Investment in art companies: a proxy for physical art?

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Abstract

An equally-weighted basket of six quoted companies related to art is created and compared with three hedonic art indices built using more than 75000 auction sales for 99 artists. We find that returns of art-related equities are not directly linked to returns of median and top prices of physical art, but are positively correlated to returns of the 5% cheapest artworks. They are also positively correlated to changes in volumes at auction, once a 6 months lag is taken into account. The basket is then included when calculating the optimal portfolios for a rolling window of size 500 trading days using a new approach based on GARCH filtering and R-Vine copulae. Such optimal portfolio can be seen as an ideal investment from an ex-post point of view. We find that art-related companies brought no diversification benefits during the banking crisis of 2008-2009, but were of interest in 2009-2012, during the European debt crisis. These patterns closely follow evolution of exchanged volumes of art at auction. We conclude that an investment in art companies offers exposure to volumes in the art market, but not to the price levels of physical art.

Keywords: portfolio diversification, hedonic regression, art investment, art stocks
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1 Introduction

The question of "art as an investment" has frequently been debated. Attempts to know whether or not art is something worth investing in has led to disparate results. Baumol (1986) initially concluded that *"art is a floating crap game"*, Goetzmann (1993) reaffirmed that risks taken by an art investment are not compensated enough by financial returns, while Worthington and Higgs (2004) found no diversification benefit of art in a Markowitz mean-variance efficient portfolio. Renneboog and Spaenjers (2013) also concluded that art is not an investment that can possibly beat the expected return of equities. On the contrary, Buelens and Ginsburgh (1993) highlighted the fact that returns depend on art movements and that some of them can significantly outperform equity and bond markets. Mei and Moses (2002) stated that art as a whole is attractive for portfolio diversification. Hodgson and Vorkink (2004) found that Canadian art brings diversification benefits to a Canadian equity portfolio. Oosterlinck (2011) demonstrated the important role played by art as a safe haven during Nazi occupation in France. He showed that art was in high demand and outperformed most asset classes (excepted gold) during the war. In particular, smaller artworks outperformed larger ones that were harder to hide or carry, revealing the pragmatic approach of investors to art as a physical asset. The notion of "investment in art" is a synonym for speculation: since a painting or a sculpture does not yield a significant financial dividend or revenue of some sort, but only an aesthetic dividend (Mandel, 2009), the hopeful investor can only buy an artwork with the view of selling it at a higher price. Investing in art is not straightforward: in addition to authenticity risks (Bocart and Oosterlinck, 2011) transaction fees can be as much as 25% of the value of an object sold at auction (Ashenfelter and Graddy, 2003). This is rather significant, especially when considering unattractive expected long term returns of an investment in art (+3.97% per year according to Renneboog and Spaenjers, 2013). Nevertheless, diversified financial vehicles exposed to art exist, such as art funds, probably the closest form of a diversified art portfolio an investor can purchase. One of the main advantages of art funds is that they can possibly benefit from valuable insider information, in a fashion similar to art dealers. Unfortunately, their diversification strategies are rarely disclosed, let alone the artworks held by these vehicles. Liquidity of art funds can also be an issue, since they are not always quoted on stock exchanges. Another method for the rational investor to catch some diversification benefits related to the art market could be to invest in listed art-related companies. These securities are readily accessible, they are liquid and transaction costs are truly negligible, at least compared to the standards of the art market. However, little is known as to the real benefits of investing in a basket of art-related companies. Our goal in this paper is to further investigate the diversification benefits of liquid, publicly

traded corporations whose business is closely related to the art market. In the next sections, we investigate how art-related shares are linked to art prices, and how they behaved in a period ranging from October 2001 to October 2012. In particular, we want to know if these companies were of any interest from a diversification perspective during two consecutive financial crises. We describe a strategy genuinely available to an investor who has the possibility to allocate funds between equity and bond indices, energy commodities, agricultural commodities and an art-composite index easily constructible using art-related equities. Our method to investigate the appropriateness of shares of art companies as a diversification tool during the last decade is comparable to the one that Goetzmann and Ukhov (2006) used for foreign British investments: by construction, an "optimal" portfolio can be seen as an ideal investment from an ex-post point of view. Focusing on the financial crisis, we can interpret that an increase in the weight of art stocks in an "optimal" asset allocation during the crisis would reveal that art-related companies were a good diversification tool against distress. On the other hand, a drop in the weight of art companies in an optimal asset allocation as compared to other financial assets during the crisis would reveal that art-related stocks were not effective diversification tools in case of financial distress and did not share the expected benefits of physical art. The next section presents data we use in this study and introduces the methodology. Section 3 presents the empirical results we have obtained with the method. The last section presents our conclusions.

2 Data and methodology

In order to study investment in art-related companies, we opt to construct a composite index with equal weights of public companies that openly disclose their financial exposure to visual arts: artnet, artprice.com, Sotheby's, Weng Fine Art, Art Vivant and Seoul Auction (all converted in U.S. dollars) explicitly mention their exposure to the art market in their annual reports. The rationale behind constructing an index rather than considering each stock individually is that we want to appreciate the general performance of "art stocks" in a diversified portfolio, and not a given stock in particular.

These six companies are quoted daily on national exchanges. Other peers active in the market for collectibles, such as Noble Investment PLC, Collectors Universe or Stanley Gibbons Group Ltd were discarded because of their low exposure to visual arts. Out of the six companies used to build the art composite index (ACI), only four were listed in October 2001: artprice.com, artnet, Sotheby's and Art Vivant. Seoul Auction was first listed on the Korea Exchange in August 2008 while Weng Fine Art was listed on the Deutsche Borse in January 2012. Artprice.com and artnet are two European companies providing databases of art auction prices. In 2011, both companies

also started online art auction services. Sotheby's is an auction house active internationally. It sold its real estate unit, "Sotheby's International Realty", in 2004. Art Vivant is a Japanese company that manages a gallery network and sells prints, oil and watercolor, carvings, and glass works. Seoul Auction is an auction house specialist in Korean art. Weng Fine Art operates as an art dealer. Its website states that it purchases with an annual budget of about 10 million euros more than 1,000 works of art every year. Its focus of trade is around 500 well-known artists of the 20th Century, such as Picasso, Matisse, Warhol, Lichtenstein and Hirst. Table 1 presents key financial figures for each company constituting the index.

Table 1: Financial information on the companies constituting the basket

	artprice.com	artnet	Sotheby's	Art Vivant	Seoul Auction	Weng Fine Art
Turnover 2011 (mUSD)	6.75	17.27	831.00	44.37	13.24	8.44
Net Income 2011 (mUSD)	0.12	0.04	171.00	10.25	- 0.03	0.99
Market Capitalization 29-10-2012 (mUSD)	304.91	31.01	2,086.00	30.96	48.37	54.91

The index is equally weighted on the 29th of October, 2001 and rebalanced every 30 trading days. Rebalancing is necessary to avoid a situation in which a single stock would constitute too large a share of the index. Blume and Stambaugh (1983) discussed the long term bias related to portfolio rebalancing. Since in our case the index is rebalanced only every 30 days and we consider limited periods of 500 trading days, this effect is largely negligible and does not significantly impact on our results[1]. This "art composite index" (ACI) is compared with world government bonds, world credit bonds, world equities, agricultural commodities, energy commodities, companies active in the real estate business and gold, all denominated in U.S. dollars. The study covers a period of eleven years ranging from the 29th of October, 2001 to the 29th of October, 2012. We have selected this combination of dates because it is the one that maximized the amount of available data for a sample of 11 years at the time of data collection. Financial data are provided by Thomson Reuters Datastream. We use the Citigroup World Government Bond Index (converted in U.S. dollar), the Citigroup World Big Corporation Bond Index, the MSCI World Equity Index, the S&P GSCI Agricultural Index Spot (a basket of agricultural commodities) the S&P GSCI Energy Spot (a basket of energy commodities), the Gold spot price per fine ounce from the Bank of England. For real estate, we follow the same rationale as for art, and use the MSCI World Real Estate, a basket of real-estate related stocks. We also want to describe relationships between art-related companies and the underlying physical art market. To achieve this purpose, we build a semi-annual physical art index: we use 75,763 sold lots at auction, coming from Tutela Capital S.A.'s[2] database. The sales concern 99 artists

