On the relationship between reserve prices and low estimates: an empirical reassessment

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Abstract
Using a unique hand-collected dataset, which comprises all auctions hold in Italy by the most important Italian auction house in the 1990s and which includes confidential information on reserve prices, we find for the first time direct empirical evidence in support of several studies in the cultural economics literature that reserve prices are set in a range of about 75% of the presale low estimates.
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1. Introduction

The relationship between reserve prices and low estimates is an open debate in the economics literature on art auctions (Ashenfelter and Graddy, 2003). McAndrew and Thompson (2007) note that "the market place experience reported by major auction houses indicates a tendency for reserve prices to be set in a range around 75% of the presale low estimate" and indicate the interval 70-80% as a plausible range of values for the mean ratio of reserve price to low estimate (RtL). Several studies in the cultural economics literature using theoretical arguments and empirical indirect evidence, support the plausibility of this interval and point value (Ashenfelter et al., 2002; Mei and Moses, 2005; Ashenfelter and Graddy, 2011; McAndrew et al., 2012). Since reserve prices are private information that sellers and auction houses keep secret to the bidders both before and after the auction has taken place,[1] to the best of our knowledge no empirical study has yet provided direct evidence on this practice.

Using a unique hand-collected dataset that includes secret information on reserve prices, our empirical analysis suggests that the prediction of a value of about 75% for the mean RtL ratio is reasonably accurate. The existence of a quasi-constant relationship between reserve prices and low estimates indirectly reveals information on secret evaluations of artworks by sellers and represents a step step towards the development of a consistent framework on art auctions and, in particular, on the empirical relationship that links the

[1] As Ashenfelter and Graddy (2011) note, the only publicly know information on a reserve price refers to the well-known "Portrait of Dr. Gachet" by Van Gogh.

estimates and the reserve prices of the items auctioned, with the connected implications on sales rates.

2. Data and empirical strategy

In our empirical analysis, we use a unique hand-collected dataset on all auctions held by the international auction house Finarte in the four-year period from 1994 to 1997.[2] Our dataset includes observations on 5561 paintings made by 514 artists and presented in 29 different auction sales, held in Milan and Rome. A unique feature of our dataset is that it includes reserve prices for unsold items, which we collected from the transcripts of Finarte internal auction logs. We completed our dataset by hand-collecting additional information on artworks, artists and auctions from the auction catalogs and post-auction reports.

In Table 1, we provide definitions for each variable in our dataset along with descriptive statistics distinguishing between sold and unsold items. We find appreciable difference in mean values of several variables for sold and unsold items, a result that suggests that a selection mechanism might be at work.

Since the RtL ratio is observed for unsold items only, we deem that this selection mechanism may cause a sample selection problem. To address this problem we estimate

[2] Finarte, highly reputed among Italian and international art connoisseurs, was led by the banker C. Porro since its establishment in 1959 and until 2001. This auction house was the most important auction house in Italy for about 50 years. In 2001, Finarte experienced a change of management and in 2011, it went bankrupt. Finarte was listed on the Milan Stock Exchange from 1970 to 2011.

selection models (Heckman, 1979) that can be formally expressed as (Collins et al., 2009; Marinelli and Palomba, 2011)

$$\begin{cases} z_i^* = \mathbf{w}_i'\boldsymbol{\theta} + u_i \\ RtL_i = \mu + \varepsilon_i \quad \Leftrightarrow z_i^* > 0 \end{cases} \tag{1}$$

where we make assume the following joint distribution of the stochastic error terms:

$$\begin{bmatrix} u_i \\ \varepsilon_i \end{bmatrix} \sim \mathrm{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_u^2 & \sigma_{u\varepsilon} \\ \sigma_{u\varepsilon} & \sigma_\varepsilon^2 \end{bmatrix} \right) \tag{2}$$

The first equation in (1) is the "selection equation" and the second equation is the "RtL ratio equation". In the selection equation, we model the propensity of artwork i to go unsold, z_i^*, as a linear combination, through the vector of parameters $\boldsymbol{\theta}$, of several observable characteristics included in the vector $\mathbf{w}_i$ (Candela et al., 2012). The variable z_i^* is latent. However, we observe the dichotomous variable z_i, which indicates if the artwork is actually unsold, $z_i = 1 \Leftrightarrow z_i^* > 0$. Thus, we do not observe the RtL ratio when $z_i = 0 \Leftrightarrow z_i^* \leq 0$.

If $\sigma_{u\varepsilon} \neq 0$ then a sample selection bias exists and direct OLS estimates of the mean RtL ratio, μ, are inconsistent. However, a consistent estimate of μ can be obtained by simultaneously estimating the selection and RtL ratio equations via maximum likelihood (Fertig and Görlitz, 2013).

