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Ars longa, vita brevis: The death of the creator and the impact on exhibitions and auction markets

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Ars longa, vita brevis: The death of the creator and the impact on exhibitions and auction markets [*]

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Abstract

This paper studies the death effect on artists' exhibitions and commercial success in the secondary art market. Based on a random sample of 1'000 popular artists born after the turn of the 20th century, we construct a novel panel data set of their worldwide exhibition history and auction transactions. By applying a regression discontinuity and event study design, we find an overall negative effect of artist death on the number of exhibitions. However, this post mortem effect disappears in longer term. Roughly ten years after death, exhibitions are back to pre-death levels. Arguably, transaction cost and higher auction prices after death also temporarily increase the average cost of exhibiting artworks, e.g. higher market valuation raises (unobserved) insurance cost for exhibitions. Hedonic auction price models confirm this intuition and suggest a significant price premium posthumously. We find substantial heterogeneity in the treatment depending on the age and reputation of the artist at death. Overall findings explain important mechanisms for the post mortem value of artistic work and have important policy implications for the creative sectors and the design of legacy stewardship rules, including a possible justification for rights granted post mortem such as copyright.

Keywords: death-effect; empirical; artists; museums; exhibitions; event-study; regression discontinuity design; auctions; hedonic price models
JEL Codes: D44; Z11

1 Motivation

What are the determinants of post mortem value of visual artworks in exhibitions and auctions? How do secondary art markets complement each other, and what is the role of post mortem granted rights and other legacy stewardship rules in there? Anecdotal evidence suggests that museums, galleries and art fairs play an important role in building and preserv-

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ing economic value over time and beyond death.[1] In economic terms, while media coverage around death might help to temporarily promote artists, death is also a clear signal of scarcity to the market. Death puts a natural end to the production of new art and scarcity in supply increases the price of a work. The effect on post mortem prices has been well documented in the visual arts and the empirical auction literature (Agnello and Pierce, 1996; De Silva et al., 2022; Ursprung and Wiermann, 2011; Ursprung et al., 2021; Ekelund et al., 2000). For exhibitors participating in the secondary art market and preserving cultural heritage, the economic effect of death has not been studied yet. Moreover, by researching the post mortem value of artworks, our empirical results contribute to the understanding of the dynamic effects of post mortem public policies, such as copyright protection granted beyond the creator's lifetime.

Exhibitors are important price makers in auction markets. Given their prestige as institutions, they can help build an artist's reputation and visibility (Fraiberger et al., 2018). In this way, as knowledgeable curators of exhibitions, they provide important market signals of quality and trust to art markets. Thus, by curating artworks, exhibitors promote the artists and impact the general price formation in auction markets as they provide otherwise scarce information on provenance and economic value of artworks (Li et al., 2022).[2] At the same time, exhibitors can be price takers in auction markets as buying collectors and exhibitors of the art that requires insurance (Pommerehne and Feld, 1997).[3] Transaction costs that can accrue right after death,[4] and uncertainty over the quality of estate management may add to the above effects of higher postmortem market prices on exhibitions and acquisitions. From a theory standpoint, museums could favor exhibiting living artist over dead ones as exhibitions typically grow more costly and accessions less affordable after their death. But considering the promotional effects of death this is not a given. Whether death yields a positive or negative effect on exhibition activity is an open empirical question we address in this paper.

[1] The Rijksmuseum in the Netherlands curates an internationally recognized exhibition of paintings by the Dutch artist Johannes Vermeer in 2023. Although the artist died almost 350 years ago and created no more than 50 artworks throughout his life, all 450'000 tickets were successfully pre-sold (at a price of 22.5 Euro each Rijksmuseum).

[2] Typically, artworks on loan for an exhibition across prestigious venues will see an increase in their market value (anonymous museum expert).

[3] On the one hand, museums are rarely buyers as most of their new artworks accessions are donations by wealthy individuals and they often cannot compete with private bidders in auction markets. On the other hand, exhibiting costs are likely to increase with higher auction prices as artwork insurance cost (which account for the gros of total exhibition costs) will rise with with higher market valuation ((Amsellem, 2013) and as suggested by an anonymous museum expert).

[4] For example, artist heirs or foundations see property and rights ownership transferred to them and gain control; accordingly, exhibitors have to renegotiate or set up new artist contracts and uses.

By analyzing a dataset of 22 thousand exhibitions of a random sample of thousand popular artists, we find that visual artists have a commercial afterlife in exhibitions and that their artwork have substantial post mortem economic value. Compared to living artists, however, deceased artists see fewer exhibitions on average, and arguably their works are less well preserved and represented after death. This negative and causal effect is temporary, however. Specifically, using regression discontinuity and event study designs, we find a steady increase in exhibitions over the years before death and a sharp but short-lived decline after death. Results are robust to the inclusion of artists, decade of exhibition, country of exhibition fixed effects, and to clustered standard errors at the artist-level. We conduct placebo timing and outcome tests that confirm our main findings. In a next step, we study more than 30 thousand auction transactions with the same artists, where traceable, and find significant positive auction hammerprices post mortem by utilizing hedonic price models. This finding provides empirical support for the previously theorised increase in (unobserved) exhibition insurance costs. Finally, we provide for an in-depth study of age and reputation at death as underlying mechanisms explaining a large part of the variation in post mortem exhibition and auction histories.

Different to the positive posthumous auction price premium (as also evidenced in other auction literature, e.g., Ekelund et al. (2000)) we further estimate a significant but short-term negative effect of death on exhibitions. Given that provenance information is an important factor in the determination of auction prices (Li et al., 2022), the exhibition effect we observe can stifle information and the exchange of market signals (Etro and Stepanova, 2021), eventually deepening (or compensating) some of the post mortem effects found on auction markets. Put differently, with fewer exhibitions being installed after death, fewer signals on quality and trust are being sent to auction markets as provenance information is only gradually becoming available after death.[5] Accordingly, the causal death effect is likely to interplay with secondary market outcomes that we aim to disentangle in this study.

We provide supporting evidence on the post mortem value of artworks and a possible justification of post mortem policy interventions in certain jurisdictions (for example, post mortem

[5]Although another field of art, there is also a burgeoning number of new literature on Non-Fungible-Token Art on market signals and prices (Schaar and Kampakis, 2022; Nguyen, 2022; Whitaker, 2019).

term of protection in copyright and related right, post mortem right of publicity, post mortem tax requirements and estate regulation etc.). However, how much interventions impact transaction costs and the post mortem incentives to commercialize and preserve visual artworks is less well understood and an important area for future research.

Second, the research adds to on-going public debates on the longer-term preservation of cultural works and identifies post mortem curation determinants in the visual arts sector (Topaz et al., 2019; Kizhner et al., 2021), as we can show significantly in favor of younger artists upon death. We add to the literature on creativity and age (Galenson and Lenzu, 2016; Galenson, 2009, 2006; Graddy and Lieberman, 2018) showing that age is also an important factor for post mortem commercialization and distribution of creative works, not only for the supply of new works during life. Different to the average artist in our sample, younger dying artists see post mortem increases in exhibitions. For them, death serves as a credible signaling device for scarcity of supply in visual art markets including the limited oeuvre of artworks available for new and exclusive exhibitions. For the majority of old and more mature artists in our sample, death is expected and has little to no informational value in markets (Ursprung et al., 2021).

Third, as our study is one of the first to combine exhibition outcomes and auction market results, we contribute new empirical evidence on market complementarities that materialize after death. A relatively higher reputation at death has been discussed as a mechanism to sustain exhibition activity post mortem. This corroborates the general idea found in the literature that institutional career paths substantially matter for the success of visual artists in later career stages (Fraiberger et al., 2018). The evidence we provide points to the fact that the post mortem auction price premium is substantially driven by young dying artists. Interestingly, this holds true for both higher and lower reputation artists in terms of exhibiting at reputable museums at the time of death. Our study thus contributes nuanced insight to studies on post mortem auction prices (Agnello and Pierce, 1996; De Silva et al., 2022; Ursprung and Wiermann, 2011; Ursprung et al., 2021).

The remainder of the paper is structured as follows. Sections 2 and 3 summarize the literature and the data, section 4 outlines the empirical strategy, and section 5 presents main results. Section 6 discusses mechanisms and section 7 concludes.

2 Related Literature

The impact of post mortem effects on the art market has been, to the best of our knowledge, solely studied in the literature on auction prices (Agnello and Pierce, 1996; De Silva et al., 2022; Ursprung and Wiermann, 2011; Ursprung et al., 2021; Etro and Stepanova, 2021; Pénasse et al., 2021). Despite numerous studies on general price formation and hedonic price models in art auctions (Mei and Moses, 2001; Ashenfelter and Graddy, 2003, 2006, 2011; Beggs and Graddy, 2009), the death effect has received nevertheless little attention (Ursprung and Wiermann, 2011). Our research on exhibitions contributes to the existing literature on death effects pioneered by Ursprung and Wiermann (2011), and goes beyond the empirical study of auctions and pricing. We consider the total supply of an artist's works, including holdings of the artist, private collectors, galleries, and also works held and exhibited by museums. In anticipation of an artist's death (i.e. certainty over supply/ production), prices and demand will increase, as hypothesized by Ekelund et al. (2000) and based on the durable goods monopolist assumption by Coase (1972). We add an interesting dimension to this larger discussion by looking at the impact of museums and other exhibitors on price formation in auctions, as museums can be seen as important demanders in the art market.

