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Abstract

We analyze art pricing in a unique dataset on Paris auctions between 700s and 800s. Prices reflect the objective features of the paintings and of the sale, and they reveal a substantial death effect, with upward jumps in the years after the death of the artists. Both the hedonic and repeated sale price indexes show a declining pattern for the price of paintings (relative to the cost of living) starting with the French Revolution. On this basis, we analyze the emerging role and market power of art dealers and employ network theory to study whether they created rings to manipulate the outcome of the auctions for their profits. Dealers appear to have been divided into four main communities heavily trading between themselves and we find evidence of collusive behavior with lower hammer prices for buyers belonging to the same community of the dealers organizing the auction. © 2015 John Wiley & Sons Ltd.

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The Market for Paintings in Paris between Rococo and Romanticism

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I. INTRODUCTION

Recent research in cultural economics has investigated the organization of historical art markets and the economic behavior of its players, both in the case of primary markets (see De Marchi and Van Miegroet, 2006; Etro and Pagani, 2012, 2013; Etro et al., 2015) and secondary markets, especially auctions of paintings (see Montias, 2002; De Marchi and Van Miegroet, 2008, 2014).¹ In this work we analyze the organization of auctions in Paris between the mid-XVIII century and the first half of the XIX century through a unique dataset and we examine the determinants of art prices and bidding strategies in that period. At the time Paris was not only a major economic center, but was turning into the most developed international market for art and becoming the leading center of the most innovative artistic production, first with the leadership in the Rococo style, then with Neoclassicism introduced by David right before the French Revolution and finally with the early Romantic style at the beginning of the 800s (Levey, 1972). The large and detailed nature of our dataset allows us to investigate interesting aspects of the auction market, such as the evolution of prices through hedonic and repeated sales price indexes or the existence of a substantial impact of the death of artists on prices, to study the network of traders active in these auctions and test whether they were competitive or affected by forms of collusion between rings of dealers.

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1. Classic references on cultural economics are Frey and Pommerehne (1989) and, on the return on art investments, Frey and Eichenberger (1995).

In the XVIII century art dealers became fundamental players in the trade of paintings, and started to affect buyers' taste and artists' production. Their market power increased over time, and during the second half of the XIX century they will reach the key role of intermediaries between painters and collectors that will shape the modern primary market for paintings and affect the same evolution and diffusion of impressionism. The origins of such a process in the XVIII century are quite interesting. Most of the first Paris' art dealers, such as Gersaint, Remy, LeBrun, Paillet, had shops in the Notre Dame area and started to directly organize auctions in order to sell the collections of their clients and re-sell artworks bought from other sales. The publication of sale catalogues was a key innovation: they contained detailed descriptions of the characteristics of the paintings and, often, also the identity of the previous owners and of the buyers. Some of these catalogues arrived to our days and have been collected in a dataset at the Getty Research Institute, which is at the basis of our investigation.

The econometric analysis is built on prices of paintings corrected for the cost of living, and, therefore, it emphasizes the main determinants of the relative prices of paintings at the time. As usual, prices are increasing with size, and lower for copies, for anonymous paintings and for multiple sales. Our proxies for the quality of the work, such as the length of the catalogue description, the dummy for high quality mentioned in the description and the dummy for paintings whose current location is known are all strongly correlated with the price. There are only minor differences between prices of different national schools (except for higher prices of Dutch paintings). The best French paintings include those by Lorrain, Poussin, Watteau, Fragonard, Greuze, Vernet, David and Girodet-Trioson, while lower prices are associated with Boucher and especially Chardin.

Focusing on French artists, who were mostly based in Paris, we find evidence of a substantial "death effect" (see Frey and Pommerehne, 1989). Auction prices exhibited a significant upward jump in the few years immediately after the death of the artists. Moreover, in line with the recent analysis on the topic by Ursprung and Wiermann (2011), the magnitude of the death effect was wider for painters dying at an intermediate age, when the reputation of the artist was consolidated and the discrete change in future expected production (due to the death) was larger.

On the basis of this analysis we build a price index (in real terms) for the Paris art market between the XVIII century and the XIX century adopting both the hedonic regression method and the repeated sales method (see Goetzmann 1993, Pesando, 1993, and Chanel et al., 1996). Both price indexes emphasize a similar pattern, with a declining shape starting at the time of the French Revolution. Possible reasons could be related with the impact of the political turmoil in undermining the supply of valuable assets, or with the reduction of demand for

art associated with the decline of the economic status of the high class of the *Ancien Régime* and the emergence of a *bourgeoisie* interested in a different art.

While the evolution of relative prices did follow the equilibrium of demand and supply of art, the outcome of each auction could be affected by the dealers that organized auctions and were the main buyers as well; potentially, this was one of the first sources of the art dealers' market power which will influence so much the future of art in Paris. To verify if this was the case, we look for evidence of market power by some dealers and collusive practices between them. First, we check whether some dealers were able to trade at prices that were systematically different from the others: focusing on repeated sales, which allows us to look at the exact same painting sold by different dealers, we show that this was indeed the case. Next, we study how networks between dealers affected prices, testing the hypothesis, suggested by De Marchi and van Miegroet (2008, 2014), for which they were able to collude, buying paintings at lower prices in auctions organized by dealers of the same community compared to when they were buying in auctions organized by rival dealers. We test this hypothesis employing a methodology of network theory (see Jackson, 2008) to analyze the network of dealers who organized auctions and traded in these auctions.

Adopting a community detection algorithm we emphasize the existence of four main communities of dealers that were primarily trading between themselves and, possibly, affecting prices: in line with historical accounts (De Marchi and van Miegroet, 2014) these communities were led respectively by Remy (with Gersaint), Paillet, LeBrun and Regnault-Delalande. We then look at whether being part of a community had any significant impact on transactions: what we find is that dealers were able to purchase paintings at lower prices when the auction was organized by a dealer of the same ring, but when they were buying from auctions organized by dealers of other communities they had to bid higher. Overall, this suggests that dealers had market power and exploited it for their own profits.

The paper is organized as follows. Section II describes the dataset and the organization of these auctions. Section III presents all the empirical findings. Section IV concludes.

