A Model for Pricing the Italian Contemporary Art Paintings at Auction

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Abstract. This paper aims to model the auction prices of Italian contemporary art paintings. The contribution to the existing literature is twofold concerning both the methodological and the conceptual aspects. From the former point of view, we use the two-stages Heckit model which allows us to take into account the sample selection bias deriving from the "buying" risk, that affects transactions at auction. From the latter point of view, we have found that some sale characteristics such as auction house prestige and year of sale, are more important than the physical aspects of the paintings. Moreover, some artistic characteristics, the artist's name and their living status are also relevant.
The whole analysis is carried out after creating a new dataset of 2817 transactions which took place at the most important auction houses between 1990 and 2006.

1 Introduction

The prices of paintings depend upon a set of variables, concerning the characteristics of the paintings themselves, but also other aspects more difficult to be measured, such as the artist's popularity or the auction house's prestige. Several questions about the level of art prices are still open and literature has not clearly defined what are the main drivers of their dynamics and what are the conditions for a more liquid and riskless investment in artworks.

From the theoretical point of view, there are two main theories regarding the price determination: on one hand, [3] claims that there may exist no equilibrium level for art prices, so they can float more or less aimlessly with unpredictable oscillations emphasized by the activities of investors/speculators; on the other hand, [17] assume that a "natural price" does not exist for paintings, neverthless market forces related to demand and supply determine prices for artworks, as for any other economic good.

From the empirical point of view, the pricing of paintings is generally discussed within the framework of market price indexes, with the aim of evaluating the rate of return of an investment upon such assets. In this context, the hedonic regression (from [2] onwards) seems to be a good methodology to select the variables which can be useful to model the evolution of artwork prices.

The key-objective of this paper is to carry out an empirical analysis about the price determinants of Italian contemporary art paintings at auction. The analysis is two-fold because it allows us to jointly model how some explanatory variables contribute to the probability of having an unsold item and to the price levels of sold works.

In doing so, a preliminary sample selection is obviously required. We consider a sample of 2817 painting transactions from the 21 Italian contemporary artists who showed the biggest turnover at auction during the period 1998-2002, according to [35]. Starting from the available information about this sample of transactions, we made a new dataset in which all the variables are grouped into four categories, being the usual painting-specific attributes: they are the physical qualities of the work, the characteristics of the artist, the artistic and the sale characteristics of the paintings.

The reminder of this paper is organized as follows: in section 2 we introduce the problems related to the sample selection and the choice of the relevant variables. The whole empirical analysis is carried out in section 3 and section 4 concludes. Finally, the Appendix includes the complete list of all available variables.

2 The sample selection

The analysis of the price dynamics of paintings sold at auction has to be based upon the choice of an appropriate sample. In this article, all the available information is taken from "Artindex Plus", a detailed database which contains the catalogue's information about several artworks[3]: more precisely, it provides the picture of the painting plus different pieces of information about the artist and the artwork itself (see section 2.1 for details).

Our sample choice substantially depends upon the reaching of a sort of homogeneity between variables: given that the market of paintings is composed of unique goods, we focus the attention upon Italian contemporary art because we need to deal with goods as comparable as possible[4].

Since Italian contemporary art itself is not completely homogeneous[5], we limited our analysis to the 21 Italian contemporary artists who showed the biggest turnover at the most important international auctions during the period 1998-

[3] Artindex Plus is provided by Gabrius S.p.A. operating in Milan and belonging to the Munus Culture Holding (AMB network); for more details see *http://www.munusartinvest.com.*

[4] The market of paintings is usually divided in four branches which have their own dynamics and characteristics: Old Master, XIX Century, Modern Art and Contemporary Art.

[5] In practice, there are differences among "emerging" and "historical" contemporary art painters.

2002, according to [35][6]. The reason for this selection is that the paintings are considered as investment goods for which the main characteristics depend upon the market dynamics; the aestethic component is not supposed to be relevant here. The homogeneity in our sample is also preserved by the exclusion of prints and drawnings because these items have their own specific price dynamics, as claimed by [26], and are often traded in separate sessions at auction.

Finally, we restrict the period of observation to the years which go from 1990 to 2006, since the Artindex Plus data regarding auction sales before 1990 are very poor and incomplete. Following this sample selection, we work with a dataset of 2817 painting transactions placed at the most important auction houses.

A problem encountered in studying art prices stems from the fact that the auction data samples could suffer from some problems of selection bias, as already underlined by [38]. It is well known that the art market is divided into "primary", "secondary" and "auction" market: in the former the artist personally sells her works to buyers, while in the second the galleries and the art dealers trade paintings with private or institutional collectors. Auction represents the remaining solution, therefore it can not take into account all types of paintings. Neverthless, in this case public information exists and this overcomes most of the typical problems due to the incomplete and asymmetric information availability of the art market. Moreover, we suppose that auction prices affect the art market because collectors and professional art dealers take these price as guidelines, following the approach of [16]. Finally, we also consider auction prices as adequate approximations of true equilibrium prices, as pointed out by [6].

With this sample selection, we try to give an empirical contribution for a sector that literature has often neglected[7].

2.1 The data

For each item Artindex Plus provides the following information: a picture of the painting, personal details about the artist, physical characteristics of the painting (date of execution, width and height, support, medium), artistic characteristics

[6] [35] define the "turnover" as the number of sold works multiplied by their mean price.

Moreover, they conventionally define as the Italian contemporary artists those Italian painters who carried out their activity after 60's. This selection criterium is not strictly applied, since some Italian painters, still working after 1960's, but historically placed with the best artists of Futurism or other artistic currents preceding the 1960's, are not included in their sample (for example, Carlo Carrà). So, in the analysis of [35], the Italian contemporary art conventionally starts with the contributions of Fontana (1899-1968), Burri (1915-1995), Marini (1901-1980) and Manzoni (1933-1963).

[7] For previous contribution see for example [5], [1], [30], [34] or [25]. Only [6] uses data about the Italian market of Modern and Contemporary oil paintings.

of the painting (list of previous owners, signature, date, title, expertise, literature citations, list of exibitions), sale characteristics of the painting (lot number, auction house, city, month and year of transaction), economic characteristics of the paintings (hammer prices, hammer prices plus transaction fees, pre-sale evaluation by experts who provide the estimation of a range of prices).

Tables in the Appendix report the descriptions of the variables used in our work.

2.2 Dependent variables

Given that we aim to model the auction price levels taking into account the problem of unsold paintings, our dependent variable is given by the auction price of each painting. In our dataset we have both the hammer price and the total purchase price: the latter differs from the former because it includes the auction house's transaction fees. All the prices related to unsold paintings at auction are not observable, hence they are set as zero.

Both types of prices are all converted to US Dollars to make them comparable, obtaining series p_i and P_i respectively. Finally, we consider their logarithmic transformation, indicated with y_i and Y_i.

2.3 Explanatory variables

The main evidence related to the variables identification concerns the qualitative nature of most of the available data; for this reason several variables are dummies. The explanatory variables for the price of Italian contemporary art paintings are organized into four categories; the list of potential price determinants and their codes are reported in the Appendix.

