The Economics of Aesthetics and Record Prices for Art since 1701

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Abstract: Aggregate art price patterns mask a lot of underlying variation—both in the time series and in the cross-section. We argue that, to increase our understanding of the market for aesthetics, it is helpful to take a micro perspective on the formation of art prices, and acknowledge that each artwork gives rise to a market for trading in its private-value benefits. We discuss relevant recent literature, and illustrate the potential of this approach through a historical study of record prices for art at auction since 1701.

JEL classification codes: D10; D44; D84; G10; Z11.

Keywords: art; auctions; price formation; price indexes; private values; record prices.

I. Introduction

Over the last half century, a growing literature in economics has substantially improved our knowledge of the risk-return properties of diversified art portfolios, the correlation patterns between artwork characteristics and prices, and the impact of shifts in income and wealth distributions—and in market sentiment—on average art prices. These quantitative, econometric studies have been useful in documenting the integration of the market for art into a broader economic and social context, but this framework of analysis also has its limits. Focusing on the aggregate time-series dynamics and average cross-sectional pricing differences masks considerable idiosyncratic variation that is peculiar to the demand and appreciation of art, and is potentially highly relevant to economists seeking to understand how prices are set, to (typically undiversified) collector-investors, and to observers of the art market wishing to learn about the dynamics of art buyers' preferences from prices.

In this article, we propose that, to further increase our economic understanding of the market for aesthetics, it is useful to examine the formation of art prices on a disaggregate level—using cases that elucidate the complexity of price formation. In a market characterized by private values, idiosyncratic tastes, and non-pecuniary benefits of ownership and display, sometimes the details can be as useful as the statistics in revealing fundamental market determinants. In econometric terms, a deeper understanding of outliers can reveal factors that would otherwise be difficult to capture through standard aggregate measures.

Our starting point is that anybody's valuation of an artwork should be a function of both the expected (non-financial) private-value benefits over the holding period and the expected (financial) resale revenues (Lovo and Spaenjers, 2014). The latter cashflow is in itself endogenously related to the distribution of tastes among potential buyers at the time of resale. Each individual artwork thus gives rise to a market for trading in its current and future private-value benefits. Within this framework, we discuss recent theoretical and empirical studies on the different forces that drive bidders' willingness to

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pay at art auctions. Conclusions that emerge from this body of work are that the enjoyment associated with art ownership is multi-faceted, that preferences interact with wealth and social status in determining the magnitude of private values, that beliefs about resale revenues matter, and that the strategic choices made by the auction house prior to a sale can affect its outcome.

We then illustrate the relevance of a micro perspective to the formation of art prices through a particular case study. Based on historical research, we identify all 35 sales of artworks between 1701 and 2014 that set record prices—in nominal GBP terms—at auction. At one time in history each of these pieces held the special distinction of being the most expensive work of art ever sold through a commonly observed market. A review of these works reveals an interesting paradox: an extraordinary price does not necessarily equate to a unique or extraordinary artwork. Standard hedonic analysis would not have predicted such extreme values. Moreover, the timing of record transactions does not always coincide with general periods of price increases. Based on an in-depth study of the different sales in our series, we conclude that auction records may be set in situations characterized by one or more of the following elements: (i) extreme supply constraints, (ii) instances of social competition among "nouveaux riches", (iii) resolution of uncertainty about the potential resale value of the artwork, and (iv) idiosyncratic shifts from hedonic weights. These factors emerged from an outlier analysis of a very small but special sample of auction records, but they have the potential to be tested in the future using econometric methods that rely on the law of large numbers.

The remainder of this paper is organized as follows. Section II reviews the main strands of the literature on art prices. Section III proposes a new framework to understand art price formation, and discusses recent related studies. Section IV presents our record series. Section V explains how it illustrates the relevance of a micro perspective on art prices. Section VI concludes.

II. Main Strands of the Literature on Art Prices

II.1. Art price indexes

The first efforts to estimate the investment performance of art occurred in the early 1960s. A popular book by Rush (1961) presented indices for different artistic genres and even included a comparison with stocks. Early efforts to estimate the investment performance of art were hindered by difficulties in collecting price data (Coslor and Spaenjers, 2013). Academic interest in the topic grew with a number of contributions (e.g., Anderson, 1974; Baumol, 1986; Goetzmann, 1993) that used historical auction sales data compiled by art historian Gerard Reitlinger (1961) in his influential book "The Economics of Taste: The Rise and Fall of Picture Prices, 1760-1960". A popular methodology used to construct price indexes for infrequently traded assets in these early studies was the repeat-sales regression, which estimates average returns based on purchase and sale prices of items trading twice. An alternative approach is the hedonic regression, which constructs a price index by regressing all available transaction prices—so not only those of sales pairs—against time dummies, controlling for the quality-determining or "utility-bearing" (Rosen, 1974) characteristics of each artwork. Over the last two decades, researchers have applied these two methods to ever-larger databases of art auction sales. For example, Mei and Moses (2002) build a price index starting in 1875, based on resales at the New York offices of Sotheby's and Christie's. Goetzmann, Renneboog, and Spaenjers (2011) do a similar long-term exercise using London auction data from Reitlinger (1961) and an online sales database. Other papers (e.g., Renneboog and Spaenjers, 2013) consider shorter time intervals but use data from a wider set of auction houses and locations.

Although different methodologies and sample periods yield slightly different conclusions with respect to the long-term return to art investment, estimated returns generally beat inflation but remain below the performance of equities. To illustrate this, Figure 1 compares the real GBP investment performance of art to that of financial assets between start-1900 and end-2013. For the period 1900–2007, we rely

on estimates of price changes in the U.K. art market from Goetzmann, Renneboog, and Spaenjers (2011).[1] We link the resulting series to six years of returns from Artprice.com (2014). Figure 1 also shows returns on U.K. Treasury bills, government bonds, and equities, using data from Dimson, Marsh, and Staunton (2002, 2014). Art outperformed bonds—mainly because of a strong performance over the second half of the time frame—but significantly underperformed equities. Table 1 compares mean returns and standard deviations for all four assets. The annualized real return (standard deviation) for art over the full 113-year time period is 2.3% (15.2%), compared to 5.3% (19.8%) for equities.

[Insert Figure 1 and Table 1 about here]

Much research looks into the returns to oil paintings sold in important art market centers, but some studies construct indexes for particular media, art movements, quality categories, artist nationalities, or countries of sale. A full review of the existing literature goes beyond the scope of our paper, but two findings of this body of work are that, at least over the last half century, more expensive categories of art have outperformed other types of art, and that "younger" (e.g., contemporary) art typically combines higher returns with higher volatility (e.g., Renneboog and Spaenjers, 2013). Such cross-sectional variation in returns enables further examination of the relation between economic fundamentals and prices (cf. Section III).