II. ART AUCTIONS IN PARIS AT THE END OF THE ANCIEN REGIME

The art dealer Edmè-Francois Gersaint (1694–1750) was the first major dealer that contributed to transform the French art market during the XVIII century. Since 1733 he introduced detailed catalogues for auctions with biographies of the artists and descriptions of the works (see De Marchi and Van Miegroet, 2006, Ch. 19). He organized important sales, including those of the collections of Quentin de Lorangère in 1744 (whose catalogue contained the famous biography of the painter Watteau), Antoine de la Roque in 1745 and the vicomte de

Fonspertuis in 1747 (see McClellan, 1996). Other important dealers of this period were Francois Joullain (1697–1778), Pierre Remy (1715–1797), Jean-Baptiste Pierre LeBrun (1748–1813), Alexandre Joseph Paillet (1743–1814) and Francois-Leandre Regnault-Delalande (1762–1824). Our dataset covers auctions taking place between the 1730s and the 1840s, but we restricted the sample to Paris in a period of 75 years from 1745 until 1820 for which we have consistent and richer data.

The main dealer of the period was certainly LeBrun. He introduced the provision of a rich information on the items on sale in his catalogues, including past auction prices when available. Besides this, he was the first dealer to be consistently engaged in arbitrage activities, traveling abroad to purchase paintings to be resold in Paris (see De Marchi and van Miegroet, 2014). Also other dealers introduced innovations that promoted the art market as we know it today: some of them produced catalogues illustrated with engravings of the works on sale, and publicized their auctions in the *Mercure de France*, the *Journal de Paris* and the *Journal des Arts, des Sciences et de la Littérature*. Catalogues were distributed not only in Paris: they were sent to Brussels, Amsterdam and London, challenging auctioneers in those cities, creating an integrated market and spreading the fame of new artists (De Marchi and Van Miegroet, 2008).²

1. The dataset

For our investigation we have built a dataset based on transactions recorded in the catalogues put together at the Getty Research Institute. Sale prices are recorded in *livres* before the French Revolution and in *francs* after that.³ To convert prices in relative values we normalized them with the annual price of wheat.⁴ The period under consideration includes a phase of the French Revolution in which an additional form of paper money, the *assignat*, was issued by the National Assembly (from 1789 to 1796) to finance increasing public spending and debt, which generated an episode of hyperinflation (see Sargent and Velde, 1995): since *assignats* were widely circulating, a few auctions of this short period of the French Revolution were held in this currency, but we have excluded them in the impossibility of properly calculating relative prices. For the studied period we have 1,336 auctions accounting for 89,601 sales.

2. Gersaint was credited for rediscovering Berchem, while LeBrun and Paillet for rediscovering Vermeer (whose *Astronomer* and *Geographer* were brought by Paillet to Paris in 1785 in the unsuccessful attempt to sell them to the King of France).
3. Subdivisions of *livres* are *sous* (also *sols*): 1 *livre* = 20 *sous*, 1 *sou* = 12 *deniers*, and prices were converted in decimal numbers. Gold and silver coins circulated simultaneously in France: a *Louis d'or* (gold coin) was worth 24 *livres*, an *écu* (silver coin) was worth 6 *livres*.
4. We obtained information on the price of wheat in Paris from the dataset build by Robert Allen (Global Commodity Price Database: <http://www.history.ubc.ca/faculty/unger/ECPdb/data.html>).

The average size of the auctions is of 67 paintings but the distribution is skewed, with half of the auctions having less than 47 paintings (of course auctions included also drawings, watercolors, sculptures and other artworks that we do not consider here). The average price of paintings is 295 livres and the highest price is 70,000 (francs) for an “Adoration of the Magi” by Rembrandt sold in 1809 (now in the Royal Collection in London). The average size is smaller than half a square meter. Most of the paintings (89 %) have a precise attribution, which of course is not always reliable (it may include works from the *atelier* of the artists), but represents a precious source of information. The artists in the dataset belong to all the main national schools, which confirms that the French art market was one of the first global markets for paintings of all times. Most of the observations are from the Dutch school (29 %), the French one (26 %), the Flemish one (17 %) and the Italian one (14 %). However the French school has the largest absolute number of artists, which includes all the most famous masters from the XVIII century (the most frequent being Francois Boucher, Jean Honoré Fragonard, Jean Baptiste Greuze, Claude Vernet and Hubert Robert), the XVII century (with many lots by Sébastien Bourdon, Nicolas Poussin, Francisque Millet, Claude Lorrain, Gaspard Dughet, Jacques Courtois and the Le Nain brothers) and even the XVI century (with Francois Clouet). Spanish paintings have the highest average price of 560 livres, followed by the Dutch and Flemish schools (491 and 266 livres respectively), the Italian school (241 livres) and the French one (236 livres).⁵

Some artists account for an extraordinarily large number of observations, often due to uncertain attributions (for instance over two thousand works by Teniers the Younger and about a thousand by Rubens, or, more properly, his *atelier*). For 11 % of the observations there is an explicit mention that the works are copies. For 43 % of observations we also know the height and length of the paintings (translated in meters); we created dummies for paintings with oval or round shapes.⁶ For the majority of observations (64 %) we know the support on which the painting was executed (for 58 % on canvas, 34 % on wood panels, 5 % on copper plates). In 18 % of the observations multiple paintings were sold together (for example, four paintings representing allegories of the seasons): in such cases we built a variable which indicates how many paintings were in such a group to test for the existence of quantity discounts. Moreover, 2 % of the paintings are reported to have an inscription (mentioning the signature or the

5. This may reflect a selection bias in the sense that only the very best Spanish paintings and highly selected Dutch paintings were brought to Paris, while the best Italian paintings did not reach Paris at the time. Only at the end of the period under consideration the Louvre started to accumulate Italian masterpieces for the *Musée Napoléon*.
6. To avoid selection bias when we control for size (mainly reported for the high quality paintings) we also build size dummies to be employed in larger samples where we use as a reference category the group of paintings with unknown size.

anagram of the author, or the date of execution) which could make the attribution more reliable for the buyers. We also measured the length of the description of the paintings (number of letters) to obtain a rough proxy for the quality of the paintings as perceived by the art dealers. Another dummy identifies paintings whose description contains words as *très-joli*, *superbe*, *magnifique* and similar expressions (9 % of observations). Finally, we have information on the order of the painting in the catalogue, which may hide selling strategies by the auctioneers.⁷

