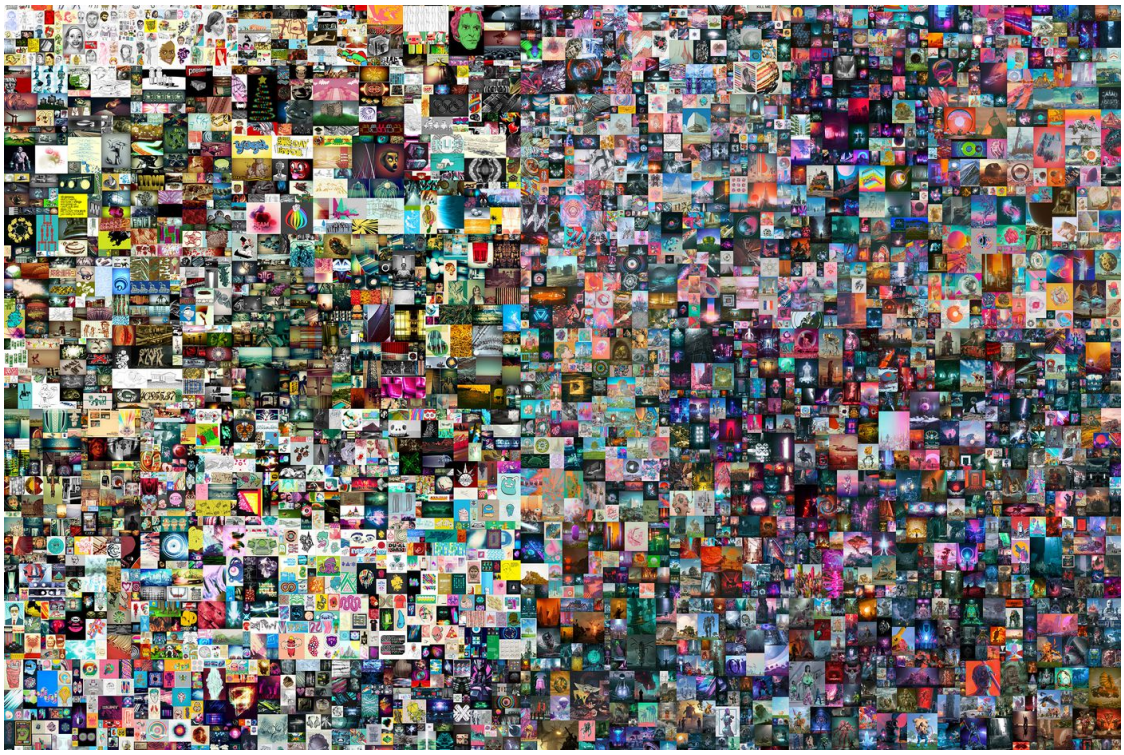
To blockchain or not to blockchain?

An exploration into the possible application of blockchain technology by auction houses.



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Abstract

The present study examines whether auction houses will adopt blockchain technology and what are the factors that may influence the intention of adopting such technology. The potential use of blockchain technology in the art market has recently become a trending topic. Nonetheless, it is hard to understand what will be the future developments of this technology in the art market and which of the traditional intermediaries will make use of the technology. A few auction houses integrated the technology in their auctions to sell digital artworks, while other have not yet used the technology. Adopting the technology may be important to afce the growing competition posed by online platforms that utilise blockchain technology to sell artworks online,

This research will try to assess if auction houses are prompt to adopt blockchain technology, what are the main determinants that could influence their decision to integrate the technology and how the Covid-19 pandemic contributed to change their opinion on the possibility of using blockchain technology. By using the Technology Organization Environment framework (TOE) the research will try to individuate the main determinants that influence auction houses in their decision to apply blockchain technology. Then, it will investigate the perception of auction houses towards a possible application of the technology if the Covid 19 pandemic had not occurred.

The data is gathered through a questionnaire that was sent to auction houses around Europe. The conclusions that this research is able to make are that auction houses are likely to adopt blockchain technology if they have knowledge of blockchain technology and of its potential applications in the art market, Moreover they are more likely to embrace the technology if they recognise the perceived benefits that the technology could provide if used and if they believe their auction house to be economically and structurally ready to adopt this kind of technology. On the other hand, the perceived complexity of blockchain technology influences negatively the intention of applying it. The research was also able to conclude that the Covid 19 pandemic had a positive impact on the willingness to explore the potential application of blockchain technology into auction houses.

Keywords: Auction Houses, Blockchain, NFTs, TOE Framework, Art Market

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1. Introduction

The art market faced an increasing need to digitalise after the spread of the Covid-19 pandemic in 2020. The rules imposed by the pandemic forced the majority of actors in the art market to digitally readapt (Bucholz et al. 2020). The digitisation trend also fostered the creation of new online platforms that could compete with the traditional actors in the art market. In particular, in the secondary art market, new middlemen arised. The digital revolution of the art market, along with the implementation of new technologies, such as blockchain, provided a new way of dealing art. Blockchain technology is basically a distributed system of information consisting of a chain of data blocks linked using cryptography (MacDonald-Korth et al. 2018). This nascent and still growing technology has several applications. Up to today, the most popularised and successful application of blockchain is its development as cryptocurrencies, most famously Bitcoin. The application of this technology in the art sector influenced both the production and the market for artistic works. An increasing number of art-tech startups and more or less independent initiatives have begun to explore second-generation blockchains such as Ethereum and the emergent practice of tokenization (i.e., the issuance of new crypto assets primarily to self- fund decentralized projects) as a means to intervene in the structures and processes underlying the rampant financialization of art (Lotti 2019). Blockchain technology in the art market promoted the increase in popularity of platforms that allow buying and selling of part ownership of artistic works. Also, blockchain technology aided the creation and proliferation of several marketplaces that focus on the trading of digital art. Online digital art marketplaces are involved in the primary and secondary sales of artworks. Digital artists can create digital artworks and sell them directly on these marketplaces. The implementation of blockchain technology in the art market has been an incredible source of innovation and renovation. The benefit that this technology brings to the commercialisation of art could disrupt traditional intermediaries and middlemen in the art market in favour of innovative digital platforms. The use of blockchain technology is also going to facilitate the authentication of art pieces, and this could benefit the fair valuation of art works. Lastly, the implementation of blockchain technology, could provide new possible forms

of ownership, for instance, the rise to fame of fragmented ownership of art pieces (Adam 2018) on websites could lead to the disruption of auction houses and art fairs, as this practice may completely revolutionize the way in which trading art is conceived. This digital revolution may drastically change the way in which auction houses work and their way of dealing and selling art. This was already proven by the major sales of crypto artworks registered on the blockchain distributed ledger by major auction houses such as Christie's and Phillips. In the past, auction houses have not been fast in adapting to the digital changes of the art market, but applying blockchain technology to their traditional business model could possibly benefit them.

This research is going to assess if the application of blockchain technology could be feasible and beneficial for traditional auction houses, and how auction houses are thinking of implementing this new technology in their business model. By doing so this thesis aims at answering the following research question: *What are the main factors that could influence auctions houses to adopt blockchain technology in their business model?.* The thesis is also willing to explore the effect that the Covid-19 pandemic had on auction houses' decision to adopt blockchain technology in their business model. A sub-question is formulated: *To what extent did the global pandemic impact on auction houses' willingness to adopt blockchain technology?* Answering this sub-research question is particularly interesting as this research is one of the first attempt to survey the effect of the Covid 19 pandemic on the auction houses' intention to apply innovative technologies to the working practices.

The thesis will initially look at the theoretical framework in which this research is framed into. The theoretical framework will firstly look into understanding the general characteristics of the art market. Secondly, it will discuss the role of auction and auction houses in the art market. Thirdly, the theoretical framework will examine how digitalisation contributed to changing the standard practices in the art market and how it contributed to the transformation of auction houses. Lastly, the theoretical framework of this thesis will inspect what is blockchain technology and what are its possible applications in the art market.

The following chapter of the research , will provide an in-depth description of the methods used to answer the research questions. The Technology Organization Environment Framework will be used to assess what are the determinants that influence the possibility of adopting blockchain technology in the near future by auction

houses. Whereas, an analysis of the opinions of auctions houses on the possibility of applying blockchain technology will be carried out to investigate if auction houses' perception on the possible adoption of an innovative and possibly disrupting technology such as blockchain, have changed after the Covid-19 pandemic.

The results of the statistical analysis performed on the dataset will be displayed in the fourth chapter. Whereas, in the fifth chapter are drawn the conclusions and, the final reflections on the results, the limitations and the relevance of this work. The main conclusion of this research will be that, amongst the factors that could influence blockchain technology adoption, technological and organizational factors, rather than environmental factors, play larger role in influencing the opinion of auction houses about the possibility of adopting blockchain technology. The thesis will also conclude that the Covid-19 pandemic had a positive effect on the willingness of auction houses to adopt blockchain technology and cryptocurrencies in their working practices.

2. Theoretical Framework

2.1 Art markets

The research is framed in the context of previous research on the characteristics of the art market. The term art market refers to the process through which works of art are created and distributed (Zorloni 2006). The art market is continuously growing both economically and socially. In 2020 the size of the art market was estimated to be $64.1 billion worldwide (McAndrew 2020). The art market is divided into two segments: primary and secondary (Findlay 2014)(Velthuis 2011) (Zorloni 2003). The primary market is the segment of the market in which artists sell their work for the first time. They usually sell their work through art galleries or dealers, that will sell their art works through their businesses or at art fairs. In the secondary art market artworks are resold, usually through the intermediation of auction houses and art dealers (Velthuis 2011) (Findlay 2014). In this segment of the market, the commercial value of an artwork is usually higher than in the primary art market, this is because the artists that are sold on the secondary art market are usually more established. Because of the heterogeneity of artworks and the difficulties in assessing the economic value of an artwork, sales at auction houses represent the only viable benchmark to assess and compare the economic value of artistic works (Ashenfelter & Graddy, 2003).

To better understand the role of auction houses in the art market, it is important to comprehend the motives that drive collectionists to buy art. Velthuis (2011) recognises three different motivational categories that can be distinguished for buyers in the art market. Firstly, works of art may be bought because of reasons directly related to the work of art itself. For instance, one could purchase an artwork because they find it aesthetically pleasing or maybe because they have a profound artistic sentiment. Another set of reasons to buy art could be because of its financial value. Art is often bought as a financial speculative investment. Most literature agrees on the fact that rates of return of investment on artworks are lower than the ones on stocks and bonds (Malik & Phillips, 2012), however art is often used to diversify traditional investment portfolios, mainly because of the low correlation of returns between art works and financial assets (Worthington and Higgs, 2004). Lastly, art works may be bought for

social reasons. The ‘art world’ is still considered very exclusive, and when one buys a work of art enters into a very restricted social circle, such as a group of collectors that attend the same art galleries and participate in the same events.

Goods that are created and distributed in the art market that have a larger symbolic rather than material value (Hirsch, 1972). Thus, as argued before, these are esteemed not only for their economic utility as investment goods, but also for their intangible social, artistic and cultural value (Bourdieu, 1983; Caves, 2000). Because of the difficulty in assessing objective artistic and economic value for artworks, the art market can be considered a market for credence goods (Velthuis 2011)(Prendergast 2014). Credence goods are those goods whose quality is uncertain and can’t be individually determined by consumers after their consumption (Kretschmer et al. 1999). In such a framework of asymmetric information, where consumption goods show qualitative uncertainty (Akerlof 1970; Ginsburgh, 2003), a demand for intermediary (Viscusi, 1978) arises to deal with the agency problems generated by the art market (Caves 2006). Thus, the value of artistic goods and services heavily relies on the opinion of ‘experts’ (Velthuis 2011). Changes in tastes and preferences, on which individual participants in art markets may have little influence, can radically increase or diminish the artistic and economic value of objects within art markets (Bonus and Ronte, 1997). The credence aspect of artistic goods underlines the importance of cultural institutions and intermediaries in determining the economic and cultural value of artworks. Moreover, empirical studies indicate that there is a positive correlation between ‘cultural judgements’ done on an artwork by museums or art critics and its future economic value (Frey and Pommerehne, 1989).

Experts are also integral in facing the problems of asymmetric information that are present in the art market. Information asymmetries favour opportunity for fraud and deceits. Furthermore, they allow some players in the art market to hold more information than others in order to score higher economic returns (Akerlof 1970). Some participants may, for instance, have better knowledge about the authorship, authenticity or provenance of a work of art than their competitors, which could enable them to make excess returns (Velthuis 2015). In general, the art market faces the problem of a lack of transparency. Information regarding the quality of the art supplied or the willingness to pay on the side of buyers is incomplete, difficult and often expensive to gather. Also,

prices for which art dealers sell works of art are frequently unknown. The lack of transparency is also striking when it comes to the identity of buyers and sellers, whose names are not usually disclosed (Velthuis 2011). Transparency has been increased by new digital resources that provide information on artworks, artists and cultural institutions. Because of digitisation and globalisation it is now easier to acquire data about an artwork's sale that has been auctioned on the other side of the world.

This dissertation is going to focus on the contemporary art market. The contemporary art is made of various 'disciplines' (video art, painting, photography, sculpture, digital art, drawing, music, performance, installations) and includes everything that was produced from the 1960s to this day (Zorloni 2013). As stated before, the contemporary art market is made of two sub-markets, the primary and secondary market, which can be further segmented into other four markets that denote the characteristics of artworks: the classical contemporary art market (branded market), the junk art market, the avant-garde market and the alternative art market (Abell's 1980). The classic contemporary market is a global one, formed by living, but already historic, artists (precisely defined as the classics of contemporary art), whose works have been already sold in the secondary market. The avant-garde market is formed by the most known artists, that are represented by the most prestigious galleries and that are often represented in the most important art fairs and exhibitions. The alternative market is a more national market in which more traditional artists operate. This market is more accessible by young collectors, as the prices in this segment of the contemporary art market are relatively low. Finally, the junk art market is the one in which commercial activity is completely prevalent over cultural activity, artworks are sold for their commercial value, rather than for their aesthetic or cultural value, and usually have very low prices (Robertson 2005) (Zorloni 2005) (Zorloni 2013).