A number of methodological issues with price index estimates have not yet been completely resolved. For example, there is the issue of endogeneity of trading. Items may only (re)sell if they have gone up in value (Goetzmann, 1996); Korteweg, Kräussl, and Verwijmeren (2015) study such survivorship bias and find that standard repeat-sales art price indexes may have to be adjusted downwards. However, the extent to which hedonic regression coefficients or even longer-term repeat-sales return estimates are

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[1] In this paper, we report returns after unsmoothing the repeat-sales regression coefficients of Goetzmann, Renneboog, and Spaenjers (2011), because averaging prices over intervals induces spurious first-order autocorrelation (Working, 1960). The resulting standard deviation presents a conservative (i.e., high) estimate of the volatility of art investment. Measures of risk based on repeat-sales regression indexes are subject to upward bias due to small-sample issues (Goetzmann, 1992).

biased is still unclear. For example, Lovo and Spaenjers (2014) build a model of rational endogenous trading in artworks. Long-term return estimates in their simulated economy are not biased: forced sales make all artworks trade, even if only on a very infrequent basis. Chambers, Dimson, and Spaenjers (2015) follow the estimated value of a complete art collection—the one put together by the economist John Maynard Keynes—over time, and find a performance over the last half century very similar to that shown by an auction-based art price index. Another issue is that of buy-ins. Goetzmann and Peng (2006) show how the existence of reservation prices may lead price indexes to underestimate (overestimate) true returns when the market is doing surprisingly well (badly), leading to an underestimation of volatility.

II.2. Hedonic pricing

Hedonic regressions do not only enable the construction of price indexes, but they also allow some insight into the price-determining characteristics of artworks. Hedonic models estimated in art price studies typically include easily quantifiable characteristics of the artist (e.g, artist dummies and/or reputation measures) and the work (e.g., size, medium, strength of attribution). The regression results then show the implicit "premia"—and thus the average willingness to pay among art buyers— associated with certain characteristics. (Hedonic models often also include characteristics of the sale (e.g, auction house, month of sale), which are supposed to pick up otherwise unobservable differences in quality.) For example, Renneboog and Spaenjers (2013) find that works that are "attributed to" an artist are on average 52% cheaper than works that are certainly by the artist; the authors also quantify the premia that art buyers are paying on average for oil paintings, signed works of art, self-portraits, etc. Other studies have focused on more subtle variations in hedonic pleasure. For example, Lazzaro (2006) uses hedonic regressions to quantify the differences in utility from owning an original versus a

posthumous Rembrandt print, and Pownall (2014) shows that artworks with darker colours carry a premium relative to objects with a lower colour intensity.

II.3. Determinants of art market returns

An artwork is essentially a claim on the pleasure and pride experienced as its owner. As the "consumption" of art is discretionary, the marginal utility of—and therefore the willingness to pay for—its non-pecuniary payoffs can be expected to vary with wealth shocks (Aït-Sahalia, Parker, and Yogo, 2004). Table 1 shows a positive contemporaneous correlation of real art and equity returns. We also show the aggregated slope coefficient (Dimson, 1979) of a regression of art returns against both lagged and same-year equity returns, as it may take time before changes in equity wealth are reflected in art prices. This equity market "beta" equals 0.44.

Art price indexes also typically drop in recessionary periods. For example, the art index in Figure 1 shows annualized real returns of −19.8% in 1919–1920, −31.4% in 1930–1931, −15.5% in 1974–1975, −24.1% in 1991, and −21.9% in 2008. Table 1 shows a positive covariance of art returns with GDP growth rates that is statistically significant at the 0.10 level. Yet, as masterpieces are unique and indivisible goods that are in excess demand, the number and the buying power of wealthy households may be more relevant in determining the price of high-end art than the average wealth across all households—just like for real estate in "superstar cities" (Gyourko, Mayer, and Sinai, 2013). Goetzmann, Renneboog, and Spaenjers (2011) indeed find evidence of a long-run relationship between high-end art prices and top incomes.

Not only fundamental drivers of luxury consumption demand may affect the willingness to pay for art. Art price indexes typically show bubble-like behavior (e.g., Kräussl, Lehnert, and Martelin, 2014), such as short-term persistence and longer-term reversion. Moreover, returns and volume changes tend

to be positively correlated. The absence of short-selling in the art market—coupled with the limited amount of artworks for sale in each period—facilitates the emergence of bubbles (e.g., Haruvy and Noussair, 2006). Renneboog and Spaenjers (2013) show that high-income consumer confidence and art buyer sentiment indeed predict art returns. Moreover, differences of opinion about the future of the market may encourage relatively pessimistic art owners to sell to optimists in bubble periods (Pénasse and Renneboog, 2014), in the spirit of, for example, Scheinkman and Xiong (2003). Yet, it should be noted that—like in any market—bubbles can be hard to detect, and that some of the observed time-series patterns in prices and volume could be explained in other ways. For example, a positive price-volume correlation may also arise if art owners suffer from nominal loss aversion (Genesove and Mayer, 2001; Graddy et al., 2014), or if changes in the bidding population (rationally) affect prices and sale decisions simultaneously (Lovo and Spaenjers, 2014).

III. New Perspectives on Art Prices

The literature has painted a clear picture of the aggregate historical price dynamics in the art market, and of the covariance of the price of an "average" artwork with changes in other economic variables. This work is important, because it allows one to compare the risk-return profile of art as an asset class—or of a certain type of art—with those of other investments, and to evaluate the potential role of diversified art collections—or even art investment funds—in a portfolio. Reviewing the available evidence, Dimson and Spaenjers (2014) write that, from a pure financial perspective, an investment in art or other collectibles may only be interesting to "investors who already have a diversified portfolio of financial assets, who have a long investment horizon, and who can sit out periods of high illiquidity and low demand for luxury consumption". This conclusion may not be surprising, as one could expect the non-pecuniary benefits of holding collectibles to depress expected financial returns in equilibrium (Mandel, 2009; Jovanovic, 2013; de Roon, Koedijk, and Pownall, 2014; Lovo and Spaenjers, 2014).

At the same time, however, it should be recognized that price indexes hide a lot of variation, and may not be representative of the price dynamics for any individual artist or artwork. We can get a sense of how much of the variation in art prices is systematic by looking at the R-squareds of repeat-sales regressions. Goetzmann (1993) and Mei and Moses (2002) report that their indexes explain 0.59 and 0.64 of the sample return variation, respectively; the R-squared can be expected to be lower in more heterogeneous samples than theirs.[2] Art price indexes thus leave a substantial part of the returns on individual objects unexplained, which is especially relevant as many collector-investors—by choice or by lack of investable capital—focus on a very small of artists and thus tend to be undiversified. We argue that, to increase the economic understanding of the auction market for aesthetics, it is useful to go beyond average price dynamics, and acknowledge that a separate "market" is associated with each individual artwork.

