Art as an Investment:

Risk and Return Characteristics of

Chinese Contemporary Art

by

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ABSTRACT

The Chinese contemporary art market has experienced an exponential growth over recent years, with more and more domestic individual and institutional investors adding art into their investment portfolios for diversification. In this paper, we study the investment performances of the Chinese contemporary art market, and hope to find out the risk and return characteristics of Chinese contemporary art. We collected 3065 auction sales data in major auction houses over the sample period 2000 to 2016 and created an art price index with hedonic regression modeling. Our empirical results show that Chinese contemporary art during this time exhibited an average annual return of 15.23%, outperforming bonds while underperforming Chinese stocks. Our results also show that the low and even negative correlation of our art index with indices for traditional asset classes makes Chinese contemporary art a useful vehicle for portfolio diversification, although our further analysis suggests that its impact on risk diversification can still be rather limited.

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1. Introduction

The global contemporary art market has grown exceptionally within the past 20 years, thanks to the growing prosperity of the general art market. The total sales of the global art market have risen from less than $150 million in 1970 to more than $45 billion at the end of 2016 (Renneboog & van Houtte, 2000), with the contemporary art segment making a remarkable contribution to this growth. According to the latest *Artprice Art Market Report 2016*, the auction turnover of the global contemporary art market has experienced an increase of 1,370% and its global transaction volumes have quadrupled in the past 16 years (Artprice, 2016). Such dramatic development makes contemporary art an increasingly important sector in the art market, and attracts global art investors.

In particular, many art investors turn towards the Chinese contemporary art market, which has had a huge development in a short time, growing from less than 1% of the global auction turnover in 2000 to 24% in 2016. For global investors, continuous astonishing record auction sales make Chinese contemporary art extremely attractive. For instance, Zeng Fanzhi's *the Last Supper* was sold for a record-breaking USD23.3 million at Sotheby's Hong Kong in 2013, and Zhang Xiaogang's *Bloodline: Big Family No.3* reached a sales price of USD 10.7 million in 2014 (Naji, 2013). Data also shows that Hong Kong and Beijing are now the world's third and fourth marketplace for contemporary art auction sales (Artprice, 2016), indicating the fact that even as an emerging art market that only started its boom from the early 2000s, China is now one of the most important global players in the contemporary art market.

One factor that contributes to this sudden boom and prosperity of the Chinese contemporary art market is the massive increase in the number of art consumers, as a new

generation of wealthy buyers, both private and institutional, have emerged over the last few decades, driven by the domestic economic reform and globalization. Showing distinct preference for contemporary art, those investors treat contemporary art not only as a source of aesthetic enjoyment, but also as an alternative asset class that helps yield a potential capital gain (McAndrew, 2010, p.17).

Previous literature on the financial returns of art generally agree that art generates relatively lower financial returns than traditional assets such as stocks, but it is still an attractive investment since it can diversity risk in investment portfolios (Mei & Moses, 2002). Most research that reach such conclusions are conducted toward the American or Western market, where the art markets are relatively more mature and stable, but little attention has been paid to the financial characteristics of art in the emerging Chinese contemporary art market. Given the phenomenal growth and the uniqueness of this specific market, this paper intends to fill this gap and conduct an extensive analysis on the investment characteristics of Chinese contemporary art.

This paper explores the risk and return characteristics of Chinese contemporary art and attempts to answer the following questions: How does the investment characteristics of Chinese contemporary art differ from that of other categories? Is Chinese contemporary art a good investment? Should Chinese contemporary art be added in an investment portfolio for diversification?

For our empirical research, we will construct an art price index using a hedonic approach and apply this index to evaluate the risk and return characteristics of Chinese contemporary art. For the data set, we consider the price behavior of artworks, over the period from 2000 to 2016, for a portfolio of major Chinese contemporary artists. We then use over 3000 auction sales data to construct the hedonic semi-annual art price index for the period 2000 to 2016. We will also

apply the mean-variance optimization model to investigate the performance of Chinese contemporary art in a mixed investment portfolio.

The remainder of this paper is organized as follows. Section 2 introduces the history and market performance of Chinese contemporary art, and lists some relevant research findings. Section 3 presents the data set and discusses the hedonic regression method used for our research. Section 4 analyzes the empirical results, and Section 5 concludes.

2. Art as an Investment

The motives for investing in art are various. For some, the ownership of a painting is wholly an aesthetic issue, for the personal satisfaction gained through aesthetic appreciation is the most important to them (Atukeren & Seckin, 2007). Most buyers, however, take the potential capital gain of artworks into consideration when making investment decisiona. According to the *2016 Deloitte Art & Finance Report*, 72% of art collectors say they buy art for passion with an investment view (D'Angelo, 2016). Clare McAndrew (2010) gives artwork a specific definition in her book *Fine Art and High Finance*: "Artworks are dual in nature: on the one hand, they yield a non-monetary viewing benefit, while on the other hand, they are capital assets that yield a return from their appreciation in value over time" (p. 17).

Even considered as a new asset class, several characteristics distinguish art from other traditional financial assets. First is the heterogeneity of artworks. Since each piece of artwork is unique and cannot be substituted, it is hard to find a standard to valuate different artworks. Also, art is a relatively illiquid asset that generally carries higher risks than liquid ones such as stocks and bonds (McAndrew, 2010, p.18).

Nevertheless, some factors, apart from the record prices and possibly superior relative returns, have sparked investors' great interest in investing in art (McAndrew, 2010). The research conducted by Mei & Moses in 2002 asserts that art investment enjoys capacity for diversifying risk in investment portfolios. What's more, Alexander Forbes, in her article *5 Things to Know about Investing in Art Right Now* states that "art, especially at the high and ultra-high end of the spectrum, can be non-correlated in nature or at the very least less dramatically affected by macroeconomic swings and geopolitical uncertainty…thus art is well used as a store of value…and another key factor for including art in investors' portfolios is inflation protection" (Forbes, 2016). Many investors treat art as an alternative investment vehicle to hedge against rising inflation and volatile financial market. Another attractive attribute of art lies in its ability to rebound from market turmoil, since the art market rebounded much quicker than markets of any other traditional financial assets after the 2008 global financial crisis.

For the Chinese art market, thanks to China's explosive economic growth and the sudden emergence and rising of a new generation of high net worth individuals, the so called "new money" in China, is "becoming increasingly educated about art and taking a pragmatic approach when it comes to auction buys, viewing Chinese art as an asset class" ("Jing Daily," 2013). They are now the major participants in the domestic art market, and many of them show their special preference for the contemporary category. Statistics show that a growing number of the wealthy in China identify personal interest as their main purpose of investment (Liu, 2014). Therefore, as most of today's domestic wealthy individuals have witnessed and participated in the whole development process of Chinese contemporary art, their investing in art may possibly be seen as an investment not only for wealth creation, but also for spiritual fulfillment.

2.1 History of Chinese Contemporary Art

The public interest on Chinese contemporary art has only started over recent years, due to the very short history of Chinese contemporary art. Chinese contemporary art first emerged in the late 1970s, with the first unofficial art exhibition after the Cultural Revolution: "Star Art Exhibition" staged in public in 1979. The exhibition was organized by the Stars Art Group(星星画会), an avant-garde group of self-taught young artists at that time. The end of the Cultural Revolution enabled those young artists to be exposed to Western contemporary art, and such sudden exposure led to a rapid turnover of their artistic styles. Under the influence of the Western culture, those Chinese artists started to "champion individualism and freedom of expression both in their work and public activities" ("Artsy," 2017). The period from the late 1970s until the late 1980s thus saw the dramatic development of avant-garde art, as many art groups emerged and collaborated during this time. With the Chinese Economic Reform and Open Door policy, some of those artists, including Ai Weiwei and Li Shuang, went abroad to study contemporary art. The 85 New Wave, a nationwide avant-garde movement, is an important milestone in the development of Chinese contemporary art, as between 1985 and 1989, seventy-nine art organizations across the country were founded and they put on exhibitions, staged conferences and wrote manifestos. In the 1990s, Chinese contemporary art started to gain international attention. "Thanks to the first batch of prominent overseas Chinese artists who gradually gained recognition in the international auction market, Chinese contemporary art was introduced to the Western art community" (Chang, 2013). The seminal exhibition "China's New Art Post-1989", which was first held in Hong Kong in 1993 and subsequently held in Australia and the United States, was the first major collection of Chinese experimental art to exhibit outside mainland China, and it marked the incipient engagement of Chinese contemporary art with the international market (Debevoise, 2014). Since 2000, Chinese

contemporary art has continuously risen on the international stage, with the Metropolitan Museum of Art (the MET) holding its first-ever Chinese contemporary show in its history *Ink Art* in 2013 ("Jing Daily," 2013). Under further globalization and the economic development of China, Chinese contemporary art has also captured the spotlight in the global art market with Chinese contemporary artists fetching record prices in international art market.