2. Identifying repeated sales

For a small selected group of paintings (almost 3 % of the observations), the dataset reports the current location of the painting. For instance, we have records of repeated sales for “Hercule and Omphale” by Francois Boucher (1735, now at the Puskin Museum, Moscow), “The Butler’s Table” by Jean-Baptiste-Simeon Chardin (1756, now at the Musee des Beaux-Arts, Carcassonne), “Annette and Lubin” by Jean-Honoré Fragonard (1761, now in Palazzo Barberini, Rome), or “The Death of Marat” by Jacques-Louis David (1793, now at the Musées Royaux des Beaux-Arts, Brussels). Clearly, such repeated sales are recorded only for relatively famous paintings whose description has allowed art historians to identify without doubts the precise work, but this provides us with precious information. First, it is a proxy of quality in itself that we can account for in our hedonic regressions. Second, and most important, it allows us to identify when the same painting is sold repeatedly, which will be at the source of our analysis of the price index on repeated sales and of the market power of different art dealers.

As the current place is known for 2,522 observations we were able to identify repeat sales among them: this is the case for 1,393 observations representing 505 paintings sold repeatedly. Additionally we identified 42 sales accounting for other 84 observations from the painting catalogue description where a dealer was indicating the year and historical price the painting was paid in a previous auction. Notice that 81 % of these observations are for paintings sold two or three times, but we also have a painting sold eight times (“A stream in Hilly Country” by Philips Wouwerman, 1666, now at The Wallace Collection, London), a couple of paintings sold seven times and so on. The average price of this subset of the data is almost ten times higher than the average price of the whole dataset, amounting to 2,926 livres, with the most expensive painting sold in 1777 for

7. Information on the outcome of the sale is not always clear. In the future it would be interesting to distinguish between sold, unsold, withdrawn and guaranteed lots (see Graddy and Hamilton, 2014, for an analysis of modern auction house guarantees).

36,001 livres (“The Alliance of Jacob and Laban” by Pietro da Cortona) by the art dealer Remy to the art dealer LeBrun and resold in 1784 for 35,901 livres to the art dealer Paillet as an intermediary for the King of France Louis XVI (the painting ended up at the Louvre).

3. *Empirical strategy*

In the following analysis we will mainly analyze hedonic regressions that relate the log of the price of paintings to a number of explanatory variables and time dummies. An advantage of our empirical analysis compared to previous investigations on historical markets (Etro and Pagani, 2012, 2013; Etro et al., 2015) is that we are able to control not only for fundamental characteristics such as size, support, originality of the work, attribution to a school and a painter and so on, but also for the characteristics of the transaction that vary from auction to auction: the lot number, the length of the catalogue description, the average price of the other paintings sold in the auction, the characteristics of the dealers organizing the sale and buying the lots and the associated network structure. To some extent, our information is even more complete than what is usually available for modern auctions: indeed, the identity of the buyer is typically secret in modern auctions, which makes it impossible to analyze networks of buyers and collusive practices between auction organizers and buyers. We will study the connections between art dealers with the tools of network theory to verify the impact of centrality of the dealers and collusion in affecting auction results.

We will also compare the hedonic price index with an index based on repeat-sales only. In this case, the logprice is regressed on a set of time-period dummies and a set of individual “painting” dummies. The antilogs of the coefficients of the time-period dummies will be our estimated values for the price index. As noted in Pesando (1993) econometrically this procedure is equivalent to the classical method of regressing the change in the (logarithm of the) price of each painting on a set of dummy variables – one for each time period during which the painting is held (see Goetzmann 1993, Pesando, 1993, and Chanel et al., 1996). In our case the period under consideration is divided into 25 time intervals of 3 years length. Dummies for these time periods are introduced together with the dummies for the 547 repeat-sale paintings. As well known, the benefit of using repeat sales is that the resulting index directly controls for the variable quality of paintings using fixed effects. The drawback is that the index is constructed from a subset of the available data. In our case the subset of repeat sales includes 1.5 % of the available data and is biased toward high quality paintings, nevertheless the results will closely follow what found with the hedonic methodology.

III. EMPIRICAL RESULTS

In Table 1 we run our first regressions: a baseline hedonic regression (1) with the main control variables for the entire sample and a regression (2) with artist fixed effects run on a reduced dataset, limited to the artists who have more than thirty

Table 1
Log of painting price hedonic regressions

	Regression (1)		Regression (2)	
Year	1.845***	(41.07)	2.029***	(27.73)
Year squared	-0.00051***	(-41.40)	-0.00057***	(-27.96)
Artist fixed effects			(YES)	
Anonymous painting	omitted		-	
Copy	-0.486***	(-39.69)	-	
Uncertain attribution	0.569***	(14.86)		
German school	0.823***	(31.64)		
French school	0.842***	(57.52)		
Italian school	0.854***	(51.34)		
Spanish school	0.860***	(18.09)		
Flemish school	0.860***	(54.07)		
Dutch school	1.157***	(77.98)		
Current place known	0.775***	(32.86)	0.710***	(27.25)
Nr. of paintings sold together	-0.566***	(-69.18)	-0.391***	(-25.70)
Inscription	0.039	(1.29)	-0.015	(-0.34)
Height (in meters)			0.633***	(16.15)
Length (in meters)			0.897***	(26.17)
Size (in square meters)			-0.346***	(-17.31)
Size unknown	omitted		-	
Size < 0.25 square meters	0.002	(0.17)		
Size 0.25–0.5 square meters	0.190***	(13.40)		
Size 0.5–1 square meters	0.281***	(17.33)		
Size 1–2 square meters	0.431***	(22.70)		
Size 2–4 square meters	0.587***	(20.56)		
Size > 4 square meters	0.842***	(13.58)		
Round	-0.282***	(-7.51)	-0.082	(-1.40)
Oval	-0.101***	(-3.71)	-0.005	(-0.13)
Unknown support	omitted		-	
Canvas	0.069***	(6.41)	omitted	
Wood panel	0.171***	(14.32)	0.169***	(10.17)
Copper	0.209***	(10.52)	-	
Av. price of the rest of auction lots	0.0021***	(103.62)	0.0017***	(68.61)
Description length	0.0023***	(117.41)	0.0016***	(61.25)
Beautiful	0.319***	(23.55)	0.239***	(13.91)
Catalogue Nr	-0.00064***	(-12.36)	-0.00017**	(-2.04)
Constant	-1636.294***	(-40.68)	-1798.681***	(-27.47)
Observations	89 601		31 709	
Adjusted R ²	0.547		0.600	

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

observations (about six hundred artists).⁸ We control for time with a linear and a quadratic term, but similar results emerge when we introduce time-period dummies to build the price index.

