



HIGHER SCHOOL OF ECONOMICS
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RESEARCH PAPER:

The impact of parameters of
artworks on their auction price and
attractiveness for investment
purposes

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1 Introduction

According to [The Art Basel & UBS report](#) sales in the global art market in 2018 reached \$67.4 billion, up 6% year-on-year. Despite the fact that the number of transactions on this market is much less than e.g. in retail, a steady increase in sales and a growing interest of buyers in investing in fine art shows the growing role of this market. Since the value of works is unpredictable and cannot be evaluated using traditional methods, such as measuring costs or incomes, the price in the market is unpredictable. Furthermore, the uniqueness of artwork, the subjectivity of their perception and unequal access to information about paintings in the absence of transparency of information can be perceived as an important functional deficiency of art markets ([Bianchi, 2015](#)).

Therefore, the market of art is a unique sphere comparing to traditional markets even when considering its traditional segment.

Since art is often characterized by a high selling price, it is important to understand if buyers are willing to pay a high price for pleasure or they may perceive the paintings as an investment. In this regard, in my research, I consider the attractiveness of paintings for investment. In addition, an important hypothesis is to verify the similarity of the financial market with the online segment of the art market, which is significantly different from the traditional art market.

The possibility and tendency of the auction house to influence the price by overstating the expectations of buyers will also be considered. To test hypotheses and evaluate indicators, the data of the Christie's auction house for 2017-2020 will be used.

2 Literature review

In recent years, there has been a significant increase in interest in auction pricing of artworks in the literature. The question of value evaluation in online market of art addresses to the field of forecasting of price changes in this market and the possibility of the fact that online segment is not similar to the live sales. Pioneering works in this sphere analyse how online art auction design differs from live one and how this difference may affect the price and the willingness of bidders to pay more or less for an artwork according to the information they have on the website.

In the beginning of the XXI century with the increasing popularity of the Internet it was found that despite the fact that both bidders and buyers do better online while dealing with pieces of art, online auctions have not up to this moment reached their full potential ([Eiichiro Kazumori, John McMillan, 2005](#)). In this work authors find key features of online auctions. First, they talk about the lack of transparency in the online market because bidders have limited access to information, expressed in accessible for

all participants previews while on a live auction bidders inspect the item during it's exhibition themselves and then they can get the advice from the auction-house experts. Secondly, they emphasize the fact that transaction costs of online auctions are much less. It means that sellers save on the costs of hosting the pre-sale exhibition and of running the theatrical performance that makes up a live auction. Instead of this, they are capable for the running of the website only. Buyers also have to pay less as their participation costs are much less than in live auctions, e.g. they do not have to spend on travelling to the place where the event is held.

Thus, the study of the online art market requires a detailed discussion of several topics: art pricing features and the impact of heterogeneity of goods on art market, the features of online auctions and the specifics of their conduct in various auction houses, as well as the direct impact of this sale format on the price of artworks.

In next subsections of literature review I will combine the assessment of previously written works with explanations regarding the specifics of the art market.

2.1 Value and price of artworks

Traditional economic approaches for price estimation based on the evaluating exchange value and the utilitarian value of a good are not quite applicable for the art market. The vast majority of buyers of art objects are primarily interested in getting pleasure and only then they may consider the paintings from the point of view of it's utility, focusing, for example, on the feasibility of investing in a particular painting. Prices in the art market are highly heterogeneous. They largely depend on the reputation of the artist, fashion for certain works of art, the style of the picture, the subjective perception of buyers and a number of factors, the assessment of which is not similar to the typical for the classical economy approach with price forecasting based on available data on the cost of manufacturing the product. In addition, art objects are characterized by uniqueness, which makes the assessment of their value especially extraordinary.

As a rule, auction price of an artwork largely depends on the published or expressed opinion of the auction house experts and their expectations regarding the value of the painting. At the same time, as Smith noted "even auctions, which should approximate the economic model most closely because of their alleged transparency, deviate significantly from this model. Contrary to the assumptions of economic theory, bidders do not know the economic value of objects for sale; their estimates tend to be based on collective opinions that are highly subject to modification." (Smith, 1993). Thus, prices do not reflect a simple set of individual estimates, but rather complex, collective estimates subject to intra-group influence (Velthuis, 2003). Indeed, auction house informs bidders about the expected selling price and sets the initial bid price, while the

final price depends entirely on the actions of the auction participants, which are able to both raise expectations about the value of the painting or underestimate it.

It was concluded (Velthuis, 2003) that the art market is characterized by a close interweaving of economic and cultural value, which causes a number of pricing paradoxes. Velthuis in his socio-economic work declares that dealer plays an important role in the pricing process. The main tasks of dealers are paradoxically as follows: to avoid lowering prices and to prevent differentiating prices for the artist's work of the same size. The first idea is caused by a paradox of uncertainty regarding prices. If the expected price is high enough, then buyers assume that the artwork has significant value, if the price is low, then the expectations regarding the auction value of the painting will be underestimated. This causes a paradox, because high expectations of value result in an increase in auction estimations, which, in turn, raise expectations about the value of the picture. At the same time, if price expectations for similar paintings are strongly differentiated, pricing is more chaotic and may be characterized by a strong underestimation of certain paintings. This explains the second task of dealers and illustrates the reason why they tend to set the same price for paintings of the same size, even if they know that some will be sold better.

Therefore, the pure artwork pricing depends on the specific subjective perception of the particular bidders, the estimated cost of the painting from experienced and educated experts or dealers, and the collective actions of the bidders during the auction.

2.2 Auction specific

First of all, it is important to note that the procedure for holding an auction varies from on the auction house to another. As part of this work, the facts of competition between auctions and the procedures for establishing both the expected price and the reserve selling price are important for consideration.