[1] the following robustness checks have been performed: computing ACI with and without rebalancing, with and without Weng Fine Art, and using Sotheby's only. In all cases, conclusions are unchanged

[2] a company specialized in art as an investment

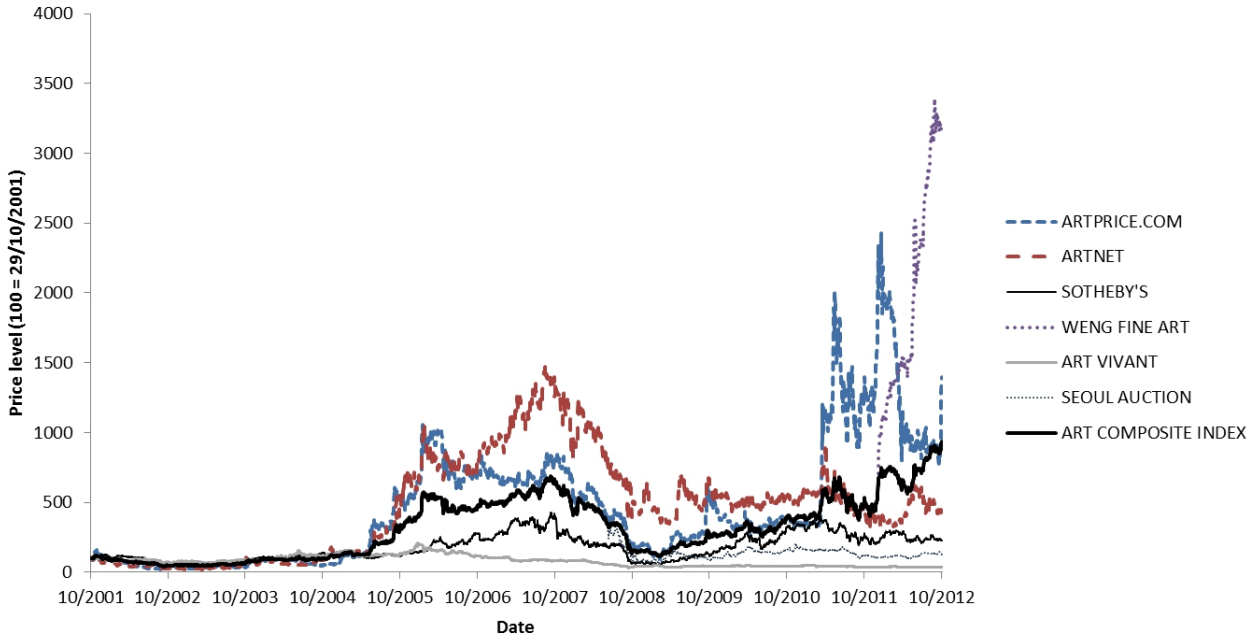

Figure 1: Six quoted companies constitute the Art Composite Index

arbitrarily selected to cover the main segments of the art market: old masters, impressionism, post-impressionism, modern art and contemporary art, all gathered in a single art index. Different methods exist to construct art indices based on data collected at auction. Buelens and Ginsburgh (1993) derived an art index using a hedonic regression methodology. The goal of hedonic regression is to regress the logarithm of the price of each artwork on its characteristics in order to extract the marginal impact of time on returns. Mei and Moses (2002) built an art index using a particular case of hedonic regression in which artworks are organized by pairs of resold artworks. This nested case is generally called the Repeat Sales Regression (RSR).

Ordinary Least Squares (OLS) is frequently used to estimate art indices. However, the estimation based on it is not immune to criticisms: Collins et al. (2009) introduced a method to correct for sample selection bias linked to reserve prices and time instability of parameters. Scorcu and Zanola (2010) presented a quantile hedonic regression to take into account the segmentation of the market according to price level. Jones and Zanola (2011) have shown that in case of heteroskedasticity, a retransformation bias must be corrected when using OLS. Hodgson (2011) used Bickel's semi-parametric approach to correct for violation of normality assumption. Nahm (2010) modified the linear form of the hedonic regression by including a partially linear component that is estimated non-parametrically. Bocart and Hafner (2011) presented a

semi-parametric estimator of functional art returns based on a generalized Nadaraya-Watson estimator. Bocart and Hafner (2012) showed that volatility as estimated from OLS-based hedonic indices is biased. They offer a Kalman-filtering approach to estimate returns and volatility of an investment in heterogeneous goods.

Since we desire to summarize relationships between art companies and price segments in the art market, we select Scorcu and Zanola (2010) quantile approach to compute the art index. We compute three hedonic art indices, for quantiles 5%, 50% and 95%. Table 2 presents variables used in the model and their corresponding coefficients from the quantile regressions and the OLS regression. Table 3 shows the estimates of time dummy variables from the regressions.

In a second stage, we want to assess the appropriateness of holding a composite index of art stocks in a financial portfolio. When constructing an "optimal" portfolio, a typical framework for it is the Mean-Variance model proposed by Markowitz (1952), which characterizes portfolio return with expected return and portfolio risk with variance. However, since employing variance as a proxy for risk is valid only for normally distributed returns, it was necessary that variance should be replaced with an appropriate risk measure considering the non-normal and fat-tailed nature of financial random variables such as bonds and equities. After the pioneering work of Uryasev and Rockafellar (2002), Conditional Value at Risk (CVaR) has been spotlighted as a useful risk measure due to its attractive features: it inherits most advantages of VaR and is a coherent measure of risk. Hence, we apply the Mean-CVaR model for portfolio optimization, which finds the tradeoff between the expected return and the risk characterized by CVaR.

To find the optimal asset allocation in the Mean-CVaR model, we should generate a random sample of moderate size drawn from the distribution of a multivariate time series which is assumed to represent the distinctive feature of the assets of interest. For such purpose, we consider the copula-GARCH model, which models each marginal time series using GARCH models and combines each time series by considering a certain copula, which links the innovations of each marginal time series together. This model has been popularly used nowadays in financial applications because it is able to capture not only asymmetric co-movements thanks to the copula part, but also marginal univariate features such as excess kurtosis and volatility clustering due to the GARCH modeling part. Specifically, the method is formally structured in the following way:

- For each asset return $R_{j,t}$ (j is an index for denoting an asset), we fit a GARCH(1,1) model of the form $R_{j,t} = \mu + h_{j,t}\,\epsilon_{j,t}$ with variance equations $h^2_{j,t} = \alpha_{j,0} + \alpha_{j,1} R^2_{j,t-1} + \beta_{j,1} h^2_{j,t-1}$ and obtain the residuals $\hat{\epsilon}_{j,t}$ from each marginal time series.