A. Characteristics of the artist: personal characteristics of the artist who painted the work.
- *1) Name of the artist*: 21 different dummy variables, one for each artist in the sample.
- *2) Living status*: dummy variable[8] (1 if the painter is deceased at the time of the sale and 0 otherwise).
- *3) Year of birth*.

B. Physical characteristics: related to the execution of the artwork.
- *4) Medium*: this variable allows us to control the assumption of a superior market value as a consequence of the media durability and particulars[9].

[8] All other things being equal, the price of artworks are often supposed to increase once an artist has died, as pointed out by [24].

[9] Generally, oil paintings are supposed to be more expensive than other media. See, among others, [11], [34], [25], [24].

5) *Support*: 10 different types of support upon which the artwork is painted are available. The related dummy variables have the value of one when the specified support is used, alone or jointly with another, and zero otherwise.
6) *Size*: the surface (expressed in m^2) and the squared surface as in [34], [24] and [40]. In particular, [11] describes the price of painting as a concave function of dimensions.

C. Artistic characteristics: these variables are supposed to be as proxies of the prestige and the popularity of the artwork in the art world. They are all dummy variables taking into account for the following characteristics:

7) *Authentication by the artist*
8) *Publication in catalogues or monographies*
9) *Date*
10) *Recognition by experts*
11) *Literature*: citations in the artistic literature (see [14])
12) *Signature*
13) *Title*
14) *Exhibitions*
15) *Number of previous owners*: according to auction houses, the price reached for a painting is influenced by its provenance. The number of previous owners can be useful in order to test whether a painting rarely traded in the auction market reaches a greater price than a painting that has often been put on sale (see [15]). Obviously, this is not a dummy variable[10].

D. Sale characteristics: with this set of explanatory variables we test the hypothesis that sale conditions have an effect upon the marketability and upon the final price reached by the painting at auction.

16) *Auction house*: [32], [13], [34], [25], [24], among others, show that Christie's and Sotheby's systematically obtain higher hammer prices; this evidence is generally attributed to the leading role played by both institutions in this business.
17) *Marketplace*: dummy variables for the 18 different marketplaces in database.
18) *Sale date*: dummy variable for each year (from 1990 to 2006) and for each month of sale.
19) *Pre-sale estimates*: before an auction sale takes place, experts usually provide an estimate of the potential market value of the painting. Pre-sale estimates are usually provided as a range.

[10] The dataset does not allow us to classify all previous owners according to their institutional nature (for example, museum, gallery or private collector), because it provides only the names of previous owners.

3 The model

The aim of our proposed methodology is to model the auction prices of the Italian Contemporary Art paintings. Examining the determinants of auction prices from a speculative perspective, we have to consider the possibility of unobserved final prices; in other words, as well as the price reached by sold works, we have to take into account the "buying risk" affecting each transaction. Since in our sample various artworks go unsold, the analysis must be divided into two stages: in the first stage, a distinction between sold and unsold paintings is made, while in the second stage, prices of sold paintings are modelled.

3.1 The Heckit model

From the statistical point of view the possibility of unsold items at auction imply a problem of selection bias which can arise from censoring data. In particular, the properties of painting prices can vary taking unsold works into account, thus data can suffer from nonrandomness.

To address this problem the Heckit model [23] is used; this model allows us to carry out the analysis when the dependent variable is continous but censored for values under a defined threshold. This methodology was introduced to correct the selection bias occurred for nonrandomly selected samples and provides consistent estimates which eliminate the specification error for the case of censored data. Recently, [40] used this methodology upon a sample of Picasso prints censored for repeat-sales, as well as [8] upon a sample of Symbolist paintings.

Analitically, the Heckit model consists of

$$\begin{cases} s_i^* = z_i'\gamma + u_i \quad i = 1, 2, ..., N \\ w_i = x_i'\beta + \varepsilon_i \;\Leftrightarrow\; s_i^* > 0, \end{cases} \tag{1}$$

where N is the sample size. The first equation is the "selection equation", where s_i^* is a latent variable which is positive if the auction price is greater than the reservation price. Moreover, the $1 \times K$ vector z_i' contains the individual characteristics that determine if the painting is sold or not, γ is a K-dimensional vector of unknown parameters and u_i is a random disturbance. The latent variable s_i^* is not observed, therefore we define a dichotomic variable s_i as

$$s_i = \begin{cases} 1 \;\text{ if } s_i^* > 0 \\ 0 \;\text{ otherwise.} \end{cases} \tag{2}$$

In practice, for sold paintings $s_i = 1$, while it is zero otherwise.

The second equation of the system (1) is the linear model of interest in which w_i is the dependent variable; x_i is the $1 \times M$ vector of exogenous variables, β

is a M-dimensional vector of unknown parameters and ε_i is a random error term. The explanatory variables in x_i could be also included in z_i and viceversa. Moreover, we assume that the random disturbances are jointly distributed as

$$\begin{bmatrix} u_i \\ \varepsilon_i \end{bmatrix} \sim \text{i.i.d.} \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_u^2 & \sigma_{u\varepsilon} \\ \sigma_{u\varepsilon} & \sigma_\varepsilon^2 \end{bmatrix} \right). \tag{3}$$

In our model the selection bias arises because the price w_i is observed only when the i-th painting is sold (therefore $s_i = 1$) and when $\sigma_{u\varepsilon}$ is different from zero; in such a situation, [23] shows that OLS estimation yields biased and inconsistent estimates of β.

Generally, the estimator for the Heckit model is the Maximum Likelihood (ML) under the assumption of joint normal distribution in equation (3); this method guarantees consistent and asymptotically normal and efficient estimates (see for example [22]). Unfortunately, in our analysis ML estimation of the model (1) does not achieve convergence, hence we use the Heckman's (1979) two-step procedure which yields a less efficient estimator.

The whole procedure can be briefly outlined as follows: given that $\phi(\cdot)$ and $\Phi(\cdot)$ respectively are the density and the cumulative density functions of the standardised Gaussian distribution, the first step consists of the ML estimation of the probit model $\Pr(s_i = 1) = \Phi(z_i'\gamma)$. This equation predicts whether an item goes sold/unsold and it is useful to obtain the inverse of the Mills Ratio given by $\lambda_i = \phi(z_i'\gamma)/\Phi(z_i'\gamma)$, which will be used as an additional regressor during the second step to correct the potential sample selection bias.

Once λ_i is inserted in x_i vector, its coefficient is $\beta_\lambda = \sigma_{u\varepsilon}\sigma_\varepsilon^2$ and the second equation in (1) can be estimated via the OLS method. The covariance between u_i and ε_i can also be estimated and the standard t-statistic on β_λ is used to test if any problem of selection bias occurrs in our analysis.

