On the Efficiency of Art Markets
Evidence on Return Rates from Old Masters
Paintings to Contemporary Art

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September 2019

Abstract

Return rates should not depend systematically on past prices or the place of sale in efficient art markets. We provide evidence consistent with such hypothesis from repeated sales of Old Master Paintings, Modern art and Contemporary art auctioned worldwide at Christie's and Sotheby's in 2000-2018. We also control for changes in transaction costs (buyers' premiums and artists' resale rights), characteristics of the sale (evening sales, price guarantees and past bought-ins) and news on the lots (changed attributions, public exhibitions or death of the author) that appear reflected in art returns. We confirm the absence of masterpiece effects in American, Chinese and Ethnic art. Finally, using historical data on prices during Renaissance, Baroque and Neoclassical periods, we find evidence that price changes are independent from initial prices also in the long run.

Keywords: Art market, Mei-Moses index, Market efficiency, Law of one price, Masterpiece effect, Contemporary art

JEL Classification: C23, Z11

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1 Introduction

Understanding what determines art prices and their changes is challenging for the very reason that each art object is unique. The economic perspective has made some progress by interpreting paintings, or other durable artistic goods, as particular assets that provide an aesthetic dividend and an appreciation, which should be consistent with alternative forms of financial investment (Baumol, 1986; Mandel, 2009). However, empirical investigations of art returns over multiple centuries have provided puzzling results. According to Baumol (1986) art prices fluctuate aimlessly without being anchored to any fundamentals. The classic study by Mei and Moses (2002) and subsequent ones have found positive returns consistent with art investment as a tool of financial diversification, but also inconsistent with basic principles of market efficiency: returns tend to be systematically lower for artworks of higher value, generating the so-called negative masterpiece effect, and different depending on the place of sale, in contradiction with the law of one price (see also the surveys by Ashenfelter and Graddy, 2003, 2006).

In an efficient art market (Fama, 1970), price changes should reflect new information that is publicly available, and should not depend systematically on price levels or past prices (for instance, one cannot expect systematically different returns from purchasing a \$1 million painting rather than ten paintings of \$100,000) or past returns, or the place of trade, otherwise arbitrage opportunities could be rapidly exploited.[1] We provide new evidence consistent with the efficiency hypothesis by investigating the determinants of art returns in a unique dataset on the full set of repeated sales taking place in auctions at Sotheby's and Christie's in New York, London, Paris, Amsterdam, Milan and China between 2000 and 2018. This contributes to avoid the survivorship bias of datasets covering more than one or two centuries as those of Baumol (1986) and Mei and Moses (2002), which may tend to over-represent successful old master paintings, whose transactions have been repeatedly recorded, and to under-represent initially cheap artworks, whose appreciation goes unrecorded. It also allows us to jointly control for a variety of determinants of art returns and understand their impact on art prices.

Since 2000, we find that the average annual return of art investment has been around 4% per year in nominal terms, but substantial differences must be taken into account between art sectors, with contemporary art realizing higher returns than modern art and old master paintings realizing lower returns (part of which could be due to differences in aesthetic dividends

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[1]The irrelevance of historical information for future returns corresponds to the weak form of efficiency in the sense of Fama (1970), while the fact that returns fully reflect new public information corresponds to the semi-strong form of efficiency. Early analyses of art price indexes have found mixed evidence on efficiency in a weak form (Erdős and Ormos, 2010; David *et al.*, 2013).

for the investors, underlying risk of the sector, and transaction costs). More important for our purposes, in all these three sectors there is no evidence of masterpiece effects (neither of serial correlation in returns) and we do not find significant differentials between return rates in different auction houses or places of sale, which is consistent with the efficiency hypothesis. We then verify to what extent art returns reflect news emerging between purchase and sale, including changes in transaction costs (that are important due to the large increase in commissions over the last years), in the observable characteristics of the sale (such as whether this has been moved to an evening sale, whether the lot has been subject to a new price guarantee or whether there was a failure to sell it in an auction between purchase and sale), and new information on the value of the artwork, for instance a new attribution for old master paintings, a public exhibition for modern artworks and the death of the author for contemporary art. Some of these factors have been considered alone (for instance in the important works of Beggs and Graddy, 1997, 2008; Banternghansa and Graddy, 2011; Graddy and Hamilton, 2017; Ekelund *et al.*, 2017, and others), but a joint analysis contributes to avoid the possibility of spurios relations. Changes in transaction costs and new information on the value of artworks emerge as crucial determinants of art returns, and allow us to present a corrected art price index depurated from these effects. We cannot reject the efficiency hypotheses also conditional on these controls.[2]

We submit the hypothesis of art market efficiency to additional tests on different investments across space and over time. Other geographical regions or different artistic traditions experienced a flourishing trade in the last decades, as in case of American, Chinese and Ethnic art. We consider these sectors briefly and separately due to the limitation of the datasets, but we can confirm the absence of masterpiece effects and, at least in part, the evidence on the law of one price. Exceptions derive mainly from Chinese art, whose booming trade may not be fully integrated in the international art market.

We finally return to the long run analysis of Baumol (1986) and Mei and Moses (2002) in a different perspective. Using art historical data from Renaissance, Baroque and Neoclassical periods we identify artists for whom we can match historical prices and contemporary prices, and we test whether price changes have been independent from the initial prices, a long run implication of the lack of masterpiece effects. The data derive from the primary market of Renaissance Italy (Etro, 2018), from inventories and auctions in the markets of the 1600s in

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[2]Notice that we are not denying the possibility of inefficiencies in local art markets or profitable opportunities for players with market power in the primary market, as witnessed by the flourishing sector of art galleries in New York, world capital of art since the second half of the last century (and led first by Leo Castelli and then by the Pace and Gagosian galleries). In other words, we are not arguing for efficiency in the strong form of Fama (1970), but simply that arbitrage opportunities are limited in the international auction market for secondary sales.

Italy and Amsterdam (see Montias, 2002) and from auctions in Paris and London between 1700s and early 1800s (from the Getty Research Institute; see Etro and Stepanova, 2015, 2017). To avoid the survivorship bias and expand the number of observations, we focus on the highest prices per painter between the historical records and the highest prices per painter between the contemporary sales. For all periods and schools we cannot reject the independence of price changes from the initial price levels. While this evidence should be evaluated *cum grano salis*, it is consistent with the idea that art prices are effectively anchored to fundamentals reflecting a distribution of preferences of the art collectors, and price changes are independent from the initial prices and appear to be driven by aggregate fluctuations of art returns in efficient art markets.[3]

The rest of the work is organized as follows. Section 2 reviews the literature on art returns. Section 3 describes the main dataset. Section 4 analyzes the empirical results. Section 5 analyzes other art sectors. Section 6 looks at the long run perspective. Section 7 concludes.

2 Review of the literature

Early works on return rates of art investment were descriptive. For instance, the major work of Reitlinger (1961) analyzed prices in the U.K. for famous painters in the period 1760-1960, documenting the gradual increase of the prices of Italian old masters, the rise of Impressionists and other modern artists, and the rapid increase and then decline of the prices of living British artists between the end of the 1800s and the beginning of the 1900s.[4] Subsequent econometric investigations have adopted either the hedonic approach[5] controlling for different characteristics of the paintings, or the repeated sales approach (introduced by Bailey *et al.*, 1963) focused on multiple sales of the same paintings. The latter is appropriate when the control for the characteristics of each artwork is crucial but the quantifiable evidence is incomplete. The systematic investigation of art returns from repeated auction sales was started by Baumol (1986), who used the Reitlenger dataset to show that real annual return rates were normally

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[3]Notice that this independence of price changes from price levels reproduces a Gibrat's law of proportionate effect (Gibrat, 1931), which is consistent with a lognormal distribution of art prices.

[4]Similarly, Rush (1961) has analyzed auction prices mainly in the U.S. for old masters and modern painters with particular reference to the period 1925-1960, building the first price indeces for different artistic schools on the basis of comparable paintings by their leading painters, and emphasizing the downturn of art prices during the Great Depression and the spectacular increase during the 1950s, especially for modern abstract art. Later on, Herchenröder (1980) has analyzed the art market in the period 1960-1980, when the safest investments were represented by the Dutch school of old masters and the raising stars were contemporary American artists of abstract expressionism and pop art.

[5]The hedonic approach is due to Court (1939). The most comprehensive study of art returns based on the hedonic approach is probably the one by Renneboog and Spaenjers (2013). It finds a nominal return rate of 4% on investment in paintings from all schools during the period 1951-2007.

distributed around an average of 0.6% for 640 multiple sales (selected with a distance of at least twenty years) and to argue that art prices are not anchored to any equilibrium level but float aimlessly. Goetzmann (1993) has extended the Reitlinger dataset with two additional decades of auction sales reaching an estimate for the real return rate of 2% over 3,329 multiple sales between 1716 and 1986, and with much higher return rates for the most recent periods, which is not surprising given the booming prices of paintings traded in the 1980s.

The fundamental contribution of Mei and Moses (2002) has analyzed auction prices mainly in New York for old masters and modern painters, reconstructing prices over a century of past transactions when possible, for a total of 4,896 multiple sales (with average holding periods of 28 years) over the period 1875-2000. Adopting the procedure of Case and Shiller (1987), the authors have proposed what is now known as the *Mei-Moses® Art Index*, estimating real return rates of 4.9% since 1875 and 8.9% since 1950, with a low correlation with the returns of other assets: this suggests that art investment had a performance comparable to stocks, at least in the most recent period, and represented a good tool of portfolio diversification.[6]

Studies on return rates based on repeated sales over long periods are often problematic (see Goetzmann, 1993, 1996; Ashenfelter and Graddy, 2003). It is well understood that datasets based on sales over multiple centuries suffer from a relevant *survivorship bias*, since more successful artworks are more likely to reach certain markets (such as London or New York in the XX century) and are more likely to have been sold repeatedly over long periods in recorded transactions without going out of fashion. This has two crucial implications. First, datasets based on sales over long periods tend to overestimate the performance of investment in old master paintings (since transactions for successful investments are more likely to be recorded), and cannot fully account for the role of contemporary art. Second, artworks that are initially cheap and then become more expensive tend to be underrepresented (since records for the initial transactions are more likely to be lost), and this sample selection creates a bias in favor of return rates that are inversely related to the initial prices: the negative masterpiece effect found by Mei and Moses (2002) and the subsequent literature could be the consequence of this. We will limit the survivorship bias by focusing on a more restricted period of time, for which we collected a comprehensive set of repeated sales based on the analysis of all the auctions at Sotheby's and Christie's worldwide (fully available online for this period since 2019). Moreover, we will deal separately with old master paintings, modern art and contemporary art, and confirm our results also on other art sectors (as well as in a new dataset on historical records since Renaissance).