- As we are not interested in parametric models for the marginal distributions of $\epsilon_{j,t}$, all

residuals are transformed into uniform ones by means of the empirical probability transform, *i.e.*

$$\hat{U}_{j,t} = \hat{F}_j(\hat{\epsilon}_{j,t}) \ \text{ with } \hat{F}_j(x) = \frac{\{\#\hat{\epsilon}_{j,t} \,|\, \hat{\epsilon}_{j,t} \leq x\}}{\#\hat{\epsilon}_{j,t}}.$$

– Using the transformed residual $\hat{U}_{j,t}$, we estimate the copula function $C(U_{1,t}, \ldots, U_{p,t})$ which links $\epsilon_{1,t}, \ldots, \epsilon_{p,t}$ together and hence $R_{1,t}, \ldots, R_{p,t}$ as well. Here, p is the number of the assets of interest.

For the third step in the description, we should specify a family of copulae within which we will search for an appropriate copula linking the assets of interest. To that end, we consider a class of the regular vine copula proposed by Dissmann et al. (2013), which is a flexible construction that models multivariate dependence with a cascade of bivariate copulae (In our analysis, we use six kinds of bivariate copulae, which are Gaussian, Student t, Clayton, Gumbel, Frank and Joe copulae).

Once the appropriate copula-GARCH model is estimated, we find the efficient frontier of asset allocations in the Mean-CVaR model following the method of Uryasev and Rockafellar (2002). Suppose that we generate a collection of n possible scenarios of $\mathbf{R}_t = (R_{1,t}, \ldots, R_{p,t})^\top$ at time t using the estimated copula-GARCH model, which we denote by $\{\mathbf{R}_t^1, \ldots, \mathbf{R}_t^n\}$, and we consider CVaR at the β confidence level (in our analysis, we set $\beta = 0.95$). Then, the optimal position for each asset, $w_j \geq 0$ $(j = 1, \ldots, p)$ and $\sum_{j=1}^p w_j = 1$, is obtained through the following optimization problem:

$$\begin{aligned}
(\hat{\alpha}, \hat{\mathbf{w}}, \hat{\mathbf{u}}) = \arg\min_{\alpha, \mathbf{w}, \mathbf{u}} \quad & \alpha + \frac{1}{n(1-\beta)} \sum_{i=1}^n u_i \\
\text{subject to} \quad & \\
& \mathbf{w}^\top \mathbf{R}_t^i + \alpha + u_i \geq 0, i = 1, ..., n; \\
& u_i \geq 0, \ i = 1, \ldots, n; \\
& n^{-1} \sum_{i=1}^n \mathbf{w}^\top \mathbf{R}_t^i \geq \rho; \\
& \mathbf{w}^\top \mathbf{1} = 1; \\
& \mathbf{w} \geq 0 \ \ \text{(elementwise)};
\end{aligned}$$

where $\mathbf{u} = (u_1, \ldots, u_n)^\top$, $\mathbf{w} = (w_1, \ldots, w_p)^\top$ and ρ is the investor's expected return. Since $\hat{\mathbf{w}}$ (the optimal allocation vector), $\hat{\alpha}$ and $\hat{\mathbf{u}}$ depend on ρ, we have the efficient frontier function at

time t:

$$(\text{CVaR}_\beta(\rho), \text{Expected Returns}(\rho)) = \left(\hat{\alpha}(\rho) + \frac{1}{n(1-\beta)} \sum_{i=1}^{n} \hat{u}_i(\rho), n^{-1} \sum_{i=1}^{n} \hat{\mathbf{w}}(\rho)^\top \mathbf{R}_t^i \right).$$

Since we have to choose just one optimal allocation for our analysis, we use the STARR ratio, which was proposed by Stoyanov et al. (2007) and is defined by

$$\text{STARR}(\rho) = \frac{\text{Expected Returns}(\rho)}{\text{CVaR}_\beta(\rho)},$$

and find the ρ which maximizes the STARR ratio.