Moreover, as shown by [31], the assumption of normality of the probit residuals u_i is required to have consistency and plays a key role because it represents the sufficient condition to define λ_i as in equation given above. Following [12] we carried out the following conditional moment (CM) test based on the OPG Regression[11]

$$\iota = \hat{\gamma} Z + \hat{b} G + \text{residuals}, \tag{4}$$

where ι is a vector of ones, Z is the matrix whose each row is z_i' and $\hat{\gamma}$, $\hat{b}$ are ML estimates from the probit $\Pr(s_i = 1) = \Phi(z_i'\gamma + G_i'b)$. To take into account for asymmetry and kurtosis, the i-th row of the matrix G is

$$G_i' = \left[[(z_i'\hat{\gamma})^2 + 2]\hat{u}_i \;\; z_i'\hat{\gamma}[(z_i'\hat{\gamma})^2 + 3]\hat{u}_i \right], \tag{5}$$

[11] Outer Product Gradients Regression; see for example [12] for details.

where $\hat{u}_i$ are the model generalised residuals [see for example 31]. It can be shown that, for each observation, G_i' contains the sample counterparts of the orthogonality conditions about the conditional moments $E(u_i^k | u_i < -z_i'\gamma)$, when k is 3 and 4 respectively [see 36].

The basic idea is that, if G_i' is not statistically relevant in the selection equation, the probit model is correctly specified. Hence, the null hypothesis of the CM test is $H_0 : b = 0$ and the test statistic is given by N times the R^2 of the regression (4). Given that G has two columns, the asymptotic distribution is the standard χ_2^2.

3.2 Empirical results

The starting point of our analysis consists of the Heckit estimation where the second equation in (1) can be thought as a sort of an hedonic regression in which the selection bias has been taken into account. All results for $w_i = y_i, Y_i$ are provided in Tables 1 and 2, while Table 3 contains some regression statistics; some explanatory variables among those presented in section 2.3 are dropped to avoid collinearity and, after some preliminary estimates, other variables are excluded to reach the possible maximum reduction of parameters, without any loss of relevant information.

The first emerging aspect is that the estimates of the auction prices of the Italian Contemporary Art paintings are quite similar for the logarithms of the hammer price (y_i) and of the total purchase price (Y_i): the presence of transaction fees does not seem to have any relevant impact upon our analysis, also considering that there are 4 missing values for P_i in our original sample (see the total observations in Table 3). The sample size reduction is due to three missing values in $surface$ and $squares$.

The null hypothesis of the CM test is strongly accepted in both cases and this supports the consistency of our estimates in which λ_i is not statistically different from the inverse of the Mills Ratio.

The t-statistic evaluated for λ_i indicates that some correction for the sample selection bias is needed and, for this reason, the Heckit model is superior to OLS.

The negative estimated value of the coefficient related to λ_i depends upon $\hat{\sigma}_{u\varepsilon} < 0$: this suggests that paintings that go sold are more likely to be those with a lower price, since cheaper paintings are likely to be bought by a wider group of potential buyers.

Moreover, the [4] normality test highlights that the model disturbances are not jointly normally distributed and this is probably the reason why the ML estimation process does not converge.

The contributions given by the explanatory variables in the two steps of the estimation are discussed below.

First step Only the dummies related to painters Boetti, Campigli, Fontana and Magnelli positively contribute to the outcome of artwork transactions. This suggests that the paintings made by this group of artists are, on average, less likely to go unsold at auction, showing a strong tendence to be easily traded. If the artist is dead at the moment of sale the painting has a higher probability to go unsold, as highlighted by the negative and significant coefficient related to $dead$. The variable $birth$ has been dropped according to the results of preliminary analysis in which it was found to be not statistically relevant in both steps of estimation.

Media and support do not play any relevant role upon the probabiliy that paintings go unsold; only items painted with $enamel$ are less likely to be sold. Even if in our sample most of the paintings are made on canvas and paper (see Table 5), they do not affect the estimation.

All the variables used to capture the prestige and the popularity of the paintings do not seem to be relevant at this stage of the estimation, with the only exception being $literature$ which has a very feeble effect (the p-value is about 0.11).

The outcome of the sale, in terms of sold/unsold work, is highly determined by the auction house where the sale is arranged. For the need of parsimony, we consider only Christie's, Sotheby's and Finarte where more than 90% of transactions are placed. All their coefficients are positive and highly significant. The findings about Christie's and Sotheby's are coherent with those of [13] who argued that some auction houses are able to systematically influence the successful outcome of the sale since they often attract more high valued artistic works[12]. The result of Finarte could be intepreted as a consequence of the "home bias effect", that is a general preference of buyers for domestic art production, as pointed out by [7].

It has also been previously proved that the other auction houses, the city and month of sale do not seem to have an additional effect on the probability of going unsold.

Some years affect the outcome of the sale more than others: in particular 1993, 1997 and 2002 show negative and statistically significance relationships, while 1992 and 2004 instead have a positive and significant parameter.

[12] *...the quality of a painting , not captured by our characteristics, is partly picked up by the saleroom coefficients: a "good" Picasso would go to Christie's or Sotheby's New York, a less good one would be sold at Drouot's [...] it is impossibile to disentangle the two effects.*

Second step It is straightforward evident from Table 2 that almost all variables play a key role in determining auction prices and the impact given by the majority of painters seems to be decisive. The number of the exceptions is very small and the statistical significance attributed to Pomodoro is scarse probably because only two works belong to our sample (see Table 4).

The estimation highlights that Campigli and Fontana, who have a positive and significant impact upon the selection equation, also show an analogous effect upon the second step; on the contrary, the coefficient related to Boetti has the opposite sign of that in the selection equation. The paintings made by Burri, Cattelan, Manzoni and Marini also seem to reach market values higher, on average, than other artists, while the negative parameters related to different painters suggest that their works generally achieve lower prices.

The variable $dead$ do not have any effect, while the variable $birth$ is dropped because of its statistical irrelevance. From our model one can argue that the death of the artist before the moment of sale only increases the probability that paintings go unsold, but does not affect auction prices. This result is in contrast with both contributions of [1] and [39]: the former paper showed an increase by 154% of the auction prices of American art when the artist was still alive, while the latter work found that paintings made by deceased artists are associated with a price increase of 100.58%.

Our estimation suggests that painting media do not have a relevant effect upon the total purchase price of a painting; the only exceptions are oil and the residual variable $other$ for which the coefficients produce an increasing effect upon artwork prices. It is difficult to compare these findings with previous analyses especially because these contributions are sometimes limited to historical periods when only few media were known [see for instance 14] or restricted to single medium samples [6].

The contributions of the supports are heterogeneous because $canvas$ seems to have a significant and positive influence upon painting prices, while $paper$ has the opposite effect.

The coefficient signs of the variables regarding the size of paintings are those expected and coherent with the findings of [11]: in particular, the artwork prices can be described as a concave function in which the surface and the squared surface have a positive and negative relationship respectively. This suggests that, if the size is augmented, the Italian Contemporary Art prices tend to increase at first, but then decrease when the painting becomes too large and difficult to hang.

Among the artistic characteristics of the paintings, the publication in catalogues, the number of exhibitions, the literature and the number of previous owners have a positive effect, while the variable $expertise$ surprisingly shows

negative contributions, contrary to our expectation. Variables $authentic$ and $signature$ do not have any effect upon the estimation, maybe because the prestige of some auction houses serves as a guarantee of authenticity.

