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The winner's curse on art markets

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No. 564

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The Winner's Curse on Art Markets

Roman Kräussl and Elizaveta Mirgorodskaya*

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Abstract

We investigate the effect of overreaction in the fine art market. Using a unique sample of auction prices of modern prints, we define an overvalued (undervalued) print as a print that was bought for a price above (below) its high (low) auction pricing estimate. Based on the overreaction hypothesis, we predict that overvalued (undervalued) prints generate a negative (positive) excess return at a subsequent sale. Our empirical findings confirm our expectations. We report that prints that were bought for a price 10 percent above (below) its high (low) pricing estimate generate a positive (negative) excess return of 12 percent (17 percent) after controlling for the general price movement on the prints market. The price correction for overvalued (undervalued) prints is more pronounced during recessions (expansions).

JEL Classification:E32, G11, G14

Keywords: Overreaction, winner's curse, pricing estimates, repeat sale, auction, art market

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1 Introduction

Overreaction to new information is a frequently occurring phenomenon in financial markets. Barberis et al. (1998) argue that investors become excessively optimistic (pessimistic) about future news announcements after a series of good (bad) news and send stock prices to unjustifiably high (low) levels. Once subsequent news become known, it is likely to contradict this optimism (pessimism) leading to the correction of mispricing in the long-run (Poterba and Summers, 1988).

De Bondt and Thaler (1985, 1987) confirm the overreaction hypothesis by showing that a portfolio of winner stocks tends to underperform the portfolio of loser stocks in the course of five subsequent years. They show that investors overreact (underreact) to the current winner (loser) stocks sending their prices to unjustifiable high (low) levels in the short-run. In the long-run the mispricing corrects itself leading to prices reverting to their mean values.

One possible reason for the overreaction phenomenon is investors' overconfidence about their own valuations (Roll, 1986). Malmendier and Tate (2008) show that overconfident CEOs tend to overestimate their ability to generate returns, to overpay for target companies and to undertake value-destroying mergers. Keloharju (1993) shows that investors with disproportionately large allocations in IPOs generate initial negative returns, whereas investors with small allocations generate initial positive returns, on average.

Such overreaction is also known in the auction theory as the winner's curse. The winner's curse is defined as the tendency of the winning bidder to systematically bid above the actual value of an object and to incur losses (Lind and Plott, 1991). Capen et al. (1971) suggest that in a situation when the value of an auctioned object is unknown, bidders will derive their own estimates of the value. Individual estimates will vary substantially from too low to far too high. The winner of the auction is likely to be the bidder with the highest estimates. As a result, the winner is likely to be the loser as she might pay well above the actual value of the object. Thaler (1988) argues that the winner's curse cannot occur if all bidders are rational and

the evidence of the winner's curse in market settings would be anomalous. Kagel and Levin (1986) and Lind and Plott (1991) present evidence of the winner's curse in laboratory experiments.

In this paper we investigate the overreaction and winner's curse phenomena on the actual auction data for modern prints. We compare the actual realized selling price to the auctioneer pricing estimates and suggest that a bidder who is willing to pay a price for a print above its high pricing estimate is overconfident about her own valuation, is prone to overreaction, causes the mispricing, and incurs losses at the subsequent sale as a result. We suggest that the relation holds in the opposite direction as well. The bidder that pays a price for a print below its low pricing estimate enjoys the excess return at the subsequent sale.

We assume that auctioneer pricing estimates are accurate and are the best indication of a fair value of a print. Auctioneers have to protect their reputation as experts who understand market conditions in the art field (Mei and Moses, 2005). Ashenfelter (1989) asserts that auctioneers' pricing estimates are very close to be unbiased and are better predictors of the prices fetched than any hedonic price function. Milgrom and Weber (1982) show theoretically that systematic over- or undervaluations would be difficult to explain on the art market or any other markets. Fair pricing estimates reduce uncertainty on the art market, make it more transparent, and thus, make lower bidders more aggressive. This puts an upward pressure on the bidding of others, which is of interest to the auctioneers. Auctioneers are also constrained by the fact that artworks may fail to sell if their reservation prices are set too high due to excessively high pricing estimates. The reservation price is a minimum price set by the seller of an artwork, below which the item goes unsold. The reservation price remains unknown to the bidders and is often thought to be within 60–80% of the low pricing estimate. If a bid for an artwork at auction does not reach the reservation price, the item remains unsold and is said to be “bought-in” (Ekelund et al., 1998).

Contrary to our main assumption, Mei and Moses (2005) argue that pricing

estimates are upwardly biased for expensive artworks and are associated with future adverse abnormal returns. The authors argue that auction houses are interested in results that yield higher prices and a higher percentage of lots sold since they charge a commission fee as a percentage of the realized price. They suggest that the effect of the winner's curse would not explain the abnormal returns as the impact of overbidding at the purchase might have been cancelled out at the sale as new buyers would also overbid.

In this paper, we manually search for repeat-sale prints in the Gordon's Prints Price Annual database. In total, our unique sample includes 4,728 fine art prints of 178 different artists, which corresponds to 93,406 repeat-sale pairs for the time span of 1985–2011. Our data contain information on the artist name, print title, sale date, auction house, price in the U.S. dollars and the native currency, high and low pricing estimate in the U.S. dollar and the native currency, edition number, lot number, auction house, medium and conditions. We construct repeat-sale indices for all prints in our sample and for subsamples based on artistic styles and artist's market relevance. We follow the Case and Shiller (1987) three-stage Generalized Least Squares (GLS) approach for our repeat sale index construction. We extend the analysis by Mei and Moses (2005) with additional print-specific variables to test for the winner's curse phenomenon after controlling for the general price movement on the prints market.

Our results show strong evidence of the overreaction and winner's curse on the market of modern prints. We find that a bidder who pays a price for a print above its high pricing estimate (i.e., an overvalued print) by 10 percent incurs a negative excess return of 12 percent at the subsequent sale. On the other hand, a bidder who obtains a print for a price below its low pricing estimate by 10 percent (i.e., an undervalued print) enjoys a positive excess return of 17 percent at the subsequent sale after controlling for the general price movement on the prints market and other control variables. Our results are consistent with the overreaction hypothesis defined by Barberis et al. (1998) and the winner-loser effect reported by De Bondt

and Thaler (1985, 1987). Our results hold for nominal and real returns and across different economic states. We find the price correction for overvalued (undervalued) prints is more pronounced during recessions (expansions).

Apart from our main finding we report evidence of the violation of the law of one price. Pesando (1993) finds evidence of the fact that prices paid by art investors are systematically higher at certain auction houses. Our results confirm his finding and show that the reselling of prints at the major auction houses Christie's or Sotheby's generates a positive 0.16% excess return after controlling for the general price movement on the prints market.

The remainder of the paper is organized as following: Section 2 describes our data and methodology. Section 3 presents our findings. Section 4 concludes.

2 Data and Methodology

2.1 Sample

We obtain our data from the Gordon's Prints Price Annual database, which is the leading provider of international auction results for fine art prints, posters, illustrated books, and Picasso ceramics. Our sample includes 4,728 prints of 178 artists with a total sample volume¹ of 93,406 transactions and a total sample turnover² of \$893,915,036 for the time span of 1985–2011.

Gordon's Prints Price Annual database provides information on each print such as its artist name, title, sales price in the U.S. dollars, sales price in the native currency, high and low pricing estimates in the native currency, edition number, lot number, auction house, medium and conditions. In order to identify repeat-sale pairs, we manually searched for identical prints that matched the characteristics in the database. We treat each sale as a unique point.

In contrast to Mei and Moses (2002, 2005), who collected their data on paintings sold at the main salesrooms of Christie's and Sotheby's, we focus our study on

¹Volume is the total number of sale records.

²Turnover is the total dollar proceeds from sales.

modern prints. Prints are generally considered to be a more economical alternative to paintings. Prints are multiples and typically published in editions of 50, 100, or more. As such they are traded more frequently than paintings and are thus more suitable for the construction of a well-defined repeat-sale index (Pesando and Shum, 2008) and for analyzing potential overreaction on the art market.

We focus on 178 artists with the largest volume in the entire database. Among others, our sample includes such prominent artists as *Pablo Picasso*, *Andy Warhol*, *Rembrandt*, etc. We define Top Artists as the ten artists with the highest total sales volume in our sample. These artists are *Pablo Picasso*, *Andy Warhol*, *Rembrandt*, *Marc Chagall*, *Joan Miro*, *Albrecht Durer*, *Kathe Kollwitz*, *Roy Lichtenstein*, *Henri de Toulouse-Lautrec*, and *David Hockney*. For the entire list of artists and their corresponding total sample volume and the U.S. dollar turnover please see Table A1 in the appendix.

We identify two major artistic styles: Impressionist and Modern (Im/M) and Post-war and Contemporary (Pw/C). Other styles that are included in our sample are American, 19th Century European, Old Masters, British and Irish Art, Swiss Art, Asian, and Latin American. We do not distinguish between other styles due to the insufficient number of observations.

Christie's and Sotheby's are by far the largest auction houses and Impressionist and Modern and Post-war and Contemporary styles are the major artistic styles in terms of the sample volume and the U.S. dollar turnover. The sample volume of Sotheby's (Christie's) auction houses accounts for 24% (21%) of the total sample volume and 35% (31%) of the total sample U.S. dollar turnover. Impressionist and Modern (Post-war and Contemporary) prints account for 54% (21%) of the total sample volume and 53% (31%) of the total sample U.S. dollar turnover.

