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Peer Effects in Art Prices

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Abstract

Art often serves as an investment tool. However, the prices for some of the pieces are not easy to predict, and removing the price uncertainty is crucial to attracting even more investment in the art market. This paper assumes that the reputation of the artists and their social connections can play a significant role in determining the prices of their work. I check if a link to a higher valued or more famous peer has a positive effect on the prices of art pieces and on the probability of a successful sale. To test this hypothesis, I use the network of abstract artists, whose works' value is not always straightforward determined, and the prices of their works auctioned in 2000-2015 at Sotheby's, one of the most significant art and collectibles brokers in the world. The results suggest that consumers are willing to pay more for a particular artist's work, once there is a connection between the artist and a more valuable set of peers. However, the probability of sale is not affected. The auctioneer's predictions about future prices exhibit a similar trend.

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1 Introduction

Art is receiving significant attention in recent years as a possible investment. For example, global auction turnover since 2010 has never fallen lower than ten bln. dollars.¹ It is often attributed to the category of so-called passion investments, which also includes jewelry, antiques, classic cars, wine, and similar objects. Passion investments are assessed to amount to 6% of total wealth (The Wall Street Journal, 2010), and the high-net-worth investors allocate globally around 17% of their cash to art (World Wealth Report 2013). According to Knight Frank Luxury Investment Index 2014, the 10-year capital appreciation of art is among the highest and equal to 226%². However, the existing literature often shows the underperformance of art in comparison to other types of investments and the high volatility of art prices³. Hence, the attractiveness of the art market cannot be explained by investment purposes only. Buying pieces of art is also a widespread tendency among high earners to strengthen their status and to yield respect in society (Goetzmann, 1993). As a result, global art and antique sales are steadily high in the last several years, with a total value close to 50 billion Euros (except for the 2009 crisis)⁴.

It is common to explain art prices with the hedonic price model with the following standard set of explanatory variables: artists' characteristics, works' characteristics, such as medium, authenticity, attribution, size, and topic, as well as the sales characteristics, such as a date and a place⁵. Artists' reputation plays an important role, but it is not always clear how to account for it, especially in samples of similar artists. Renneboog and Spaenjers (2013) include a dummy for mentioning of the artist in the classic art history textbook "Gardner's Art Through Ages" and a dummy of exhibiting at Documenta in Kassel, one of the most influential contemporary art exhibitions. While such an approach is useful to analyse a relatively broad sample of artists, it is not suitable to control for the reputation and professional recognition of the abstract artists

¹Report by Artprice.com, more details here.

²Consult here for more details.

³For example, Goetzmann (1993) reports an average annual real return on oil paintings of 3.8% for the period between 1850 and 1986, with returns around 15% after 1940. Mei and Moses (2002) calculate the return of 4.9% for 1875-1999, with 8.2% after 1950. Renneboog and Spaenjers (2013) are more cautious in their estimation, with 3.97% over the period 1957-2007. See Ashenfelter and Graddy (2003) for a summary of findings.

⁴European Fine Art Foundation report

⁵See Ashenfelter and Graddy (2003) and Ashenfelter and Graddy (2006) for a detailed summary

in my sample as the majority of them were included in the first Documenta in 1955.

This paper proposes a novel approach to explore price formation and account for reputation. Additionally to the commonly used determinants, I am looking at the artists' connections as a crucial determinant of the artist's development and the resulting price formation, which is missing in the existing analysis. I expect connections to influence art sales in two ways. First of all, following the classical peer effect logic, artists' links are influencing the development of artists' style and quality of the works. Artists may learn from better peers, and produce works of improved quality, adopt peers' style or modify their style. Thus, connections to well-established peers may improve the artist's quality. Second, the prices of the work of one artist may be driven by the prices of the connected artists. If the artists worked together or belonged to the same movement, their works will likely carry some similarities and face similar demand and prices on the market. Alternatively, the following scenario is possible: if the demand for some artist's works increases, and thereby also their price, this artist may become too expensive, and buyers would be willing to switch to similar (most likely connected) artists, causing the rise of demand and resulting market price for the latter.

The movie "Exit Through the Gift Shop" about street artist Banksy provides anecdotal evidence on the importance of connections in creating a reputation on the art market: a previously unknown artist used a quote about him by a famous street artist Banksy on the posters advertising his solo show. The phrase boosted the interest of the general public and attracted many visitors along with big money to the show. Mediocre pieces of art brought millions of dollars to their creator. However, it would not have happened without the stated connection between the artist and Banksy. While this is just a fun anecdote, also scientific literature investigating the importance of connections and peers is growing in cultural economics. However, while previous literature has focused on the effects of peers on creativity and productivity, my paper investigates effects on market outcomes. For example, Vedres (2017) explores the joint participation in jam sessions on jazz musicians' creative success; Borowiecki (2013) looks at the relationship between the productivity and potential connections inside geographical clusters in classical music. A recent article by Fraiberger et al. (2018) shows the importance of connections in the art market using co-exhibition networks that affect the success of the artists' careers. The

length and trajectory of the career depend on the location of the artist in the network. My paper is, however, the first to look at the connections between the individual artists, and how such connections are reflected in the art prices.

To do so, I use data on the artists from the abstract movement and their works, which I collected manually from the open resources specifically for this project. Abstract art is one of the art movements, along with contemporary art, for which the price is especially challenging to determine. Hence, exploring networks as an additional channel of price formation will help to understand the price differences better.

I apply the peer effect model discussed by Manski (1993) to the panel data on the prices of abstract artists' works auctioned at Sotheby's in 2000 - the first half of 2015. I am interested in the *endogenous effect* of peers' prices, i.e. how the individual outcomes (prices of works) will be affected by the average prices of their peer group. I am using the average of past auction prices and the same-period prices of connected artists as a predictor of each work's price. The presence of the simultaneous outcomes causes the identification problem of *the endogenous effect* due to the reflection problem. The price of works will not only be affected by peers' prices but will itself affect the prices of peers' works sold in the same period. Bramoullé et al. (2009) suggest an identification strategy for networks that deals with the reflection problem, which can also be applied in my analysis. To identify the effect of the peers' prices, I need the network to have intransitive triads, i.e. there should exist two artists that are not connected directly, but via one more artist. This assumption allows for exogenous variation in the peer groups that ensures that the endogenous effect of peers' outcomes is identifiable. This assumption is plausible for most of the networks and the network of abstract artists in particular.

Even though the data has a panel structure and the outcome variable is constructed differently in comparison to the classical peer effect model, I can apply the instrumental variables approach proposed by Bramoullé et al. (2009) following Lee (2003) to find the consistent estimator of the endogenous effect. Exogenous characteristics of the second-level connections (friends of friends) are serving as instruments for the average past prices of connections. The presence of intransitive triads ensures that friends of friends are not influencing prices directly, but only via the prices of common friends. A similar analysis is also applied to the estimation of the probability

of sale based on the realized sales of connections.

The main finding of the paper is the presence of a positive peer effect in art price formation. A 10% price increase in the peers' average past prices leads to the 2-3% increase in one's own hammer and auctioneers' estimated prices. I further argue that the sample's most famous artist, Pablo Picasso, is likely to be influencing the sales of connected artists, but his works' prices might not be affected by the prices of connections. I treat Picasso's prices as independent of peers' prices and only include them as the elements of the explanatory variable and repeat the analysis as before. The positive peer effect becomes even more prominent in such setting: a 10% price increase in the peers' average past prices leads to the 4,5-6% increase in one's own hammer and auctioneers' estimated prices. The probability of sales, on the contrary, does not exhibit any significant peer effect in both settings. So buyers would have been willing to buy the works independent of the value of artist's connections, but are ready to pay more for the "better" connected artists. The reputation of the connecting artists, therefore, might force more potential buyers to bid higher, resulting in higher hammer prices, but seems not to affect the overall market perception of the work. If the market likes some art piece, it will be bought anyways; if the market does not find the work attractive, connections to valuable artists will not likely change it.