Before commenting on the main determinants of the price of paintings, we should point out that some of our proxies for the quality of the paintings are extremely important as control variables, especially in the baseline regression where we do not control for the artists fixed effects. In particular, when the description of the painting by the dealer in the catalogue includes an additional word of average length (five letters) the price increases by 1 %, and the use of a specific word such as *très-joli* (or a similar one) in the description is associated with a price that is 37 % higher. Our dummy for identified paintings (whose current location is known) is another proxy for the quality of the painting and is associated with prices that are more than the double compared to average. Moreover, the positive coefficient of the average (real) price of the rest of the auction confirms that there are some common quality features in each auction that cannot be detected through all the other explanatory variables. Finally, the order of paintings in the catalogue (which was not necessarily the same as in the auction, about which we do not have information) is negatively correlated with prices:⁹ this may suggest that the best works were strategically listed at the beginning of the catalogues, but the size of effect is quite small.

Turning to objective characteristics of the paintings, we confirm standard results obtained in similar regressions for other historical periods. The price is increasing with size as can be seen from the coefficients of the size dummies: compared to a painting of unknown size, a painting large up to a square meter is 32 % more expensive, and a painting of 4 square meters or more is 132 % more expensive (oval and round shapes exhibit only a small discount). Within attributed paintings, an additional meter of height leads to a price that is 88 % higher, but the marginal impact is decreasing with size. Differences in prices between different supports are small, with canvases paid 7 % more than a painting on unspecified support and paintings on wood and copper paid only 20 % more. Multiple paintings sold together have a unitary price that is 77 % lower than average, which is partly due to quantity discounts and partly to lower quality for serial works. Compared to paintings whose author is unknown, copies are paid 62 % less while an uncertain attribution leads to a 77 % higher price. Attributed paintings have higher prices, but the differences between national schools are small, with prices around 130 % higher than the anonymous paintings, with the only exception of the more expensive Dutch paintings. We also checked for genre differentials within a subset of the sample for which we attributed paintings to

8. In regression (1), we omit paintings of unknown size and control size with dummies. In regression (2) we exclude copies to focus on certain attributions and we focus only on paintings on canvas or wood panel.

9. On the declining price in auctions the standard reference is Beggs and Graddy (1997).

the traditional genres: differences were not economically or statistically significant with the exception of portraits, that are typically less paid in the secondary market (the same result for Dutch auctions of the XVII century is reported by Etro and Stepanova, 2013).

The artists fixed effects (available in the working paper version of this research) provide a ranking of their market evaluation for paintings of similar characteristics. Within the French school high prices were reached by works of XVII century painters such as Nicolas Poussin, Claude Lorrain and the Le Nain brothers, the greatest artists of the Rococo age, such as Antoine Watteau, Jean Baptiste Pater and Jean Honore Fragonard, later masters such as Claude Vernet and Jean Baptiste Greuze, neoclassical artists like Jacques-Louis David and Jean-Baptiste Regnault, and even an early painter of romanticism such as Anne-Louis Girodet-Trioson.¹⁰ Extremely high prices were also reached by landscape painters of the early 800s (Louis Gauffier, Jean Joseph Bidauld, Nicolas Taunay, Jean Bertin, Pierre de Valenciennes and Jean Louis Demarne) and genre painters of the same period (Marguerite Gerard, Martin Drolling, Jacques Swebach or Louis Boilly). Remarkably, paintings by other famous artists such as Simon Vouet, Philippe de Champaigne, Francois Boucher and Jean-Baptiste-Simeon Chardin did not reach high prices at the time. Within the Italian school we find high prices for painters from the XVIII century such as Panini, Locatelli, Batoni, Conca and Canaletto, and many older masters.¹¹ Most of the best Dutch and Flemish artists are from the Golden Age.¹² Between the German artists, the neoclassical artist Anton Raphael Mengs reached some of the best prices, while paintings attributed to old masters did not.

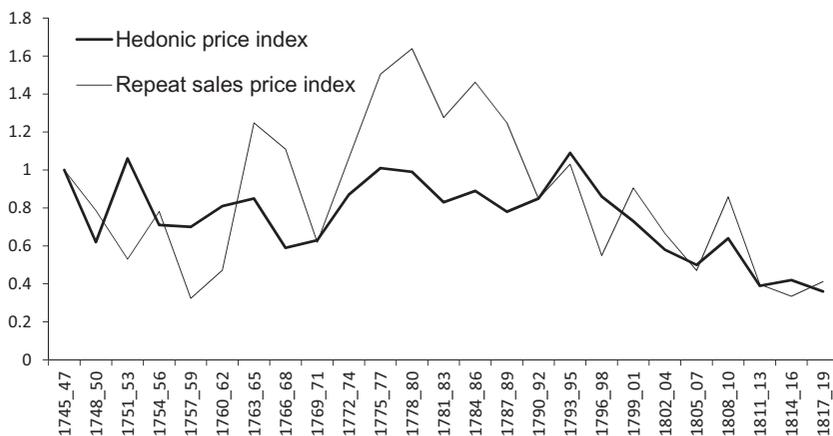
1. Hedonic and repeated sale price indexes

The baseline regression suggests that prices did follow a inverted-U pattern with respect to time. Augmenting the regression with time-period dummies we can build the hedonic price index shown in Fig. 1. Limiting the analysis only to repeated sales we can build the repeated sales index which is shown in the same figure. In spite of conceptual differences between the two indexes, they exhibit a remarkably similar pattern, slightly increasing in the first half of the sample, but clearly decreasing in the second half, with the decline starting around the time of

10. Other neoclassical painters are reported in only few sales, as Antoin-Jean Gros, with a portrait of Napoleon sold for 130 livres in 1807, Jean-Germain Drouais with an historical painting sold for 108 livres in 1814, or Pierre-Paul Prud'hon, with one of his portraits sold for 110 livres in 1818.
11. Top prices were for Renaissance masters such as Raphael, Andrea del Sarto, Correggio and Luini, and Baroque painters such as Albani, Cortona and Reni, while Caravaggio's works were still poorly paid.
12. This is the case mainly for genre painters, Italianate landscapists and other landscape painters, but mid-range prices are obtained by today's most recognized masters such as Rembrandt, Hals, Rubens and van Dyck.