Our broad sample consists of 80,281 repeat-sale pairs of 4,728 individual prints that we used for our semi-annual repeat-sale index construction, which substantially exceeds the 5,500 resale pairs in Mei and Moses (2005) sample, and is comparable to

the 80,214 repeat sales of 17,901 prints in Pesando and Shum (2008).³ The sample for Impressionist and Modern (Post-war and Contemporary) style prints comprises of 43,112 (17,021) repeat-sale pairs of 2,581 (1,030) individual prints. We obtain 40,472 repeat-sale pairs of 2,090 prints for Top Artists. The number of sales for each print ranges from 2 to 943 with an average of 62 times between 1985 and 2011.

In order to test our winner's curse hypotheses, we compare the realized sale price to pricing estimates. Our database includes data on high and low pricing estimates only for prints sold from 1998 onwards only. Thus, our final sample for the hypotheses testing contains 27,596 repeat-sale pairs for which both high and low pricing estimates data was available and that got sold between 1998 and 2011. There are 12,964 repeat-sale pairs for Impressionist and Modern, 6,121 for Post-war and Contemporary style, and 15,596 for Top Artists.

We perform our analysis on nominal and real returns. For the real returns we use the U.S. Consumer Price Index (CPI) downloaded from *Datastream* as a proxy for the level of inflation in the U.S. Additionally, we distinguish between business cycles by using the NBER classification for expansions and recessions.

2.2 Methodology

We apply the repeat-sale regression (RSR) methodology, developed by Bailey et al. (1963), for the construction of our semi-annual prints art market index. Originally used for the real estate index construction, the RSR found its practical applications in the construction of art indices. Anderson (1974), Baumol (1986), Goetzmann (1993), Mei and Moses (2002, 2005), Pesando (1993), and Pesando and Shum (2008) applied the RSR to the art market.

The RSR involves estimating μ_t , a continuously compounded return of the price index, as in the following:

³The number of repeat-sale pairs in our sample is lower than the total sample volume (93,406). This is due to multiple sales of identical prints on the same day. There are 4,093 dates with multiple sales of the same prints that account for the total of 14,279 sales in our sample. In order to address this issue we took the average of all sale prices on the same day for the same print and treated it as a single sale. For the robustness check we also performed the analysis on the highest and lowest sale price among all sale prices for the same print on the same day.

$$r_i = \ln(P_{i,s}/P_{i,b}) = \sum_{t=b_i+1}^{s_i} r_{i,t} = \sum_{t=b_i+1}^{s_i} \mu_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t}, \quad (1)$$

where r_i is the continuously compounded return of print i , $P_{i,s}$ is the price of print i at time s (sales price), $P_{i,b}$ is a price of the print i at the time b (purchase price), μ_t is the average return of prints in a portfolio at time t , and $\varepsilon_{i,t}$ is the print-specific return, which is assumed to be uncorrelated over time and across prints. We are interested in estimating a semi-annual price index, μ , which is a T -dimensional vector whose individual elements are μ_t over the time interval $t = 1, \dots, T$.

In order to estimate Equation (1) we employ the three-stage Generalized Least Squares (GLS) approach proposed by Case and Shiller (1987). Stage 1 involves assigning a dummy variable to each repeat-sale pair, which takes a value of -1 in the period when the print is purchased and +1 in the period when the print is sold; 0 otherwise. We regress a series of log returns on a matrix Z , whose rows are dummy variables for each print and columns are holding periods. Stage 2 involves obtaining the residuals from the stage 1 regression, squaring these residuals and regressing them on the time between sales. The fitted values from stage 2 are transformed into weights (W) by taking a reciprocal of the square root of the fitted values. In stage 3, the log returns are weighted with W and regressed again on a matrix of dummy variables Z as in stage 1. The estimated coefficients are μ_t , which can be expressed as follows:

$$\mu = (Z'W^{-1}Z)^{-1}Z'W^{-1}r, \quad (2)$$

where Z is a matrix with rows of dummy variables and columns for each holding period, W is a vector of weights from stage 2, and r is a series of log returns.

The difference between the estimated coefficients is a geometric log return of the prints index. We convert the geometric log return into the arithmetic return in the following way:

$$R_t = \exp((\mu_t - \mu_{t-1}) + \sigma^2/2) - 1, \quad (3)$$

where R_t is the arithmetic return of the prints index at time t , μ_t is the estimated coefficient of the RSR for each holding period $t = 1, \dots, T$, σ^2 is the variance, which is equal to the slope coefficient from the stage 2 regression (Case and Shiller, 1987).

For the analysis of the performance of the market of modern prints, we propose to estimate repeat-sale indices for the whole sample, the individual Impressionist and Modern and Post-war and Contemporary styles, and for the Top Artists so that we can compare nominal and real annualized arithmetic and geometric returns for each category. Additionally, in order to test for the winner's curse phenomenon, we follow the approach proposed by Mei and Moses (2005) and extend Equation (1) with print-specific variables in the following way:

$$r_i = \sum_{t=b_i+1}^{s_i} \mu_t + \gamma_1 \text{Overbid}_i + \gamma_2 \text{Underbid}_i + \Theta X_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t}, \quad (4)$$

where r_i is a continuous log return of print i between the time of purchase b_i and the time of sale s_i ; μ_t is the print index estimated following Case and Shiller's (1987) three-stage GLS method as in Equations (1) and (2).

Overbid_i is the overbidding measure, which is equal to $\ln(P_{i,b}/P_{i,b}^H)D_{1,i}$ where $P_{i,b}$ is the price of print i at purchase date b , $P_{i,b}^H$ is the high pricing estimate of print i at purchase date b , and $D_{1,i}$ is a dummy variable that takes the value of 1 if the print i is purchased at date b for a price above its high pricing estimate ($P_{i,b}^H$), and 0 if print i 's selling price is below $P_{i,b}^H$. We expect to find a negative γ_1 coefficient if our winner's curse hypothesis holds.

Underbid_i is the underbidding measure that is equal to $\ln(P_{i,b}/P_{i,b}^L)D_{2,i}$, where $P_{i,b}^L$ is the low pricing estimate of print i at purchase date b and $D_{2,i}$ is a dummy variable that takes the value of 1 if the selling price of print i is below its low pricing estimate ($P_{i,b}^L$) and 0 if the selling price is above $P_{i,b}^L$. Since Underbid_i is negative, we expect to find a negative γ_2 coefficient, if our expectations for undervalued fine

art prints hold.

X_t is a set of control variables. We include two control variables originally proposed by Mei and Moses (2005) in our regression: one control variable for average pricing estimates and one for the spread in pricing estimates. The control variable for average pricing estimates is $\ln(P_{i,s}^{AVE}/P_s^{AVE})$, where $P_{i,s}^{AVE}$ is the average of $P_{i,s}^H$ and $P_{i,s}^L$ at sales date s and P_s^{AVE} is the average of all $P_{i,s}^{AVE}$ for the year s . Mei and Moses (2005) find a positive coefficient for their average pricing estimates variable for the entire sample and subsamples based on the artistic styles such as American, Impressionists and Old Masters.

The control variable for the spread in pricing estimates is $\ln((P_{i,s}^H - P_{i,s}^L)/P_{i,s}^{AVE})$, where $P_{i,s}^H$ and $P_{i,s}^L$ are high and low pricing estimates of print i at sales date s , respectively, and $P_{i,s}^{AVE}$ is the average of $P_{i,s}^H$ and $P_{i,s}^L$. Mei and Moses (2005) find a positive coefficient for the spread for Old Master paintings.⁴

Additional control variables are a dummy variable for the auction house, $D_{i,s}^{AH}$, which takes the value of 1 if the print i is sold at the major auction houses Christie's or Sotheby's at sales date s , but is bought at an auction house or a gallery other than Christie's or Sotheby's at purchase date b , 0 otherwise. The coefficient for the auction house dummy variable tests for the violation of the law of one price (Pesando, 1993). We expect to find a positive coefficient for the auction house dummy variable if fine art prints, which are resold at Christie's or Sotheby's, generate higher returns.

$D_{i,b}^{BC}$ is a dummy variable for the U.S. business cycles, which takes at purchase date b for print i the value of 1 if the purchase date is classified by NBER as a recession and 0 if classified as an expansion.

$\ln(P_{i,s}^{AVE}/P_{i,b}^{AVE})$ is the last control variable that accounts for the change in the average pricing estimates between the purchase date b and the sales date s of print i . This variable captures the extent to which pricing estimates are accurate and are able to predict future print returns.

For the last part of our analysis we extend the regression as in Equation (4) to

⁴For the American, Impressionist styles and the total sample, the coefficients for the spread are not statistically significant from zero (Mei and Moses, 2005).

account for different states in the business cycle. We estimate the following model:

$$\begin{aligned}
 r_i = & \hspace{15em} (5) \\
 & = \sum_{t=b_i+1}^{s_i} \mu_t + (1 - D_{i,b}^{BC})(\gamma_{11}Overbid_i + \gamma_{12}Underbid_i) + \\
 & + (D_{i,b}^{BC})(\gamma_{21}Overbid_i + \gamma_{22}Underbid_i) + \Theta X_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t},
 \end{aligned}$$

where all variables are defined as before.