The sale year substantially affects the final purchase price of Italian contemporary art paintings: each year from 1991 to 2004 shows statistically significant and negative coefficients, while years 2005 and 2006 do not seem to be relevant. From the economic perspective the series of these coefficients can be used to built the yearly price index I_t, with all other characteristics being equal. This index shows the contribution to auction prices dynamics given by years of sale and its equation is $I_t = 100 \cdot \exp\{\hat{\beta}_t\}$, where $t = 1991, 1992, \ldots, 2006$. Just the hammer price index is plotted in Figure 1 since the curve related to the total purchase price (Y_i) is very similar. The base year is 1990 in which $I_t = 100$. For both series this index substantially shows an increase from 1994, while only in 2006 it has a value greater than those of the base year. This is consistent with the evidence of the art market downturn experienced in the early ninetees [see, among others, 29] and the upturn of the market in recent years.

Finally, even if Table 1 highlights that principal auction houses strongly determine the outcome of sale, their contribution to price levels is not relevant and, for this reason, they have been dropped from the second the step of the estimation.

4 Concluding remarks

This paper aims to model the prices of paintings given a set of explanatory variables regarding different characteristics. The whole analysis is carried out after creating a sample of 2817 transactions of paintings made by 21 Italian contemporary painters and sold at auction during the period 1990-2006. To take the problem of sample selection bias arising from the inclusion of unsold paintings into account, the Heckit model [23] is used to obtain consistent estimates.

Our estimation highlights that some mechanism of selection bias occurrs hence this methodology is superior to OLS. The main finding is that auction prices for the Italian Contemporary Art market depend upon several variables such as auction house prestige, year of sale, artist's popularity and different artistic characteristics of paintings (publication in catalogues, number of exhibitions, citations in the artistic literature, number of previous owners). This finding is consistent with the main existing literature.

Contrary to previous studies [see for example, 11 or 39], we found that traditional media, supports and conventional proxies of artistic qualities are less able to explain the marketability of paintings, while they have a strong effect on price levels. Other variables playing a leading role upon the outcome of sale are

those related to sale characteristics (for example, auction house prestige) and to the years in which the transactions take place; the years of sale also affect the auction price determination.

A price index that fits the cyclical nature of the Italian Contemporary Art market has been derived from the coefficients related to the years of sale: after an initial decline it tends to increase from 1994 and finally have a strong rise after 2003. This evidence reflects the downturn of the art market in the early ninetees and it is coherent with previous literature. This is also consistent with the upturn in contemporary painting prices experienced in recent years. Some suggested reasons for this cycle could be macroeconomic factors such as the dependence of the art market upon per capita income [17], financial courses such as the correlation between art market cycles and bullish/bearish financial markets [9] or simply art fads such as collectors' changing attitudes towards contemporary art [5].

Bibliography

[1] Agnello, R. and Pierce, R.: Financial returns, price determinants and genre effects in American art investment. Journal of Cultural Economics **20** (1996) 359–383

[2] Anderson, R.C.: Paintings as an investment. Economic Inquiry **12** (1974) 13–26

[3] , Baumol, W.J.: Unnatural value: or art investment as floating crap game. American Economic Review **76** (1986) 10–14

[4] Box, G.E.P. and Pierce, D.A.: Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. Journal of the American Statistical Association **65** (1970) 1509–1526

[5] Buelens, N. and Ginsburg, V.: Revisiting Baumol's "art as a floating crap game". European Economic Review **37** (1993) 1351–1371

[6] Candela, G. and Scorcu, A.E.: A price index for art market auctions. An application to the Italian market for modern and contemporary oil paintings. Journal of Cultural Economics **21** (1997) 175–196

[7] Candela, G. and Scorcu, A.E.: *Economia delle arti*. Zanichelli, Bologna (2004)

[8] Collins, A., Scorcu, A.E. and Zanola, R.: Sample selection bias and time instability of hedonic Art Price Indexes. Working Paper DSE **610** (2007)

[9] Chanel, O.: Is art market behaviour predictable?. European Economic Review **39** (1995) 519–527

[10] Chanel, O., Gérard-Varet, L.-A. and Ginsburgh, V.: The relevance of hedonic price indices. The case of paintings. Journal of Cultural Economics **20** (1996) 1–24

[11] Czujack, C.: Picasso paintings at auction, 1963-1994. Journal of Cultural Economics **21** (1997) 229–247

[12] Davidson, R. and MacKinnon, J.D.: *Estimation and inference in econometrics*. Oxford University Press, New York (1993)

[13] De la Barre, M., Docclo, S. and Ginsburgh, V.: Returns of Impressionist, Modern and Contemporary European Painters, 1962-1991. Annales d'Economie et Statistique **35** (1994) 143–181

[14] Figini, P. and Onofri, L.: *Old master paintings: price formation and public policy implication*. in Marciano, A. & Josselin, J. M. (eds.), *The law and economics of the Welfare State: a political economics approach*, Edwar Elgar Publisher (2005)

[15] Fiz, A.: *Investire in arte contemporanea*. Franco Angeli, Milano (1995)

[16] Frey, B.S. and Pommerehne, W.W.: Art investment: an empirical inquiry. Southern Economic Journal **56** (1989) 396–409

[17] Frey, B.S. and Pommerehne, W. W.: *Muse e Mercati. Indagine sull'economia dell'arte*. Il Mulino, Bologna (1991)

[18] Ginsburgh, V. and Jeanfils, P.: Long-term comovements in international markets for paintings. European Economic Review **39** (1995) 538–548

[19] Goetzmann, W.N.: Accounting for taste: art and financial markets over three centuries. The American Economic Review **83** (1993) 1370–1376

[20] Goetzmann, W. and Spiegel, M.: Private value components and the winner's curse in Art Index. European Economic Review **39** (1995) 549–555

[21] Grampp, W.D.: *Pricing the priceless. Art, Artists and Economics*. Basic Books, Inc., New York (1989)

[22] Greene, W.H.: Sample selection bias as a specification error: comment. Econometrica **49** (1981) 795–798

[23] Heckman, J.J.: Sample selection bias as a specification error. Econometrica **47** (1979) 153–161

[24] Higgs, H. and Worthington, A.: Financial return and price determinants in the australian art market, 1973-2003. The Economic Record **81** (2005) 113–123

[25] Hodgson, D. and Vorkink, K.P.: Asset pricing theory and the valuation of canadian paintings. Canadian Journal of Economics **37** (2004) 629–655

[26] Holub, H. W., Hutter, M. and Tappeiner, G.: Light and shadow in art price computation. Journal of Cultural Economics **17** (1993) 49–69

[27] Locatelli-Biey, M. and Zanola, R.: The market for Picasso prints: an hybrid approach. Journal of Cultural Economics **29** (2005) 127-136

[28] Locatelli-Biey, M. and Zanola, R.: Investment in paintings: a short run price index. Journal of Cultural Economics **23** (1999) 211–222

[29] Mei, J. and Moses, M.: Art as an investment and the underperformance of masterpieces. American Economic Review **92** (2002) 1656–1668