2.2 Auctions and Auction Houses

The research is going to be focused on auction houses. Auction houses operate in the secondary art market. In the secondary market prices are usually higher than in the primary market, as the artistic and economic value of an artist and of their work has been already established. The appearance of an artwork at an auction signals

professional recognition for an artist (Goetzmann et al. 2016)(Bocart et al. 2017). Artists who sell their work in the secondary art market are usually established and the quality of their works recognised by the art community. The sellers at auctions are usually private individuals who bought an artwork in the primary or secondary art market and are willing to sell it because there is demand for the author and the value of the artwork increased, or they just want to cash money and selling through dealers may be less advantageous and require a long time. The buyers at art auctions are usually private collectors, art dealers and institutional buyers, such as museums or private galleries.

Art auctions usually work in the following way: sellers bring their items for sale to the auction house on a specific date and buyers gather to buy them or bid through intermediaries, including by telephone, and now by internet, with the process coordinated by an auctioneer (Ashenfelter & Graddy 2011)(2019). Art auctions usually utilise the English auction method, which consists in taking the highest bid offered by clients as the final price, or "hammer price", of the artwork. The seller will generally set a 'reserve price', and if the bidding does not reach this level, the item will go unsold. Items that have gone unsold are usually referred to as "bought in''. Reserve prices are usually created after an agreement between an art expert and the artwork's seller. Auctioneers are very secretive about reserve prices, as the reserve price protects sellers from having to sell at a lower price in the case there is not enough interest for the auctioned item. It is thought that, keeping reserve prices secret, may induce a higher rate of participation of bidders at an auction (Vincent 1995). Usually the reserve price is set at the 70% of the pre-sale value estimate made by the auction house (Ashenfelter and Graddy 2011). Traditionally, auction houses make their money by earning a premium from the buyer and from a commission paid by the seller. For the two major auction houses, Christie's and Sotheby's, the commission that the buyer has to pay is usually between 13 percent and 30 percent of the hammer price (Christie's 2020) (Sotheby's 2019). The specific commission depends on the auction house, the type of auction and the location in which the auction takes place. The commission that the sellers pay to the auction house is far smaller than the one paid by the buyer. This commission is usually negotiated between the seller and the auction house (Christie's 2020), and in most cases it amounts to more or less the 10% of the hammer price (Ashenfelter & Graddy 2002). If an item goes unsold, the auctioneer will receive neither

a buyer's premium nor a seller's commission. To make sure the seller bears some of the cost of auctioning but not selling an item, auctioneers usually charge the seller a fee on unsold items. This fee is often a percentage of the reserve price set by the seller, which obviously gives the seller an incentive to keep the reserve price low. In addition, some auction houses will not allow a seller to put up an easily recognized item for resale until some time has passed.

The auction mechanism is fundamental to understand price formation and the economic value of artworks that are dealt in the art market. An aspect of auction houses that might be involved in the process of artworks' price formation is the pre-sale estimate made by the auction house. Before an auction, auction houses experts, publish in the auction's catalogue an estimate of the worth of the artworks that are up to bid. The truthfulness of these predictions has been questioned in several academic papers. Ashenfelter's (1989) finds that these predictions show that auction houses are generally truthful; the average of the auctioneer's high and low estimate is very highly correlated with the price actually received and that the estimates made by auctioneers are a far better estimate on the price of the artwork than hedonic price functions (Abowd & Ashenfelter 1988). The price estimates provided by the auction house's art experts are usually based on the previous auction performance of an artwork.

The position in which an item is placed during an auction might also affect its 'hammer price' (Ashenfelter 1986) (Beggs and Graddy 1997). Beggs and Graddy (1997) found that in art auctions, the ratio value of pre-sale estimates has a declining pattern throughout the auction. This phenomenon, also empirically verified by Ashnefelter (1986) in wine auctions, is known as 'declining price anomaly'. The declining price anomaly shows one of the ways in which auctioneers can affect the price of auctioned artworks.

The auction house or the location in which an artwork is sold may also affect its final valuation at an auction. Theoretically, in the absence of different transaction costs, no systematic price differences should exist between distinct markets (Ashenfelter and Graddy 2006), this is known as the 'law of one price'. However, this condition does often not hold true. Pesando (1993) found that prices of identical prints were on average 14 percent higher at Sotheby's in New York than at Christie's in New York in the period

from 1989 and 1992. He also found that prices were, on average, 7 percent higher in New York compared to London.

It is claimed that when an advertised item goes unsold at an auction it will be sold for a lower value at future auctions. The items that have gone 'unsold' during an auction are usually known as 'burned'. Indeed, empirical evidence shows that artworks that failed between sales usually return about 30 percent less than other auctioned artworks (Beggs & Graddy 2008). The 'burning effect' occurs as an artwork's failure to sell may be perceived as a downward trend in common taste for a specific painting. The 'burning effect' may also be due to the fact that the seller could decide to lower the reserve price of the unsold item at sequent auctions because of an urgent need to sell the artwork.

Because of the fact that the two major auction houses, Christie's and Sotheby's, retain a large share of the market and effectively operate in a market that is keen to a duopoly, they have a strong incentive to collude on buyers' and sellers' commissions and on prices of artworks. As a matter of fact, Christie's and Sotheby's were involved in a large price fixing scandal in 2001 (Ashenfelter & Graddy 2005)(2019), as they were found guilty of colluding on the values of buyers' premiums.

Auction houses could be considered platforms in a two sided-market. A two-sided market is one whose organization requires the existence of two very different but interdependent user groups that rely on one another in order to enjoy network benefits (Rochet and Tirole, 2003) (Towse 2011). The two independent user groups involved in the process of auctions are sellers and buyers. A person that would like to sell an artwork at an auction will consider the number of potential buyers that use the same platform, as the larger is the number of potential buyers, the higher will be the possibility that their artwork is sold at the auction. In a similar way, a buyer will benefit from a large selection of artworks. Thus, larger and established auction houses have a consistent advantage over the competition. Moreover, because of the network effects, platforms in two-sided markets will enjoy higher returns to scale. Users will be willing to pay a higher price to access bigger networks, so the margins of successful platforms will increase as the number of users that make use of the platform increases (Eisenmann et al. 2006). This is why art auctions houses do their best to attract the larger number of sellers and buyers to their establishments. An art auction should be regarded more as a social process rather than an event, as the role of the auction house

goes beyond the mere organisation of the sale. The auction house is responsible for reaching out to create a community of buyers, sellers and other knowledgeable agents, such as scholars and professional experts (Brodie 2018). The role of experts, such as appraisers and scholars, in auction houses is fundamental. Indeed, in a market dominated by lack of transparency and information asymmetries, trust and status appear to be key (Arora & Vermeylen 2012). Status derived from training, experience and institutional linkages generates trust in the potential consumers of art.

As already argued, the current art market is dominated by just a handful of large auction houses, the two largest are Christie's and Sotheby's (McAndrew 2020). In the contemporary art market, the market structure for auction houses tends to be international for highly valued and well-known artists (mainly classical contemporary and avant-garde) and local for lesser-known artists whose work may fall into the categories of alternative (Zorloni 2005). More in general, smaller and local auction houses usually reflect the lower end of the market. Contemporary art sales in auction houses are becoming more popular and relevant. As a matter of fact, in 2019, post war and contemporary art accounted for 53 percent of total sales made at auctions (Mc Andrew 2020).

Large and multinational auction houses, such as Christie's and Sotheby's, had a fundamental role, in recent times, in developing a globalised art market and attracting collectors and artists from all over the world. By being able to access a large number of collector markets across the globe, the multinational auction houses are able to deal artworks expeditiously away from their country of production to wherever they could be demanded (Archer 2020) (Codignola 2018). The increasing digital presence of Christie's and Sotheby's (Hiscox 2020), and other multinational auction houses, has helped to make the art market even more global facilitating the matching between buyers and sellers internationally.

2.3 Digitisation and Digital Auctions

The process of digital transformation and digitalisation has been a concept that the art market addressed since the 1990s. The art market began to approach digital tools in the 1990s both for the production and the distribution of artworks. By digitisation, this

essay refers to the transformation process of the traditional business models of institutions involved in the art world, in order to incorporate and capitalize on the applications of the Web 2.0 (Arora and Vermeylen 2013).

The most visible impact brought about by the digital shift of the art market so far, is the creation of new platforms that are helpful in decreasing the presence of asymmetric information between buyers and sellers in the art market. Thanks to the internet a potential buyer has now access to a larger amount of information on the artwork that they are willing to buy. It is easier, for instance, to track what were the previous selling prices of an artwork, or at what prices similar artworks have recently sold for. For the art market, the Internet fostered the creation of a global platform for the spread of information across nations (Codignola 2018). The characteristics of Web 2.0 enabled the market to easily share information, thus limiting the long standing problems of information asymmetries. Numerous web-based platforms that provide information on artworks were created. These websites grant the possibility to virtually anybody to obtain information on size, authorship and previous evaluations of artworks on websites, such as ArtFact, ArtNet or ArtPrice, wit the consequence of increasing the general level of transparency in the art market. The availability of information on these data banks may drive customers away from more established intermediaries, as they "*might feel fooled for the prices they paid [previously] and try online-intermediaries instead*" (Heereman von Zuydtwyck, 2014). Christie's and Sotheby's have also started to publish information about past auctions online, where they are available and can be consulted by anyone. On the other hand, online art marketplaces have been less transparent and less prompt to publish reliable and consistent data about their sales (Migroet et al. 2018)

With the increased popularisation of the internet and of digital tools, the most reputable auction houses, Christie's and Sotheby's, decided to organize online auctions. Auction houses have been conservative in their engagement with the virtual realm. Christie's made its first online auction in 2012, whereas Sotheby's approached the online market in 2016. However, the online auctions created by traditional auction houses have been usually partially online (Milano 2016)(Migroet et al. 2019). In these partially online auctions, the auction may take place in Hong Kong or New York and there will also be the possibility for the online audience to make bids for the artworks that are auctioned.

The location in which the auction is effectively held might regulate possible constraints and may determine the currency that is used in the bidding process. Online-only auctions exist, but before the advent of the Covid-19 pandemic, they represented a very small share of the total auctions offered by the major auction houses. Online live bidding had served more as a marketing tool rather than a serious economic opportunity for major auction houses (Arora & Vermeylen 2013). Furthermore, the prices bid in online only auctions are generally lower than those in live auctions. In March 2020, the average price for art sold online was still $6,859 (Halperin 2020), far distant from the $60 million that Sotheby's had estimated for a Francis Bacon painting at a live auction (Pogrebin et al. 2020).

However, during the first half of 2020, the revenue from pure online-auction made by Christie's, Sotheby's and Phillips was more than five-times higher than the revenue in the same period of 2019 (Hiscox 2020). Because of the regulations imposed during the spread of the Covid 19 pandemic, various intermediaries had to increase their level of digitalisation, as online became the only channel for sales and promotion for most of the industry (Bucholz et al. 2020). The art market's digitisation seemed to have benefited also smaller auction houses that can now potentially access a larger share of the market. In fact, the share of small auction houses that offer online sales to their clients is rising annually. As a matter of fact, in 2019, auction houses with sales under $1 million made 23% of their sales online, whereas larger auction houses, those with total sales over $10 million, made only 4% of their total sales online (McAndrew 2020).

The rise of digitalisation also encouraged the creation of numerous platforms that provide auctions and operate only on the digital market. The leading online marketplace for artworks is Artsy (Hiscox 2020). This platform partners with more than four thousand cultural institutions, such as museums, art galleries and art auctions in order to create the world's largest online fine art marketplace. Artists and collectors can also directly sell their artworks to interested buyers on Artsy (Hiscox 2020) (Artsy 2021). These new competitors in the digital secondary market applied similar techniques as the ones established in traditional auctions. Usually artworks, on digital platforms, are dealt both through auction of singular items over a long period of time or in organised auctions in which multiple items are bidded at a specific time such as in traditional auctions.

However, the online art market is yet to be fully developed (Hiscox Online Art Trade Report 2018). As artworks are usually considered experience goods, digital experiences do not seem to be able to replicate the full aura as it is experienced when in presence of the physical object (Renneboog & Spaenjers, 2015). The consumption of an artwork entails personal contacts, attending auctions and galleries, and being able be in the presence of the artwork, these peculiarities that make the art world special, have not yet been translated to the online sector (Malik & Phillips, 2012).

2.4 Blockchain and its possible applications in the art market

Blockchain technology, also defined as distributed ledger technology, was popularised around 2008 (Whitaker 2018). Blockchain is essentially a distributed, shared and secured ledger that helps to track and record resources without the need of any centralized authority (O'Dair 2019). The first and more popular application of blockchain technology up to today, has been the creation of cryptocurrencies, such as BitCoin or Etherum. Now, the application of blockchain technology goes beyond the decentralised and digital currencies. Blockchains have evolved, as well as proliferated. In his account on the use and potentiality of blockchain in the creative industries, O'Dair (2019) recognises seven classes of blockchain applications: as well as currency, there is underlying architecture, financial services, proof-as-a-service, identity management, governance and, finally, property and ownership. As O'Dair argues, the popularisation of new uses of blockchain technology led to the creation and proliferation of DApps, or decentralised applications. DApps are the user-friendly application of blockchain technology.