The art market is characterized by a certain hierarchy (Nauro F. Campos and Renata Leite, 2009), which is closely related to auction houses or artwork sales markets. At the first level there are local markets, painting agencies, and private dealers. One level higher there are large socio-geographical centres that host famous auction houses, private or public collections, as well as major dealers and important buyers (New York, London, etc.). The top level is assigned to international markets, in which the most important role is played by the largest auction houses (Christie's, Sotheby's). In my work, I consider the data of Christie's auction house, so subsequently all the facts will relate specifically to the upper hierarchical level of the art market

Sotheby's introduced online auctions earlier than Christie's which for a long time kept aloof from online auctions until this measure became obviously necessary due to the development of e-commerce. It was remarked, by their experts: 'What we sell is

something that need to be looked at and discussed.’ (Eiichiro Kazumori and John McMillan, 2005).

After registering on the platform, the buyer is provided with information about ongoing auctions, lots for them, brief descriptions of paintings and the upper and lower bounds on the expected sale value. In the work "Auctions and the Price of Art" it was found that the expected sale prices set by the auction house can be both a true reflection of the experts' expectations regarding the sale price, and too high prices to get more profit from the auction. Altering the lower expected value may occur because the seller wants to set a high reserve selling price, and therefore the auction house raises the lower limit of the expected price, hoping to stimulate buyers to set a higher price.

With the growing number of studies on this topic, the opinion of experts regarding the tendency of auction houses to give an honest assessment of goods has changed. Milgrom and Weber (1982) and Ashenfelter (1989) conclude that setting truthful price is the best policy and auction houses are more likely to be truthful about their estimates. However, in the beginning of the XXI century several authors who analysed exactly the same period or expanded version of it as previous ones decided that spread between high and low estimate may indicate the uncertainty of the auction house or it's wish to set a higher price (Ashenfelter, 2001). It was also found that auctioneers strategically set higher estimates so that to alter final prices (Mei and Mosses, 2002).

While expectations regarding the price are formed jointly by the owner of the artwork in conjunction with auction house experts, the reserve price, as a rule, is determined directly by the seller of the artwork and plays an important role in the issue of the value of the painting. If the final bid price is below the reserve one, the picture is unsold or "bought-in" (It means that unsold items are sometimes bought by auction houses themselves) (Ashenfelter, 1989). That is, if the maximum price that the buyer is willing to pay below the minimum cost acceptable for the seller, the artwork is not for sale. Auction houses prefer to keep secret reserve price. Ashenfelter also while explaining the model of the English auction suggests that in a classic auction the optimal reserve price is the same regardless whether it is announced publicly or kept in secret. Moreover, the reserve price does not depend on the number of auction participants. Given these facts, the reserve price can be assumed not to affect seriously on the participants' decisions regarding artwork value and therefore will not be considered in detail in my work. It is important to note that it is prohibited by laws of some countries or states (for example, New York law) to set a reserve price above the lower limit of the expected price (Nauro F. Campos and Renata Leite Barbosa, 2009). In my work, I consider English auctions, and Christie's auction house, so this comment does not play a big role.

Online art auctions differ from real ones in several ways. First of all, the role

of the auction house in online auctions is reduced to the content of the platform for conducting and forming auction rules. International auction houses such as Christie's and Sotheby's have partnership with dealers from all over the world, they, in turn, provide artworks and conduct assessments of their value (Eiichiro Kazumori, John McMillan, 2005). In addition, auction house does not hold preliminary exhibitions and does not have to provide bidders with printed catalogue. Descriptions of all products are available on the website for any registered user.

In addition, online art auctions are held according to the Ebay procedure, that is, the auction time is limited and allows buyers to bid at the last moment. An empirical study found that bidders at online art auctions are more likely to bid at the last moment, since this is the winning strategy of a classic auction (Pownall, Wolk, 2013).

Thus, the following necessary features of auction trading can be summarized: buyers are provided with equal access only to the information posted on the website, the expectations set by experts regarding prices, which play an important role, can be both truthful or overvalued in connection with the reserve price of the an artwork, the procedure for conducting an online auction significantly different from the live one, and the main difference is the time limit.

2.3 Online auction pricing

Since online art auctions appeared relatively recently, there is not yet a large base of researches focusing on pricing directly on the market of e-commerce of artworks. At the same time, there is an important study of art auctions in Latin America. In it, the authors, using the collected data as an example, test hypotheses regarding the effect of a masterpiece, the effect of a strong reduction in prices, and also examine the effect of various parameters of paintings on their value and determine which are most important for buyers when making decisions (Nauro F. Campos and Renata Leite Barbosa, 2009). The authors find that the signature negatively affects the sale of the painting, but the material is very significant in determining the price. They also found out that the characteristics of the artist's biography, his age at the time of writing the painting, and whether he was alive at the time of the auction have a significant role.

It is worth noting that their study is based on live auction data and does not take into account the asymmetry of information between buyers. In my work, I will test hypotheses regarding the importance of similar parameters, but confidence in their significance in determining the final price is supported by the fact that all buyers have the same limited information about an artwork.

Another important study analysing the effect of various parameters of paintings at an online auction on their final price is the study of Reddy and Dass (Srinivas K. Reddy and Mayukh Dass, 2006)]. They consider both the parameters associated

with the specifics of online auctions, and the unchanging parameters of the paintings. However, the authors largely concentrate on the influence of parameters not on the final price, but on the dynamics of its change during the auction. In the end, they come to the conclusion that it is auction parameters (such as the starting bid) that are of greatest importance when setting the price, while less weight is given to the parameters inherent to the picture, regardless of the auction. In their research, the authors use much less parameters of the paintings and focus more on the specifics of price movement, while in my work I will consider a larger number of characteristics and the effect will not be exactly the same as that obtained by the authors of the article.

2.4 Art as investment

At the moment, few works have been written that evaluate the online art market as a platform for investment. The key difference between the work of the Highfill and O'Brien (2007) from mine is that they consider the online art market as an example of Ebay auction, while I am studying classical English auction. They conclude that the effects are mixed and the paintings sold on this platform are more likely to be objects of consumption. As the likelihood that goods there are investments is still possible, this hypothesis cannot be rejected.