[30] Mok, H.M., Ko, V.W., Woo, S.S. and Kwok, K.Y.: Modern Chinese paintings: an investment alternative? Southern Economic Journal **59** (1993) 808–816

[31] Pagan, A. and Vella, F.: Diagnostic tests for models based on individual data: a survey. Journal of Applied Econometrics **4** (1989) 29–59

[32] Pesando, J.E.: Art as an investment: the market for modern prints. The American Economic Review **83** (1993) 1075–1089

[33] Pesando, J.E. and Shum, P.M.: The return to Picasso's prints and to traditional financial assets, 1977 to 1996. Journal of Cultural Economics **23** (1999) 183–192

[34] Renneboog, L. and Van Houtte, T.: The monetary appreciation of paintings: from Realism to Magritte. Cambridge Political Economy Society **26** (2002) 331–358

[35] Sacco, P., Santagata, W. and Trimarchi, M.: *L'arte contemporanea italiana nel mondo. Analisi e strumenti*, Collana Opera DARC, Skira, Milano (2005)

[36] Skeels, C.L. and Vella, F.: A Monte Carlo investigation of the sampling behavior of conditional moment tests in Tobit and Probit models. Journal of Econometrics **92** (1999) 275–294

[37] Stein, J.P.: The monetary appreciation of paintings. Journal of Political Economy **85** (1977) 1021–1035

[38] Wieand, K., Donaldson, J. and Quintero, S.: Are real asset prices internationally? Evidence from the art market. Multinational Finance Journal **2** (1998) 167–187

[39] Worthington, A.C. and Higgs, H.: A note on financial risk, return and asset pricing in Australian modern and contemporary art. Journal of Cultural Economics **30** (2006) 73–84

[40] Zanola, R.: The dynamics of art prices: The selection corrected repeat-sales index. Working Paper **85**, Dipartimento di Politiche Pubbliche e Scelte Collettive (POLIS), Università del Piemonte Orientale (2007)

Appendix

Heckit estmation

Table 1: Heckit estimation (1^{st} step)

	dependent variable: y_i				dependent variable: Y_i			
variable	coeff.	s.e.	t-stat	p-value	coeff.	s.e.	t-stat	p-value
constant	-0.0348	0.3226	-0.1078	0.9142	-0.0302	0.3227	-0.0936	0.9254
Characteristics of the artist								
Adami	-0.3406	0.2820	-1.2080	0.2271	-0.3431	0.2820	-1.2164	0.2238
Beecroft	-0.3884	0.5256	-0.7390	0.4599	-0.3935	0.5256	-0.7487	0.4540
Boetti	0.7326	0.2226	3.2916	0.0010***	0.7327	0.2226	3.2913	0.0010***
Burri	0.0056	0.2129	0.0265	0.9788	0.0043	0.2129	0.0204	0.9838
Campigli	0.3642	0.2116	1.7217	0.0851*	0.3651	0.2116	1.7254	0.0845*
Castellani	0.1181	0.2941	0.4015	0.6881	0.1163	0.2942	0.3953	0.6927
Cattelan	0.0390	0.5298	0.0735	0.9414	0.0365	0.5300	0.0689	0.9451
Chia	-0.2070	0.2846	-0.7273	0.4671	-0.2088	0.2846	-0.7336	0.4632
Clemente	-0.4006	0.2953	-1.3566	0.1749	-0.4131	0.2956	-1.3974	0.1623
Cucchi	0.0589	0.3183	0.1849	0.8533	0.0555	0.3184	0.1744	0.8616
Fontana	0.3571	0.1872	1.9070	0.0565*	0.3572	0.1873	1.9073	0.0565*
Kounellis	0.1475	0.3338	0.4418	0.6586	0.1325	0.3347	0.3958	0.6922
Magnelli	0.3987	0.2283	1.7467	0.0807*	0.3979	0.2283	1.7429	0.0813*
Manzoni	0.1895	0.2194	0.8637	0.3878	0.1894	0.2195	0.8630	0.3881
Marini	0.3642	0.2501	1.4561	0.1454	0.3661	0.2501	1.4637	0.1433
Melotti	-0.0838	0.4984	-0.1682	0.8664	-0.0814	0.4985	-0.1633	0.8703
Merz	-0.2495	0.3291	-0.7582	0.4483	-0.2513	0.3292	-0.7634	0.4453
Music	-0.1315	0.2613	-0.5034	0.6147	-0.1354	0.2613	-0.5181	0.6044
Paladino	-0.2377	0.2795	-0.8505	0.3950	-0.2476	0.2798	-0.8848	0.3763
Pomodoro	-1.1805	0.7890	-1.4962	0.1346	-1.1791	0.7895	-1.4935	0.1353
dead	-0.4077	0.1928	-2.1142	0.0345**	-0.4107	0.1929	-2.1288	0.0333**
Physical characteristics								
enamel	-0.6613	0.2568	-2.5752	0.0100**	-0.6560	0.2568	-2.5547	0.0106**
mixed	-0.0662	0.1202	-0.5512	0.5815	-0.0661	0.1202	-0.5499	0.5824
oil	0.0474	0.0921	0.5147	0.6068	0.0493	0.0921	0.5347	0.5928
tempera	0.0299	0.1208	0.2475	0.8046	0.0305	0.1208	0.2521	0.8010
other	0.1384	0.0942	1.4694	0.1417	0.1408	0.0942	1.4956	0.1348
canvas	0.0964	0.0781	1.2350	0.2168	0.0939	0.0781	1.2016	0.2295
paper	-0.0829	0.1009	-0.8217	0.4112	-0.0889	0.1011	-0.8798	0.3790
Artistic characteristics								
authentic	-0.0990	0.1075	-0.9214	0.3569	-0.0972	0.1075	-0.9044	0.3658
catalogue	-0.0161	0.0808	-0.1990	0.8423	-0.0167	0.0808	-0.2064	0.8365
exhibit	0.0185	0.0181	1.0227	0.3065	0.0188	0.0182	1.0341	0.3011
expertise	-0.0663	0.1374	-0.4824	0.6295	-0.0667	0.1374	-0.4852	0.6275
literature	-0.1379	0.0866	-1.5919	0.1114	-0.1369	0.0866	-1.5800	0.1141
owners	0.0152	0.0290	0.5236	0.6005	0.0146	0.0290	0.5023	0.6154
signature	0.0303	0.0670	0.4526	0.6508	0.0301	0.0670	0.4487	0.6536
Sale characteristics								
christies	0.6503	0.1018	6.3914	0.0000***	0.6510	0.1018	6.3977	0.0000***
sothebys	0.8105	0.1011	8.0196	0.0000***	0.8075	0.1011	7.9886	0.0000***
finarte	0.3952	0.1094	3.6134	0.0003***	0.3950	0.1094	3.6120	0.0003***
*d_*1991	0.2600	0.1696	1.5327	0.1254	0.2609	0.1696	1.5384	0.1240
*d_*1992	0.2926	0.1535	1.9063	0.0566*	0.2942	0.1535	1.9161	0.0554*
*d_*1993	-0.3722	0.1522	-2.4454	0.0145**	-0.3716	0.1522	-2.4418	0.0146**