The paper is organized as follows. Section 2 discusses the proposed peer effect model and suggested estimation method. Section 3 introduces the data and provides some of the descriptive analysis. Section 4 provides the empirical results. Section 5 concludes.

2 Methodology

I am analyzing the sample of all works sold at Sotheby's for the sample of abstract artists.⁶ In order to estimate the endogenous effect of average prices of connected artists on the prices of the artist's own work, I am proposing the peer effect model, similar to Manski (1993), with the

⁶The sample is defined and discussed in the next section.

appropriate modification. For artworks $i \in [1, I]$ in the set of all artworks by all artists $j \in [1, J]$:

$$P_i^j = \alpha_0 + \alpha_1 t_i + \beta_0 Z_i + \beta_1 X_j + \beta_2 \sum_{l \neq j} G_{jl} X_l + \gamma \sum_{l \neq j} G_{jl} \bar{P}_l^{-t} + \nu_j + \epsilon_i^j \quad (1)$$

where P_i^j - the price of the piece i by artist j .

\bar{P}_l^{-t} - average prices of works by artist l , sold before piece i was auctioned.

Z_i - the characteristics of art piece that include the type of work, their size, date of creation, provenance, exhibition history etc.⁷

X_j, X_l - the characteristics of the artists, such as major work mediums (paintings, sculptures, and others), country of birth and living, years active, etc.

G_{jl} - an adjacency matrix with $1/n_j$ in the jl cell, if an artist j is connected to an artist l , and n_j is the total number of connections of an artist j .

ν_j - the unobserved characteristics of the artists.

Here β_2 represents the exogenous effect, how the similar characteristics of the connected artists influence the outcomes, γ is the endogenous effect, showing how the outcomes of the connections may influence the outcome of the individual. The presence of an individual unobservable effect creates an additional issue for the identification of the endogenous effects.

Potentially, the correlated effects can also be present in the model, making the smaller group within the network to behave similarly due to the unobserved similarities of the group. However, the network used in this paper is rather small, and the similarities of the subgroups will be captured by observed characteristics, such as the country of origin or/and work, the group affiliation, and similar. In a more general setting, the local differences can deal with the correlated effects problem, averaging over the first level connections' outcome variables. The presence of links of the length three or more is then ensuring the identification of endogenous effect, and so $G_{jl}^3 X_l$ can be used as instruments for the endogenous covariates.

Since the network is held constant in the panel, the fixed effects model, which is more suitable from the empirical point of view, is not applicable. The connections' average exogenous characteristics will be invariant for all works by the same author, and therefore, the exogenous peer

⁷The variables will be discussed in detail in later sections.

effects cannot be identified. So one should either use the random effects analysis or Hausman and Taylor type models.

Both possibilities are plausible, depending on the assumptions one believes in. The unobserved individual effects in our setting might represent, for example, the level of talent of the particular artist, his/her popularity, as well as characteristics not included or missing in the vector of relevant covariates attributed to the artist. The level of talent and some potential covariates are more likely to be uncorrelated with explanatory variables, so there might be a correlation between popularity and one of the explanatory variables. In particular, the artists from a specific movement might be more attractive at a particular point in time, and hence, I expect a positive correlation with the characteristics and outcomes of the artists' connections. In this case, the random effects will produce inconsistent estimators of all parameters, and the Hausman and Taylor type models are more suitable. Such models are, however, more computationally demanding, and once the correlation mentioned above is absent, the random effects are preferable.

Hausman and Taylor type model

If there is a potential correlation between individual unobservables and the explanatory variables and time-constant variables are of interest⁸, as follows from the arguments mentioned above, neither fixed effects nor random effects are suitable for the analysis. As discussed, I can ignore the possibility of correlated effects since they are not very likely to be present in the current setting.

I am combining the Hausman and Taylor (1981) approach and the instrumental variable approach to the peer effect model proposed in Bramoullé et al. (2009). First, I divide all explanatory variables into two vectors: time-variant $\mathbf{Z}_i^j = \{t_i, Z_{i1}^j, \sum_{l \neq j} G_{jl} \bar{P}_l^{-t}\}$ and time-constant $\mathbf{X}_j = \{1, X_j, \sum_{l \neq j} G_{jl} X_l\}$. I follow Hausman and Taylor (1981) and partition both vectors as follows: $\mathbf{Z}_i^j = (\mathbf{Z}_{i1}^j, \mathbf{Z}_{i2}^j)$ and $\mathbf{X}_j = (\mathbf{X}_{j1}, \mathbf{X}_{j2})$, where \mathbf{Z}_{i1}^j is $1 \times K_1$, \mathbf{Z}_{i2}^j is $1 \times K_2$, \mathbf{X}_{j1} is

⁸Note, that notion of time is used here not in the direct sense, but instead follows the conventional terminology of panel data analysis. Time here denotes each time one of the works was auctioned.

$1 \times J_1$, \mathbf{X}_{j2} is $1 \times J_2$, and the following assumptions hold:

$$\mathbb{E}(\mathbf{X}_{j1}\nu_j) = 0 \quad \text{and} \quad \mathbb{E}(\mathbf{Z}_{i1}^j\nu_j) = 0$$

Additionally, the further assumption is necessary:

$$\mathbb{E}(\epsilon_i^j | \mathbf{X}_j, \mathbf{Z}_1^j, \dots, \mathbf{Z}_{w_j}^j, \nu_j) = 0, \quad i = 1, \dots, w_j$$

with w_j being the number of works of artist j in the sample.

I can then rewrite the original model in a simplified way:

$$P_i^j = \beta Z_i^j + \alpha X_j + \nu_j + \epsilon_i^j \tag{2}$$

where $\beta = (\alpha_1, \beta_0)$ and $\alpha = (\alpha_0, \beta_1, \beta_2, \gamma)$.

Note that under assumptions in this subsection, the time-variant variables are likely to include the endogenous outcome variable of connections. I am suggesting a modification of the HT approach with the appropriate use of instrumental variables to identify the endogenous peer effect, which are the exogenous characteristics of friends of friends, as suggested by Bramoullé et al. (2009). The estimation procedure is as follows:

1. First, one needs to estimate the model with fixed effects to get the consistent estimators of time-variant variables' coefficients. However, time-variant variables include endogenous outcomes of the friends. In order to achieve consistent estimation in the first step, I propose using the IV approach with the following vector of instruments $\{t_i, Z_i^j, \sum_{l \neq j} G_{jl} \sum_{k \neq l} G_{lk} X_k\}$, and with fixed effects. Then the vector $\hat{\beta}_{FE}$ consistently estimates the coefficients of the time-variant variables.
2. Using the estimator of the first step, calculate the residuals as follows:

$$\hat{d}_j = \bar{P}^j - \hat{\beta}_{FE} \bar{Z}^j = \alpha X_j + \nu_j + \bar{\epsilon}^j \tag{3}$$

3. Now, I estimate 3 with a 2SLS approach using the standard vector of instruments in the

Hausman and Taylor (1981) approach $[Z_{i1}^j, X_{j1}]$.

4. Using the residual variance σ^{*2} from the previous step and estimator of σ_ϵ^2 from the first step, calculate $\sigma_\nu^2 = \sigma^{*2} - \sigma_\epsilon^2/\bar{T}$, where \bar{T} is a harmonic mean of T_j 's. Then compute the weighting coefficients for GLS as:

$$\theta_j = 1 - \left(\frac{\sigma_\epsilon^2}{\sigma_\epsilon^2 + T_j \sigma_\nu^2} \right)^{0.5}$$

5. Finally, the following transformations are made: $P_i^{j*} = P_i^j - \theta_j \bar{P}^j$, $Z_i^{j*} = Z_i^j - \theta_j \bar{Z}^j$, $X_{j*} = X_j - \theta_j \bar{X}$. Then I regress P_i^{j*} on Z_i^{j*}, X_{j*} , using a 2SLS approach with the vector of instruments $[Z_i^j - \bar{Z}^j, Z_{i1}^j, X_{j1}, \sum_{l \neq j} G_{jl} \sum_{k \neq l} G_{lk} X_k]$.