Table 2: Linear regressions: variables and coefficients

	Coefficient QR 5%	Coefficient QR 50%	Coefficient QR 95%	Coefficient OLS	p-value (OLS)			Coefficient QR 5%	Coefficient QR 50%	Coefficient QR 95%	Coefficient OLS	p-value (OLS)	
(Intercept)	8.1E+00	9.4E+00	1.2E+01	1.0E+01	0.00E+00	***	(artist)Jean Dubuffet	1.9E-02	5.7E-01	-4.7E-02	1.1E-01	1.15E-01	
height	4.3E-04	4.8E-03	1.1E-02	1.9E-03	8.08E-19	***	(artist)Joan Miro	-2.3E-01	-1.3E+00	-3.3E-02	-1.3E+00	1.56E-140	***
width	6.2E-04	8.2E-03	1.1E-02	5.1E-03	6.22E-129	***	(artist)Joseph Mallord William Turner	-1.7E-01	1.2E+00	1.9E+00	8.2E-01	1.72E-10	***
fee	4.9E-01	7.7E-01	9.8E-01	9.4E-01	0.00E+00	***	(artist)Juan Gris	5.6E-01	2.0E+00	2.5E+00	1.4E+00	1.09E-21	***
(artist)Alexej Jawlensky	2.6E-02	1.8E+00	1.6E+00	1.2E+00	3.63E-36	***	(artist)Jules Rene Herve	-1.3E+00	-1.9E+00	-3.6E+00	-2.4E+00	1.69E-213	***
(artist)Alfred Sisley	1.8E+00	3.0E+00	1.3E+00	2.3E+00	1.48E-74	***	(artist)Karel Appel	-4.5E-01	-4.0E-01	-1.6E+00	-7.5E-01	1.61E-32	***
(artist)Andre Derain	-2.1E+00	-2.1E+00	-2.0E+00	-2.2E+00	3.69E-252	***	(artist)Lucas Cranach	-8.1E-02	2.3E-01	1.9E+00	2.4E-01	1.54E-01	
(artist)Andy Warhol	-8.7E-02	-5.7E-01	3.9E-02	-5.5E-01	6.68E-33	***	(artist)Lucian Freud	2.5E-01	1.9E-01	2.0E+00	2.6E-01	6.74E-03	**
(artist)Annibale Carracci	-6.1E-01	-8.8E-02	2.0E+00	-2.9E-01	4.55E-01		(artist)Lucien Adrion	-1.1E+00	-1.7E+00	-3.1E+00	-2.1E+00	2.54E-65	***
(artist)Antoni Tapies	-3.2E-01	8.9E-02	-1.2E+00	-4.1E-01	4.69E-07	***	(artist)Marc Chagall	-1.4E-01	-8.0E-01	1.6E-01	-8.2E-01	3.51E-65	***
(artist)Arman	-6.8E-01	-1.0E+00	-2.3E+00	-1.4E+00	1.00E-141	***	(artist)Marcel Broodthaers	-1.0E-01	-8.7E-01	-1.5E+00	-1.1E+00	6.35E-10	***
(artist)Berthe Morisot	7.8E-02	6.7E-01	7.5E-01	1.8E-01	2.79E-01		(artist)Marsden Hartley	-8.4E-01	1.4E+00	1.1E+00	6.9E-01	3.51E-06	***
(artist)Camille Pissarro	-5.0E-01	-1.2E-01	1.2E+00	-7.6E-02	2.76E-01		(artist)Mary Stevenson Cassatt	-4.3E-01	-5.0E-01	9.5E-01	-7.9E-01	1.02E-13	***
(artist)Canaletto	-3.5E-01	-1.1E+00	1.7E+00	-9.0E-01	3.20E-11	***	(artist)Maurice de Vlaminck	-7.7E-02	4.5E-01	-5.0E-01	7.2E-03	9.15E-01	
(artist)Chaim Soutine	2.1E+00	2.6E+00	2.1E+00	2.2E+00	1.24E-48	***	(artist)Max Liebermann	-1.3E+00	-2.2E-01	3.6E-02	-6.1E-01	6.74E-15	***
(artist)Charles Angrand	-1.7E+00	-2.1E+00	-1.5E+00	-2.2E+00	1.71E-11	***	(artist)Max Slevogt	-1.9E+00	-9.6E-01	-1.4E+00	-1.5E+00	5.58E-18	***
(artist)Claude Monet	8.4E-01	3.5E+00	2.5E+00	2.6E+00	6.74E-142	***	(artist)Morgan Russell	-2.2E+00	-2.5E+00	-1.9E+00	-2.6E+00	3.18E-17	***
(artist)Clyfford Still	2.6E+00	3.3E+00	1.4E+00	3.4E+00	2.02E-17	***	(artist)Natalia Goncharova	-1.2E+00	-6.1E-01	-1.7E-01	-8.7E-01	4.00E-24	***
(artist)Cy Twombly	-4.7E-02	8.4E-01	4.1E-01	4.1E-01	9.93E-06	***	(artist)Nicolas de Stael	2.2E-01	8.4E-01	8.4E-01	5.9E-01	4.50E-06	***
(artist)David Hockney	-2.5E-01	-1.1E+00	-1.3E+00	-1.3E+00	1.66E-109	***	(artist)Nicolas Poussin	-2.1E+00	6.7E-01	8.7E-01	-2.5E-01	5.55E-01	
(artist)David Teniers	-6.5E-01	8.2E-01	1.6E-01	1.9E-01	1.77E-01		(artist)Odilon Redon	-1.6E-01	4.5E-01	5.4E-01	2.7E-02	7.96E-01	
(artist)Diego Rodriguez de Silva y Velasquez	7.0E-01	-6.9E-01	2.9E+00	1.9E-01	7.92E-01		(artist)Oskar Kokoschka	-6.4E-01	-3.3E-01	-2.1E-01	-5.8E-01	2.39E-08	***
(artist)Donald Judd	1.0E-01	8.8E-01	3.5E-01	4.7E-01	1.36E-07	***	(artist)Pablo Picasso	-1.7E-01	-8.1E-01	5.2E-01	-9.2E-01	7.70E-93	***
(artist)Edouard Manet	-2.6E-01	-3.4E-01	1.9E+00	-2.6E-01	8.02E-02	.	(artist)Paul Cezanne	7.0E-01	1.3E+00	2.6E+00	1.2E+00	5.04E-31	***
(artist)Edouard Vuillard	-8.5E-01	7.9E-02	4.3E-01	-3.5E-01	6.35E-06	***	(artist)Paul Gauguin	-1.5E-01	3.3E-01	1.9E+00	2.1E-01	3.31E-02	*
(artist)Edvard Munch	4.3E-02	6.2E-01	1.2E+00	4.1E-01	6.55E-06	***	(artist)Paul Klee	4.6E-01	8.7E-01	1.5E+00	4.9E-01	2.53E-09	***
(artist)Egon Schiele	2.1E-01	2.1E+00	2.5E+00	1.5E+00	2.28E-63	***	(artist)Paul Ranson	-3.9E-01	-3.4E-01	-1.2E+00	-5.3E-01	1.05E-01	
(artist)Emil Nolde	6.0E-02	8.2E-01	5.2E-01	2.2E-01	8.99E-04	***	(artist)Paul Serusier	-1.5E+00	-3.2E-01	-5.9E-01	-8.3E-01	2.45E-10	***
(artist)Emile Bernard	-1.8E+00	-1.8E+00	-1.5E+00	-2.0E+00	7.04E-73	***	(artist)Paul Signac	2.2E-03	8.5E-02	6.8E-01	-2.1E-01	4.51E-03	**
(artist)Eugene Boudin	-4.9E-01	7.5E-01	2.2E-01	4.2E-03	9.54E-01		(artist)Pavel Filonov	2.1E+00	2.2E+00	2.0E+00	1.7E+00	3.99E-03	**
(artist)Felix Vallotton	-1.9E+00	-1.6E+00	-5.9E-01	-1.7E+00	1.64E-30	***	(artist)Piero Manzoni	3.5E-01	2.0E+00	9.4E-01	1.3E+00	1.05E-30	***
(artist)Fernand Leger	-1.1E-01	7.7E-01	1.1E+00	4.7E-01	4.38E-13	***	(artist)Pierre-Auguste Renoir	-1.2E-01	1.1E+00	1.3E+00	4.1E-01	1.01E-11	***
(artist)Francis Bacon	-9.7E-02	-1.2E+00	1.5E+00	-9.2E-01	2.41E-32	***	(artist)Pierre Alechinsky	-6.9E-01	-8.9E-01	-2.3E+00	-1.1E+00	5.42E-38	***
(artist)Franz Marc	-2.7E-01	1.1E-01	1.6E+00	-1.4E-01	4.27E-01		(artist)Pierre Bonnard	-8.1E-01	-4.3E-01	9.7E-01	-3.1E-01	3.46E-05	***
(artist)Georges Braque	-2.8E-01	-9.2E-01	1.9E-01	-8.6E-01	1.28E-32	***	(artist)Piet Mondrian	5.0E-01	1.7E+00	3.0E+00	1.5E+00	7.29E-16	***
(artist)Georges Lemmen	-1.9E+00	-1.6E+00	-1.7E+00	-1.9E+00	1.36E-53	***	(artist)Raoul Dufy	-1.7E+00	-7.3E-01	-3.6E-01	-1.0E+00	5.25E-72	***
(artist)Georges Seurat	1.2E-02	2.9E+00	2.7E+00	1.8E+00	1.75E-15	***	(artist)Richard Prince	-5.9E-02	5.3E-01	-5.0E-01	1.6E-01	3.48E-02	*
(artist)Georgia O Keeffe	1.6E+00	3.0E+00	2.0E+00	2.3E+00	1.70E-26	***	(artist)Robert Delaunay	3.9E-01	6.1E-01	-2.8E-01	2.4E-01	1.69E-01	
(artist)Gerhard Richter	-6.8E-02	4.0E-01	3.2E-01	2.6E-01	5.11E-05	***	(artist)Roy Lichtenstein	-1.6E-01	-1.2E+00	-7.5E-01	-1.1E+00	5.94E-100	***
(artist)Giacomo Balla	-4.0E-01	6.0E-01	3.7E-01	3.2E-02	7.81E-01		(artist)Salvador Dali	-1.1E+00	-7.3E-01	-2.5E-01	-1.0E+00	9.94E-72	***
(artist)Gustav Klimt	4.2E-01	3.7E-01	1.0E-01	1.2E-01	1.59E-01		(artist)Sam Francis	-2.0E-01	-4.4E-01	-1.2E+00	-8.4E-01	4.92E-45	***
(artist)Gustave Caillebotte	2.8E+00	2.6E+00	2.2E+00	2.4E+00	3.60E-30	***	(artist)Sandro Botticelli	-1.1E+00	2.1E+00	2.2E+00	1.7E+00	4.65E-03	**
(artist)Hans Hofmann	-1.9E-01	2.4E-01	-9.2E-01	-1.2E-01	2.98E-01		(artist)Space Invader	-2.0E+00	-2.1E+00	-3.7E+00	-2.5E+00	2.43E-19	***
(artist)Hans Memling	3.9E+00	2.0E+00	-7.7E-01	1.4E+00	3.66E-01		(artist)Theo van Rysselberghe	-1.3E+00	-4.8E-01	-2.5E-01	-8.3E-01	1.20E-13	***
(artist)Henri de Toulouse-Lautrec	-1.7E-01	-7.4E-01	-7.8E-01	-1.0E+00	2.83E-64	***	(artist)Victor Vasarely	-6.9E-01	-5.5E-01	-2.1E+00	-1.1E+00	1.73E-64	***
(artist)Henri Fantin-Latour	-1.5E+00	1.5E-01	8.7E-01	-2.2E-01	5.92E-02	.	(artist)Vincent van Gogh	2.7E+00	3.3E+00	3.3E+00	2.9E+00	2.78E-54	***
(artist)Henri Matisse	-2.3E-02	-4.8E-01	1.0E+00	-5.2E-01	1.75E-21	***	(artist)Willem de Kooning	-1.2E-01	5.8E-01	1.4E+00	3.4E-01	1.51E-05	***
(artist)Jackson Pollock	-1.3E-01	6.1E-01	1.8E+00	3.5E-01	5.49E-02	.	(artist)Yves Klein	1.4E-01	7.9E-01	1.0E+00	3.8E-01	2.82E-05	***
(artist)Jean-Michel Basquiat	4.0E-01	1.0E+00	-4.4E-02	7.3E-01	1.05E-22	***	(artist)Zao Wou-Ki	-1.9E-01	8.0E-01	-4.6E-01	2.4E-01	1.12E-02	*
(artist)Jean Arp	-6.7E-01	-3.1E-01	2.5E-01	-5.7E-01	9.98E-09	***	(artist)Zhang Daqian	-1.2E+00	-1.1E-02	-2.6E-02	-5.2E-01	1.90E-02	*
							(support)paper	-5.6E-02	-1.3E-01	-7.7E-01	-3.2E-01	1.05E-120	***