2.2 Market Performance of Chinese Contemporary Art

The dramatic economic growth has made China a new global player in the global art market. Owing to the global art market boom, the Chinese contemporary art market started its staggering development from the beginning of the 21st century, and experienced its first boom in the mid-2000s. From 2003 until the end of 2007, "the Chinese contemporary art market rose over 11,000 percent" (McAndrew, 2010, p.7). This rapid rise of the Chinese market signified a shift of art market power from west to east, as China replaced France for the third place in global art auction market in 2007.

The second boom of the Chinese contemporary art market happened in 2010. Although affected by the global financial crisis in 2008, the Chinese art market recovered faster than any other art market. As noted in the *Artprice Contemporary Art Market Report 2016*: "Whilst most global art markets were experiencing a significant value correction and a dramatic decrease in auction volumes in 2009, Christie's and Sotheby's Hong Kong sales in 2009 drummed up the second highest total ever, and set the scene for a dramatic boom in 2010" ("Artprice," 2016), in 2010, China surpassed the US for the first time to become the largest art market, with a market share of 33%. Due to an escalating domestic anti-corruption policy and a slowing economic growth in China, however, the Chinese contemporary art market showed a sharp contraction in

2012, and since then has experienced unprecedented volatility. The general correction of the financial market in 2014 and the downturn in the economy also saw contractions in the Chinese contemporary art market. Nonetheless, today, China still comes third in the contemporary art segment where it accounts for 24% of global turnover (Artprice, 2016), and it continues to be the fastest growing contemporary art market in the world.

2.3 Art Price Indices & Existing Indices for Chinese Contemporary Art

Two major obstacles in analyzing the art market are "the heterogeneity of artworks and the infrequency of trading" (Mei & Moses, 2002), so an art price index is essential for empirical analysis of the investment characteristics of art. In our research, in order to analyze the financial characteristics of Chinese contemporary art, we should first find an art index that tracks the performance of Chinese contemporary art market.

Today, two existing indices are specifically targeted to Chinese contemporary art: the Artron Contemporary Top 18 Index and the Artron Contemporary 50 Index. Both indices are developed by Artron, China's first and most comprehensive database for the art market. These two indices are constructed under different methodologies and samples, therefore show different returns for contemporary art. The Artron Contemporary Top 18 Index is built by the naïve art price indices method, while the Artron Contemporary 50 Index uses repeat-sales regression method.

In fact, three methodologies are widely adopted to construct art price indices: naive art price indices method, repeat-sales regression (RSR) method, and hedonic regression method.

Naive art price indices are built by taking the average sales price of a set of price data. Stein (1977) and Candela and Scorcu (1997) are two representatives of using this index method.

All sales data are included in this model, and the naive price index method is the simplest approach among the three methodologies. However, it may generate the most biased result because it ignores the heterogeneity of each artwork, which is one of the most important characteristics of art.

The Artron Contemporary Top 18 Index uses the Naive art price indices method to calculate the average price per square feet of the artwork based on a sample of art market transactions. In this model, the price data of the auction sales of 18 top Chinese contemporary artists in every auction season are taken as the sample, and the index shows an average semiannual return of 8.8% of the Chinese contemporary art market in a period from 2000 to the end of 2016.

The Repeat-Sales regression (RSR) method, a method that is also extensively used in real estate studies, uses prices of the same object traded at two distinct moments in time to compute the rate of return for the given object (artwork) and time interval. This method is commonly applied to the art market by researchers such as Baumal (1986), Mei and Moses (2002), Goetzmann (1993) and Pesando (1993). The advantage of this method is that it overcomes the heterogeneity issues of different artworks. However, since only artworks that have been sold for at least twice can be selected in the data set, a large number of sales data are omitted in the model. This selection bias may lead to a less representative result for the whole art market. Because Chinese contemporary art market has developed dramatically only since the early 2000s, the number of artworks that have been transacted more than once is very small. In this way, a repeat-sales price index may not track the art market correctly. Given this reality, Artron still constructs a repeat-sales index: the Artron contemporary 50 index.

The Artron contemporary 50 index uses repeat-sales regressions to track the price difference between each subsequent sale of the chosen 50 top Chinese contemporary artists. The sample size is small as it merely includes a very small subset of available art market transactions. The result shows that using repeat-sales regression method, the average semiannual return for Chinese contemporary art market is 10.72% in the past 17 years.

The hedonic regression is based on the assumption that the value of each artwork can be determined by a number of different characteristics with an implicit price (Ginsburgh, 2006). In a hedonic regression model, "artwork prices are defined as implicit prices of a set of attributes concerning the artist, the painting, and characteristics of the sale and are estimated by regressing the product prices on these hedonic variables" (McAndrew, 2010). This method became very popular in the mid-1990s, and was applied by researchers such as Beulens & Ginsburgh (1993) and Higgs & Worthington (2005). The major drawback of this methodology is that the determination of hedonic characteristics is subjective, thus "neither the set of hedonic variables nor the functional form of the relationship is known with certainty. Such subjectivity can result in inconsistent estimates of the implicit prices of the attributes, which may have a strong influence on predictions formed using the hedonic price index" (McAndrew, 2010, p.17).

So far, there does not exist a hedonic price index designed for Chinese contemporary art. Considering that a hedonic art price index may better reveal the general performance of the market, a hedonic price index is necessary to be built in order to study the Chinese contemporary art market.

However, one important thing to note is that "all price indices suffer bias because of the inherent problems in the data available on art sales. The only data readily available and made

publicly accessible are art auction data" (McAndrew, 2010), while more than half of the total art sales are made through private dealers, whose price data are inaccessible.

To conclude, each methodology has its pros and cons, and there does not exist a perfect method that can precisely show the whole performance of the market. Many examples of different art price indices are presented in the next section, and researchers generate different conclusions about art investment based on different methodologies they use.

2.4 Literature on Art Returns

The field of study on the financial performance of art investment got its first attention from Gerald Reitlinger (1961), who encompassed 5900 auction sales data from 1760 to 1960 to study the value change of artworks in the long term. Based on Reitlinger's findings, from the mid-1970s, systematic research on art investment have been conducted, and early scholars include Anderson (1974), Stein (1977) and Baumal (1986).

By constructing hedonic price indices for artworks sold from 1780 to 1960, Anderson (1974) estimated that art held an average annual return rate of 3.3%. He then performed repeat-sales regression and estimated an annual return rate of 4.9% in the period between 1653 and 1970, while in both cases art underperformed the common stocks.

Stein (1977) built a geometric mean price index on auction records of the works whose painters died before 1946. The result shows an annual average return of 10.47% in the US market and 10.38% in the UK market during 1946 to 1968, indicating that artworks generate lower returns than stocks as well as bonds.

In 1986, Baumol did a research on the returns in the art market over three centuries (1650 – 1960) using repeat-sales regressions and got a surprising result. He found that the average annual

real return is just 0.55% with very high risk. Baumol then concluded that little evidence could show that art investment can generate profit for investors in the future, and investing arts is as a "floating crap game".

Baumol's research was published during the great art price boom in the late 1980s. Because of this shocking finding, researchers have paid increasing attention to the financial performance of art, and Baumol's work is then considered as the starting point of a growing interest in art investment among academics (Chang, 2013).

Most earlier researchers held negative attitudes towards art investing, while many other researchers held different thoughts about this topic later.

In 1993, Buelens and Ginsburgh re-examined the dataset used in Baumol's study with both hedonic approach and repeat-sales method. Their results show that paintings actually generate higher returns than stocks and bonds, except the period of war and general insecurity.

One of the most representative researches on art investment is conducted by Jianping Mei and Michael Moses in 2002. They constructed a new data set of repeated sales of art paintings and developed an annual index of art prices for the period 1875–2000. They find that for the entire period, the annual real return of art outperforms fixed-return securities, though at the same time art underperforms stocks. They also argue that art has lower volatility and lower correlation with other assets, making it more attractive for portfolio diversification than previously thought (Mei &Moses, 2002). Their finding is later verified by many researchers, and Mei/Moses Fine Art Index is now widely recognized as a preeminent measure of the state of the art market.

Besides many past studies that were conducted focusing on the general art market, extensive researches have been dedicated to regional markets more recently, owing to the continuous growth of regional art markets. Of course, by using different methodologies, different

data sources and sample periods, researches generate very different result on risk and return characteristics of different art market.