The proposed approach provides consistent estimators of endogenous peer effects, as well as of all additional covariates, including time-constant determinants of connections. I do not prove the consistency of the resulting estimators in this paper, but the result follows from a straightforward application of the proofs in Hausman and Taylor (1981) and Lee (2003).

3 Data description

The data in this paper consists of several parts: the data on the artists' connections, the data on the artists' characteristics, and the collection of the prices for the artists' work sold at the auctions at Sotheby's since 2000.

The network data is taken from the diagram prepared by the group of researchers for the exhibition "Inventing Abstraction, 1910-1925" at the Museum of Modern Art, New York, in December 2012-April 2013.⁹

Insert Figure 1 here

This diagram represents documented relationships among the artists, who played significant roles in the development of the new art language.¹⁰ Appendix C lists all the artists in the

⁹A detailed interactive network can be found online at the MOMA website.

¹⁰Description of the links on the exhibition website: "Vectors connect individuals whose acquaintance with one another during these years could be documented".

sample. I manually transformed this diagram into adjacency matrix, with $1/n_i$ at the ij cell, if the artist i is connected to the artist j , and n_i is the total number of connections of the artist i . Moreover, I collected additional information about art groups at the time, such as Der Blaue Reiter (The Blue Rider), De Stijl, and others, to be able to distinguish between the links of different intensity. Table 1 shows the number of artists affiliated with the groups and the number of artists worked in a particular country. Some of the artists worked in more than one country, and I included each of them if it was mentioned either on the official website of the MOMA exhibition or in "A Dictionary of Twentieth-Century Art," Chilvers (2003).

Insert Table 1 here

The existing network determined the sample of the artists used for the analysis. However, the final sample does not include several of the names from the initial list. The excluded personalities are people essential for establishing abstract movement, but not creative artists, for example, Guillaume Apollinaire, a writer and an art critic, or Claude Debussy, a composer. Therefore, the auctioned items related to these people are mostly representing some personal items, books, manifests, or similar. There are 83 artists in the initial list; I excluded 11 of them.

The set of artists' characteristics comes from different biographical sources. It includes years of life and years active, the country of birth and the country, where the artist was the most active, primary artistic medium (such as paintings, sculpture, photography), belonging to a specific group.

The dataset on prices was collected for this paper from the Sotheby's auction house website. I obtained all lots for each artist in the sample, auctioned at Sotheby's, sold and not sold. The data were available for the auctions that took place from the year 2000; earlier lots are not available online. For each lot, the following information is mostly available: a presale price estimates of the work, hammer price of sold lots, date of creation, type of work, size, provenance, history of exhibitions. Some descriptive information, however, is missing for many observations. There are also some additional catalog notes, including conditions, authenticity information, exhibition history, and some others. However, it is challenging to use all this information in the analysis, as there is no obvious way to re-translate these descriptions into quantitative variables.

Several data limitations should be pointed out. **First of all**, I am analyzing only the data from one auction house. Potentially, it can cause some distortion of the results. For example, looking at one auction house does not allow controlling for the availability of the works of a particular artist on the market. However, each auction house tends to exhibit similar patterns and to be a good proxy for the art market in general. Adding data on the sales in other auction houses is computationally demanding; however, I believe that my results have strong external validity and can be extrapolated on the other auction houses. Discussions in Ashenfelter (1989) and Ashenfelter and Graddy (2006) confirm this argument.

Secondly, the types of works included in the sample differ a lot: oil paintings, watercolors, lithographs, different types of sculptures, photographs. I control for each type of work with the set of dummy variables. However, the description is missing for almost 30% of lots; hence, not I cannot attribute them to a particular medium. Since most of the artists in the sample used different media in their work, I cannot univocally determine the medium based on the works' author. I am treating these lots as not attributed. However, buyers at the auction were aware of the type of work on sale. This missing information can cause a bias in estimation. However, most of the missing information corresponds to the sales in the years 2000-2003. I will compare the results of the full sample with the results from the restricted sample of the sales after 2003 to address this issue.

The prices are reported in the local currency of the auction, which requires price adjustment not only for the inflation but also for the exchange rates. Most of the prices are in USD (43,3% of the lots), in GBP (42,3%), or EUR (13,6%). Several lots are in Swiss Franks, Australian, and Hong Kong Dollars. I use daily historical exchange rates to convert all of the prices into US Dollars. I then adjust prices by CPI of USD, taking the beginning of the sample, January of 2000 as a baseline of 1. In both nominal and real terms, the most expensive transaction in my sample is "Garçon á la Pipe" by Pablo Picasso sold at Sotheby's New York in May 2004 for 104 million USD.

The total sample consists of about 12000 auctioned lots; the sample of sold lots is smaller and consists of 9857 lots.

Description of the sales

Insert Table 2 here

Table 2 shows the differences in prices for different media. The oil paintings are expectantly the most expensive, and the photographs have the lowest prices. Drawings form the most prominent group, with almost half of all the sales. Not attributed works amount to more than 40% of all sold lots, which is more than in a full sample. The distribution of prices of unattributed works suggests that most of them are likely to be either drawings or photographs. So not attributed works will rarely belong to the categories with higher prices. Hence, I can still analyze the full sample, controlling for oil paintings, watercolors, and sculptures only.

Insert Figure 2 here

Figure 2 demonstrates the distribution of the auctioned and sold lots of the observed period. The number of lots in abstract art varies during the observed period, with the most prominent decrease around the 2008 crisis. However, the percentage of the lots sold in the first years after the crisis is among the highest (82% in 2009 and 96% in 2010), suggesting the cautious behavior of sellers, choosing potentially better selling works, and cautious behavior of buyers willing to protect their money in more stable investment during the crisis period. In comparison to the other financial instruments, usually unstable and volatile in the crisis years, art can be seen as a more reliable way to invest. In recent years, the level of sales recovered to the pre-crisis year. Note that the data was collected in the middle of 2015, determining the low amount of sales this year.

Insert Table 3 here

Table 3 provides more details on the dynamics of the prices and sales of abstract art over the discussed period. The first four years of the observations show the relatively low total value of sales, as well as the average price of the lots. After that, the sales increased significantly with a slight decline around after 2008. Demand for abstract art auctioned during that period is not homogeneous; therefore, year dummies should be included in the analysis.

Data also includes minimal and maximal presale price estimates of each lot, set by the auction house before the beginning of the auction. For the sold lots, these prices are quite an accurate estimate of the hammer price, with a correlation of around 95%. However, these prices do not help to predict whether the lot will achieve the reserve price set by auction and seller together. I am using both hammer prices and presale estimates as an outcome variable to estimate the endogenous peer effect on price formation. However, the two have a different meaning. The former represents the market response, whereas the latter can be viewed more as an objective valuation of works. I will discuss both possibilities.

Network characteristics

The network, as was already mentioned, consists of 83 artists. Table 4 gives some of the characteristics of the network.

Insert Table 4 here

The network has quite a high number of average connections, more than 12. It is highly likely that not all connections affect the outcome variables. However, it is almost impossible to restrict connections further. One option is to put a higher weight on those, working in the same country or affiliated with the same group. Most of the links connect artists who lived or worked in the same country for a significant amount of time. The share of the links in the same group is, however, rather small. Not all artists belonged to official groups, even though they belonged to a particular movement, whereas some of the artists had affiliations to several groups. Therefore, the group affiliation might be useful as a control variable of artists' characteristics, but not as an indicator of the tightness of connections.

The transitivity of the network is 46%, which means there are enough intransitive triads and it is sufficient for identifying assumption to hold.