Secondary art market studies have found heterogeneous death effects, which are mainly driven by other important determinants such as artist age at death. Ursprung and Wiermann (2011) used quantile regression models and standard hedonic art price regressions and found that the death effect is negative for artists who died young. If an artist dies before the 'peak of reputation' is reached, this may negatively impact post mortem art market prices. Ursprung et al. (2021) use a regression discontinuity design and differences-in-differences strategies to find heterogeneity in the death effect on art prices. The authors disentangle the determinants of death effects, age at death, and reputation, and find a negative relationship between young and middle-aged artists and no effect for artists who die at high age. Using a comprehensive repeated sales auction data set, Etro and Stepanova (2021) find a 26% higher hammer price of artworks by contemporary artists who died up to two years before the sale. Interestingly, the authors find that being displayed in a public exhibition increased resale prices of modern art about 15%.

Moreover, Ekelund et al. (2000) find a positive short-term death effect in the value of artworks of 21 Latin American artists who died between 1977 and 1996, but prices seem to decrease again in the mid-long term. The authors also find that artists share some characteristics of durable good monopolists, as initially discussed by Coase (1972). Maddison and Jul Pedersen (2008) provide further evidence for artists sharing generally these characteristics and suggest that the only "credible commitment" of an artist to not over-produce is to either "die or at least grow old". The authors find a positive death effect (for Danish painters and auctions) but decreasing in years following the death. Moreover, Galenson and Lenzu (2016) found an inverse U-shaped relationship between prices and age when artistic work is produced, using age-auction price profiles. In a recent study, Mei et al. (2022) estimate residual variance of art prices and find that it is positively related to the average price level achieved by artists and the inverse U-shaped age-price profile for all artists peaks around the age of 35.

Our research also relates to the growing stream of research looking at the supply of works falling into the public domain (Biasi and Moser, 2021; Heald, 2020, 2014, 2007; Reimers, 2019; Flynn et al., 2019; Li et al., 2018; Buccafusco and Heald, 2013). As most contemporary art collections are not yet in the public domain, the distribution and accessibility of artworks in exhibiting venues is subject to copyright law. We provide first-hand evidence on the persistence of artwork commercialization in museums once artists transition from pre- to post mortem protection periods, at a crucial point in time when the provisioning of incentives to create naturally comes to an end with the death of the artist. Our results can help inform and refine policies that grant post mortem copyright protection.

3 Data Collection

3.1 Exhibition data

The online host-service 'Artist-Info' is an independent art world data provider that facilitates the search of modern and contemporary art exhibitions from 1880 to the present, based on artists, venues, curators, or exhibition titles (Artist-Info, 2021).[6] The primary dataset is ob-

[6] According to their webpage, artist-info comprises information on up to 192,200 unique artists, 7,844 curators, 219,850 exhibitions in 12,524 venues spanning from 1880 to the present, situated in 1,533 cities across 163 countries Artist-Info (2021).

tained through web-scraping artist searches conducted in November 2022.

To implement our empirical strategy, we obtain a random sample of 1,000 artists born after 1900, ensuring they have known birth and death year information, and subsequently collect their exhibition histories in a panel data set.[7]. We set the birth year threshold at 1900 for two primary reasons: first, to ensure a reasonable pool of artists who could have deceased by 2022; second, to facilitate the comparison of artistic work from roughly the same era, namely, Modern Art. Lastly, after visually inspecting exhibition records, it appears that the data for this century of artistic work is the most comprehensive.

Table 1 presents the summary statistics at the artist exhibition year-level. An initial query of the random sample of 1,000 artists yielded historical data for 21,020 unique exhibitions. These exhibitions took place between 1916 and 2022, with an average exhibition year of 1986. The majority of artworks were displayed in venues located in Germany (36 percent), the United States (30 percent), Italy (7 percent), and France (6 percent). Solo exhibitions accounted for 27 percent of the total. On average, artists had between 1 and 60 exhibitions per year (mean 4.7 and median 3); the log-transformed variable displayed in the table ranges from 0 to 4.09. Most exhibitions in our panel feature male artists, with female artist exhibitions as low as 12 percent.[8] The most popular artists in terms of total exhibitions in our random sample include Andy Warhol (934 exhibitions), Roy Lichtenstein (476 exhibitions), Sigmar Polke (399 exhibitions), Louise Bourgeois (346 exhibitions), and Robert Motherwell (297 exhibitions), as shown in table 2.

Artists in the sample were born between 1900 and 1963, with an average birth year of 1923, and passed away between 1930 and 2022, with an average death year of 1998.[9] Figure 1 displays the distribution plots for our primary variable of interest, post mortem determinants.

[7] Regrettably, web-scraping the entire data was not possible. After contacting the data host, we received a list of artists with known birth and death years. Due to data access limitations and the inability to target the entire data, we employed a semi-automated web scraper, drawing a random sample of 1,000 artists (June 2022). It is worth noting that 4 artists were dropped from the final sample due to unclear or missing birth and death year information. Additionally, the relatively unrealistic age at death minimum of 12 resulted from two "Studio/conglomerate" of artists. Consequently, we excluded a total of $N = 115$ observations.

[8] It should be noted that the original data set did not disclose gender information. However, by leveraging previous work on patent data and name-gender-dictionaries (Martínez et al., 2021; Lax Martínez et al., 2016), we were able to match gender information for 79 percent of exhibitions.

[9] It should be noted that the summary statistics in table 1 are presented at the exhibition year-level, while average years of birth and death are calculated at the artist-level.

The left panel illustrates the distribution of years of death, while the right panel indicates age at death. At the artist-level, the average age at death is approximately 77 years. Interestingly for our study, about 31 percent of the exhibitions in our panel occur post mortem. We offer separate summary statistics for relevant pre- and post mortem variables in table 3.

In summary, we examine the exhibition histories of prominent artists born after 1900 and deceased between 1930-2022. The random sample of 1,000 artists features more than 20 thousand exhibitions in total. Within this sample, over 30 percent of exhibitions are run after death.

3.2 Auction Data

As a second source, we compile data on auction transactions from Artsy based on a non-fuzzy string match of artist names derived from the exhibition data. We match and collect all auction records of *paintings* of 317 artists, accounting for roughly one third of the total random sample.[10] The 33,043 auctions took place in years 1986 to 2023. Most paintings are auctioned at Christies, Sothebys and MeetingArt (Vercelli). The average (median) hammer price of successfully sold items is USD 62,151 (USD 14,527), with a standard deviation of USD 131,651. For each auctioned artwork, we collect hedonic characteristics, such as the artwork medium or top auction house assignment. Auctions took place up to 34 years before and 79 years after the death of an artist (with a mean auction 10 years after decease). A total of 76 percent of auctions were auctioned post mortem. The final data set is described in table 4.

To further illustrate results, Figure 2 displays the average auction hammer price (left panel) and total supply of auctions (right panel, sold or not) for a 20-year period around the death of artists. While the yearly average number of auctions noticeably increases posthumously, auction prices appear to experience only a moderate increase.

In Figure 3, we combine and visualize both data sources, exhibitions and auctions, for the

[10] There are several reasons why not all artists are represented in the auction sample. A string search of names can result in imperfect matches, particularly for artists with multiple middle names, artist pseudonyms, or misspellings. Additionally, more recently born artists may not have the same chances to enter the secondary market, and a certain level of reputation is typically required for successful auction sales. Finally, some artists may never enter the secondary market at all. Nevertheless, we re-run the main exhibition event study using the 317 artists from the auction matches only. Our results are robust to using this smaller sample, and continue to be significant and negative shortly after the death of the artists.

Table 1: Summary Statistics: Exhibitions

Variable	Obs	Mean	Std. Dev.	Min	Max
Birthyear	21,020	1923.833	13.82562	1900	1963
Deathyear	21,020	1998.466	14.69634	1930	2022
Age at death	21,020	74.63268	14.83023	22	106
Reputation at Death	21,020	1394.33	2203.77	0	11478
log (Reputation at death+1)	21,020	5.574331	2.679631	0	9.348274
Exhibition year	21,020	1986.251	21.39027	1916	2022
Female	16,557	.12158	.32681	0	1
Solo exhibition dummy	21,020	.2705994	.4442801	0	1
Exhibition Biennale	21,020	.0097	.0978	0	1
Postmortem dummy	21,020	.3106565	.4627734	0	1
Log(y n exhibitions)	21,020	1.065821	.9263888	0	4.094345
Exhibition years to/-from Death	21,020	-12.21465	23.42416	-79	88

Note: This table shows the summary statistics. Log(y n exhibitions) is the log of yearly number of exhibitions (artist-exhibition year-level). Note that all is reported on the exhibition-level. Reputation at death as described in 5.5. A total of 477 artists have 0 reputation at death.

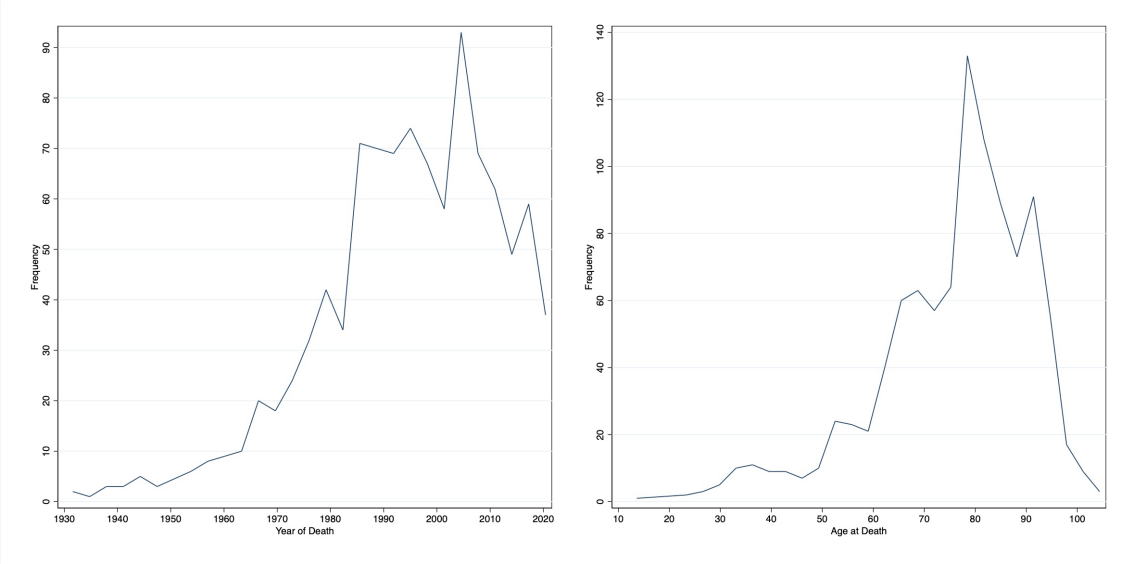

Figure 1: Exhibitions: distribution of death year and age at death

Note: This figure shows the frequencies (artist-level) of the year of death (left) and age at death (right). N=1'000.