3 Discussion of Results

3.1 Repeat-sale indices

Table 1 reports the estimated μ_t coefficients of the repeat-sale (RS) indices for all data, the Impressionist and Modern and Post-war and Contemporary styles, and for the ten Top Artists estimated by using the Case and Shiller (1987) three-stage GLS methodology as defined in Equations (1) and (2). Table 1 reports the results for the real log return data. We take the average price of the multiple sales of the same print on the same day. The estimated coefficients represent a log-price index of the prints market, where the difference between coefficients is the geometric return of the index at a particular point in time (Pesando, 1993). We estimate all indices on a semi-annual basis. Most of the estimated coefficients for the selected categories are strongly statistically significant at the 1% level, which indicates a high degree of reliability of our RS indices. Insignificant coefficients are caused by an insufficient number of RS pairs at a particular semi-annual period.

[Please insert Table 1 about here]

Table 2 reports the descriptive statistics of our semi-annual RS indices. The nominal (real) annualized arithmetic return over the period January 1985 to December 2011 for the full sample of 80,281 repeat sales is 3.1% (2.2%), for the subsample of 43,112 Impressionist and Modern repeat-sale pairs it is 3.2% (2.2%), for the subsample of 17,021 Post-war Contemporary repeat sales it is 7.5% (6.2%), and for our

sample of ten Top Artists it is 3.5% (2.8%). Our rates of return are comparable to the rates reported in Pesando and Shum (2008). They report a 1.5% annual real geometric return for modern prints for the period between January 1977 and February 2004 compared to our 1.4% annual real geometric return for all prints for the period between January 1985 and December 2011. On the contrary, Mei and Moses (2002) report a substantially higher 8.2% annual real arithmetic rate of return for the paintings market for the period of 1950–1999, 5.2% for the period of 1990–1999, and 4.9% for the period of 1875–1999. We report an annual standard deviation of our all prints index to be 12.4%, which is lower than the standard deviation of 19.9% reported by Pesando and Shum (2008) for the period 1977–2004 and the standard deviation of 21.3% reported by Mei and Moses (2002) for the period 1950–1999.

[Please insert Table 2 about here]

While the return for the Impressionist and Modern and for the Top Artists prints is comparable to the return of all prints, the Post-war and Contemporary prints seem to significantly outperform all other prints and to generate the highest return for our sample time span. These prints also tend to exhibit the largest level of volatility compared to all prints volatility. The annual volatility of Post-war and Contemporary prints is 21.7% compared to 12.4% for all prints, 12.8% for Impressionist and Modern and 14.9% for the ten Top Artist prints.

Figure 1 depicts the semi-annual repeat-sale indices for the full sample, and separately for our subsamples of Impressionist and Modern, Post-war and Contemporary, and for the ten Top artists based on real returns. Our indices exhibit similar trend pattern as the hedonic pricing indices for the international art market in Kräussl et al. (2016).

[Please insert Figure 1 about here]

The prints market underwent two periods of boom and bust during the time span between 1985 and 2011: one during the expansion in the late 1980s followed by a bust in 1990 as discussed in Fase (1996) and another during the expansion of 2003–2007 followed by a decline at the time of the financial crisis and the bankruptcy

of the U.S. investment bank Lehman Brothers in September 2008. The first boom in the market of modern prints was triggered by the Japanese real estate bubble in late 1980s. Between 1986—1991, Japanese investors were able to borrow funds backed by the collateral value of the land. As the value of the real estate skyrocketed, the investors allocated their abundant money resources to the international art market. Hiraki et al. (2009) site evidence of spectacular Japanese collectors' art purchases at auctions during this period.

The prints market grew at an annual real arithmetic rate of 18.0% from 1985 until 1990 (Figure 1). At the end of 1989, the all prints index reached a level of 224, starting out from a level of 100 at the beginning of 1985 in real terms. The style Post-war and Contemporary outperformed other styles and grew at a real rate of 42% on the annual basis during 1985–1989 and reached a level of 661 in 1989:S2. The style Impressionist and Modern and top ten artists followed closely the overall prints market and grew at the real rate of 19% and 16% on the annual basis, respectively. Post-war and Contemporary style also exhibits the largest volatility between 1985 and 1989. Its annual volatility reached 22%, while all prints, Impressionist and Modern style and Top Artists annual volatility was 7%, 11%, and 9%, respectively.

A boom on the prints market followed by a bust in the early 1990s. In the late 1980s beginning 1990s, the Japanese economy was unable to sustain the excessive monetary easing policy. The credit supplies were curtailed leading to a sharp decline in the Japanese real estate prices and subsequently a bust of the bubble in the international art market (Ashenfelter and Graddy, 2005; Kräussl et al., 2016). The number of Japanese investors in the art market decreased dramatically, which triggered the loss of about half the global asset value in art between 1990 and 1993 (Hiraki et al., 2009).

Our all prints index fell to a level of 130 in real terms between 1989:S2 and 1993:S2, which corresponds to a total loss of 108% and a real decline of 14% on the annual basis. The styles Post-war and Contemporary and Impressionist and Modern fell by 177% and 115%, respectively, over the same period, which corresponds to the

real annual decline by 22% and 14%, respectively. Ten top artists lost 88% and were declining with the real annual rate of 11% in 1989:S2–1993:S2. The annual volatility of all prints between 1989:S2 and 1993:S2 was 14%, 11% for the style Impressionist and Modern, 15% for Post-war and Contemporary prints, and 21% for top ten artists.

Between 1994 and 2000 the prices for modern prints remained less volatile and grew at the annual real rate of 3% with the annual volatility of 10%. Similarly, Post-war and Contemporary and Impressionist and Modern styles grew at the annual real rate of 4% and the annual volatility of 13% and 10%, respectively.

Similar to the situation in the late 1980s, the prices for fine art start to grow at the beginning of the Millennium. As the world enjoyed abundant credit supply in the mid-2000s fueled by the excessive trade of structural products backed by the value of the U.S. real estate, the prices for fair art went up dramatically. Our all prints index grew at the annual real rate of 6% with the annual volatility of 10% between 2004 and 2007. The Post-war and Contemporary prints outperformed all other styles and grew at the real rate of 9% on the annual basis and the annual volatility of 16%. The style Impressionist and Modern (Top Artists) followed closely the overall prints market and grew with the real annual rate of 6% (5%) and the annual volatility of 13% (10%). The prints market reached its new peak in the second semester of 2007. Our all prints index reached a level of 211. Impressionist and Modern style reached a 205 level, Post-war and Contemporary peaked at 644, and Top Artists index was around 244. Albeit high, these price levels never surpassed the levels reached in 1989:S2, except for the Top Artists index.

In September 2008 one of the biggest investment bank Lehman Brothers filed for bankruptcy putting the global financial markets to a halt. The financial crisis of 2008 resulted in a sharp decline of asset prices in all classes including the prices for modern prints. As the global economy was confronted with economic troubles in 2008, the market for modern prints declined albeit not as sharp as in the early 90s. Between 2007:S1 and 2009:S1 all prints lost 22% of its value, which were able to re-

gain by 2011:S2. Impressionists and Modern lost 35%, Post-war and Contemporary 37%, and Top Artists 29% during the same period.

Figure 1 shows that the dip of the prints prices, albeit significant, was not so sharp in the post-financial crisis period 2007–2009. It appears that in 2009 the market for modern prints picked up again. Kräussl et al. (2016) report art prices up to 2014 and suggest that the art market demonstrates the explosive behavior after the financial crisis, which can indicate another pricing bubble. A potential reason for such an increase might be the quantitative easing policy implemented excessively by the Federal Reserve Bank in the U.S. and the European Central Bank in the Eurozone to boost the global economy and overcome the prolonged recession.

To summarize, it appears that the prices for modern prints grow in the periods of abundant money supply and decline in the periods of economic crises. Two noticeable prints market booms occurred in the late 1980s and mid-2000 fueled by the expansion of the Japanese and world economies, respectively. These booms followed by drastic busts as the Japanese and U.S. real estate markets collapsed. While the overall prints market, Impressionists and Modern style, and ten Top Artists moved in unison during the period between 1985 and 2011, the style Post-war and Contemporary demonstrated significant outperformance and largest swings. This observation is on contrary to Kräussl et al. (2016), which claim that Impressionists and Modern style was most affected by investor exuberance.

3.2 Over- and underreaction to pricing estimates

Table 3 reports the estimated coefficients for our overbidding and underbidding measures for the model in Equation (4) for real returns after controlling for the general price movement of the prints market and other control variables such as the auction house dummy, death dummy, business cycle dummy, and Mei and Moses (2005)'s variables for average pricing estimates and spread. The data for both high and low pricing estimates is only available from 1998 onwards. Therefore, the sample size for our analysis is limited to 34,302 observations of 27,596 repeat-sale pairs for all

prints, 15,863 observations of 12,964 pairs for Impressionist and Modern style, 9,175 observations of 6,121 repeat-sales for Post-War and Contemporary, and 18,176 observations of 15,596 repeat-sales for ten top artists.

Following the theory of the overreaction and winner's curse, we expect to find evidence of underperformance (outperformance) of prints at time s that were bought for a price above (below) their high (low) pricing estimates at time b . There are 16,626 (11,237) prints that were bought for a price above (below) its high pricing estimate at time b for all data, 7,575 (6,223) for the Impressionist and Modern style, 5,078 (1,879) for the Post-war and Contemporary style, and 9,579 (4,788) for the Top Artists. The overbid (underbid) prints are above (below) their high (low) pricing estimate by 35% (17%) for the whole subsample, 33% (16%) for the Impressionist and Modern style, 36% (17%) for the Post-war and Contemporary style, and 36% (16%) for ten Top Artists, on average.