We can build on Lovo and Spaenjers (2014) to formalize this idea. The authors define an "emotional dividend" as the amount an individual is willing and able to pay for each period of ownership of an artwork; it is the quantitative counterpart of the non-financial utility associated with being an art owner. Any individual i's valuation of an artwork then equals the present value of the emotional dividends expected between purchase and resale, plus the present value of the expected auction proceeds—net of transaction costs—at resale:

$$PV_{i,t} = PV(\text{emotional dividends})_{i,t \to t'} + PV(\text{expected resale revenues})_{t'} \tag{1},$$

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[2] We report the R-squared for the OLS repeat-sales estimator in Goetzmann (1993). As a point of comparison, the R-squareds for the (first-stage) OLS repeat-sales estimators for the four (city) housing markets in Case and Shiller (1987) range from 0.62 to 0.83.

where t is the time of purchase and t' is the optimal time of resale.[3] The magnitude of the emotional dividend per period—which determines the first (non-financial, private-value) component in equation (1)—depends both on individual i's preferences and on his financial wealth. The expected resale revenues—which determine the second (financial, common-value) component in equation (1)—are endogenous to the *distribution* of emotional dividends in the population of bidders at time t': the resale price can be expected to be higher if more individuals derive high enjoyment from the work. This element of the time-t valuation should be the same for all non-financially-constrained bidders planning to resell at t'.

Even if hedonic models do rather well in explaining average cross-sectional price differences between artworks, they mask variation in the nature of emotional dividends or private use values that exist for each individual work. Furthermore, the structure of patterns of tastes and wealth—which together determine the distribution of these emotional dividends—across potential art buyers may change over time. These dynamics do not only affect returns through the private-value component of art valuations; expectations about future market conditions for an artwork have an impact on prices through the common-value component as well. Finally, the strategic choices made by the auction house prior to the sale can also affect the sale price. In the following paragraphs, we show how recent literature has explored these issues.

III.1. The nature of emotional dividends

The preferences underpinning the non-financial utility that individuals derive from owning an artwork can take different forms. There is of course the viewing pleasure, and the admiration of artistic skill or

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[3] As Dimson, Rousseau, and Spaenjers (2014) discuss in the context of wine, pinning down the appropriate rate at which to discount the future non-financial benefits and financial cashflows may not be straightforward. It is arguably a function of many different factors, including the potential for diversification benefits offered by the investment.

genius. But duplicates are not worth as much as original artworks: price differences exist between works with different strengths of attribution to artists (Lazzaro, 2006; Renneboog and Spaenjers, 2013). Newman and Bloom (2012) argue that two psychological mechanisms can explain such findings: they find that both "the assessment of the art object as a unique creative act (performance) and the degree of physical contact with the original artist (contagion)" have an effect on people's valuations.

A subtle twist is that the pride and enjoyment associated with ownership may be much stronger than the pleasure experienced by art lovers when viewing art that they like but is not theirs. Frey and Eichenberger (1995) argue that "an art object yields additional benefits if it is owned (and not just rented) because the art object's 'aura' is therewith appropriated". The importance of such ownership effects—which may be entirely foreseeable by potential art buyers, and therefore come on top of the standard endowment effect (Thaler, 1980)—could explain the absence of a well-developed art rental market.

Art buyers may not only be paying for the personal satisfaction of ownership; social signaling may also play a role. Heffetz (2011) shows that there is a relation between the visibility of expenditures on a category of goods and the elasticity of consumption with respect to income. Public perceptions of one's tastes may determine social status (Bernheim, 1994). In this view, an art collector's intrinsic preferences are not necessarily aligned with common tastes, but the collector conforms to a homogeneous standard of behavior due to status concerns.

The durability of art makes it not only a consumption good, but also a store and display of wealth. If wealth provides social status, then it may directly enter into the utility function of economic agents. In the presence of such a "capitalist spirit" (e.g., Bakshi and Chen, 1996), the wealthy may pay a premium for art relative to the stream of consumption services that is inherent to the artwork (Satchell and Srivastava, 2014). Mandel (2009) constructs an asset pricing model that incorporates a

conspicuous utility dividend that is a function of the art's price, introducing a relation between the private-value and the common-value components of an artwork's value.

Also social competition within the walls of the auction room may be important. Auction participants may get utility from winning for winning's sake—to be the "top dog" (Shogren and Hayes, 1997). Even if the experimental evidence for such an effect is limited (Holt and Sherman, 1994; Shogren and Hayes, 1997), it could play a more important role when members of the global elite are competing for a trophy item.

The observations that ownership is a condition for complete hedonic enjoyment and that the need for social recognition may impact bidding behavior also suggest an important role for supply in the determination of prices. We can define supply as the number of artworks of an artist that is still in private hands. Supply typically shrinks over time, as museums continue to acquire items but only rarely de-accession. Moreover, there is the issue of re-attributions. For many Old Masters, the number of works that are considered to be executed by the master has decreased historically as attention to authenticity heightened and technology advanced; Seinstra (2014) shows how the number of paintings included in various Rembrandt "oeuvre catalogues" more or less halved over the twentieth century.[4] If supply is severely constrained, bidders may be faced with their one and only opportunity to acquire an item by a certain artist if it comes up for sale, reinforcing the idea that an auction can indeed be "won", and inducing exceptionally high demand.

The above discussion makes clear that the emotional dividends from acquiring and owning an artwork—which underlie its price—can take many forms. Whether hedonic regression models are able

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[4] This points to the difficulty of measuring the returns to "Rembrandt" paintings, for example, over the very long run. One may speculate, however, that decreases in "attribution risk" have had an (ex ante unexpected) positive impact on returns realized by art investors over the twentieth century. It is still unclear how discoveries of fakes affect the market for an artist in the short run, even though the findings of Bocart and Oosterlinck (2011) suggest that the demand for certification goes up after a discovery.

to explain cross-sectional price variation between art objects depends crucially on whether the included variables capture these private-value-determining features and on the (absence of) idiosyncratic variation around average preferences.

III.2. Time-series variation in the distribution of emotional dividends

Aggregate art price indexes will capture the price dynamics of individual artists or works more accurately if there is a substantial systematic component in how emotional dividends change over time. There will be less variation in price changes around the average trend if preferences are relatively stable over time. While the multi-dimensional nature of preferences for artworks makes this hard to evaluate—for example, how does the demand for conspicuous consumption change over time, and how does this differentially affect the demand for each artwork?—recent research suggests that there is at least a strong endurance in the relative popularity of leading artists, even over longer time frames (Ginsburgh and Weyers, 2010; Graddy, 2013; Vermeylen, van Dijck, and De Laet, 2013). Of course, the degree to which different movements or mediums are in fashion may still be changing slowly over time. Moreover, changing wealth patterns may make certain groups of individuals' preferences more or less impactful. Therefore, while the correlation between the aggregate movements of global wealth and art prices is interesting, the interaction between regional wealth patterns and local cultural tastes certainly deserves as much attention. Saltzman (2009) documents "America's raid on Europe's great pictures" in the early twentieth century; art dealer Joseph Duveen famously commented that "Europe has a great deal of art, and America has a great deal of money". Hiraki et al. (2009) find a strong correlation between the demand for art by Japanese collectors and Japanese stock prices, leading to an increase in Impressionist and Post-Impressionist art prices during the late 1980s bubble period in the Japanese economy. More recently, art from emerging economies has appreciated in value strongly (Kräussl and Logher, 2010; Renneboog and Spaenjers, 2011; Velthuis and Baia Curioni, 2015). In line

with these findings, Renneboog and Spaenjers (2015) show that national equity markets help explaining country-specific art returns, but become irrelevant for the artists with the highest reputations.