Table 2: Summary Statistics: Pre Post Mortem

	Pre Mortem		Post Mortem	
Variable	Mean	SD	Mean	SD
Female	.11	.31	.15	.36
Exhibition year	1978.08	19.95	2004.38	10.62
Solo exhibition dummy	.28	.45	.24	.43
Exhibition Biennale	.012	.1089	.004	.0665
log(y n exhibitions)	.99	.83	1.23	1.09
Exhibition years to/-from Death	-24.35	16.07	14.71	11.89

Note: Summary statistics for the $n = 21'020$ observed exhibitions pre- and post mortem. Log(y n exhibitions) is the log of yearly number of exhibitions (artist exhibition year-level)

Table 3: Top 20 Artists (N Exhibitions)

Artist [age, reputation]	N	Artist [age, reputation]	N
		...	...
Andy Warhol [59, 8.77]	934	Emil Schumacher [87, 7.01]	234
Roy Lichtenstein [74, 9.37]	476	Eduardo Chillida [78, 7.52]	233
Sigmar Polke [69, 8.21]	399	Piero Dorazio [78, 7.03]	224
Louise Bourgeois [99, 8.38]	346	Robert Mapplethorpe [43, 6.88]	213
Robert Motherwell [76, 8.77]	297	Robert Smithson [35, 6.73]	205
François Morellet [90, 7.41]	282	Bernard Schultze [94, 4.61]	203
Alighiero Boetti [54, 6.49]	263	Tom Wesselmann [73, 7.75]	200
Mike Kelley [58, 8.18]	253	Alberto Burri [80, 7.34]	171
Franz West [65, 7.9]	243	John Cage [80, 6.21]	152
Mario Merz [78, 7.68]	240	Jan Schoonhoven [80, 6.29]	147
...	...		

Note: This table shows the top-20 artists in terms of total number of exhibitions observed. In brackets: age at death and an approximation of reputation at death, as detailed in section 4 and 5.

artists in our sample with at least one observed auction result. This descriptive figure clearly illustrates an increase in demand for exhibitions during an artist's lifetime, followed by a continuous decline after death. In contrast, and unsurprisingly, secondary market activity begins to surge approximately 20 years before an artist's death, with a constantly high supply of auctions in the years following their passing.[11]

4 Empirical Specification

4.1 Exhibitions

Following causal inference literature (Angrist and Pischke, 2008; Cattaneo et al., 2019; Lee and Lemieux, 2010), we set up an empirical framework that estimates the favoured eventstudy design, regression discontinuity design and multi-level fixed effects models to calculate the heterogeneity in post mortem effects. Our main set of results focuses on the post mortem

[11] It is worth mentioning that the presented figure is derived from a sample of artists (261) whose death occurred prior to 2013. This selection ensures that all data points can potentially have a period of ten years after their death for an accurate comparison.

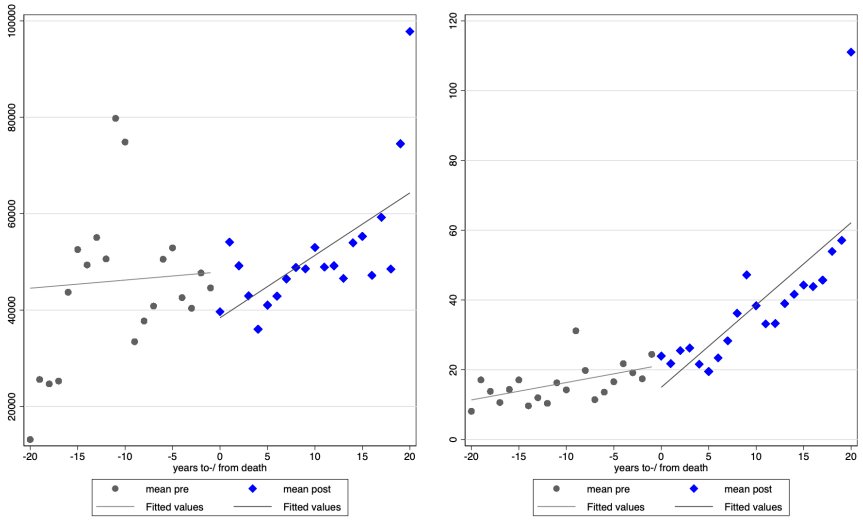

Figure 2: Auctions: Descriptives

Note: This figure plots the descriptive statistics for the mean (artist - year) auction price (left panel) and total number of auctions (sold or not- right panel) for 20 years to-/ from the death of artists.

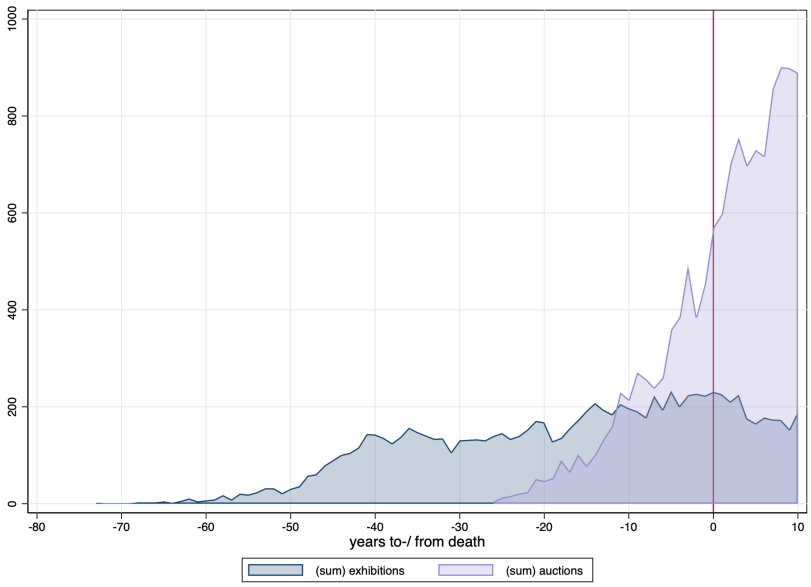

Figure 3: Auctions and Exhibitions: Descriptives

Note: This figure plots the descriptive statistics for the total number of exhibitions and auctions based for years to-/ from the death of artists. We only plot exhibitions of the 261 artists with observed auctions, as detailed in 3, and death year < 2013.

Table 4: Summary Statistics: Auctions

Variable	Obs	Mean	Std. Dev.	Min	Max
Auctions					
log(price)	22,043	9.66	1.7	4.23	13.81
notsold	33,346	.34	.47	0	1
year	33,338	2007.64	8.89	1986	2023
month	33,338	7.45	3.36	1	12
Characteristics and Auction Houses					
oil	33,346	.57	.49	0	1
acryl	33,346	.15	.36	0	1
canvas	33,346	.66	.48	0	1
board	33,346	.14	.35	0	1
mixedmedia	33,346	.05	.21	0	1
paper	33,346	.08	.28	0	1
Christies	33,346	.23	.42	0	1
Sothebys	33,346	.06	.24	0	1
Bonhams	33,346	.03	.17	0	1
Artist					
birthyear	33,346	1921.97	10.24	1900	1958
deathyear	33,346	1997.96	11.79	1930	2021
female	33,346	.039	.19	0	1
age at death	33,346	75.99	12.04	22	102
auction years to-/ from death	33,338	9.68	14.15	-34	79
postmortem [0,1]	33,346	.76	.43	0	1
N exhibitions pre mortem	33,346	75.41	83.21	0	322
log(exhibition reputation at death)	33,346	5.08	2.96	0	9.37

Note: This table shows the summary statistics of the auction data (paintings). The artist-characteristics are derived from the matching process with the main exhibition data set.

effect (i.e. the event of death) on exhibition outcomes in our panel data, in a setting for artist i in exhibition year t and museum exhibition country c:

$$y_{it} = \alpha + \sum_{j=2}^{J} \beta_j (Lead\ j)_{it} + \sum_{k=1}^{K} \delta_k (Lag\ k)_{it} + \mu_i + \phi_t + \gamma_c + \theta_m + \epsilon_{itcm}, \tag{1}$$

where y_{it} describes the dependent variable yearly number of exhibitions (log), and leads and lags are binary variables indicating exhibition year of artist i took place k (j) years to (from) its death (up to K and J years), and accordingly uses the 'not yet treated' as control periods (see Clarke and Schythe (2020) or a practical application e.g. Borusyak and Jaravel (2017); Schmidheiny and Siegloch (2019)). We control for artist-(μ), exhibition country (γ), exhibition year (or decades ϕ), and museum (θ) fixed effects.