Our research hypothesis requires $\mu=0.75$ or, more reasonably, $\mu\in[0.7, 0.8]$, as generally suggested in the literature.

3. Results

In Table 2, we show four regression models. Model 1 provides a direct, possibly biased, estimate of μ via OLS; Models 2–4, based on the Heckman approach, provide for selection bias correction, and reveal that artworks, artists and auctions characteristics affect the probability of non-sale.

In Model 1, the mean RtL ratio is estimated quite precisely. The estimated value of μ (0.896), however, is far above the upper limit of 0.8 of the acknowledged admissible interval. This result could be due to a sample selection problem as the results of the Wald test of independent equations at the bottom of Model 2 seems to suggest.

In Model 2, the point estimate of μ (0.777) is highly significant, falls within the hypothesized 0.7-0.8 interval and is very close to its midpoint. However, at the bottom of the table we reject the hypothesis of a point value of 0.75 for μ.

In Model 3, we add year fixed effects to the RtL ratio equation to control for time heterogeneity. We find evidence in support of $\mu=0.75$ and that the year 1995 systematically differs from all the other years. For this reason, in Model 4 we show estimates based on a restricted sample excluding observations from 1995. In this model,

the point estimate of μ (0.759) is very close to the estimate in Model 3; unsurprisingly, the empirical evidence neatly supports the hypothesis $\mu=0.75$.

In columns 2-4 we also show the selection equation, that is purely instrumental to our main conclusion about the RtL ratio. In all three cases the indications are similar: the age of the artwork, the existence of a signature and the relative position of the item within the auction are not statistically significant in determining the outcome of the sale. Works of art of a living artist, put on sale at Rome rather than Milan, or with a relatively large surface are less likely to be sold. On the contrary, artworks put on sale in evening sessions, and in the fall season, with a careful photographical valorization in the catalogue or that are sold in a favourable moment of the auction sequence (a positive momentum) are less likely to be unsold. Finally, the high and the low estimates have an opposite effect on the auction outcome. Whereas an higher high estimate increases the likelihood of the sale, an higher low estimate has an opposite effect, an unsurprising result, given the link between the low estimate and the reserve price.

In Table 3, we report mean RtL ratios by medium. The results confirm the relevance of the selection problem in our application and show that no appreciable and systematic difference in the mean RtL ratios by medium exists. Also the previous results concerning the selection equation (not reported for the sake of brevity) are substantially confirmed.

4. Conclusions

We have access to the transcripts of the internal auction logs one of the most important Italian auction houses over the time period 1994-1997. After controlling for sample selection bias, we find evidence – based on this unique hand-collected dataset, which comprises information on otherwise secret reserve prices – in support of several studies in the cultural economics literature that hypothesized a mean value of about 75% for the RtL ratio of the auctioned items.

Consistent with the view supported in Ashenfelter and Graddy (2011), we find direct evidence that the mean RtL ratio is quasi time-invariant, since time heterogeneity could at times influence this value. Medium heterogeneity, which is somewhat implicit in the suggestion by McAndrew and Thompson (2007) that RtL ratios may be item specific (the artwork medium being one of the most relevant item characteristic), turns out to be immaterial in our dataset.

While our analysis does not directly concern the issue of the unbiasedness of the estimates in predicting the subsequent sale prices, the quasi-constant relationship between reserves and low estimates provides an indirect support to this hypothesis.

A comprehensive and widely agreed theoretical framework for artworks sold in sequential auctions with affiliated values has yet to be developed. Empirical analyses on art auctions have so far focused on stylized facts, distinguishing between price and quantity signals. Our work attempts to bring these two strands of the literature together.

A crucial feature of our analysis is the availability of the reserve prices for unsold items. Since auction houses are secretive about reserve prices, our direct estimates could be a benchmark for all studies putting forth indirect methods for investigating the relationship between reserve prices and low estimates.

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Table 1. Variable descriptions and descriptive statistics

Variables	Description	Mean	Sold 58% Mean (a)	Unsold 42% Mean (b)	Δ a – b	Sign
RtL	Ratio of reserve price (observed only when an artwork is unsold) to low estimate.	0.90		0.90		***
high estimate	Logarithm of the high estimate.	8.78	8.73	8.83	-0.10	***
low estimate	Logarithm of the low estimate.	8.54	8.49	8.61	-0.12	***
living artist	Dummy variable equal to 1 if the artist is alive.	0.33	0.30	0.36	-0.06	
signature	Dummy variable equal to 1 if the artwork is signed.	0.93	0.93	0.93	0.01	***
surface	Artwork surface in square meters.	0.36	0.35	0.39	-0.04	***
artwork age	Artwork age in years.	43.87	44.84	42.55	2.30	**
photograph	Dummy variable equal to 1 if a photograph of the artwork is present in the catalog.	0.60	0.62	0.58	0.03	
evening session	Dummy variable equal to 1 if the artwork is presented in auction after 6 p.m.	0.41	0.40	0.42	-0.02	
lot relative position	This variable indicates the relative position of the lot with respect to all lots in the auction.	0.51	0.51	0.52	-0.01	***
momentum	Dummy variable equal to 1 if, within the same auction, the previous artwork has been sold.	0.56	0.63	0.45	0.18	
season (jul - dec)	Dummy variable equal to 1 if the auction takes place between July and December.	0.36	0.35	0.36	0.00	***
venue	Dummy variable equal to 1 if the auction takes place in Rome.	0.35	0.29	0.43	-0.14	***
medium	Set of 22 dummy variables indicating the art medium. The modal medium is oil (42% of the observations).					
year	Set of 4 dummy variables indicating the year (from 1994 to 1997) in which the auction takes place.					