4 Results

I am considering several scenarios in the analysis. Recall that there are no hammer prices for some works, as not all lots were sold. Unsold lots do not necessarily indicate the quality or

importance of the work, but more likely to be a characteristic of the market situation or the reservation price the seller puts on the work. First, I am analyzing the sample, excluding these observations. The results characterize the price formation determinants but do not describe the overall market trends. Therefore, I am also looking at the full sample, using the presale price estimates, established by the auction house, instead of the hammer prices, and representing a possibly more objective value of the work. Moreover, I am using a similar approach to estimate the probability of the work to be sold at the auction.

4.1 Subsample of sold lots

As was described in Section 2, I am relying on the modified version of Hausman-Taylor Type models. Table 5 shows the estimation results for the subsample of sold lots. Note that some of the exogenous characteristics of friends have a slightly different meaning than the works' or sales' own exogenous characteristics. The characteristics related to the works or the auction are not artist-specific; therefore, the average is taken as links' characteristics, which in many cases has the meaning of shares. For example, averaging the dummy variable of oil paintings as a type of work gives the share of oil paintings among the works of the artist's connection. Since most of the variables are either dummy variables or shares, the logarithm of prices is more appropriate than raw prices. To avoid the problem with the logarithm of zero, I take a logarithm of $Price + 1$.

Insert Table 5 here

The model detects a highly significant positive effect of the average prices of friends' works on the price of one's own work. The magnitude is, however, not very high. For example, the increase in friends' average price by 10% will increase the work's price by around 2%. Works' and sales' characteristics, as well as some of the links' characteristics, have a greater magnitude of the effects. Note the positive effect of one's own work sale in all the crisis and post-crisis years in the model. It probably suggests that once the work got on the auction in these years, it is more likely to be less risky since the share of sold lots in these years is very high; hence,

the prices are slightly higher.

As was discussed in Section 3, most of the missing information in the sample is for the sales in the period 2000-2003. I am, therefore, restricting the sample to the sales after 2003 to check whether the results remain stable in the subsample with fuller information. Table 6 presents the estimation results.

Insert Table 6 here

It can be observed that most of the results hold for the restricted sample. First of all, the positive effect of the average price of works of friends exists and is more prominent than in the sample of all sold lots. The 10% increase in the average price of connections' sold works will cause almost a 5% increase in the price of work.

In general, the restriction of the sample is not changing the results of the estimation significantly. I will discuss the determinants of the price other than the average price of works of connected artists later in the section.

4.2 Full sample

I am using two approaches for the analysis of the full sample. First, I am using presale estimates as the outcome variable. Then I am looking at the probability of works to be sold.

4.2.1 Presale Price Estimates

The estimation with new outcome variables: maximal and minimal auctioneer's presale price estimates of the lot delivers similar results to the ones obtained for the hammer prices of sold lots.

Insert Table 7 here

Results, presented in Table 8, suggest that the higher average price expected by the auctioneer for the artists' connections is, the higher the expected price of the artist's own work, similar to the hammer price results obtained previously. Once the auction house expects the high demand, and hence, high price for the works of artist's connections, it also expects similar demand trends

for the artist's own works. This assumption of the auctioneers confirms by the hammer prices of connected artists moving in one direction. The increased interest in one artist leads, indeed, to raising interest in the artist's connections, setting higher prices for all of them.

The other coefficients exhibit quite similar behavior to ones in Section 4.1.

4.2.2 Probability of successful sale

Next, I am looking at the linear probability model to estimate the effect of the share of successful connections' sales on the probability of the work to be sold. Table 8 summarizes the results for such estimation.

Insert Table 8 here

Unlike for the prices, the probability of selling the work is independent of the share of sold works of the artist's connections. This additional evidence suggests that the willingness of the buyers to pay and the expected by auctioneer payments are moving in the same direction for connected artists, but the quantity demanded is not. On the one hand, connected artists might be viewed as substitutes, but it is not reflected in the probabilities of works to be sold. For the substitute goods, the probability of selling the work should have decreased with the increase in sales in the network. On the other hand, the comovement of prices suggests the existence of similar demand behavior of buyers of the connected artists. It would then increase not only the prices of works but also the probability of selling the work when the share of sold works of connected artists is increasing. The resulting insignificance of the endogenous effect is most likely reflecting the existence of both the above-mentioned effects.

4.3 Sample without Picasso

Pablo Picasso is probably the most famous and established artist among the artists studied in this paper. Clearly, being connected to Picasso might bring additional attention to the lesser-known artists. However, it is not very likely that Picasso's prices depend on the artist from his network. Therefore, I am repeating the analysis for the sample that does not include Picasso's works in the dependent variable, treating the Picasso-peers links as directed links. Picasso's

prices only play a role as a factor, influencing the prices of his network.

Note that the peers were still influencing Picasso in the past, potentially affecting his style and quality, therefore. Hence, the analysis of the full sample of artists, as discussed in Sections 4.1 and 4.2, is still crucial to fully explore peer effects on the art market.

Insert Table 9 here

Peer effects on the prices of works of art become even more prominent in such a setting. Once only the prices for the works of lesser-known artists depend on the average prices of connections, the magnitude of the peer effect becomes 2-3 times higher than in the full sample of artists. A 10% increase in prices of connections leads to a 4.4 - 6.1 % change in the price of an artist's work.

I repeat the analysis for the presale estimates.

Insert Table 10 here

Similarly, the endogenous peer effect is more prominent in a case when the prices of Picasso's works are considered not to be dependent on the prices of works of connected artists. A 10% increase in prices of connections leads to a 5.6 - 6 % change in the price of an artist's work.

I also look at the probability of selling the works of all artists except Picasso (Table 11) and find similar results as for the full sample.

Insert Table 11 here

The other determinants more or less follow the same trends as previous models. I am discussing some of the other detected effects in the next subsection.

4.4 General observations about other determinants

- All models could capture the differences in the prices for different media: oil paintings have the maximum premium. Moreover, the higher share of oil paintings among connections also results in the higher own price.

- The hammer price and the presale estimates are higher in the 2008 crisis year, and two years after it when the art market still did not recover from the crisis. 2009 and 2010 also have a positive effect on the price of the estimated prices, reflecting the caution behavior of the sellers in these years. However, these estimates become insignificant once Picasso's works are not part of the dependent variable. It suggests that the big share of 2008-2010 positive effects was driven by Picasso, whose works have high chances of a successful sale, thus confirming the "safe investment" argument.
- Sotheby's London, New York, and Paris are the central auction locations and attract more buyers; hence, the more valuable lots are likely to be auctioned there. The price of sold lots is, therefore, likely to be higher for sales in one of the three locations.
- Russian art is trendy in recent decades¹¹, with every auction house having their own Russian Art Auction a couple of times per year, and "works by Russian Avant-Garde are among the most sought-after on the international market" (Hewitt, 2014). The result of my analysis suggests that the prices of Russian artists are, on average, lower, but being connected to more Russian artists increase the price. The high demand for Russian art does not result in higher prices in comparison to the other nationalities, and hence more Russian artists in the artist's network will, on average, increase the artist's own price, as she or he is more likely not to be Russian. It is reasonable to assume that the affordability and availability of Russian abstract art is one of the determinants of high demand and lower prices.
- Similar to the existing literature, I find the positive effect of the signed work on the price. The signature provides additional authenticity confirmations. Interestingly though, the share of connections' signed works drives the price downwards. Even if the artists were friends or collaborators in real life, the market often views connected artists as competitors. Hence, the more signed works there are among the works of connected artists, the tighter the competition to attract the buyer. The buyer has more chances to switch to similar authentic work once more pieces are signed.

¹¹See, for example, the report on London Russian Weeks Auction sales

5 Conclusion

This paper adopts the peer effect logic to analyze the price formation on the art market. I explore the auction results for abstract art from Sotheby's auction house for 2000-the first half of 2015 and the connections between the abstract artists as reported for the MOMA exhibition "Inventing abstraction." The artists' connections serve as an essential determinant of the artists' style, works' quality, and of the resulting price of their works. The effect of the peers can be channeled by collaborations, joint exhibitions, resulting in similar style and quality of works, or the particular reputation of one of the artist's connections.