Table 3: The estimates of the time dummy variables from the linear regressions (Base date: 1st semester 2001)

	Coefficient QR 5%	Coefficient QR 50%	Coefficient QR 95%	Coefficient OLS	p-value (OLS)	
2001 2nd semester	1.7E-02	-3.1E-01	-3.2E-01	-3.6E-01	6.0E-13	***
2002 1st semester	7.8E-02	-1.7E-01	-2.1E-01	-2.1E-01	7.6E-05	***
2002 2nd semester	5.5E-02	-1.8E-01	-4.3E-01	-3.1E-01	1.5E-10	***
2003 1st semester	1.1E-01	-3.8E-02	-1.7E-01	-1.0E-01	5.0E-02	*
2003 2nd semester	1.3E-01	-5.0E-02	-1.0E-01	-1.5E-01	1.8E-03	**
2004 1st semester	2.2E-01	1.5E-01	6.7E-02	8.3E-02	9.6E-02	.
2004 2nd semester	2.5E-01	6.5E-02	-1.8E-01	-1.1E-01	2.6E-02	*
2005 1st semester	2.2E-01	1.1E-01	1.6E-01	3.4E-02	4.7E-01	
2005 2nd semester	2.8E-01	1.2E-01	1.6E-01	9.4E-03	8.4E-01	
2006 1st semester	3.4E-01	3.9E-01	5.1E-01	3.2E-01	3.0E-11	***
2006 2nd semester	2.7E-01	2.8E-01	4.3E-01	1.2E-01	8.0E-03	**
2007 1st semester	1.5E-01	3.1E-01	9.7E-02	3.3E-02	5.1E-01	
2007 2nd semester	5.8E-02	-4.6E-02	-1.5E-01	-3.1E-01	7.6E-11	***
2008 1st semester	-3.1E-01	-3.7E-01	-2.9E-01	-6.7E-01	4.6E-35	***
2008 2nd semester	-1.7E-01	-3.3E-01	-6.4E-01	-6.5E-01	3.0E-37	***
2009 1st semester	-4.2E-02	-3.0E-02	-2.5E-01	-2.4E-01	1.2E-05	***
2009 2nd semester	-1.4E-01	-2.5E-01	-4.7E-01	-5.0E-01	1.1E-22	***
2010 1st semester	1.9E-02	5.7E-02	-2.5E-02	-6.5E-02	2.2E-01	
2010 2nd semester	-5.9E-02	-2.1E-01	-3.4E-01	-4.3E-01	3.2E-17	***
2011 1st semester	-6.1E-02	-4.1E-03	-9.1E-02	-1.5E-01	6.1E-03	**
2011 2nd semester	2.5E-02	8.8E-03	1.2E-01	-1.1E-01	7.9E-02	.

3 Empirical results

We start our analysis by estimating the correlation between the semi-annual hedonic price indices (HPI) and the financial indices, including the ACI. The goal of this analysis is to check if returns of physical art relate to financial indices. The results are displayed in Table 5. First, focus on hedonic price indices that target median and top art prices. The analysis tends to point out that correlation between returns of physical art and returns of most financial indices is close to zero. This supports the hypothesis that art as a physical asset is relatively uncorrelated to equities in general and to art-related companies in particular. Nevertheless, the correlation between the median hedonic price index and gold bullion was of +25%. This positive relationship between physical art and gold could be explained by the status of art as a safe haven against crises and inflation, a feature shared with gold. Oosterlinck (2011) alread showed evidence of such positive relationship during the second world war.

On the other hand, the HPI that focuses on the 5% cheapest artworks exhibits completely different characteristics: prices of these artworks seem to be positively correlated (+67%) with the MSCI World Real Estate. This is also expected: growth of real-estate stock may be the sign of a growing real estate market, hence growing needs to decorate newly built walls. Indeed, because they are the 5% cheapest artworks, we can possibly see this price index as one that

reflects art as a consumption good rather than a pure investment vehicle. It is known that growth in real estate is expected to positively influence demand for decoration: these results were highlighted by Hiraki et al. (2009) and Bocart et al. (2011) who drew these conclusions observing cointegration between the real estate bubble and the art bubble of the 1980s in Japan. We also observe that cheaper art is correlated to equities (+62%). This confirms the tight relationship between very affordable art and the general economy reflected by the global stock markets. The ACI is also positively correlated to cheap art, a sign that art-related companies may be more dependent on art as consumption than on expensive art as investment.

Table 4: Correlation of art-related stocks with semi-annual Hedonic Price Indices (HPI)

Correlation of semi-annual returns	HPI. Tau = 0.05	HPI. Tau = 0.50	HPI. Tau = 0.95	Δ auction volumes (6 months lag)
ACI	51%	-6%	-8%	65%
Sotheby's	48%	-4%	-6%	69%
Art Vivant	22%	21%	19%	39%
Artnet	56%	2%	1%	56%
Artprice	27%	-4%	-8%	49%

Table 4 shows the correlation of art companies constituting the ACI with the HPI[3]. Returns of individual companies exhibit a pattern similar to the composite index: no linear relationship with median and top prices, but a positive correlation with returns of lower prices. Artnet' stock returns are sensitive to the returns of the 5% cheapest works (+56% correlation). Sotheby's stock returns are also much more correlated to price level of the 5% cheapest artworks (+48%) than to the median (-4%) and top market (-6%), which can be surprising considering that the auction house generally does not accept to auction items worth less than 5000 USD. A plausible explanation is that Sotheby's turnover could be driven by cheaper artworks rather than expensive ones. Also, an increase of prices of cheaper artworks means more items to auction for Sotheby's, since more objects are more likely to pass the mark of 5000 USD, hence driving Sotheby's future volumes upward. To confirm this hypothesis that art stocks are being driven by volumes rather than prices, we include in the correlation analysis the semi-annual change, in percentage, of volumes of 99 artists sold at auction. This factor is well correlated with ACI's semi-annual returns (+65%), provided that one takes a 6 months lag into account. A reasonable explanation for this lag is that most auction sales are planned at least three to six months in advance whereas, under the efficient market hypothesis, the stock market immediately incorporates expectations of future sales in the stock prices. A first conclusion from this descriptive analysis is that the ACI and art-related companies covered by this analysis reflect more the anticipation of volumes exchanged in the art market than the general level of art prices.