* p<0.10, ** p<0.05, *** p<0.01. Robust SEs.

Table 2. OLS and Selection models for the RtL ratio

Model	[1] All observations No sample bias correction			[2] All observations Sample bias correction			[3] All observations Sample bias correction			[4] Excluding 1995 Sample bias correction		
RtL ratio equation	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign
constant (μ)	0.896	0.003	***	0.777	0.011	***	0.761	0.010	***	0.759	0.013	***
1995							0.057	0.008	***			
1996							-0.004	0.008				
1997							0.007	0.011				
Selection equation	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign
constant				-0.354	0.375		-0.418	0.374		0.215	0.415	
high estimate				-0.649	0.240	***	-0.616	0.239		-1.454	0.240	***
low estimate				0.782	0.231	***	0.748	0.230	***	1.550	0.230	***
living artist				0.163	0.037	***	0.162	0.037	***	0.177	0.043	***
signature				-0.034	0.063		-0.039	0.063		0.012	0.074	
surface				0.094	0.037	**	0.097	0.037	***	0.085	0.041	**
artwork age				-0.001	0.001		-0.001	0.001		-0.001	0.001	
photograph				-0.290	0.044	***	-0.291	0.043	***	-0.261	0.051	***
evening session				-0.144	0.046	***	-0.139	0.046	***	-0.158	0.052	***
lot relative position				0.017	0.068		0.012	0.068		0.030	0.075	
momentum				-0.261	0.034	***	-0.262	0.033	***	-0.213	0.039	***
season (jul - dec)				-0.096	0.033	***	-0.089	0.033	***	-0.166	0.040	***
venue (rome)				0.350	0.045	***	0.358	0.044	***	0.180	0.049	***
year fixed effects				yes			yes			yes		
medium fixed effects				yes			yes			yes		
Test of indep. eqns. χ^2				109.02		***	136.28		***	90.74		***
H_0: $\mu = 0.75$ (F or χ^2)	2604.75		***	6.33		**	1.05			0.52		
Number of observations	2363			5561			5561			4135		
Uncensored observations				2363			2363			1676		
Censored observations				3198			3198			2459		

* p<0.10, ** p<0.05, *** p<0.01. Robust SEs.

Table 3. RtL ratios by medium (selection equation omitted for brevity)

	[5] No sample bias correction			[6] Sample bias correction		
RtL ratio equation	Coef	SE	Sign	Coef	SE	Sign
constant (μ)	0.851	0.054	***	0.772	0.064	***
watercolor	-0.001	0.056		-0.098	0.065	
acrylic	0.064	0.060		0.032	0.068	
charcoal	0.057	0.057		0.033	0.066	
china	-0.001	0.057		0.012	0.069	
collage	0.025	0.056		-0.016	0.065	
decollage	0.000	0.062		-0.028	0.072	
gouache	0.021	0.063		0.002	0.074	
graphite	0.111	0.066		0.045	0.073	
water paint	0.014	0.060		0.022	0.071	
lithography	0.097	0.068		0.066	0.083	
pencil	-0.038	0.056		-0.074	0.065	
mixed	0.040	0.056		0.036	0.065	
oil	0.040	0.055		0.001	0.064	
pastel	0.041	0.055		-0.031	0.064	
pen	0.057	0.060		-0.009	0.069	
drypoint	-0.040	0.061		-0.071	0.071	
sanguine	-0.014	0.057		-0.070	0.077	
serigraphy	0.104	0.093		0.038	0.105	
enamel	-0.041	0.061		-0.090	0.072	
tempera	-0.062	0.059		-0.106	0.070	
xylography	0.062	0.056		0.031	0.065	
Test of indep. eqns. χ^2				155.83		***
H_0: $\mu = 0.75$ (F or χ^2)	3.46		*	0.12		
Number of observations	1676			4135		
Uncensored observations				1676		
Censored observations				2459		

* p<0.10, ** p<0.05, *** p<0.01. Robust SEs.