Little research had been done on Canadian art market before Hodgson and Vorkink in 2003. They used a sample of auction prices for major Canadian painters for the period 1968-2001 and constructed a hedonic model to analyze the influence of various factors. Their studies conclude that Canadian art returns at 7.6% annually with a standard deviation of 17.3%. The low correlation between art market and the local stock market proves that art provides diversification benefit to a portfolio of Canadian equities (Hodgson & Vorkink, 2003).

Kraeussl and Logher (2008) analyzed the performance of three major emerging art markets: Russia, China, and India. According to their three national art market indices built by hedonic regression, the geometric annual returns are 10.00%, 5.70%, and 42.20% for Russia (1985–2008), China (1990–2008), and India (2002–2008), respectively (Kraussl & Logher, 2008). Specifically, Chinese art market demonstrates a negative correlation overall and a negative market beta.

The political developments in the Middle East and North Africa in the year 2011 have had significant effects on the economies of many MENA countries, and also the MENA art market. Kräussl constructed another research on the risk and return characteristics of the Middle Eastern & Northern African Art Markets in 2014, trying to figure out the market behavior. Using a hedonic regression model consists of 3544 data, he reveals a geometric annual return of 13.9% over the sample period 2000 to 2012, implying that investing in MENA paintings would be profitable.

Up to now, scholarly work on Chinese contemporary art investment is still lacking. Hsieh, Lee and Tzeng (2010) applied the repeat-sales regression method to show that "the returns on

Asian Contemporary and Chinese 20th Century Modern Art during 2000-2009 have exhibited

higher returns (8.39%) and higher standard deviation (40.70%) than typical stock markets"

(Hsieh, Lee, & Tzeng, 2010). Their findings also show that art is a relatively attractive asset for

portfolio diversification. Simon Chang (2013) applied the weighted average method and found

that during the period of 2003 to 2011, Chinese contemporary art outperforms traditional assets

like stocks and bonds, with return and risk taking into consideration.

3. Data and Methodology

3.1 Methodology

Given the fact that there is no existing Chinese contemporary art price index created using

a hedonic approach, which is the most popular approach in the academic world, and that a more

systematic analysis on the market performance of Chinese contemporary art is needed, we intend

to apply in this paper the hedonic regression method to construct an art price index to track

financial performance of Chinese contemporary art. The main advantage of a hedonic price index

is that all auction data can be taken into account, and each sale (including repeat sales) is

included as an independent sale with its own characteristics.

Our hedonic regression may be denoted by the following equation:

$$\ln p_{m,t} = \alpha + \sum_k \beta_k X_{k,m,t} + \sum_t \delta_t D_{m,t} + \varepsilon_{m,t} \quad \textbf{(1)}$$

where:

$X_{k,m,t}$: the value of characteristic k of artwork m at time t

$D_{m,t}$: the time dummy variable that equals 1 if the art object m is sold at time t (0 otherwise)

β_k: the parameter estimate of the implicit price of each of the m art characteristics

δ_t: the coefficient value for the time dummy t

To build our hedonic price index, we apply the antilog of the sequence of time dummies δ.

Then the value of the hedonic price index in year t is represented as:

$$\text{Index}_t = 100 * \exp(\widehat{\delta}) \qquad (2)$$

The time dummy coefficient equals to 0 for the initial, left-out period (S_2000). Then

price indices are converted in continuously compounded semi-annual returns through：

$$R_t = 100\% * (\ln(\frac{Index_t}{Index_{t-1}})) \qquad (3)$$

3.2 Data

We use the auction price data of artworks to build up our sample data set. As we noted in

the previous section, we only have access to auction sales data, since sales data from the dealer

market are not available. In this way, we track the trends of auction sales data as proxies for the

performance of the whole Chinese contemporary art market.

3.2.1 Artron Database

We obtain all auction data from Artron. Artron is China's first and most comprehensive

database for art market. The database covers over 95% of secondary market transaction around

China, and it contains information of around 4.5 million auction records, details of over 840

auction houses, over 18,000 auctions and of over 30,000 artists (Artron).

For each auction record, the database provides the following catalogue information:

- Characteristics of the artwork: title of the painting, name of the artist, the date of production

  (if available), topic, medium (if available), size (if available), Authentication

- Auction characteristics: auction house and the location of auction, date of auction, estimated

  price (if available), hammer price (if the lot is sold).

3.2.2 Artist Selection

We want to include artworks that are created by the most representative Chinese contemporary artists in our sample. The selection of artists to be included in our index is highly subjective. We look for those contemporary artists who are highly renowned in both the domestic auction market and international art auction market, have had remarkable auction sales before, and have made contributions to the development of Chinese contemporary art.

We finally decided to include the sample artists of the Artron Contemporary 18 index: Liu Ye(刘野), Zhang Xiaogang (张晓刚), Luo Zhongli(罗中立), Li Shan(李山), Wang Guangyi(王广义), Fang Lijun(方力钧), Zeng Fanzhi(曾梵志), Yue Mingjun(岳敏君), Liu Xiaodong(刘小东), Liu Wei(刘炜), Zhou Chunya(周春芽), Qi Zhilong(祁志龙), Yang Shaobin (杨少斌), Zeng Hao(曾浩), Yin Zhaoyang(尹朝阳), Feng Zhengjie(俸正杰), Yan Peiming(严培明), Guo Jin(郭晋). Those artists are leading figures in the Chinese contemporary art scene today. Most of them are listed in the Hu Run Art List 2015, a ranking of the top 100 Chinese artists alive today based on the sales of their works at public auction. Since their works are very popular among investors and are liquidly traded in global auction marketplace, the auction price data of their artworks may be representative for the performance of the Chinese contemporary art market.

Figure 1 below presents statistics of our sample artists, including the total number of paintings sold for each artist examined, the average price per painting of each painter, and the standard deviation for the average prices. In our data set, 369 lots belong to the artist Zhou Chunya (ZCY), while the artist Yan Peiming (YPM) holds the minimum lots in our sample, with only 47 pieces. As the most successful Chinese contemporary artists in the global auction market, Zhang Xiaogang (ZXG) and Zeng Fanzhi (ZFZ) both own very high average auction prices. The mean prices for both artists' works exceed 5 million CNY, more than 10 times the

mean price of Zenghao (ZH)'s work. As for the price risk, artworks by Zeng Fanzhi (ZFZ) suffer from the highest volatility since the standard deviation is very high.

Auction data by Artists

Artist		auction from:	auction to:	Total lots	sample lots	Mean(in CNY)	S.D.
刘野	**LY**	1996.4.30	2016.12.31	393	232	2,541,014.9	4,297,113.5
张晓刚	**ZXG**	1998.10.27	2016.12.31	559	299	5,256,156.4	9,346,860.2
罗中立	**LZL**	1996.4.21	2016.12.31	1253	286	1,491,698.6	3,645,472.7
李山	**LS**	1997.10.26	2016.12.31	1694	135	871,893.4	1,308,473.9
王广义	**WGY**	2000.11.05	2016.12.31	494	259	1,412,379.9	1,877,387.1
方力钧	**FLJ**	2000.5.7	2016.12.31	475	222	2,790,247.6	5,376,999.8
曾梵志	**ZFZ**	1997.10.26	2016.12.31	612	357	5,972,283.3	11,167,694.6
岳敏君	**YMJ**	2000.5.7	2016.12.31	479	225	3,148,664.4	5,688,275.7
刘小东	**LXD**	1999.1.24	2016.12.31	273	151	4,619,871.3	9,038,591.2
刘炜	**LW**	1997.10.26	2016.12.31	533	292	2,210,386.5	3,840,991.1
周春芽	**ZCY**	1996.10.18	2016.12.31	1365	369	1,749,255.6	3,064,690.7
祁志龙	**QZL**	2000.4.30	2016.12.31	152	89	589,739.0	643,445.6
杨少斌	**YSB**	2002.4.23	2016.12.31	269	149	978,408.7	1,095,462.0
曾浩	**ZH**	1997.10.26	2016.12.31	120	49	408,821.4	402,893.9
尹朝阳	**YZY**	2000.11.6	2016.12.31	451	147	1,125,711.8	1,326,434.7
俸正杰	**FZJ**	2004.5.15	2016.12.31	235	107	629,596.3	523,455.8
严培明	**YPM**	2005.5.29	2016.12.31	86	47	2,755,062.0	2,777,756.6
郭晋	**GJ**	2000.5.7	2016.12.31	255	117	276,776.9	217,765.5

Figure 1: Statistics of Auction data for 18 sample artists

3.2.3 Auction Records

The auction records for paintings by these 18 major contemporary painters are collected over the period from Spring 1996 to Fall 2016. Our painter selection resulted in a database consisting of 9698 auction records, including those works that were bought-in. To ensure the accuracy of our data, we chose several major auction houses as our sample auction houses, and only included auction sales that occurred in those auction houses. Our sample auction houses are Beijing Council, Poly, Hanhai, China Guardian, Sotheby's and Christies's. The first four auction houses are major auction houses that are based in China, and the rest two are the global leaders of the art auction market. As both Sotheby's and Christies's have their branches in mainland China and Hong Kong, we then broke these two global auction houses into three sub-categories: Sotheby's China (including mainland China and Hong Kong), Christies's China (including

mainland China and Hong Kong), and the Overseas branches (including Christies's London, Christies's New York, Sotheby's London and Sotheby's New York). To ensure all data are relevant and valid, we omitted all bought-in lots, and our final database consists of 3532 auction records.