I am proposing the model, combining Hausman and Taylor (1981) approach for the panel data with the Manski(1993) peer effect model and Bramoulle et al. (2009) instrumental variables strategy.

I am analyzing both the sample of only sold lots and the full sample using presale estimates. Both settings exhibit the positive peer effect of connections' average prices. The market is, therefore, quite responsive to the artist's connections performance and reputations, and the buyers are willing to pay more if the artist has a connection to the "better" artist. The auctioneers' behavior towards price formation is similar. The auction house views the connected artists similarly, expecting the demand to move in the same direction and setting the presale estimates for the connected artists similarly.

The results are even stronger when the connections to the most famous artist in the sample, Pablo Picasso, are treated as directed. I make the links between Picasso and others to be relevant only for one direction: Picasso is influencing his peers, whereas his peers are not influencing him. Such an assumption can hold when talking about the prices, as Picasso has an established market reputation, and it doesn't matter for the buyers, whether he was connected to Natalia Goncharova or not.¹² However, peers could have influenced Picasso during their work interactions. Therefore, both analyses of the full sample of artists and the sample without Picasso in the dependent variable are relevant for the discussion of the peer effect on art prices.

The probability of sales, unlike the prices, is not influenced by peers' performance. The buyers

¹²He actually was.

are willing to purchase the work regardless of peers' quality and reputation; however, once the peers are valued higher, they are willing to pay more for the work.

The paper is the first looking at the effect of artists' connections on art prices and shows clear evidence of the importance of them for the price formation and market outcomes at the art market.

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Tables and Figures

Figure 1: Network of abstract artists

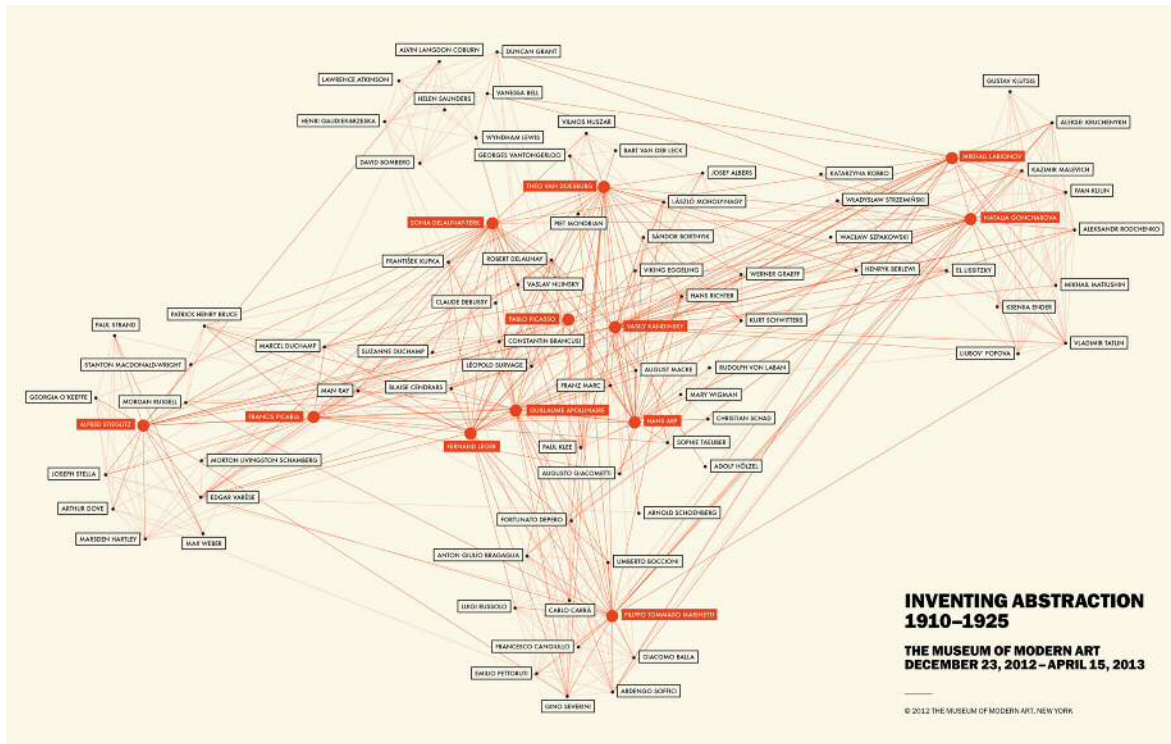


Figure 2: Distribution of sales over the years

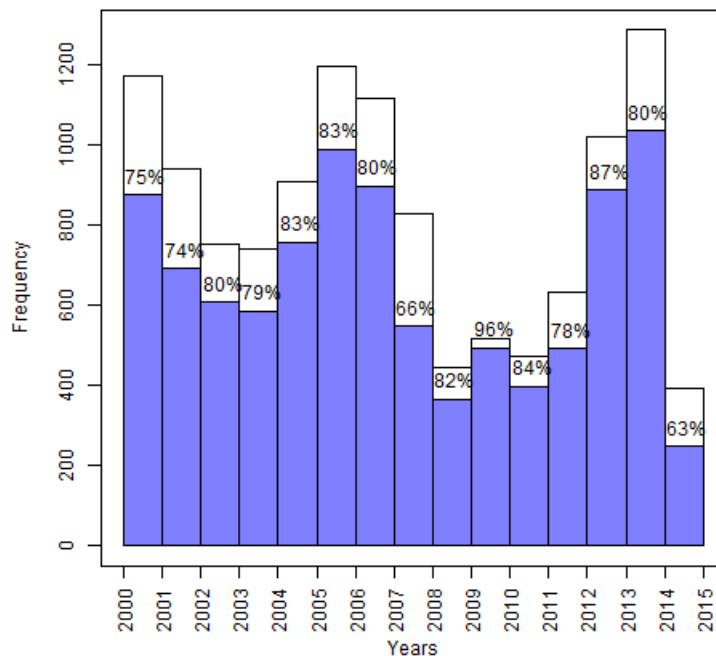


Table 1: Countries and art groups allocation

Countries	Art groups
France (30), USA (20), Germany (18), Russia (18), Italy (15), Switzerland (9), England (8), Poland (5), Spain (4), The Netherlands (4), Hungary (3), Romania (2)	Der Blaue Reiter (7), Puteaux Group (6), De Stijl (4), Union of Youth (4), Donkey's Tail (3), Supremus (3), 291 Gallery (3), Jack of Diamonds (2), Societe Anonyme (2), Bloomsbury group (2)

Table 2: Average prices

	Median	Mean	Standard deviation	# of observations
All sold	20 570	384 000	2 701 223	9857
Sold after 2003	25 550	463 620	3 041 266	7686
Oil paintings	195 800	1 919 583	6 727 491	1637
Watercolors	86 040	396 300	1 238 530	351
Drawings	27 270	179 300	824 219	4166
Sculptures	43 810	541 300	3 144 502	225
Photographs	21 900	91 480	281 245	389
Not attributed	11 000	83 191	545 287	4103

Table 3: Prices over time (in 2000 prices)

	Average	Sum	Maximum	Sold lots	Total lots
2000	181 916.44	57 121 761	10 064 195	314	421
2001	55 504.83	31 138 212	3 016 847	561	749
2002	97 233.27	67 090 953	5 634 195	690	938
2003	109 052.58	66 085 862	10 659 028	606	753
2004	497 636.84	291 117 551	116 695 313	585	740
2005	179 560.06	135 747 408	21 430 066	756	906
2006	300 164.66	296 562 685	114 225 355	988	1195
2007	430 133.71	385 399 804	36 309 073	896	1114
2008	704 978.33	385 623 149	50 360 523	547	826
2009	424 994.75	155 548 077	14 712 432	366	446
2010	374 195.48	184 478 373	12 049 552	493	515
2011	803 838.78	319 123 997	53 231 183	397	471
2012	700 985.01	343 482 657	56 631 229	490	632
2013	549 474.89	486 834 749	61 579 591	886	1018
2014	464 436.80	480 227 654	44 430 080	1034	1285
2015	400 162.95	99 240 411	18 688 892	248	392