Figure 1

Price indexes for the French art market (1745–1820)



the French Revolution.¹³ The same pattern emerges when we look at price indexes for different price ranges using quantile regressions, and when we take into account dealers fixed effects.

Understanding the rationale for the price pattern is important. On one side, high or increasing prices during the *Ancien Régime* were in line with a flourishing national economy and with a market increasingly protected and subsidized at the central level by the *Académie Royale de Peinture et de Sculpture*¹⁴, under the supervision of the King and important collectors (such as Madame de Pompadour, the Duc d'Orleans, Pierre Crozat, Ange Laurent de La Live de Jully and Joseph Marie Terray). On the other side, in a Schumpeterian perspective, the expectation of increasing prices could be the driver of artistic innovations, which indeed took place in Paris: in the first half of the century Watteau and his followers introduced a new category of genre paintings such as the *fête galante* (with figures in ball dress or costumes of the Italian comedy interacting amorously in parkland settings), during the middle of the century Boucher and others became the leading masters of the international Rococo style, and during the 1770s and 1780s David gave the fundamental contribution in developing the neoclassical style .

13. The low return of the investment in art is in line with a classic result in cultural economics, usually motivated with the existence of a separate “psychic payoff” from the art investment (see Frey and Eichenberger, 1995, and Baumol and Throsby, 2012).

14. The Académie was financing the travel of the winners of the *Grand Prix* to the *Académie de France* in Rome, where they could study the classics and complete their artistic education. Back in Paris, these painters were presenting a *morceau d'agrément* and a *morceaux de réception* to be able to exhibit their works at the *Salon de peinture et de sculpture*, which was crucial to gain commissions.

On the other side, decreasing prices starting from the beginning of the French Revolution require additional historical investigations. Possible sources of this change of trend could be related with the impact of the political turmoil associated with the Revolution in undermining the supply of valuable assets, or with the reduction of demand for art associated with the social decline of rich tax farmers of the *Ancien Régime* and of the aristocracy, and even the emigration of part of the upper class at the time of the French Revolution. As noticed by Hauser (1951, Vol. III, p. 149) French artists were profoundly affected by the Revolution: “the emigration robbed them of their wealthiest and most competent buyers. The number of *émigrés* grew from day to day and the old art public that stayed behind was neither in a position nor in a mood to buy works of art. Most artists were exposed to dire privation at the outset.”

One may suspect that part of the price evolution that we have emphasized could either depend on changes of taste in Paris, in particular with older styles getting out of fashion at the end of the 700s, or it could be affected by the prices of foreign paintings following a different trend. To verify whether this is the case, in Table 2 we focus only on the French school and, in particular, on all the paintings attributed with certainty to French artists who can be clearly identified and for whom we know the year of birth and death. In regression (1) we control for the usual variables and add the year of birth of the painter, which is our proxy for the artistic style at the time in which the author was active. The sign of the coefficient is positive and significant, suggesting that more recent styles were better paid probably because they were more fashionable. Most important, the size of the effect is not negligible: each decade of difference in age between artists leads to a price differential of 2 % (however, it could be that more recent paintings were simply better conserved and this percentage could reflect depreciation of the asset). Beyond this, it is important to remark that the inverse-U pattern of prices is not affected, as are most of the other coefficients.

2. The “death effect” for French artists

Within the analysis of French artists in Paris auctions we can also check for the existence of a “death effect” for the artists active in this period (see Frey and Pommerehne, 1989, Ekelund et al., 2000, and Ursprung and Wiermann, 2011). In regressions (2) and (3) of Table 2 we look for sudden jumps of prices at the time of the death of a painter, which at theoretical level is usually justified with the discrete change in the expected future supply of artworks. More precisely, the motivation of the “death effect” is associated with the Coase (1972) paradox on the monopolistic price of durable goods (here the paintings), which is decreased by the ability of the monopolistic producer (here the artist) to increase future

Table 2
Log of painting price hedonic regressions, French school

	Regression (1)	Regression (2)	Regression (3)
Birth Date	0.00185*** (11.71)		
Work sold 1–2 years after death		0.193*** (3.36)	
Work sold 3–5 years after death		-0.0058 (-0.99)	
Work sold 6–10 years after death		0.030 (0.64)	
D_Dage			-0.036** (-2.24)
D_Dage ²			0.0011** (2.43)
D_Dage ³			-0.000007** (-2.39)
Artist fixed effects		(YES)	(YES)
Year	2.301*** (21.18)	2.113*** (19.95)	2.218*** (8.41)
Year squared	-0.0006*** (-21.32)	-0.0006*** (-20.14)	-0.0006*** (-8.53)
Current place known	0.671*** (15.99)	0.638*** (16.04)	0.395*** (5.32)
Nr. of paintings sold together	-0.607*** (-34.94)	-0.520*** (-31.36)	-0.540*** (-16.99)
Inscription	0.276*** (4.39)	0.143*** (2.39)	0.168* (1.91)
Size dummies	(YES)	(YES)	(YES)
Unknown support	omitted	omitted	omitted
Canvas	0.062*** (2.71)	0.056*** (2.60)	0.116*** (2.65)
Wood panel	0.047 (1.50)	0.011 (0.36)	0.044 (0.73)
Copper	0.321*** (5.47)	0.263*** (4.76)	0.360*** (3.15)
Av. price of the rest of auction lots	0.002*** (46.59)	0.002*** (46.02)	0.001*** (19.93)
Description length	0.002*** (57.33)	0.002*** (45.64)	0.002*** (24.44)
Beautiful	0.332*** (12.18)	0.247*** (9.72)	0.203*** (4.36)
Catalogue Nr	-0.0004*** (-3.20)	-0.0005*** (-4.05)	-0.0004* (-1.84)
Constant	-2045.974*** (-21.03)	-1870.532*** (-19.73)	-1958.683*** (-8.28)
Observations	17 856	17 856	4 207 ^(a)
Adjusted R ²	0.487	0.565	0.629

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

D_Dage – interaction of age at death with dummy variable work sold in the year of death or 1–2 years after.