We find negative and strongly statistically significant coefficients for the *Overbid_i* variable for all data, the subsample of Impressionist and Modern prints, Post-war and Contemporary prints, and our ten Top Artists for real returns. This finding confirms our expectation of the underperformance of the prints at time s that were bought for the price above high pricing estimates at time b . Based on the obtained OLS coefficients, it appears that a winning bid that exceeds its high pricing estimate by 10% is associated with a 12% adverse real abnormal return at the subsequent sale for the overall prints market, 13% for the Impressionist and Modern style, 13% for the Post-war and Contemporary style, and 11% for ten Top Artists after controlling for the general price movement on the prints market and other control variables (Table 3).

[Please insert Table 3 about here]

In this paper we assume that the auctioneer pricing estimates are accurate and are the best indication of the current price of a print (Ashenfelter, 1989). A bidder who decides to pay a price for a print above its high pricing estimate is willing to pay a higher price than the best indication of its worth. Such a bidder is either over-

confident about her own estimates of the print's worth or assigns an extra aesthetic value to the art object, which cannot be measured in monetary terms (Coffman, 1991). The print becomes overvalued and incurs a negative excess return at the subsequent sale, consistent with mean-reversion (Barberis et al., 1998; De Bondt and Thaler, 1985, 1987; Poterba and Summers, 1988). As a result, the owner of the overvalued print suffers from the winner's curse (Capen et al., 1971; Kagel and Levin, 1986; Lind and Plott, 1991). To confirm this suggestion, we find that there are 5,182 overvalued prints that are sold for a lower price versus 4,269 overvalued prints that were sold for a higher price at time s than at time b in our total sample.

Our results conflict with the suggestion by Mei and Moses (2005) that overvalued art objects will be overvalued at a subsequent sale as new bidders are prone to the winner's curse as well. On contrary, we find evidence of the reversion of the prices for the overvalued prints at the subsequent sale. Mei and Moses (2005) assume that the pricing estimates are upwardly biased for expensive paintings, which causes the adverse subsequent abnormal return. On the contrary, we assume that auctioneer pricing estimates are accurate and the adverse subsequent abnormal return is caused by bidders' overconfidence. We were able to find confirming evidence of our hypothesis after controlling for Mei and Moses (2005) variables of the average pricing estimates and the spread.

In contrast to Mei and Moses (2005), we find negative and statistically significant coefficients for the average pricing estimates variable for the subsample of Impressionist and Modern prints and Top Artists (Table 3). The coefficients are insignificant for all prints and Post-war and Contemporary style. Additionally, we find a negative and statistically significant coefficient for the spread variable for all data, sub-samples based on the artistic style, and ten top artists. Mei and Moses (2005) find positive and statistically significant coefficients for the average pricing estimates for all data, American style, Impressionist style, and Old Masters and a positive and statistically significant coefficient for the spread for Old Masters paintings. In contrast to the findings in earlier literature, we cannot conclude that the

auctioneer pricing estimates are upwardly biased and result in the adverse subsequent abnormal return. We suggest that the inclusion of our variables for overvalued and undervalued prints might explain the absence of the results by Mei and Moses (2005) in our analysis.

Additionally, we report a positive and statistically significant coefficient for the change in the pricing estimates control variable between the dates b and s for the full sample, two different styles, and Top Artists. The estimated coefficients imply that a log change in the average pricing estimates of 10% is associated with the positive real subsequent excess return of 11% for all sample data, 11% for the Impressionist and Modern style, 13% for the Post-war and Contemporary style, and 10% for the Top Artists after controlling for the general price movement on the prints market and other control variables. This result suggests that actual prices follow the auctioneer pricing estimates closely. Anderson (1974) asserts that auctioneers' pricing estimates are better predictors of the prices fetched than any hedonic price function. Our results render support to our assumption that the auctioneer pricing estimates are an accurate and timely indicator of the changes in the print price.

We find a negative and strongly statistically significant coefficient for the *Underbid_{*i*}* variable for all data, Top Artists, and two artistic styles for real returns (Table 3). The coefficient implies that a bidder who obtains a print for a price 10% lower than its low pricing estimate enjoys a positive real excess return of 17% for all data, 17% for the Impressionist and Modern style, 19% for the Post-war and Contemporary style, and 16% for the ten Top Artists at a subsequent sale after controlling for the general price movement on the prints market and other control variables. This result confirms our expectations of the outperformance of undervalued prints at the subsequent sale.

If the auctioneer pricing estimates are accurate, a print sold for a price below its low pricing estimate is undervalued. There are 3,145 undervalued prints that were sold for a higher price versus 1,585 undervalued prints that were sold for a lower price at time s than at time b for all data in our sample. Thus, undervalued

prints appear to be an attractive buy, since it is twice as likely to rise in value at a subsequent sale. However, we have to note that it is not always possible to buy a print below its low pricing estimate. Even if there are no higher bids, a too low bid might never reach the reservation price, which is typically 60–80% of the low pricing estimate, and the print goes unsold (Ekelund et al., 1998).

Our analysis is based only the actual sales of the prints and excludes all “bought-in” records as these are not actual sales. One might argue that the undervalued print might be “bought-in” between times b and s , and thus, it was not a good buy. We argue that the exclusion of “bought-in” sales does not bias our results. Unsold prints that do not reach the reservation price still remain at the collector and no loss is generated. At the next bidding at time s the actual trade occurs and the collector exchanges the print for money. The monetary gain or loss is only visible at time s , when the actual trade occurs, and not when the print is unsold.

Additionally, the reader should note that we analyze the subsequent excess return at time s and not how the print performs relative to its pricing estimates at time s . It is possible that the pricing estimates might be adjusted downwards for the undervalued prints and the print can still be sold below new low pricing estimate at time s . However, as long as the print generates a positive excess return at time s after controlling for the general price movement on the prints market, the print is a good buy, albeit still undervalued. In this case, the price correction is partial.

Table 4 reports the estimated *Overbid_{*i*}* and *Underbid_{*i*}* coefficients for different economic states as in Equation (5) separately for the full sample, for our two different artistic styles, Impressionist and Modern and Post-war and Contemporary, and for the subsample of Top Artists. Similar to our previous analysis, our sample begins from 1998 onwards due to the availability of the pricing estimates in our dataset. We distinguish between two economic states: expansion and recession defined by NBER. Our results for the overbidding and underbidding measures remain unchanged. In line with our expectations, during expansions as well as during recessions paying a price for a print above its high pricing estimate leads to a negative

excess return at the subsequent sale. Thus, paying a price for a print that exceeds its high pricing estimates by 10% during expansions results in an adverse real abnormal return of 12%, 13%, 12%, and 11% for the entire sample, Impressionist and Modern style, Post-war and Contemporary style, and top ten artists at the subsequent sale, respectively, after controlling for the overall price movement on the prints market. The effect is stronger for the recessionary states of the economy. A fetched price for a print that exceeds high pricing estimate by 10% during recessions is associated with a negative real abnormal return of 13%, 14%, 14%, and 13% for all data, Impressionist and Modern style, Post-war and Contemporary style, and ten top artists at the subsequent sale, respectively, after controlling for the overall price movement on the prints market. The results are strongly statistically significant. The effect of the winner's curse is similar in magnitude across different artistic styles.

[Please insert Table 4 about here]

Similarly, the coefficients for the $Underbid_i$ variable are negative and strongly statistically significant for the full sample, for the Top Artists, and for the two different artistic styles during both expansions and recessions. The excess return is higher during expansions than recessions. A print sold for a price below its low pricing estimate by 10% during expansions results in a positive real excess return of 17%, 17%, 20%, and 16% for all sample, Impressionist and Modern style, Post-war and Contemporary style and Top Artists at a subsequent sale, respectively, after controlling for the overall movement on the prints market. Similarly, during recessions a price for a print below its low pricing estimate by 10% results in 16%, 16%, 16%, and 14% higher real excess return at the subsequent sale for all data, both artistic styles and Top Artists, respectively, after controlling for the overall price movement on the prints market. The price correction for overvalued (undervalued) prints is more pronounced during recessions (expansion).

3.3 The “Auction House” Effect

Tables 3 and 4 report the estimated coefficients for the auction house dummy variable (D_i^{AH}). We find that a print sold at Christie’s or Sotheby’s at time s after being bought at any other auction house or a gallery at time b generates a positive real excess return of 0.17%, 0.16%, 0.14%, and 0.16% for all data, Impressionist and Modern style, Post-war and Contemporary style, and Top Artists, respectively. Our finding is in line with Pesando (1993) who reports systematically higher prices paid by art collectors at Christie’s and Sotheby’s. Pesando (1993) interprets such anomaly as the violation of the law of one price. The law of one price in economics states that in efficient markets there must be a single price at which a commodity is traded regardless of its location (Pesando, 1993). This fundamental assumption rules out the possibility of arbitrage. It appears that it is possible to earn additional return by simply selling a print at Christie’s or Sotheby’s auction house compared to other less renowned auction houses and galleries. The violation of the law of one price points out to the inefficiency of the prints markets.

4 Conclusion

In this paper we investigate the overreaction and winner’s curse phenomena on the market of modern prints. We hypothesize that a print sold for a price above its high pricing estimate is an example of overreaction and will incur losses at a subsequent sale. On the other hand, a print sold for a price below its low pricing estimate will benefit from a positive excess return at a subsequent sale. We base our hypotheses on the assumption that auctioneer pricing estimates are accurate and are the best predictor of the current market value of an art object. We use actual auction data on the modern prints downloaded from Gordon’s Prints Price Annual database. Our data sample consists of 4,728 prints of 178 artists with the total volume of 93,406 sales for the time span of 1985–2011.