As a second step of our analysis, we investigate the absolute performance of art-related

[3]Weng Fine Art and Seoul Auction are discarded because their quotation covers too few semesters

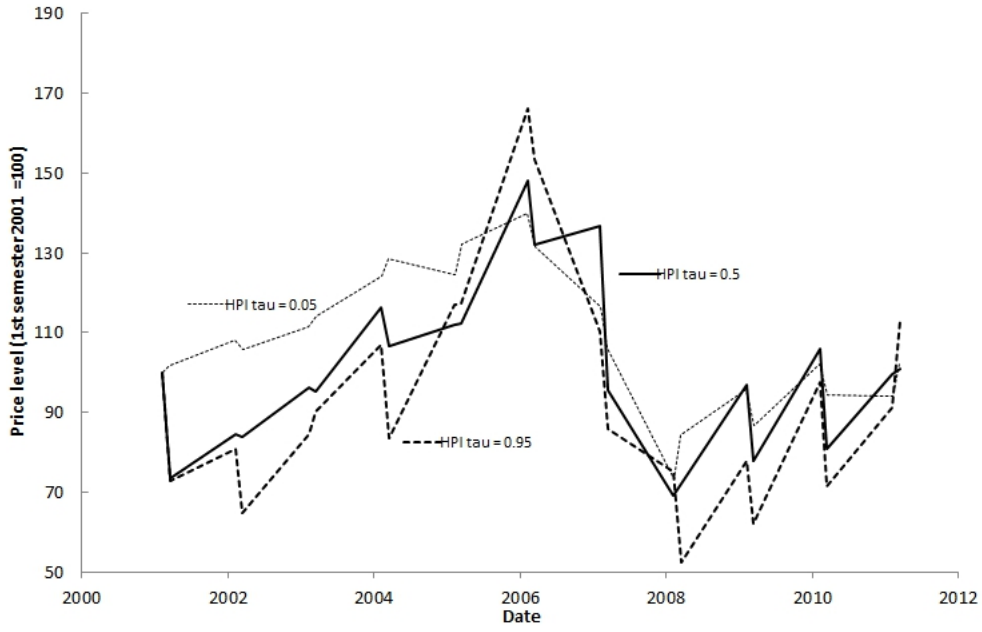

Figure 2: Semi-annual Hedonic Price Indices for physical art

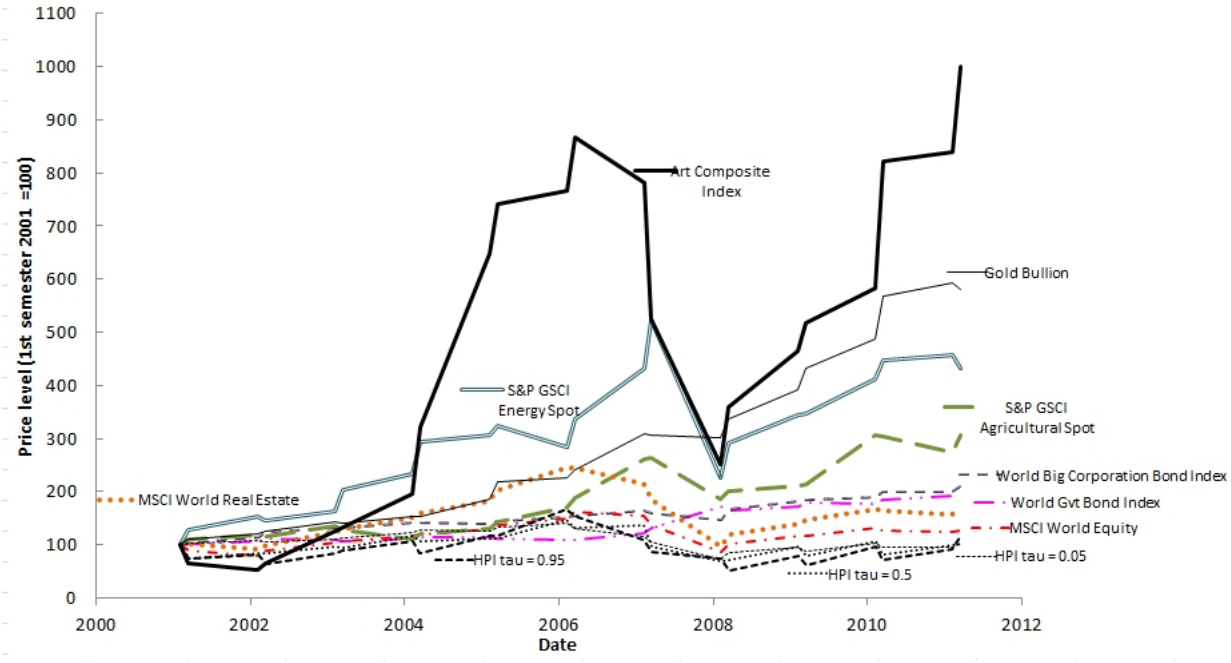

Figure 3: Semi-annualized financial indices and semi-annual HPI

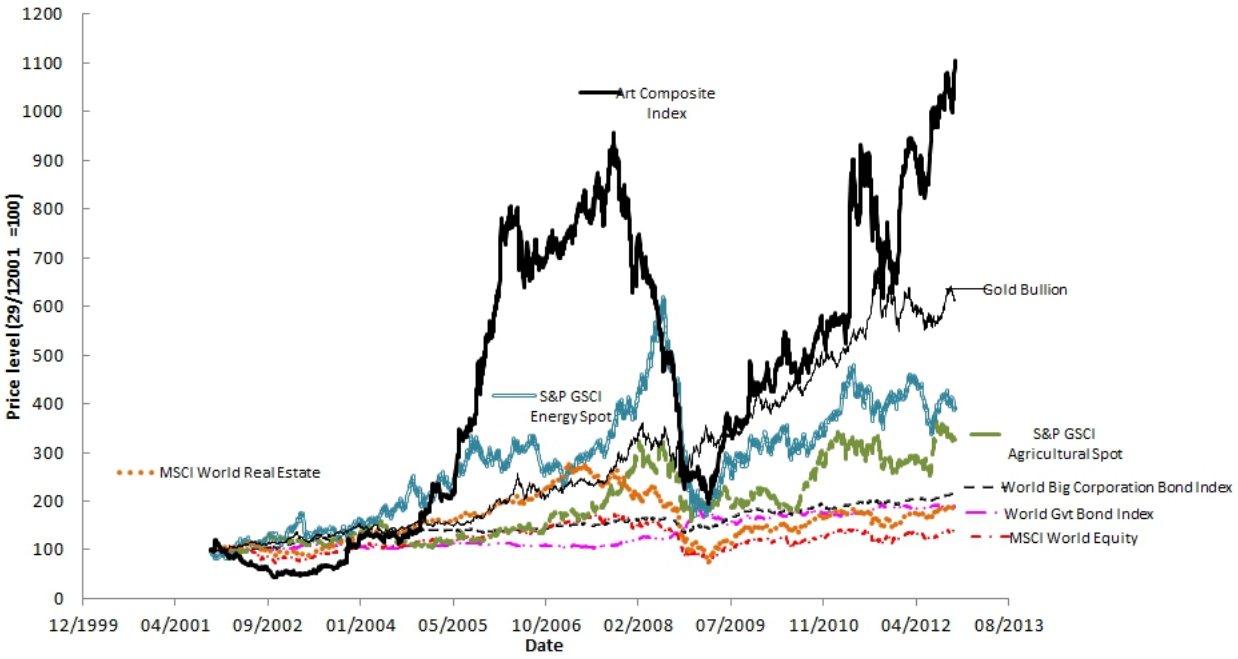

Figure 4: Daily financial indices

Table 5: Correlation of financial indices with semi-annual Hedonic Price Indices (HPI)