In the regression discontinuity design, we estimate a similar type of equation:

$$y_{it} = \alpha + \beta_1 postmortem_{it} + k(Year_t) + \mu_i + \phi_t + \gamma_c + \theta_m + \epsilon_{itcm}, \tag{2}$$

However, we construct the treatment variable as a dummy equals one for post death exhibition years, $postmortem_{it}$ = $1\,[t \geq PostMortem_{it}]$ to capture the overall effect. The forcing variable (Lee and Lemieux, 2010; Cattaneo et al., 2019), $k(Year)$, is constructed as a continuous function of time periods to-/ from death (cf. table 1). In various models of the baseline results, we allow for polynomial functions of $Year$ and interactions with the $PostMortem$ Dummy. We exploit the (arguably) exogenous discontinuity given by the deaths of artists. As descriptive evidence shows, we indeed observe a discontinuity in the raw data for the entire number of exhibitions in years around death of artists.

Finally, we address potential heterogeneity in the treatment. To do so, we interact $postmortem$ with a variable of age, $reputation$ (at the time of death) respectively. This type of regression allows us to research the impact of age and reputation at death on post mortem exhibition outcomes.

4.2 Auctions

To further validate results, we study the relationship between an artist's death and the impact on secondary market auction sales. We use high-dimensional fixed effect models that incorporate hedonic characteristics of the artworks being sold. The baseline auction results are estimated as follows:

$$log(price)_{i,a,t} = \alpha + \delta postmortem_{i,a,t} + \boldsymbol{X'}_{i,a,t} + \rho_T + \phi_M + \theta_V + \mu_A + \epsilon_{i,t,a} \tag{3}$$

where artwork i by artist a is sold at date t. The vector $\boldsymbol{X'}$ represents the hedonic characteristics of the artwork and auction houses.[12] ρ_T, ϕ_M, θ_V and μ_A represent auction-year, auction month, auction house, and artist fixed effects. The main coefficient of interest, δ, is represented by a dummy variable, equal to one for auctions that take place post mortem,

[12] Given the structure of the data, we perform a string-search in the artwork-name based on often used hedonic characteristics of artworks and medium, such as "nude, abstract, paper, oil etc." and identify transactions made at most prominent auction houses, Christies, Sothebys and Bonhams. (Li et al., 2022).

zero otherwise. Finally, $\epsilon_{i,t,a}$ is the error term. Outcome variables are log-transformed auction prices (in USD) and a binary variable for unsold items, $notsold[0,1]$.

4.3 Limitations

One limitation of the data is that we cannot observe, obviously, the overall and 'true' number of total exhibitions. This is mostly the case given the lack of a systematic and comprehensive database of overall exhibitions in museums, galleries or art fairs worldwide. Upon visual inspection and contacting the data host, our data seems not to have systematic selection biases, most importantly, regarding pre-and post mortem exhibition records.[13]

The burgeoning numbers of art price studies based on auction data (some of which researching the death effect) calculate estimates using hedonic characteristics of the sold artworks. Although these artwork specific control variables are insightful, our artist exhibition-level data does not allow to identify characteristics on the exhibited artwork-level. In contrast, our results on the auction price-death interplay includes and controls for hedonic artwork characteristics. Given that the treatment (death) is on the artist-level, we are nevertheless confident that our main identification strategy properly addresses data limitations and describes the mechanism of interest.

Another source of possible bias could come from individual museums reporting exhibition information differently. While we can ensure that our data does not include obvious duplicates (i.e. same exhibition, artist and dates), we screen our data regarding differences in reporting collection- or temporary exhibitions. Arguably, museums might tend to self-select and curate exhibitions along pieces from their own collection. At the same time, it could be that the data is biased with museums multi-reporting permanent exhibitions of their collection, or differences in reporting artists in temporary exhibitions. Beyond exhibition venue fixed effects and accounting for exhibitions' reputation as in section 5.5, we manually inspect the data. First, it seems that exhibitions reported on artist-info.com are very well curated (e.g. by giving the exact date of the exhibitions, the exhibition curator's name and the specific exhibition venue

[13] According to the host-service, differences in availability of overall exhibition histories can occur due to work-force availability or differences in access to web-pages of museums, galleries or venues (e.g. for very recent years). Also, the host service is based in Germany, and it seems that German artists could therefore also be 'over represented' in the data sample. All of this is less of a problem for our empirical strategy, but might influences the external validity of our results as it will be discussed in the conclusion of this paper.

name). Second, we search for duplicates in the data in terms of year-name and year-name-exhibition venue combinations. More than 90 percent of our observations have no more than 10 exhibitions in a given year (worldwide), and almost 93 percent of observations do not have more than one exhibition in the same venue and year (98 percent not more than two exhibitions). These numbers seem to clearly support the validity of our data.

Overall, our large-scale panel data is capable to address most of the above data limitations, and allows to apply high-standard econometric tools, e.g. by including multi-level fixed effect models for artists, countries and exhibition years.

5 Results

5.1 Event Study: Short- and long-run Death Effects

We now present the first results based on the event study design. We report coefficients based on leads and lags (i.e., exhibition years before and after the death of artists) and the number of exhibitions (log) as the dependent variable (exhibition year and artist-level) as specified in Equation (1). The counterfactual trend is given by the 'not yet treated' artists and coefficients are normalized around the exhibition year to the death minus one. In our panel data, artists died between 1930 and 2022 (cf. Table 1), and we therefore control for the year (or decades) of exhibition.[14] The regressions also include artist- and country of exhibition fixed effects.

Given the long periods both prior and after the treatment, i.e., the death of an artist, we first take a closer look at the short-term impact on exhibitions. The results are illustrated in Figure 4. The coefficients of interest are insignificant and close to zero before the death, indicating a valid common pre-trend. In the years following the death, the pattern of coefficients clearly decreases and is partly statistically significant. Interestingly, exhibitions are (arguably) scheduled in advance, and the stickiness of the coefficients is reflected by the fact that the coefficients begin to become statistically significant only two years after death.

[14] Section 5.3 discusses the robustness of these results in detail.

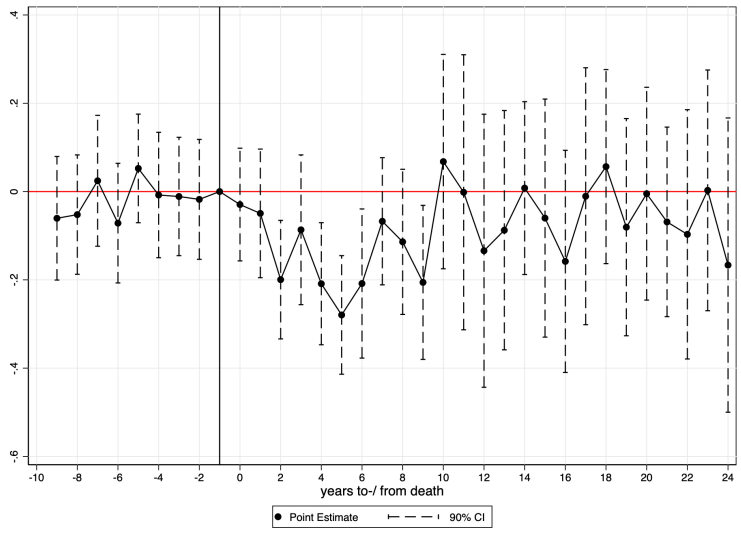

Figure 4: Exhibitions: long-term event study exhibitions to-/ from death

Note: This figure plots the regression coefficients of years to-/from death of the artist and the yearly number of exhibitions (log) artist exhibition year-level. The coefficients are normalized around -1 exhibition year prior to the event. Further included covariates are solo-exhibition dummy, exhibition year, artist, museum venue, and country fixed effects. Standard errors are clustered at the artist-level and we report 90 percent confidence interval.

At large, figure 4 also reveals findings for a wider time window, models including a total of 10 leads and 25 lags around the death of the artist. Again, the figure shows a stable number of exhibitions among the artists in the years leading up to their deaths. The persistent negative effect is reflected for up to nine periods following the death of an artist. The coefficient jumps up at the 10th 'anniversary' of the artist's death. Intuitively, this makes sense as museums, galleries, or other venues may honor and increasingly curate the artist on this occasion, also potentially benefiting from cross-promotion with other events in the same year. The coefficients become statistically insignificant afterwards.

5.2 Exogenous Discontinuity in Death Effects

Table 5, featuring models (1) through (4), presents the basic regression discontinuity design (RDD) results as outlined in equation (2). In all models, the post mortem effect consistently exhibits a negative trend. In the baseline model (2), which incorporates artist and exhibition decade fixed effects, we observe a negative effect of approximately -0.067. By introducing exhibition venue and country fixed effects in model (3), the coefficient becomes more pronounced at -0.079. When employing $year^2$ and $year^3$ polynomials and the treatment interaction term in model (3), the effect achieves statistical significance at the 1% level.