Benjamin and Mandel (2009) think that art objects should not be treated like standard financial assets, since they have their own strong specifics. They also consider previously written works on the profitability of paintings and conclude that the average return of art objects is at the level of 2-3%. In their study, they conclude that financial instruments are preferred to art in a "mean-variance-efficient portfolio". In my research, I will consider an online segment of the art market, which differs significantly from that considered in previous works.

3 Model

To test the hypothesis about the attractiveness of paintings for investment, several stages of analysis will be done. To begin with, it is important to evaluate what parameters of the paintings determine its price at the auction. It is necessary to divide these parameters into changing from one auction to another and unchanging, inherent to the picture throughout the entire time. If the second group strongly affects the price, then it can be assumed that the assessment of the value of the painting does not depend on the auction parameters, which means that the painting will not be confirmed by external shocks and will be good for investment.

It is also important to determine whether the auction house and the specificity of auctions artificially affect the price. If so, and if this is a common phenomenon, then

the price of the painting is an artificial financial bubble. In this case, the paintings are bad for investment, because their resale value can significantly decrease. The main function of the auction house is to establish the expected selling price. Therefore, a hypothesis will be tested on whether this assessment is true or whether the seller deliberately overestimates it.

In addition, it is important to compare how the art market behaves in comparison with the financial market. This study will evaluate the correlation between the performance of both markets. It is also interesting for research to consider the dynamics of changes in indicators and identify patterns associated with the external shocks of both markets. The initial hypothesis is that markets are similar.

4 Data

4.1 Data collection and description

4.1.1 Data collection

For my research, I collected data from Christie's auction house. The choice of this auction house is motivated by two factors. Firstly, Christie's is the second largest and most popular auction house in the world, right after Sotheby's, according to data for 2018-2019. Its market share is about 25%.¹ Secondly, on the Christie's website the information is presented in a very convenient for parsing form, data on expected prices and a starting bid are available.

Of all the ongoing auctions, only those that were held online were selected. These are the following categories: African, Oceanic & Pre-Columbian Art, Asian Art, Islamic & Middle Eastern Art, Fine art. Such a choice of categories is explained by the fact that in my research I will study the paintings only, therefore, data from furniture auctions and other things was not collected.

Data was collected on 16 auctions held from 2017 to 2020. The data contains information on more than 700 lots, for each of which characteristics are obtained regarding the expected sale prices, realisation prices, auction information and picture parameters. The variables used for the analysis and how they were obtained will be described below. All variables are divided into two categories: changing and unchanging. Unchanging variables mean that their value for a particular picture does not change from one auction to another, varying ones relate to auction parameters and change over time.

¹ "The best auction houses", ArtPrice, accessed May 6, 2020, <https://www.artprice.com/artprice-reports/the-contemporary-art-market-report-2019/the-best-auction-houses>

4.1.2 Data description

Unchanging characteristics

Heigh, Width: the data was obtained from the description of the paintings by cutting out the lines, the missing values are filled with the average for a particular auction. Variables indicate the height and width of the painting in centimetres;

Area: this variable is obtained from the two previous ones and means the surface area of the picture in square centimetres;

Styles: this variable indicates the style in which the picture is drawn. It is worth to note that in our sample it takes more geographic meanings, indicating whether the picture belongs to Latin American, Asian or Indian art;

Title: a number of paintings did not have a title, so this variable was created. It takes the value 1 if the painting has a title and 0 otherwise;

Set: some lots are not one picture, but an album, a collage or a set of several scrolls, so I entered a variable that indicates if it is a single artwork or several in one lot;

Materials: dummy variables - materials or techniques used in an artwork. The following options were met in the sample: oil, ink, colour, gouache, pastel, silver.gelatin, chromogenic, charcoal, pigment, etching, leaf, leaves, opaque pigments, pencil, acrylic, watercolour, pen, marble.dust, scroll, engraving, mezzotint, aqua tint, digital, casein, handmade.paper, cardboard, lithograph, silkscreen, canvas, silk, print, prints, board, wove.paper, masonite, paperboard;

Year written: based on the data in the description and years of the artist's life, the years of painting were deduced, which I added to this variable;

Age: using the previous variable and the year the auction was held, the age of the painting at the time of sale was obtained.

Changing characteristics

Price realised: this characterization determines the selling price of the painting;

Price estimate: it refers to the expectations of the auction house regarding the value of the painting and includes the lower and upper boundaries of the expected price;

Lot number: this characteristic indicates the lot number of the painting at the auction and shows whether the picture was shown at the top of the list or not;

Starting bid: the starting bid shows the price at which the auction bidding began;

Duration: shows the duration of the auction in days. Most auctions last from 7 to 10 days, but there are several in the sample that differ significantly in duration;

Total sales: shows total sales on the auction on which an artwork was sold (in USD, converted according to the exchange rate for the beginning of each auction);

Currency: indicates the currency of the auction (USD, HKD, GBP);

Auction year: determine the year the auction was held (2017-2019);

Average estimate price: this variable was added because of the fact that both Low and High estimated price do not always matter. It shows the average expected sale price.

Financial indicators

I also added the index values of the most famous financial instruments to the auction start date for each artwork.

S&P, Dow Jones, NASDAQ, T-bills: these indicators were taken due to their prevalence for analysis and since they represent both industrial indices and highly reliable government bonds

4.2 Data analyses

Before starting the regression analysis, we should better look at the characteristics of the paintings and how they are related to each other and to the selling price.