Table 4: Network characteristics

Network statistics	Definition	Value
Average indegree	Average number of ingoing ties	12.84 (6.44)
Minimum indegree	Minimal number of ties	2
Maximum indegree	Maximal number of ties	28
Density	Proportion of existing ties in the network	0.1566
Transitivity	The ratio of the triangles and the connected triples in the graph	0.4629
Links from the same country		0.8435
Links inside the group		0.0999
Links inside the group, if belonged to a group		0.2807

Table 5: Results for sold lots

	HT coefficient	St.errors
Intercept	5.8431***	(0.4502)
Av.log price of friends' works	0.2100***	(0.0396)
<i>Work's characteristics</i>		
Oil painting	1.8821***	(0.0564)
Watercolor	0.8831***	(0.0951)
Drawings	0.0712***	(0.0211)
Sculpture	0.4373***	(0.1018)
Signed	0.0905*	(0.0409)
<i>Sale's characteristics</i>		
2008	0.5067***	(0.1099)
2009	0.6001***	(0.1445)
2010	0.4253***	(0.1054)
London	1.1734***	(0.0611)
New York	1.3110***	(0.0602)
Paris	1.2232***	(0.0836)
<i>Artist's characteristics</i>		
Germany	0.8917***	(0.1953)
USA	0.4346***	(0.1222)
Russia	-0.5319***	(0.1494)
France	0.1702	(0.1251)
<i>Link's characteristics</i>		
Share of oil paintings	4.4817***	(0.7365)
Share of watercolors	-13.7987***	(1.7828)
Share of drawings	3.0995***	(0.4698)
Share of sculptures	19.3141***	(2.8638)
Share of signed	-4.2331***	(1.0076)
Share of 2008	-2.8661	(2.3180)
Share of 2009	7.9435*	(3.4122)
Share of 2010	2.0724	(2.1864)
Share of London	-2.0054***	(0.3252)
Share of New York	-1.6443***	(0.4181)
Share of New York	-1.8742*	(0.8974)
Germany	-1.2918**	(0.4090)
USA	1.3554***	(0.3210)
Russia	1.5394***	(0.3464)
France	0.4408	(0.2897)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05

Table 6: Results for sold lots, after 2003

	HT coefficient	St.errors
Constant	0.7785	(0.8236)
Av.log price of friends' works	0.4748***	(0.0629)
<i>Work's characteristics</i>		
Oil painting	2.0393***	(0.0592)
Watercolor	0.9451***	(0.0971)
Drawings	0.0942***	(0.0220)
Sculpture	0.5057***	(0.1048)
Signed	0.1344**	(0.0425)
<i>Sale's characteristics</i>		
2008	0.4485***	(0.1133)
2009	0.6417***	(0.1479)
2010	0.4513***	(0.1098)
London	1.2308***	(0.0736)
New York	1.2279***	(0.0734)
Paris	1.3054***	(0.0920)
<i>Artist's characteristics</i>		
Germany	0.5054*	(0.2356)
USA	-0.0653	(0.1452)
Russia	-0.8252***	(0.1846)
France	0.4353**	(0.1444)
<i>Link's characteristics</i>		
Share of oil paintings	3.8206***	(0.8498)
Share of watercolors	-25.5104***	(2.1668)
Share of drawings	4.6402***	(0.5863)
Share of sculptures	31.6601***	(3.4135)
Share of signed	-4.2900***	(1.0503)
Share of 2008	-4.8166*	(2.4015)
Share of 2009	5.5946	(3.5738)
Share of 2010	3.7339	(2.3060)
Share of London	2.7894***	(0.7378)
Share of New York	0.0581	(0.5187)
Share of Paris	-2.7023*	(1.0609)
Germany	-1.6585**	(0.5258)
USA	3.1815***	(0.4670)
Russia	2.4603***	(0.4056)
France	-0.7833 [•]	(0.4134)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05, [•] - p-value < 0.1

Table 7: Results for the full sample, max and min EP

	HT, Max	St.errors	HT, Min	St.errors
Constant	6.0498***	(0.5291)	5.5607***	(0.5127)
Av.log price of friends' works	0.2582***	(0.0589)	0.2824***	(0.0592)
<i>Work's characteristics</i>				
Oil painting	1.9814***	(0.0482)	1.9850***	(0.0483)
Watercolor	0.7853***	(0.0793)	0.7773***	(0.0794)
Drawings	0.1147***	(0.0181)	0.1197***	(0.0181)
Sculpture	0.3649***	(0.0889)	0.3701***	(0.0891)
Signed	-0.0027	(0.0352)	0.0024	(0.0352)
<i>Sale's characteristics</i>				
2008	0.4159***	(0.0917)	0.4128***	(0.0919)
2009	0.3286**	(0.1228)	0.3394**	(0.1230)
2010	0.3367***	(0.0956)	0.3394***	(0.0958)
London	1.0497***	(0.0520)	1.0589***	(0.0521)
New York	1.3784***	(0.0514)	1.3771***	(0.0514)
Paris	1.0408***	(0.0728)	1.0752***	(0.0729)
<i>Artist's characteristics</i>				
Germany	0.8262***	(0.1633)	0.8128***	(0.1638)
USA	0.0364	(0.1032)	0.0343	(0.1036)
Russia	-0.2953*	(0.1184)	-0.2973*	(0.1188)
France	-0.0302	(0.1039)	-0.0378	(0.1043)
<i>Link's characteristics</i>				
Share of oil paintings	3.8181***	(0.6082)	3.7477***	(0.6090)
Share of watercolors	-8.6305***	(1.4906)	-8.3245***	(1.4927)
Share of drawings	2.7959***	(0.4001)	2.7872***	(0.4008)
Share of sculptures	18.9193***	(2.4763)	19.0783***	(2.4806)
Share of signed	-5.2945***	(0.8565)	-5.3716***	(0.8569)
Share of 2008	2.0565	(1.8858)	1.9166	(1.8880)
Share of 2009	4.2149	(2.9067)	3.7798	(2.9115)
Share of 2010	-0.4010	(1.9024)	-0.3303	(1.9047)
Share of London	-2.1043***	(0.2902)	-2.2078***	(0.2910)
Share of New York	-0.9220*	(0.4685)	-1.0074*	(0.4684)
Share of Paris	-0.1922	(0.7501)	-0.3167	(0.7512)
Germany	-1.2763***	(0.3550)	-1.2084***	(0.3562)
USA	0.4926•	(0.2791)	0.4820•	(0.2797)
Russia	0.2748	(0.2677)	0.3010	(0.2683)
France	0.3970	(0.2437)	0.4625•	(0.2446)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05, • - p-value < 0.1

Table 8: Probability of the lot to be sold

	HT coefficient	St.errors
Constant	0.7068***	(0.0616)
Share of friends' sold lots	-0.1132	(0.1954)
<i>Work's characteristics</i>		
Oil painting	-0.0262*	(0.0125)
Watercolor	-0.0169	(0.0202)
Drawings	-0.0203***	(0.0046)
Sculpture	0.0028	(0.0227)
Signed	0.0544***	(0.0090)
<i>Sale's characteristics</i>		
2008	-0.0743**	(0.0231)
2009	0.1026***	(0.0311)
2010	0.1561***	(0.0242)
London	0.0171	(0.0133)
New York	-0.0123	(0.0131)
Paris	0.0667***	(0.0184)
<i>Artist's characteristics</i>		
Germany	0.0930*	(0.0383)
USA	0.0396	(0.0247)
Russia	-0.0949***	(0.0273)
France	0.0368	(0.0245)
<i>Link's characteristics</i>		
Share of oil paintings	0.5299**	(0.1661)
Share of watercolors	-1.0326**	(0.3779)
Share of drawings	0.1310	(0.1078)
Share of sculptures	0.5539	(0.6039)
Share of signed	-0.1355	(0.2121)
Share of 2008	-2.2870***	(0.4808)
Share of 2009	2.4864***	(0.7361)
Share of 2010	0.1707	(0.4761)
Share of London	0.1982	(0.1370)
Share of New York	-0.0133	(0.1441)
Share of Paris	-0.2351	(0.2116)
Germany	-0.2189**	(0.0843)
USA	0.2395***	(0.0605)
Russia	0.1925**	(0.0696)
France	-0.1078•	(0.0572)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05, • - p-value < 0.1