D_Dage² – interaction variable squared.

D_Dage³ – interaction variable in cube.

^(a) – dataset is reduced to artists who have at least 2 observations in each of the following periods: before death, in 1–2 years after death, 3 or more years after death.

production: by definition, death provides a credible commitment to limit production, which is absent as long as the artist is alive.¹⁵

The results are quite impressive, emphasizing a large and both statistically and economically significant jump of prices at the death of the painters. In regression (2) of Table 2, we add a dummy for the sale of a painting taking place in the year of the death or in the next two years, and we estimate a jump upward of almost 20%. Moreover, the estimate of the discontinuity is biased downward because in the year of death we cannot control whether the sale occurred before or after the death, and we cannot separate artists whose bad health status could lead to anticipated effects on prices. We noticed large jumps in prices at the death of Jean Baptiste Deshayes, Jean Baptiste Le Prince, Francois Ménageot, Simon Lantarat, Gabriel Briard, Charles Lacroix, Etienne Theaulon and Martin Drolling. However, this effect appears to be only temporary, since in the subsequent years prices are not significantly different from the average evaluation of the painters: this is in line with the hypothesis of reversion toward the mean after the death pointed out by Ekelund et al. (2000).

We can also verify the conjecture of Ursprung and Wiermann (2011) for which the death effect should be maximum when death occurs at an intermediate age, because the artist has an established credibility (for future quality) and a sudden death induces a discrete change in her/his future expected production – while the death effect should be negative at younger age, when the reputation of the artist is not established yet. Regression (3) is confined to the painters that did die within the period under consideration (and with sales both before and after their death), and controls for the age at which the painter died with linear, quadratic and cubic interactions with the death effect. This allows us to construct in Fig. 2 the non-linear relation between the estimated death effect and the age of death, confirming the inverse-U shape (with a peak in the early seventies) found by Ursprung and Wiermann (2011) within modern auctions. Already at the time of the *Ancien Régime*, art prices exhibited a discontinuous increase when established artists died at an early age.

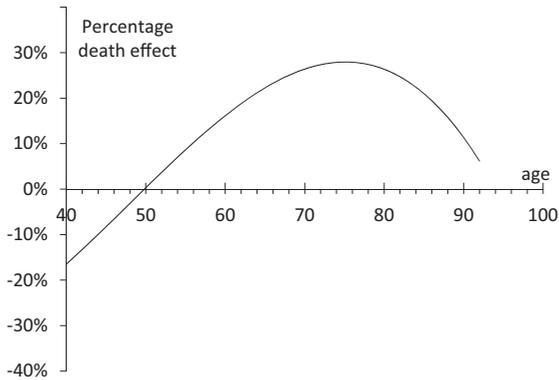
3. Auction efficiency and market power of the art dealers

In competitive and efficient auctions, the identity of buyers and sellers should not affect prices. Indeed, the fact that a trader buys paintings at a price systematically below their market value would attract new bidders willing to outbid that trader and exploit the arbitrage opportunity. Analogously, a trader cannot afford to sell paintings at prices systematically above their market value. Since we know the identity of the art dealers organizing the auctions and, for a large part of the

15. See Ursprung and Wiermann (2011) for an interesting theoretical discussion and convincing empirical support of the existence of a “death effect” in modern auctions. We analyze what is probably the oldest available evidence of a death effect in an auction setting.

Figure 2

"Death effect" at the age of death



dataset, we also know the identity of the buyers, we can potentially test for the efficiency of the auction market. However, such a test is complicated by many determinants of bidding behavior that we cannot control for. For instance, a dealer may only trade paintings of high quality and share extra information about the quality, or may have a mandate from rich clients with high willingness to pay, and therefore purchase high quality paintings, while we are not perfectly able to control for quality.

A safe test of auction efficiency can be run focusing on sales of identical paintings by different dealers, that is on repeated sales (this is indeed a natural experiment available in the dataset): in a competitive and efficient market, a dealer cannot systematically obtain higher prices compared to other dealers when trading the same identical object, otherwise that trader would make extra profits fruit of a market power. In Table 3 we run a regression on repeated sales with the usual fixed effects for each painting. We control for the time of sale with a linear and a quadratic term and we include two characteristics of the lot on sale that could be directly chosen by the art dealer, namely the length of the description of the painting in the catalogue, a proxy of the effort at revealing information on the quality of the work, and the position of the lot in the catalogue, which again could be used strategically to reveal information. Finally, we add dummies for all the dealers organizing the auctions. Again, the "law of one price" suggests that there are no reasons why the same painting should have significantly different prices when described with more or less words in a catalogue or when it is sold by one dealer or the other. However, our test for these basic predictions fails dramatically. Some dealers were able to sell the same paintings at prices that were significantly higher than others (Gersaint was the most famous between

Table 3

Log of painting price repeat sales regression with Dealers Fixed effects		
Year	4.795***	(8.49)
Year squared	-0.00134***	(-8.52)
Description length	0.000480***	(5.19)
Catalogue Nr	0.000364	(1.46)
Repeat sales Fixed effects		(YES)
Paillet network		
Paillet A.J.	0.0661	(0.91)
Delaroche H.	-0.124	(-0.61)
Lebrun network		
Lebrun J.B.P.		omitted
Constantin G.J.	0.217	(0.70)
Joullain F.C.	-0.00208	(-0.01)
Lebrun J.A.	-0.160	(-1.13)
Joullain son	0.421	(0.88)
Saubert L.F.	0.149	(0.27)
Lerouge N.	0.161	(0.40)
Remy network		
Remy P.	0.187*	(1.95)
Basan P.F.	0.0187	(0.10)
Folliot J.	-0.543	(-1.43)
Langlier J.	1.290***	(3.81)
Boileau N.F.J.	0.0704	(0.53)
Gersaint E.F.	0.88**	(2.06)
Mariette P.J.	0.755*	(1.83)
Colins F.L.	0.380	(0.63)
Regnault-Delalande network		
Regnault-Delalande F.L.	-0.555**	(-2.40)
Henry	0.737***	(2.93)
Destouches F.	1.537**	(2.41)
Perignon A.N.	0.786***	(3.27)
Paillet C.	0.313	(1.35)
Elie C.	0.819***	(2.61)
Delaneuille	0.788**	(2.52)
Coquille A.	-0.158	(-0.35)
Barrois	1.385**	(1.98)
Constant	-4268.6***	(-8.45)
Observations	1 132	
Adjusted R ²	0.808	