To begin, I will consider the correlations between various parameters. The results are presented in [Table 1](#):

Table 1: Correlation Matrix

	area	lotNumber	priceRealised	avgEstimate	startingBid	durationDays	saleUnif	age	SP	Dow	t.bill	NASDAQ
area	1	0.045	0.033	0.132	0.008	-0.006	-0.105	-0.172	-0.013	-0.033	-0.068	-0.017
lotNumber	0.045	1	0.241	0.300	0.255	-0.145	0.475	-0.222	0.349	0.276	-0.075	0.338
priceRealised	0.033	0.241	1	0.710	0.745	-0.205	0.352	-0.066	0.153	0.152	0.061	0.154
avgEstimate	0.132	0.300	0.710	1	0.955	-0.293	0.325	-0.080	0.221	0.198	0.021	0.219
startingBid	0.008	0.255	0.745	0.955	1	-0.278	0.341	-0.048	0.200	0.177	0.013	0.197
durationDays	-0.006	-0.145	-0.205	-0.293	-0.278	1	-0.142	0.046	0.090	0.175	0.291	0.107
saleUnif	-0.105	0.475	0.352	0.325	0.341	-0.142	1	0.180	0.258	0.300	0.231	0.269
age	-0.172	-0.222	-0.066	-0.080	-0.048	0.046	0.180	1	-0.101	-0.121	-0.101	-0.106
SP	-0.013	0.349	0.153	0.221	0.200	0.090	0.258	-0.101	1	0.947	0.256	0.998
Dow	-0.033	0.276	0.152	0.198	0.177	0.175	0.300	-0.121	0.947	1	0.553	0.965
t.bill	-0.068	-0.075	0.061	0.021	0.013	0.291	0.231	-0.101	0.256	0.553	1	0.316
NASDAQ	-0.017	0.338	0.154	0.219	0.197	0.107	0.269	-0.106	0.998	0.965	0.316	1

Interestingly, the greatest correlation of the final price is observed not with the estimation of the auction house about price, but with the starting bid. It is also important that the financial indices taken into account are correlated with each other. That can be explained by factors influencing them that are inherent in the financial market

Correlation with binary variables is not indicative in the sample. Therefore, it is more convenient to check the dependence by visualizing them. The [graphs below](#) show the price realised versus interesting binary variables. I should notice visually prominent features:

Auction year: the likelihood of selling a painting at a higher price generally increases over the years, but it is noticeable that in 2018 more paintings were sold at a price higher than the average for this year.

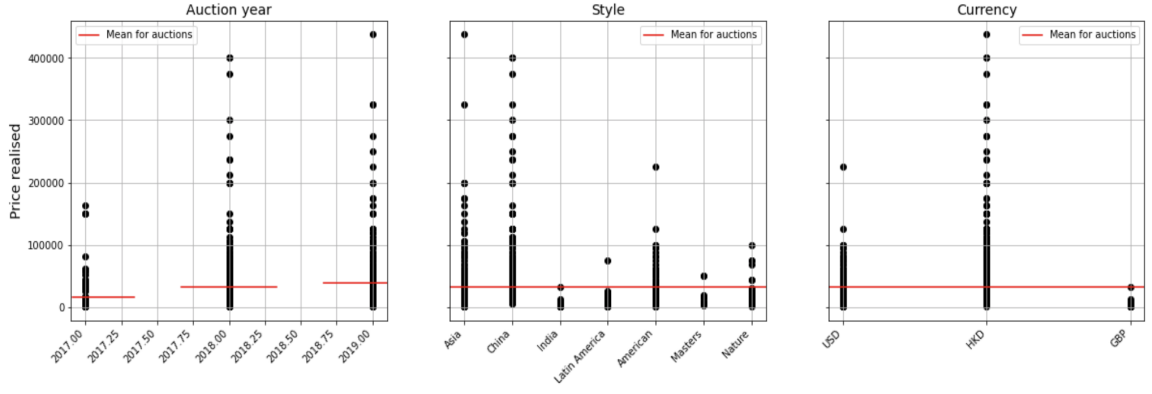


Figure 1: Dummy variables relation with price realised

Painting style: to begin with, I should note that Asian art in our sample assumes the art of all of Asia without the Chinese one, since the proportion of purely Chinese paintings in the sample is very large. Interestingly, both Asian and Chinese paintings are sold mainly at prices above average at auctions. Indian style paintings barely reach average selling prices.

Currency: distribution shows that most expensive paintings were sold on auctions held in the Hong Kong dollar currency. This fact can be explained by the fact that the sample contains a lot of items of Asian art, auctions for which were mainly held in this currency.

5 Analyses

5.1 Regressions

As far as I could see after a lot of tests regressions without constant in my case have better results so I'll interpret it. The results of full regression with all variables, with unchanging and changing only are presented in [Table 2²](#).

First of all, it's easy to see that the result of regression with changing variables only is quite close to the one with all the variables taken into account. Therefore, it might be clear that parameters set by the auction house have the major affect on final price. While Adjusted R^2 in the first columns isn't very different from the third one (0.694 to 0.697 respectively), F Statistic varies widely from one to another (31.205 to 159.588 respectively). At the same time, the right one takes into account much less variables than the left one. That's the reason why both (will all variables and changing only) might be significant

Turning to significant variables, they are mostly changing variables and depend on the auction. It's also interesting that we can see a lot of negative coefficients.

² Hereinafter, all calculations are made by me (with R) and based on the collected data

