuring artworks created entirely by AI in the post-human age. The show explored the intersection between AI and contemporary art by creating a dynamic human–machine relationship. Both *Artists and Robots* and *Gradient Descent* were remarkable events, as they made an attempt to mainstream both in the art market and the art world the phenomenon of AI-generated art and present it as a nascent art movement of the twenty-first century.

AI-generated art is the most salient example of the presence of AI-based technology in the contemporary art market. Furthermore, AI is also widely used as an e-marketing tool to link art and collectibles. In this case, AI functions as a machine-learning recommendation program that matches prospective customers with a particular product upon examination of their online activities, such as Internet searches and web browsing. This technology is already extensively used in the movie and TV industry. It is estimated that the choice of at least 80% of watched content is made upon algorithmic recommendations (The Art Market 2019, p. 302). The online art market has only recently endorsed AI-based marketing. The biggest online art marketplace that offers this service is Artfinder launched in 2013. The company's AI algorithm recommends artworks "based on visual similarities to a piece selected by a buyer" (Sheffield 2017). Basically, Artfinder works similarly to a famous music streaming service, Spotify, that uses the Discover Weekly algorithm to recommend songs to listeners with matching music tastes. Besides Artfinder, some other online art companies that have developed AI-generated e-marketing strategies to stimulate online art trade include ArtAdvisor (provides users with information about artists and helps improve their product searches), Thread Genius (suggests similar artworks coming up for sale and assists with the attribution of artworks), and The Art Genome Project (maps together the characteristics of "genes" that connect artists, artworks, art objects, design, and architecture over time). Recommendation-based e-marketing developed with AI can be good "where buyers are sensitive to costs, or there is a high price elasticity of demand" (The Art Market 2019, p. 302). At the same time, there is one important limit to the applicability of this algorithm to online art trade, namely the impossibility to generate or find a complete substitute for unique and highly valuable items such as works of art. Even though there might be some substitutability between artworks by some artists, suggesting a substitute that simply looks identical or has the same size, material, or contents to an experienced art collector may not always be satisfactory.

Whereas AI-generated art and AI-based art marketing are the most branded innovative tools able to contribute to the further development of the online art market, there are three more lesser known AI-generated technologies that are slowly gaining ground in online art trade. The first emerging technology, developed by researchers from Rutgers University in cooperation with the Atelier for Restoration and Research of Paintings in the Netherlands, is represented by a machine-learning algorithm that detects art forgeries (Elgammal et al. 2017). It uses AI to analyze thousands of tiny strokes that compose a picture and detect fake pieces. The algorithm is able to identify a forgery in every instance, simply by looking at a single stroke, a task that cannot be physically done by a human being. The second emerging technology is Virtual Reality (VR). As a technological innovation, VR is not new per se. However, VR has only recently been integrated into the online art market. Given the falling foot traffic in offline art galleries, online art companies have started to apply a 360-degree on-screen view of art to offer a VR tour of art shows. By creating an alternative method of attending art events and art exhibitions, VR enhances e-commerce "by reaching buyers who are unable to visit galleries and exhibitions but remain reluctant to buy from a flat image" (The Art Market 2019, p. 300). The third emerging technology is Augmented Reality (AR). Like in the case of VR, AR is not the most up-to-date technological innovation. Nevertheless, it has only recently appeared in the online art market. AR makes it possible to combine physical elements with the digital world. Online art platforms such as Saatchi Art and Artsy have developed AR applications to offer their clients the possibility to "preview works of art at home or in other contexts through digitally hanging them on their walls" (The Art Market 2019, p. 300). This technology is very welcomed by the majority of contemporary art market players as it reduces the need to "move" real artworks, hence saving significantly on transportation and installation costs.

The introduction of AI to the online art trade has several crucial implications for art market research. On the one hand, AI-generated art reshapes the boundaries of the so-called creative economy. In more general terms, creativity can be defined as "making something new that also opens up a new category, a new genre, or a new type of thing" (Gold 2007, p. 5). With the introduction of digital coding to cultural and creative industries, the creative economic sector becomes a combination of creativity and electronics. In this context, AI stands for one of multiple weightless and intangible "digital bits" that exert a major influence on "how we have ideas and how we express, share and communicate them" (Howkins 2007). AI, being a specific form of digital coding, fosters the development of the notion of collaborative creativity that bears consequences for "the ownership of, and compensation for, creative products" (Howkins 2007). Furthermore, algorithm-produced art challenges the conventional phenomenon of the singularity of art (Boden and Edmonds 2019), hence leading to the emergence of the term "technological singularity of art" (Kurzweil 2005), which implies that a non-biological medium has a computational capacity to emulate the richness of human intelligence to detect and suggest new original ideas. Unlike AI-generated art, AI-based online art market practices turn art market data into actionable intelligence and contribute to the emergence of machine-learning driven art market analytics. Traditional art market analytics requires "heavy IT involvement" and generates "lots of data points" that are difficult for an average user "to navigate or contextualize" (MIT Technology Review Insights 2018, p. 2). As AI-driven art market analytics is still not applied in practice, we cannot characterize precisely its advantages and drawbacks. Notwithstanding, we suppose that this innovative analytical method can potentially enable art market players to "drive greater automation of tasks and derive insights at breakneck speed" (MIT Technology Review Insights 2018, p. 2). In addition, AI makes art market analytics more predictive and prescriptive. This technology allows art businesses to foresee outcomes and "proactively seize opportunities rather than waiting to react" and helps art consumers exploit the autonomous capabilities of the software to "query the optimal data sources" and "serve up insights based on identified correlations and patterns" (MIT Technology Review Insights 2018, p. 3).