We find that a print sold for a price above (below) its high (low) pricing estimate

by 10 percent results in a loss (gain) of 12 percent (17 percent) at a subsequent sale after controlling for the general price movement on the prints market and other control variables. The price correction of overvalued (undervalued) prints is more pronounced during recessions (expansions). Our results hold for all data and for our subsamples based on artistic styles and Top Artists. Apart from our main finding, we find evidence of the “Auction House” effect. We find that prints that are resold at Christie’s or Sotheby’s auction houses after being bought at any other auction house generate a positive excess return of 0.16% after controlling for the general price movement on the prints market.

Table 1. Repeat-Sale Indices, Real Return, Semiannual: 1985:S1–2011:S2

This table reports the estimated μ coefficients of the repeat-sale regression methodology as in Equation (1). We estimate the repeat-sale regression by following Case and Shiller’s (1987) three-stage GLS methodology. We perform the analysis on the full sample, the Impressionist and Modern (Im/M) style, the Post-war and Contemporary (Pw/C) style, and on the Top Artists, which include Pablo Picasso, Andy Warhol, Rembrandt, Marc Chagall, Joan Miro, Albrecht Durer, Kathe Kollwitz, Roy Lichtenstein, Henri de Toulouse-Lautrec, and David Hockney. Statistical significance is denoted by asterisks *, **, and *** at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All Data	<i>t</i> -stat.	Im/M	<i>t</i> -stat.	Pw/C	<i>t</i> -stat.	Top Artist	<i>t</i> -stat.
1985:S1	-0.385***	(-11.296)	-0.421***	(-9.438)	-0.979***	(-8.884)	-0.388***	(-8.325)
1985:S2	-0.396***	(-12.102)	-0.429***	(-10.459)	-1.015***	(-10.102)	-0.321***	(-7.079)
1986:S1	-0.245***	(-8.270)	-0.215***	(-5.651)	-1.016***	(-11.106)	-0.216***	(-5.241)
1986:S2	-0.178***	(-5.865)	-0.188***	(-4.789)	-0.828***	(-8.977)	-0.185***	(-4.699)
1987:S1	-0.108***	(-3.965)	-0.059*	(-1.757)	-0.662***	(-8.599)	-0.099***	(-2.643)
1987:S2	-0.024	(-0.848)	0.055	(1.527)	-0.310***	(-4.131)	-0.056	(-1.395)
1988:S1	0.083***	(3.464)	0.062**	(2.036)	-0.152**	(-2.370)	0.131***	(4.032)
1988:S2	0.168***	(6.929)	0.173***	(5.793)	0.063	(1.035)	0.120***	(3.596)
1989:S1	0.235***	(11.226)	0.250***	(9.199)	0.376***	(7.963)	0.189***	(6.730)
1989:S2	0.378***	(17.632)	0.383***	(13.558)	0.666***	(15.439)	0.302***	(10.302)
1990:S1	0.325***	(16.883)	0.349***	(13.877)	0.545***	(13.385)	0.231***	(8.870)
1990:S2	0.212***	(9.459)	0.270***	(9.632)	0.352***	(6.587)	0.107***	(3.456)
1991:S1	0.015	(0.686)	0.048	(1.630)	-0.020	(-0.379)	-0.038	(-1.193)
1991:S2	-0.068***	(-2.961)	-0.004	(-0.149)	-0.121**	(-2.181)	-0.145***	(-4.288)
1992:S1	-0.064***	(-2.901)	-0.132***	(-4.375)	-0.215***	(-3.870)	-0.106***	(-3.393)
1992:S2	-0.202***	(-8.985)	-0.184***	(-5.952)	-0.183***	(-3.694)	-0.293***	(-9.026)
1993:S1	-0.081***	(-3.537)	-0.126***	(-4.096)	-0.303***	(-5.505)	-0.053	(-1.638)
1993:S2	-0.221***	(-10.338)	-0.238***	(-8.275)	-0.325***	(-6.533)	-0.226***	(-7.288)
1994:S1	-0.169***	(-8.078)	-0.176***	(-6.311)	-0.212***	(-4.404)	-0.182***	(-6.119)
1994:S2	-0.234***	(-10.786)	-0.222***	(-7.924)	-0.330***	(-6.434)	-0.295***	(-9.615)
1995:S1	-0.101***	(-4.880)	-0.076***	(-2.805)	-0.157***	(-3.034)	-0.118***	(-3.997)
1995:S2	-0.169***	(-7.946)	-0.089***	(-3.263)	-0.261***	(-5.052)	-0.194***	(-6.337)
1996:S1	-0.150***	(-7.521)	-0.109***	(-4.182)	-0.328***	(-6.534)	-0.161***	(-6.699)
1996:S2	-0.172***	(-8.250)	-0.073***	(-2.711)	-0.344***	(-6.573)	-0.180***	(-5.867)
1997:S1	-0.106***	(-5.201)	-0.093***	(-3.437)	-0.275***	(-5.672)	-0.087***	(-3.143)
1997:S2	-0.220***	(-9.453)	-0.207***	(-6.523)	-0.211***	(-3.970)	-0.222***	(-6.744)
1998:S1	-0.152***	(-7.097)	-0.105***	(-3.623)	-0.203***	(-4.268)	-0.138***	(-4.639)
1998:S2	-0.093***	(-4.349)	-0.109***	(-3.810)	-0.280***	(-5.442)	-0.066**	(-2.289)
1999:S1	-0.117***	(-5.486)	-0.089***	(-3.098)	-0.239***	(-4.988)	-0.131***	(-4.329)
1999:S2	-0.116***	(-5.476)	-0.078***	(-2.682)	-0.243***	(-5.198)	-0.118***	(-3.939)
2000:S1	-0.057***	(-2.719)	-0.018	(-0.646)	-0.151***	(-3.060)	-0.099***	(-3.385)
2000:S2	-0.149***	(-6.484)	-0.131***	(-4.162)	-0.331***	(-6.478)	-0.162***	(-4.938)
2001:S1	-0.203***	(-8.460)	-0.181***	(-5.521)	-0.325***	(-6.076)	-0.240***	(-6.811)
2001:S2	-0.201***	(-8.808)	-0.246***	(-7.967)	-0.299***	(-5.751)	-0.179***	(-5.599)
2002:S1	-0.212***	(-9.139)	-0.155***	(-4.891)	-0.230***	(-4.216)	-0.260***	(-7.873)
2002:S2	-0.160***	(-7.723)	-0.149***	(-5.232)	-0.231***	(-4.962)	-0.186***	(-6.505)
2003:S1	-0.117***	(-5.401)	-0.063**	(-2.242)	-0.165***	(-3.281)	-0.095***	(-3.068)
2003:S2	-0.062***	(-2.959)	-0.063**	(-2.114)	-0.045	(-0.999)	-0.045	(-1.485)
2004:S1	-0.043**	(-1.988)	-0.043	(-1.501)	0.018	(0.383)	-0.064**	(-1.977)
2004:S2	0.006	(0.296)	0.001	(0.040)	0.015	(0.379)	0.023	(0.832)
2005:S1	0.067***	(3.434)	0.070***	(2.644)	0.111***	(2.802)	0.062**	(2.248)
2005:S2	-0.003	(-0.183)	-0.023	(-0.806)	0.013	(0.342)	0.037	(1.281)
2006:S1	0.092***	(4.800)	0.089***	(3.304)	0.121***	(3.084)	0.124***	(4.532)
2006:S2	0.026	(1.343)	-0.018	(-0.671)	0.020	(0.546)	0.035	(1.341)
2007:S1	0.122***	(6.320)	0.110***	(3.958)	0.217***	(5.711)	0.122***	(4.415)
2007:S2	0.203***	(10.455)	0.116***	(4.075)	0.397***	(10.922)	0.279***	(10.465)
2008:S1	0.071***	(3.589)	0.020	(0.718)	0.334***	(9.071)	0.065**	(2.318)
2008:S2	-0.131***	(-5.999)	-0.143***	(-4.503)	-0.098***	(-2.442)	-0.164***	(-5.112)
2009:S1	-0.237***	(-10.064)	-0.257***	(-7.589)	-0.271***	(-5.830)	-0.224***	(-6.480)
2009:S2	-0.089***	(-3.835)	-0.140***	(-4.089)	-0.058	(-1.307)	-0.076**	(-2.266)
2010:S1	-0.053***	(-2.360)	-0.092***	(-2.788)	0.016	(0.394)	-0.020	(-0.625)
2010:S2	-0.040*	(-1.766)	-0.079**	(-2.319)	0.038	(0.887)	-0.038	(-1.160)
2011:S1	-0.029	(-1.237)	-0.053	(-1.522)	0.113***	(2.585)	-0.026	(-0.765)
2011:S2	-0.011	(-0.431)	-0.062	(-1.570)	0.049	(1.015)	0.056	(1.517)
Adj.R sq.	0.022		0.023		0.069		0.022	
OBS	80,281		43,112		17,021		40,472	

Table 2. Descriptive Statistics

This table reports the descriptive statistics of our semi-annual repeat-sale indices for all data of 4,728 prints, for 1,030 Impressionist and Modern (Im/M) style prints, for 2,581 Post-War and Contemporary (Pw/C) style prints, and for our subsample of 2,090 Top Artists prints for the period between 1985 and 2011. Top Artists include Pablo Picasso, Andy Warhol, Rembrandt, Marc Chagall, Joan Miro, Albrecht Durer, Kathe Kollwitz, Roy Lichtenstein, Henri de Toulouse-Lautrec, and David Hockney. We report annualized geometric and arithmetic return in nominal and real terms.