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Table 1 — *continued from previous page*

	dependent variable: y_i				dependent variable: Y_i			
variable	coeff.	s.e.	t-stat	p-value	coeff.	s.e.	t-stat	p-value
d_1994	-0.1253	0.1445	-0.8671	0.3859	-0.1445	0.1452	-0.9953	0.3196
d_1995	0.0688	0.1504	0.4573	0.6475	0.0698	0.1504	0.4642	0.6425
d_1996	-0.0857	0.1412	-0.6070	0.5439	-0.0897	0.1414	-0.6344	0.5258
d_1997	-0.4023	0.1452	-2.7701	0.0056***	-0.4006	0.1452	-2.7586	0.0058***
d_1998	-0.1693	0.1530	-1.1062	0.2686	-0.1673	0.1530	-1.0931	0.2743
d_1999	0.1649	0.1392	1.1845	0.2362	0.1657	0.1392	1.1909	0.2337
d_2000	-0.1001	0.1415	-0.7076	0.4792	-0.0983	0.1415	-0.6949	0.4871
d_2001	-0.1726	0.1376	-1.2542	0.2098	-0.1712	0.1376	-1.2440	0.2135
d_2002	-0.2619	0.1353	-1.9349	0.0530*	-0.2605	0.1353	-1.9248	0.0543*
d_2003	-0.0511	0.1391	-0.3670	0.7136	-0.0500	0.1391	-0.3597	0.7191
d_2004	0.4562	0.1519	3.0036	0.0027***	0.4574	0.1519	3.0119	0.0026***
d_2005	0.1862	0.1379	1.3504	0.1769	0.1878	0.1379	1.3623	0.1731
d_2006	0.2148	0.1423	1.5097	0.1311	0.2162	0.1423	1.5197	0.1286

* indicates statistical significance at the 10% level.
** indicates statistical significance at the 5% level.
*** indicates statistical significance at the 1% level.

Table 2: Heckit estimation (2^{nd} step)

	dependent variable: y_i				dependent variable: Y_i			
variable	coeff.	s.e.	t-stat	p-value	coeff.	s.e.	t-stat	p-value
$constant$	3.3029	0.2448	13.4935	0.0000***	3.4341	0.2422	14.1780	0.0000***
$Adami$	-0.7652	0.2167	-3.5311	0.0004***	-0.7534	0.2145	-3.5120	0.0004***
$Beecroft$	-2.2322	0.4070	-5.4853	0.0000***	-2.2017	0.4027	-5.4670	0.0000***
$Boetti$	-0.4771	0.1710	-2.7909	0.0053***	-0.4796	0.1692	-2.8340	0.0046***
$Burri$	1.1525	0.1604	7.1865	0.0000***	1.1472	0.1587	7.2300	0.0000***
$Campigli$	1.2194	0.1589	7.6732	0.0000***	1.2137	0.1573	7.7170	0.0000***
$Castellani$	-0.1641	0.2136	-0.7679	0.4425	-0.1508	0.2114	-0.7130	0.4755
$Cattelan$	0.9315	0.3510	2.6537	0.0080***	0.9186	0.3474	2.6450	0.0082***
$Chia$	-0.5868	0.2137	-2.7464	0.0060***	-0.5754	0.2115	-2.7210	0.0065***
$Clemente$	-0.0013	0.2242	-0.0060	0.9952	0.0025	0.2225	0.0110	0.9910
$Cucchi$	-0.5377	0.2277	-2.3620	0.0182**	-0.5193	0.2253	-2.3050	0.0212**
$Fontana$	1.1076	0.1442	7.6810	0.0000***	1.0934	0.1427	7.6610	0.0000***
$Kounellis$	0.2706	0.2369	1.1422	0.2534	0.2745	0.2353	1.1660	0.2435
$Magnelli$	0.1114	0.1699	0.6556	0.5121	0.1116	0.1682	0.6640	0.5068
$Manzoni$	1.3272	0.1652	8.0327	0.0000***	1.3074	0.1635	7.9980	0.0000***
$Marini$	0.9097	0.1846	4.9268	0.0000***	0.8922	0.1827	4.8820	0.0000***
$Melotti$	-1.0547	0.4120	-2.5602	0.0105**	-1.0569	0.4076	-2.5930	0.0095***
$Merz$	-0.5038	0.2506	-2.0103	0.0444**	-0.4909	0.2480	-1.9800	0.0478**
$Music$	0.3222	0.2004	1.6073	0.1080	0.3218	0.1984	1.6220	0.1048
$Paladino$	-0.5513	0.2105	-2.6192	0.0088***	-0.5430	0.2086	-2.6020	0.0093***
$Pomodoro$	-0.4690	0.7805	-0.6009	0.5479	-0.4601	0.7720	-0.5960	0.5512
$dead$	-0.0305	0.1450	-0.2102	0.8335	-0.0225	0.1437	-0.1570	0.8755
$enamel$	0.1295	0.2290	0.5655	0.5718	0.1303	0.2265	0.5750	0.5652
$mixed$	0.0917	0.0856	1.0718	0.2838	0.0837	0.0847	0.9890	0.3229
oil	0.1565	0.0647	2.4192	0.0156**	0.1508	0.0641	2.3520	0.0187**
$tempera$	0.0706	0.0868	0.8137	0.4158	0.0685	0.0860	0.7970	0.4255
$other$	0.1607	0.0658	2.4430	0.0146**	0.1520	0.0652	2.3330	0.0197**
$canvas$	0.1537	0.0558	2.7551	0.0059***	0.1510	0.0552	2.7340	0.0063***
$paper$	-0.4449	0.0709	-6.2718	0.0000***	-0.4425	0.0705	-6.2800	0.0000***

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Table 2 — *continued from previous page*