Most of the estimates of the determinants of return rates and tests of the law of one price on

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[6]See also Dimson and Spaenjers (2011) on collectible stamps.

repeated sale regressions do not control in an exhaustive way for the new information emerging between purchase and resale that affect returns, and ignore the impact of changes in buyer's premia and artists' resale rights. These news are important because they should be reflected in prices and returns in an efficient market. Some of these factors have been considered separately, but not jointly, and not in the analysis of the law of one price, as we will do here.[7]

Few works have tested implications of art market efficiency, and have analyzed distinct factors that can predict (or at least correlate with) returns. Mei and Moses (2002) have emphasized the existence of unexploited opportunities of arbitrage across different auction houses: this confirms violations of the law of one price found also by Ashenfelter (1989) and Pesando (1993) in related auction markets (see Ashenfelter and Graddy, 2003, 2006, for surveys).[8] They have also tested for the masterpiece effect, according to which more expensive artworks would feature higher returns: contrary to this hypothesis, which is popular between art dealers (often recommending clients to "buy the best they can afford"), Mei and Moses (2002) have found that masterpieces tend to substantially underperform relative to other works, confirming earlier findings on prints (Pesando, 1993) and contemporary art (Ashenfelter and Graddy, 2003, 2006).[9]

Other works have analyzed the impact on prices and returns of some particular news. For instance, the same artwork sold at more exclusive evening sales or earlier between the lots on sale tends to have a higher return (Beggs and Graddy, 1997), artworks that went unsold in earlier auctions are "burnt" and tend to exhibit lower returns later on (Beggs and Graddy, 2008; Ekelund et al., 2017) and artworks that have a price guarantee may obtain higher (though riskier) returns (Graddy and Hamilton, 2017). We will jointly verify these predictions in our environment and test additional ones. For old masters' paintings, an upgrade from an uncertain attribution to the authorship of a master (due to the discovery of a signature or a critical revision) is going to increase returns: while the nature of the attribution is often exploited in hedonic models, we are not aware of the use of upgraded attributions of the same painting in

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[7]Some of the available datasets of repeated sales are based on the identification of multiple sales of the same artworks, and sometimes just of artworks with the same author and title, ignoring errors due to unrecorded transactions of the same artwork and to transactions of different artworks with the same author and title. We can avoid also these problems because our dataset identifies when the initial buyer is also the subsequent seller of the same artwork.

[8]Notice that deviations from the law of one price in the primary market would be consistent with natural forms of price dispersion on search goods, though according to Velthuis (2013) price dispersion is rare in the primary markets of New York and Amsterdam (where prices are set by few dealers for each artist, are fixed by size and hardly decreasing). Our focus is not on the primary market but on the international secondary market.

[9]Such a negative masterpiece effect on repeated sales over more than a century (which appears unrelated to risk differentials) provides the undesirable implication that the price of masterpieces should gradually converge toward an average price, which appears counterfactual. Further evidence of abnormal returns related to presale estimates is in Mei and Moses (2005).

repeated sales regressions. For modern paintings, a new public exhibition increases the prestige of the work and the return at the time of sale (as found in hedonic models by Hellmanzik (2016) and emphasized by Fraiberger *et al.*, 2018).[10] For contemporary art, the death of the artist should generate a price increase due to the (negative) impact on the expected supply of the deceased author, and this should increase the effective return (as originally found in hedonic models by Ekelund *et al.*, 2000). The impact of these and other news may be related (for instance, a painting with an upgraded attribution may be moved to an evening auction in a different location and one with a downgraded attribution may lose a price guarantee and go unsold): for this reason a joint econometric analysis is important to verify the determinants of art returns and the hypothesis of conditional efficiency.

3 Data on old master paintings, modern art and contemporary art

We have built our dataset by web scraping catalogues of auctions accessible online by the two leading auction houses, Christie's and Sotheby's, in New York, London, Paris, Amsterdam, Milan and emerging centers in China (Hong Kong and Shanghai) since 2000.[11] This period is subsequent to the one in which the two auction houses were accused of collusion in fixing fees on sellers. It includes an initial decade of booming prices especially for contemporary art and, after the Great Recession, a period of either declining or moderately increasing prices depending on the sector. The average holding period between purchase and resale is 7.9 years for old master paintings, 7.1 years for modern art and 6.4 for contemporary art, which severely limits chances of relevant changes in fashion.

Overall, we collected data from 570 auctions of "Old Masters Paintings", 386 auctions of "Impressionists and Modern Art" and 656 auctions on "Post-War and Contemporary Art", for more than 220 thousand sales. Through information on the provenance of the artworks we could identify each repeated sale taking place in auctions by Sotheby's and Christie's between 2000 and 2018 worldwide, which allows us to be confident that the analysis does not suffer of the survivorship bias that is typical of datasets on transactions recovered over many decades or centuries. Of course, the dataset excludes sales by art galleries and trade in other auction

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[10]We refer to Etro *et al.* (2018) for the impact of exhibition in the Paris Salon during the late 1800s.

[11]The dataset was updated in March 2019. Notice that auctions of old master paintings were recently discontinued in Amsterdam and Milan, and we omitted auctions of old master paintings from Christie's in Rome. We have not considered online auctions that were introduced in the last years for objects of lower value. We should also add that our dataset does not include separate auctions dedicated to the sale of important collections, which contain various artworks, some of which may have been resold at auction in this period.

houses, but one should keep in mind that a large majority of auction trade in artworks with international demand has been intermediated by Sotheby's and Christie's.

3.1 Data description

The dataset consists of 5,277 purchase-and-sale price pairs, divided in 1,013 by old masters, 1,677 by modern artists and 2,587 by contemporary artists. The three joint datasets cover art investment in the main historical fields of Western art, which have been at the basis of most investigations in cultural economics.[12]

Old masters paintings cover most of the established European masters, including Italian masters since the 1400s (especially from Renaissance and the Baroque age), Flemish and Dutch painters mainly from the 1500s and 1600s, French ones especially from the 1700s, and British ones largely from the early 1800s. Given the wide period under consideration and the abundance of works whose attribution is uncertain or associated with a generic school, only a reduced group of old masters are represented by multiple repeated sales (led by van Ostade, Vrancx, Guardi, Boucher and Turner), while most of the others are represented by a single repeated sale. The dataset includes paintings and drawings, with top prices for a *Battle between Carnival and Lent* by Brueghel the Younger sold for almost 7 million pounds in 2011, an *Old man at a casement* by Govaert Flinck sold for 10 million dollars in 2017 and a *Minuet* by Giandomenico Tiepolo sold for 3 million pounds in 2017.[13]

The almost two hundred modern artists include all the main Impressionist painters and post-Impressionist painters, with Renoir featuring the largest number of repeates sales (55), followed by Pissarro (42), Sisley (32), Monet (27) and Degas (28), as well as international artists active in the first half of the 1900s, such as Picasso (with 114 repeated sales), Chagall (51), Matisse (37), Utrillo (27), Picabia and Giacometti (22), Leger (19), Miró (18), Dalí, Bonnard and Ray (17 each), Kandinsky (16), Braque (14) and Magritte (12), while less frequent are repeated sales by other leading painters of the same period such as Klimt, Munch, Klee, Modigliani, Carrá or De Chirico. Modern artworks are mostly oil paintings, but include also drawings, watercolors, sculptures and more. Top prices in the dataset refer to *Nu couché (sur le côté gauche)* by Modigliani sold for \$ 157 million in 2018, a *Suprematist Composition* by Malevich sold for \$ 85 million in 2018, *Femme assise, robe blue* by Picasso (\$ 40 million in 2017) and *Vue de l'asile et de la Chapelle de Saint-Remy by Van Gogh* (\$ 35 million in 2018).

Concerning the more than five hundred contemporary artists in the dataset, there are 152

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[12]For a recent survey on cultural economics in historical perspective see Borowiecki and Greenwald (2018).
[13]All mentioned prices include commissions.

repeated sales of works by Andy Warhol, 74 by Jean-Michel Basquiat, 60 by Damien Hirst, 65 by Alexander Calder, 56 by Gerhard Richter, 55 by Sam Francis, 47 by Jean Dubuffet and 40 by Lucio Fontana. They are followed by Yves Klein (36), Willem de Kooning (33), Frank Stella (20), Robert Rauschenberg (17), Roy Lichtenstein (16), David Hockney and Francis Bacon (12), Banksy (11) and Jeff Koons (10). Fewer repeated sales are recorded for other contemporary artists from all the world, including other famous ones such as Mark Rothko, Jackson Pollock, Barnett Newman, Alberto Burri, Piero Manzoni, Dan Flavin, Maurizio Cattelan and Christo. The dataset includes both paintings and sculptures; in spite of their recent emergence and unusual format, also street art and installations are represented by artists in the dataset, providing a rather comprehensive sample of the international contemporary art. Top prices within our repeated sales are achieved by Francis Bacon, with a *Portrait of George Dyer Talking* and *Three Studies for a Portrait of John Edwards* sold in 2014 respectively for 42 million pounds and 80 million dollars, and three American artists, namely de Kooning with $ 66 million for an *Untitled XXV*, Basquiat with $ 57 million for an untitled work (both sold in 2016), and Warhol with $ 37 million for a *Double Elvis [Ferus Type]* (sold in 2018).

Listed prices include the buyers' premium. We have computed the latter through publicly available data on the transaction cost schemes at Christie's and Sotheby's (see for instance Horowitz, 2014) and auction houses' websites. Through this, we have derived the hammer prices, which are our unit of analysis, in line with most of the previous literature. For the regression analysis we have converted all prices, commissions and estimates in US dollars of 2000. For this reason, our empirical analysis should be interpreted in terms of real returns for American investors or at least in terms of US dollars.