	(1)	(2)	(3)	(4)
	All Data	Im/M	Pw/C	Top Artists
Ann. Geometric Return (Nominal)	2.35%	2.34%	5.00%	2.34%
Ann. Geometric Return (Real)	1.41%	1.36%	3.88%	1.68%
Ann. Arithmetic Return (Nominal)	3.14%	3.16%	7.45%	3.45%
Ann. Arithmetic Return (Real)	2.18%	2.15%	6.21%	2.77%
Ann. Standard Deviation (Arith)	12.40%	12.76%	21.76%	14.90%
Min Return Semiannual Real Arith	-18.42%	-19.95%	-35.17%	-20.61%
Max Return Semiannual Real Arith	16.32%	23.79%	42.29%	27.06%
OBS	80,281	43,112	17,021	40,472

Table 3. Overreaction to Pricing Estimates: 1998–2011

This table reports the estimated coefficients for Equation (4): $r_i = \sum_{t=b_i+1}^{s_i} \mu_t + \gamma_1 \text{Overbid}_i + \gamma_2 \text{Underbid}_i + \Theta X_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t}$, where r_i is the real return of print i , μ_t is the average return of a portfolio of prints at time t , Overbid_i (Underbid_i) is our overbidding (underbidding) measure, X_t is a set of control variables, $\varepsilon_{i,t}$ is the print-specific return, b is the purchase date, and s is the sales date. D_i^{AH} is an auction house dummy variable that takes the value of 1 when the print is resold at Christie's or Sotheby's after being bought at any other auction house. $\ln(P_{i,s}^{AVE}/P_s^{AVE})$ is the Mei and Moses (2005) control variable for the average pricing estimates, where $P_{i,s}^{AVE}$ is the average of high and low pricing estimates at date s , and P_s^{AVE} is the average of average pricing estimates at year s . $\ln((P_{i,s}^H - P_{i,s}^L)/P_{i,s}^{AVE})$ is the Mei and Moses (2005) control variable for the spread, where $P_{i,s}^H$ is the high pricing estimate of the print i at time s , and $P_{i,s}^L$ is the low pricing estimate of the print i at time s . $D_{i,b}^{BC}$ is a business cycle dummy variable that takes the value of 1 if the date b is classified by the NBER as a recession and 0 if classified as an expansion. We estimate the repeat-sale regression by following the Case and Shiller (1987) three-stage GLS approach. We take the average price of the prices of the print, which is sold more than once on the same date. We use the U.S. CPI as the rate of inflation. We estimate the model on all data, Impressionist and Modern (Im/M) style, Post-War and Contemporary (Pw/C) style, and Top Artists. Statistical significance is denoted by asterisks *, **, and *** for the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
	All Data	Im/M	Pw/C	Top Artist
Overbid_i	-1.206*** (-104.836)	-1.314*** (-74.582)	-1.253*** (-48.296)	-1.115*** (-82.770)
Underbid_i	-1.689*** (-54.763)	-1.675*** (-39.444)	-1.856*** (-23.285)	-1.555*** (-40.001)
Control variables				
D_i^{AH}	0.166*** (20.358)	0.161*** (13.637)	0.143*** (7.618)	0.161*** (17.365)
$\ln(P_{i,s}^{AVE}/P_s^{AVE})$	0.001 (0.296)	-0.023*** (-5.534)	0.007 (1.147)	-0.012*** (-3.421)
$\ln((P_{i,s}^H - P_{i,s}^L)/P_{i,s}^{AVE})$	-0.139*** (-17.070)	-0.161*** (-13.112)	-0.105*** (-6.526)	-0.102*** (-9.475)
$\ln(P_{i,s}^{AVE}/P_{i,b}^{AVE})$	1.096*** (258.440)	1.129*** (178.105)	1.271*** (119.506)	1.018*** (207.421)
$D_{i,b}^{Death}$	-0.025*** (-2.468)	-0.073*** (-4.430)	0.132*** (6.484)	0.035*** (2.563)
$D_{i,b}^{BC}$	-0.162*** (-13.082)	-0.142*** (-7.725)	-0.271*** (-9.436)	-0.183*** (-12.019)
Adj. R-sq.	0.756	0.754	0.754	0.788
OBS	27,596	12,964	6,121	15,596

Table 4. Overreaction to Pricing Estimates During Recessions and Expansions: 1998–2011

This table reports the estimated coefficients for the following model in Equation (5): $r_i = \sum_{t=b_i+1}^{s_i} \mu_t + (1 - D_{i,b}^{BC})(\gamma_{11}Overbid_i + \gamma_{12}Underbid_i) + (D_{i,b}^{BC})(\gamma_{21}Overbid_i + \gamma_{22}Underbid_i) + \Theta X_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t}$ where r_i is the real return of the print i , μ_t is the average return of a portfolio of prints at time t , $Overbid_i$ is our overbidding measure, $Underbid_i$ is our underbidding measure, X_t is a set of control variables, $\varepsilon_{i,t}$ is the print-specific return, b is the purchase date and s is the sales date. $D_{i,b}^{BC}$ is a business cycle dummy variable that takes a value of 1 if the date b is classified as recession in NBER and 0 if classified as expansion. D_i^{AH} is the auction house dummy variable that takes a value of 1 when the print is resold at Sotheby's or Christie's after being bought at any other auction house or a gallery. $\ln(P_{i,s}^{AVE}/P_s^{AVE})$ is a Mei and Moses (2005) control variable for the average pricing estimates, where $P_{i,s}^{AVE}$ is the average of high and low pricing estimates at date s and P_s^{AVE} is the average of average pricing estimates at year s . $\ln((P_{i,s}^H - P_{i,s}^L)/P_{i,s}^{AVE})$ is the Mei and Moses (2005) control variable for the spread, where $P_{i,s}^H$ is the high pricing estimate of the print i at time s and $P_{i,s}^L$ is the low pricing estimate of the print i at time s . $D_{i,b}^{Death}$ is the death dummy variable that takes a value of 1 if an artist of the print i was dead at the time of purchase b , and 0 if he or she was alive. We estimate the repeat-sale regression by following Case and Shiller (1987) three-stage GLS approach. We take the average price of the prices of the print, which is sold more than once on the same date. We use the U.S. CPI as the rate of inflation. We estimate the model on all data, for Impressionist and Modern (Im/M) style, for Post-War and Contemporary (Pw/C) style, and for Top artists. Statistical significance is denoted by asterisks *, **, and *** for 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
	All Data	Im/M	Pw/C	Top Artist
Expansions				
$Overbid_i$	-1.191*** (-98.159)	-1.303*** (-70.452)	-1.224*** (-44.265)	-1.096*** (-77.340)
$Underbid_i$	-1.711*** (-48.987)	-1.694*** (-36.000)	-1.951*** (-20.936)	-1.597*** (-35.590)
Recessions				
$Overbid_i$	-1.335*** (-39.038)	-1.407*** (-26.583)	-1.443*** (-20.413)	-1.265*** (-31.363)
$Underbid_i$	-1.597*** (-24.366)	-1.579*** (-16.033)	-1.582*** (-10.322)	-1.414*** (-18.268)
Control variables				
D_i^{AH}	0.166*** (20.377)	0.161*** (13.637)	0.143*** (7.625)	0.161*** (17.385)
$\ln(P_{i,s}^{AVE}/P_s^{AVE})$	0.000 (0.260)	-0.023*** (-5.569)	0.007 (1.114)	-0.013*** (-3.525)
$\ln((P_{i,s}^H - P_{i,s}^L)/P_{i,s}^{AVE})$	-0.139*** (-17.032)	-0.161*** (-13.093)	-0.102*** (-6.386)	-0.102*** (-9.480)
$\ln(P_{i,s}^{AVE}/P_{i,b}^{AVE})$	1.096*** (258.541)	1.130*** (178.096)	1.272*** (119.632)	1.019*** (207.549)
D_i^{Death}	-0.028*** (-2.749)	-0.075*** (-4.542)	0.127*** (6.223)	0.030** (2.225)
D_i^{BC}	-0.141*** (-10.477)	-0.126*** (-6.278)	-0.230*** (-7.416)	-0.156*** (-9.526)
Adj. R-sq.	0.757	0.754	0.754	0.788
OBS	27,596	12,964	6,121	15,596