Table 2: Full regressions

	<i>Dependent variable: Price Realised</i>		
	All	Unchanging	Changing
	(1)	(2)	(3)
Heigh	-118.996* (65.379)	-7.009 (82.350)	
Width	6.613 (71.572)	76.012 (91.782)	
lotNumber	-1.253 (1.888)		0.990 (0.845)
presaleEstimateHigh	-0.414* (0.241)		-0.675*** (0.231)
presaleEstimateLow	0.608 (0.442)		1.196*** (0.403)
startingBid	1.856*** (0.274)		1.683*** (0.223)
durationDays	-11,396.500** (5,043.157)		218.773 (987.731)
saleUnif	0.144*** (0.052)		0.020*** (0.008)
isTitled	6,208.139 (4,816.964)	11,314.340** (5,670.185)	
isSet	-1,886.865 (4,616.686)	1,786.895 (6,412.265)	
age	-18.890 (33.980)	-41.070 (41.169)	
area	0.894 (0.682)	-0.161 (0.808)	
oil	5,413.311 (6,072.401)	10,727.300 (8,237.097)	
ink	-1,068.479 (4,912.425)	-13,846.510** (6,747.694)	
color	-2,175.087 (7,747.446)	-5,137.880 (10,770.580)	
gouache	-4,336.210 (7,792.454)	3,886.968 (10,868.230)	
pastel	3,832.758 (8,468.425)	-278.459 (11,090.830)	
silver.gelatin	-13,086.490 (34,481.640)	-52,705.420 (48,028.400)	
chromogenic	-18,053.960 (13,171.660)	-49,365.220*** (18,027.740)	
charcoal	-1,234.742 (9,658.087)	-9,482.148 (13,221.630)	
pigment	-15,284.900 (14,805.670)	-32,141.200 (20,720.060)	
etching	-5,674.410 (14,272.160)	-13,653.460 (19,560.670)	
leaf	-32,354.740*** (10,667.300)	-30,994.240** (14,773.110)	
leaves	-33,666.370*** (11,323.290)	7,093.194 (15,507.810)	
Opaque.pigments	9,750.644 (16,698.040)	21,694.550 (23,401.700)	
pencil	12,676.190 (18,384.520)	-36,517.910 (25,331.620)	
acrylic	-2,652.165 (7,175.076)	1,016.294 (9,874.343)	
watercolor	2,793.554 (9,336.218)	18,112.420 (12,936.560)	
pen	-13,948.800 (17,607.750)	28,981.520 (24,212.140)	
marble.dust	-2,537.739 (34,253.970)	53,270.370 (47,587.850)	
scroll	-14,692.310** (5,814.774)	-28,296.000*** (7,898.535)	
engraving	-4,396.904 (16,965.750)	3,199.099 (23,649.530)	
mezzotint	-7,546.400 (35,189.490)	-1,670.101 (49,302.310)	
aquatint	-4,619.405 (17,359.030)	5,714.231 (23,901.490)	
digital	-11,192.050 (15,002.640)	-7,712.421 (20,768.750)	
casein	3,689.752 (25,156.450)	-6,671.739 (35,044.520)	
handmade.paper	-3,304.867 (13,251.350)	-10,598.950 (18,354.420)	
cardboard	7,329.952 (14,240.030)	-1,855.177 (19,715.010)	
lithograph	-1,719.924 (6,068.590)	-11,074.460 (8,346.063)	
silkscreen	-21,815.110 (16,324.700)	-41,555.640* (22,685.790)	
canvas	-3,218.164 (5,687.210)	-941.367 (7,884.721)	
silk	13,840.030 (12,439.930)	24,941.990 (17,285.590)	
print	13,072.700* (7,691.277)	13,681.640 (10,647.870)	
prints	-7,386.322 (18,432.740)	-27,871.190 (25,418.010)	
board	-4,226.005 (5,545.947)	-5,196.511 (7,749.223)	
wove.paper	-2,892.998 (10,749.960)	119.104 (14,434.390)	
masonite	5,793.589 (17,967.610)	18,640.540 (25,128.920)	
paperboard	4,919.966 (11,371.330)	14,380.590 (15,790.080)	
Style.American	-1,816.229 (8,970.751)	5,552.379 (7,079.577)	
Style.Asia	40,508.320** (19,803.050)	28,385.440*** (7,285.281)	
Style.China	22,347.790 (13,712.390)	80,028.180*** (10,785.930)	
Style.India	92,838.850** (41,068.690)	14,278.240 (20,423.240)	
Style.Latin.America	76,513.650** (30,664.000)	1,440.624 (8,361.006)	
Style.Masters	5,597.855 (13,965.660)	23,960.710 (19,102.300)	
saleCurrency_HKD	-8,550.696 (27,392.540)		-6,207.801 (8,446.295)
saleCurrency_GBP			-4,700.530 (10,738.580)
saleCurrency_USD	41,283.830 (32,058.120)		-8,289.824 (8,678.815)
Year.s.2017	-7,602.344 (7,424.422)		3,451.072 (4,321.570)
Year.s.2018	5,014.166 (3,940.261)		5,739.951* (2,925.865)
Year.s.2019			
SP			
Dow			
t.bill			
NASDAQ			
Observations	774	774	774
R ²	0.717	0.434	0.697
Adjusted R ²	0.694	0.396	0.693
Residual Std. Error	33,368.940 (df = 716)	46,830.580 (df = 726)	33,418.080 (df = 763)
F Statistic	31.205*** (df = 58; 716)	11.593*** (df = 48; 726)	159.588*** (df = 11; 763)

Note:

*p<0.1; **p<0.05; ***p<0.01

The higher estimated price is, the lower the final price is. It might refer to the unwillingness of buyers to bid for an item if the price is expected to be too high for them.

At the same time, the lower estimated price is, the higher the final price is. Bidders may set price higher than the lowest as they consider that this item can be bought easily by adding just an ε to the bid they were going to do.

The strong negative relation with duration of the auction in the first model can be seen, but it is positive in the last one. If all buyers are informed about artwork parameters they may believe that the longer auction is, the more people would know some more information and the price will increase. Therefore, they aren't interested in bidding. On the other hand, when only minuscule share of information is available, bidders suggest they are all in same condition and continue raising the price.

Here is also positive relation between price and total sales of the auction. When buyers see that other lots are sold with high prices they are more likely to believe that an artwork they are willing to buy might be considered as valuable. So they will increase their price.

Positive relation between the Chinese style of an artwork and its price is also seen. These paintings are usually quite old and refer to extensive collections. Alternatively, the vast majority of paintings in the data are Chinese so the sample might be unbalanced. At the same time the sample of paintings tagged as Latin American is much smaller but strong positive relation can be seen too.

Importantly, title of an artwork matters. Especially when bidders don't have any information about estimated prices they are caring about the fact if the painting is titled or not.

Surprisingly, it was found that here is negative relation with scroll technique and positive with pencil usage, while straight dependants cannot be seen and scroll artworks are more likely to be high priced.

In regression for all variables, the parameter responsible for whether the picture is a single object or a set of artworks is included with a negative coefficient, while when taking it into account in regression with only unchanging variables, its coefficient is positive. Perhaps if all expectations regarding the lot on the auction are known, bidders regard the composition of the lot from several works of art as a signal of low quality of artworks and are less inclined to set a high price for such lot. If they know only the characteristics of the artwork without expectations regarding the price and other parameters of the auction, then they can perceive such a lot as a good option for acquiring several paintings in one lot.