Correlation of semi-annual returns	HPI. Tau = 0.05	HPI. Tau = 0.50	HPI. Tau = 0.95
Art Composite Index	51%	-6%	-8%
World Gvt Bond Index	-67%	18%	18%
World Big Corporation Bond Index	42%	-6%	-10%
MSCI World Equity	62%	2%	0%
S&P GSCI Agricultural Spot	48%	13%	12%
S&P GSCI Energy Spot	49%	-14%	-16%
MSCI World Real Estate	67%	-5%	-6%
Gold Bullion	28%	25%	21%

Table 6: Compound Annual Growth Rate

CAGR	29/10/2001 - 29/10/2012	15/09/2008 - 29/10/2012
World Gvt Bond Index	6%	9%
World Big Corporation Bond Index	7%	12%
MSCI World Equity	3%	0%
S&P GSCI Agricultural Spot	11%	24%
S&P GSCI Energy Spot	13%	30%
MSCI World Real Estate	6%	9%
Gold Bullion	18%	45%
Art Composite Index	24%	67%

stocks. In Table 6, we compare performance of the ACI against other financial indices. With a Compound Annual Growth Rate of +24%, the index of art-related stocks strongly outperformed other asset classes over the course of the years. The CAGR (Compound Annual Growth Rate) of the ACI is of +67% between the 15th of September 2008 (date of the collapse of Lehman Brothers) until end of October 2012. In comparison, gold prices exhibited a CAGR of +45% during the same period.

Table 7: Correlation between financial indices

Correlation 29/10/2001 - 29/10/2012	World Gvt Bond Index	World Big Corporation Bond Index	MSCI World Equity	S&P GSCI Agricultural Spot	S&P GSCI Energy Spot	MSCI World Real Estate	Gold Bullion	Art Composite Index
World Gvt Bond Index	100%	5.98%	-40.87%	-17.99%	-21.64%	-36.67%	-5.14%	-17.06%
World Big Corporation Bond Index		100%	11.64%	10.07%	11.51%	18.37%	33.94%	13.39%
MSCI World Equity			100%	25.97%	33.40%	79.37%	9.40%	39.02%
S&P GSCI Agricultural Spot				100%	34.62%	19.67%	17.14%	11.14%
S&P GSCI Energy Spot					100%	26.93%	21.91%	12.77%
MSCI World Real Estate						100%	11.19%	35.42%
Gold Bullion							100%	5.23%
Art Composite Index								100%

Table 8: Correlation between financial indices after Lehman's collapse

Correlation 15/09/2008 - 29/10/2012	World Gvt Bond Index	World Big Corporation Bond Index	MSCI World Equity	S&P GSCI Agricultural Spot	S&P GSCI Energy Spot	MSCI World Real Estate	Gold Bullion	Art Composite Index
World Gvt Bond Index	100%	5.98%	-40.87%	-17.99%	-21.64%	-36.67%	-5.14%	-13.96%
World Big Corporation Bond Index		100%	11.64%	10.07%	11.51%	18.37%	33.94%	24.87%
MSCI World Equity			100%	25.97%	33.40%	79.37%	9.40%	54.18%
S&P GSCI Agricultural Spot				100%	34.62%	19.67%	17.14%	11.14%
S&P GSCI Energy Spot					100%	48.89%	24.15%	28.96%
MSCI World Real Estate						100%	10.27%	46.95%
Gold Bullion							100%	1.22%
Art Composite Index								100%

Table 7 shows that over the 11 years of our analysis, daily returns of ACI are most correlated with the ones of the MSCI World Equity Index (39%) then with the MSCI World Real Estate (35%). Interestingly, despite their relatively comparable long run performances, returns of art companies are least correlated to daily returns of gold prices over the course of the entire period (5%). Table 8 that focuses on the post-Lehman era shows that correlation between art companies and stocks increased during this period.

The ACI is the most volatile index of all, with an annualized volatility of +35.2% between October 2001 and October 2012. This high volatility compares to the S&P GSCI Energy Spot Index (+32.18%). The ACI is strongly skewed right (+1.08), a characteristic only shared with government bonds (+0.58). Also, our pool of art-related companies has the biggest kurtosis: +9.0, in front of the MSCI World Equity Index (+7.6).

To sum up, amongst our selected indices, the ACI cumulates many superlatives: the most volatile, the most skewed with the fattest tails. Opportunity to include this equally-weighted

Table 9: Moments

Moments 29/10/2001 - 29/10/2012	World Gvt Bond Index	World Big Corporation Bond Index	MSCI World Equity	S&P GSCI Agricultural Spot	S&P GSCI Energy Spot	MSCI World Real Estate	Gold Bullion	Art Composite Index
Volatility (annualized)	5.91%	17.87%	24.43%	31.82%	19.29%	18.95%	35.28%	51.14%
Skewness	0.58	0.00	- 0.18	0.00	- 0.04	- 0.21	- 0.29	1.08
Kurtosis	6.34	4.40	7.60	1.99	2.03	7.52	3.74	8.98

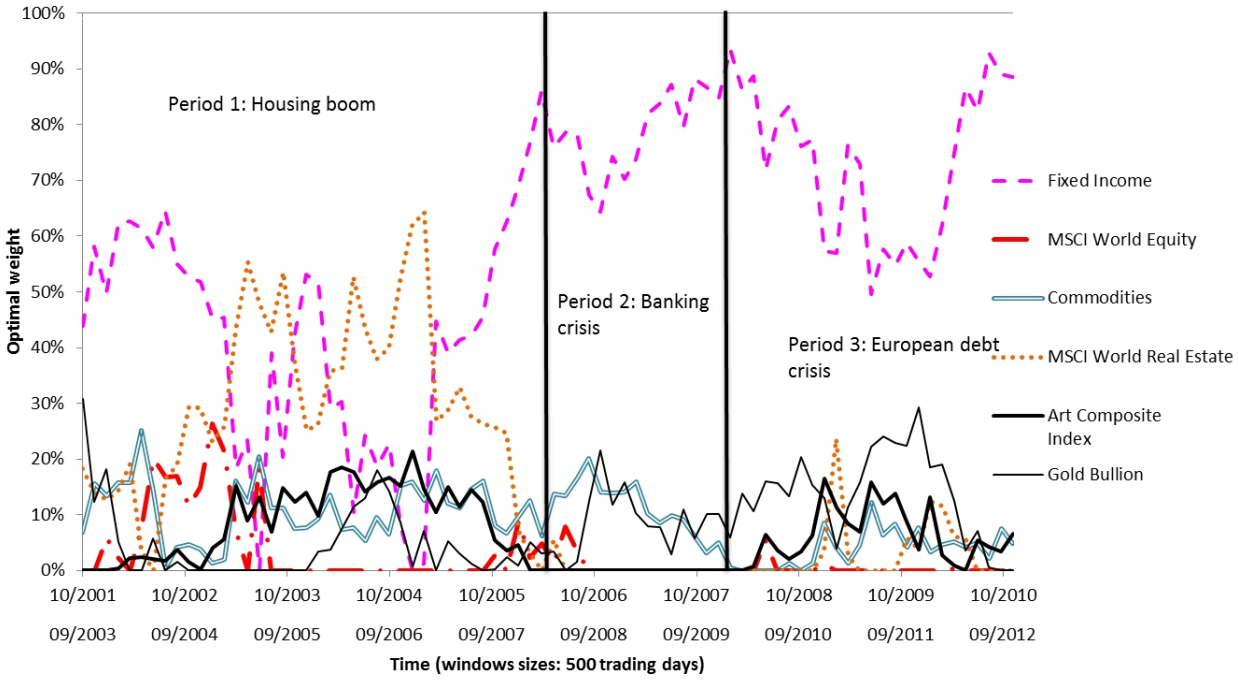

Figure 5: Optimal weights of assets. 30 days rolling portfolio. Calibration period: 500 trading days