	dependent variable: y_i				dependent variable: Y_i			
variable	coeff.	s.e.	t-stat	p-value	coeff.	s.e.	t-stat	p-value
$surface$	0.6517	0.0290	22.5074	0.0000***	0.6445	0.0287	22.4870	0.0000***
$squared$	-0.0528	0.0032	-16.5274	0.0000***	-0.0521	0.0032	-16.4930	0.0000***
Artistic characteristics								
$authentic$	0.1071	0.0794	1.3487	0.1775	0.1124	0.0785	1.4310	0.1524
$catalogue$	0.2797	0.0564	4.9577	0.0000***	0.2742	0.0558	4.9120	0.0000***
$exhibit$	0.0266	0.0105	2.5321	0.0113**	0.0258	0.0104	2.4870	0.0129**
$expertise$	-0.2376	0.0939	-2.5317	0.0114**	-0.2311	0.0929	-2.4880	0.0128**
$literature$	0.2850	0.0621	4.5891	0.0000***	0.2848	0.0614	4.6360	0.0000***
$owners$	0.1339	0.0192	6.9852	0.0000***	0.1310	0.0190	6.8990	0.0000***
$signature$	0.0585	0.0464	1.2613	0.2072	0.0562	0.0459	1.2230	0.2213
Sale characteristics								
d_1991	-0.4911	0.1108	-4.4328	0.0000***	-0.4956	0.1097	-4.5200	0.0000***
d_1992	-0.6814	0.1008	-6.7568	0.0000***	-0.6957	0.0998	-6.9680	0.0000***
d_1993	-0.7115	0.1202	-5.9177	0.0000***	-0.6991	0.1190	-5.8760	0.0000***
d_1994	-0.9473	0.1049	-9.0351	0.0000***	-0.9313	0.1051	-8.8590	0.0000***
d_1995	-0.8258	0.1017	-8.1168	0.0000***	-0.8069	0.1007	-8.0150	0.0000***
d_1996	-0.8497	0.0994	-8.5487	0.0000***	-0.8398	0.0987	-8.5100	0.0000***
d_1997	-0.8158	0.1147	-7.1096	0.0000***	-0.7942	0.1135	-6.9950	0.0000***
d_1998	-0.7270	0.1111	-6.5431	0.0000***	-0.7073	0.1099	-6.4340	0.0000***
d_1999	-0.6131	0.0933	-6.5709	0.0000***	-0.5975	0.0924	-6.4690	0.0000***
d_2000	-0.6601	0.1003	-6.5825	0.0000***	-0.6230	0.0992	-6.2790	0.0000***
d_2001	-0.7199	0.0992	-7.2536	0.0000***	-0.6781	0.0982	-6.9060	0.0000***
d_2002	-0.6017	0.1000	-6.0148	0.0000***	-0.5464	0.0990	-5.5210	0.0000***
d_2003	-0.5960	0.0970	-6.1416	0.0000***	-0.5321	0.0960	-5.5420	0.0000***
d_2004	-0.3894	0.0977	-3.9857	0.0001***	-0.3329	0.0967	-3.4410	0.0006***
d_2005	-0.1714	0.0929	-1.8446	0.0651*	-0.1082	0.0920	-1.1770	0.2393
d_2006	0.0564	0.0953	0.5914	0.5542	0.1278	0.0943	1.3550	0.1755
λ_i	-0.5537	0.1733	-3.1942	0.0014***	-0.5504	0.1722	-3.1970	0.0014***

* indicates statistical significance at the 10% level.
** indicates statistical significance at the 5% level.
*** indicates statistical significance at the 1% level.

Table 3. Regression statistics

Dependent variable	y_i	Y_i
Mean of dependent variable	4.0932	4.2402
Std. dev. of dependent variable	1.2911	1.2808
Total observations	2814	2810
Censored observations	803	803
Censored observations (%)	28.5	28.6
Error sum of squares	1078.65	1052.25
S.E. of residuals	0.4371	0.4373
$\hat{\sigma}_{\varepsilon}^2$	0.8231	0.8147
$\hat{\sigma}_{u\varepsilon}$	-0.6727	-0.6755
Akaike Information Criterion	3246.58	3243.88
Bayesian Information Criterion	3573.47	3570.69
Hannan-Quinn Information Criterion	3573.47	3361.82
McFadden R^2 (probit)	0.0685	0.0686
LR test (probit)	230.658	230.674
p-value	0.0000	0.0000
CM test for the normality of u_i	0.7481	0.6789
p-value	0.6879	0.7122
Joint normality test for residuals	157.402	162.969
p-value	0.0000	0.0000

List of variables

Table 4. Characteristics of the artist (N=2817)

variable	description	birth	dead	obs.
Name of the artist				
$Adami$	1 if the author is Valerio Adami, 0 otherwise	1935	-	170
$Beecroft$	1 if the author is Vanessa Beecroft, 0 otherwise	1966	-	9
$Boetti$	1 if the author is Alighiero Boetti, 0 otherwise	1940	1994	212
$Burri$	1 if the author is Alberto Burri, 0 otherwise	1915	1995	126
$Campigli$	1 if the author is Massimo Campigli, 0 otherwise	1895	1971	268
$Castellani$	1 if the author is Enrico Castellani, 0 otherwise	1930	-	114
$Cattelan$	1 if the author is Maurizio Cattelan, 0 otherwise	1960	-	10
$Chia$	1 if the author is Sandro Chia, 0 otherwise	1946	-	155
$Clemente$	1 if the author is Francesco Clemente, 0 otherwise	1952	-	101
$Cucchi$	1 if the author is Enzo Cucchi, 0 otherwise	1950	-	65
$Fontana$	1 if the author is Lucio Fontana, 0 otherwise	1899	1968	720
$Gnoli$	1 if the author is Domenico Gnoli, 0 otherwise	1933	1970	64
$Kounellis$	1 if the author is Jannis Kounellis, 0 otherwise	1936	-	51
$Magnelli$	1 if the author is Alberto Magnelli, 0 otherwise	1888	1971	105
$Manzoni$	1 if the author is Piero Manzoni, 0 otherwise	1934	1963	137
$Marini$	1 if the author is Marino Marini, 0 otherwise	1901	1980	68
$Melotti$	1 if the author is Fausto Melotti, 0 otherwise	1901	1986	8
$Merz$	1 if the author is Mario Merz, 0 otherwise	1925	-	41
$Music$	1 if the author is Zoran Music, 0 otherwise	1909	2005	241
$Paladino$	1 if the author is Mimmo Paladino, 0 otherwise	1948	-	150
$Pomodoro$	1 if the author is Arnaldo Pomodoro, 0 otherwise	1926	-	2
Living status				
$Dead$	1 if the painter is dead at the moment of selling, 0 otherwise			1705
Year of birth				
$Birth$	Year of birth			

Source: Artindex Plus - Gabrius S.p.A.

Table 5. Physical characteristics (N=2817)

variable	description	obs.
Medium		
$collage$	1 if the medium is collage, 0 otherwise	5
$enamel$	1 if the medium is enamel, 0 otherwise	29
$gouache$	1 if the medium is gouache, 0 otherwise	1
$mixed$	1 if the medium is mixed, 0 otherwise	385
$pencil$	1 if the medium is pencil, 0 otherwise	2
oil	1 if the medium is oil, 0 otherwise	1429
$tempera$	1 if the medium is tempera, 0 otherwise	320
$other$	1 if the medium is other, 0 otherwise	1037
Support		
$board$	1 if the support is board, 0 otherwise	185
$canvas$	1 if the support is canvas, 0 otherwise	2254
$cartoon$	1 if the support is cartoon, 0 otherwise	173
$fabric$	1 if the support is fabric, 0 otherwise	75
$marble$	1 if the support is marble, 0 otherwise	5
$masonite$	1 if the support is masonite, 0 otherwise	26
$panel$	1 if the support is panel, 0 otherwise	166
$paper$	1 if the support is paper, 0 otherwise	275
$wood$	1 if the support is wooden base, 0 otherwise	7
$support$	1 if the support is other, 0 otherwise	146
Size		
$surface$	Painting area (in m^2)	
$squared$	Painting squared area	

Source: Artindex Plus - Gabrius S.p.A.

Note: for some paintings different media or different supports are jointly used.