After checking the correlation between low and high estimated prices, it was revealed that the correlation between the expected price margins is quite high (more than 0.8). Therefore, several variants of price prediction were tested: based on only

one of the boundaries of the estimated price (high or low) and with an average value. The results were not significantly different from each other. Moreover, this variable did not become significant at any level.

Based on the same logic, the variables responsible for the height and width of the painting were removed from consideration, they were replaced by the variable of the total surface area. The correlation between the former variables was also high (more than 0.7).

After all that, regression with the significant variables only were checked. I've selected only those variables which were significant at least in one of previous regressions. Then I've dropped all insignificant variables this result too. The last step was to exclude even presale estimates and, surprisingly this regression has the highest R^2 and F Statistic.

The results of it can be seen in the [Table 3](#).

Table 3: Significant

	<i>Dependent variable:</i>
	priceRealised
lotNumber	2.193*** (0.840)
startingBid	1.823*** (0.069)
leaf	-30,206.320*** (9,962.483)
leaves	-28,670.900*** (10,596.240)
scroll	-19,280.150*** (4,945.341)
Style_China	24,458.800*** (5,118.552)
saleCurrency_HKD	-3,628.294 (4,692.442)
Year.s.2018	6,757.841*** (1,885.213)
Observations	774
R ²	0.703
Adjusted R ²	0.700
Residual Std. Error	33,044.420 (df = 766)
F Statistic	226.218*** (df = 8; 766)
<i>Note:</i> *p<0.1; **p<0.05; ***p<0.01	

After a multiple change of variables, only the most significant were left. They turned out to be the lot number at the auction, the starting bid, the material, which is leaf or leaves, technique, which is scroll, Chinese style, the currency of sale - Hong Kong dollar and if the year of sale is 2018. Such results are very interesting. Firstly, among the significant variables, the unchanging parameters of the picture are quite important, which means that the final price is determined not only by the auction characteristics of the lot. Secondly, part of the variables clearly indicate that such parameters as Asian style, performance in Asian techniques and auctioning in Chinese currency largely determine the final price of the painting.

5.2 Comparison with financial instruments

In addition to checking the ability to predict the price on the basis of the available data about the painting, the hypothesis about the similarity of artworks with to

financial instruments is also important. Therefore, I examine the direct relationship between the price of paintings and some financial indices³.

First, I calculated the average indices on the dates of all auctions, and then the correlations between the average prices and estimations and the values of financial indices grouped by years were built. The results are presented in the Table 4.

Table 4: Correlation Matrix: financial indices by years

	Mean price	Mean estimated	S&P	Dow	T-bill	NASDAQ
Mean price	1	0.971	0.994	0.992	0.631	0.998
Mean estimated	0.971	1	0.992	0.933	0.427	0.984
S&P	0.994	0.992	1	0.972	0.541	0.999
Dow	0.992	0.933	0.972	1	0.723	0.982
T-bill	0.631	0.427	0.541	0.723	1	0.580
NASDAQ	0.998	0.984	0.999	0.982	0.580	1

It is important that there is a high correlation between the realised price of paintings in various years and the behaviour of financial instruments. It is also interesting that the correlation of estimated prices with the same indices is always lower. At the same time, correlations are much higher for stock and industrial indices than for government debt securities.

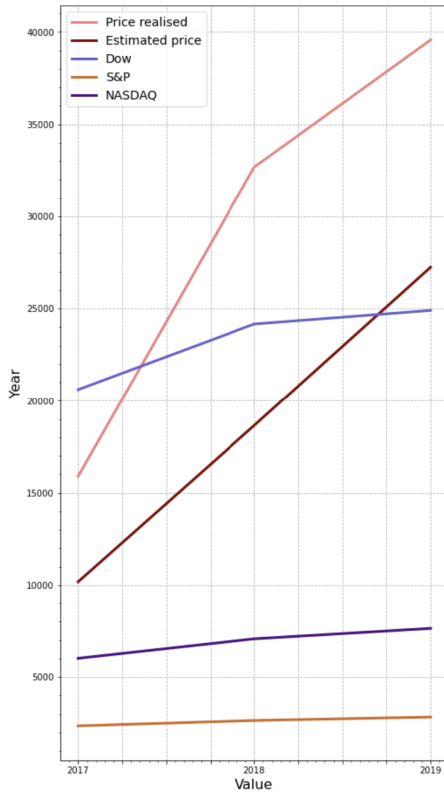


Figure 2: Prices of paintings and values of indices by years

This may indicate that the artworks' volatility is similar to the volatility of financial instruments, which means that the art market reacts similarly to external shocks and paintings can be considered as investment objects, since their value can also vary from fundamental economic indicators and the global situation as a whole.

At the same time, if to try using regressions to explain the price of the paintings based on the values of financial indices, a linear dependence will be get, and the indices will not explain the target variable. The same can be seen in the example of previous regressions. Thus, it can be assumed that changes in the financial market do not cause changes in the art market, but the factors affecting both of these markets may be similar.

For the more clarity of further analysis, Figure 2, which shows the dynamics of changes in prices and indices, is presented. It can be seen that

³ The values were taken from Yahoo!Finance, accessed May 6, 2020, <https://finance.yahoo.com>

there was an increase in all indicators over the analysed period. However, the growth of all indicators was more significant until 2018, after which it slowed down. This may indicate that 2018 was a special year for both the financial market and the art market. At the same time, as it was found out earlier, that in 2018, paintings were sold at prices above average for the rest of the years.

Then it can be assumed that due to the financial crisis of 2018, which affected financial instruments, many investors chose to invest significant amounts of money in art objects, which explains the increase in sales for 2018 and a decrease in the growth of financial instruments. At the same time, an important feature is precisely this similarity with the online art market, since by its specificity it resembles more closely to the financial market and allows investors of different levels to quickly switch between assets without high transaction costs associated with visiting auctions and gaining special knowledge.