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Repeat sales sample is constrained to paintings sold at least by 2 different dealers and to dealers with more than 1 observation.

them), especially when the descriptions they placed on the catalogue was longer and more accurate (than in a different sale of the same painting). This suggests that different dealers did play a significant role in revealing or manipulating valuable information for the buyers. In other words, dealers had some superior information and some market power that could be used to obtain extraprofits from the art trade.

At this point, one may wonder how art dealers could exploit such a power and whether connections and (possibly) collusion between them could have any role in shaping prices. In a competitive market we would not expect any systematic influence of connections of traders on bidding behavior, but these art dealers were the dominant players in the market and could exploit such a dominance. Indeed, art history and economic history scholars have suggested (see in particular De Marchi and van Mieghoet, 2014) that the Paris art market was characterized by “rings” of dealers able to control prices to a certain extent. Our final purpose is to test for this hypothesis.

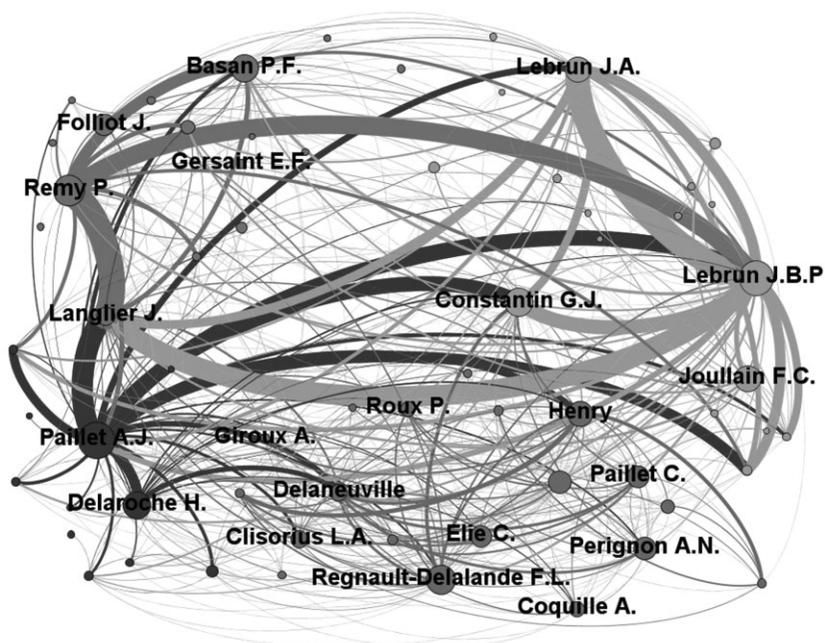
4. *Networks of art dealers and collusion*

To test for collusion between dealers in the Paris art market we study their connections with the tools of network theory (see Jackson, 2008). In our dataset we have identified 63 dealers who organized 1,108 auctions during the period examined, accounting for 82,265 transactions (for the small number of remaining auctions we do not know the identity of the organizers). For many of these transactions the buyers were actually other dealers, and for 9,190 of them we have exactly identified both buyers and sellers from our list of dealers. To focus on network interactions, we excluded from the analysis 5,176 transactions where a dealer is the buyer in his own auction. As a matter of fact, unreported regressions show that dealers managed to buy at lower prices in auctions organized by themselves, which confirms the previous finding that dealers had market power, but the key question for collusion is whether there was a group of other connected dealers who could systematically buy at lower prices from their auctions.

In Fig. 3 we show the resulting network of Paris art dealers. Each node of the network represents a dealer. A link between two nodes represents a connection between two dealers if one dealer bought a painting in an auction organized by the other. These links are “directed”, i.e. they go from a dealer who is auction organizer to a dealer who is buyer. The number of links leaving from a node is its node’s out-degree.

The network we obtain is connected, that is, it consists of a single component: we do not find dealers disconnected from the main component and trading only between themselves. Node out-degrees are largely variable across dealers, with an average of 8 and maximum levels of 39 for Paillet and 36 for LeBrun. We find a heavy tail in the distribution of degrees, which is a typical feature of many social networks (see the classic work by Barabási and Albert, 1999). Looking at some classical network statistics (see Jackson, 2008), we observe that the *clustering coefficient* (0.74) is higher than the *density coefficient* (0.2), which suggests that this is a non-random network in the sense of Erdős and Rényi (1960). The average shortest path between two nodes is small (1.97), which leads us to conclude that the network exhibits the so-called “small-world” property (see

Figure 3
Networks of art dealers



Note: Paillet community in blue, Gersaint-Remy community in red, Regnault-Delalande community in violet, Lebrun community in green. Node's size is proportional to its out-degree

Watts and Strogatz, 1998). Moreover, when an auction has many visitors (i.e. potential buyers) we expect more competition among buyers and we expect more aggressive bidding behavior: *nodes out-degree* are a proxy of how many visitors that dealer has when organizing an auction and we expect them to be positively correlated with prices.