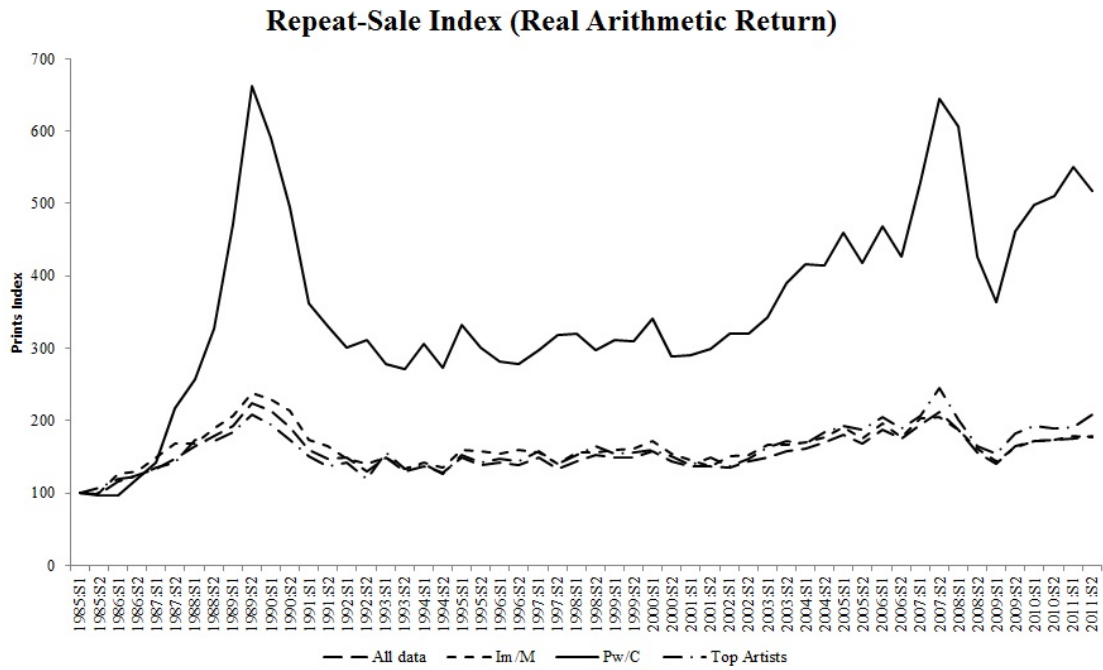


Figure 1. Repeat-Sale Indices

This figure plots our repeat-sale indices for all data in our 4,728 prints sample, for the subsample of 1,030 Impressionist and Modern (Im/M) prints, for the subsample of 2,581 Post-war and Contemporary (Pw/C) prints, and for our sample of 2,090 Top Artist prints on a semi-annual basis for the time span of 1985–2011. The indices are constructed by using real arithmetic returns. We take the average price of the print with multiple sales on the same day.

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Table A1. Sample Statistics

This table reports the descriptive statistics of all 178 artists in our sample. We report the total volume, turnover and the number of prints, the maximum selling price, the style and the year of death per each artist. Volume is the total number of sale records. Turnover is the total U.S. dollar sale proceeds. We rank the artists by volume.

(1) Artist name	(2) Volume	(3) Turnover	(4) N. of Prints	(5) Max Price	(6) Style	(7) Death Year
PICASSO,PABLO	13578	\$177,596,706	544	\$619,850	Im/M	1973
WARHOL,ANDY	6719	\$144,998,659	199	\$826,900	Pw/C	1987
REMBRANDT	6368	\$56,165,649	212	\$506,000	Old Masters	1669
CHAGALL,MARC	6815	\$66,257,425	284	\$444,000	Im/M	1985
MIRO,JOAN	5354	\$46,533,234	283	\$165,000	Im/M	1983
DURER,ALBRECHT	3078	\$31,690,480	208	\$409,250	Old Masters	1528
KOLLWITZ,KATHE	2609	\$8,219,980	126	\$61,000	Im/M	1945
LICHTENSTEIN,ROY	2168	\$28,931,926	101	\$301,000	Pw/C	1997
TOULOUSE-LAUTREC,HENRI DE	2011	\$42,294,051	77	\$767,000	Im/M	1901
HOCKNEY,DAVID	1853	\$20,059,176	123	\$23,100,000	Pw/C	NA
PIRANESI,G.B.	1594	\$2,643,551	58	\$15,525	Old Masters	1778
WHISTLER,JAMES	1571	\$6,879,957	72	\$282,000	american	1903
RENOIR,PIERRE-AUG.	1543	\$13,310,788	53	\$176,000	Im/M	1919
BENTON,THOMAS HART	1431	\$3,184,973	57	\$18,000	american	1975
BECKMANN,MAX	1234	\$8,997,743	68	\$220,150	Im/M	1950
ROUAULT,GEORGES	1177	\$8,195,860	59	\$400,000	Im/M	1958
BRAQUE,GEORGES	1245	\$8,308,301	77	\$96,000	Im/M	1963
HUNDERTWASSER,F.	1107	\$3,277,554	49	\$12,100	Pw/C	2000
MATISSE,HENRI	1070	\$22,407,253	64	\$313,250	Im/M	1954
ICART,LOUIS	1028	\$2,637,634	48	\$19,800	Im/M	1950
HECKEL,ERICH	781	\$3,462,768	50	\$91,200	Im/M	1970
WOOD,GRANT	779	\$2,497,141	32	\$10,800	american	1942
ZORN,ANDERS	774	\$1,229,989	47	\$15,000	Old Masters	1920
JOHNS,JASPER	739	\$27,386,171	53	\$842,500	Pw/C	NA
VILLON,JACQUES	662	\$3,405,033	51	\$40,000	Im/M	1963
ERNST,MAX	556	\$1,327,475	27	\$13,200	Im/M	1976
TISSOT,J.J.	549	\$1,858,746	30	\$35,200	19th century european	1902
BONNARD,PIERRE	543	\$3,758,903	27	\$210,000	Im/M	1947
GOYA,FRANCISCO DE	524	\$3,244,237	24	\$175,000	Old Masters	1828
LAURENCIN,MARIE	507	\$1,748,490	37	\$14,300	Im/M	1956
RICHTER,GERHARD	500	\$2,459,583	23	\$38,240	Pw/C	NA
LEGER,FERNAND	578	\$3,081,218	34	\$46,200	Im/M	1955
CORINTH,LOVIS	479	\$736,724	39	\$11,960	Im/M	1925
MOORE,HENRY	479	\$1,159,411	33	\$11,550	Im/M	1986
MILLET,J.F.	470	\$2,165,556	21	\$146,520	19th century european	1875
MUCHA,ALPHONSE	458	\$4,364,300	27	\$100,350	19th century european	1939
DINE,JIM	456	\$2,417,644	30	\$45,100	Pw/C	NA

Table A1 – Continued from previous page

(1) Artist name	(2) Volume	(3) Turnover	(4) N. of Prints	(5) Max Price	(6) Style	(7) Death Year
LEWIS,MARTIN	456	\$4,086,524	26	\$50,400	american	1962
STELLA,FRANK	452	\$4,440,698	40	\$104,250	Pw/C	NA
SLOAN,JOHN	441	\$1,153,802	27	\$12,000	american	1951
DIX,OTTO	426	\$2,950,449	29	\$57,340	Im/M	1969
FEININGER,LYONEL	405	\$1,636,248	25	\$25,000	Im/M	1956
LIEBERMANN,MAX	396	\$520,565	29	\$5,980	Im/M	1935
HODGKIN,HOWARD	387	\$1,206,929	27	\$8,750	Pw/C	NA
MOTHERWELL,ROBERT	380	\$3,756,760	29	\$156,000	Pw/C	1991
BUFFET,BERNARD	377	\$1,321,632	29	\$13,200	Im/M	1999
FRANCIS,SAM	358	\$2,322,701	22	\$51,750	Pw/C	1994
KANDINSKY,WASSILY	355	\$4,761,712	19	\$70,700	Im/M	1944
MARINI,MARINO	342	\$708,465	24	\$23,100	Im/M	1980
RAUSCHENBERG,R.	340	\$1,011,653	23	\$22,500	Pw/C	2008
ESCHER,MAURITS	331	\$3,793,432	15	\$31,250	Im/M	1972
ENSOR,JAMES	327	\$1,602,443	25	\$57,500	Im/M	1949
WESSELMANN,TOM	320	\$1,730,408	20	\$45,600	Pw/C	2004
MANET,EDOUARD	319	\$1,023,713	23	\$187,000	Im/M	1883
PECHSTEIN,MAX	312	\$1,052,921	22	\$16,120	Im/M	1955
CASSANDRE,A.M.	292	\$2,118,017	17	\$50,600	Old Masters	1968
SCHMIDT-ROTTLUFF,K.	291	\$1,556,499	24	\$30,940	Im/M	1976
ROSENQUIST,JAMES	288	\$1,464,836	23	\$41,800	Pw/C	NA
CASSATT,MARY	272	\$697,252	9	\$28,200	american	1926
DUBUFFET,JEAN	271	\$3,513,876	23	\$165,000	Pw/C	1985
KLEE,PAUL	267	\$4,778,600	14	\$93,500	Im/M	1940
MUELLER,OTTO	266	\$2,277,401	17	\$80,500	Im/M	1930
KATZ,ALEX	263	\$885,251	17	\$2,640,000	Pw/C	NA
FELIXMULLER,CONRAD	257	\$461,619	15	\$7,500	Im/M	1977
DALI,SALVADOR	245	\$1,305,830	19	\$19,120	Im/M	1989
GRIESHABER,HAP	238	\$546,477	16	\$71,300	other	1981
BACON,FRANCIS	233	\$1,810,948	15	\$58,000	Pw/C	1992
MERYON,CHARLES	233	\$527,933	12	\$15,400	Old Masters	1868
GAUGUIN,PAUL	231	\$3,109,643	25	\$24,000,000	Im/M	1903
VOGELER,HEINRICH	231	\$414,229	13	\$9,375	Im/M	1942
HAYTER,STANLEY W.	229	\$389,629	14	\$8,800	Pw/C	1988
OSTADE,ADRIAEN VAN	205	\$1,004,459	13	\$19,700	Old Masters	1685
CURRY,JOHN STEUART	194	\$374,159	9	\$8,880	american	1946
PISSARRO,CAMILLE	191	\$513,487	12	\$21,066	Im/M	1903
FRANKENTHALER,H.	186	\$1,025,551	15	\$16,250	Pw/C	2011
BUHOT,FELIX	180	\$309,891	11	\$5,386	Old Masters	1898
BELLOWS,GEORGE	178	\$2,842,668	14	\$123,500	american	1925
CEZANNE,PAUL	177	\$1,862,372	13	\$79,750	Im/M	1906
COROT,JEAN BAPTISTE CAMILLE	171	\$268,011	12	\$9,020	19th century european	1875