III.3. Beliefs about the common-value component

Rationally-behaving art owners will only want to resell when the expected auction proceeds exceed the (individual-specific) value of continued ownership. Under certain conditions, increases in price levels in the art market may thus trigger increases in the volume of consignments to auction houses. One factor that will directly impact expected auction proceeds is a change in the number of bidders in the market (Goetzmann and Spiegel, 1995; Lovo and Spaenjers, 2014). If there is uncertainty about what the shape of the (future) distribution of private-value benefits—which determines the common-value component—looks like, then also changes in the beliefs about this distribution should impact the valuation of an artwork. Using survey data, Pénasse, Renneboog, and Spaenjers (2014) find that, in the cross-section, optimistic beliefs in the market outlook for specific artists are correlated with higher prices. Renneboog and Spaenjers (2013) show that art buyer sentiment is more highly correlated with price changes for modern and contemporary art, for which uncertainty about future tastes is likely to be higher. Beggs and Graddy (2008) show downward price trends after buy-ins (i.e., items failing to reach the reserve price), which can be explained by common-value effects.

III.4. Auctions and auction house strategies

Ashenfelter and Graddy (2003) argued that "the auction institution itself… can have a profound influence on the price of art". A first important element in this context are auction houses' transaction fees: commissions charged to sellers and premiums charged to buyers. The structure of these

transaction costs has changed over time: buyer's premiums at Christie's and Sotheby's have grown steadily since they were first introduced in the 1970s. (In the case of important consignments, seller's commissions are nowadays often negotiated down to zero—or even below.) Both types of fees can of course be considered as a tax on the *seller*, as bidders can—and do—capitalize buyers' premia into their bids (Ashenfelter, 1989; Ashenfelter and Graddy, 2003; Marks, 2009).

Second, auction houses typically issue a low and a high auction estimate prior to the sale, as guidance for prospective buyers. A number of papers (e.g., Bauwens and Ginsburgh, 2000; McAndrew, Smith, and Thompson, 2012) has examined whether pre-sale estimates are informationally efficient. Yet, a related question is whether auction houses can influence auction outcomes by setting estimates strategically, for example as to increase participation or affect bidders' beliefs about potential resale revenues. In line with such a hypothesis, Mei and Moses (2005) find that art buyers overpay for expensive paintings because of a "consistent upward bias" in their estimates.

Third, the auctioneer will decide on the ordering of lots for sale. Beggs and Graddy (1997) show that more expensive artworks are typically auctioned off first, and that sale premiums (relative to the pre-sale estimate) on average decline as an auction progresses. Hong et al. (2015) examine the effect of ordering on revenues, using the predetermined rotation of Sotheby's and Christie's during auction weeks in New York. They find that total revenues are higher if the auction with the most valuable items is held first, and attribute this result to anchoring effects (Tversky and Kahneman, 1974) on the part of bidders (which were first documented in the context of art auctions by Beggs and Graddy (2009)).

Fourth, and finally, auction houses have over the last decades become more innovative in the financial services that they provide to both buyers and sellers. For example, they started offering credit to potential buyers in the 1980s—a controversial move at the time (Lacey, 1998; Coslor and Spaenjers, 2013) that may have pushed up prices in some cases by alleviating bidders' credit constraints. More

recently, auction houses have also started guaranteeing minimum prices to sellers of high-end works. Graddy and Hamilton (2014) explore how such (in-house or outside) guarantees can change the bidding environment—for example through the signal that they send on the potential market for the item—and thus affect sale prices.

IV. Art at Auction: A Record of Records

On 12 November 2013, the Francis Bacon triptych "Three Studies of Lucian Freud" was sold at Christie's New York for 127 million USD, or almost 90 million GBP—a world record price for a work of art at auction. In this section, we construct a long-term history of such record prices, going back to the start of the eighteenth century.[5] In Section V, we will discuss how our new data series illustrates the relevance of going beyond studying aggregate price patterns, and taking a disaggregated perspective on the formation of art prices.

We believe that the history of record-breaking auction transactions forms a particularly interesting case study of art price formation. Record sales are typically covered extensively by the popular press, and often trigger a debate about what paintings are really "worth". Artworks that broke records can be considered as the ultimate luxury goods, and their prices as a measure of the maximum willingness to pay for cultural objects.

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[5] Especially before the middle of the twentieth century, dealers were often buying at auction to sell at a higher price to their clients, and private market prices could far exceed auction records (e.g., Saltzman, 2009). However, we focus only on auction prices because reliable and exhaustive historical data on private transactions do not exist.

IV.1. Defining and identifying records

We use the following criteria to identify art auction record prices.[6] First, we only consider artworks (created by an identifiable artist), so no books, jewelry, etc. We exclude lots in which multiple artworks are pooled together. Second, the work needs to be traded at a public auction. Moreover, we only consider the highest price from each auction: if a record gets broken within the same sale, we exclude it from the list, as such transactions were arguably never reported or remembered as record-breaking. Third, at the auction the work needs to be acquired by a party other than the consignor. In other words, we consider record-breaking reserve prices as irrelevant. Fourth, we consider prices including auction house transactions costs payable by the winning bidder, as we want to capture the total sum laid out by the acquirer. Christie's and Sotheby's introduced a buyer's premium in the 1970s, but other auction houses already had buyer's fees in place before. (However, we do not consider VAT and other taxes.) Fifth, it is clear that the currency perspective may matter. Because the global art market for a very long time was centered in London, we take a GBP perspective. New York only became an important trading place for art in the twentieth century.

Even starting from such clear guidelines, the identification of record-breaking transactions in the history of the art auction market is difficult. Although online art auction databases have good coverage going back until the 1960s at least, no exhaustive online or offline database exists for older auctions. However, throughout history, a number of different "repertoires" listing art auction sales have been published. The starting point of our research is Reitlinger (1961), which lists for a wide range of artists a history of prices, including some eighteenth-century ones starting in 1701. However, closer examination of the highest prices in Reitlinger reveals that many of the prices included are not auction prices, but prices of private transactions, reserve prices, estimates, and so on. We exclude all these

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[6] Art auctions have historically been of the "English auction" type. We do not find evidence of a different auction mechanism in our database of record transactions.

non-auction prices. We then further investigate all remaining relevant entries, by cross-checking and potentially correcting the sale and price information in Reitlinger with a number of sources, such as the online art historical databases Lugt's Répertoire Online and the Getty Provenance Index. We also consult (often annotated) hard copies of the original auction catalogues in the National Art Library in London, or alternatively order them from online booksellers. We only include a potentially record-breaking transaction in our list if it does not violate any of the criteria spelled out before, and if the available evidence allows us to determine the location and date of the auction, and the exact price paid.