5.3 Estimated price analyses

Since it was assumed that the auction house could overestimate the expected value, I will consider how the price estimates and its real values are related.

Ashenfelter and Graddy (2003) suggested that price estimations are directly related to the final selling price, and expressed the view that auction houses can intentionally influence value estimates.

Suppose that while determining the future value of a painting, an auction house, on the basis of existing requirements, receives an estimate of the value expressed by μ . Now when the auction house will establish an estimate of the price, it will make an adjustment for possible variance σ^2 :

$$\begin{cases} PresaleEstimateLow = \mu - \sigma^2 \\ PresaleEstimateHigh = \mu + \sigma^2 \end{cases} \begin{cases} \mu = \frac{PresaleEstimateLow + PresaleEstimateHigh}{2} \\ \sigma^2 = \frac{PresaleEstimateHigh - PresaleEstimateLow}{2} \end{cases}$$

Next, I will consider the values of μ and σ^2 in my data and will try to determine the policy of auction houses regarding the establishment of the estimated price. To begin with, I note that in more than 65% of cases, the auction house incorrectly determines the limits of the estimated price of the painting. In 76% of cases of erroneous valuation, the auction house underestimates the picture and sets the estimated value lower.⁴

In the Figure 3⁵ on the right, it is noticeable that the selling price often is not included into the evaluation intervals of the auction house, and it is usually higher. At the same time, the spread in expected prices is greater in cases where the auction

⁴These facts are based on calculations made on the data I collected from the website of Christie's auction house

⁵ Hereinafter, visualization is done based on the data collected

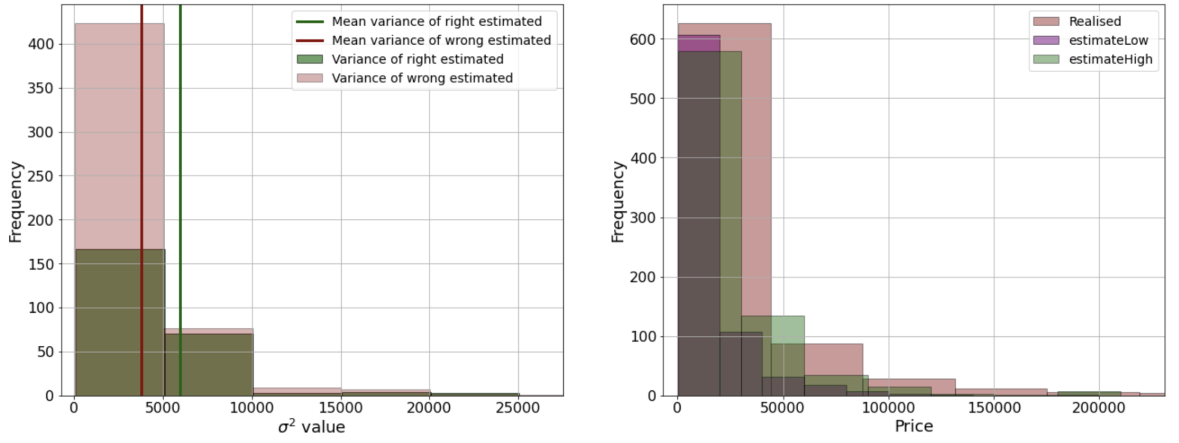


Figure 3: The distribution of σ^2 and prices in the sample

house correctly determines the gap. That is, which is intuitively clear and confirmed by the

Figure 3 on the left shows that the larger the interval between estimates of value, the more likely the auction house to guess the price right. This can be interpreted in another way. If buyers can determine the uncertainty of the auction house about the price, based on the spread of prices, then they are not inclined to go beyond price estimates and are more likely to set prices not higher than expected. If the spread of them is small, then buyers are guided by their considerations regarding the cost and the price can be set higher than expected.

Interestingly, the value of the price spread at which the probability of an auction house error decreases sharply is in this sample at about $5000 - \varepsilon$. This value is approximately the eighth of the average value of the painting on auctions.

However, I will check the hypothesis that the auction house is able to correctly determine the price, for this I will assume that the estimate of the value of the painting (μ) is equal to the price of its sale. As indicated in the literature review, there is an opinion that the auction house tends to overestimate the cost estimate, based on this an alternative hypothesis is given.

$$H_0 : PriceRealised = \mu$$

$$H_1 : PriceRealised < \mu$$

To test the hypothesis, suppose that the samples are independent, the true variances are unknown, but equal. Given the number of observations, we can approximate the normal distribution.

$$\overline{PriceRealised} - \bar{\mu} \sim \mathcal{N}(\mu_{PriceRealised} - \mu_{Expected}, \frac{2\sigma_0^2}{n})$$

where σ_0^2 is the variance that is calculated as:

$$\sigma_0^2 = \frac{\hat{\sigma}_p^2(n_p - 1) + \hat{\sigma}_{exp}^2(n_{exp} - 1)}{n_p + n_{exp} - 2}$$

Then,

$$t_{stat} = \frac{\overline{PriceRealised} - \bar{\mu}}{\hat{\sigma}_0^2 \cdot \sqrt{\frac{1}{n_p} + \frac{1}{n_{exp}}}} \sim t_{\alpha, n_p + n_{exp} - 2}$$