Table 5: Regression Discontinuity: Overall

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	bandwidth [-9,9]				bandwidth [-9,9]			
post mortem	-0.103*	-0.0673	-0.0785	-0.179**	0.307*	0.651	0.650	0.513
	(-2.06)	(-0.92)	(-1.31)	(-2.71)	(2.22)	(1.92)	(1.90)	(1.74)
post mortem $\times ageatdeath$					-0.00535**	-0.00984*	-0.00994*	-0.00822*
					(-3.02)	(-2.45)	(-2.45)	(-2.29)
age at death					-0.00897***			
					(-6.18)			
year	0.0138*	0.000749	0.00384	0.0181**	-0.00797	0.00222	0.00240	0.00522
	(2.06)	(0.26)	(1.34)	(2.64)	(-1.69)	(0.84)	(0.90)	(1.94)
$year^2$		-0.0000369	-0.0000165	0.000598*		-0.0000733**	-0.0000711**	-0.0000479*
		(-1.86)	(-0.76)	(2.22)		(-3.07)	(-2.93)	(-2.13)
$year^3$		-0.000000542	-0.000000211	0.00000664*		-0.000000800	-0.000000775	-0.000000447
		(-0.89)	(-0.40)	(2.27)		(-1.21)	(-1.17)	(-0.77)
post mortem $\times year$	-0.0282**			-0.00820				
	(-3.01)			(-0.47)				
post mortem $\times year^2$				-0.000808				
				(-1.05)				
post mortem $\times year^3$				-0.00000580				
				(-1.02)				
solo	-0.00513	-0.00148	0.000368	0.00106	-0.00219	-0.00347	0.000480	-0.00240
	(-0.15)	(-0.12)	(0.03)	(0.08)	(-0.07)	(-0.30)	(0.04)	(-0.18)
N	4721	20796	18694	18694	4721	20796	19701	18694
R^2	0.421	0.642	0.705	0.706	0.436	0.645	0.646	0.707
Artist FE	no	√	√	√	no	√	√	√
Exhibition Decade FE	√	√	√	√	√	√	√	√
Country FE	√	no	√	√	√	no	√	√
Museum FE	√	no	√	√	√	No	no	√
Cluster SE	no	artist	artist	artist	no	artist	artist	artist

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: This table shows the regression coefficients as specified in the table and in chapter 4. The depended variable is the log-transformed yearly number of exhibitions (artist year-level). $postmortem$ is a dummy equal 1 for exhibitions after the artists death (zero otherwise) and $year$ a continuous variable of exhibition years to-/ from death. $AgeAtDeath$ is a time-invariant variable of age at death at the artist-level.

In Figure 5, we plot the regression discontinuity design graph, with 9 normalized exhibition years to-/ from the death of the artist. Additionally, the figure presents average within bins and a line of a polynomial fit of order 4. We utilize the *STATA* command *rddplot* package which does not allow to include fixed effects. The plot appears to corroborate the estimated negative coefficient for artists' exhibition outcomes following their death. While pre-periods follow an increasing and almost linear trend, the post mortem coefficients drop sharply following the first nine exhibition years after the event. This outcome is also reflected in Table 5, model (1), which underscores the importance of selecting an appropriate bandwidth [-9,9] for the RDD significance-levels and results.

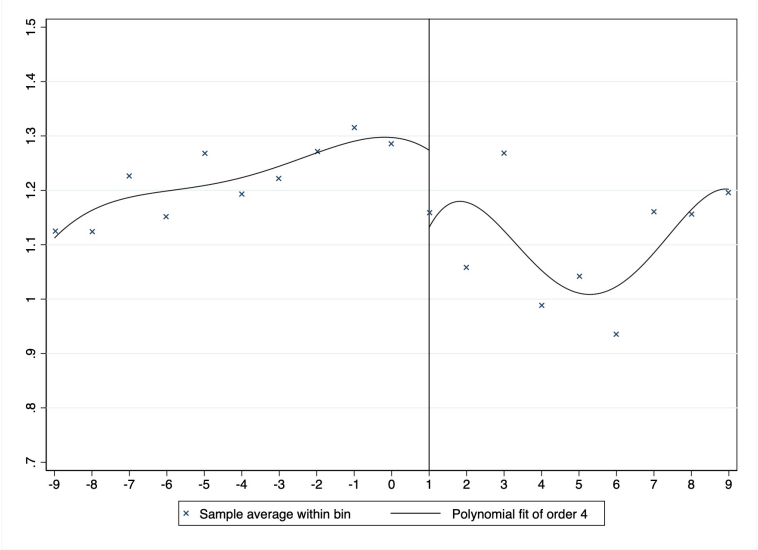

Figure 5: Exhibitions: regression discontinuity design

Note: This figure shows the log-transformed yearly number of exhibitions (artist exhibition year-level). The x-axis is constructed as a counter of exhibition years to-/ from death of the artist. The sample is restricted to -9 to 10 exhibition years to-/ from death. The crosses represent sample average within bin and the line a polynomial fit of order 4. Standard errors are clustered at the artist-level.

Based on these calculations, we conclude that the post mortem effect on exhibition outcomes seems to be negative, also when we change the bandwidth of the estimation period to the entire career life cycle we observe (model 2-4). However, this effect may not be unassailably robust when choosing longer (or shorter) sample periods.

5.3 Robustness

To ensure the validity of our results and identification strategy, we conduct various robustness checks. As shown in Figure 6 panel (A), we use the same specification as before, where the outcome variable is the logarithm of the annual number of exhibitions, but we apply a placebo treatment period of 10 years before the artist's death, with 10 leads and lags. We observe no significant discontinuity around the placebo treatment, as indicated by the sample average within bins. The results thus provide further evidence on the robustness of our main findings.

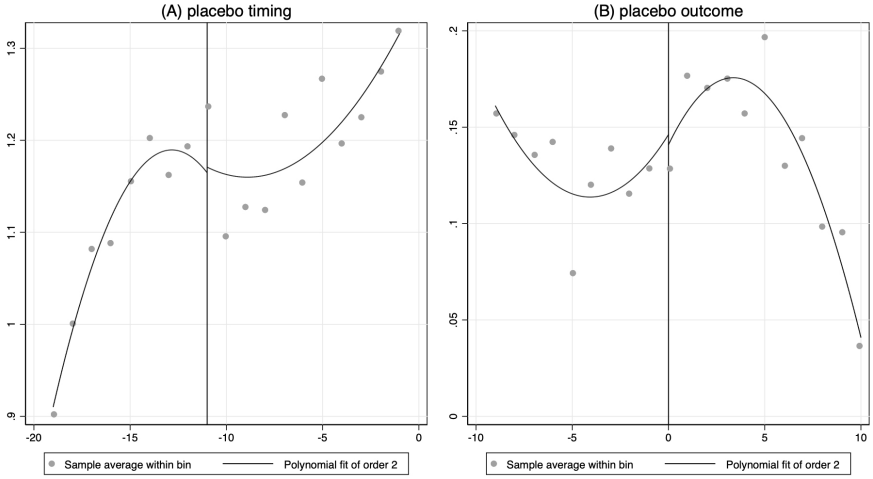

Figure 6: Exhibitions: placebo timing and outcome

Note: This figure shows the log-transformed yearly number of exhibitions (artist exhibition year-level). The x-axis is constructed as a counter of exhibition years to-/ from death of the artist. Panel (A) is restricted to -20 to -1 exhibition years to-/ from death with the placebo timing set at eleven years prior the death of the artist. Panel (B) is using a dependent variable of a dummy equals one for exhibitions by female artists. The crosses represent sample average within bin and the line a polynomial fit of order 2. Standard errors are clustered at the artist-level.

The next robustness check addresses possible concerns regarding the sample and the balancing of artists in pre- and post mortem periods. Essentially, as we are using an unbalanced panel, results could be biased by artists entering or exiting the panel before or after our 'treatment'. We therefore replicate the regression discontinuity results from figure 5, now excluding artists with only pre-mortem observations from the sample. Figure 7 shows that the pre-mortem results (dashed line) do not systematically differ compared to the full sample. Again, we observe a sharp (short term) drop in the yearly number of post mortem exhibitions in this more robust sample. In the regression discontinuity plot of Figure 6 panel (B), we look at exhibitions by female artists as a placebo outcome variable (dummy) and test if gender com-

position and selection into the sample before and after the treatment can generate a similar drop in exhibitions. This is not the case and hence provides further support to the crucial aspect of our identification strategy: we cannot observe any discontinuity around the cut-off year for other covariates.

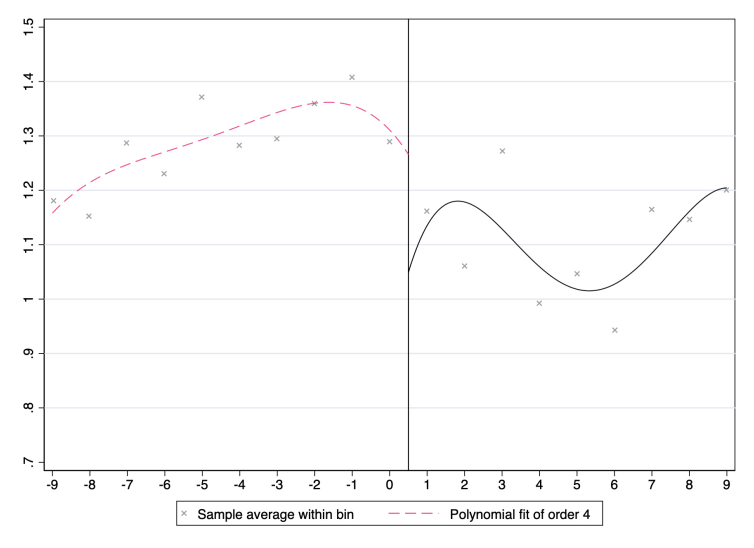

Figure 7: Exhibitions: robust pre-post balance

Note: This figure shows the log-transformed yearly number of exhibitions (artist exhibition year-level). The x-axis is constructed as a counter of exhibition years to-/ from death of the artist. The sample is restricted to -9 to 9 exhibition years to-/ from death. The crosses represent sample average within bin and the line a polynomial fit of order 4. Standard errors are clustered at the artist-level. The panel is balanced along artists with at least one observation post mortem.