We use information on the buyers' premium at purchase, in percentage of the hammer price, and on the change in the same percentage premium at the time of sale. A constant level of the commission rate should not affect the return rate (since what matters for prices is the total willingness to pay of the buyers), but its change between purchase and resale should have a large impact on the return, and in the last two decades buyers' premia have been increasing substantially (while sellers' premia are typically much lower or null, as well as unknown to the public). For instance, in 2000 Sotheby's fixed its commission rate at 20% on the first $15,000, 15% up to $100,000 and 10% thereafter, in 2005 introduced a 20% rate up to $200,000 with 12% thereafter, in 2008 had a 25% rate on the first $50,000, 20% up to $1,000,000 and 12% thereafter, and new cut-offs were introduced in 2013 for prices in pounds and euros. The schemes of Christie's kept changing in similar ways, but differences in commissions by the two auction houses have been often existing in some price range. At the time of writing Sotheby's applies

a commission of 25% below $300,000 (or 200,000 pounds in London, or 180,000 euros in the Euroarea), 20% up to $4 millions (or 3 million pounds, or 2 million euros) and 12.9% thereafter, except for Amsterdam, where the three rates are 30.5%, 24.4% and 15.74%. Christie's has the same rates with dollar cut-offs set respectively at $300,000 and $3 millions (and different ones for pounds and euros). The overall pattern speaks of highly similar commission rates between Sotheby's and Christie's with increasing levels and regressivity during the last two decades.

We also know when the sale was subject to the artist resale right, which was initially introduced in France (as *Droit de Suite*) and then extended to the European Union, and implies a small additional commission on the hammer price to be paid to the living author or the heirs (see Banternghansa and Graddy, 2011). While the impact of this burden is debated, it represents an additional transaction cost whose introduction or change can affect negatively art returns. We know whether the sale was an evening sale or not and whether there was a price guarantee on the lot: since we are interested in the impact of news on returns, we control for changes to or from evening sales and introductions or eliminations of price guarantees between purchase and sale. For old masters, we have identified each change in attribution between sales as a "New attribution", and we have identified paintings with attribution upgraded from a generic school to a precise attribution, and from an uncertain attribution to a sure authorship, as well as paintings with the opposite destiny (notice that attribution is rarely a relevant issue for ordinary modern and contemporary art). For modern art we have identified artworks which were displayed in a public exhibition between sales (while this is too rare for old master paintings and too heterogeneous in terms of the type of exhibition for contemporary art). Finally, we have built dummies for paintings by contemporary artists who were already dead at the time of purchase, who were still alive at the time of resale, who died just one or two years before the resale (the group for which we expect the strongest death effect) and who died more than two years before the sale.

A preliminary look at the annual nominal return rates (for artworks of unchanged attribution) shows an average return of 4% over all three sectors, but this hides wide differences between sectors. Contemporary art features the highest return, 6%, but also the highest volatility, with a standard deviation of 19%, followed by modern art, with an expected return of 4% and a standard deviation of 14%, and by old master paintings, with an expected return of -1% and a standard deviation of 16%. These returns are low compared to those emphasized in the literature for earlier periods (notably in the case of old master paintings), which maybe due to bad performance of art in the last two decades but also to a survivorship bias affecting other samples. The differences in returns between sectors are interesting (though they may not reflect

long run expected returns), and only in part due to differences in the changes of transaction costs or other controls. An important role in explaining different returns may be associated with (unobservable) differences in the aesthetic dividend of investment in alternative art sectors. In particular, an average investor in old master paintings may obtain a higher aesthetic dividend from owning art (rather than a standard asset) compared to the aesthetic dividend obtained by the average investor in contemporary art:[14] if this is the case, contemporary art commands a higher average return to attract investment. However, also differences in risk may play a role, since contemporary art is riskier than old master paintings and modern art, but provides higher returns on average.[15] Last, we cannot exclude that there is something special about investment in contemporary art, where artistic values are far from established and trade is focused on emerging artists.

The most spectacular returns on art investment for old masters are typically related to paintings whose attribution has been upgraded to a sure authorship.[16] However, high returns are not confined to rare rediscovered paintings: the same authorship of a *Madonna* by Sassoferrato was associated with a purchase for $39,000 in 2003 and a resale for $346,000 in 2016, a drawing by Rubens on *Scipio Africanus welcomed outside the gates of Rome* purchased in 2008 for 250 thousands pounds was resold in 2017 above one and a half million dollars, while a still life by Jan Davids. de Heem purchased in 2005 at 132,000 euros was resold four years later at 337 thousand pounds. In modern art, some of the top return rates in our dataset, have been associated with Giacometti (with a bronze purchased at about two hundred thousand pounds in 2002 and resold for $1.8 million in 2016), Leger, Jacques Lipchitz, Édouard Manet, Paul Signac, and Picasso with multiple works (as a *Femme assise* purchased for about 444 thousand dollars in 2004 and resold for $2.8 million in 2018). In contemporary art, the best performance in our dataset is for two works by Peter Doig (*Swamped* and *The Architect's Home in the Ravine*, both purchased in 2002 just above £300,000 and resold respectively for $26 million and $20 million in 2015), followed by two works by Basquiat (*Furious Man*, *PRE-AGRAV*) and others by Richter (*Gudrun*), Fontana (*Spatial concept, the end of God*), Enrico Castellani (*White surface*), Otto Piene (an untitled work sold for 11,000 euros in 2003 and 360,000 euros

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[14]Recently, neoroscientists have studied different reactions to contemporary art, which is mostly abstract, and traditional art, which is mostly figurative, founding the basis for differences in aesthetic dividends (Kandel, 2016).

[15]Considering reattributed old master paintings, which includes rare disasters and positive "black swans" increases the average return on old masters at similar levels as modern art.

[16]For instance, a *Horse with a rider* was sold in 2015 at Christie's in Amsterdam for $ 14,000 as a work by a follower of Van Dyck, but after further art historical studies (and the removal of overpainting) that have identified Rubens as its author, it was resold at an evening sale of Sotheby's in New York for $5.1 million in 2017. This is the only outlier omitted from the empirical analysis.

Table 1: Descriptive statistics

	Old Masters	Modern Art	Contemporary Art
	Average	Average	Average
	(Standard deviation)	(Standard deviation)	(Standard deviation)
Hammer price at purchase (in USD2000)	151,652 (460,772)	580,406 (1,906,867)	416,255 (1,261,755)
Increase in buyers' premium (in % of hammer price)	4.0 (2.8)	3.7 (3.2)	2.6 (3.2)
Increase in Artists' resale right (in % of hammer price)		0.40 (1.01)	0.17 (1.03)
	Average annualized real return (Standard deviation)	Average annualized real return (Standard deviation)	Average annualized real return (Standard deviation)
Overall	-0.033 (0.16)	0.018 (0.137)	0.035 (0.179)
Day → Evening	-0.013 (0.076)	0.046 (0.118)	0.110 (0.151)
Evening → Day	-0.059 (0.065)	-0.009 (0.087)	0.015 (0.142)
Previously not guaranteed item gets guarantee	0.029 (0.096)	0.026 (0.12)	0.113 (0.157)
Previously guaranteed item loses guarantee	-0.05 (0.075)	0.006 (0.079)	0.028 (0.173)
Previously Failed to sell	-0.093 (0.119)	-0.059 (0.084)	-0.096 (0.166)
Christie's → Christie's	-0.023 (0.233)	0.019 (0.153)	0.043 (0.177)
Sotheby's → Christie's	-0.031 (0.147)	0.012 (0.159)	0.033 (0.176)
Christie's → Sotheby's	-0.038 (0.102)	0.026 (0.116)	0.038 (0.173)
Sotheby's → Sotheby's	-0.03 (0.112)	0.008 (0.118)	0.024 (0.188)
NY → NY	-0.038 (0.089)	0.022 (0.134)	0.034 (0.172)
London → London	-0.034 (0.228)	0.003 (0.109)	0.013 (0.166)
NY → London	-0.022 (0.099)	0.034 (0.147)	0.072 (0.197)
London → NY	-0.051 (0.108)	-0.001 (0.106)	0.037 (0.206)
Paris → NY	-0.039 (0.144)	0.073 (0.198)	0.047 (0.157)
NY → Paris	-0.039 (0.06)	0.033 (0.143)	0.079 (0.199)
Paris → Paris	-0.119 (0.006)	0.017 (0.084)	0.003 (0.135)
Paris → London	-0.044 (0.065)	0.054 (0.291)	0.059 (0.177)
London → Paris	-0.019 (0.098)	0.000 (0.100)	-0.009 (0.157)

in 2015, right after the death of the author), Yoshitomo Nara and other living artists.

We report descriptive statistics on prices and returns in Table 1. The average old master painting is cheaper than the average modern or contemporary artwork. The average real return rate for all the sectors is 2%, but again the differences are substantial across sectors: contemporary art has an average return of 4% in real terms against 2% for modern art and a negative return of -3% for old master paintings in real terms.

3.2 Empirical strategy

The repeated sales approach estimates a continuously compounded return r_{it} on artwork i in period t decomposed as $r_{it} = r_t + e_{it}$, where r_t is the average return in t and e_{it} is an error term, assumed uncorrelated over time and across artworks. Given information on purchase price $B_{i,t}$ at time t and resale price $S_{i,t+h}$ after h_i periods, the logged relative price can be expressed as:

$$r_i = ln\left(\frac{S_{i,t+h_i}}{B_{i,t}}\right) = \sum_{\tau=t+1}^{t+h_i} r_\tau + \sum_{\tau=t+1}^{t+h_i} e_{i\tau} \tag{1}$$

This kind of equation has been estimated by Mei and Moses (2002) and the subsequent literature adopting the three-stage least-square (3SLS) procedure of Case and Shiller (1987), which provides price indexes and return rates corrected for heteroskedasticity when the variance of the error term is not constant and changes with the holding period. We will replicate this estimate in our dataset. To test for our efficiency hypothesis we augment (1) as in:

$$r_i = \sum_{\tau=t+1}^{t+h_i} r_\tau + \alpha_0 ln B_{i,t} + \boldsymbol{\alpha L_i} + \sum_{\tau=t+1}^{t+h_i} e_{i\tau} \tag{2}$$

where α_0 is a coefficient on the initial log price and $\boldsymbol{\alpha}$ is a vector of coefficients for a set of dummies $\boldsymbol{L_i}$ concerning combinations of auction houses and locations where the paintings were purchased and resold. The absence of any masterpiece effect and the law of one price require all the coefficients α_j to be zero.