Table A1 – Continued from previous page

(1) Artist name	(2) Volume	(3) Turnover	(4) N. of Prints	(5) Max Price	(6) Style	(7) Death Year
KOKOSCHKA,OSKAR	165	\$210,475	12	\$6,325	Im/M	1980
KENT,ROCKWELL	162	\$260,450	12	\$7,170	american	1971
RUSCHA,EDWARD	162	\$1,907,138	12	\$133,000	Pw/C	NA
SEVERINI,GINO	160	\$422,035	10	\$45,600	Im/M	1966
INDIANA,ROBERT	157	\$929,205	7	\$31,250	Pw/C	NA
VUILLARD,EDOUARD	157	\$1,356,358	14	\$29,700	Im/M	1940
KOONING,WILLEM DE	152	\$1,504,674	11	\$104,500	Pw/C	1997
BEUYTS,JOSEPH	148	\$457,565	12	\$56,120	Pw/C	1986
HAMILTON,RICHARD	147	\$1,538,705	11	\$43,200	Pw/C	2011
MARSH,REGINALD	144	\$449,433	12	\$41,400	american	1954
THIEBAUD,WAYNE	144	\$2,054,015	10	\$60,000	Pw/C	NA
TAMAYO,RUFINO	136	\$234,559	12	\$6,000	latin american	1991
TAPIES,ANTONI	132	\$289,937	9	\$30,000	Pw/C	2012
JANSSEN,HORST	127	\$269,566	11	\$18,000	Pw/C	1995
NOLDE,EMIL	127	\$1,041,650	9	\$40,320	Im/M	1956
BEARDEN,ROMARE	126	\$456,616	10	\$15,600	Pw/C	1988
STEINLEN,THEOPHILE	124	\$910,181	9	\$43,700	Old Masters	1923
DIEBENKORN,RICHARD	122	\$4,587,697	7	\$422,500	Pw/C	1993
REDON,ODILON	121	\$1,373,463	8	\$84,000	Im/M	1916
CHRISTO	120	\$305,826	8	\$7,021	Im/M	NA
ESTEVE,MAURICE	120	\$198,122	7	\$9,750	Pw/C	2001
KUNIYOSHI,YASUO	120	\$614,109	8	\$4,200,000	american	1953
SIGNAC,PAUL	120	\$890,659	6	\$41,400	Im/M	1935
HARING,KEITH	119	\$1,154,940	8	\$73,250	Pw/C	1990
LOZOWICK,LOUIS	115	\$412,398	8	\$26,200	american	1973
CORBUSIER,LE	113	\$268,003	8	\$6,875	Im/M	1965
VALLOTTON,FELIX	109	\$909,717	8	\$45,650	Im/M	1925
BAUMEISTER,WILLI	106	\$230,769	6	\$13,000	Im/M	1955
BARLACH,ERNST	103	\$174,301	7	\$6,600	Im/M	1938
HOPPER,EDWARD	101	\$2,712,444	4	\$75,000	american	1967
HIRST,DAMIEN	99	\$1,930,472	5	\$60,000	Pw/C	NA
ARMS,JOHN TAYLOR	94	\$245,532	6	\$5,760	american	1953
ZILLE,HEINRICH	94	\$143,140	7	\$5,950	Im/M	1929
ESTES,RICHARD	92	\$863,027	7	\$31,200	Pw/C	NA
DELVAUX,PAUL	91	\$666,038	7	\$19,550	Im/M	1994
LANDECK,ARMIN	88	\$168,789	5	\$6,670	other	1984
AVERY,MILTON	84	\$193,786	6	\$6,210	american	1965
CADMUS,PAUL	82	\$293,527	5	\$12,650	american	1999
HOFER,KARL	82	\$82,809	6	\$2,375	Im/M	1955
MUNAKATA,SHIKO	82	\$456,149	5	\$22,000	ASIAN	1975
CHIRICO,GIORGIO DE	71	\$103,676	7	\$2,784	Im/M	1978
HASSAM,CHILDE	71	\$314,222	4	\$16,800	american	1935

Table A1 – Continued from previous page

(1) Artist name	(2) Volume	(3) Turnover	(4) N. of Prints	(5) Max Price	(6) Style	(7) Death Year
BROCKHURST,GERALD	70	\$492,915	4	\$22,500	British and Irish Art	1978
MARC,FRANZ	70	\$274,587	4	\$20,910	Im/M	1916
SCHIELE,EGON	70	\$1,058,152	5	\$132,250	Im/M	1918
ARP,JEAN	69	\$148,043	5	\$9,200	Im/M	1966
MAGRITTE,RENE	109	\$558,696	8	\$14,950	Im/M	1967
OLDENBURG,CLAES	68	\$139,560	6	\$7,800	Pw/C	NA
PANKOK,OTTO	68	\$57,553	4	\$3,220	Im/M	1966
BRES DIN,RODOLPHE	67	\$508,011	4	\$90,000	Old Masters	1885
ZUNIGA,FRANCISCO	65	\$93,085	5	\$4,080	latin american	1998
RIVERS,LARRY	64	\$164,801	6	\$17,600	Pw/C	2002
PALMER,SAMUEL	63	\$217,510	5	\$11,160	Old Masters	1881
GIACOMETTI,ALBERTO	61	\$550,011	6	\$43,700	Im/M	1966
MARCKS,GERHARD	61	\$129,178	4	\$11,385	Im/M	1981
ROHLFS,CHRISTIAN	61	\$190,659	4	\$10,350	Im/M	1938
MARIN,JOHN	59	\$125,827	3	\$12,000	american	1953
FOUJITA,TSUGUHARU	58	\$571,884	5	\$5,720,000	Im/M	1968
FLINT,W.R.	57	\$69,276	5	\$2,530	other	1969
MURAKAMI,TAKASHI	57	\$155,433	5	\$8,750	Pw/C	NA
ILSTED,PETER	55	\$116,812	4	\$5,750	19th century european	1933
SULTAN,DONALD	55	\$183,929	5	\$17,600	Pw/C	NA
LAM,WIFREDO	54	\$159,031	5	\$10,925	latin american	1982
TWOMBLY,CY	54	\$3,213,640	2	\$350,500	Pw/C	2011
ALBERS,JOSEF	53	\$250,206	3	\$22,800	Pw/C	1976
PURRMANN,HANS	53	\$57,228	4	\$2,990	Im/M	1966
ALBRIGHT,IVAN	52	\$75,494	3	\$3,120	american	1983
GOUDT,HENDRIK	52	\$181,155	3	\$11,000	Old Masters	1630
FUCHS,ERNST	51	\$51,467	5	\$2,375	Pw/C	NA
LONGO,ROBERT	51	\$132,733	4	\$11,250	Pw/C	NA
TOOKER,GEORGE	51	\$69,519	4	\$3,120	american	2011
KURZWEIL,MAX	50	\$58,831	1	\$2,214	Im/M	1916
CROSS,HENRI EDMOND	49	\$52,977	3	\$2,990	Im/M	1910
ARCHIPENKO,A.	48	\$79,620	4	\$3,840	american	1964
MAN RAY	44	\$105,846	3	\$5,040	Im/M	1976
MUSIC,ANTON ZORAN	44	\$66,886	5	\$10,350	Im/M	2005
DALI,SALVADOR	43	\$159,110	4	\$10,370	Im/M	1989
VLAMINCK,MAURICE	43	\$71,434	4	\$7,700	Im/M	1958
GOLTZIUS,HENDRICK	42	\$192,594	3	\$12,000	Old Masters	1617
BASELITZ,GEORG	41	\$108,217	4	\$7,170	Pw/C	NA
NESCH,ROLF	41	\$33,449	2	\$2,700	other	1975
FREUD,LUCIAN	40	\$497,463	3	\$37,250	Pw/C	2011
HAMAGUCHI,YOZO	40	\$287,693	3	\$4,400,000	Pw/C	2000
JONGKIND,J.B.	40	\$58,430	3	\$33,000	Im/M	1891

Table A1 – *Continued from previous page*

(1) Artist name	(2) Volume	(3) Turnover	(4) N. of Prints	(5) Max Price	(6) Style	(7) Death Year
MUNCH,EDVARD	40	\$3,376,091	4	\$437,000	Im/M	1944
NAY,ERNST WILHELM	40	\$46,279	3	\$3,800	Pw/C	1968
AUDUBON,J.J.	36	\$1,832,002	5	\$203,150	american	1851
COLIN,PAUL	34	\$396,710	3	\$29,900	Im/M	1985
FONTANA,LUCIO	34	\$133,464	5	\$9,200	Pw/C	1968
CALLOT,JACQUES	29	\$152,311	3	\$25,300	Old Masters	1635
RODIN,AUGUSTE	26	\$29,522	2	\$2,860	Im/M	1917
GELLEE,CLAUDE	24	\$73,641	2	\$11,270	Old Masters	1682
KASIMIR,LUIGI	24	\$21,217	2	\$1,380	Im/M	1962
GROOMS,RED	23	\$26,016	2	\$4,480	Pw/C	NA
HELLEU,PAUL CESAR	21	\$128,161	2	\$10,925	19th century european	1927
CANALETTO	14	\$91,611	1	\$11,352	Old Masters	1768
KELLY,ELLSWORTH	11	\$33,414	1	\$5,250	Pw/C	NA
DUFY,RAOUL	10	\$33,513	1	\$4,800	Im/M	1953
MAILLOL,ARISTIDE	10	\$151,982	1	\$17,835	Im/M	1944
Total	93,406	893,915,036	4,728	\$1,680,674		

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