Previous literature on auction price formation (Ashenfelter and Graddy, 2003) has noted that results may be subject to bias when dealing with superstars. For example, 'Andy Warhol' represent over 4.4 percent of the total exhibitions in our sample (see Table 3). While previous models have already addressed the issue of outliers by including multiple fixed effects and a log-transformed outcome variable, we further test the robustness of our results by removing (using only) the top 10 artists (in terms of exhibition frequency) from the sample. We find that our results remain robust and significant even with the two restricted samples (not reported).
15

Recent applied econometric literature has focused on the consistency of (staggered adopted)

[15]We thank to the authors of Graddy and Lieberman (2018) who mentioned the possibility of top artists dominating results, and it is therefore crucial to test for robustness by using the top 10 panel of artists only.

event study estimators and the need for homogeneity in treatment effects (Baker et al., 2022; Sun and Abraham, 2021; Borusyak et al., 2021; Goodman-Bacon, 2021; De Chaisemartin and d'Haultfoeuille, 2020). The two-way fixed effects (TWFE) estimator produces consistent results only if the treatment effect of death is approximately homogeneous across exhibition years and artists. To address this issue, we use the proposed estimator by Borusyak et al. (2021), which is robust to heterogeneity in treatment effects. Figure 8 (panel left) shows the results of our re-estimation. The pattern of estimated pre- and post-treatment coefficients is very similar, and importantly, the common pre-trend holds in all 10 exhibition years before the death of the artists. We again obtain a short-term significant drop after the treatment, followed by an increase in the longer run, consistent with our baseline results. Relatedly, we re-run our main estimates based on the three-step interaction weighted (IW) estimator developed by (Sun and Abraham, 2021).[16] By doing so, we further address the potential bias of the staggered adoption of the treatment in our estimates. The short-term negative post mortem exhibition outcomes are also confirmed when using this robust estimator, as illustrated in Figure 8 (right panel).

Finally, we can assess the robustness of our results along both the intensive and extensive margin. We re-estimate the years before/after the death of an artist against a dummy variable that equals one if the artist had an exhibition in that year (and zero otherwise). We report the sample average within (artist) bins using dots, and we also calculate a fitted line. This analysis is again based on the balanced sample. The outcome (not-reported) reveals a continuous increase in the share of exhibiting artists in the years leading up to an artist's death. This trend can be attributed to the fact that relatively young artists (i.e., at the early stages of their careers) may not have exhibitions every year, while more established artists can exhibit more frequently and in more locations. In our sample, we observe a relatively stable share of exhibiting artists up to 40 years prior to the death of the artist, at around 15 percent. This share gradually decreases to 10 percent posthumously, likely reflecting a post mortem depreciation effect.

[16] We use the *STATA* package *eventstudyinteract*, which categorizes the 'units' into different cohorts based on their initial treatment timing (Sun, 2021). The steps incorporate an interaction term of the treatment with the cohorts and a weighted average (based on sample shares) of the initial estimates. As we are confronted with relatively many leads, lags, and a large number of units, the maximum number of years around the death was restricted to 6, due to computational reasons. These estimates are also robust against using more leads and lags or sub-sample cohorts of treatment periods when running the command (very time consuming) on fastest editions of the software (not reported).

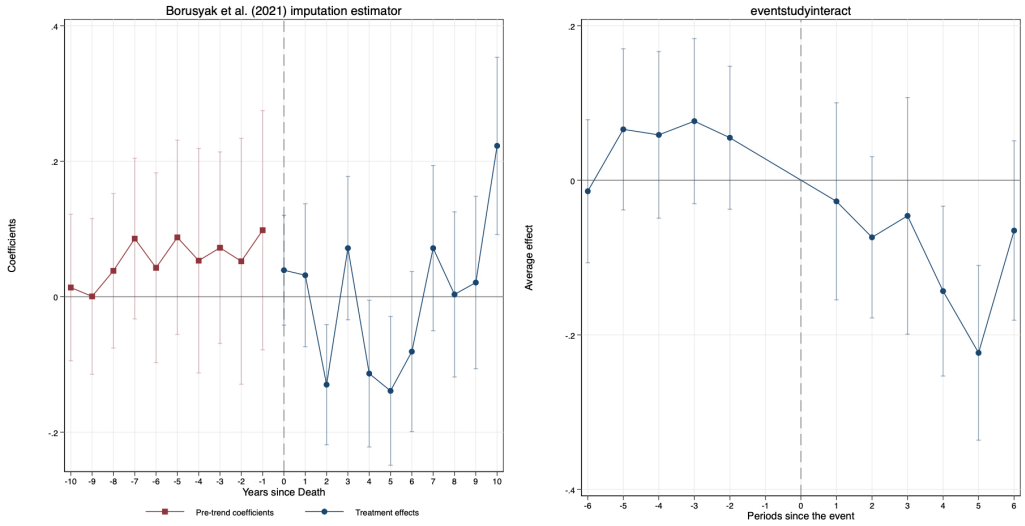

Figure 8: Exhibitions: pre-trend testing imputation approach and eventstudyinteract

Note: This figure (panel left) shows the estimator proposed by (Borusyak et al., 2021), *STATA* command: $didimputation$. The estimator includes artist, exhibition year and exhibition country fixed effects. Estimates on the right-hand side introduce the interaction weighted (IW) estimator *eventstudyinteract* developed by Sun (2021).

5.4 Age at Death

Both panels in Figure 1 illustrate the distribution of artist death years and age at death in our data. We have not yet addressed this heterogeneity in the treatment. We rerun the baseline RDD estimates and introduce a variable 'age at death' that we interact with the post mortem dummy.

The results of this analysis are presented in Table 5, models (5) to (8). Interestingly, the overall coefficient of post-death exhibition outcomes now consistently turns positive. As discussed in the previous section, our findings in the overall career cycle sample are not fully robust, indicating that the post-death effect is somewhat unstable in effect directions in the long-run panel. The results presented in this section could provide an explanation for this observation, in addition to cyclical effects. Consistent with prior literature in art auctions and cultural economics, age at death appears to be relevant in explaining post mortem outcomes. In our estimates (model 5 onwards), which subsequently introduce all types of fixed effects, we observe a robust and statistically significant negative effect for the interaction coefficient '$postmortem \times ageatdeath$'.[17] We interpret this result as follows: with an increase in age at

[17]We perform an outlier-robustness check, similar to the one reported in Section 5.3, by excluding the artist 'Andy Warhol' (or other superstars) who was born in 1928 and died in 1987, and whose exhibition records could be relatively

death, artists appear to be more negatively affected by post mortem exhibition outcomes than artists who die young. In other words, our results suggest no (or positive) death effect for artists dying young, while older and more established artists started on a higher level of pre-death exhibitions and were more strongly affected by the negative post-death effect we estimate in our baseline results.

Finally, we visualize the results discussed above in Figure 9 using the same event study estimator as described in Equation (1). We split the estimates into two samples. The left panel includes 763 artists who died at age 68 or older ($N = 15,646$), while the right panel plots the results for 235 artists who died at age 67 or younger ($N = 5,485$). We chose the age 68 and younger as it represents the 25th percentile of the distribution of age at death. As anticipated, the results and effects are different between the two samples. In the panel with artists who died relatively old, we observe an overall negative and persistent death effect on exhibition outcomes. For some years, especially the years closely following the death of the artists, this effect is statistically significant at the 90-% level. On the right-hand side, we plot the event study coefficients including only artists who died relatively young, i.e., at age 67 or younger. The effect direction is not as clear as before. While we can estimate a negative short-term impact (around t_{+4} to t_{+8}) of death on exhibition outcomes, in the longer run, the number of exhibitions seems to increase after the 10th anniversary of the artists' death.

In Figure 10, we plot the average marginal effects of $Postmortem = 1$ on exhibition outcomes. The reported average marginal effects are computed at different levels of 'age at death', starting from the age at death of 22. We again identify the positive death effect for artists dying young, but effect direction changing to negative for artists dying around the age of 50 or older. However, given the relatively small sample size of exhibitions by artists dying at age 50 or younger ($n = 1489$), statistical significance (at the 90% level) is only present for older artists.

important in the regressions. However, the results are robust to excluding exhibitions by Andy Warhol. In model (5), we estimate with a bandwidth of 9 years around the treatment.

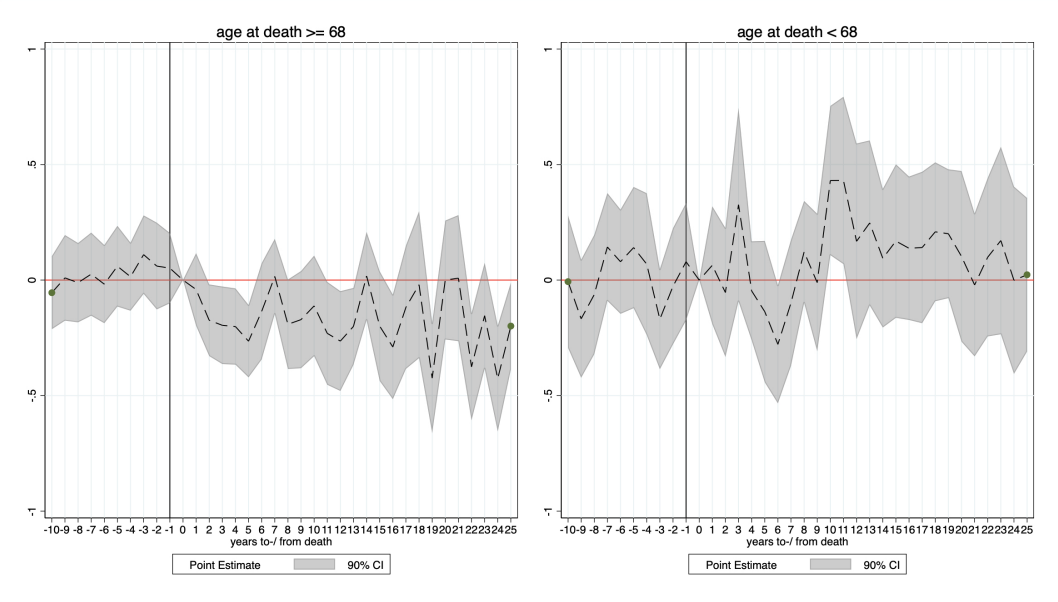

Figure 9: Exhibitions: old and young at death effects

Note: This figure shows the event study graphs for artists who died at age 68 or older (left panel) vis-a-vis artists who died at age 67 or younger (right panel). Both figures plot the regression coefficients of years to-/from death of the artist and the yearly number of exhibitions (log) artist-exhibition year level. The coefficients are normalized around 0 exhibition year prior to the event. Further included covariates are exhibition year, artist and country fixed effects. Standard errors are clustered at the artist-level and we report 90 percent confidence interval.