Figure 2 shows the annual turnover (in million CNY), the annual number of paintings sold and the average price (in 1,000 CNY) for the 18 selected Chinese contemporary artists over the period 2000 to 2016. The great fall of all three objects in year 2009 can be considered as the art market's subsequent reaction to the 2008 financial market turmoil, and this downturn happened in every segment of the world art market, with a great reduction in liquidity. China recovered soon and the market turnover in 2011 exceeded that in 2008, a sign of strong market rebound. However, another two significant drops in the total number of sales and average artwork prices happened in 2012 and 2015, possibly due to the macroeconomic instability and the political uncertainty over these years. While the market was extremely weak in 2015, the average price of artworks sold in the market increased sharply in 2016, accompanied with an increasing total turnover, showing good sign for the market.

Number of Paintings Sold, Turnover and Average Price per Painting(2000-2016)
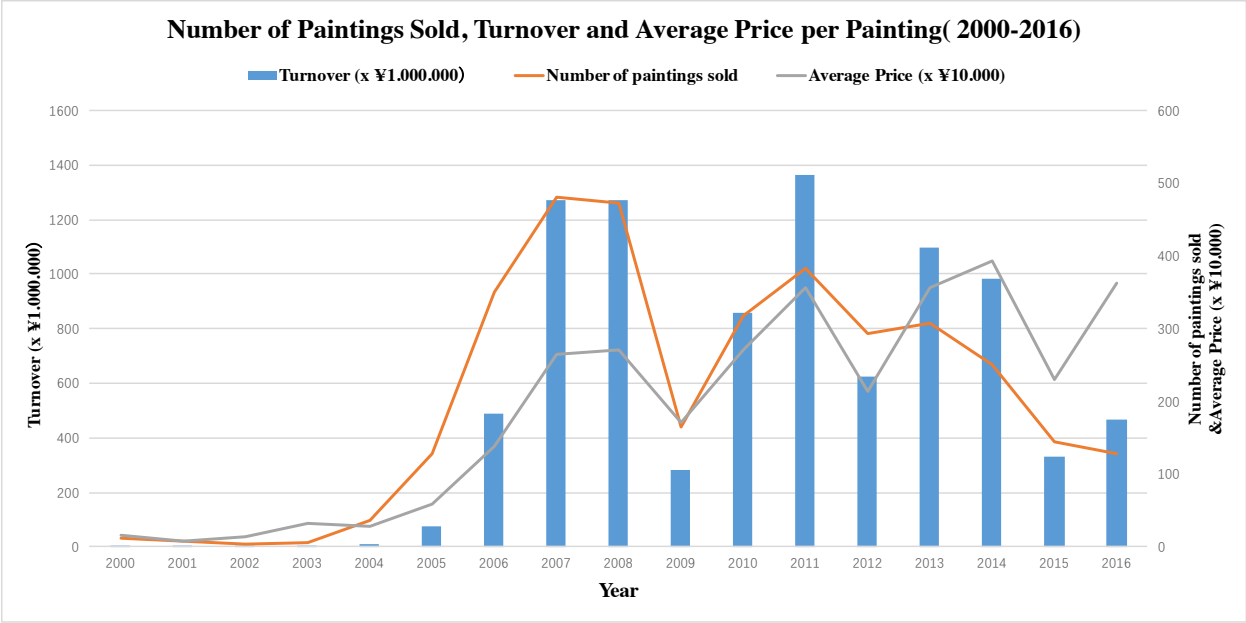
Figure 2: Number of Paintings Sold, Turnover and Average Price per Painting (2000-2016)

The charts in Figure 3 show the number of paintings sold when classified by region and by auction house. Hong Kong is the major marketplace for Chinese contemporary art, consisting 53% share of the market, and mainland China, basically Beijing and Shanghai, only takes up 39% of the market. When classified by auction houses, 63% of the auction sales of Chinese contemporary art took place in either Sotheby's or Christie's, two traditional dominators in the global art market.

Number of Paintings sold: by Region

- Mainland China(Beijing&Shanghai)
- Hong Kong
- Overseas(London&New York)

1360, 39%

1883, 53%

289, 8%
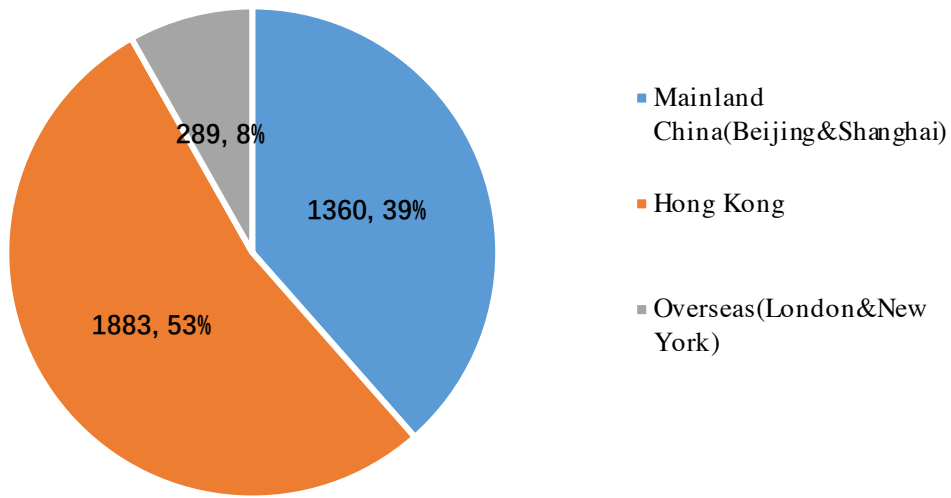
Number of Paintings sold: by Auction House

- Sotheby's & Christie's
- other

2211, 63%

1321, 37%

Figure 3: Number of Paintings sold per Region, Number of Paintings sold per Auction House.

3.3 Variables

The vital part of making a hedonic regression model is to find out the characteristics that affect the art price. Our hedonic regressions include a number of attributes related to the artwork. We denote the hedonic variables as the personal characteristics of the artists, the physical characteristics and the sales characteristics of the artwork.

ï Personal characteristics of the artist:

Artist dummy. Artist dummies are included to capture each artist's uniqueness.

ï Physical characteristics of the work:

Medium and material dummies. In this study, we focus our analysis on 2 dimensional artworks such as paintings and printings, because the physical characteristics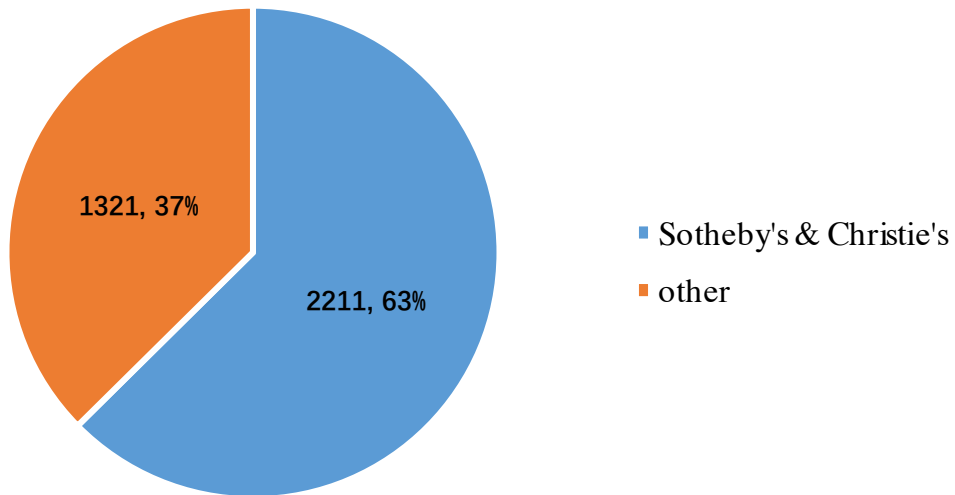 of such artworks are easier to measure. Artists use different medium (such as oil, watercolor and drawing) and material (such as canvas, paper) to make their work. Oil on canvas is the most widely-used combination of media and material. We introduce dummies for different combination categories.