basket of art-related companies in a diversified financial portfolio is further investigated by observing evolution of an optimal portfolio through the last decade. The portfolio is rolled every 30 trading days and is calibrated on 500 trading days. Figure 3 presents results of this optimal portfolio rolling throughout the entire period. For the sake of clarity of the plot, we sum optimal weights of government bonds and corporate bonds to create a "Fixed Income" category. Similarly, energy and agricultural commodities are gathered under a category "Commodities".

The evolution of the portfolio is in line with well-known developments of financial markets during the last decade. We identify three periods: the real estate boom of 2000 - 2006, the banking crisis in 2007 - 2009, and the European debt crisis of 2009 - 2012.

The first period highlights developments during the U.S. housing boom. We define the first period as a time frame between October 2001 and March 2008, a month hit by the bail-out of

Bear Stearns by the Federal Reserve. During this first period, the MSCI World Real Estate overwhelms the optimal portfolio: at one point (between February 2005 and January 2007) it is supposed to have accounted for 64% of the entire portfolio. However, equity completely disappeared from the optimal portfolio as soon as July 2005. Shares of other assets are evenly split. The Art Composite Index has a 18% share in the time window ranging from May 2004 to April 2006. This level was never reached again. During this first period, the average optimal weight for the ACI is of 8.9% against 4.6% for gold and 4.7% for energy, 6% for agricultural commodities and 4.7% for the MSCI World Equity Index.

The second periods ranges from the Bear Stearn's bail-out until the start of the European debt crisis in October 2009. Only three types of assets held their ground in the optimal portfolios during these challenging times: commodities, gold and fixed income. Art stocks' weight completely dropped to zero, revealing the uselessness of holding art-related stock during the banking crisis. Take note that commodities and gold are physical assets. Since we have shown that returns of art stocks are not directly correlated to returns of physical art, our analysis lacks evidences of a possible role of physical artworks during the banking crisis, but definitely discards the idea that a combination of art-related stocks were an effective diversification tool. The second period ends in October 2009 that marks the start of the European debt crisis (see Lane, 2012). Indeed, this month corresponds to the general Greek election that emphasized the sovereign risk of Greece and the possibility of a default inside the Euro Area.

During the third period, the MSCI World Equity still does not recover, to the contrary of art-related stocks that benefit from a rally. Fixed Income drops to a 50% allocation, simultaneously, art-stocks takes over commodities to top 16% allocation between July 2009 and June 2011. Gold's share in the optimal portfolio reaches a maximum of 29% in the period covering December 2009 to November 2011.

Table 10: Descriptive statistics of optimal weights in rolling portfolio

Average weight	World Gvt Bond Index	World Big Corporation Bond Index	MSCI World Equity	S&P GSCI Agricultural Spot	S&P GSCI Energy Spot	MSCI World Real Estate	Gold Bullion	Art Composite Index
Housing boom	12%	28%	5%	6%	5%	30%	5%	9%
Banking crisis	49%	31%	1%	6%	4%	0%	9%	0%
European debt crisis	33%	38%	0%	3%	1%	3%	14%	7%
Maximum weight								
Housing boom	53%	76%	26%	22%	16%	64%	18%	21%
Banking crisis	81%	63%	6%	12%	9%	0%	22%	6%
European debt crisis	56%	68%	1%	12%	8%	24%	29%	16%

Increase of the weight of art-related stocks in an optimal portfolio can reasonably be explained by anticipation of higher volumes in the art market that may have boosted returns of art

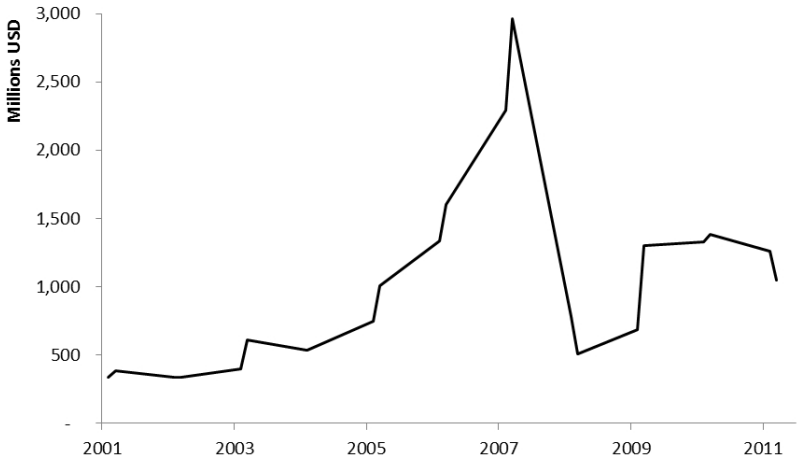

Figure 6: Semi-annual volumes (in USD) of sales at auction for 99 artists

companies. This is confirmed by data on observed volumes at auction (see Figure 4). It remains to unveil why volumes of physical art went up during the European debt crisis. We offer three paths for further research: first, quantitative easing by central banks may have directly or indirectly fuelled liquidity of markets of certain goods that can be perceived as a hedge against inflation, such as art or gold. Second, fears related to the Greek crisis could have triggered a flight to assets less exposed to geographical or political risks. Under that perspective, physical art could be a hedge against political risks, in a fashion similar to what Oosterlinck (2011) describes for the Second World War: a painting can be easily transported in any country and/or sold in any currency. Third, following a severe art market disruption in 2008, sellers may have tried to postpone their sales, waiting for better market conditions (for a similar behaviour in the art market in case of forgery scandals, see Bocart and Oosterlinck, 2011) what could have created a temporary drought in volumes during the banking crisis, followed by an increase in 2009, since sellers cannot postpone their sales indefinitely.

4 Conclusion

Our analysis suggests that holding art-related stocks does not deliver the expected benefits of holding physical art: art-linked equities exhibit no correlation with median and top art prices, but are instead positively correlated to cheaper, bottom 5% artworks and real estate equities. This highlights the close relationship between these industries and art as a consumption good. More striking, prices of art companies depend on changes in expected volumes at auction, so

that a long position in a basket of art-related stocks yields an exposure to market activity, not to price levels. This contrasts with, for instance, oil or gold companies that are closely related to the price of the underlying asset they mine. Such discrepancy can be easily understood, since art companies do not produce art: a gold miner can extract gold, but, as intermediaries, art companies depend on existing flows in the market. Using a new framework for portfolio optimization based on R-Vine copulae, we confidently affirm that holding a composite index of these companies was useless during the banking crisis, though it was beneficial during the European debt crisis thanks to a corresponding increase in volumes. These results lead to suggestions for further research: why art volumes took off during the European debt crisis? Was this directly related to new monetary policies and increased liquidity supply? Or did art simply benefit from economic recovery led by these policies? Does the art market activity soar during political distress and could physical art and/or art-related companies be genuinely seen as a financial hedge against political risk ?

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