Table 9: Results for the sample without Picasso on the LHS

	All sold	St.errors	Sold after 2003	St.errors
Constant	3.8993***	(0.5719)	-0.4896	(0.9530)
Av.log price of friends' works	0.4597***	(0.0517)	0.6231***	(0.0744)
<i>Work's characteristics</i>				
Oil painting	1.0888***	(0.0793)	1.1756***	(0.0824)
Watercolor	0.8341***	(0.1138)	0.7206***	(0.1147)
Drawings	-0.2806***	(0.0347)	-0.2396***	(0.0359)
Sculpture	-0.0498	(0.1353)	-0.0435	(0.1373)
Signed	0.3694***	(0.0713)	0.3752***	(0.0733)
<i>Sale's characteristics</i>				
2008	0.1245	(0.1582)	0.1468	(0.1555)
2009	-0.1371	(0.2076)	-0.0069	(0.2077)
2010	0.0149	(0.1619)	0.0171	(0.1646)
London	1.3951***	(0.1072)	1.5571***	(0.1337)
New York	1.5996***	(0.1088)	1.5325***	(0.1340)
Paris	1.2554***	(0.1391)	1.4067***	(0.1564)
<i>Artist's characteristics</i>				
Germany	0.8059***	(0.2071)	0.1638	(0.2493)
USA	0.2239•	(0.1309)	-0.0893	(0.1517)
Russia	-0.7599***	(0.1652)	-1.1390***	(0.2015)
France	0.1608	(0.1376)	0.3179*	(0.1589)
<i>Link's characteristics</i>				
Share of oil paintings	0.2319***	(1.0877)	4.4027***	(1.2365)
Share of watercolors	-18.3184***	(2.1469)	-27.8025***	(2.6108)
Share of drawings	2.9076***	(0.5231)	4.3018***	(0.6445)
Share of sculptures	17.3978***	(3.5088)	26.1035***	(4.0578)
Share of signed	-0.8457	(1.2234)	-3.4278**	(1.2584)
Share of 2008	6.3985*	(2.9183)	0.3624	(2.9536)
Share of 2009	-2.9528	(4.9374)	2.2323	(5.1334)
Share of 2010	-1.9334	(2.8878)	-4.7293	(3.0562)
Share of London	-1.6651***	(0.3790)	4.5658***	(0.8390)
Share of New York	-2.9554***	(0.4663)	0.3661	(0.5765)
Share of Paris	1.1411	(1.1435)	4.3993**	(1.4047)
Germany	-1.8619***	(0.4344)	-2.0329***	(0.5552)
USA	2.3924***	(0.3662)	3.2146***	(0.5130)
Russia	1.2149**	(0.3773)	2.2288***	(0.4432)
France	-0.5185	(0.3211)	-2.5326***	(0.4727)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05

Table 10: Results for the sample without Picasso on the LHS, estimated prices

	Max EP	St.errors	Min EP	St.errors
Constant	3.9348***	(0.6183)	3.4616***	(0.5999)
Av.log price of friends' works	0.5645***	(0.0698)	0.6000***	(0.0702)
<i>Work's characteristics</i>				
Oil painting	1.2587***	(0.0620)	1.2581***	(0.0622)
Watercolor	0.7065***	(0.0880)	0.7040***	(0.0882)
Drawings	-0.2172***	(0.0266)	-0.2195***	(0.0266)
Sculpture	-0.1063	(0.1065)	-0.1028	(0.1068)
Signed	0.2528***	(0.0551)	0.2571***	(0.0552)
<i>Sale's characteristics</i>				
2008	0.1022	(0.1224)	0.0912	(0.1229)
2009	-0.3977*	(0.1652)	-0.4033*	(0.1657)
2010	-0.2697*	(0.1358)	-0.2692*	(0.1362)
London	0.9875***	(0.0792)	0.9857***	(0.0795)
New York	1.3052***	(0.0805)	1.2858***	(0.0808)
Paris	0.8283***	(0.1055)	0.8326***	(0.1058)
<i>Artist's characteristics</i>				
Germany	0.7993***	(0.1649)	0.7809***	(0.1656)
USA	-0.0663	(0.1054)	-0.0622	(0.1060)
Russia	-0.4160***	(0.1230)	-0.4144***	(0.1235)
France	-0.0661	(0.1080)	-0.0778	(0.1084)
<i>Link's characteristics</i>				
Share of oil paintings	2.6990***	(0.7983)	2.5530**	(0.8010)
Share of watercolors	-10.1409***	(1.6409)	-9.9890***	(1.6460)
Share of drawings	3.2245***	(0.4131)	3.1785***	(0.4145)
Share of sculptures	19.4740***	(2.8037)	19.5856***	(4.0578)
Share of signed	-5.7133***	(0.9301)	-5.7064***	(0.9322)
Share of 2008	10.4938***	(2.2149)	10.5450***	(2.2218)
Share of 2009	1.3098	(3.8174)	1.2472	(3.8288)
Share of 2010	-7.9089***	(2.3057)	-8.1817***	(2.3117)
Share of London	-1.9985***	(0.3118)	-2.0970***	(0.3126)
Share of New York	-2.5320***	(0.4928)	-2.6480***	(0.4926)
Share of Paris	3.1677***	(0.8834)	3.1899***	(0.8859)
Germany	-1.5540***	(0.3570)	-1.4986***	(0.3587)
USA	1.2207***	(0.2923)	1.2325***	(0.2930)
Russia	-0.3242	(0.2860)	-0.3139	(0.2872)
France	-0.4941	(0.2549)	-0.4637	(0.2564)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05

Table 11: Probability of the lot to be sold, no Picasso

	HT coefficient	St.errors
Constant	0.5946***	(0.0733)
Share of friends' sold lots	0.3069	(0.2573)
<i>Work's characteristics</i>		
Oil painting	-0.0052	(0.0177)
Watercolor	-0.0017	(0.0250)
Drawings	-0.0066	(0.0076)
Sculpture	0.0205	(0.0302)
Signed	0.0522***	(0.0156)
<i>Sale's characteristics</i>		
2008	-0.0067	(0.0334)
2009	0.1249**	(0.0454)
2010	0.2206***	(0.0376)
London	0.0174	(0.0219)
New York	0.0247	(0.0222)
Paris	0.1166***	(0.0289)
<i>Artist's characteristics</i>		
Germany	0.0029	(0.0383)
USA	0.0575*	(0.0256)
Russia	-0.0432	(0.0291)
France	-0.0242	(0.0256)
<i>Link's characteristics</i>		
Share of oil paintings	-0.3767	(0.2720)
Share of watercolors	-1.2597**	(0.4482)
Share of drawings	-0.0650	(0.1218)
Share of sculptures	-0.8938	(0.7336)
Share of signed	0.5914*	(0.2629)
Share of 2008	-1.3261*	(0.621)
Share of 2009	1.3954	(1.0481)
Share of 2010	0.3024	(0.6252)
Share of London	-0.0599	(0.1782)
Share of New York	-0.2157	(0.1820)
Share of Paris	-0.2706	(0.2706)
Germany	-0.1202	(0.0854)
USA	0.1699**	(0.0647)
Russia	0.1175	(0.0732)
France	-0.0455	(0.0608)