5.5 Reputation and Age at Death

As demonstrated in previous literature, an artist's reputation plays a significant role in understanding post mortem effects on auction price formation (Ursprung and Wiermann, 2011; De Silva et al., 2022). However, measuring reputation can be challenging. We rely on the work of Fraiberger et al. (2018), who mapped co-exhibition networks of up to half a million artists to capture the movement of art between institutions. We utilize a list of the top-100 most prestigious art museums based on the computed network ranks and create various variables to approximate the reputation of the exhibitions in our dataset.[18] We sum up the rankings of the exhibitions to calculate the approximated 'reputation' up to the artist's death, resulting in a variable of reputation at death ($reputation$).

The main results are presented in Table 6. Note that in benchmark models (1) and (2), we

[18]Our primary variable is constructed as follows: We rate the reputation of each exhibition on a scale from 0 to 100, where 100 represents the Museum of Modern Art, 99 corresponds to the Guggenheim, and so on, with 2 being the Francois Pinault Foundation, 1 the Whitechapel Gallery, and 0 representing all other museums in our data. Subsequently, we manually search for exhibitions at the Venice Biennale, a highly prestigious venue for artists to exhibit (Li et al., 2022). We identify a total of 203 exhibitions at the Venice Biennale, featuring a total of 135 artists, and rank these exhibitions with a $reputation = 100$' (see Table 1 and Table 3).

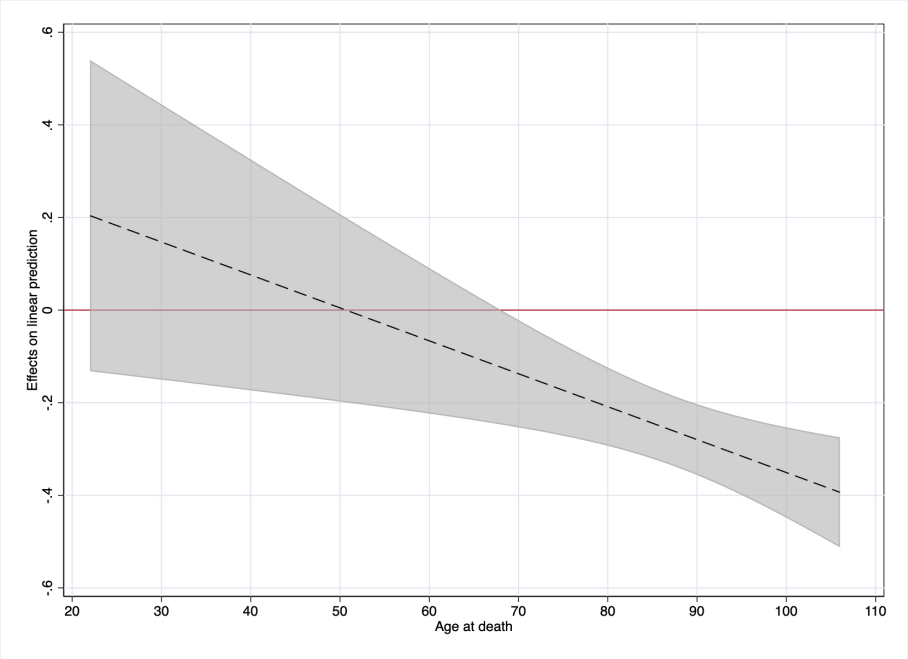

Figure 10: Exhibitions: postmortem effect marginal effects age at death

Note: This figure shows the average marginal effects for the overall death effects for different levels of age at death. The dependent variable is (log) yearly number of exhibitions (artist year-level). The model includes artist, country, and year of exhibition fixed effects. Standard Errors are clustered at the artist-level.

do not include artist fixed effects, which allows us to regress on the time-invariant age at death ($ageatdeath$) and reputation at death ($reputation$) variables. The reputation benchmark model (1) highlights the significance of including reputation at death as a control variable, estimating a highly statistically significant positive coefficient. The post mortem dummy stays statistically significant and negative, as seen in previous benchmark models. Once we include a control for age at death (from model 2 onwards), the post mortem coefficient becomes positive again. Our measures of reputation and age at death estimate consistent effects in terms of direction.

In our preferred set of regressions (models 3 and 4), which includes all fixed effects and interaction terms of the post mortem dummy with heterogeneity in the 'treatment' (in terms of age and reputation at death), we draw the following conclusions. In the most demanding models, the negative (and significant) measure of age at death appears to negatively impact post mortem exhibitions ($postmortem \times ageatdeath$). However, for artists who had a higher reputation at the time of their death, we observe positive exhibition outcomes in subsequent years ($postmortem \times reputation$). Although insignificant, these results demonstrate that the simple $postmortem$ dummy becomes positive compared to the baseline results that do not

Table 6: Age and Reputation at Death

	(1)	(2)	(3)	(4)
post mortem	-0.146***	0.633***	0.460	0.0466
	(-6.04)	(9.68)	(1.80)	(0.20)
reputation	0.000192***	0.000194***		
	(59.12)	(61.40)		
age at death		-0.00761***		
		(-12.11)		
post mortem $\times reputation$	0.0000392***	0.0000420***	0.0000276	0.000359*
	(8.00)	(8.79)	(0.98)	(2.03)
post mortem $\times ageatdeath$		-0.0107***	-0.00825*	-0.00236
		(-12.75)	(-2.53)	(-0.79)
post mortem $\times repuation \times ageatdeath$				-0.00000465
				(-1.87)
year	0.00471***	-0.00406***	0.00534*	0.00513
	(6.08)	(-4.97)	(2.00)	(1.91)
year^2	-0.0000345***	-0.0000884***	-0.0000448*	-0.0000413
	(-3.38)	(-8.21)	(-2.00)	(-1.84)
year^3	-0.00000136***	-0.00000144***	-0.000000412	-0.000000326
	(-5.24)	(-5.68)	(-0.74)	(-0.59)
solo	-0.0133	-0.0165	-0.00454	-0.00549
	(-0.93)	(-1.19)	(-0.35)	(-0.42)
N	18929	18929	18694	18694
R^2	0.540	0.563	0.707	0.709
Artist FE	No	No	√	√
Exhibition Decade FE	√	√	√	√
Country FE	√	√	√	√
Museum FE	√	√	√	√
Cluster SE	no	no	Artist	Artist

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: This table shows the regression coefficients as specified in the table and in chapter 4. The depended variable is the log-transformed yearly number of exhibitions (artist year-level). $PostMortem$ is a dummy equal 1 for exhibitions after the artists death (zero otherwise) and $year$ a variable of exhibition years to-/ from death with 0 in the year of the death. $ageatdeath$ is a variable of age at death at the artist-level. $reputation$ is a variable of exhibitions reputation summarized until the death of the artist, as specified in chapter 5.5.

include measures of reputation and age at death (see Table 5), underlining the relative importance of these variables.

5.6 Auction Results

In this section, we present the estimation results obtained from the sample of matched artist (where auction data is available). Our aim is to supplement our findings of death effects on exhibitions by examining the auction hammer prices and the probability of unsold auctions for (a subsample of) the same artists. To address the possibility of differing effect directions, we begin by analyzing them separately in regressions and then combine both pieces of information: exhibitions and auction transactions.

The key findings regarding auction prices are summarized in Table 7. All models incorporate artist fixed effects, and standard errors are clustered at the artist-level. In Model (1) of Table 7, the dummy variable for auctions held after an artist's death is statistically significant and positive, indicating a positive correlation between achieved hammer prices of paintings

and the artist's death. By incorporating artwork-specific controls (Model 2) and auction year and month fixed effects (Model 3), the coefficient remains positive and significant, but with a smaller effect size. Even after accounting for auction house fixed effects in Model (4), we continue to estimate a significant positive effect. Overall, auctions of artists who died achieve, on average, 16% to 19% higher hammerprices (exp(0.152) - 1).[19] Figure 11 illustrates the previously discussed estimates, and shows the increasing trend of auction hammer prices posthomously (in all of the estimated 20 lags). Moreover, the graph shows an insignificant, but increasing pre-treatment trend.

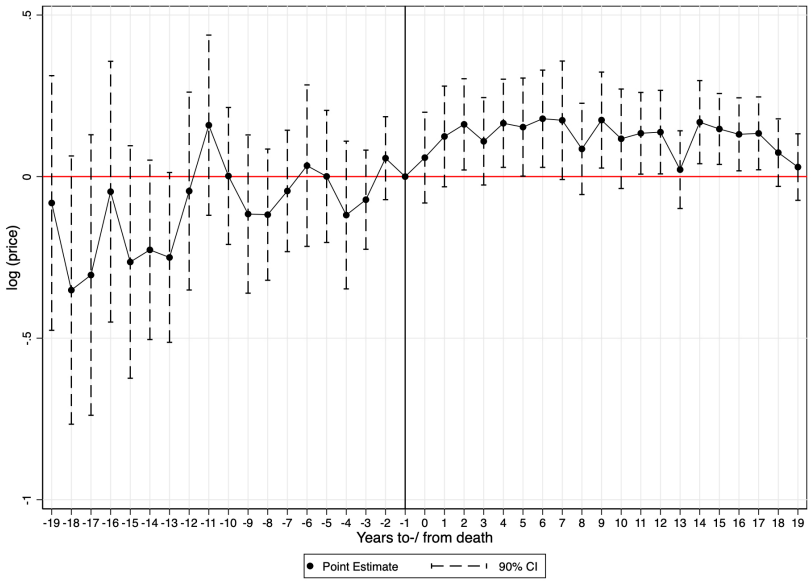

Figure 11: Auctions: Event study auction price years to-/ from Death

Note: This figure plots the regression coefficients of years to-/from death of the artist and the (log) price of auction results. The coefficients are normalized around -1 auction year prior to the event. Further included covariates are hedonic artwork characteristics, auction year, month, artist and auction house fixed effects. Standard errors are clustered at the artist-level and we report 90 percent confidence interval.