After making calculations based on available data, I obtain the following results:

$$\sigma_0^2 = 1636190046.36$$

$$t_{stat} = 5.887$$

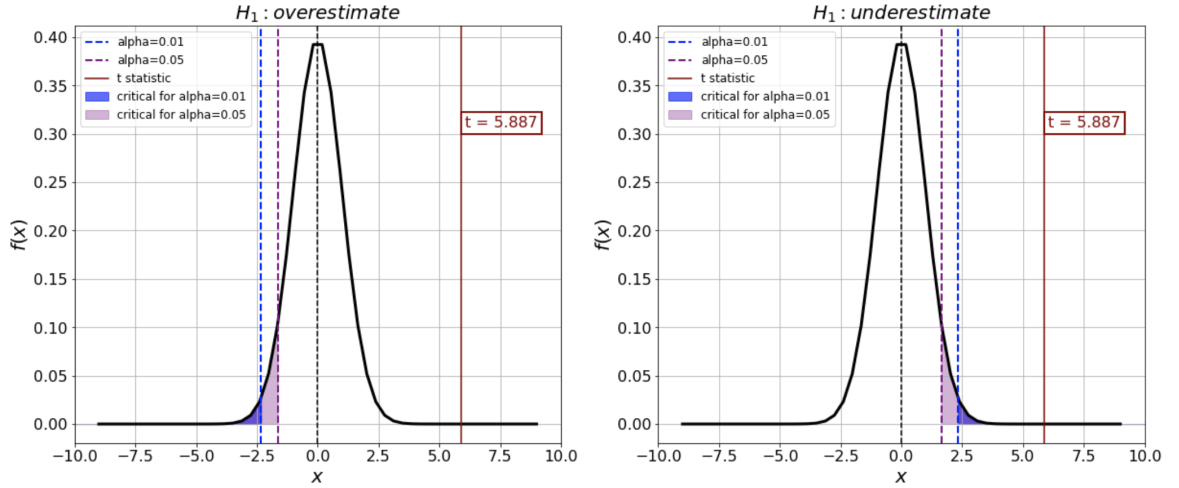


Figure 4: Testing one-sided hypotheses

As can be seen from the [Figure 4](#), the hypothesis that the auction sets an estimate of the price above their really expected has not been confirmed. On the contrary, the hypothesis that auction houses underestimate the paintings in their preliminary estimates can be suggested.

6 Results

6.1 Price prediction

Using regression analysis, it was found that when evaluating all the data available to bidders, auction indicators are more important to determine the final price than the unchanging parameters of the paintings. At the same time, if to consider only significant indicators, it can be assumed that some of the initial parameters of the paintings determine the final price of an artwork to a large extent.

Since it is important to check the assumption about the attractiveness of the paintings for investment, it is interesting to look at which parameters indicate a higher value of the picture.

The regression showed that it was important that the painting belonged to Chinese art and that it was performed in special techniques: scroll and leaves. Examples of such works are presented in the [picture](#).



Su Hanchen, (10th-13th century), Fan Leaves of the Song Dynasty.



Su Shi (1037-1101),
Wood and Rock. Overall
with mounting: 27.2 x
543 cm



Xu Daoning, (10th-13th century), Fan Leaves of the Song Dynasty.

The works of Chinese masters of antiquity are characterized by high value not only because they survived after more than thousands of years. Such paintings are always considered to be the result of the painstaking work of masters, they depict important historical events, and the techniques of their execution are highly professional and elegant. Therefore, it is believed that such paintings are not fostered by the flow of fashion, and their value is not lost over the years.

For example, the scroll from the [picture](#) (in the middle), which caused the cultural revolution in China, was sold after five-minute trading for almost \$60 million USD. It became the most expensive Asian lot ever sold in Christie's ⁶.

In general, on the basis of the analysis, it is concluded that some parameters of the paintings (Chinese style, special techniques) can tell customers the value of the painting, but the parameters set by the auction house are still more important

6.2 Financial analyses

Analysis of the prices of paintings in conjunction with financial indices showed that the art market is prone to the same external shocks as the financial market. It is important that changes in financial performance does not directly affect the prices of

⁶Christie's, accessed May 6, 2020, <https://www.christies.com/features/Su-Shi-scroll-painting-sells-for-almost-60-million-dollars-9579-3.aspx>

paintings. That is, buyers are more likely not to switch between these assets in case of instability. At the same time, the factors determining the changes in both markets are apparently similar.

In my research I consider the online art market. It is more flexible, it is also characterized by lower transaction costs and requires less special knowledge. In addition, this segment of the art market is less transparent information, which makes it even more similar to the stock market. Based on the facts above, it can be assumed that both markets are generally similar. That is, considering the possibility of investing money, buyers can perceive the online art market not only as a platform for buying objects for pleasure, but also as an opportunity to invest profitably.

6.3 Auction house policy impact

If the buyer considers the online art market as a platform for investing funds, it is important to understand whether the auction house can affect the price of paintings. Earlier work (Mei and Mosses, 2002) suggested that the auction house could raise the expected selling price, thereby encouraging buyers to set a higher price. In this case, the attractiveness of the art market for investment would be lower. If the price of a painting is justified not by its (even subjective) characteristics, but by artificially raising expectations, then it would not be profitable for investors to invest in such paintings. Indeed, if they want to resell the painting, the price may fall, because the previous cost was based not only on the parameters of the painting.

However, analysis showed that auction houses, on the contrary, underestimate the picture. Therefore, the price of the painting is set based on the bidding of the auction. Uncertainty about the true value remains and the price is not under the strong influence of the auction house. In this regard, it is assumed that prices on the online art market are set almost like in the financial market. This once again confirms the fact that artworks on online platforms can be perceived as objects of investment.

7 Discussion

As mentioned earlier, there are not many works considering the online art market in the context of English auctions as a platform for investment.

Unlike Highfill and O'Brien (2007), I came to the conclusion that the online market for English auctions is similar to the financial market, and a number of factors studied may indicate the possibility of considering paintings as investment items. At the same time, it is difficult to draw a clear line where pictures are acquired as objects of pleasure and where as objects of investment.

The test of Ashenfelter's hypotheses regarding the affect of the auction house on

the value of the painting showed that this is more likely an exception rather than the rule.

It is important that all conclusions are made solely on the basis of a selection of Christie's auctions and may not be confirmed when considering other auction sites with a different pricing policy

8 Conclusion

The study showed that the hypothesis that the financial market is similar to the online art market cannot be rejected. In addition, the price of paintings can be predicted on the basis of unchanging parameters, which makes it possible to invest in paintings, regardless the auction. However, the characteristic of online auctions parameters play an important role.

It was found that the auction house is unlikely to interfere with the pricing process, which means that the value is formed on the basis of bidders. This allows not to reject the similarity of the market under study with financial instruments. It also turned out that the art market is similar to the financial market in responding to external shocks.

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