The discussion on the possible uses of this technology in the art market has become a trending topic in recent times. As a matter of fact, decentralised applications that use blockchain technology in order to provide services in this market are growing rapidly. For some, the potential use of this technology may revolutionise the traditional art market, modifying the standard practices that are common in this sector. Blockchain technology has been used by platforms that operate in the art market to facilitate licensing, to perform authentication, to create new forms of ownership and to perform secure payments (O'Dair 2019).

Firstly, by tracking movements and provenance of artworks, the application of blockchain technology could be influential to secure transparency and increased information. The Ethereum blockchain platform is an operating chain that offers the possibility of creation of art registries. The blockchain distributed ledger could serve as an immutable and decentralised record in which information about the title, past ownership and current legal ownership of an artwork could be registered (Whitaker 2018). Blockchain technology could also be used to produce and permanently tie certificates of authenticity to artworks. Verisart, Codex Protocol and Artory are three companies that focus on registering artworks and providing certificates of authenticity and provenance to their owners. Artory became the first company to list on the blockchain a major auction sale, as it registered the Ebsworth Collection, sold at Christie's in New York in October 2018 (Kinsella 2018) (Christie's 2018). Artory, which operates in the Ethereum blockchain, offered to collectors that acquired artworks during the auction, a certificate of authenticity encoded to the blockchain. The main challenge of these companies, that try to reduce the opacity and the scarcity of information that are characteristic of the fine art market, is to create a physical connection between the blockchain listing and the physical artwork. Possible practices to do so include Value Protocol, Dust Identity and Tagsmart, which stamps the back of a work of art, then glues a QR code over the top to create a "tag". A certificate and digital passport are then issued, which can be put on the blockchain (Adam 2018).

Another application of blockchain technology is to guarantee scarcity in digital art. Digital art has become more popular with time, and the issue of maintaining the unicity of a digital file, that could potentially be easily reproduced, came upon. Blockchain technology grants the possibility of registering one's digital work on the distributed ledger and allows creators to specify sales conditions and sharing rights for their work (Zeilinger 2014).

Blockchain technology also offers the possibility of fractional ownership of works of art. This is possible through the process of tokenization, that is assigning to different shares of an artwork a correspondent token. Using either U.S. dollars or cryptocurrencies, individuals can use these platforms to purchase tokens that represent shares in various works of art. Once they own one or more shares in a work of art, they can treat them like any other investment, they can acquire more shares of the artwork or sell their shares

depending on the fluctuations of the price of the artwork (O'Neil 2018). The possibility of acquiring fractions of artworks could potentially democratise the world of art collecting. A larger number of people could have the possibility of accessing the art market with smaller investments. The practice of selling shares of artworks could potentially also be applied by museums or other cultural institutions as an alternative way of funding (O'Neil 2018).

The development of blockchain technology in the art market also contributed to the creation of new intermediaries. Online-based marketplaces that sell primarily digital art and collectibles are increasing in number and in popularity. These platforms, thanks to the application of Ethereum blockchain technology, provide secure, fast and peer to peer (P2P) payments. One of the more successful amongst the platforms that trade digital art and collectibles in the form of non-fungible tokens (NFTs) is SuperRare. The company describes itself as "*Instagram meets Christie's*" (SuperRare 2020). SuperRare, as most other blockchain based NFT marketplaces, includes both primary and secondary sales of artworks. There are no costs for sellers of digital art on this platform, and the only cost bared by the buyer is the transaction cost, which equals to 3 percent of the "knock down price". Artworks, on SuperRare, can be bought in two ways. The first one is through making an offer for an artwork that is not on sale in an auction. The owner of the artwork can decide to accept or refuse the offer. The artwork may also have a "buy now" option, the artist or the owner of the artwork can set a price at which the artwork will be sold. All artworks are technically always on the marketplace. The second way to exchange artworks on SuperRare is through auctions. There are two types of auctions: 'schedule auctions' and 'reserve auctions'. In 'schedule auctions,' the seller specifies a set time for which the auction is going to last and they will also set a starting price. The auction then works as an English Auction. In 'reserve' auctions, the seller sets a public reserve price, that, when met, kicks off the timed auction. The first bid must be at least the reserve price. When the reserve price is met by the first bid, the auction is triggered and the timer starts a 24-hour countdown to the end of the auction (Perkins 2021). This second auction method was inspired by digital artist Coldie, one of the platform best selling artists (Perkins 2020).

The popularity of digital artworks in the form of NFTs has spiked in the first months of 2021. A digital artwork sold at more than $350,000 at the end of February on the

blockchain based platform *Nifty Gateway* (Kastrenakes 2021)(Nifty Gateway 2021). In March, auction house Christie's organised an online-only auction that featured a collection of digital artworks by prominent digital artist Beeple. The 'hammer down' price for the collection amounted to almost $70 million dollars. Christie's was the first major auction house to sell a digital artwork with a unique NFT and to accept cryptocurrency as a form of payment for it. Auction houses continued to sell on their websites digital artworks, in the form of non-fungible tokens (NFTs) well into 2021 (Art Rights 2021). At the beginning of June, Sotheby's held its first multi lot auction that featured only crypto artworks, "*Naively Digital: A Curated NFT Sale*". Not only the larger international auction houses began to sell digital artworks on their online platform, even auction houses with a smaller outreach decided to follow the trend and organise curated sales of crypto artworks. An example is Italian auction house Cambi, that in June 2021 organised an auction of crypto artworks in collaboration with the online art marketplace SuperRare (Cambi Aste 2021).

Most of the application of blockchain technology in the art market are based on the Ethereal blockchain. One of the downsides of using Ethereum blockchain based platforms, are the high costs of transactions, also known as gas prices. Gas refers to the fee, or pricing value, required to successfully conduct a transaction or execute a contract on the Ethereum blockchain (Frankenfield 2021) (Kay 2021). Gas prices are the fee that is awarded to Ethereum miners, who perform all the important tasks of verifying and processing transactions on the network, for their computational services. The higher will be the demand for transactions on the Ethereum blockchain, the higher will be the average cost of transactions. In order to carry on a transaction expeditiously, a user that is willing to make a transaction on the Ethereum blockchain, will have to pay higher transaction costs. Thus, for instance, on an artworks' marketplace, someone who is willing to bid on an artwork may have to pay a larger transaction cost if they are willing to make a bid that will arrive faster to the seller.

Transparency has been a key issue when addressing the potential benefits that digital tools could provide the art market. Blockchain technology could increase the level of transparency and decrease asymmetric information between buyers and sellers of artworks. The Hiscox Report, has also acknowledged the potential for Blockchain to address this issue stating that "*the main benefits of blockchain technology in relation to*

art center on its potential to improve authentication and provenance. The technology can allow the creation of safe and secure certificates of authenticity that follow artworks from their inception" (Hiscox 2020), On the other hand, as revolutionary as Blockchain could possibly be to the art industry, it is important to note that the art markets are firm into tradition and reluctant to adopt structural changes to their current business models. Therefore, Blockchain's ability to make significant changes to the market's transparency issues will most likely exist as an idea for an extensive period until it is put in place. Anyhow, as shown by the latest Hiscox report, the number of industries involved in the art market that make use of blockchain technology is constantly rising (Hiscox 2020), and auction houses are amongst those establishments in the art market that have been exploring the potentiality of blockchain technology.

3. Research Methodology

3.1 Technology Organization Environment (TOE) Framework

The main goal of this research is to assess the viability of the use of blockchain technology by auction houses that operate in the art market., and to examine what determinants may are more influential in their decision to adopt the technology. To measure the contextual factors that influence the adoption of blockchain technology, the Technology Organization Environment (TOE) framework from Tornatzky & Fleischer (1990) will be applied. The TOE framework was created to analyse the acceptance and the possible adoption of a technology at an organizational level of analysis. This framework was used extensively, in the last period, to analyse the factors that firms take into consideration when deciding to integrate the use of blockchain technology in their business practices (Chloessy et al. 2021).

In this framework, there are three categories to evaluate when looking into the application of a new technology in a business model: technological context, organizational context, and environmental context. For the model the adoption and integration of technological innovations are clearly affected by the technological, organizational, and environmental contexts within a firm.

The choice of using the TOE framework is supported by the fact that this framework is more suited to investigate the determinants of technological adoption than other innovation models, such as the technology acceptance model (TAM) and the diffusion of innovation model (DOI). Specifically, the TAM seems too focused on the individual behaviour towards the adoption of an innovative technology, rather than on a firm's willingness to potentially adopt an innovative technology (Albrecht et al 2018). To analyse the possible application of blockchain technology by auction houses, this research takes into account the factors that might influence the three categories that configure the TOE framework. The factors are chosen after evaluating the extensive literature review by Clohessy et al. (2021) on the uses of the TOE framework in the specific research on blockchain technology adoption.

3.1.1 Technological Factors

From a technological perspective, several considerations emerged as significant in order to assess the potential application of a new technology into a business model; amongst them: the perceived complexity of the technology and the perceived relative advantage that the application of the technology could bring to the firm. When looking at the technological factors that influence the adoption of a new technology into a firm's business model, one must look at the firms' opinion on current and future technologies that firm can apply.

Complexity

Studies show that a technology will not be adopted if it is too difficult to understand, learn and use (Sonnenwald et al. 2001) Moreover, Rogers (2001) argues that the adoption of new technologies is less likely when the application of the technology is considered challenging. In particular, blockchain technology is often believed to be too complex for many to understand (Wei 2018). As previously mentioned in the literature review, blockchain technology is still in a nascent stage and its characteristics are not well known and well understood by the majority of the population. The perceived complexity of blockchain technology may thus negatively influence the auction houses' intention to integrate the technology, thus the following hypothesis is formulated:

H1 : *The perceived complexity of blockchain technology is negatively associated with its possible adoption by auction houses in the art market.*

Perceived Benefits

An innovation to be truly 'innovative' must give an advantage to whomever applies it (Rogers 1995). Relative advantage can be described as the extent of positive change that comes with the adoption and use of a certain technology compared to previous state of affairs. Blockchain technology could provide several benefits and advantages to auction

houses. For instance, the application of blockchain technology may help auction houses to increase their revenue, decrease the information asymmetry, and reduce costs. If auction houses recognise that the benefits that the application of blockchain technology could be significant, they will be more prompt to integrate the technology in their business model. Hence, the following hypothesis:

H2: *The perceived benefits of blockchain technology are positively associated with its possible adoption by auction houses in the art market.*

3.1.2 Organizational Factors

The organisational factors measure the availability of resources and the current characteristics of the firm (Baker 2012). From an organizational perspective, the role of innovativeness, organizational readiness and knowledge of the technology were highlighted in previous researches as important when evaluating the propension to apply an innovative technology to the current working practices of a firm.

Organizational Readiness

Organizational readiness represents to what extent an organization will be able to integrate the new technology in their current way of working (Wang et al. 2010) The term organizational readiness is popular in change management. An organization is believed to be prepared to confront an important change in its structure if it has adapted human, financial and infrastructural resources (Weiner 2009). Perceived organizational readiness is going to be evaluated by asking to rate the firm preparedness to make economic and structural investments to adapt a new technology to their business model. When organizational readiness is strong, companies are more likely to persist with the adoption of the technology irrespective of the challenges they encounter (Clohessy & Acton, 2019). Thus, this research will test the following hypothesis:

H3: *The perceived organizational readiness of blockchain is positively associated with possible blockchain adoption by auction houses in the art market.*

Innovativeness

Innovativeness refers to the current level of technological advancement of the company and their reliance on innovative technologies. Rogers (2003) defined innovativeness as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than any other member of the system." Innovativeness tests the capacity to integrate innovative practices and technologies in the working practices of a firm. A firm's existing technologies are important in the adoption process because they broadly suggest the scope and pace of technological change that a firm can undertake (Collins et al. 1988). In order to have a better comprehension of the level of innovativeness of auction houses, respondents will be asked when they started organising online auctions and if they are already accustomed to selling non-physical artworks (video art, digital art). The capacity to adapt innovative technology to a firm's business model is believed to be positively related to the possibility of applying innovative technology in the future. For this reason, we formulate the following hypothesis:

H4: *The innovativeness of an auction house is positively associated with possible adoption of blockchain technology.*

Knowledge

It is reiterated by multiple sources that there is a lack of understanding among business, consumers and authorities regarding the potential use cases for blockchain technology, the ways in which it operates and what the technology can actually do (Jannsen et al. 2020). Having knowledge of the possible uses of blockchain technology in the art market may positively affect the intention to adopt the technology. Having complete knowledge of the characteristics and uses of an innovative technology is positively associated with its possible implementation (O'Dair et al. 2016), therefore:

H5: *A higher knowledge of the characteristics of blockchain technology is positively associated with the intention of adopting blockchain technology.*

Size of the organization

The size of the organization is usually associated positively with the possibility of applying innovative technologies (Trigo et al. 2015)(Baker 2012). In our survey, the size of an auction house will be approximated by the number of auctions that it holds on average in a year. This is mainly because asking for other characteristics that could help in evaluating the size of an auction house, such as the establishment's revenue or the number of their employees, was deemed difficult, as the person that is answering the questionnaire may not have this type of information. Then, we formulate the following hypothesis:

H6: *The size of an auction house is positively associated with their willingness to adopt blockchain technology.*

3.1.3 Environmental Factors

The environmental perspective includes considerations that affect an organization's daily business operations, such as industry and competitive dynamics, government interactions, and regulation. Factors that may influence the application of a new technology from this perspective are, for instance market dynamics and regulatory environment (Baker 2012)(Clohessy et al. 2020).