Topic dummies. We categorize our artworks sample into several major topics: portrait, landscape, object and abstract. Some artists might have their preferences in choosing topics for their works. The topic of an artwork can significantly affect the aesthetic appreciation of art objects. Our observation finds out that in our data set, 80% of the artworks belong to the portrait paintings.

Size. The size of the painting is represented by the natural logarithm of the dimension, which is computed as length times height, in meters.

ï Sale characteristics of the work:

Sales date dummies. A set of semi-annually dummy variables. Most sales happen in either the Spring auction season or Autumn auction season of each year.

Auction house dummies. Separate dummy variables for each important auction house.

Period. The time interval between the time of creation and the time of sale is considered to examine the effect of time. When the work is done over a period of several years, the year of its final completion is considered as the time of creation.

For some suction records, some detailed information was missing, so we ended up with a sample of 3065 complete auction records. Those data composed our final sample for hedonic regression.

4. Empirical Results

4.1 Hedonic Pricing Model

The equation (1) was estimated using Ordinary Least Squares (OLS) regressions. In order to obtain a more precise econometric model, we employed the Hendry (1995) approach, which eliminates the least significant variable in each step until all variables are significant at a pre-specified level. By doing so, we have run regressions for several times, and omitted some variables during the process. In our final hedonic pricing model, most explanatory variables are significant at least at the 5% level, while all the time dummies are kept in our model for theoretical reasons, regardless of their significance.

The dependent variable is the natural log of the hammer sale price in CNY. The independent variables in our final model include: 1 dimension variable, 1 period variable, 2 medium dummies, 1 topic dummy, 6 auction house dummies, 33 time dummies, 17 artist dummies. In most cases, the dummy variable reflecting the "other" was left out. The exception is the artist dummy, where the sample artist Lishan was left out. In total 61 variables are used in

our sample, with 28 descriptive variables, and 33 time dummies variables. The time dummies are represented in the semiannual term, with a baseline time of 2000 Spring.

The estimated coefficients of our hedonic pricing model are displayed in Table 1. With an adjusted R^2 of 0.76, our model describes more than three fourths of the paintings' price change. However, when excluding the artist dummies, the adjusted R^2 drops to 0.56, a 20% decrease in terms of the goodness of fit of our model. Therefore, the artist dummy variables are important control variables in this hedonic model and should not be left out.

The positive sign of the dimension coefficient (0.6741) in Table 1 indicates that normally the prices of the Chinese contemporary paintings increase as the paintings become larger. Surprisingly, the regression results show that different auction houses do not have obvious price effect on art prices, since all sample auction house variables return small negative coefficients, although some of them are not significant. Specifically, unlike the situation in some other markets, artworks are not sold at a premium in Sotheby's or Christie's over artworks sold in other auction houses. This may due to the fact that the auction houses we included in the sample are major auction houses that their brand names are already considered as guarantees of quality by investors. We are also surprised to find that the time period between the creation and sale of a certain artwork does not affect art price hugely, as it only shows a coefficient of 0.0361.

The variable of oil on canvas returns an extremely high positive coefficient of 0.9408, showing that oil on canvas commands the highest price for Chinese contemporary art among all surface variables. This result is consistent with our expectation, since a great majority of artworks in our sample are painted on canvas.

The coefficients of artist variables vary from artist to artist, which imply that the title and reputation of a painter are highly relevant to the final prices of his/her artworks.

The coefficients of the time dummies allowed us to construct our art price index. Using the equation (2), we calculated the hedonic price index for Chinese contemporary art, and then employed this index to calculate semi-annual rate of returns for Chinese contemporary art.

The first column of Table 2 presents the semi-annual returns of our hedonic index from 2000 to 2016, and the Figure 4 visualizes those returns. Note that the time dummies before 2004 Fall were not significant, so the index before 2004 Fall may not be representative enough of the real performance of the art market at that time. Our hedonic index shows that Chinese contemporary art market grew dramatically from 2004 until early 2008, with an average semi-annual return of more than 30% during this period. Sharp rise also happened from late 2009 till 2011, while later the market has become more volatile. 2008 Fall witnessed a huge fall on return, with a negative return of rate at -48.38%, which coincided with the general performance of the financial market, as the art market also experienced huge contraction affected by the global financial crisis at that time. Similar situation happened in 2015, when the Chinese contemporary art market was affected by the 2015 Chinese stock market crash.
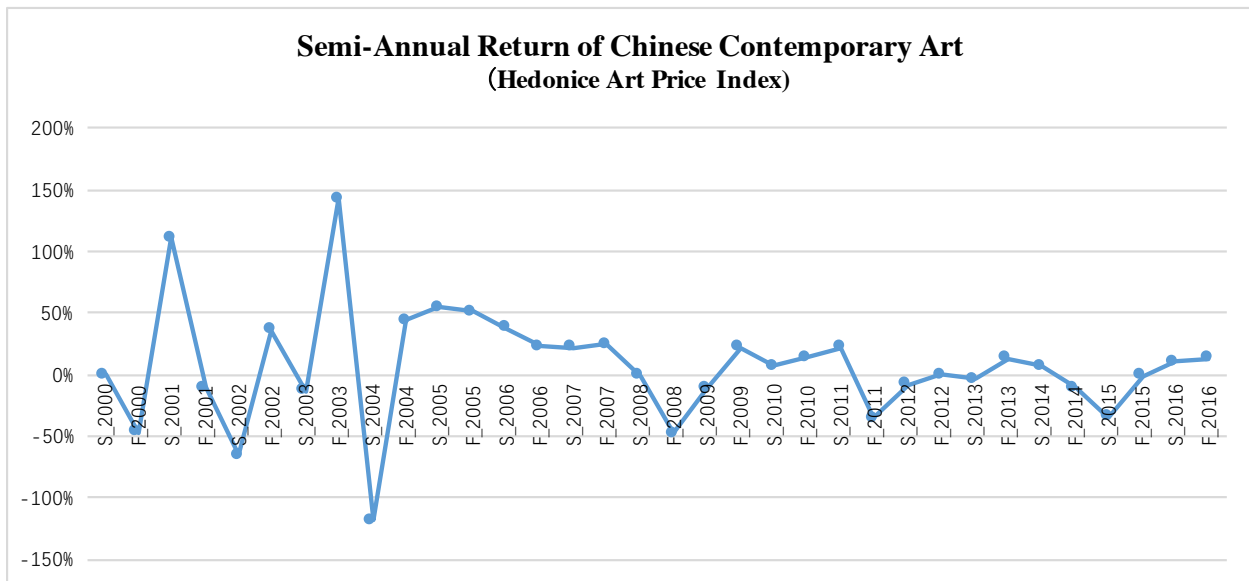
Figure 4: Return of Chinese Contemporary Art

4.2 Comparison with Other Art Indices

In order to get a more comprehensive understanding of the Chinese contemporary art market, in this section, we compare the hedonic price index with the two existing art indices: the Artron Contemporary 50 Index and the Artron Contemporary Top 18 Index. Table 2 shows the semi-annual return data in the 17-year period (2000-2016) for all three different art price indices. Our calculation shows that the repeat sales index (Artron Contemporary 50 Index) yields an average semi-annual return of slightly over 10%, while our hedonic regression index generates the lowest return of 7.16%. However, repeat sales regression only takes into account a smaller sample size, so it normally yields a higher selection bias compared with other two methodologies.

Because our hedonic index and the Artron Contemporary Top 18 Index take data from the same artist sample, these two indices have a relatively high correlation, at 0.7 level. Each of these two indices has negative correlation with the Artron Contemporary 50 Index.

The Figure 5 spots three indices together to visualize the movement of three art indices. All indices exhibited enormous growth since the base year in 2000, though all of them decreased hugely during the 2008 Financial crisis, retrieved from late 2009, and dropped again in 2012. Since 2013, the performances of these indices have differentiated a lot from each other, indicating the rising level of volatility and instability in the Chinese contemporary art market.