However, between purchase and sale there are news and changed conditions that can affect prices and can be incorporated in the returns, possibly affecting our efficiency tests. Therefore, we augment (2) with a number of sale-specific controls as in:

$$r_i = \sum_{\tau=t+1}^{t+h_i} r_\tau + \alpha_0 ln B_{i,t} + \boldsymbol{\alpha L_i} + \boldsymbol{\beta X_i} + \sum_{\tau=t+1}^{t+h_i} e_{i\tau} \tag{3}$$

where $\boldsymbol{\beta}$ are coefficients for changed conditions $\boldsymbol{X_i}$ between purchase and sale for a given

artwork i.[17] This allows us to verify whether art returns incorporate new information that is publicly available and further investigate the determinants of art returns and the efficiency hypothesis. It also allows us to build a corrected price index which eliminates price variations due to changes in transaction costs and news on the artworks.

4 Empirical results

In Fig. 1 we show the nominal repeated sales price index for the three sectors, estimating (1) without any controls, as in the standard analysis of Mei and Moses (2002). In line with what mentioned above about return rates, this emphasizes wide differences between sectors: while contemporary art experienced a rapid increase in prices until 2007 followed by a drastic decline during the Great Recession, with a substantial recovery thereafter, modern art experienced a moderate initial increase in prices and stable valuations after the Great Recession, and old master paintings exhibited a minimal increase in the first decade of the century and a gradual decline in prices in the second one.[18] The initial pattern and the superior performance of contemporary art is consistent with earlier findings by Campbell (2008).

In Fig. 2 we display annualized return rates (hammer price on hammer price) in relation with the holding period for each repeated sale: the slope of the relation is not significantly different from zero (also when we exclude intermediate transactions between purchase and sale), which suggests that there are no simple profitable opportunities from investment strategies that vary in terms of the holding period (but one should keep in mind for practical purposes that considering the fixed cost of the buyer's commission, the effective return from investing at art auctions would be increasing in the holding period).[19] This allows us to focus our empirical analysis of the determinants of art returns on the total returns.

We now move to the econometric analysis to test for our efficiency hypotheses. We start in Table 2 by running regression (2) which controls for the initial price of the artworks and location dummies, as well as the time dummies. In principle, we expect that, in an efficient

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[17]We found no influence of the size of paintings on return rates for old master paintings, which is consistent with the absence of arbitrage opportunities. It would be interesting to test the impact of other artists characteristics on returns, such as the age of execution (emphasized by Galenson, 2002, 2006), but we do not have systematic data on this. Nevertheless, preliminary result show an interesting positive relation between return rates on contemporary art and age of the artists at the time of resale.

[18]It is well known that a record sale of new works by Damien Hirst took place at Sotheby's on September 15, 2008, the same day in which Lehman Brothers went bankrupt. Things changed radically after that (see Horowitz, 2014).

[19]This is in contrast with findings by Lovo and Spaenjers (2018) who emphasize a negative correlation between residuals of a repeated sales regression and the holding period. The difference may be due to the fact that our sample covers a larger number of repeated sales.

Figure 1: Nominal Price indexes for old master paintings, modern and contemporary art
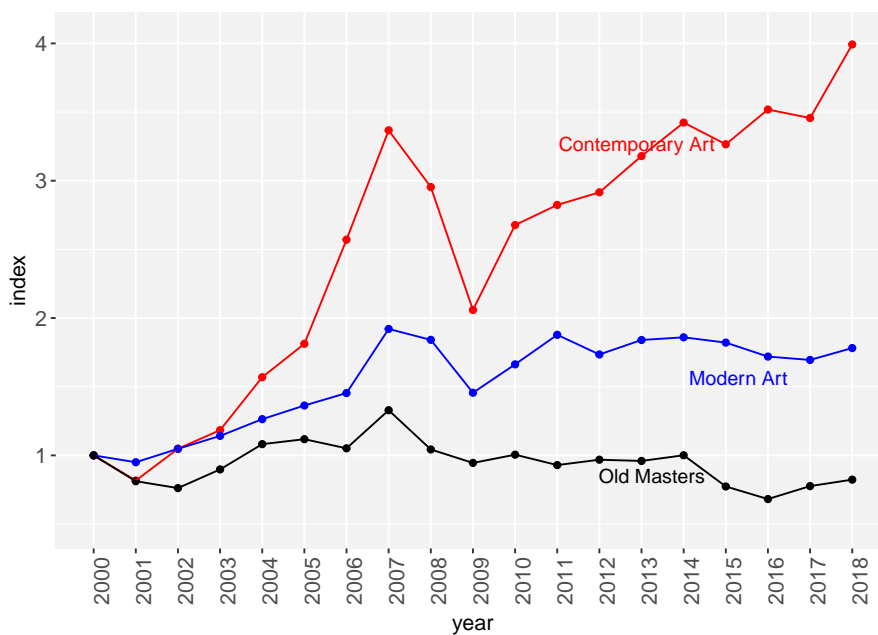

Figure 2: Nominal annual return rates and holding period

Note: Red dots indicate observations when owner changed. Blue line is linear regression fit with 95% confidence bands.

art market, investors could not obtain higher returns by either increasing or reducing the monetary size of their investment. This contrasts with the common view among art dealers that investors should just buy the best (i.e. most expensive) artworks they can afford. On the other side, most of the empirical evidence made available in earlier studies supports the opposite view, for which masterpieces command lower returns (Pesando, 1993; Mei and Moses, 2002; Ashenfelter and Graddy, 2003, 2006). Our results appear consistent with the efficiency hypothesis. We do not find any significant masterpiece effect for any of the three sectors. The coefficient for the logprice at purchase is negative for old masters, as in earlier investigations, but it is not statistically significant. The coefficients for modern and contemporary art are neither economically or statistically significant. Notice that, contrary to Mei and Moses (2002) we have not interacted the initial logprice with the holding period, therefore the magnitude of the coefficients would be even lower (and always statistically insignificant) if we had adopted their correction.

An additional implication of market efficiency in weak form (Fama, 1970) is that not only past prices but also past returns should not systematically predict future returns. Early analyses focus on art price indexes and have found mixed evidence: Erdős and Ormos (2010) cannot reject the random walk hypothesis in the US art market for the latest decades, while David et al. (2013) find high positive autocorrelation in art returns in contrast with efficiency in a weak form. Here we provide the first direct exploration of the hypothesis that returns are not correlated with past returns on a sample of twice repeated sales. Our sample includes 149 artworks that have been purchased and sold a first time, generating a first return rate, and then resold a second time, generating a second return rate (18 old master paintings, 47 modern ones and 84 contemporary ones), with cases of sale a third time, generating an additional twice repeated sale of the same artwork.[20] In Fig. 3 we plot the annualized return rates for subsequent investments: this already shows that there are no systematic patterns in return rates. A regression of art returns on past returns provides the following results:

$$r_{iT} = 2.777 - 0.060 r_{iT-1} + \varepsilon_i \qquad \text{N.obs.} 149, R^2 = 0.0051$$
$$(1.419) \quad (0.069)$$

confirming that we cannot reject the absence of autocorrelation between returns (a result confirmed also sector by sector). This is again consistent with art market efficiency in a weak

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[20]The average holding period is around five years, therefore slightly below the average in the full sample. The average return of the second investment is relatively low for old master paintings and relatively high for modern and contemporary art compared to the full sample.

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Figure 3: Return rates and past return rates

form.

The law of one price suggests that prices in an efficient market should not depend on the auction house or the location of sale, and therefore return rates should not depend on them either. Nevertheless, earlier works have often failed to support such an equalization of returns (see Pesando, 1993; Mei and Moses, 2002; Ashenfelter and Graddy, 2003, 2006). Our more recent and comprehensive dataset allows us to conclude that arbitrage opportunities have been largely eliminated. Table 2 reports for each combination of auction house and location at purchase and sale the percentage of total observations for each sector. We do not find any significant differences in returns for artworks purchased either at Sotheby's or Christie's and sold in the same or a different auction house for each one of the three artistic sectors under consideration. Moreover, most of the coefficients on the different locations of purchase and resale are not significantly different compared to purchase and sale in New York. Most of the exceptions concern minor combinations (possibly affected by small sample bias) and some of them will also vanish once we control for further determinants of art returns.[21]

In Table 3 we report results from the full specification (3) controlling for news emerging between purchase and sale. We start by discussing the impact of the main control variables and then return to the test of the law of one price and the masterpiece effect. Changes in transaction costs have an important impact on returns. An increase in the buyer premium (as a percentage of the hammer price at purchase) is expected to reduce the hammer price at sale

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[21]There are, of course, differences in the realized returns of artists. Between highly traded contemporary artists, returns above average have been found for Klein, Richter, Fontana, Calder and Basquiat, while Warhol and Dubuffet had returns that were not significantly different from the average and Hirst had returns below average.