We then review a number of additional historical auction sale reference works, to see whether there are any record sales between 1701 and 1960 not included in Reitlinger. We identify two records for the early 1700s (using an exchange rate of 11 guilders to the pound) in a collection of priced Dutch art auction catalogues put together by Gerard Hoet (1752). Automated queries on the text of the two volumes of Roberts (1897) describing the important sales at Christie's between 1766 and 1896, and of the seven volumes of eighteenth- and nineteenth-century auction results of Mireur (1911–1912), did not yield additional transactions that are records according to the criteria spelled out before.

For the period since the publication of Reitlinger's volume, our starting point is the online database Blouin Art Sales Index (BASI). We convert all prices to GBP and add the buyer's premium whenever necessary. One additional record-breaking post-1960 transaction not included in BASI, the 1961 sale of Rembrandt's "Aristotle with a bust of Homer", was identified based on a review of press articles on auction price records.

The above-described procedure results in a database of 35 art auction records between 1701 and end-2014. Table 2 shows for each record the date of sale, the price in GBP, the name of the artist, the title of the work, and the location of sale. Figure 2 shows the timing of records, and illustrates that records have mainly been clustered in three periods: the early 1800s, the 1910s and 1920s, and post-1950. The same figure also shows an index tracking the evolution of the standing record price in real GBP terms

since 1701, an aggregate art price index since 1765 based on Goetzmann, Renneboog, and Spaenjers (2011), and a number of macro-economic data series.

[Insert Table 2 and Figure 2 about here]

IV.2. Caveats

We need to stress that our list should not be considered as "the" list of records, but as "a" list of records, for three reasons. First, we believe that the criteria we used to identify records are sensible and defensible, but they are not without impact on the list. We can give many examples. If we had taken a USD rather than GBP perspective, there would have been no 1984 Raphael and 2002 Rubens records; by contrast, our list would have included a 1986 Manet record. A focus on deflated rather than nominal prices would of course have implied a shorter list. Because we only consider one artwork per auction, there are no 1958 Manet and Van Gogh records on our record. If we had focused on hammer prices rather than prices inclusive of transaction costs, a 1913 Romney record would have to be added and a 1980 Van Gogh dropped from our list. Second, it is not impossible—it is even probable—that we have missed a record-breaking auction. For example, Mühsam (1925) mentions an 1872 sale of a Van Dyck painting in London for 37,800 GBP. That sale would be a record, but we could not find any evidence of the auction in other data sources. More generally, for the first 250 years of our time frame, we need to base our analysis on a selective reading—it is infeasible to review all sales in all books covering the history of the art market—of the data that have survived. Third, there are a few items that may not entirely follow our own criteria. For example, it is unclear whether the 1804 Dou record should be considered as a buy-in, as "experts" involved in the sale pushed up the price and the work was eventually purchased by the auctioneer.

IV.3. Record prices for art at auction 1701−2014

For all transactions listed in Table 2, we collect information on the identity of the seller and the circumstances of the sale, the identity of the buyer, the characteristics of the artwork, and the organization of the sale by the auction house. Sources that we consult include auction catalogues, notes on the transactions in the Getty Provenance Index and the different art market reference works mentioned before, books on the history of the art market, press articles and academic texts covering the record sales, and entries on the artworks in Wikipedia and on museum websites. We briefly describe the chronology of our list here, and add (rumoured) buyer identities to Table 2, but a full description of all works and sales is beyond the scope of this paper.

The list starts with a string of eight records set between 1701 and 1811 by three seventeenth-century Dutch and Flemish masters: Gerard Dou (four times), Anthony Van Dyck (twice), and Rembrandt (twice). The high prices paid for Dou may nowadays be a surprise to many, but Reitlinger (1961) notes that "in 1771 a Gerard Dou was about the most expensive thing you could buy". According to Smith (1829–1842), the Dou picture that set a record in 1771 (and which Reitlinger describes as "Picture in three wings") is the same as the first entry on our list. At the 1771 sale, the work was bought by an agent of Catherine the Great, but the ship that transported it sank on the way to Russia. Also the two Van Dyck sales of "Rest on the flight into Egypt" in 1713 and 1733 refer to one and the same painting. In the 1713, it was the first lot in the sale of the collection of William III of England, who had died in 1702 (Jonckheere, 2004). At the 1733 sale, it was bought for Sir Robert Walpole, but it would later move to Catherine the Great's collection. The 1808 Dou record is the last transaction in the Netherlands on our list. The next entry, the sale of Rembrandt's "Shipwright and his wife" in 1811 is the first of many record transactions at either Christie's or Sotheby's.

After 1811, our list shows a gap of more than four decades. In 1852, a painting by Murillo on the "Immaculate conception" was auctioned off as part of the estate sale of one of Napoleon's

commanders, Marshal Soult, who had compiled an impressive art collection during the invasion of Spain. The work triggered a bidding war between the Louvre, the National Gallery, and the Tsar of Russia, and was ultimately auctioned off to the Louvre for 24,600 GPB, more than four times the price paid for Rembrandt's "Shipwright and his wife". (The painting has later been donated back to Spain.)

It took almost sixty years before the record set by the Murillo was broken. In 1910, art dealer Knoedler bought a portrait by Frans Hals at auction in New York—the first record sale in the U.S.—for the equivalent of 28,250 GBP (and resold it to Henry Frick for 31,000 GBP). The transaction was quickly followed by more Old Master record transactions. In 1912, a Mantegna painting was sold in Berlin to a dealer for 29,500 GBP, and in 1913 Duveen paid 44,000 GBP for a Rembrandt in Paris. Both paintings were resold to Benjamin Altman. New records continued to be set after the end of the First World War, but the works looked entirely different. In 1919 and 1926, George Romney and Sir Thomas Lawrence became the most expensive artists ever, with their late-eighteenth-century portraits of girls and women.

Only in 1957 did an auction price eclipse the 77,700 GBP paid for Lawrence's "Pinkie" in 1926. A still-life with apples by Gauguin was sold for 104,630 GBP at auction in Paris. In 1958, the Cezanne painting "Garçon au gilet rouge" was sold for more than double the previous record price. The work was the sixth lot in an auction of seven modern masterpieces; lots three (Manet) and four (Van Gogh) had already broken the Gauguin record. Yet, the record price was quickly exceeded by the sum paid for Rubens in 1959, and then for Rembrandt in 1961. The 817,052 GBP paid for Rembrandt's "Aristotle with a bust of Homer" in 1961 was more than three times more than the 275,000 GBP paid for Rubens two years before. In turn, the Rembrandt record was shattered in 1970, when 2.3 million GBP was paid for a Velasquez portrait. Both the Rembrandt and the Velasquez were acquired by the Metropolitan Museum.