Competitive Pressure

Market dynamics, which also includes competitive pressure and market standards, are global level market forces that can have a positive or negative impact on an organization (Clohessy et al. 2020). The application of blockchain technology by a competitor may positively influence the possibility of adopting the technology of other competitor firms. In certain cases, adopting a new technology could even be a strategic necessity to effectively compete in the industry (Dwivedi et al., 2009). Potential competitors for auction houses that use blockchain technology could be online marketplaces of digital

art, which are often cited as potential disruptive forces for traditional intermediaries in the art market (Veitch 2017). The perceived competitive pressure of auction houses will be evaluated by asking in the questionnaire if recent adoption of blockchain technology by competitors had an influence on their intention to adopt the technology in the future. This hypothesis may be particularly relevant after the recent sales of crypto artworks by major auction houses. These events may have encouraged other auction houses to look into the possible application of blockchain technology in their business model. Thus, the following hypothesis is introduced:

H7: *Perceived competitive pressure is positively associated with possible blockchain adoption by auction houses in the art market.*

Regulatory Environment

The identification of the regulatory environment consideration is significant as government regulation can impact information technology positively or negatively (Baker, 2012) (Pennings & Harianto, 1992). Regarding the application of blockchain technology, the absence of a clear regulatory environment may negatively influence the intention to adopt blockchain technology. The main characteristic of blockchain technology is that of being a decentralised ledger, thus there is no central authority that can effectively regulate the uses of blockchain and cryptocurrencies. More clarity in the regulatory environment and regulatory support concerning blockchain technology could prove to be essential for the widespread adoption of blockchain technology. The following hypothesis is introduced:

H8: *The absence of regulatory support for the application blockchain is negatively associated with the possibility of blockchain technology adoption by auction houses in the art market.*

3.2 Research Model

This model is a visual representation of the model that the research is going to use for evaluating the role of different factors on the willingness of adopting blockchain

technology. On the left part of the diagram there are the independent variables, namely relative advantage, complexity, innovativeness, organizational readiness, size of the auction house, perceived competitive pressure and regulatory support. The independent variable have been divided according to the grouping proposed by the TOE framework. The eight independent variables are divided in three groups: technological context, organizational context and environmental context.

On the right part of the diagram the dependent variable can be found, namely blockchain adoption.

Figure 1. Conceptual Model

The following table (Table 1) displays a summary of the hypothesis based on the factors, based on the Technology Organization Environment (TOE) framework that may

influence blockchain technology adoption by auction houses. Hypotheses have been formulated in order to understand which variables can be associated with the willingness to adopt blockchain technology. The hypothesis will be tested with the use of multivariate regression analysis. In the following table a summary of the formulated hypothesis is listed.

Table 1, Summary of the hypothesis

Number	***Hypothesis***
H1	The perceived complexity of blockchain technology is negatively associated with its possible adoption by auction houses in the art market.
H2	The perceived benefits of blockchain technology are positively associated with its possible adoption by auction houses in the art market.
H3	The perceived organizational readiness of blockchain is positively associated with possible blockchain adoption by auction houses in the art market.
H4	The innovativeness of an auction house is positively associated with possible adoption of blockchain technology.
H5	A higher knowledge of the characteristics of blockchain technology is positively associated with the intention of adopting blockchain technology.
H6	The size of an auction house is positively associated with their willingness to adopt blockchain technology.
H7	Perceived competitive pressure is positively associated with possible blockchain adoption by auction houses in the art market.
H8	The absence of regulatory support for the application blockchain is negatively associated with the possibility of blockchain technology adoption by auction houses in the art market.

3.3 Data Collection and sample selection

The thesis is centred on the possible application of blockchain technology by auction houses, thus the unit of analysis of this study consists of auction houses, based in Europe, that usually deal in contemporary artworks. For the purpose of this research, a questionnaire was sent to auction houses of different sizes from the following countries: Italy, France, Spain, Germany, Switzerland, Netherlands, Sweden, Austria, Belgium and

the United Kingdom. All the auction houses that received the questionnaire deal in contemporary artworks and organise online auctions. This is because the research wishes to assess if auction houses will adopt blockchain technology and what determinants could influence their decision to adopt the technology. Online presence is an essential requirement in order to utilise blockchain technology and auction houses that deal artworks, and more in particular contemporary artworks, may be more interested in the applications of this technology as they could exploit it to sell crypto artworks in the form of Non Fungible Tokens (NFTs). Auction houses were individuated by looking at the nationals auction houses association's lists.

. In total, the questionnaire was sent to 107 auction houses. Very large auction houses, such as, for instance, Christie's, Sotheby's and Phillips, have purposely not been contacted,. Firstly, because information about their usage of blockchain technology is already public, and secondly, because getting an answer to the questionnaire from such large corporations would have been extremely difficult. The complete list of auction houses to which the questionnaire was sent can be found in appendix A.
The questionnaire was sent by email to the 107 auction houses. If after one week the auction house had not completed the questionnaire, a reminder was automatically sent by the survey distribution software. Many auction houses have also been contacted by the telephone to politely encourage them to fill in the survey.

The data has been collected through the use of a survey. Survey methodology can be defined as the practice of "*collecting information from a sample of individuals through their responses to questions*" (Check & Schutt, 2012, p. 160). Surveys are an often used method when dealing with research methods such as the TOE framework. The questionnaire that was sent out to auction houses was divided in three parts. A this research aims at understanding the influence of different independent variables on on e dependent variable, conducting a survey is the most appropriate research strategy for this study. When conducting a survey, the researcher, addresses the research question directly to the targeted population represented by a sample. This survey will collect the necessary data via a questionnaire ,which is one of the most often used instruments in surveys. When using survey methodology, appropriate sampling, question design and data collection need to be ensured, so that the collected data can be analyzed

quantitatively and provide representative and truthful results. (Fowler, 2013). For the purpose of preserving the privacy of the respondents, the answers to the questionnaire have been kept anonymous.

The first part of the questionnaire consisted of the questions that were important to create the independent variables that the research is willing to evaluate in order to respond to the main research question, *what are the main factors that could influence auctions houses to adopt blockchain technology in their business model?* This first part of the questionnaire is composed by 24 questions.

The second section of the questionnaire included those questions that were important to answer the second research question, namely "To what extent did the global pandemic impact on auction houses' willingness to adopt blockchain technology?". This research question was created to better comprehend if the Covid-19 pandemic had a visible effect on auction houses's intention to adopt blockchain technology or accept cryptocurrencies as a form of payment. This second research method was inspired by a paper that investigated the change in students' expectations because of Covid-19 (Aucejo et al. 2021).

In the third and last section of the questionnaire, respondents were asked for generic information about their age, the level of study they completed and their gender. This section was useful to have a clear understanding of the characteristics of the respondents in the sample.

3.4 Measurement of the variables

This study includes 8 independent variables which represent the identified factors influencing blockchain adoption among auction houses. Most of the variables described in the model are measured by items written in the form of statements to which the respondent is going to agree or disagree on a 5-point Likert type scale. The 5-point scale consists of the options strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree, which will result in ordinal data. Tornatzky and Klein (1982) support such use of perceptual measures for innovation studies, as perceptions tend to be more alike than different, and adoption decisions are usually based on perceptions.

Different questions in the survey will help to create the variables, for instance, the question '*Blockchain technology is too complex to be integrated in our establishment*' will be used amongst other questions as a measure of complexity. The factors in the model will be measured by a combination of 2,3 or 4 items, which will be then transformed into interval data to enable the performance of parametric tests. The methodology used to test the model is inspired by the model proposed by Grover (1993) in his research on the adoption of customer based interorganizational systems.

The dependent variable for this model is the willingness to adopt blockchain technology in the near future. The result of the research is going to assess how the different independent variables might affect the possible willingness to adopt blockchain technology by auction houses. The measurement of this variable is based on the question "*My auction house is willing to look into the adoption of blockchain technology in the near future*". The answers to this question are measured on a 5 point Likert scale, as all the other independent variables.

In order to answer the second research question, "*To what extent did the global pandemic impact on auction houses' willingness to adopt blockchain technology?*", the questionnaire's respondents were asked to choose a percentage value that corresponded to the percent value that they would associate to the possibility of adopting blockchain technology or integrate the use of cryptocurrencies in their business model. The question tried to evaluate if this percentage value has changed because of the advent of the Covid-19 pandemic. As the Covid-19 pandemic forced many auction houses to develop new and unforeseen digital strategies, by increasing their online participation, the pandemic may have had a positive effect on their willingness to apply blockchain technology to their business model or to accept cryptocurrencies as a method of payment for their services. The question asked for the percentage value of the possibility of adopting blockchain technology in the near future, as it wanted to estimate how the self-assessment of auction houses regarding the adoption of blockchain technology changed because of the pandemic.

3.5 Analysis of the data

After the data is collected, cleaned, and subsequently transformed into interval data, a multivariate regression analysis will be performed. Multiple regression is a statistical procedure that includes two or more predictor variables in the equation of a regression line to predict changes in a criterion variable (Privitera 2018). This type of analysis will give insight into which contextual factors have a significant influence on blockchain adoption. The R-squared values, that will be calculated before the actual regression analysis, will provide more insight into the amount of variance explained by the contextual factors in the model (Privitera 2018). All of the data analysis will be carried out by using the statistical analysis software SPSS.

Before performing the regression analysis, to understand the relation between the dependent and independent variables, measurements of the research variables will be tested for reliability. Measurements must be reliable in order to "be useful and yield stable results" (Thong 1999). This implies that the measurements should yield the same results when used repeatedly in the same conditions. The reliability or internal consistency can be measured using Cronbach's Alpha coefficients. A constructed variable can be considered as reliable if the Cronbach alpha is equal to or above 0.7 and is regarded as unreliable if the Cronbach's alpha is below 0.5 (Nunnally 1978). After having assessed the reliability and the validity of the variables, the research will examine that all the requirements that are necessary to perform a multivariate regression analysis are met. A dataset should meet the conditions of linearity, normality and homoscedascity. Moreover, in order for a multivariate regression analysis to be valid there should be no collinearity and multicollinearity amongst the different independent variables (Privitera 2018).

4. Results

4.1 Characteristics of the sample

The data was collected over a time period of one month and resulted in the collection of 40 complete answers to the questionnaire. Although this number could appear rather small, it is actually representative of a consistent share of the totality of auction houses that have an online presence and that frequently deal in modern and contemporary art in Europe. The survey was distributed to auction houses across Europe, more specifically in Italy, France, Spain, Austria, Switzerland, Germany and Sweden. As mentioned before, the survey was sent directly by email to auction houses that satisfied the criteria that were necessary to answer the questions of the questionnaire. In order to better understand the profiles of the questionnaire's respondents, some general biographical information was asked at the end of the survey. Respondents gave information about their gender, their age and the highest level of education they've completed. In table 2 a summary of the responses to these general question is displayed. The large majority of the survey respondents were male, more precisely 72,5 %. (N=29), whereas only 11 respondents were female(27.5%). Respondents were grouped in five age groups. None of the respondents belonged to the category *Under 30* , whereas the majority of the people that answered the questionnaire was between 30 and 40 years old (35%). The 27.5 % (N=11) of the participants belonged to the category between 40 and 50 years old, 32,5% (N=13) was aged between 50 and 60 and only the 5% percent (N=2) was aged over 60 years old. regarding the highest level of completed study of the people that responded the survey, 10% of the population (N=10) completed high school., 35% have a university degree (N=14), 47,5% have a Master's Degree (N=19) or equivalent and 7,5% have completed a doctorate (N=3).

Table 2. General characteristics of the sample
N = 40

Variable	Frequency	Percentage

Gender		
Male	29	72.5
Female	11	27.5
Other	0	0
Prefer not to precise	0	0
Age		
Under 30	0	0
30-40	14	35
40-50	11	27.5
50-60	13	32.5
60 or older	2	5
Highest level of education completed		
High School Diploma (or equivalent)	4	10
University Degree (or equivalent)	14	35
Master's Degree (or equivalent)	19	47.5
Doctorate	3	7.5

As mentioned before, in order to ensure the quality of the research, the constructed independent variables need to be examined for psychometric properties. The independent variables have been constructed by merging different questions that were addressed in the survey. The dependent variable is the willingness to adopt blockchain technology in the near future. In order to make a good analysis of the data, the validity and reliability of the constructs must be tested. In order to test if the variables constructed had internal validity, the Cronbach's Alpha of the variables was measured. A constructed variable can be considered valid if the value of its Cronbach's Alpha is above 0,7 and is regarded as unreliable if the Cronbach's Alpha value is below 0,5.

Table 3, Cronbach's Alpha associated with each independent variable

Variable	**Cronbach's Alpha**
Perceived Benefits	0.795
Complexity	0.730
Knowledge	0.815
Size	0.906
Organizational Readiness	0.853
Innovativeness	0.787
Competitive Pressure	0.749
Regulatory Support	0.876

The variables constructed from the questions in the survey all measure Cronbach's Alpha above the threshold value of 0,7. Thus, it can be argued that all of the constructs have a sufficient level of internal consistency and can be regarded as reliable.

4.2 Multivariate Linear Regression

In order to answer the main research question of this thesis, namely " *What are the main factors that could influence auctions houses to adopt blockchain technology in their business model?",* a multiple linear regression analysis was carried out. The results of this analysis will be able to accept or reject the hypothesis formulated about the contribution of different factors to the intention of adopting blockchain technology by auction houses, and that are listed in table 1 . A linear multiple regression analysis is ideal for this type of enquiry, as this research is willing to look into the effect of different independent variables on a singular dependent variable.