*** - p-value < 0.001, ** - p-value < 0.01, * - p-value < 0.05, • - p-value < 0.1

Appendix. Additional figures

Table A.1: Artists in the sample

Name	Years	Main mode	Country born/active	Group belonging
Josef Albers	1888-1976	Paintings	Germany/ USA	-
Guillaume Apollinaire (not incl.)	1880-1918	Art critic	Poland, Italy/ France	-
Hans Arp	1886-1966	Sculpture	Germany, France	Der Blaue Reiter
Lawrence Atkinson	1873-1931	Paintings (graphical)	England	-
Giacomo Balla	1871-1958	Paintings	Italy	-
Vanessa Bell	1879-1961	Paintings	England	Bloomsbury group
Henryk Berlewi	1894-1967	Paintings	Poland/ Germany, France	-
Umberto Boccioni	1882-1916	Paintings (Sculpture)	Italy	-
David Bomberg	1890-1957	Paintings	England	Whitechapel Boys
Anton Giulio Bragaglia	1890-1960	Photography	Italy	-
Constantin Brancusi	1876-1957	Sculpture	Romania/ France	-
Patrick Henry Bruce	1881-1936	Paintings	USA	-
Francesco Cangiullo	1884-1977	Paintings	Italy	-
Carlo Carra	1881-1966	Paintings	Italy	-
Blaise Cendrars (not incl.)	1887-1961	Writer	Switzerland/ France	-
Alvin Langdon Coburn	1882-1966	Photography	USA	Linked Ring
Claude Debussy (not incl.)	1862-1918	Composer	France	-
Robert Delaunay	1885-1941	Paintings	France/ France	Der Blaue Reiter, Puteaux Group
Sonia Delaunay-Terk	1885-1979	Paintings	Ukraine/ France	-
Fortunato Depero	1892-1960	Paintings (Sculpture)	Italy/ Italy, USA	-
Theo van Doesburg	1883-1931	Paintings	The Netherlands	De Stijl
Arthur Dove	1880-1946	Paintings	USA	-

Marcel Duchamp	1887-1968	Paintings (Sculpture)	France/ USA	France, Anonyme, Puteaux Group
Suzanne Duchamp	1889-1963	Paintings	France	-
Viking Eggeling	1880-1925	Various media	Sweden/ Germany	Das Neue Leben, Novembergruppe
Kseniia Ender	1894-1955	Paintings	Russia	-
Henri Gaudier-Brzeska	1891-1915	Sculpture	France/ England	-
Augusto Giacometti	1877-1947	Paintings	Switzerland/ Switzerland, Italy	-
Natalia Goncharova	1881-1962	Paintings	Russia/ Russia, Ger-	Puteaux Group, Donkey's Tail
Duncan Grant	1885-1978	Paintings	England	Bloomsbury Group
Marsden Hartley	1877-1943	Paintings	USA/ USA, Ger-	-
Vilmos Huszar	1884-1960	Paintings	Hungary/ Netherlands	De Stijl
Vasily Kandinsky	1866-1944	Paintings	Russia/ Russia, Ger-	Der Blaue Reiter
Paul Klee	1879-1940	Paintings	Switzerland/ many, Switzerland	Der Blaue Reiter
Ivan Kliun	1873-1943	Sculpture	Russia	Union of Youth, Supremus
Gustav Klutsis	1895-1938	Photography	Latvia/ Latvia, Rus-	-
Katarzyna Kobro	1898-1951	Sculpture	Russia/ Poland	-
Aleksei Kruchenykh (not incl.)	1886-1968	Poet	Russia	-
Frantisek Kupka	1871-1957	Paintings (Graphics)	The Czech Republic/ France	Puteaux Group
Rudolph von Laban (not incl.)	1879-1958	Dancer	Hungary/ Switzerland	-

Mikhail Larionov	1881-1964	Paintings	Russia/ France	Russia, Donkey's Tail	Jack of Diamonds, Donkey's Tail
Fernand Leger	1881-1955	Paintings	France	Puteaux Group	Puteaux Group
Wyndham Lewis	1882-1957	Paintings	Canada/ England	-	-
El Lissitzky	1890-1941	Graphics (Photography)	Russia/ Russia, Ger- many	UNOVIS	UNOVIS
Stanton Macdonald-Wright	1890-1973	Paintings	USA	Synchromism	Synchromism
August Macke	1887-1914	Paintings	Germany	Der Blaue Reiter	Der Blaue Reiter
Kazimir Malevich	1878-1935	Paintings	Russia	Union of Youth, Supremus, UNOVIS, Donkey's Tail	Union of Youth, Supremus, UNOVIS, Donkey's Tail
Franz Marc	1880-1916	Paintings (Printmaker)	Germany	Der Blaue Reiter	Der Blaue Reiter
Filippo Tommaso Marinetti (not incl.)	1876-1944	Poet	Italy/ Italy, France	-	-
Mikhail Matiushin	1861-1934	Paintings	Russia	Union of Youth	Union of Youth
Laszlo Moholy-Nagy	1895-1946	Photography (various media)	Hungary/ England, USA	-	-
Piet Mondrian	1972-1944	Paintings	The Netherlands/ France, The Nether- lands	De Stijl	De Stijl
Vaslav Nijinsky (not incl.)	1889-1950	Dancer	Russia/ Russia, Rus- sia	-	-
Georgia O'Keeffe	1887-1986	Paintings	USA	291 Gallery	291 Gallery
Emilio Pettoruti	1892-1971	Paintings (Drawings)	Argentina/ Argentina	-	-
Francis Picabia	1879-1953	Paintings	France/ USA, Spain	Puteaux Group	Puteaux Group
Pablo Picasso	1881-1973	Paintings (Sculpture)	Spain/ Spain, France	-	-
Liubov Popova	1889-1924	Paintings	Russia/ France	Knave of Diamonds, Supremus	Knave of Diamonds, Supremus
Man Ray	1890-1976	Photography (Various media)	USA/ USA, France	-	-
Hans Richter	1888-1976	Paintings (Filmmaker)	Germany/ Switzerland, USA	Artistes Radicaux	Artistes Radicaux

Aleksandr Rodchenko	1891-1956	Photography (Sculpture)	Russia	October Circle
Morgan Russel	1886-1953	Paintings	USA/ USA, France	Synchronism
Luigi Russolo	1885-1947	Paintings (Composer)	Italy/ Italy, Argentina	-
Helen Saunders	1885-1963	Paintings	England	-
Christian Schad	1894-1982	Paintings	Germany/ Germany, Switzerland, Italy	-
Morton Livingston Schamberg	1881-1918	Paintings (Photography)	USA	Societe Anonyme
Arnold Schoenberg (not incl.)	1874-1951	Composer	Austria/ Germany	Der Blaue Reiter
Kurt Schwitters	1887-1948	Various media	Germany	-
Gino Severini	1883-1966	Paintings	Italy/ Italy, France	-
Ardengo Soffici	1879-1964	Paintings (Writer)	Italy/ Italy, France	-
Joseph Stella	1877-1946	Paintings	Italy/ USA, France, Italy	-
Alfred Stieglitz	1864-1946	Photography	USA	291 Gallery
Paul Strand	1890-1976	Photography	USA	291 Gallery
Wladyslaw Strzeminski	1893-1953	Paintings	Poland/ Russia	Blok
Leopold Survage	1879-1968	Paintings	Russia/ France	-
Waclaw Szpakowski	1883-1973	Graphics	Poland	-
Sophie Taeuber-Arp	1889-1943	Paintings (Graphics)	Switzerland	Cercle el Carre
Vladimir Tatlin	1885-1953	Paintings (Architecture)	Russia	Union of Youth
Tristan Tzara (not incl.)	1896-1963	Poet	Romania/ Romania, Switzerland, France	-
Georges Vantongerloo	1886-1965	Sculpture	Belgium/ The Netherlands, France	De Stijl
Edgar Varese (not incl.)	1883-1965	Composer	France/ Germany, USA	-
Max Weber	1881-1961	Paintings	Russia/ USA	-
Mary Wigman (not incl.)	1886-1973	Dancer	Germany/ Germany, Switzerland	-