In the 11 years from 1980 until 1990, our list shows nine records, which is as much as over the first two centuries of our sample. Of course, the art market boom in this period is well-known. The record

went from 2.5 million GBP for one Van Gogh ("Le jardin du poète, Arles") in 1980 to 49 million GBP for another one ("Portrait du Dr. Gachet") in 1990. Two other Van Gogh paintings set records in between. In March 1987, almost 25 million GBP was paid for a painting from Van Gogh's Sunflower series—more than three times the 8.1 million GBP price tag associated with Mantegna's "Adoration of the Magi" in 1985—and less than eight months later "Irises" raised 30.3 million GBP. Apart from the Van Goghs and the Mantegna, we also see record prices for works by J. M. W. Turner in 1980 and 1984, for a Raphael in 1984—the only drawing on our list—and for a Picasso in 1989. Although the sale of Picasso's "Les Noces de Pierrette" was held in Paris, the auction house published a bilingual French-Japanese sale catalogue, held an exhibition of the work in Tokyo a few weeks before the sale, and organized a video satellite connection with the Japanese capital during the auction. It was the first record sale outside the main auction rooms of Sotheby's or Christie's in more than four decades.

In the early 2000s, the record set in 1990 by Van Gogh's portrait of his doctor was broken first by a large-scale Rubens masterpiece, and then by Picasso's "Garçon à la pipe". In 2010, Giacometti's "L'homme qui marche I" was the first and only sculpture to become the record holder, but it quickly yielded its position to another Picasso, "Nude, green leaves, and bust". A version of Munch's iconic "The scream" sold for 74 million GBP in 2012. But in 2013 Bacon's triple portrait of Lucian Freud fetched 89.4 million; at the end of 2014 it is still the most expensive piece of art ever to be sold at auction worldwide.

V. Understanding Art (Record) Prices

The timing of the records in our series is largely consistent with previous findings on the relation between macro-economic trends on the one hand and art prices on the other. For example, Figure 2 suggests that sharply decreasing wealth inequality (and trade openness) in the U.K. and the U.S. can help explaining the lack of records between 1926 and 1957, and that the fast succession of records over

the last three-four decades is related to the strong growth in wealth worldwide. However, the records also illustrate the problem with a pure macro perspective. Even adjusting for the changes in taste through time, we see a decoupling of price from quality at the boundary. Not all the record-breaking works in Table 2 are regarded as the masterworks of the artists who created them, or can even be labeled as "unique" items. Moreover, record transactions do not always coincide with periods of price increases. For example, we observe no records during the second half of nineteenth century (when average prices increased sharply), while we see a number of records between 1910 and 1926 (when average prices plateaued).

We argue that auction price records are often set in situations characterized by one or more of the following elements: (i) extreme supply constraints, (ii) instances of social competition among "nouveaux riches", (iii) resolution of uncertainty about the potential resale value of the artwork, and (iv) idiosyncratic shifts from hedonic weights. In the following paragraphs, we will address each of these points, which illustrate the relevance of the micro perspective on art price formation advocated in Section III.

V.1. Supply constraints

One recurring feature in our series—especially for records set by Old Masters—is the presence of extreme supply constraints. Supply and volume at auction are affected by many factors: the original production by an artist, the collecting by long-lived institutions, financial shocks to collectors, and major disruptions and expropriations such as those that have occurred in twentieth-century Europe. The low rate of return to art investment prior to 1960, for example, may have been due in part to the large volume of art that came to the market due to liquidity shocks around wars and recessions. By the same token, the transfer of masterworks into museums and more permanent collections in the post-war period may have increased scarcity and raised prices for a dwindling supply of sought-after works. The

diminishing supply of high-quality works by Raphael surely contributed to the record price paid for a Raphael study in black chalk—according to the catalogue entry "an auxiliary cartoon"—in 1984. A year later, a news report on the acquisition of Mantegna's "Adoration of the Magi" said that "Mantegna paintings are rare, and very few are left in private hands" (Los Angeles Times, 1985). Until three years before its record sale in 2004, Rubens' "Massacre of the innocents" was considered to be by one of his assistants or followers; the re-attribution turned it into one of the very few large-scale paintings not yet in museums.

V.2. New wealth and the establishment of social recognition

The changes in the type of purchasers of our record pieces are informative. In the eighteenth and nineteenth century the buyers were mainly European monarchs and rulers. In the early twentieth century we only see purchases by—or on behalf of—wealthy American businessmen: Henry Frick, Benjamin Altman, Andrew Mellon, and Henry Huntington. Much of their wealth had been created relatively recently. After the Second World War, the population of buyers internationalizes, in line with changing wealth patterns, but continues to consist mainly of bankers, industrialists, etc. The strong Japanese demand in the late 1980s that followed the country's economic boom manifests itself in our record series: Japanese buyers were behind three of the four record purchases between 1987 and 1990.

The record series also illustrates how auction houses can actively seek to increase—or lever—wealthy individuals' buying power. In 1987, Sotheby's financed half of Australian industrialist Alan Bond's record purchase of Vincent van Gogh's "Irises", with the painting itself as collateral. (Bond was not able to repay the loan, and in 1990 sold the piece to the Getty museum in a deal also involving Sotheby's.) In 2013, Christie's changed the lot number of Francis Bacon's "Three studies of Lucian

Freud" from 32 to 8A just before the sale. Rumour had it that this was done because one of the interested Chinese collectors would only bid on the work if it had lot number 8 (Bloomberg, 2013).

Apart from the importance of new money itself, our record series also clearly illustrates the role of social competition—often among "nouveaux riches"—in the determination of art prices at auction. Indeed, some of the record prices materialized after a fierce bidding war between different parties. We give a few examples. First, in 1852, the Louvre, the National Gallery, and the Tsar of Russia fought for Murillo's "Immaculate conception". Jouin (1895) describes the sale as follows: "The greatest nations were represented with their rival gold, and loud applause accompanied each royal bid. When, for the sum of 615,300 francs, it was knocked down—'To France, gentlemen!' cried the Count de Nieuwerkerke—then broke forth the delirium of a battle won."

Second, in the early twentieth century, the search of the American new wealthy for European pictures created fierce competition between collectors. After Peter Widener bought a Rembrandt in 1911, Benjamin Altman "informed Henry Duveen that he required his own Rembrandt" (Saltzman, 2009); Duveen would pay an auction record price when acquiring one in 1913. Similarly, Secrest (2004) reports on the competition between Andrew Mellon and Henry Huntington for Romney and Lawrence portraits—leading to auction record prices in 1926. But prices were also driven up by the rivalry between dealers. For example, before the 1910 sale of Frans Hals' portrait of an old woman, art dealer Knoedler had vowed not to let his rival Duveen—who, like him, was buying pictures for Henry Frick—"get this picture at any price within reason" (Saltzman, 2009).

Third, and finally, in 1957, Gauguin's "Apples" sold for a record price in Paris after a bidding war between Greek shipping owners. The New Yorker reported "a sudden desire to acquire the canvas which ignited simultaneously in the bosom of Mr Goulandris and Mr Stavros Niarchos, causing an explosion of human nature that blew the roof off the international art market" (cited in Hook, 2009). More generally, the transformation of auctions from dull wholesale trading sessions into glamorous

high-society events has almost certainly contributed to the increase in competitive ambiance at auctions since the 1950s.