Assumptions for multivariate linear regression

Linear regression analysis requires the fulfilment of certain prerequisites, in order to yield truthful and acceptable results. Firstly, a necessary assumption that has to be made before conducting a multiple linear regression analysis is *linearity*. When we do linear regression, we assume that the relationship between the response variable and the predictors is linear. In order to test the linearity of the relation between independent variables and dependent variables, visual representations of the correlation between each independent variable and the independent variable were produced. The linear relationship between the Dependent Variable and the Independent Variables can be observed in Appendix 2.

Secondly, another assumption that must be taken into consideration before running a multiple linear regression analysis is that there should be no *collinearity* between the different variables that are part of the testing. Every observation should be independent and not correlated with other variables. The independence of observations can be tested using Durbin - Watson test. The result of this test is a value that is between 1, that represents the lowest possible value, and 4, that is the highest possible value. Values between 1.5 and 2.5 are desirable, whereas values below 1.5 and above 2.5 denote problems with possible autocorrelation of observations. The Durbin-Watson statistic is 2.368 which is between 1.5 and 2.5 and therefore the data is not autocorrelated.

The dataset analyzed using linear multiple regression should not contain *multicollinearity* either. This means that there should not be any strongly correlated independent variables. The reasoning behind this prerequisite is that a strong correlation between two independent variables might make it difficult to distinguish the impact of different variables on the dependent variable. Multicollinearity can be examined using Pearson correlation matrix as well as Variance Inflation Factors (VIFs). According to O'Brien & Sharkey Scott (2012), correlations above 0.9 will result in serious multicollinearity problems. As can be seen in Appendix E, none of the correlations between IVs in the dataset measures above 0.9. As argued in Laerd Statistics (2015), the more important measure for spotting multicollinearity are the VIFs which express the inflation of variance associated with the respective Beta coefficients. Generally it can be argued that multicollinearity is present when the value of the VIF is higher than 10 in a given independent variable (Laerd Statistics, 2015). Some argue that the threshold should be lower, and that multicollinearity could be

present also if the value of the VIF is 5 (Rogerson 2001). The VIFs associated with the IVs in the regression model are reported in Appendix D. It is important to notice that no VIFs in the regression model that has been created for this research score higher than 3, thus there is no reason to believe that multicollinearity is present amongst the independent variables in the sample.

Another assumption that has to be made before performing a multivariate regression analysis on a dataset is that the residual of the regression should follow a *normal distribution.* The residuals are the difference between the observed value and the predicted value. In order to examine if the relation between the independent variables and the dependent variable is normal, a normal Predicted-Probability (P-P) plot is presented in the appendix. Looking at the diagram in Appendix F, it can be seen how the residuals conform to the diagonal normality line indicated in the plot.

The last assumption that has to be made before running multivariate regression analysis is homoscedasticity. Homoscedasticity refers to the assumption of constant variance among data points. If this assumption is not met, the correlation coefficient tends to underestimate the data points (Privitera 2017). From the scatterplot in Apprndix , it can be observed that the data does not violate the assumption of homoscedasticity.

Multivariate linear regression

In order to assess the fitness of the model one should look at the R-squared value. The R square value can be found in the model summary that in table 4. The value of the R-square is 0,859, this means that 85,9% of the total variance of the dependent variable can be explained by the independent variables.

Table 4. Model summary of the multivariate regression analysis

R	R Square	Adjusted R Square	Std. Error of Estimate	Durbin Watson
.927	.859	.823	.587	2.386

a. *Dependant Variable*: My establishment is willing to look into the integration of blockchain technology in the near future.

b. *Predictors*: (Constant), Innovativeness, Knowledge, Regulatory Support, Relative Advantage. Organizational Readiness, Competition, Complexity.

In order to complete the overall assessment of the regression model, an ANOVA test is provided in table 5. Using an F-test with the value reported in the aforementioned table, the goodness of fit of the regression model is tested and compared to a mean model (Laerd Statistics, 2015). As can be seen in Table 5, the proposed regression model fits the data significantly better than a simple mean model. The level of significance of the ANOVA is below the threshold value of 0,05. Therefore, it can be concluded that the regression model is able to make significant predictions about the possible application of blockchain technology by auction houses.

Table 5. ANOVA

	Sum of sqaures	**df**	**Mean Square**	**F**	**Sig.**
Regression	65.297	8	8.612	23.696	.000
Residual	10.678	31	.344		
Total	75.975	39			

a. *Dependant Variable*: My establishment is willing to look into the integration of blockchain technology in the near future.
b. *Predictors*: (Constant), Innovativeness, Knowledge, Regulatory Support, Relative Advantage. Organizational Readiness, Competition, Complexity.

After having looked at the results of the ANOVA, the results of the actual multivariate regression analysis can be inspected. The level of significance was set at 0,05. Only the correlations that would yield a level of significance below 0,05 are regarded as empirically significant. In light of this, only the effect of certain independent variables on the dependent variable can be regarded as significant. In order to accept the hypothesis formulated before the result of the correlation between an independent and the dependent value must be significant.

Results of the Multivariate Regression Analysis

Table 6. Coefficients of the Multivariate Regression Analysis

	Unstandardized	***Coefficients***	
Variables	**B**	**Standard Error**	**Sig.**
(Constant)	1.517	1.256	.236
Complexity	**-0.48**	.198	**.021**
Percieved Benefits	**.398**	.136	**.006**
Knowledge	**.320**	.254	**.018**
Size	**-.269**	.120	**.033**
Org. Readiness	**.395**	.118	**.002**
Innovativeness	.158	.127	.190
Competitive Pressure	-.059	.156	.708
Regulatory Support	.021	.155	.892

The final linear multiple regression model is reported in table 6. The significant coefficients are written in bold.

Looking at the unstandardised coefficients in table 6, the perceived complexity of blockchain technology has a significant negative effect (-0.480) on the willingness to adopt blockchain technology. This relationship was theorised by the first hypothesis (H1), that can thus be accepted.

Examining the results of the regression analysis it can also be argued that there is a weak but significant positive relation (0.398) between the perceived benefits that the application of blockchain could bring upon and the possibility of its application by auction houses. Thus the second hypothesis (H2) can be formally accepted.

Organizational readiness is significantly positively correlated (0.395) with the intention of looking into the adoption of blockchain technology. This means that firms that have the perception of being able to adopt a new technology will be more likely to look into the integration of blockchain technology in their business model and that the fourth hypothesis (H3) can be accepted as valid.

Moreover, the perceived innovativeness of auction houses has a weak but positive (0.158) relation to auction houses' intention to adopt blockchain technology. Even though, the correlation is not significant, and thus the hypothesis (H4) that the innovativeness of an auction house is positively associated with possible adoption of blockchain technology is rejected .

The model highlights how one's knowledge about blockchain technology and its intention to use the same technology are positively (0.320) and significantly related. Knowledge of blockchain technology and its possible uses in the art market is positively associated with the intention of adopting the technology. Auction houses that have a self perceived larger knowledge of the technology, will be more prompt to adopt it. As a result the fifth hypothesis (H5) can be formally accepted.

Moreover, differently from what was hypothesized, the size of an auction house has a significant but negative relation (-0.269) with the intention to adopt blockchain technology. Consequently, the sixth hypothesis (H6) is rejected.

Differently from what was expected, there is a weak negative correlation (-0.059) between the competitive pressure and auction houses' intention to adopt blockchain technology. This relationship is also not significant.

Finally, differently from what was expected, the absence of regulatory support for the application of blockchain or the adoption of cryptocurrencies has almost no influence on the willingness to adopt blockchain technology by auction houses.

Table 7 presents a summary of the hypothesis that have been rejected and accepted. It can be observed that four of the eight hypothesis has been accepted, while the other four have been rejected.

Table 7, Overview of accepted/rejected hypothesis

Number	Hypothesis	Result
H1	The perceived complexity of blockchain technology is negatively associated with its possible adoption by auction houses in the art market.	***Accepted***
H2	The perceived benefits of blockchain technology are positively associated with its possible adoption by auction houses in the art market.	***Accepted***
H3	The perceived organizational readiness of blockchain is positively associated with possible blockchain adoption by auction houses in the art market	***Accepted***
H4	The innovativeness of an auction house is positively associated with possible adoption of blockchain technology.	Rejected
H5	A higher knowledge of the characteristics of blockchain technology is positively associated with the intention of adopting blockchain technology.	***Accepted***
H6	.The size of an auction house is positively associated with their willingness to adopt blockchain technology.	Rejected
H7	Perceived competitive pressure is positively associated with possible blockchain adoption by auction houses in the art market.	Rejected
H8	The absence of regulatory support for the application blockchain is negatively associated with the possibility of blockchain technology adoption by auction houses in the art market.	Rejected

4.3 Perceived impact of COVID-19 pandemic

The second empirical analysis of this thesis was time at looking at how the perception towards the adoption of blockchain technology and cryptocurrency changed after the advent of the Covid 19 pandemic. In order to assess if the opinion on blockchain technology adoption changed after the pandemic, two sets of two questions were asked in the questionnaire:

> 1A. What do you think is the percent chance (or chances out of 100) that your auction house will use any application of blockchain technology in the near future?

1B. If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house would use any application of blockchain technology in the next 18 months?

2A. What do you think is the percent chance (or chances out of 100) that your auction house is willing to adopt cryptocurrencies (such as Bitcoin and Ethereum) payment solutions in the next 18 months?
2B. If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house would be willing to adopt cryptocurrencies (such as Bitcoin and Ethereum) payment solutions in the next 18 months?

Table 8. Descriptive Statistics on the perceived impact of the Covid 19 pandemic on possibility of adopting blockchain technology.

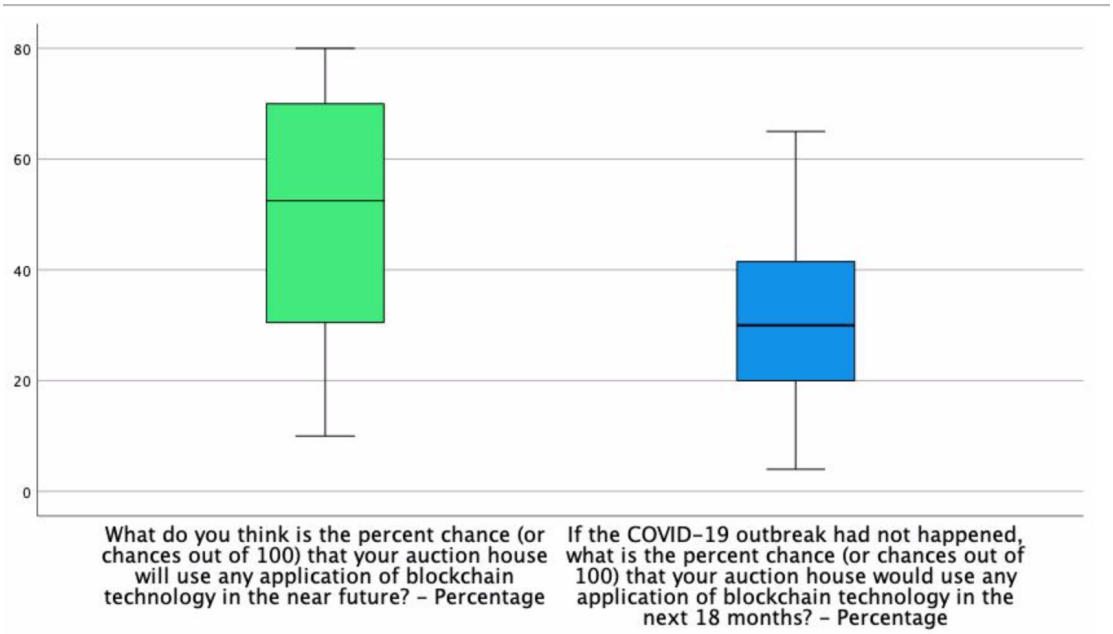
	Mean	Median	Std. Deviation	Minimum	Maximum
1A	50.90	52.50	21.70	10.00	80.00
1B	29.90	30.00	14.65	4.00	65.00
2A	33.45	30.00	16.58	2.00	80.00
2B	19.4	20.00	9.31	2.00	50.00

Some descriptive statistics about the responses to those questions are available in Table 8. Looking at table 8, the mean, the median, the standard deviation, the minimum value and the maximum value of the four questions can be compared. The mean of question 1A (59.90) is much higher than the mean of question 1B (29.90). This means that without the advent of the Covid 19 pandemic, auction houses would rate much lower their probability of using blockchain technology in the near future. Similarly, the difference in the means of question 2A (33.45) and question 2B (19.40), reflects the fact

that the global pandemic increased the chance of adopting cryptocurrencies as payment solutions in the near future. It can also be noted how the average chance that auction houses will adopt blockchain technology is much higher than the average percentage chance of their possible use of cryptocurrencies in the near future. Auction houses seem more inclined to adopt other applications of blockchain technology rather than cryptocurrencies.