4. Conclusions

All in all, the paper has touched upon several aspects that the contemporary art market currently experiences due to the emergence of new digital technologies. It has analyzed the composition and the functional orientation of the online segment of the contemporary art market and has revealed three most salient cyber phenomena that can potentially exert an enormous influence on the further development of the global online art trade. The cyber turn of the contemporary art market discussed in this article provides both opportunities and constraints to art market scholars. On the one hand, new technologies can result in the methodological renewal of academic research on the history of art markets by introducing new methods of analysis (e.g., AI-based art market analytics, blockchain provenance research), new fields of study (e.g., cryptography or algorithms-writing for art experts), and new areas of expertise (e.g., AI art marketing, art-crypto-mining, art-blockchain-banking). On the other hand, new technologies can equally challenge "traditional" art historical academic research by confronting the philosophical foundations of Aesthetics with the questions of the singularity of art (e.g., criteria and conditions for creativity), artist's identity (e.g., debate around human vs. artificial intelligence), definition of taste (e.g., certification of art through blockchain), and measurements of the value of art. We suggest that to overcome the methodological difficulties that digital technologies impose on the contemporary art market research and practice, it is necessary to adopt the spirit of academic flexibility in the three following respects: Encouragement of transversal research on the history of art markets, acceptance of the mixed-methods research methodology, and intensification of the exchange of ideas between art market "practitioners" and "theoreticians". All things considered, the main findings of this paper could serve as an impetus for the further conceptualization of Online Art Market Studies as an academic discipline and stimulate more scholarly research on other cyber art market challenges, such as the virtualization of art gallery spaces, cyber-art-crowd-funding, platform-art-economy, and digital arts management.

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References

Adam, Georgina. 2014. *Big Bucks: The Explosion of the Art Market in the Twenty-First Century*. Farnham: Lund Humphries, ISBN 978-1848221383.

An, Kyung, and Jessica Cerasi. 2017. *Who's Afraid of Contemporary Art? An A to Z Guide to the Art World*. London: Thames & Hudson, ISBN 978-0500292747.

Antonopoulos, Andreas. 2017. *Mastering Bitcoin: Programming the Open Blockchain*. Boston: O'Reilly, ISBN 978-1491954386.

Bailey, Chris, and Hazel Gardiner, eds. 2010. *Revisualizing Visual Culture*. Farnham: Ashgate, ISBN 978-0754675686.

Bentkowska-Kafel, Anna, Cashen Trish, and Hazel Gardiner, eds. 2005. *Digital Art History: A Subject in Transition*. Bristol: Intellect Books, ISBN 978-1841501161.

Bentkowska-Kafel, Anna, Cashen Trish, and Hazel Gardiner, eds. 2009. *Digital Visual Culture: Theory and Practice*. Bristol: Intellect Books, ISBN 978-1841502489.

Boden, Margaret, and Ernest Edmonds. 2019. *From Fingers to Digits: An Artificial Aesthetic*. Cambridge: The MIT Press, ISBN 978-0262039628.

Elgammal, Ahmed, Kang Yan, and Milko Den Leeuw. 2017. Picasso, Matisse, or a Fake? Automated Analysis of Drawings at the Stroke Level for Attribution and Authentication. *arXiv* arxiv:1711.03536.

Findlay, Michael. 2012. *The Value of Art: Money, Power, Beauty*. Munich: Prestel, ISBN 978-3791346380.

Flanders, Julia, and Fotis Jannidis. 2019. *The Shape of Data in the Digital Humanities*. London: Routledge, ISBN 978-1472443243.

Flynn, Tom. 2016. *The A-Z of the International Art Market*. New York: Bloomsbury, ISBN 978-1472936332.

Furneaux, Nick. 2018. *Investigating Cryptocurrencies*. Indianapolis: Wiley, ISBN 978-1119480587.

Gold, Rich. 2007. *The Plentitude: Creativity, Innovation, and Making Stuff*. Cambridge: The MIT Press, ISBN 978-0262072892.

Hackforth-Jones, Jos, and Iain Robertson, eds. 2016. *Art Business Today*. London: Lund Humphries, ISBN 978-1848220911.

Hai-Jew, Shalin, ed. 2017. *Data Analytics in Digital Humanities*. Cham: Springer, ISBN 978-3319544984.