One distinctive feature of Figure 2 is the clustering of record events. It is not surprising to see that records were broken more frequently in nominal terms in the (second half of the) twentieth century, when inflation was higher, and barriers to global trade and capital flows decreased while global wealth sharply increased. However, the inter-arrival times between records within the twentieth century are clearly not random, as one would expect from a stationary Poisson process. The clustering of records—in practice sometimes even within a single auction (cf. supra)—suggests temporal dependency. One conjecture is that the inter-temporal clustering may indicate competitive bidding with respect to how much wealthy collectors are willing to pay for major works of art—regardless of the specific characteristics of the artwork. The setting of a record itself may induce rival collectors to set a record. This may also explain the unremarkable nature of some of the record-setting works.

V.3. Resolution of uncertainty about the resale value

Our record series includes a number of works of which multiple versions or editions exist, and that can thus not necessarily be described as "unique". For example, Vincent Van Gogh did a whole series of sunflower paintings; by the time of the 1987 sale of one of them, other versions were in the National Gallery in London, the Museum of Art in Philadelphia, and the Rijksmuseum in Amsterdam. Similarly, different versions of Giacometti's record-breaking statue or Munch's "The scream" exist, but most or all are in museums, validating the importance of the work for sale. For such works, prices may be especially high because there is little uncertainty about the existing preferences for the work—and therefore about the resale potential.

Also the frequent succession of records by the same artist in short time periods, at least over the last few decades, can be linked not only to idiosyncratic changes in the demand for "consumption" of the artist's work, or to social competition, but also to the idea of resolution of uncertainty about the resale value. In such a view, the increased propensity of art owners to sell after increases in price levels could have contributed to the clustering of records—both on a market-wide and on an artist-specific level—over time.

V.4. Idiosyncratic shifts from hedonic weights

Even taking into account the above factors, it is difficult to comprehend record prices for a study in black chalk (even if it is by Raphael), for a Giacometti statue of which six editions and four artist proofs exist (and that realized a price about four times the pre-sale estimate), or for George Romney and Thomas Lawrence portraits, without relying on idiosyncratic shifts from hedonic preferences. Clearly, hedonic models only capture "average" preferences as shown by all available historical transactions, and deviations from these average correlations between artwork characteristics and prices can be important in practice.

VI. Conclusion

A growing literature in economics has substantially improved our knowledge of the risk-return properties of diversified art portfolios, the correlation patterns between artwork characteristics and prices, and the impact of shifts in income and wealth distributions—and in sentiment—on average art prices. Yet, the aggregate time-series dynamics and average cross-sectional pricing differences hide a lot of underlying variation.

We argue that, to further increase the economic understanding of the market for aesthetics, we need to examine the formation of art prices on a disaggregate level. Each individual artwork gives rise to a market for trading in its private-value benefits. Within this framework, we discuss recent theoretical and empirical studies on the different forces driving the willingness to pay of bidders at art auctions. Emerging conclusions of this new body of work are that the enjoyment associated with art ownership is multi-faceted, that preferences interact with wealth in determining the magnitude of private values, that beliefs about resale revenues affect auction outcomes, and that auction house strategies matter.

We then illustrate the relevance of a micro perspective on the formation of art prices through a particular case study. Based on historical research, we identify 35 sales of artworks between 1701 and 2014 that set price records (in nominal GBP terms) at auction. We conclude that auction price records are often set in situations characterized by one or more of the following elements: (i) extreme supply constraints, (ii) instances of social competition among "nouveaux riches", (iii) resolution of uncertainty about the potential resale value of the artwork, and (iv) idiosyncratic shifts from hedonic weights.

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Table 1. Art and Financial Asset Returns 1900–2013

Table 1 shows the deflated returns on art and financial asset classes over the time frame 1900–2013. The table also shows contemporaneous pairwise correlations, and Dimson (1979) betas with respect to real equity returns, real GDP per capita growth rates, and inflation, estimated using same-year and lagged independent variables. The data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2014). The data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2002, 2014). Data on GDP come from Officer and Williamson (2014). *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 level, respectively.

|	Geom. mean	Arithm. mean	S.D.	Contemporaneous correlations			Aggregated equity return beta	Aggregated inflation beta	Aggregated GDP growth beta
				Art	Equities	Bonds			
Art	2.3%	3.4%	15.2%	-			0.44 ***	-0.44 *	1.25 *
Equities	5.3%	7.2%	19.8%	0.22	-				
Bonds	1.4%	2.3%	13.7%	0.12	0.50	-			
Bills	0.9%	1.1%	6.3%	0.23	0.26	0.63			

Table 2. Record Prices for Art at Auction 1701−2014

Table 2 shows the record-breaking art auctions identified in this paper. For each record transaction, the table gives the year of sale, the price in GBP including buyer's premium, the artist name, the title of the work, the location of the sale, and the (rumoured) buyer.