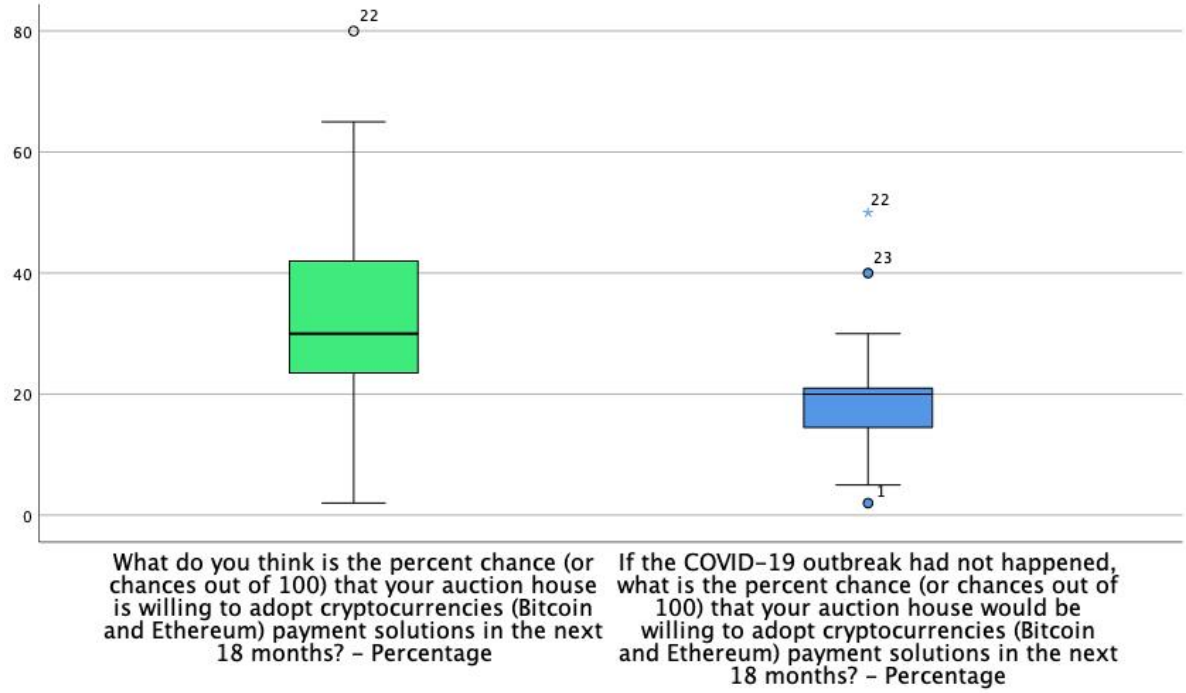
In order to further compare the mean values between the answers 1A and 1B, and between answers 2A and 2B, a one sample T-test was carried out. A one Sample T-test examines whether the mean of a population is statistically different from a known or hypothesised value (Privitera 2018). In this case the hypothesis is that the mean of the questions about the possibility in percentage value of blockchain and bitcoin adoption is different from the population mean of the questions that ask the possibility of adopting blockchain technology if Covid 19 had not happened. The results of the t-tests can be found in the appendix. The test has decreed that there was a significant difference between the mean population of question 1A and 1B, and 2A and 2B.
The difference is visually represented in the box plot below. Box plots are a standardised way of visually representing the distribution of data. Box plots represent the median, the quartiles and the minimum and maximum value of a dataset. They are useful to grasp how the dataset is distributed. The horizontal line in the middle of the box represents the median value. The upper and lower whiskers represents values that are outside the middle 50% of the dataset. The upper end of the whisker represents the maximum value in the dataset and the lower end of the whisker represents the minimum value.

Figure 2. Intention of adopting blockchain technology after the pandemic and if the pandemic had not occurred



From this graph (*Figure 2*) it can be grasped how, without the advent of the global pandemic, the percentage value associated with the possibility of adopting blockchain technology is very much lower. The average percentage that the respondent's auction house could use in the near future any application of blockchain technology is equal to 50.90%. On the other hand if the Covid-19 pandemic had not happened, the possibility that the respondent's auction houses could adopt blockchain technology would be far smaller, as the mean answer was 29.90%. Thus, as the result of T-Test demonstrated, the Covid 19 pandemic had a role in changing the perception of auction houses towards the application of blockchain technology. The box plot shows what was the highest percentage and lowest percentage associated by respondents with the possibility of adopting blockchain technology in the near future and what the same percentage would be if the pandemic had not happened. The maximum percentage is far higher in the first case than with the second. From the box plot represented in Figure 2, it can also be discerned that the distribution of answerers is more spread out for the first answer than for the second.

Figure 3. Intention of adopting cryptocurrencies after the pandemic and if the pandemic had not occurred



Similarly, in the following graph (*Figure 3*) the difference between the percentage values associated by the respondents to the possibility of adopting cryptocurrenceis, and the percentage value associated with the possibility of using cryptocurrencies if the Covid 19 had not happened is very consistent. The respondents are less prompt to adopt cryptocurrencies to their way of working in comparison to blockchain technology. As it can be seen in the graph, in this case also, the Covid-19 pandemic seemed to have augmented the possibility that auction houses could adopt cryptocurrencies as payment solutions in the near future. The points that are out of the box plots whiskers are outliers. An outlier is an observation that is numerically distant from the rest of the data. The mean response to the question that enquired about the possibility of adopting cryptocurrencies in the near future is 33,45%. Whereas if the pandemic had not occurred the average chance that auction house will adopt cryptocurrencies as a payment solution in the near future is 19,40%. From these result, it may argued that auction houses are, on average, not willing to adopt cryptocurrencies as a method of payment in the near future, although the Covid 19 pandemic slightly increased the

possibility that they will accept cryptocurrencies as a method of payments in the next 18 months.

5. Conclusion

5.1 Discussion of the results

This research aimed at exploring the potential adoption of blockchain technology by auction houses and the factors that could influence the decision of integrating such a technology in their way of working. The overall conclusion of this research is that auction houses are willing to adopt blockchain technology in the near future and that technological and organizational factors are most important to them in the decision to potentially apply any use of blockchain technology in their model. Moreover, the global pandemic had a role in increasing auction houses' willingness to explore the potential adoption of new technologies. Having stated the main results of this study, we are going to discuss the outcome of the analysis more in detail.

Through the use of the TOE framework, the research tried to gain a deeper understanding at what are the determinants of blockchain adoption for auction houses. The possible determinants for blockchain adoption were grouped in three categories: technological context, organizational context and environmental context.
Amongst the variables grouped in the technological context, it was hypothesized that the perceived benefits of applying blockchain technology would have a positive effect on auction houses' intention to integrate blockchain technology. This hypothesis was confirmed by the multivariate regression analysis. Another hypothesis was that the perceived complexity of blockchain technology would be negatively related to its potential application by auction houses, also this hypothesis was confirmed by the multivariate regression analysis, there is a weak negative correlation between perceived complexity and blockchain adoption.

Amongst the variables in the organizational framework, the hypothesis was that perceived organizational readiness of the respondents' auction house would be positively correlated with the possibility of exploring the application of blockchain technology. Perceived organizational readiness results to be the most influential variable when looking at the determinants for blockchain adoption. Auction houses that are able and ready to invest in a new technology will definitely be more prompt to explore the possibility of integrating the technology in their way of working.

The hypothesis that the innovativeness of an auction house could have an influence on blockchain adoption was proven false. Although the empirical testing showed the existence of a positive relationship between this independent variable and the dependent variable, this result did not achieve a sufficient level of significance, and thus this hypothesis was rejected in contrast with what suggested by some of the literature that was take into consideration, although referring to a quite different context (Rogers 1995).

The hypothesis that knowledge of blockchain technology could have a positive association with the willingness to adopt the technology was proven right by the statistical testing. Having knowledge of blockchain technology and its possible uses in the art market has a positive influence on the possible adoption of blockchain technology. This hypothesis was already confirmed by other researchers that looked into the possible integration of this technology in small and medium enterprises (Jannsen et al. 2020).

An unexpected result from the multivariate regression analysis was that the size of an auction house is not positively correlated with their intention to look into the application of blockchain technology. On the contrary, a weak, but significant, negative correlation between size and blockchain adoption was found. This means that larger auction houses are not more inclined than smaller auction houses to experiment with this innovative technology. This finding goes against previous findings on the relationship between size of an organization and technology application (Trigo et al. 2015).

The environment context seems to be the one that has less effect on the dependent variable, namely the possibility of adopting blockchain technology. Both of the variables that were grouped in this context were found to be insignificant. The perceived competitive pressure, and thus the pressure derived from the application of this technology by other auction houses or other web-based platforms that deal in artworks, has almost no effect on the decision of potentially applying the technology. This variable was found not to be significant also by other researchers that adopted the TOE framework in the past (Oliveira et al. 2014)(Borgman et al.2013). A reason may be that the current applications of blockchain technology in the art market are limited, and so auction houses may not feel the pressure to instantly adopt the technology. This could

change when more auction houses are going to adopt blockchain technology, potentially threatening the market power of those auction houses that did not do it.
The last hypothesis that was formulated was that the absence of regulatory support for the application of blockchain technology may have a negative effect on the intention of adopting the technology. This hypothesis was rejected as it was not found a significant relationship: auction houses do not seem to be worried by the absence of a clear set of regulations on the use of blockchain technology and cryptocurrencies.

Another important goal of this research was to gain a better understanding of how the global pandemic impacted on the possibility, for auction houses, of adopting blockchain technology. The results of the investigation are that auction houses' willingness to adopt blockchain technology has increased after the Covid 19 pandemic. After having been forced to explore new digital opportunities during the pandemic (Villa 2020), auction houses are now more open, willing to increase their revenues from online auction and eager to ameliorate the customers' experience when buying online. Blockchain technology could also attract new clients to auction houses and contribute in making auction houses, and the art market as a whole more democratic and more transparent.

5.2 Limitations and Future Research

During the period of this research, several potential limitations have emerged which need to be addressed. Although these do not substantially undermine the relevance and findings of this study, they need to be acknowledged and examined in order to adhere to academic standards.
First, the final sample size is relatively small. For the analysis of this research 107 auction houses were contacted and 40 auction houses completed the questionnaire. This number, although small, represents a large proportion of the auction houses that satisfied the criteria that were chosen before sending the questionnaire. The final value for the response rate of the survey is around 40%, this number was achieved by personally contacting by telephone many of the auction houses in order to encourage them to answer the questions of the questionnaire. A reason for the reluctance to answer the survey may have been the very specific and not well known topic of the

research. Also, other research methods, such as in depth interviews could have been suitable to answer the research questions.

Another limitation of the study is that most of the auction houses that answered the questionnaire come from only a handful of countries that resemble each other for in terms of economic and cultural development and traditions. For future researchers it may be interesting to investigate the possibility of adoption of blockchain technology in auction houses that are based in emerging art markets.

The topic of blockchain technology and auction houses has almost never been explored in academic papers and researchers. To the best of my knowledge this research was the first to investigate the potential application of blockchain technology by auction houses, and it may have set a foundation on which other researchers can build in the future.

Based on the limitations of this study, a direction for future research of blockchain adoption among auction houses may be to consider those determinants of adoption that were significant in this research. An interesting question that future researches could investigate is: what will auction houses use blockchain technology for? Will it be only to sell digital artworks or will they explore the other potentialities of these technologies? Answering those questions could be vital to have a clearer view of the future of this technology in the art market.

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7. Appendix

Appendix A

Table 7.1. Questionnaire

	General Questions
Q1	How old are you?
Q2	What is your gender?
Q3	What is the highest level of education you completed?
	Relative Advantage
Q4	The possibility of having access to information about the provenance and authenticity of artworks could benefit auction houses.
Q5	Trading digital artworks could be an interesting solution to engage new clients.
Q6	The application of digital technologies can reduce the operation costs of auction houses.
Q7	Granting the possibility of paying with cryptocurrencies (Bitcoin and Ethereum) could be an interesting solution to increase security in payments.
	Complexity
Q8	My auction house believes that blockchain technology is too complex to clearly understand its potential benefits.
Q9	Blockchain technology is too complex to be integrated in our auction house.
Q10	Blockchain technology is too costly to be applied in our auction house.
	Knowledge
Q11	I have knowledge of blockchain technology and of its possible applications in the art market, such as for the sale of NFTs.
Q11	I know what Bitcoin and other crypto currencies are and how they can be used in transactions.
	Size
Q13	How many auctions did your auction house organize in 2020?
Q14	What is the average yearly revenue of your auction house?
	Innovativeness
Q15	When did you organise your first online auction?
Q16	When did you first organise an auction that allowed only online participation?
Q17	My auction house could consider hosting only online auctions in the future.
Q18	The way in which artworks are sold is going to drastically change in the near future.

Q19	We believe that investment in technological innovation of the sale system is crucial for the survival of our auction house.
	Organizational Readiness
Q20	Our auction house has a department which oversees the application of technology and that it's responsable to look for the possible implementation of new technologies.
Q21	Our auction house has the necessary economic resources to invest in the integration of a new technology.
Q22	Applying online auctions to our auction house was relatively easy.
	Competition
Q23	Recent application of blockchain technology by other auction houses made us think about exploring the uses of this technology in our auction house.
Q24	Online marketplaces have the potential of disrupting smaller auction houses in the future.
	Regulatory Support
Q25	The absence of clear regulatory framework on the use of crypto currencies is a matter of concern.
Q26	The absence of a clear regulatory framework on the use of blockchain technology is a matter of concern.
	Blockchain Adoption
Q27	My auction house is willing to look into the adoption of t blockchain technology in the near future.
	DIF in DIF
Q28	What do you think is the percent chance (or chances out of 100) that your auction house is going to use any application of blockchain technology in the near future?
Q29	If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house is willing to look into the integration of blockchain technology in the next 18 months?
Q30	What do you think is the percent chance (or chances out of 100) that your auction house is willing to adopt cryptocurrencies (Bitcoin and Ethereum) payment solutions in the next 18 months?
Q31	If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house is willing to adopt cryptocurrencies (Bitcoin and Ethereum) payment solutions in the next 18 months?