Performance of Art Indices, 2000-2016
Semi-annual data
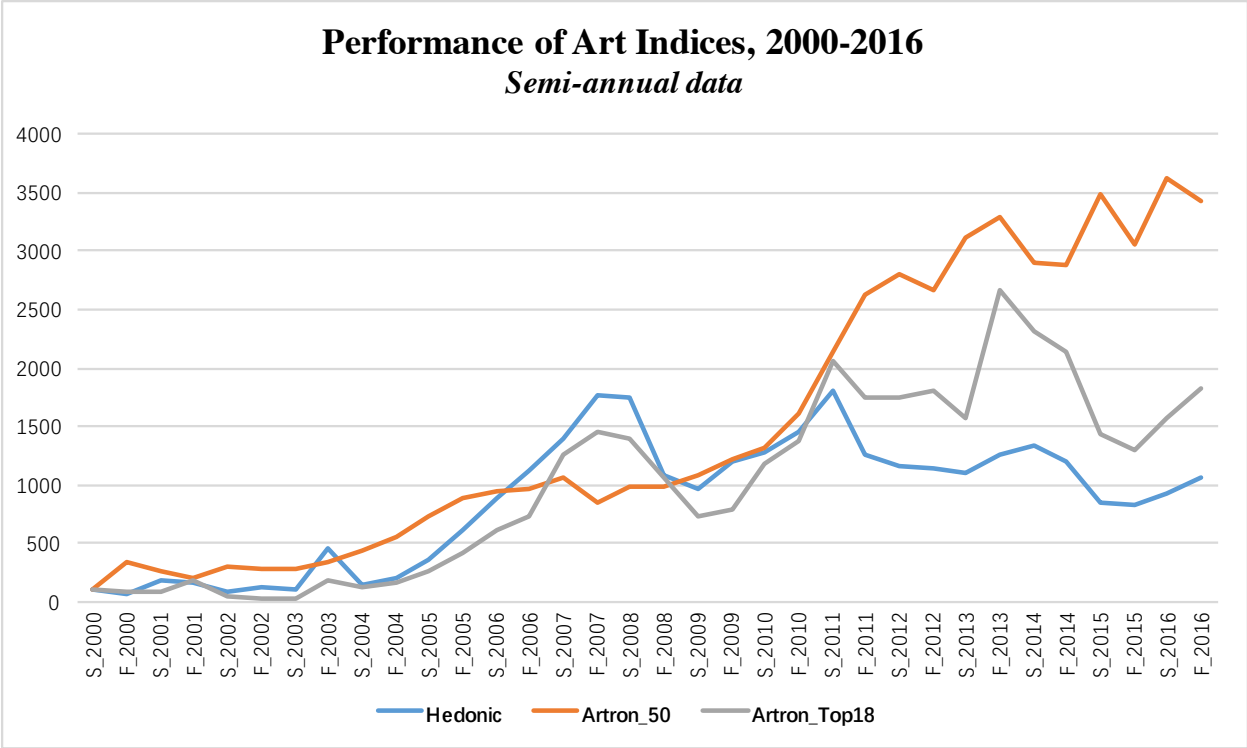
Figure 5: Performance of three Art Indices (2000-2016)

4.3 Comparison with Other Asset Classes

To find out whether art is a good investment in terms of its financial characteristics, we compared the financial performance of Chinese contemporary art with other traditional financial assets, such as stocks and bonds. For stocks, we chose Shanghai Stock Exchange(SSE) Composite Index and S&P 500 Index as proxies for China stock market and world stock market, respectively. In terms of bond market, we chose SSE T-bond Index and SSE Corp bond Index. All data are obtained from Wind and Bloomberg.

Summary statistics for the annual returns of those asset indices, their standard deviation and the correlation between each pair of assets are found in Table 3. Since the SSE Corporate Bond index was launched on June 9th, 2003, we traced the rate of return for all of these assets from 2003 to 2016. We got a comprehensive comparison on their performance from the

descriptive statistics shown in the Panel B. Among those assets, Chinese stocks yield the highest average annual return, at 19% level, and contemporary art brings an annual return of 15.23%, slightly lower than the return of Chinese stocks. However, art outperforms both Chinese T-bond and corporate bond. Chinese T-bond and corporate bond derive a 3.37& and 5.2% nominal annual return, respectively, while S&P 500 derives an average annual return of 8.16%.

Although generating a lower return than Chinese stocks, Chinese contemporary art has extremely high volatility. In fact, with a standard deviation of its return equals 0.56, art holds the highest risk among all the asset classes in our sample, which implies that one may bear very high risk when investing in Chinese contemporary art.

We then examined the correlation between each of the assets. The Panel C in Table 3 shows that art exhibits relatively low correlation with Chinese stocks (0.34), extremely low correlation with T-bond (0.08), and negative correlation with corporate bond. Thus, our preliminary results show that art can be used in a portfolio to diversify risk.

4.4 Portfolio Diversification

Hoping to determine whether investing in Chinese contemporary art can yield diversification benefits, we applied the Markowitz (1952) mean-variance optimization model and constructed an efficient frontier for different investment portfolios including and excluding art. Four assets are chosen to be included in allocation: Chinese stocks, Chinese T-bond, Chinese Corporate bond and Chinese contemporary art, and the returns of each asset's corresponding index are taken as proxies of each assets' return.

By varying the weights of different assets, we determined the portfolios with the minimum variances for several given expected returns. We did not consider long/short equity strategy in

this model because it is not applicable in the Chinese financial market. Panel C in Table 4 presents some optimal allocations for portfolio including and excluding Chinese contemporary art. In the optimal portfolio without art, T-bond is excluded in the portfolio when the expected return increases to around 6%, since T-bond bears relatively low return. When including art into the asset allocation, results show that art is only suggestive to be included in a portfolio in case of a higher expected return, at the same time a higher corresponding risk. For instance, when the expected return is 16%, the weight assigned to art is more than 20%, compared to its weight of 0.25% at a return of 7%.

Those asset allocations, with their expected returns and risk level, resulted in a mean-variance efficient frontier, of which the upper half presents the investment opportunity set. Figure 6 shows that the mean-variance efficient frontier has expanded by adding art to the portfolio, illustrating that a portfolio with Chinese contemporary art enjoys lower risk when given the same level of portfolio return. However, this shape change in efficient frontier is not huge, meaning that the diversifying effect of Chinese contemporary art is not very significant. For instance, when the expected return is 10%, adding art in a portfolio can only lead to a 0.63% decrease in risk, from 15.8% to 15.17%.

Through the mean-variance optimization model, our findings prove that art is a useful vehicle to be incorporated in the mean-variance optimal portfolio for risk diversification.
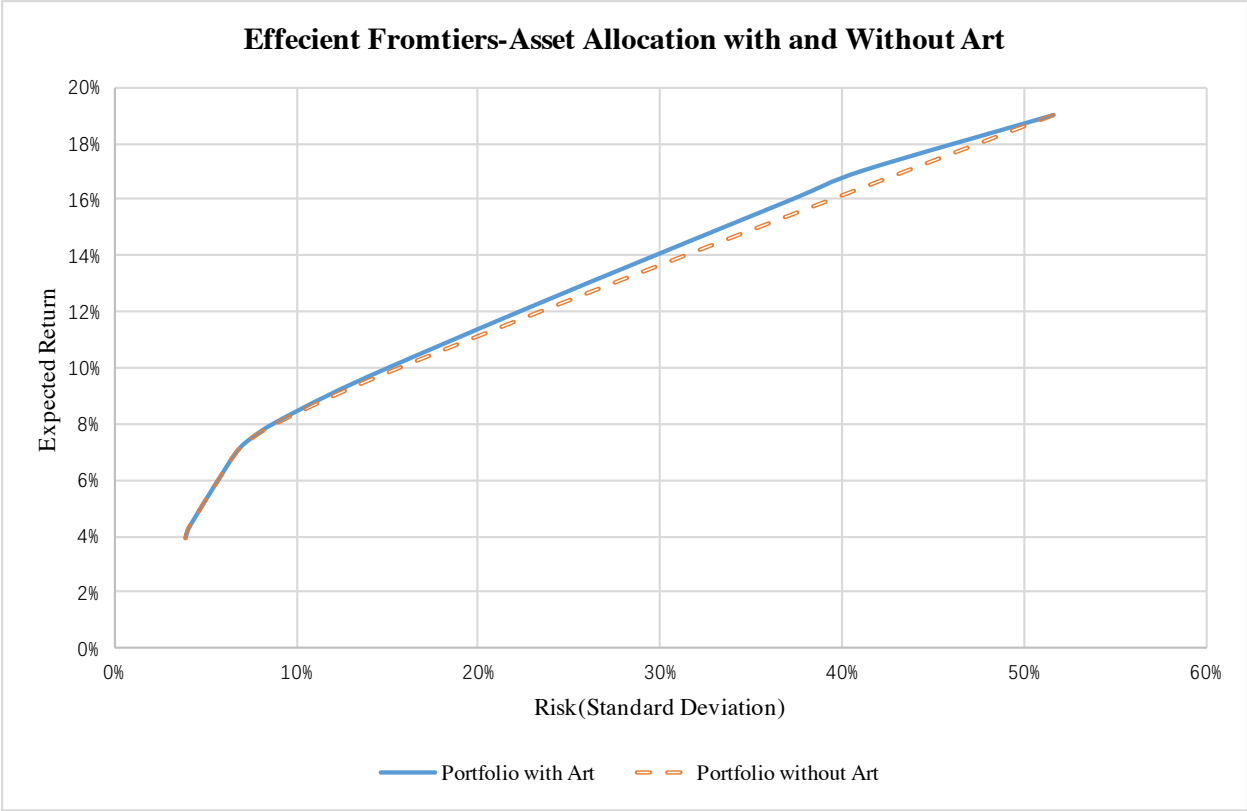
Figure 6: Efficient Frontier

5. Conclusions and Outlook

This paper collected a new data set of sales of Chinese contemporary artworks in major domestic and overseas auction houses, and constructed a semiannual art price index for the period 2000-2016 using the hedonic regression method. Based on our data set, this study came up with the following discoveries: Chinese contemporary art underperforms Chinese stocks with a lower rate of return and higher volatility, while its return is much higher than that of other fixed income securities such as the Chinese corporate bond. Our art index exhibits low and even negative correlation with indices of other assets, indicating that art is eligible to diversify risk in an investment portfolio. However, a mean-variance model further shows that the effect of risk diversification when adding Chinese contemporary art into an investment portfolio is limited.