Hatchwell, Sophie, Insh Fern, and Hana Leaper. 2019. Born Digital: Early Career Researchers Shaping Art History. *Visual Resources* 35: 171–79. [CrossRef]

Hiscox. 2019. Hiscox Online Art Trade Report. Available online: https://www.hiscox.co.uk/online-art-trade-report (accessed on 1 February 2019).

Hitti, Natashah. 2018. Christie's Sells AI-Created Artwork. *Dezeen*. Available online: https://www.dezeen.com/2018/10/29/christies-ai-artwork-obvious-portrait-edmond-de-belamy-design/ (accessed on 1 February 2019).

Horowitz, Noah. 2011. *Art of the Deal: Contemporary Art in a Global Financial Market*. Princeton: Princeton University Press, ISBN 978-0691157887.

Howkins, John. 2007. *The Creative Economy*. London: Penguin Books, ISBN 978-0141910239.

Jaskot, Paul. 2019. Digital Art History as the Social History of Art: Towards the Disciplinary Relevance of Digital Methods. *Visual Resources* 35: 21–33. [CrossRef]

Kugel, Peter. 1981. Artificial Intelligence and Visual Art. *Leonardo* 14: 137–39. [CrossRef]

Kurzweil, Ray. 2005. *The Singularity is Near*. New York: Viking, ISBN 978-0739466261.

Le Journal de ArtmarketGuru. 2018. Growth of the Online Art Market. Available online: https://www.artmarket.guru/le-journal/market/online-art-market/ (accessed on 1 February 2019).

MacDonald-Korth, Duncan, ed. 2018. *Art Market 2.0: Blockchain and Financialisation in Visual Arts*. London: The Alan Turing Institute, Available online: https://www.oii.ox.ac.uk/publications/blockchain-arts.pdf (accessed on 1 February 2019).

McAndrew, Clare, ed. 2010. *Fine Art and High Finance*. New York: Bloomberg Press, ISBN 978-1576603338.

McNulty, Tom. 2014. *Art Market Research: A Guide to Methods and Sources*. Jefferson: McFarland and Company, ISBN 978-0786466719.

Meyer, Jorn-Axel, and Ralf Even, eds. 2002. *Die Zukunft des Kunstmarktes*. Lohmar: Josef Eul Verlag, ISBN 3-89012-958-7.

MIT Technology Review Insights. 2018. Machine Learning-Driven Analytics: Key to Digital Transformation. *MIT Technology Review*. Available online: https://www.technologyreview.com/s/611996/machine-learning-driven-analytics-key-to-digital-transformation/ (accessed on 1 February 2019).

Moulin, Raymonde. 2003. *Le Marché de l'Art: Mondialisation et Nouvelles Technologies*. Paris: Flammarion, ISBN 2-08-080071-X.

Rodriguez-Ortega, Nuria. 2019. Digital Art History: The Questions that Need to Be Asked. *Visual Resources* 35: 6–20. [CrossRef]

Rosenberger, Patrick. 2018. *Bitcoin und Blockchain*. Berlin: Springer, ISBN 978-3662560877.

Saleh, Babak, and Ahmed Elgammal. 2015. Large-Scale Classification of Fine-Art Paintings: Learning the Right Metric on the Right Feature. *arXiv* arXiv:abs/1505.00855.s.

Schmitt, Jean-Marie, and Antonia Dubrulle. 2014. *Le Marché de l'Art*. Paris: La Documentation Française.

Schneider, Tim. 2017. *The Great Reframing: How Technology Will—and Won't—Change the Gallery System Forever, Kindle Edition*. Seattle: Amazon Digital Services LLC.

Sheffield, Hazel. 2017. Artfinder: The Online Art Market Using AI to Match Paintings to Buyers. *The Independent*. Available online: https://www.independent.co.uk/news/business/indyventure/artfinder-online-art-market-place-ai-paintings-buyers-gallery-a7897876.html (accessed on 1 February 2019).

TEFAF. 2017. TEFAF Art Market Report Online Focus. Available online: https://www.tefaf.com/tefaf/media/website/fair%20images/tefaf%20maastricht/2017/art%20symposium/tefaf-art-market-report-online-focus.pdf (accessed on 1 February 2019).

The Art Market. 2018. The Art Basel and UBS Global Art Market Report|2018. Available online: www.artbasel.com/about/initiatives/the-art-market (accessed on 1 February 2019).

The Art Market. 2019. The Art Basel and UBS Global Art Market Report|2019. Available online: www.artbasel.com/about/initiatives/the-art-market (accessed on 1 February 2019).

Velthuis, Olav, and Stefano Baia Curioni, eds. 2015. *Cosmopolitan Canvases: The Globalization of Markets for Contemporary Art*. Oxford: Oxford University Press, ISBN 978-0198717744.

Vickers, Marques. 2005. *Marketing and Buying Fine Art Online*. New York: Allworth Press, ISBN 978-1581154269.

Winkleman, Edward. 2017. *Selling Contemporary Art: How to Navigate the Evolving Market*. New York: Allworth Press, ISBN 978-1621535577.

Zorloni, Alessia. 2013. *The Economics of Contemporary Art*. Heidelberg: Springer, ISBN 978-3642324048.