Table 2. List of Auction Houses to which the questionnaire was sent

List of Auction Houses Contacted
Il Ponte - https://www.ponteonline.com/en

List of Auction Houses Contacted
Cambi - https://www.cambiaste.com
Galleria Pananti Casa d'aste - https://www.pananti.com/it/dipartimenti/arte-moderna-e-contemporanea.as
Meeting Art - https://meetingart.it/it/chi-siamo/associazione-nazionale-delle-case-d-asta.html
Bertolami Fine Art - https://bertolamifineart.com
Blind Arte - https://www.blindarte.com
Capitolium Art - www.capitoliumart.it
Fabiani Arte - https://www.fabianiarte.com/it/index.asp
Farsetti Arte - https://www.farsettiarte.it/it/calendario-aste/calendario-aste.asp?prosAste=true
Fides Arte - https://www.fidesarte.it/it/index.asp
FinArte - https://www.finarte.it
Maison Bibelot - www.maisonbibelot.com
Martini Studio D'Arte - www.martiniarte.it
Meeting Art - www.meetingart.it
Pandolfini - www.pandolfini.com
Sant'Agostino Aste - www.santagostinoaste.it
Babuino Casa D'Aste - https://www.astebabuino.it/it/index.asp
Gregory's Casa D' Aste - https://gregorysaste.it/it/
Art International - https://artinternationalaste.com/en/home-2/
Felima Art Casa D'Aste - https://felimart.it
Art Code - https://www.artcodecasadaste.it
Aste Arcadia - https://www.astearcadia.com/it/index.asp
Wannenes - https://wannenesgroup.com/it/
Artcurial Italia - https://www.artcurial.com/en/artcurial-italia
Aste Borromeo - https://www.asteborromeo.com
Aste Bolaffi - https://astebolaffi.it/it/search/all
Colasanti - https://www.colasantiaste.com/it/cataloghi/cataloghi.asp
Mediatrade - https://www.mediartrade.com
Art-Rite - https://www.art-rite.it
Fondaco Aste - https://www.fondacoaste.com

List of Auction Houses Contacted
Boetto Aste - http://www.asteboetto.it/index.php/it/
Della Rocca - https://www.dellarocca.net/uk/index.asp
Ambrosiana casa d'aste - https://www.ambrosianacasadaste.com
Aste Dolomia - https://www.astedolomia.com/index.php/it/
Bozner Kunstauktionen - https://bozner-kunstauktionen.com
Urania Aste (Specializzati in illustrazione) - http://www.uraniaaste.com
Itineris Casa d'Aste - https://www.itinerisaste.com/en/home
Galleria Pace - https://www.galleriapace.com/it/aste/
Lucas Casa D'Aste - http://www.lucasaste.it/it/about
Bado e Mart Auctions - https://www.badoemart.it/uk/index.asp
France
Ader - https://www.ader-paris.fr/en/home
Artcurial - https://www.artcurial.com/
Arthema - https://arthema-auction.auction.fr
Artencheres - http://www.artencheres.fr/
Millon - Auctions sales
Artprecium (Groupe Millon) - https://en.artprecium.com
Asium (Groupe Millon) - Specialised in Asian Art, also Modern and Contemporary - https://www.asium-auction.com/
Audap et Associes - https://www.audap-associes.com/
Cornette De Saint Cyr - http://www.cornettedesaintcyr.fr/
Tajan - https://www.tajan.com/
Thierry de Maigret - https://www.thierrydemaigret.com/
Osenat - https://www.osenat.com/en/home
Aguttes - https://www.aguttes.com/en/home
Piasa - https://www.piasa.fr/en/home
Pierre Berges et Associes - https://www.pba-auctions.com/
Rouillac - https://www.rouillac.com/en/1-home/
Crait + Mueller - https://www.crait-muller.com
Digard - http://www.digard.com/

List of Auction Houses Contacted
Oise Encheres - https://www.oise-encheres.com/
Brissenau - http://www.brissonneau.net/
Cannes Encheres - https://www.cannes-encheres.com
Ferri (Drouot) - http://www.ferri-drouot.com/en/home
Coutau Begarie (Drouot) - https://www.coutaubegarie.com/
Spain
Subasta Real - https://subastareal.es/
Odalys - https://odalys.com/odalys/
Balclis - https://www.balclis.com/en/
Subarna - https://www.subarna.net/es
Lamas Bolano - https://lamasbolanosubastas.com/es/
Bonanova Subastas - https://lamasbolanosubastas.com/es/
Ansorena - https://www.ansorena.com/subasta
Duran Subastas - https://www.duran-subastas.com/es
Fernando Duran Subastas - https://www.fernandoduran.com/
Sala Retiro - https://www.salaretiro.com/es
Goya Subastas - https://www.goyasubastas.com/
Subastas Segre - https://www.subastassegre.es/
Subastas Gran Via de Bilbao - https://www.subastasgranviadebilbao.com/sgvb/
Euro Art Subastas - https://www.euroartsubastas.es/subastas-de-arte-online
Austria
Dorotheum - https://www.dorotheum.com/it/
Amadeus Auction - https://amadeus-auction.com/
Lehner Kunstauktionen - http://www.lehnerkunstauktionen.at/en
im Kinsky - https://imkinsky.com/en
Switzerland
Griesbach - https://www.grisebach.com/
Koeller - https://www.kollerauktionen.ch/en/auctioncalendar.htm
Schuler Auktionen - https://www.schulerauktionen.ch/de
Piguet Hotel Des Ventes - https://www.piguet.com/fr

List of Auction Houses Contacted
Germany
Ketterer Kunst - https://www.kettererkunst.com/
Lempertz - https://www.lempertz.com/en/
Nagel - https://www.auction.de/index_e.php
Hampel Auctions - https://www.hampel-auctions.com/index.html?la=it
Stahl - https://www.auktionshaus-stahl.de/en
Van Ham - https://www.van-ham.com/en/
Lehr Kunstauktionen - https://lehr-kunstauktionen.de/en/
Neumeister - https://www.neumeister.com/en/
Schmidt - https://www.schmidt-auktionen.de/en/
Auktionshaus Arnold - https://www.auktionshaus-arnold.de/
Doebritz - https://www.doebritz.de/
Zeller - https://www.zeller.de/en/
Winterberg - https://www.winterberg-kunst.de/
Dannenberg - https://www.auktion-dannenberg.de/en/Auktionen/Alle
Netherlands
Catawiki Art Auction - https://www.catawiki.com
Arts & Antiques Group (AAG) - veilinghuisaag.com
Hessink's - https://www.hessink.com/
Venduehuis der Notarissen - https://www.venduehuis.com/nl/
Belgium
Brussels Auctions - https://ba-auctions.com/
Native Auctions - https://www.native-auctions.com/upcoming
Horta - https://www.horta.be/default.asp?sCode=HOME-fr
Galerie Moderne - https://www.galeriemoderne.be
Sweden
Bukowskis Stockholm - https://www.bukowskis.com/sv/
Stockholms Auktionsverk - http://auktionsverket.se/
Denmark
Bruun Rasmussen - https://bruun-rasmussen.dk/m/

List of Auction Houses Contacted
Lauritz - https://www.lauritz.com/en/

Table 7.3 - Model Summary of the Multivariate Regression Analysis

R	R Square	Adjusted R Square	Std. Error of Estimate	Durbin Watson
.927	.859	.823	.587	2.386

Predictors: (Constant), Innovativeness, Knowledge, Size, Regulatory Support, Relative Advantage, Organisation Readiness. Competition, Complexity

Dependent Variable: Willingness to adopt blockchain technology in the near future

Table 7.4 ANOVA

	Sum of sqaures	**df**	**Mean Square**	**F**	**Sig.**
Regression	65.297	8	8.612	23.696	.000
Residual	10.678	31	.344		
Total	75.975	39			

a. *Dependant Variable*: My establishment is willing to look into the integration of blockchain technology in the near future.
b. *Predictors*: (Constant), Innovativeness, Knowledge, Regulatory Support, Relative Advantage. Organizational Readiness, Competition, Complexity.

Table 7.5 Coefficients of the Multivariate Regression Analysis with Collinearity Statistics

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.517	1.256		1.208	.236		
	RelativeAdvantage	.398	.136	.281	2.923	.006	.491	2.038
	Complexity	-.480	.198	-.361	-2.422	.021	.204	4.900
	Size	-.269	.120	-.230	-2.235	.033	.430	2.327
	OrganizationalReadiness	.395	.118	.358	3.349	.002	.396	2.524
	Competition	-.059	.156	-.041	-.378	.708	.381	2.623
	RegSupport	.021	.155	.014	.137	.892	.418	2.393
	Knowledge	.320	.128	.254	2.508	.018	.442	2.262
	Innovativeness	.158	.118	.127	1.341	.190	.506	1.977

a. Dependent Variable: My establishment is willing to look into the integration of blockchain technology in the future.

Table 7.6 Correlation Matrix of the Independent Variables

		RelativeAdvantage	Complexity	Size	OrganizationalReadiness	Competition	RegSupport	Knowledge	Innovativeness
RelativeAdvantage	Pearson Correlation	1	-.612**	.406**	.481**	.523**	-.397*	.411**	.584**
	Sig. (2-tailed)		.000	.009	.002	.001	.011	.008	.000
	N	40	40	40	40	40	40	40	40
Complexity	Pearson Correlation	-.612**	1	-.670**	-.728**	-.570**	.704**	-.620**	-.501**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.001
	N	40	40	40	40	40	40	40	40
Size	Pearson Correlation	.406**	-.670**	1	.669**	.336*	-.338*	.423**	.408**
	Sig. (2-tailed)	.009	.000		.000	.034	.033	.007	.009
	N	40	40	40	40	40	40	40	40
OrganizationalReadiness	Pearson Correlation	.481**	-.728**	.669**	1	.372*	-.499**	.476**	.346*
	Sig. (2-tailed)	.002	.000	.000		.018	.001	.002	.029
	N	40	40	40	40	40	40	40	40
Competition	Pearson Correlation	.523**	-.570**	.336*	.372*	1	-.575**	.643**	.546**
	Sig. (2-tailed)	.001	.000	.034	.018		.000	.000	.000
	N	40	40	40	40	40	40	40	40
RegSupport	Pearson Correlation	-.397*	.704**	-.338*	-.499**	-.575**	1	-.505**	-.382*
	Sig. (2-tailed)	.011	.000	.033	.001	.000		.001	.015
	N	40	40	40	40	40	40	40	40
Knowledge	Pearson Correlation	.411**	-.620**	.423**	.476**	.643**	-.505**	1	.256
	Sig. (2-tailed)	.008	.000	.007	.002	.000	.001		.111
	N	40	40	40	40	40	40	40	40
Innovativeness	Pearson Correlation	.584**	-.501**	.408**	.346*	.546**	-.382*	.256	1
	Sig. (2-tailed)	.000	.001	.009	.029	.000	.015	.111	
	N	40	40	40	40	40	40	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7.7 T-test for comparison between the means of 1A and 1B

	Test Value (=mean of Q1) = 50.90					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house would use any application of blockchain technology in the next 18 months? - Percentage	-9.068	39	.000	-21.00000	-25.6840	-16.3160

Table 7.8 T-test for comparison between the means of 2A and 2B

	Test Value (=mean of question 2A) = 33.45					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
If the COVID-19 outbreak had not happened, what is the percent chance (or chances out of 100) that your auction house would be willing to adopt cryptocurrencies (Bitcoin and Ethereum) payment solutions in the next 18 months? - Percentage	-9.543	39	.000	-14.05000	-17.0280	-11.0720

Appendix B

Figure 7.1 Scatterplot representing the relationship between Complexity (IV) and Blockchain Adoption (DV)

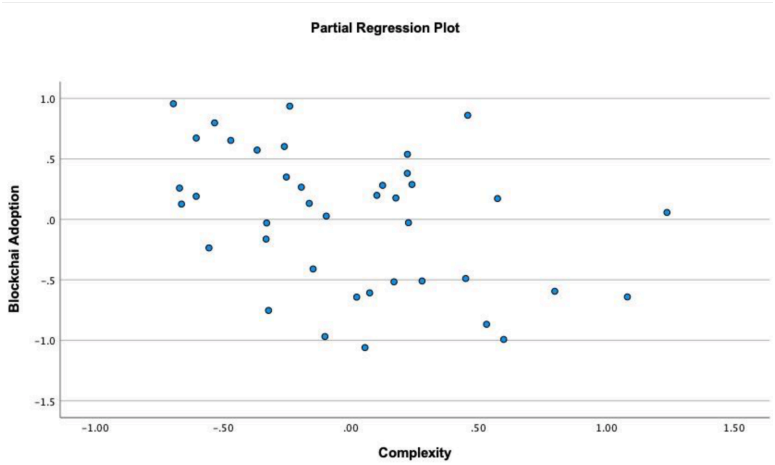


Figure 7.2. Scatterplot representing the relationship between Perceived Benefits (IV) and Blockchain Adoption (DV)

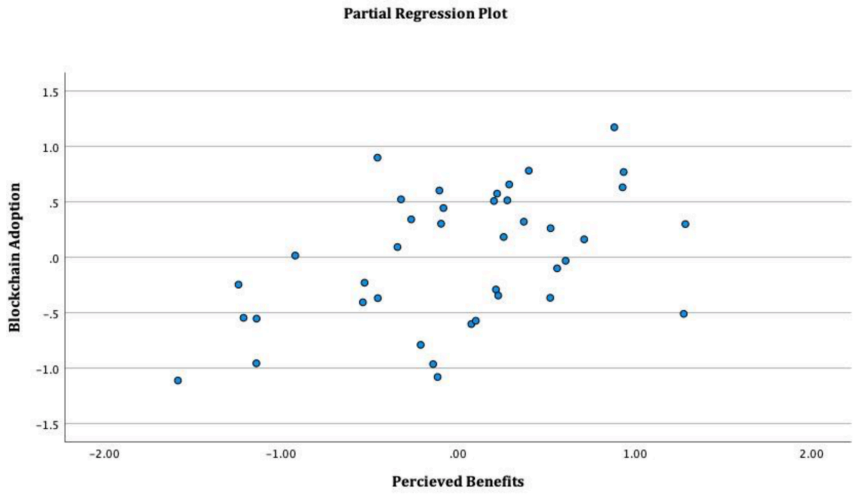


Figure7.3 Scatterplot representing the relationship between Organizational Readiness(IV) and Blockchain Adoption (DV)