Table 6. Artistic characteristics (N=2817)

variable	description	obs.
$authentic$	1 if the painter has confirmed the authenticity, 0 otherwise	187
$catalogue$	1 if the painting is published on catalogs/monographies, 0 otherwise	680
$date$	1 if the painting is dated, 0 otherwise	1700
$expertise$	1 if the painting is recognised by experts, 0 otherwise	132
$literature$	1 if the painting is cited in literature, 0 otherwise	1049
$signature$	1 if the painting is signed, 0 otherwise	2071
$title$	1 if the painting is titled, 0 otherwise	1722
$exhibit$	Number of exhibitions	
$owners$	Number of previous owners	

Source: Artindex Plus - Gabrius S.p.A.

Table 7: Sale characteristics (N=2817)

variable	description	obs.
Auction houses		
$Curial$	1 if the painting was sold at Art Curial, 0 otherwise	36
$Bonhams$	1 if the painting was sold at Bonhams, 0 otherwise	4
$Bruun$	1 if the painting was sold at Bruun Rasmussen, 0 otherwise	2
$Bukowskis$	1 if the painting was sold at Bukowskis, 0 otherwise	2
$Camels$	1 if the painting was sold at Camels Cohen, 0 otherwise	2
$Christies$	1 if the painting was sold at Christie's, 0 otherwise	914
$Dorotheum$	1 if the painting was sold at Dorotheum, 0 otherwise	9
$Doyle$	1 if the painting was sold at Doyle, 0 otherwise	2
$Finarte$	1 if the painting was sold at Finarte Semenzato, 0 otherwise	536
$Grisebach$	1 if the painting was sold at Grisebach, 0 otherwise	8
$Koller$	1 if the painting was sold at Koller, 0 otherwise	5
$Lempertz$	1 if the painting was sold at Lempertz, 0 otherwise	39
$Neumeister$	1 if the painting was sold at Nuemeister, 0 otherwise	3
$Pandolfini$	1 if the painting was sold at Pandolfini, 0 otherwise	1
$Phillips$	1 if the painting was sold at Phillips, 0 otherwise	37
$Piasa$	1 if the painting was sold at Piasa, 0 otherwise	1
$Porro$	1 if the painting was sold at Porro & C., 0 otherwise	27
$Sothebys$	1 if the painting was sold at Sotheby's, 0 otherwise	1137
$Tajan$	1 if the painting was sold at Tajan, 0 otherwise	43
Marketplace		
$Amsterdam$	1 if the painting was sold in Amsterdam, 0 otherwise	4
NY	1 if the painting was sold in New York, 0 otherwise	363
$Berlin$	1 if the painting was sold in Berlin, 0 otherwise	8
$Paris$	1 if the painting was sold in Paris, 0 otherwise	88
$Cologne$	1 if the painting was sold in Cologne, 0 otherwise	39
$Copenhagen$	1 if the painting was sold in Copenhagen, 0 otherwise	2
$London$	1 if the painting was sold in London, 0 otherwise	1109
LA	1 if the painting was sold in Los Angeles, 0 otherwise	4
$Lugano$	1 if the painting was sold in Lugano, 0 otherwise	17
$Milan$	1 if the painting was sold in Milan, 0 otherwise	994
$Montecarlo$	1 if the painting was sold in Montecarlo, 0 otherwise	3
$Munich$	1 if the painting was sold in Munich, 0 otherwise	3
$Rome$	1 if the painting was sold in Rome, 0 otherwise	140
$Stockholm$	1 if the painting was sold in Stokholm, 0 otherwise	11
$Sidney$	1 if the painting was sold in Sidney, 0 otherwise	1
$Venice$	1 if the painting was sold in Venice, 0 otherwise	17
$Vienna$	1 if the painting was sold in Vienna, 0 otherwise	9
$Zurich$	1 if the painting was sold in Zurich, 0 otherwise	5
Sale date		
d_1990	1 if the painting was sold in 1990, 0 otherwise	242
d_1991	1 if the painting was sold in 1991, 0 otherwise	100
d_1992	1 if the painting was sold in 1992, 0 otherwise	140
d_1993	1 if the painting was sold in 1993, 0 otherwise	109
d_1994	1 if the painting was sold in 1994, 0 otherwise	133
d_1995	1 if the painting was sold in 1995, 0 otherwise	135
d_1996	1 if the painting was sold in 1996, 0 otherwise	148
d_1997	1 if the painting was sold in 1997, 0 otherwise	127
d_1998	1 if the painting was sold in 1998, 0 otherwise	116
d_1999	1 if the painting was sold in 1999, 0 otherwise	190
d_2000	1 if the painting was sold in 2000, 0 otherwise	158
d_2001	1 if the painting was sold in 2001, 0 otherwise	182

continued on next page

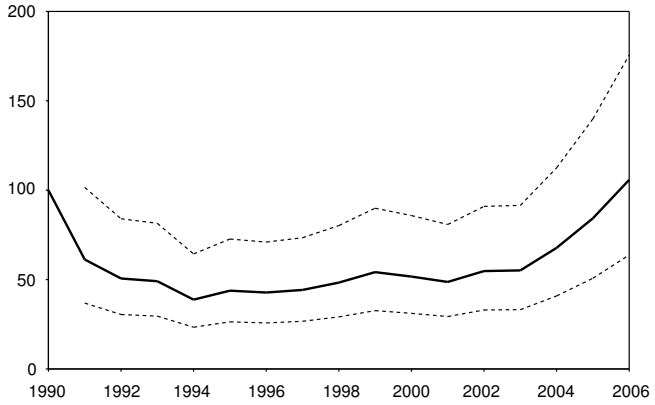
Table 7 — *continued from previous page*

variable	description	obs.
d_2002	1 if the painting was sold in 2002, 0 otherwise	201
d_2003	1 if the painting was sold in 2003, 0 otherwise	206
d_2004	1 if the painting was sold in 2004, 0 otherwise	187
d_2005	1 if the painting was sold in 2005, 0 otherwise	332
d_2006	1 if the painting was sold in 2006, 0 otherwise	211
jan	1 if the painting was sold in January, 0 otherwise	1
feb	1 if the painting was sold in February, 0 otherwise	161
mar	1 if the painting was sold in March, 0 otherwise	245
apr	1 if the painting was sold in April, 0 otherwise	134
may	1 if the painting was sold in May, 0 otherwise	564
jun	1 if the painting was sold in June, 0 otherwise	466
jul	1 if the painting was sold in July, 0 otherwise	38
aug	1 if the painting was sold in August, 0 otherwise	5
sep	1 if the painting was sold in September, 0 otherwise	4
oct	1 if the painting was sold in October, 0 otherwise	433
nov	1 if the painting was sold in November, 0 otherwise	519
dec	1 if the painting was sold in December, 0 otherwise	347
m_i	Pre-sale evaluation (minimum)	2777
M_i	Pre-sale evaluation (maximum)	2777

Fonte: Artindex Plus - Gabrius S.p.A.

Figures

Fig. 1. Price index for the Italian Contemporary Art paintings (I_t)



For each dependent variable, the dotted lines show the index confidence intervals given by $100 \cdot \exp\{\beta_t \pm 1.96 \cdot s.e.(\beta_t)\}$ for the t-th year.