Our findings on the risk and return characteristics of Chinese contemporary art have implications for investors and later researchers. The result is a little bit surprising, considering the extreme prosperity of the Chinese contemporary art market in the past two decades. An investor with a profit-generating purpose should be cautious to invest in Chinese contemporary art since it bears lower return but higher risk than Chinese stocks. What's more, Chinese contemporary art might not be the best asset in a portfolio for risk diversification. However, all of our findings are based on the assumption that art is solely a financial asset. In fact, art is far more than a financial asset, and this may possibly explain the rationale behind its market boom. Art is impossible to valuate, and many investors now may buy Chinese contemporary art mainly for its aesthetic return, because the aesthetic pleasure one may get from art is priceless, and such pleasure could outweigh any potential financial benefit.

We would like to note that our findings could be biased due to sample selection. Also, all return statistics are presented in the nominal term, without the adjustment for inflation. Other limitations of our study lie in the methodology we use, since the hedonic regression method has some drawbacks that cannot be omitted.

For researchers, further research with Chinese contemporary art can be done in a number of areas. It would be interesting to see how the behavior of Chinese contemporary art market connects with other emerging art markets such as India and Middle East, as well as the global contemporary art market. Also, comparisons can be made among the states of different art segments, including modern art and ancient Chinese art, within the Chinese market. With continuous development of the Chinese art market, we hope more research can be done toward art investment, and our research may provide a basis for relevant studies in the future.

6. Appendices

Table 1: Hedonic Model (2000-2016)

Variables	Coef.	Signif.	Std. Err.	t	P>t	[95% Conf.	Interval]
Ln(Price)							
Ln(Dimension)	0.6741	***	0.0124	54.3800	0.0000	0.6497	0.6984
Period	0.0361	***	0.0025	14.3500	0.0000	0.0311	0.0410
Oil on Canvas	0.9408	***	0.0620	15.1800	0.0000	0.8193	1.0624
Lithography&Printing	-2.2753	***	0.0807	-28.1800	0.0000	-2.4337	-2.1170
Portrait	0.2261	***	0.0436	5.1900	0.0000	0.1407	0.3116
Poly auction house	-0.0800		0.0734	-1.0900	0.2760	-0.2239	0.0640
Guardian auction house	-0.2090	**	0.0841	-2.4900	0.0130	-0.3739	-0.0441
Council auction house	-0.2120	**	0.0865	-2.4500	0.0140	-0.3817	-0.0424
Hanhai auction house	-0.2536	***	0.0901	-2.8100	0.0050	-0.4303	-0.0769
Sotheby's China	-0.1663	**	0.0707	-2.3500	0.0190	-0.3049	-0.0277
Christie's China	-0.2187	***	0.0712	-3.0700	0.0020	-0.3583	-0.0792
F_2000	-0.4679		0.5067	-0.9200	0.3560	-1.4613	0.5256
S_2001	0.6376		0.5928	1.0800	0.2820	-0.5247	1.8000
F_2001	0.5294		0.5936	0.8900	0.3720	-0.6344	1.6933
S_2002	-0.1247		0.4583	-0.2700	0.7860	-1.0234	0.7739
F_2002	0.2319		0.5081	0.4600	0.6480	-0.7645	1.2282
S_2003	0.0945		0.4597	0.2100	0.8370	-0.8069	0.9958
F_2003	1.5214	**	0.5928	2.5700	0.0100	0.3591	2.6837
S_2004	0.3315		0.4042	0.8200	0.4120	-0.4611	1.1241
F_2004	0.7650	**	0.3043	2.5100	0.0120	0.1683	1.3618
S_2005	1.3056	***	0.2925	4.4600	0.0000	0.7320	1.8792
F_2005	1.8126	***	0.2823	6.4200	0.0000	1.2590	2.3661
S_2006	2.1915	***	0.2761	7.9400	0.0000	1.6501	2.7328
F_2006	2.4174	***	0.2733	8.8400	0.0000	1.8815	2.9534
S_2007	2.6317	***	0.2733	9.6300	0.0000	2.0958	3.1677
F_2007	2.8754	***	0.2753	10.4400	0.0000	2.3356	3.4152
S_2008	2.8645	***	0.2735	10.4700	0.0000	2.3283	3.4008
F_2008	2.3808	***	0.2754	8.6400	0.0000	1.8408	2.9208
S_2009	2.2607	***	0.2855	7.9200	0.0000	1.7009	2.8205
F_2009	2.4780	***	0.2812	8.8100	0.0000	1.9266	3.0295
S_2010	2.5446	***	0.2765	9.2000	0.0000	2.0024	3.0868
F_2010	2.6797	***	0.2752	9.7400	0.0000	2.1401	3.2193
S_2011	2.8937	***	0.2752	10.5100	0.0000	2.3540	3.4334
F_2011	2.5328	***	0.2748	9.2200	0.0000	1.9940	3.0715
S_2012	2.4464	***	0.2769	8.8300	0.0000	1.9034	2.9893
F_2012	2.4435	***	0.2771	8.8200	0.0000	1.9001	2.9868
S_2013	2.4018	***	0.2782	8.6300	0.0000	1.8563	2.9472
F_2013	2.5336	***	0.2759	9.1800	0.0000	1.9926	3.0746
S_2014	2.5968	***	0.2779	9.3400	0.0000	2.0520	3.1417
F_2014	2.4883	***	0.2793	8.9100	0.0000	1.9407	3.0358
S_2015	2.1384	***	0.2859	7.4800	0.0000	1.5778	2.6990
F_2015	2.1283	***	0.2842	7.4900	0.0000	1.5710	2.6855
S_2016	2.2321	***	0.2865	7.7900	0.0000	1.6704	2.7939
F_2016	2.3635	***	0.2847	8.3000	0.0000	1.8052	2.9218
Artist_ZFZ	1.5108	***	0.0830	18.2000	0.0000	1.3480	1.6736
Artist_WGY	1.6304	***	0.0855	19.0700	0.0000	1.4628	1.7981
Artist_LY	1.4616	***	0.0918	15.9300	0.0000	1.2817	1.6416
Artist_LZL	0.6550	***	0.0905	7.2400	0.0000	0.4776	0.8324
Artist_ZXG	0.3041	***	0.0879	3.4600	0.0010	0.1318	0.4764
Artist_FLJ	1.1662	***	0.0929	12.5600	0.0000	0.9840	1.3483
Artist_YMJ	1.1711	***	0.0924	12.6700	0.0000	0.9900	1.3523
Artist_LXD	0.8695	***	0.0969	8.9700	0.0000	0.6794	1.0596
Artist_LW	1.0043	***	0.0846	11.8700	0.0000	0.8383	1.1702
Artist_QZL	-0.2171	*	0.1111	-1.9500	0.0510	-0.4350	0.0008
Artist_YSB	-0.0416		0.0964	-0.4300	0.6660	-0.2305	0.1474
Artist_ZH	-0.8510	***	0.1366	-6.2300	0.0000	-1.1188	-0.5831
Artist_YZY	-0.1300		0.0992	-1.3100	0.1900	-0.3245	0.0645
Artist_FZJ	-0.5913	***	0.1072	-5.5100	0.0000	-0.8015	-0.3810
Artist_YPM	0.2815	*	0.1470	1.9200	0.0550	-0.0066	0.5697
Artist_GJ	-1.2755	***	0.1054	-12.1000	0.0000	-1.4822	-1.0688
Artist_ZCY	0.5481	***	0.0835	6.5700	0.0000	0.3844	0.7117
_cons	3.3411	***	0.3103	10.7700	0.0000	2.7327	3.9496
Number of Obs	3065						
F(61,3003)	161.95						
Prob > F	0.0000						
R-squared	0.7669						
Adj R-squared	0.7621						
Root MSE	0.74689						

*,**,*** denote significance at the 10%, 5%, 1% levels, respectlvely.