Table 2: Repeated sale regressions on old master paintings, modern and contemporary art

					Dependent variable: Real total return					
					Old Masters		Modern Art		Contemporary Art	
$lnB_{i,t}$ Masterpiece effect					−0.007	(0.006)	0.001	(0.003)	−0.002	(0.003)
Location at purchase → location at resale										
(Transactions' volume in % for each of 3 art segments)										
Christie's	→	**Christie's** benchmark	(28%,	34%,	28%)					
Sotheby's	→	Christie's	(23%,	12%,	17%)	0.026	(0.060)	0.007	(0.038)	0.043	(0.039)
Christie's	→	Sotheby's	(23%,	30%,	28%)	0.095	(0.060)	0.031	(0.029)	−0.041	(0.035)
Sotheby's	→	Sotheby's	(26%,	24%,	27%)	0.004	(0.054)	0.021	(0.034)	0.029	(0.036)
NY	→	**NY** benchmark	(20%,	33%,	36%)					
London	→	London	(27%,	24%,	22%)	−0.056	(0.058)	−0.048	(0.031)	−0.084**	(0.035)
NY	→	London	(15%,	19%,	12%)	0.024	(0.072)	0.079**	(0.034)	0.074*	(0.043)
London	→	NY	(13%,	13%,	13%)	0.046	(0.079)	−0.047	(0.038)	0.009	(0.042)
Paris	→	NY	(3%,	3%,	1%)	−0.085	(0.124)	0.181***	(0.066)	0.144	(0.132)
NY	→	Paris	(1.6%,	2%,	1.3%)	−0.145	(0.165)	0.078	(0.092)	0.093	(0.121)
Paris	→	London	(1.1%,	3%,	1.3%)	0.081	(0.157)	0.111	(0.070)	0.125	(0.111)
London	→	Paris	(0.6%,	2%,	3%)	0.103	(0.371)	−0.075	(0.084)	−0.214**	(0.079)
Paris	→	Paris	(0.2%,	1%,	2.3%)	−0.287	(0.211)	0.161	(0.129)	0.002	(0.086)
Amsterdam	→	Amsterdam	(4%,	,	0.3%)	0.033	(0.101)			0.070	(0.225)
Amsterdam	→	London	(5%,	,	0.2%)	−0.061	(0.099)			0.002	(0.263)
London	→	Amsterdam	(3%,	,	0.5%)	0.027	(0.105)			−0.209	(0.187)
Amsterdam	→	NY	(2%,	,	0.2%)	−0.026	(0.126)			0.307	(0.218)
Milan	→	London	(1.2%,	,	1.4%)	0.619***	(0.181)			0.075	(0.119)
Milan	→	Milan	(,	,	1.2%)					0.145	(0.122)
NY	→	China	(,	,	0.7%)					0.563***	(0.161)
London	→	China	(,	,	0.6%)					−0.094	(0.182)
NY	→	Amsterdam	(1.3%,	,	0.3%)	0.002	(0.164)			−0.544*	(0.284)
London	→	Milan	(0.2%,	,	0.5%)	0.407***	(0.130)			0.208	(0.192)
Milan	→	NY	(0.5%,	,	0.2%)	0.321	(0.284)			0.232	(0.307)
Milan	→	Paris	(,	,	0.2%)					−0.120	(0.277)
Milan	→	Amsterdam	(,	,	0.1%)					0.187	(0.427)
Paris	→	Amsterdam	(0.3%,	,	0.1%)	0.007	(0.180)			−0.103	(0.391)
Paris	→	China	(,	,	0.1%)					0.397	(0.333)
Time dummies					(YES)		(YES)		(YES)	
Observations					1,013		1,675		2,580	
R^2					0.24		0.16		0.21	

Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parenthesis

Table 3: Repeated sale regressions on old master paintings, modern and contemporary art

					Dependent variable: Real total return					
					Old Masters		Modern Art		Contemporary Art	
$lnB_{i,t}$ Masterpiece effect					-0.005	(0.006)	0.002	(0.002)	-0.000	(0.003)
Transaction costs										
$\Delta_{t,t+h}$ Buyers' premiums (in % of hammer price)					-0.133^{***}	(0.013)	-0.101^{***}	(0.006)	-0.143^{***}	(0.007)
$\Delta_{t,t+h}$ Artist resale right (in % of hammer price)							-0.026^{**}	(0.012)	-0.039^{***}	(0.013)
New information for bidders										
Day $\rightarrow$ Evening					0.382^{***}	(0.074)	0.169^{***}	(0.059)	0.320^{***}	-0.052
Evening $\rightarrow$ Day					-0.009	(0.150)	-0.127^{**}	(0.059)	-0.147^{***}	-0.058
Previously not guaranteed item gets guarantee					0.052	(0.239)	0.036	(0.071)	0.171^{***}	(0.052)
Previously guaranteed item loses guarantee					0.238	(0.250)	0.024	(0.060)	0.043	(0.065)
Previously Failed to sell					-0.304^{**}	(0.130)	-0.379^{***}	(0.071)	-0.574^{***}	(0.113)
Downgraded from certain attribution to school					-0.769^{***}	(0.164)				
Downgraded to uncertain attribution					-0.517^{***}	(0.177)				
New attribution					0.059	(0.077)				
Upgraded from school					0.613^{***}	(0.114)				
Upgraded from uncertain attribution to certain attribution					0.654^{***}	(0.139)				
Exhibited on public							0.153^{***}	(0.045)		
Died within 2 years before the resale									0.260^{***}	(0.081)
Died more than 2 years before the resale									0.107	(0.071)
Location at purchase $\rightarrow$ location at resale										
(Transactions' volume in % for each of 3 art segments)										
Cristie's	$\rightarrow$	**Christie's** benchmark	(28%,	34%,	28%)					
Sotheby's	$\rightarrow$	Christie's	(23%,	12%,	17%)	0.012	(0.052)	-0.012	(0.035)	0.036	(0.035)
Christie's	$\rightarrow$	Sotheby's	(23%,	30%,	28%)	0.081	(0.051)	0.043	(0.027)	-0.019	(0.032)
Sotheby's	$\rightarrow$	Sotheby's	(26%,	24%,	27%)	0.009	(0.050)	0.033	(0.031)	0.051	(0.033)
NY	$\rightarrow$	**NY** benchmark	(20%,	33%,	36%)					
London	$\rightarrow$	London	(27%,	24%,	22%)	-0.079	(0.054)	-0.025	(0.030)	-0.053	(0.033)
NY	$\rightarrow$	London	(15%,	19%,	12%)	0.044	(0.063)	0.050	(0.032)	0.021	(0.041)
London	$\rightarrow$	NY	(13%,	13%,	13%)	0.034	(0.066)	-0.027	(0.034)	-0.012	(0.039)
Paris	$\rightarrow$	NY	(3%,	3%,	1%)	-0.021	(0.111)	0.090	(0.067)	-0.015	(0.120)
NY	$\rightarrow$	Paris	(1.6%,	2%,	1.3%)	-0.168	(0.159)	0.162^{*}	(0.097)	0.129	(0.109)
Paris	$\rightarrow$	London	(1.1%,	3%,	1.3%)	0.046	(0.181)	0.007	(0.068)	0.107	(0.106)
London	$\rightarrow$	Paris	(0.6%,	2%,	3%)	0.011	(0.256)	-0.075	(0.088)	-0.099	(0.074)
Paris	$\rightarrow$	Paris	(0.2%,	1%,	2.3%)	-0.409	(0.384)	0.053	(0.117)	-0.088	(0.079)
Amsterdam	$\rightarrow$	Amsterdam	(4%,	,	0.3%)	-0.051	(0.096)			0.027	(0.203)
Amsterdam	$\rightarrow$	London	(5%,	,	0.2%)	-0.175^{*}	(0.089)			-0.225	(0.238)
London	$\rightarrow$	Amsterdam	(3%,	,	0.5%)	0.011	(0.110)			-0.042	(0.166)
Amsterdam	$\rightarrow$	NY	(2%,	,	0.2%)	-0.121	(0.136)			0.127	(0.212)
Milan	$\rightarrow$	London	(1.2%,	,	1.4%)	0.482^{***}	(0.166)			-0.016	(0.110)
Milan	$\rightarrow$	Milan	(,	,	1.2%)					0.152	(0.112)
NY	$\rightarrow$	China	(,	,	0.7%)					0.314^{**}	(0.146)
London	$\rightarrow$	China	(,	,	0.6%)					-0.148	(0.162)
NY	$\rightarrow$	Amsterdam	(1.3%,	,	0.3%)	-0.032	(0.154)			-0.429^{*}	(0.248)
London	$\rightarrow$	Milan	(0.2%,	,	0.5%)	0.260	(0.378)			0.429^{**}	(0.173)
Milan	$\rightarrow$	NY	(0.5%,	,	0.2%)	0.153	(0.261)			0.024	(0.276)
Milan	$\rightarrow$	Paris	(,	,	0.2%)					-0.394	(0.252)
Milan	$\rightarrow$	Amsterdam	(,	,	0.1%)					0.213	(0.370)
Paris	$\rightarrow$	Amsterdam	(0.3%,	,	0.1%)	-0.039	(0.317)			-0.156	(0.373)
Paris	$\rightarrow$	China	(,	,	0.1%)					0.241	(0.317)
Time dummies						(YES)		(YES)		(YES)
Observations						1,013		1,675		2,580
R^2						0.40		0.31		0.40

and therefore the return rate. If all what matters for bidders was the total paid price, we would expect that the additional commission would exactly crowd out the hammer price, but this ignores indirect effects on the demand side (and parallel changes on the supply side associated with unobservable changes in the seller' premium), which may generate a larger impact (see also Ekelund *et al.*, 2017). Indeed, we find a substantial negative impact between 10% and 15% of the total return as a consequence of a 1% increase in the commission rate. When the artwork is subject to new or increased artist resale rights, the return is reduced further, though the impact is small due to the limited size of these commissions (typically around 2% of the hammer price when in place).

Further new information at the time of sale is clearly incorporated in the return rates (though we cannot verify how quick is the price reactions). When the same artwork is moved from a day auction to a more selective evening auction, the auction house is signaling an upgrade in the valuation of the artwork by the experts of the auction house: in such a case we find that the total return increases, especially in case of old master paintings (by 38%) and less in case of modern art (by 16%), while a negative impact is associated with a move to a day auction, though this is significant only in case of modern and contemporary art (with a corresponding reduction of the return by 13% and 15%). In line with Graddy and Hamilton (2017) we do not find a clear impact on returns when artworks are insured by price guarantees of different types: probably, this kind of news could be interpreted in different ways in the market. Instead, an earlier failure to sell a painting represents bad news reflected in a reduced return in the future. In particular, we have identified 94 paintings with a sequence of sale, failure to sell and then sale, including 20 by old masters, 44 by modern painters and 30 by contemporary artists. The negative impact on the return is high, between 30% and 60% of the return rate, and significant in all cases (supporting the results of Beggs and Graddy, 2008).

In each sector there are particular forms of information that should be incorporated in the return rates once they become publicly available. For old master paintings, the impact of an upgrade from a school or an uncertain attribution to a certain authorship (due to new information by art experts) has a positive and large impact on returns that is not far, in absolute value, from the negative impact of a downgrade to an uncertain attribution or to a school, while a simple change of attribution has no significant impact on returns (since it is a mix of attributions to better and worse artists). For modern art, display in a public exhibition between purchase and resale adds to the perception of prestige of the artist and the artwork (see Fraiberger *et al.*, 2018): indeed, we find that an exhibition exerts a positive and significant impact on prices, with an increase of the total return by 15%. For contemporary art, we checked

for the existence of a death effect (due to the reduction in the expected supply of works by the artist). Compared to artists who did not die between purchase and sale, the return on artists that died one or two years before the sale are 26% higher, with a smaller impact when the death occurred more than two years before the sale.[22] Overall, art prices and return rates appear to reflect new public information, in line with what one would expect in efficient markets in a semi-strong form (though our data does not allow us to verify whether the price reaction is too slow or too low or high).