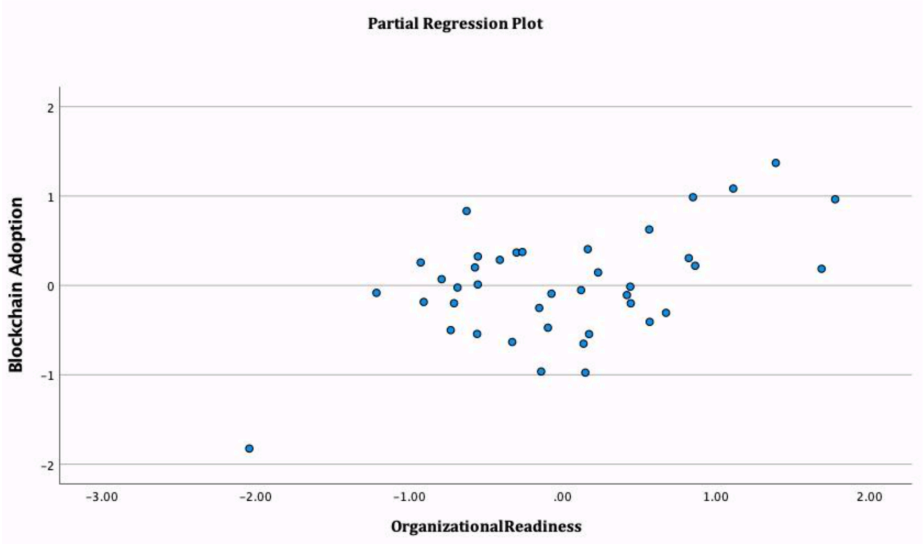


Figure 7.4 Scatterplot representing the relationship between Innovativeness and Blockchain Adoption

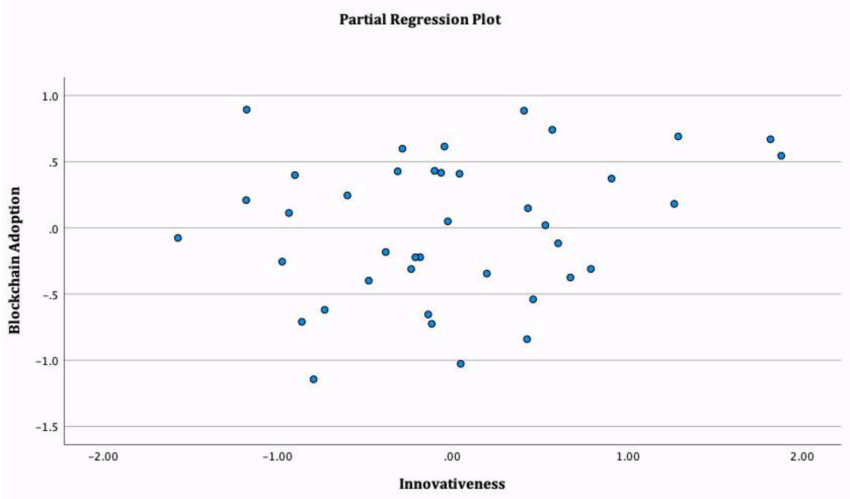


Figure 7.5 Scatterplot representing the relationship between Size and Blockchain Adoption

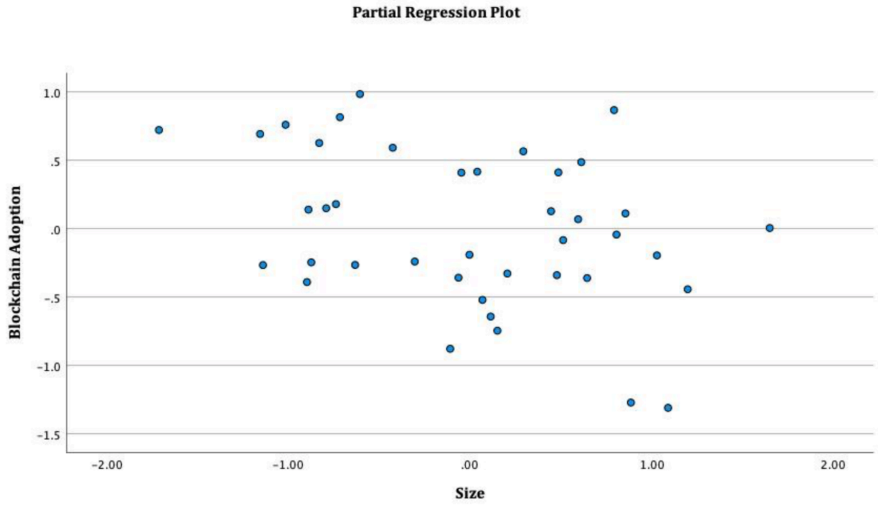


Figure 7.6 Scatterplot representing the relationship between Knowledge and Blockchain Adoption

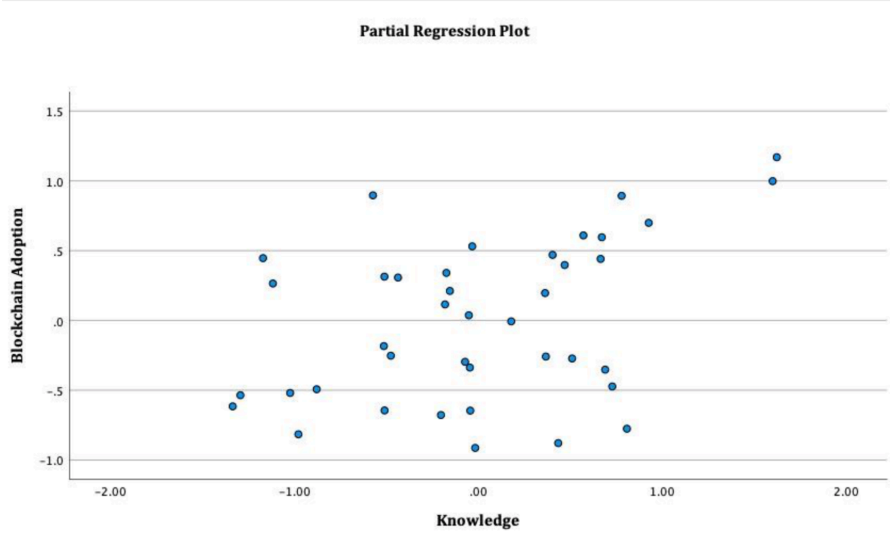


Figure 7.7 Scatterplot representing the relationship between Competitive Pressure and Blockchain adoption.

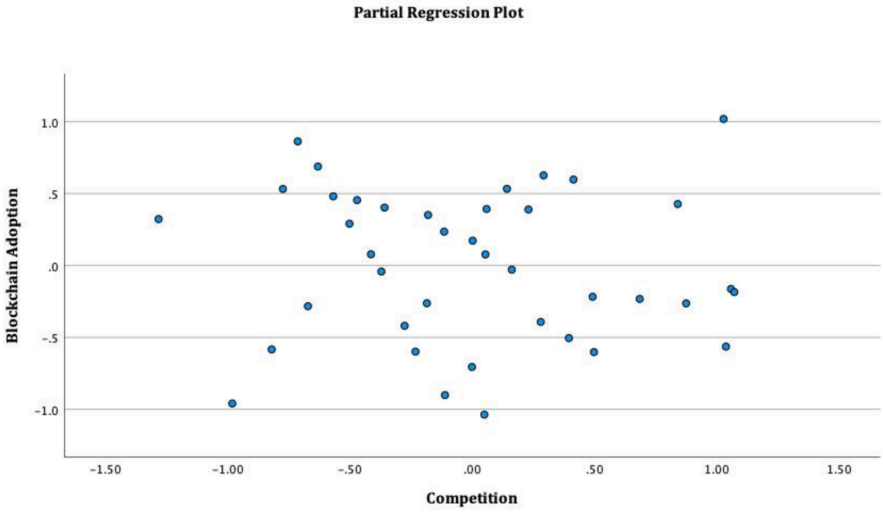


Figure 7.8 Scatterplot representing the relationship between Regulatory Support and blockchain adoption

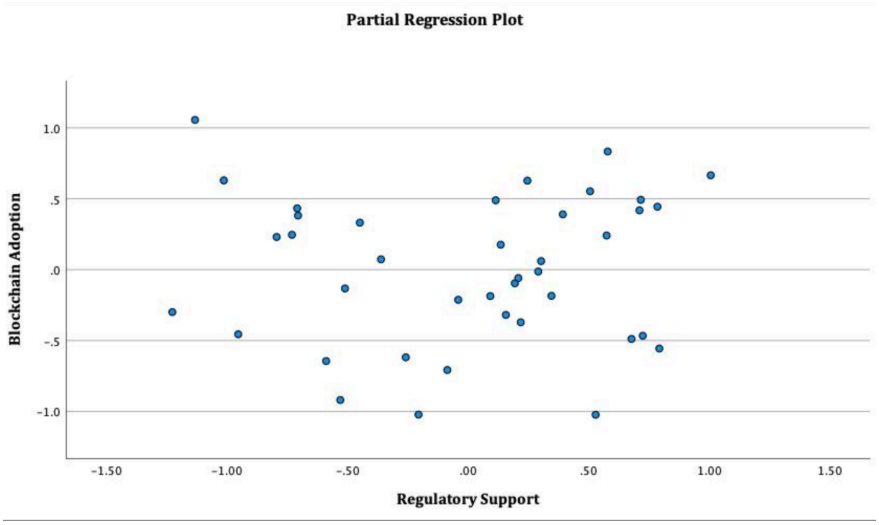


Figure 7.9. Normal P-P plot

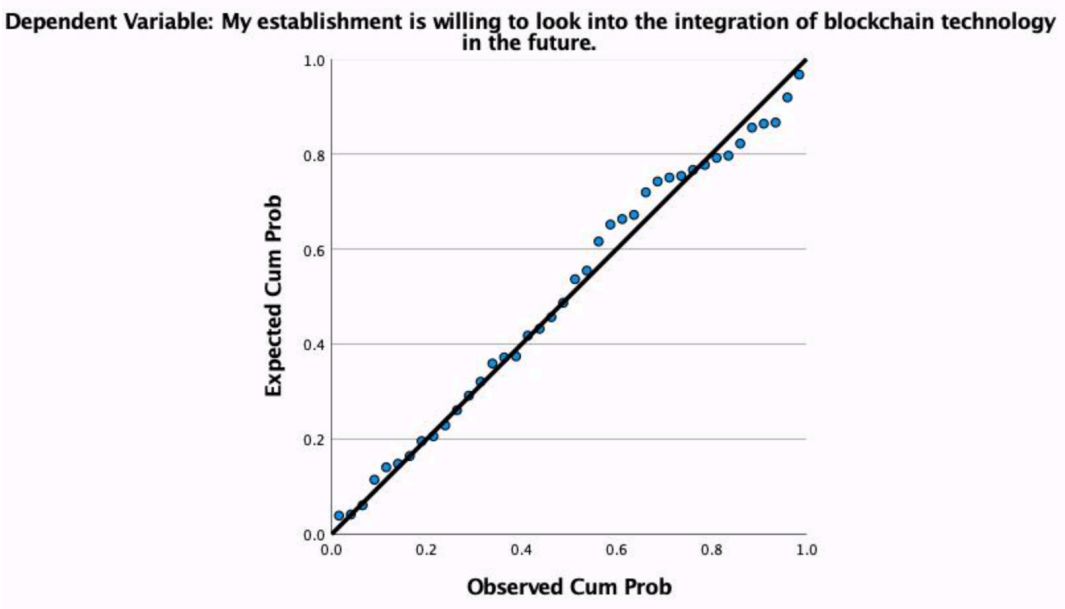
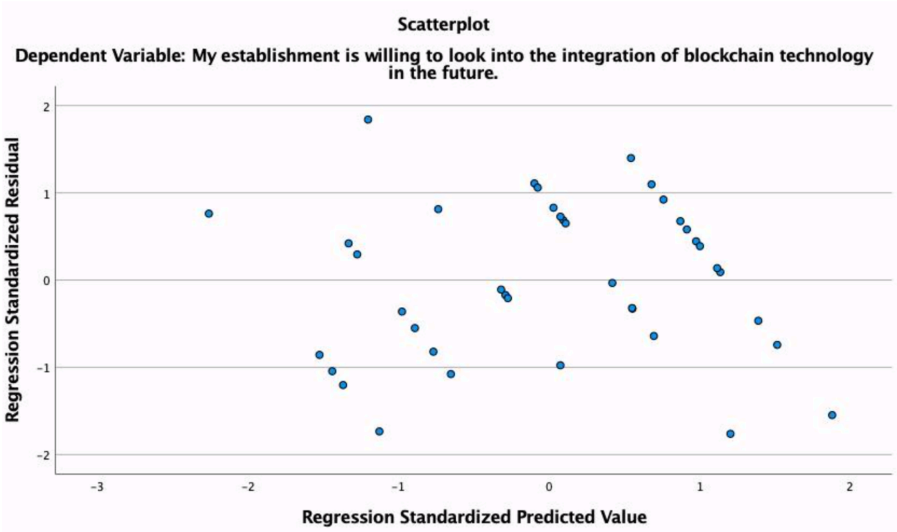


Figure 7.10. Scatterplot of regression standardised residual vs regression standardised predicted value



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