Table 2: Comparison among art indices

Panel A *Semi-annual return data 2000-2016*

	Hedonic Index	Artron_50	Artron_Top18
S_2000	0.00%	**0.00%**	**0.00%**
F_2000	-46.79%	120.32%	-17.79%
S_2001	110.55%	-23.30%	4.21%
F_2001	-10.82%	-25.18%	72.69%
S_2002	-65.42%	41.74%	-122.60%
F_2002	35.66%	-7.44%	-52.99%
S_2003	-13.74%	1.14%	0.00%
F_2003	142.69%	17.00%	175.48%
S_2004	-118.98%	24.48%	-41.94%
F_2004	43.35%	22.12%	34.22%
S_2005	54.05%	27.58%	44.23%
F_2005	50.70%	21.07%	49.13%
S_2006	37.89%	6.11%	35.90%
F_2006	22.60%	1.31%	18.54%
S_2007	21.43%	10.36%	54.42%
F_2007	24.36%	-22.56%	14.18%
S_2008	-1.09%	14.61%	-4.67%
F_2008	-48.38%	0.30%	-26.08%
S_2009	-12.00%	7.93%	-38.20%
F_2009	21.73%	12.53%	7.19%
S_2010	6.66%	8.29%	40.22%
F_2010	13.51%	19.39%	15.48%
S_2011	21.40%	28.49%	40.85%
F_2011	-36.10%	20.51%	-16.89%
S_2012	-8.64%	6.63%	0.73%
F_2012	-0.29%	-4.80%	3.24%
S_2013	-4.17%	15.43%	-14.33%
F_2013	13.19%	5.60%	52.73%
S_2014	6.32%	-12.81%	-13.50%
F_2014	-10.86%	-0.92%	-8.20%
S_2015	-34.99%	19.31%	-40.32%
F_2015	-1.01%	-13.21%	-9.40%
S_2016	10.39%	16.94%	18.54%
F_2016	13.14%	-5.33%	15.39%

Panel B.

	Hedonic Regression Hedonic Index	Repeat Sales Artron_50	Weighted-Average Artron_Top18
average semiannual return	7.16%	10.72%	8.80%
Standard Deviation	0.47	0.25	0.49
skew	0.32	2.48	0.67
kurt	2.70	10.71	4.43
max	142.69%	120.32%	175.48%
min	-118.98%	-25.18%	-122.60%

Panel C. Correlation Matrix

	Hedonic Index	Artron_50	Artron_Top18
Hedonic Index	1		
Artron_50	-0.28	1	
Artron_Top18	0.70	-0.14	1

Table 3: Comparison among financial assets

Panel A *Annual return data 2003-2016*

	SSE Composite Stock	SSE T-bond	SSE Corp Bond	Hedonic Index	S&P 500
2003	11.58%	-2.22%	-4.17%	128.95%	15.07%
2004	-14.07%	-3.81%	-4.09%	-75.63%	10.87%
2005	-5.82%	14.06%	24.08%	104.75%	2.29%
2006	130.96%	2.14%	0.77%	60.49%	9.89%
2007	97.97%	-0.46%	-5.49%	45.80%	-0.53%
2008	-64.89%	9.40%	17.11%	-49.46%	-41.53%
2009	82.63%	0.87%	0.68%	9.73%	26.48%
2010	-12.84%	3.21%	7.42%	20.17%	11.06%
2011	-20.22%	4.05%	3.50%	-14.69%	-2.39%
2012	5.83%	3.35%	7.49%	-8.93%	12.24%
2013	-3.88%	2.74%	4.36%	9.02%	28.50%
2014	57.95%	4.42%	8.73%	-4.54%	16.59%
2015	11.15%	6.09%	8.84%	-36.00%	5.95%
2016	-10.50%	3.39%	6.04%	23.52%	19.76%

Panel B.

	SSE Composite Stock	SSE T-bond	SSE Corp Bond	Hedonic Index	S&P 500
Observations	14	14	14	14	14
Artihm.mean	18.99%	3.37%	5.38%	15.23%	8.16%
Median	0.97%	3.28%	5.20%	9.37%	10.97%
Maximum	130.96%	14.06%	24.08%	128.95%	28.50%
Minimum	-64.89%	-3.81%	-5.49%	-75.63%	-41.53%
S.D	0.54	0.05	0.08	0.56	0.17
Skewness	0.84	0.82	0.83	0.56	-1.98
Kurtosis	0.17	1.54	0.92	0.22	5.69
standard error	0.14319785	0.012072485	0.021819481	0.150141062	0.045291244

Panel C. Correlation Matrix

	SSE Composite Stock	S&P 500	SSE T-bond	SSE Corp Bond	Hedonic Index
SSE composite	1				
S&P 500	0.39	1			
SSE T-bond	-0.34	-0.45	1		
SSE Corp Bond	-0.47	-0.41	0.97	1	
Hedonic Index	0.34	0.25	0.08	-0.01	1

Table 4: Markowitz portfolio optimization model

Panel A.

	Return(μ)	S.D. (δ)	Slope (μ/δ)
Stock	18.99%	53.58%	0.354411753
T-bond	3.37%	4.52%	0.746842813
Corp Bond	5.38%	8.16%	0.66
Chinese Contempoary Art	15.23%	56.18%	0.271033946

Panel B. Covariance

	Stock	T-bond	Corp Bond	Art
Stock	0.26657	-0.00771	-0.01893	0.09544
T-bond	-0.00771	0.00189	0.00331	0.00177
Corp Bond	-0.01893	0.00331	0.00619	-0.00030
Art	0.09544	0.00177	-0.00030	0.29305

Panel C. Portfolio Allocation

Optimal Portfolios without Chinese Contemporary Art

Stock	T-bond	Corp Bond	Return	S.D.	Slope
3.38%	96.62%	0.00%	3.90%	3.96%	0.985
5.29%	94.71%	0.00%	4.20%	4.09%	1.027
5.99%	84.49%	9.52%	4.50%	4.36%	1.032
6.63%	73.81%	19.57%	4.80%	4.64%	1.035
7.05%	66.69%	26.26%	5.00%	4.82%	1.037
8.17%	47.76%	44.07%	5.53%	5.33%	1.038
9.16%	31.10%	59.75%	6.00%	5.78%	1.037
11.93%	0.00%	88.07%	7.00%	6.79%	1.030
15.60%	0.00%	84.40%	7.50%	7.69%	0.975
19.27%	0.00%	80.73%	8.00%	8.97%	0.892
26.62%	0.00%	73.38%	9.00%	12.18%	0.739
33.96%	0.00%	66.04%	10.00%	15.80%	0.633
48.66%	0.00%	51.34%	12.00%	23.51%	0.510
63.35%	0.00%	36.65%	14.00%	31.47%	0.445
78.04%	0.00%	21.96%	16.00%	39.52%	0.405
100.00%	0.00%	0.00%	18.99%	51.63%	0.368

Optimal Portfolios with Chinese Contemporary Art

Stock	T-bond	Corp Bond	Art	Return	S.D.	Slope
3.38%	96.62%	0.00%	0.00%	3.90%	3.96%	0.985
5.29%	94.71%	0.00%	0.00%	4.20%	4.09%	1.027
5.99%	84.49%	9.52%	0.00%	4.50%	4.36%	1.032
6.63%	73.81%	19.57%	0.00%	4.80%	4.64%	1.035
7.05%	66.69%	26.26%	0.00%	5.00%	4.82%	1.037
8.17%	47.76%	44.07%	0.00%	5.53%	5.33%	1.038
9.16%	31.10%	59.75%	0.00%	6.00%	5.78%	1.037
11.75%	0.00%	88.01%	0.25%	7.00%	6.79%	1.030
14.46%	0.00%	83.97%	1.57%	7.50%	7.64%	0.981
17.17%	0.00%	79.93%	2.90%	8.00%	8.83%	0.906
22.60%	0.00%	71.85%	5.55%	9.00%	11.81%	0.762
28.03%	0.00%	63.77%	8.21%	10.00%	15.17%	0.659
38.88%	0.00%	47.61%	13.52%	12.00%	22.37%	0.536
49.73%	0.00%	31.45%	18.82%	14.00%	29.80%	0.470
60.58%	0.00%	15.29%	24.13%	16.00%	37.34%	0.429
100.00%	0.00%	0.00%	0.00%	18.99%	51.63%	0.368

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