Finally, we turn again our attention to whether return rates on art investment differ depending on price and location of sale to verify whether interactions with further determinants of price changes may have driven earlier results. As before, we do not find any significant masterpiece effect for any of the three sectors, and we do not find any significant differences in returns for artworks purchased in either Sotheby's and Christie's and sold in the same or a different auction house for each one of the three artistic sectors under consideration. In conclusion, the mentioned implications of the efficiency hypothesis cannot be rejected in the main sectors of contemporary art auctions, which contrasts early findings in the literature. One would be tempted to conclude that only recently globalization has generated a fully integrated market for Western art.[23] However, in the following sections we will present new evidence in support of the efficiency hypothesis also in other sectors and in a long run perspective, which strengthens the idea that the efficiency of art market is not just a recent phenomenon.
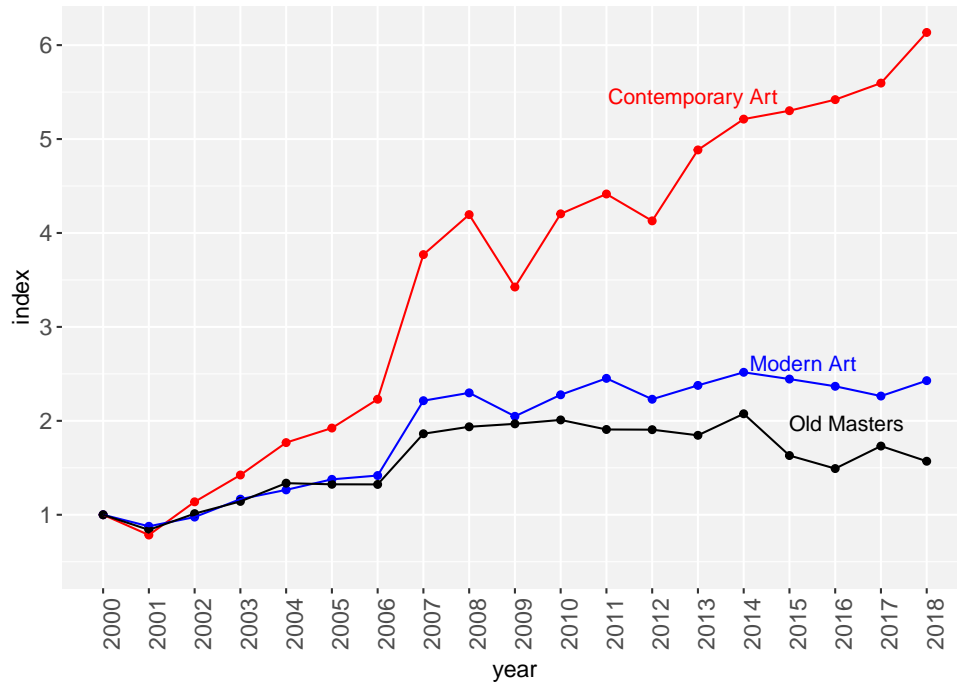
We conclude this section by presenting in Fig. 4 a corrected price index which depurates price variations from changes in transaction costs, news and other controls on the basis of our last regression analysis. In principle, this shows the real return on investment in a representative artwork of each sector abstracting from changed conditions in the auction market concerning commission rates or other transaction costs (as if the artwork was privately traded) and changed conditions of the actual artwork whose impact could not be expected *ex ante*. Our corrected price index shows a better performance for investment in all sectors (compared to the baseline Mei-Moses index of Fig. 5). Most of the differential is due to changes in commission rates of the auction houses during the last two decades, both through the increase of the average

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[22]Our sample includes 36 artists with works sold one or two years after their death, and their age at death ranges between 58 and 92 years. This offers an opportunity to interact the death dummy with the age at death and verify a significant quadratic relation with a peak for the magnitude of the death effect around 73 years old, in line with results by Ursprung and Wiermann (2011) and others in hedonic models (see Ekelund *et al.*, 2017, for a review of the related literature). Prices reflect a larger death effect when the news provide a larger revision of the expected supply of artworks by the author.

[23]Nowadays, art auctions and art fairs for contemporary art (led by the Biennale of Venice and Art Basel) and old master paintings (led by Maastricht) are frequented by investors of any part of the world, and art funds are quite active in the international market (see Horowitz, 2014).

Figure 4: Corrected real price indexes for old master paintings, modern and contemporary art
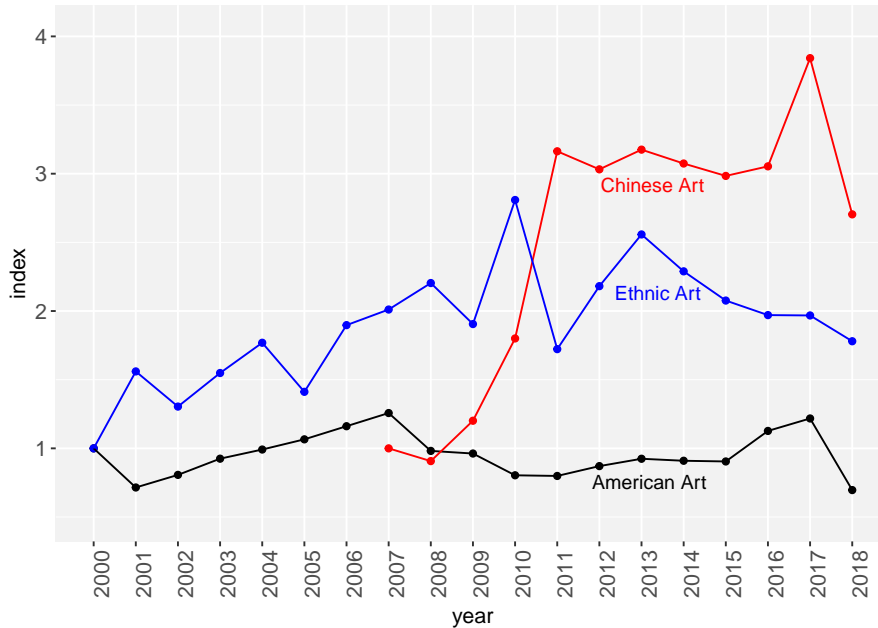

commission rate (which, for instance, moved from 10% to 25% for most transactions), and through the increase of the average prices on which the same commissions are computed. The corrected price index suggests that Sotheby's and Christie's obtained a large portion of the capital gains in the art market of this period, as one may expect in a highly concentrated sector. Nevertheless the corrected return rates on art investment in this century appear to have been positive for all sectors, including old master paintings, and quite high for contemporary art, also in the period after the Great Recession.

5   Price changes in American, Chinese and Ethnic art

To confirm our support of the efficiency hypothesis in contemporary auction markets in this section we investigate also other sectors that attract a lot of investment, namely American art, Chinese art and Ethnic art (a label under which auction houses trade works mainly from Africa, Oceania and Pre-Columbian America). We repeat the basic analysis of art returns for these sectors to verify whether the lack of masterpiece effects and arbitrage opportunities holds here as well.[24]

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[24]The analysis is preliminary for the law of one price due to the smaller samples of repeated sales and to the more limited international trade for these sectors, since auctions for American art are mainly located in New York, auctions for Ethnic art in New York and Paris and auctions for Chinese paintings in New York, Hong Kong and Shanghai. Some minor sectors have been recently investigated, but without a focus on our efficiency hypothesis: see Ekelund *et al.* (2017) on American art and Taylor and Coleman (2011) on Australian aboriginal art.

Figure 5: Nominal Price indexes for American, Chinese and Ethnic art

The sector of American art includes early American painters,[25] internationally recognized masters of the 1800s such as John Singer Sargent and James Whistler[26] and artists of the early 1900s.[27] The most expensive paintings in our dataset include works by George Bellows (*Evening swell*), Georgia O'Keeffe (*Red hills with pedernal, white clouds*), Childe Hassam and Maxfield Parrish. The sector does not include abstract artists of the second half of the 1900s, whose works are traded in contemporary art auctions. A comprehensive analysis of auctions on early American art can be found in Ekelund *et al.* (2017), whose empirical work is based on 105 observations of repeated sales between 1987 and 2011 (on 31 selected artists born before 1900), and emphasizes returns rate that are much lower than those for contemporary art and in particular contemporary American art. As shown in Fig. 5, we confirm this result in our wider dataset of 349 pairs of repeated sales. For the records, we have found the best return rates for works such as a *Mountain landscape* by Albert Bierstadt, *Narcissa* by Hovsep Pushman and *The visit* by John Falter, but the average annual return is close to zero in nominal terms, which is comparable to what we found for old master paintings.

The most lively sector of art trade in the last two decades has been Chinese art (see Robert-

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[25] For instance, they include Gilbert Stuart, the most successful portrait painter of the 1700s, John Trumbull, winner in 1817 of the first large commission in American art (four canvases for the rotunda of the Capitol building in Washington, paid 8,000 dollars each) and the landscape painters of the Hudson River School.

[26] Incidentally, Whistler can be regarded as a pioneer in a theory of investment in artistic capital and art pricing: when he was asked why demanding a high price for a painting completed in two days, he replied "I ask it for the knowledge which I have gained in the work of a lifetime" (see Lewis, 2006).

[27] The sector includes many American artists of the first half of the 1900s, especially modernists launched by the celebrated Armory Show and by innovative art galleries as the one of Alfred Stieglitz, as well as late figurative artists led by Edward Hopper. On the history of the art market in the U.S., which was mostly developed in this period, see Goldstein (2000).