Date	Year	GBP	Artist	Title	Auctioneer and sale location	Buyer
20/04/1701	1701	320	Dou	Interior with woman and child	Amsterdam	[unknown]
26/07/1713	1713	1,095	Van Dyck	Rest on the flight into Egypt	Amsterdam	Cornelis Wittert van Valkenburg
07/10/1733	1733	1,105	Van Dyck	Rest on the flight into Egypt	Rotterdam	Sir Robert Walpole, first prime minister of Great Britain
31/07/1771	1771	1,410	Dou	Interior with woman and child	Amsterdam	Catherine the Great of Russia
19/05/1798	1798	1,522	Rembrandt	The centurion	Coxe-Burrell-Foster, London	British banker Sir Francis Baring
15/11/1804	1804	1,680	Dou	Hermit in a cave	Paillet-Delaroche, Paris	Art expert and auctioneer Alexandre-Joseph Paillet
06/06/1808	1808	1,750	Dou	The evening class	Rotterdam	Louis Bonaparte, king of Holland and brother of Napoleon
12/06/1811	1811	5,250	Rembrandt	Shipwright and his wife	Christie's, London	Prince Regent George IV
19/05/1852	1852	24,600	Murillo	Immaculate conception	Paris	Louvre
07/04/1910	1910	28,250	Hals	Portrait of a woman	Amer. Art Assoc., New York	Knoedler—sold to American industrialist Henry C. Frick
20/02/1912	1912	29,500	Mantegna	Holy family enthroned	Lepke's, Berlin	Kleinberger—sold to American entrepreneur Benjamin Altman
09/06/1913	1913	44,000	Rembrandt	Batsheba	Galerie Georges Petit, Paris	Duveen—sold to American entrepreneur Benjamin Altman
06/11/1919	1919	54,600	Romney	The Misses Beckford	Christie's, London	Duveen—sold to American railroad magnate Henry Huntington
28/07/1926	1926	60,900	Romney	Mrs. Davenport	Christie's, London	Duveen—sold to American banker Andrew W. Mellon
24/11/1926	1926	77,700	Lawrence	Pinkie	Hampton's, London	Duveen—sold to American railroad magnate Henry Huntington
14/06/1957	1957	104,630	Gauguin	Apples	Galerie Charpentier, Paris	Greek shipping magnate Basil P. Goulandris
15/10/1958	1958	220,000	Cezanne	Garçon au gilet rouge	Sotheby's, London	Paul Mellon, heir to Mellon Bank fortune
24/06/1959	1959	275,000	Rubens	The adoration of the magi	Sotheby's, London	British property developer Alfred E. Allnatt
15/11/1961	1961	817,052	Rembrandt	Aristotle with a bust of Homer	Parke-Bernet, New York	Metropolitan Museum
27/11/1970	1970	2,310,000	Velasquez	Portrait of Juan de Pareja	Christie's, London	Metropolitan Museum
13/05/1980	1980	2,507,013	Van Gogh	Le jardin du poète, Arles	Christie's, New York	[unknown]
29/05/1980	1980	2,997,403	Turner	Juliet and her nurse	Sotheby's, New York	Argentine philanthropist Amalia Lacroze de Fortabat
03/07/1984	1984	3,564,000	Raphael	Study of a man's head and hand	Christie's, London	Barbara Johnson, heir to Johnson and Johnson fortune
05/07/1984	1984	7,370,000	Turner	Seascape, Folkestone	Sotheby's, London	Canadian businessman David Thomson
18/04/1985	1985	8,100,000	Mantegna	Adoration of the magi	Christie's, London	J. Paul Getty Museum
30/03/1987	1987	24,750,000	Van Gogh	Sunflowers	Christie's, London	Japanese insurance magnate Yasuo Goto
11/11/1987	1987	30,280,899	Van Gogh	Irises	Sotheby's, New York	Australian industrialist Alan Bond
30/11/1989	1989	32,934,977	Picasso	Les noces de Pierrette	Binoche et Godeau, Paris	Japanese businessman Tomonori Tsurumaki
15/05/1990	1990	49,121,762	Van Gogh	Portrait du Dr. Gachet	Christie's, New York	Japanese businessman Ryoei Saito
10/07/2002	2002	49,506,650	Rubens	Massacre of the innocents	Sotheby's, London	Canadian businessman Kenneth Thomson
05/05/2004	2004	58,223,688	Picasso	Garçon à la pipe	Sotheby's, New York	Italian businessman Guido Barilla [?]
03/02/2010	2010	65,001,250	Giacometti	L'homme qui marche I	Sotheby's, London	Brazilian philanthropist Lily Safra
04/05/2010	2010	70,452,891	Picasso	Nude, green leaves, and bust	Christie's, New York	[unknown]
02/05/2012	2012	74,003,394	Munch	The scream	Sotheby's, New York	American financier Leon Black
12/11/2013	2013	89,411,063	Bacon	Three studies of Lucian Freud	Christie's, New York	American casino owner Elaine Wynn

Figure 1. Art and Financial Asset Returns 1900–2013

Figure 1 shows deflated GBP index values for art and financial asset classes over the time frame 1900–2013. The data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2014). The data for equities, bonds, bills, and inflation come from Dimson, Marsh, and Staunton (2002, 2014). Each index is set equal to 100 at the beginning of 1900.
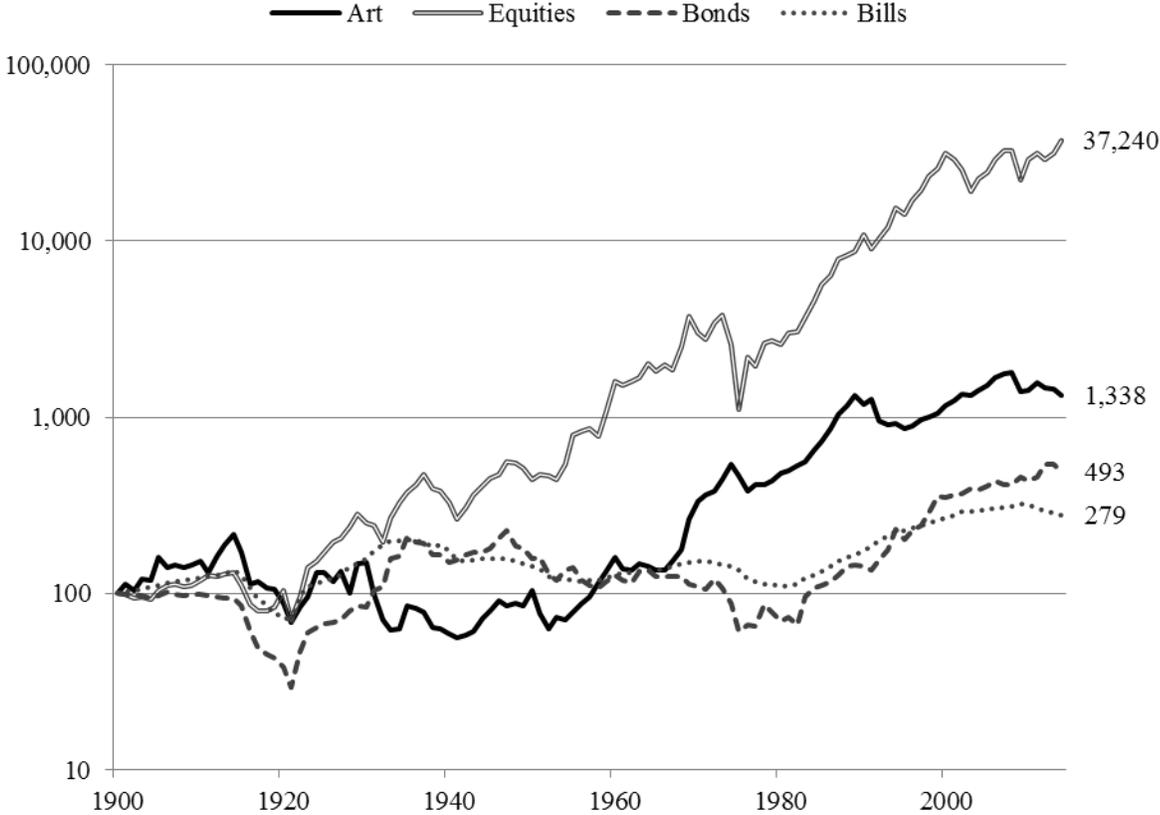
Figure 2. Art Auction Records and the Macro-Economy 1700–2013

The vertical lines in Figure 2 show the timing of art auctions records over the period 1700–2013. Figure 2 also shows an index tracking the record price level, an aggregate art price index (linked to the record price index in 1765), and a U.K. equity price index, all in deflated GBP terms, against the left axis, and U.K. inflation, the share of wealth held by the top percentile in the U.K., and a measure of openness to trade, in percentage terms, against the right axis. Data on inflation come from Clark (2014). The data for art come from Goetzmann, Renneboog, and Spaenjers (2011) and Artprice.com (2014). Data on equities come from Global Financial Data and Dimson, Marsh, and Staunton (2002, 2014). Wealth share data come from Ohlsson, Roine, and Waldenström (2008) and Piketty (2013). Data on exports, imports, and GDP come from Hills, Thomas, and Dimsdale (2010).