To verify the conjecture by De Marchi and van Miegroet (2014) that there were rings of dealers, especially those led by Gersaint with remy, by LeBrun and by Paillet, who were mainly trading between themselves and were engaged in collusive practices, we first need to identify the potential rings. To partition the network in communities of dealers in an objective way (without resorting to a subjective interpretation of historical information), we employ what in graph theory is called a “communities search algorithm.” This separates the network in communities in such a way that there are dense connections between the nodes within a community (but sparse connections between nodes in different communities). Such an algorithm maximizes an objective function that defines the

so-called “modularity of the partition.” Here we adopt the Louvain community detection algorithm (proposed in Blondel et al., 2008), which maximizes an index defined as the difference between the fraction of links that fall within communities and the expected number of links within these communities for a random graph (with identical node degree distribution).¹⁶ Through this procedure we identify the existence of four communities emphasized in Fig. 3, one led by Lebrun and Joullain with fifteen other members, one by Paillet with ten more dealers (including H. Delaroche, who we know as a late partner of Paillet), one led by Remy with fifteen other members (including Gersaint in his late activity, and also J.B. Glomy and P.C.A. Helle, who we know to have collaborated with Remy) and a last one led by Regnault-Delalande with eighteen other members. Remarkably, the algorithm distinguishes well known communities mentioned in many historical accounts and LeBrun, Paillet and Remy are exactly the leaders of the rings conjectured by De Marchi and van Miegroet (2008, 2014) in their historical analysis.

The role of the network in determining prices is analyzed both in Table 3 for repeated sales and in Table 4 for all sales. As already noticed, Table 3 shows substantial price differences between dealers even when they are selling the same identical paintings. Systematic differences in prices emerge not only between dealers but also between communities, with higher prices for dealers belonging to the community led by Gersaint and Remy. Regression (1) of Table 4 covers all sales for which the identity of the dealer organizing the auction and usual control variables are available, and it shows that prices were higher for trades involving the ring led by Remy and Gersaint and lower for the ring led by Regnault-Delalande compared to the omitted one led by Paillet. Moreover, we confirm that *nodes out-degree* are positively correlated with prices, suggesting that auctions with more potential buyers were characterized by more aggressive bidding; indirectly, this confirms that average auctions were not that competitive and, actually, the dealers could exploit a certain amount of market power¹⁷.

16. The algorithm is divided in stages that are repeated iteratively. In a first stage, a different community is assigned to each node of the network, so that the initial partition has as many communities as nodes. Then, for each node i its neighbors j are considered evaluating the gain of modularity that would take place by removing i from its community and by placing it in the community of j . The node i is then moved to the community for which this gain is positive and maximum. This process is repeated for all nodes until no further improvement can be achieved. The next stage of the algorithm builds a new network whose nodes are now the communities found during the previous stage. Communities of communities are built during this stage. The process is iterated further until there are no more changes and a maximum of modularity is attained.
17. We also used a measure of the influence of the dealer in the network known as *eigenvalue centrality* (proposed in Bonacich, 1987). This gives scores to each node that are proportional to the sum of the scores of its neighbor nodes. However, in unreported regressions featuring also the dealer out-degree as a control variable, this measure of centrality is not significantly correlated with prices, while the coefficient of dealer out-degree remains positive and significant.

To finally test for collusive practices, in regressions (2)-(4) of Table 4 we run regressions limited to the transactions where we know also the identity of the buyer and we introduce a dummy for the transactions in which both the buyer and the dealer organizing the auction belong to the same community. Regression (2) shows that dealers within same community trade at lower prices (about 7 % lower), but when dealers buy from auctions organized by dealers of other communities they have to bid higher. This happens despite the price differentials across the four communities remain approximately the same as mentioned before, which points out that art dealers were effectively able to purchase paintings at a lower price than usual when the auction organizer was part of the same ring. To verify how robust is this result, regression (3) replaces fixed effects for the four rings with fixed effects for each one of the dealers: also in this case, the discount for transactions within the same community remains and is even higher (about 8 %). Unreported regressions show that discounts emerge especially within the community led by LeBrun and the one including Remy and Gersaint.

To control even better for the characteristics of the paintings, regression (4) adds also a full set of artists fixed effects to the full set of dealers fixed effects, and the discount is still present and both statistically and economically significant. Prices appear to be always lower when the dealer organizing the auction belongs to the same ring; unreported regressions increase even more the estimated discount when we restrict the analysis to repeated sales, but the number of observations is quite limited. Such a phenomenon cannot be due to information sharing within communities, otherwise prices could be either above or below predictions depending on the nature of the shared information, and on average they would not be biased. Instead, positive discounts within rings are compatible with the hypothesis of collusive behavior: they could take place as long as the members of a ring were able to both limit the access of others in their auctions and avoid aggressive bidding against each other. Overall, this suggests that networks of dealers did manage to exploit their market power to manipulate art trade.

IV. CONCLUSION

We have analyzed auctions of paintings held in Paris between the Rococo period and the early Romantic period. Prices reflect the objective features of the paintings and of the sale, and they reveal a substantial death effect, with upward jumps in the years after the death of the artists. Both the hedonic and repeated sale price indexes show a declining pattern for the price of paintings (relative to the cost of living) starting with the French Revolution. On this basis, we have analyzed the emerging role and market power of art dealers and employed network theory to study whether they created rings to manipulate the outcome of the auctions for

their profits. Dealers appear to have been divided into four main communities heavily trading between themselves and we find evidence of collusive behavior with lower hammer prices for buyers belonging to the same community of the dealers organizing the auction.

During the XIX century, the dealers will become always more influential on artistic taste and trade, affecting also the destiny of the same artists (think of the impressionists and the post-impressionists). However, their role and their market power will move from the secondary (auction) market to the primary market, and during the second half of the XIX century they will become the main intermediaries between painters and collectors (see Cellini and Cuccia, 2014, for a theory of the art-dealer relation). Since then, they will be able to determine the fortune of new artists and exploit part of their surplus

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SUMMARY

We analyze art pricing in a unique dataset on Paris auctions between 700s and 800s. Prices reflect the objective features of the paintings and of the sale, and they reveal a substantial death effect, with upward jumps in the years after the death of the artists. Both the hedonic and repeated sale price indexes show a declining pattern for the price of paintings (relative to the cost of living) starting with the French Revolution. On this basis, we analyze the emerging role and market power of art dealers and employ network theory to study whether they created rings to manipulate the outcome of the auctions for their profits. Dealers appear to have been divided into four main communities heavily trading between themselves and we find evidence of collusive behavior with lower hammer prices for buyers belonging to the same community of the dealers organizing the auction.

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