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son, 2005). Investment in Chinese paintings has been booming, mainly in China, but we are not aware of empirical works on repeated sales in this sector. Traded artworks cover a wide period ranging from old masters of the Ming dynasty (as Shen Zhou, Tang Yin or Dong Qichang) to those of the early Qing dinasty associated with court painters of Beijing (including Wang Hui and the Italian Jesuit painter Castiglione, who introduced European techniques in China) and academic painters of other provinces (as the Loudong and Nanjing masters, Anhui landscapists and Yangzhou flower painters).[28] It includes also traditional painters active in the early and mid 1900s, such as Zhang Daqian and Fu Baoshi, to mention some of the artists who have reached the top prices, while abstract art is confined to contemporary art auctions. Our sample includes 204 repeated sales with the best returns for recent works as a *Banquet* by Huang Yongyu and *Bird and magnolia* by Yu Fei'an or classic ones as *Listening to the Running Streams* by Tang Yin, and it shows a rapid increase in evaluations over the most recent years, as emerging from Fig. 5. Annual return rates have been quite high, around 17% in nominal terms, though our evidence is limited to a few years and reveals also a high volatility, resembling qualitatively the performance of contemporary art. This pattern is unique, also compared to closer artistic traditions, as those of Korea and Japan. Therefore, it is natural to conclude that the increasing prices of both old and contemporary Chinese art reflect the emerging role of China in the world economy and its increasing domestic demand for art.

We finally provide the first exploration of returns on investment in Ethnic art with a sample of 264 repeated sales. Trade in this sector includes mostly masks, statues and other objects from Sub-Saharan Africa, Indonesia, Australia, Melanesia, Micronesia and Polynesia, as well as artworks from ancient Aztec, Maya, Inca and other pre-Columbian civilizations, ranging over many centuries. Most of the traded works are African masks and small statues (notably from Mali, Ivory Coast, Nigeria, the Congo basin and eastern Africa) often from recent periods, while works by contemporary artists and artists of the African diaspora are excluded.[29] We found the best return rates for statues from Congo and Gabon, a Maori hand club from New Zealand, statues from Easter Islands, and an Inca poncho. As shown in Fig. 5, prices for this sector have been raising in the last years: the average annual return rate is around 3% in nominal terms.

Repeated sales regressions in these three sectors are shown in Table 4. The most important result is that also here there is no evidence of masterpiece effects for any of the three sectors, which provides additional convincing evidence that the monetary size of art investment is

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[28]Some of them were probably active in a lively primary market (mainly for hanging scrolls painted with ink and colours on silk or paper) that unfortunately has not left us much evidence (see Watson, 2007).

[29]Most of the anonymous craftsmen of this sector were not active in institutionalized art markets. On African art see Visonà *et al.* (2008).

unrelated to its return. Also most of the location dummies have coefficients insignificantly different from zero, but the limited sample size does not allow us to draw firm conclusions. We also tried to add few available controls in unreported regressions, which strengthened these results,[30] with remaining arbitrage opportunities only in Chinese art (probably due to the fact that this sector is still in a transition phase with rapidly increasing demand). In conclusion, none of the six sectors that we have examined presents any evidence of masterpiece effects, and we cannot reject the hypothesis that these contemporary art markets are efficient at least in a weak form.

Table 4: Repeated sale regressions on American, Chinese and Ethnic art

					Dependent variable: Real total return		
					American Art	Ethnic Art	Chinese Art
$lnB_{i,t}$ Masterpiece effect					-0.007 (0.007)	-0.008 (0.012)	0.009 (0.014)
Location at purchase $\rightarrow$ location at resale							
(Transactions' volume in % for each of 3 art segments)							
Sotheby's	$\rightarrow$	**Sotheby's** benchmark	(36%,	68%,	44%)		
Sotheby's	$\rightarrow$	Christie's	(27 %,	18%,	7%)	0.037 (0.073)	-0.229^* (0.128)	-0.335^{**} (0.153)
Christie's	$\rightarrow$	Sotheby's	(9 %,	11%,	9%)	-0.026 (0.110)	0.190 (0.150)	0.044 (0.186)
Christie's	$\rightarrow$	Christie's	(28 %,	4%,	39%)	-0.109 (0.071)	-0.118 (0.249)	-0.064 (0.099)
NY	$\rightarrow$	**NY** benchmark	(100%,	35%,	10%)		
NY	$\rightarrow$	Paris	(,	27%,	)		0.212^* (0.121)	
Paris	$\rightarrow$	NY	(,	10%,	)		0.032 (0.155)	
Paris	$\rightarrow$	Paris	(,	28%,	)		0.125 (0.122)	
China	$\rightarrow$	China	(,	,	79%)			0.144 (0.163)
NY	$\rightarrow$	China	(,	,	2%)			0.422 (0.282)
China	$\rightarrow$	NY	(,	,	8%)			-0.240 (0.225)
Time dummies					(YES)	(YES)	(YES)
Observations					359	264	205
R^2					0.28	0.18	0.66

Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parenthesis

6 Price changes in the long run

Long run analysis of art price changes by Baumol (1986) and Mei and Moses (2002) have been based on repeated sales reconstructed over multiple centuries, starting in the 1700s in the former case and the 1800s in the latter. An intrinsic bias of this methodology of data collection is that it tends to select artworks that have been successful *ex post* and that were already valuable *ex ante*, which may generate an artificial (negative) masterpiece effect. We have avoided this

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[30]We can also confirm the role of transaction costs, and the fact that price guarantees, available only for American art, do not generate significant effects on returns.

survivorship bias by focusing on a complete set of repeated sales over a more limited span of time. However, the long run perspective is important to verify whether the implications of art market efficiency are a recent phenomenon or there is some stable law of art price change. In this section we use data on art markets since Renaissance, Baroque and Neoclassical periods to take a new look at price changes over the long run.

We identify painters for whom we can match records of prices in different historical periods and in contemporary auctions.[31] To avoid the survivorship bias and expand the number of observations, we focus on the highest price per painter between the historical records and the highest price per painter between contemporary sales. Each historical price for artist k is expressed in terms of the historical currency in a base year t, say $S_{k,t}$. Likewise, each contemporary price for the same artist is expressed in dollars of a base year T, say $S_{k,T}$. The base years are fixed at the beginning of the historical period and in 2000 for the contemporary prices. Given an exchange rate $E_{t,T}$, one could express the price change of artist k as $ln\left(\dfrac{E_{t,T} \cdot S_{k,T}}{S_{k,t}}\right)$ and test whether price changes are correlated with initial prices. For our purposes, it is easier to run a regression as:

$$ln\left(S_{k,T}\right) = \delta + \phi ln\left(S_{k,t}\right) + \varepsilon_k \tag{4}$$

where δ is a constant capturing the cumulative return on art and absorbing the exchange rate between historical and contemporary currencies, ϕ represents the elasticity of prices today with respect to historical prices and ε_k is an error term. We test the hypothesis that $\phi \approx 1$, which implies that historical prices predict contemporary prices, or more precisely that art price changes in the long run do not depend on the initial prices and therefore there are no persistent masterpiece effects.

There are many reasons why our hypothesis may not hold in our experiment. The historical price records are (to say the least) incomplete and only for a limited subset of painters we can match past and current prices, though gaps refer to both high quality and low quality painters. The best artworks of the past may have been absorbed by museum collections and the worst ones may have been lost from art trade, though also in this case the two sources of selection in the art market may balance each other. The preferences of the collectors may have changed over centuries, rediscovering certain authors and de-emphasizing others, with an impact on the

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[31]Contemporary prices used in this analysis are from all transactions (not just repeated sales) taking place at Sotheby's or Christie's in 2000-2018 worldwide. We have more than 80 thousand observations for old master paintings traded in this period. We notice that the *Salvator Mundi* by Leonardo da Vinci was exceptionally sold in an auction of contemporary art in 2017. It was sold for $450 million (including the buyer's premium), the record price for an artwork, and indeed for an handmade object.

distribution of aesthetic dividends of art and therefore on the distribution of prices; however, there is some evidence of persistence in the preferences of art collectors (see Graddy, 2013) and there is no reason to suspect that preferences change with a systematic increase in value of initially underestimated artists and a systematic decrease in value of initially overestimated artists. Last, but not least, art markets may have not been as efficient as today in the past and in different geographical areas, and deviations from general rules of price change may have not been corrected over time. All of this is enough to seriously doubt that the lack of masterpiece effect should hold over centuries, but evidence that $\phi \approx 1$ would provide further support to the market efficiency thesis in a long run perspective. We will test for this hypothesis on five different historical periods for which we have collected prices from art historical sources. The results are displayed in Fig. 6: surprisingly, the positive linear relation emerges clearly, and the unitary slope is also a fair approximation in most cases.

In the case of Renaissance, we collected prices of primary sales (commissioned by private patrons, churches or public buildings) between 1285 and 1550 all over Italy. More than three hundred price records are all converted into *gold florins* and are available for all the most famous Renaissance masters of Florence, Venice, Rome, Milan, Neaples, Mantua and other minor artistic centers of Italy, as well as for some minor painters. One of us has presented the original dataset elsewhere (Etro, 2018), arguing that this primary art market was already quite competitive, with price differentials reflecting quality differentials as perceived at the time and independent from the regional destination of the commission. The number of artists for whom we could match historical and contemporary records is limited to 51 artists, and the data show that price changes are quite variable across painters, which should not be surprising since primary prices reflect evaluations that can be widely revised over more than five centuries. Nevertheless the correlation between Renaissance and contemporary prices is positive and the estimated coefficient $\phi = 0.73$ is not far from unity. Moreover, the unitary slope remains in the 95% confidence interval, though the power of the test is admittedly low. Similar results hold for the subsequent Baroque period in Italy, whose primary market has been analyzed in Etro and Pagani (2012) and Etro *et al.* (2015) with particular reference to Baroque Rome, providing further evidence of competitive forces, as those allocating painters between artistic genres (portraits, still lifes, landscapes, genre and historical paintings) to the point of equalizing the marginal profitability of each genre. Here we have analyzed data on the secondary market (from the Getty Research Institute; see Etro and Stepanova, 2019), namely evaluations of paintings from 157 inventories of private collections, mainly from Rome, Tuscany, Mantua as well as other Italian towns between 1598 and 1718. Prices are expressed in Roman *silver scudi*

adjusted for the cost of living. The inventories include about three thousand paintings by most artists of the Baroque period active in Italy, and also by older masters whose works had been inherited or purchased by the same collectors. The number of artists with evaluations recorded in these inventories and traded in contemporary auctions almost doubles compared to the earlier period, with 91 artists matched. The data confirm the linear relation with a coefficient increased to $\phi = 0.84$. We cannot reject the hypothesis of independence of art price changes from the initial price levels.

For Dutch and Flemish artists we have more than ten thousand prices of paintings from inventories and auctions recorded in Amsterdam between 1600 and 1700. They have been initially collected and presented by Montias (2002), who has documented that art production by Dutch and Flemish artists was quite prolific in this period and art trade was extremely competitive. In Etro and Stepanova (2016) we have supported this claim with econometric evidence that the same entry of artists in the market was highly sensitive to profitability, and anecdotal evidence that competition generated cost saving innovations that reduced prices in the second part of the century. The Dutch market of the golden age provides the richest historical dataset in our possession for our purposes, with 129 painters for which we have prices from historical inventories and from our contemporary dataset (historical prices are expressed in Dutch *guilders* of 1600). Celebrated masters such as Rembrandt and Rubens lead the ranking in both periods, and the overall relation is quite precise, with a coefficient $\phi = 0.83$ which is close to unity. If we directly run the regression for the return rate over the initial price, we obtain:

$$ln\left(\frac{S_{k2000}}{S_{k1600}}\right) = 9.435^{***} - 0.162 ln\left(S_{k1600}\right) \quad \text{N.obs.} 129, R^2 = 0.012$$
$$\quad (0.576) \quad\quad (0.133)$$

confirming that we cannot reject that price changes are independent from initial prices.

Similar results emerge between the second half of the 1700s and the first half of the 1800s in the secondary market of France and England (original data from the Getty Research Institute). This period starts with the Rococo period, includes all the Neoclassical period, and concludes with Romanticism. Etro and Stepanova (2015) have analyzed prices in *livres* from more than a thousand auctions and ninety thousand sales taking place between 1745 and 1820 in Paris, which was becoming the main international art center: these data provide evidence of price adjustments reflecting new information on artworks, as the earliest available evidence of positive price jumps at the death of the authors. To focus on prices by artists active in the domestic

market here we restrict the sample to French artists, and for 79 of them we can match modern price records. This dataset provides a very precisely estimated coefficient of $\phi = 0.87$, which is again close to unitary. Finally, we consider the auction market in London between 1780 and 1840, using price data in *pounds* for over 200,000 sales. In Etro and Stepanova (2017) we have argued that this secondary market (already dominated by Christie's, with Sotheby's playing a minor role and many other small auction houses) represented an important opportunity of portfolio diversification for British investors. Again we focus on local artists for a period that is known as the golden age of British art, and we obtain 73 matches with contemporary price data. The usual regression provides a coefficient of $\phi = 0.8$, and also in this case a unitary slope remains in the 95% confidence interval. Considering the long period under consideration, we can conclude that there is no evidence of any relevant masterpiece effect in the art market for old master paintings.

Overall, the investigations of this and earlier sections suggest that art prices have been anchored to persistent differentials between artists, with changes over time that are driven by return rates depending on aggregate factors and without systematic differences for artworks of different price. Moreover, the independence of price changes from price levels has implications for the same distribution of art prices, since it reproduces a form of the Gibrat's law of proportionate effect (Gibrat, 1931), which perpetuates a lognormal distribution of art prices over time. This is consistent with empirical investigations on art pricing in different historical periods.[32]
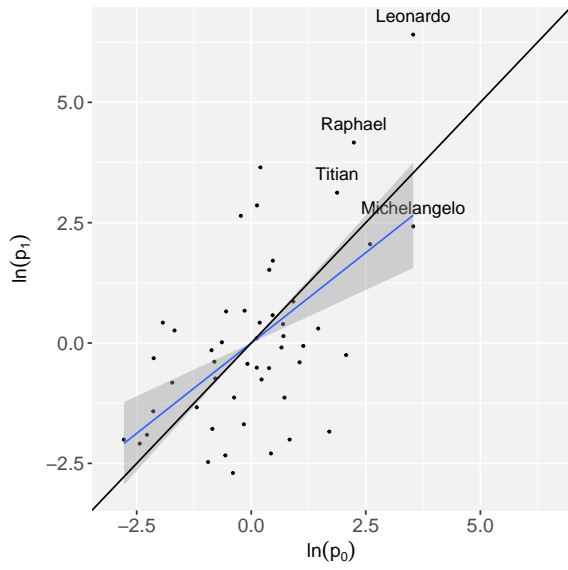
Note to Figure 6: Y-axis is centered logarithm of maximal USD price in contemporary auctions. X-axis is centered logarithm of maximal historical price. The datasets and the consumer price inflation used are described and analyzed further in Etro (2018) and Etro and Stepanova (2015, 2016, 2017, 2019).
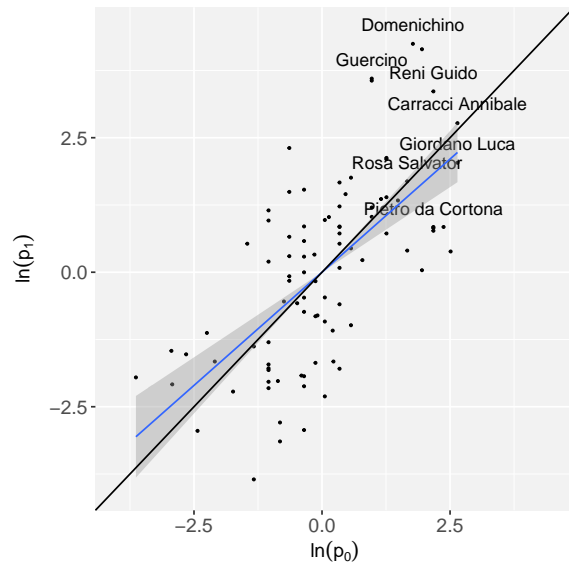
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[32]It is also well known that frictions in the data generating process or differences in growth rates of average prices per artists can deliver power laws in the tail of related distributions: this is what we found for the distribution of artistic talent (proxied by the average real price per artists with multiple observations) over different artistic periods (Etro and Stepanova, 2018).

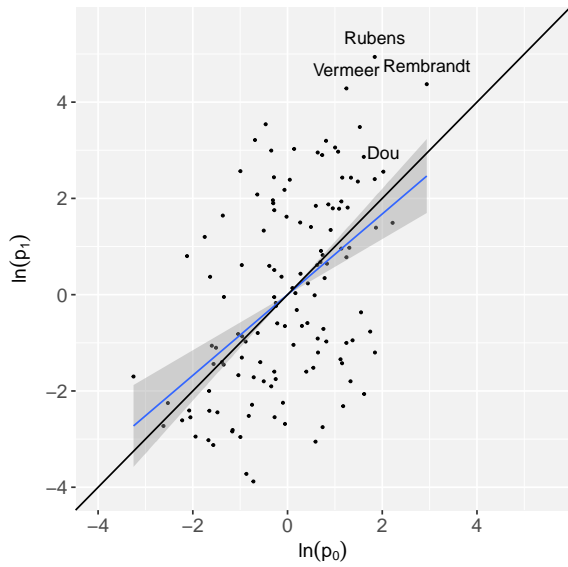Figure 6: Price correlations over centuries

(a) Renaissance (1285-1550)
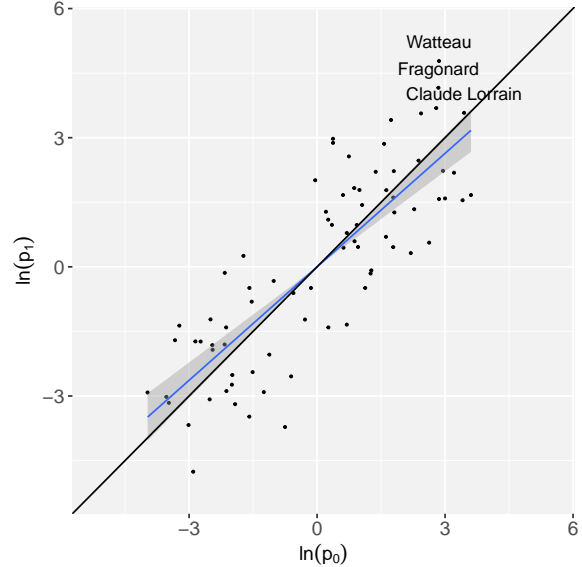slope 0.73 (0.14)

(b) Italian Baroque Art (1598-1718)
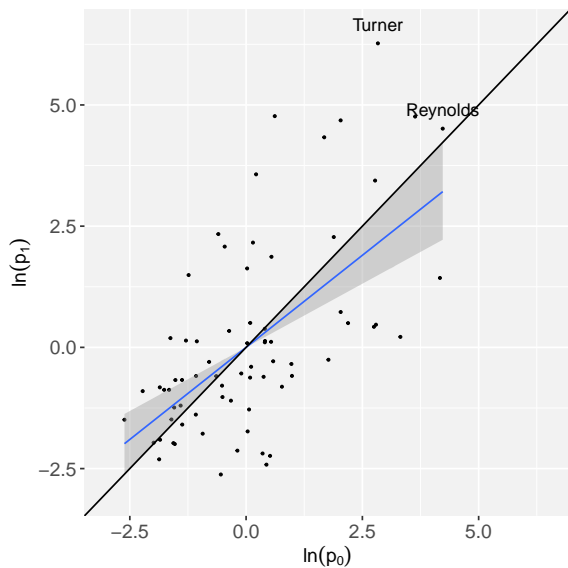slope 0.84 (0.10)

(c) Dutch & Flemish Golden Age (1597-1600)
slope 0.83 (0.13)

(d) French Art (1745-1820)
slope 0.87 (0.06)

(e) British Golden Age (1780-1840)
slope 0.8 (0.11)

7 Conclusion

We have studied return rates of art investment from repeated sale auctions held worldwide at Christie's and Sotheby's in our century. The analysis has shown that return rates differ widely across sectors, with contemporary art featuring the best returns and old master paintings featuring lower returns. However, there are also some common patterns that are consistent with the hypothesis that secondary markets for art trade are efficient. In particular, we have provided support for the hypothesis that return rates on art investment do not depend on past prices (contrary to earlier evidence of masterpiece effects) or past returns, and they are equalized between auction houses and international locations, while news on the value of artworks appear to be in part reflected in return rates.

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