Similarly, Table 8 estimates the same type of models (Model 4 using a logit regression) but for the probability of auction not being sold (not sold $[0, 1]$). [20] We observe a statistically significant negative effect of auctions not being sold posthumously, but after including all auction

[19] Our point estimates of the hedonic characteristics of the artworks and auction houses are much in line with previous literature on art price formation. The artwork size and the medium oil and canvas are highly statistically positive associated with the auction hammer price. The same holds true when controlling for the major auction houses, Christie's, Sotheby's and Bonhams. In contrast, artworks containing the keywords abstract or untitled in their name, and artworks on paper are associated with statistically significant lower hameer prices.

[20] Typically, this occurs when the buyer does not meet the sellers reserve price (i.e. lower price estimates), sometimes referred to as 'bought in'.

Table 7: Auction Price

	(1)	(2)	(3)	(4)
	DV: log(auction price)			
post mortem	0.613***	0.711***	0.175*	0.152*
	(5.71)	(6.75)	(2.02)	(2.06)
artwork				
size m^2		0.0504***	0.0565***	0.0538***
		(6.40)	(7.77)	(7.64)
abstract		-0.367***	-0.341***	-0.173*
		(-3.48)	(-3.55)	(-2.30)
landscape		-0.140*	-0.103	-0.0748
		(-1.99)	(-1.39)	(-1.25)
nude		-0.0955	-0.0493	-0.0582
		(-0.76)	(-0.46)	(-0.70)
portrait		-0.0633	-0.0887	-0.129
		(-0.56)	(-0.97)	(-1.71)
still life		-0.259*	-0.171	-0.0808
		(-2.50)	(-1.65)	(-0.97)
untitled		-0.140*	-0.154**	-0.186***
		(-2.31)	(-2.87)	(-4.07)
medium				
oil		0.129	0.192**	0.205**
		(1.83)	(2.82)	(3.14)
acryl		-0.0756	-0.0860	-0.0406
		(-1.03)	(-1.61)	(-0.75)
canvas		0.360***	0.278***	0.240***
		(6.15)	(5.61)	(5.20)
board		-0.00230	-0.0343	-0.0350
		(-0.03)	(-0.46)	(-0.51)
mixed media		-0.254**	-0.218**	-0.141
		(-2.98)	(-2.77)	(-1.83)
paper		-0.276**	-0.313***	-0.309***
		(-2.94)	(-3.38)	(-3.59)
auction house				
christies		0.474***	0.606***	
		(6.39)	(10.23)	
sothebys		0.927***	0.778***	
		(9.12)	(9.07)	
bonhams		0.299***	0.154*	
		(4.04)	(2.33)	
N	22011	20923	20923	20818
R^2	0.547	0.613	0.653	0.692
Artist FE	√	√	√	√
Year FE	No	No	√	√
Month FE	No	No	√	√
Auction House FE	No	No	No	√

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: This table shows the multi-level fixed effects regressions for the dependent variable $(log)hammerprice$. Artwork characteristics and medium are based on string-searches of the artwork name and medium. Reference category for artwork name is "other". Standard errors are clustered at the artist-level.

house fixed effects, the significance disappears. In sum, auction sales were significantly more successful in years when the artist already deceased. The result suggests that, the fact that an artist died, decreased the probability of not being sold auctions by about 1.17 percentage points.[21]

[21] Artworks auctioned at Sotheby's and Christie's face a much lower probability of being sold. Also oil artworks, on average, are less likely of not being sold. Interestingly, artworks with the keyword 'portrait' in their name face a statistically significant higher probability of not being sold.

Table 8: Probability not sold

	(1)	(2)	(3)	(4)
	DV: not sold [0,1] Multi level FE			Logit
post mortem	-0.233***	-0.244***	-0.0170	-1.144***
	(-4.25)	(-4.42)	(-0.59)	(-4.48)
artwork				
size m^2		0.00126	0.000213	0.00805*
		(1.80)	(0.27)	(2.08)
abstract		0.0135	0.0444*	0.114
		(0.56)	(2.03)	(0.91)
landscape		-0.00975	0.00161	-0.0229
		(-0.48)	(0.09)	(-0.19)
nude		0.00579	0.0197	0.0203
		(0.24)	(1.34)	(0.15)
portrait		0.0604**	0.0433*	0.335**
		(2.63)	(2.15)	(2.76)
still life		0.0209	-0.00117	0.129
		(0.89)	(-0.06)	(1.17)
untitled		-0.0384**	0.000180	-0.190**
		(-3.11)	(0.01)	(-2.90)
medium				
oil		-0.0516	-0.0359*	-0.297*
		(-1.80)	(-2.21)	(-2.00)
acryl		-0.0148	-0.0152	-0.0454
		(-0.69)	(-0.96)	(-0.40)
canvas		-0.00770	0.00286	-0.0689
		(-0.35)	(0.39)	(-0.51)
board		-0.0203	-0.00151	-0.106
		(-0.98)	(-0.14)	(-0.96)
mixedmedia		-0.0284	-0.0246	-0.105
		(-1.34)	(-1.39)	(-0.93)
paper		0.00162	0.00658	-0.0179
		(0.09)	(0.50)	(-0.20)
auction house				
christies		-0.192***		
		(-5.00)		
sothebys		-0.139***		
		(-3.55)		
bonhams		-0.0121		
		(-0.36)		
N	33318	31935	31751	31709
R^2	0.115	0.137	0.417	
Artist FE	√	√	√	√
Year FE	No	No	√	√
Month FE	No	No	√	No
Auction House FE	No	No	√	No

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: This table shows the multi-level fixed effects regressions for the dependent variable $notsold[0, 1]$. Model (4) is a logistic regression. Artwork characteristics and medium are based on string-searches of the artwork name and medium. Reference category for artwork name is "other". Standard errors are clustered at the artist-level.

The empirical evidence so far suggested a clear positive relationship between auction hammer prices and the death of artists. To again account for heterogeneity in the treatment, we have incorporated information about the exhibition histories of the artists into the auction data. In Table 9, we present a post mortem coefficient interaction with the sum of the exhibition-venue-reputation at death ($reputation$) and age at death ($ageatdeath$). This setting offers two notable contributions to the existing auction literature. Firstly, our data enables the inclusion of a comprehensive history of artist exhibitions, a frequently overlooked aspect in

the formation of art prices. Secondly, since our panel of exhibition data is not time-invariant, we can compute an approximate measure of reputation *at the time* of the artist's death (based on the measure of reputable exhibition venues). Model (1-3) regress on the dependent variable $log(auctionprice)$ and model (4) of the probability of non-sales-success. All models include artist, auction year and month fixed effects as well as hedonic control variables.

Table 9: Auction price and probability not sold: age and exhibition reputation at death

	(1)	(2)	(3)	(4)
	DV: log(auction price)			DV: not sold [0,1]
post mortem	0.259**	0.687	1.353*	-0.593*
	(2.71)	(1.15)	(2.31)	(-1.98)
post mortem $\times reputation$	-0.0000949***		-0.000112***	0.0000330**
	(-3.41)		(-4.06)	(2.63)
post mortem $\times ageatdeath$		-0.00617	-0.0130*	0.00652
		(-0.92)	(-2.02)	(1.93)
N	20923	20923	20923	31935
R^2	0.654	0.653	0.654	0.273
Hedonic Controls	√	√	√	√
Artist FE	√	√	√	√
Year FE	√	√	√	√
Month FE	√	√	√	√

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: This table shows the multi-level fixed effects regressions for the dependent variable $(log)auctionprice$ (model 1-3) and a dummy variable equals one if an auction did not result in sales success [0, 1] (model 4). Artwork characteristics and medium are based on string-searches of the artwork name and medium. Reference category for artwork name is "other". $log(repatdeath)$ is the artists total of exhibition reputation, explained in detail in section 5.5. Standard error are clustered at the artist-level.

In Table 9, Models (1-3) consistently display a positive coefficient for artwork prices auctioned posthumously. Model (1) highlights a significant negative relationship between reputation at death and hammer price, while Model (2) reveals a negative relationship between age at death and hammer price. Model (3) incorporates both interaction terms. In line with our findings, the probability of unsold auction items remains negative and significant post mortem (Model 4), even after controlling for reputation and age at death. Here, both the reputation and age coefficients exhibit a positive relationship with the post mortem dummy.

We graphically illustrate these effects in Figure 12, where we present the marginal effects of ($\log$) hammer prices posthumously at different age-at-death levels, divided into two groups: artist with high and low exhibition reputation at the time of death. Again, our reputation measure enables us to approximate the level of reputation at the time of death, derived from a separate source of information, i.e. the exhibition reputation measure. However, we advise caution in interpreting the results for artists who died at age 40 or younger, as the number of

observations in this category is relatively small. Nevertheless, the results are positive and significant for artists who died around the age of 65 as well, with lower reputation artists facing a higher price premium posthumously. It is important to note that high-reputation artists generally exhibit a positive postmortem coefficient, while low-reputation artists show a change in coefficient direction for those who died around the age 79.

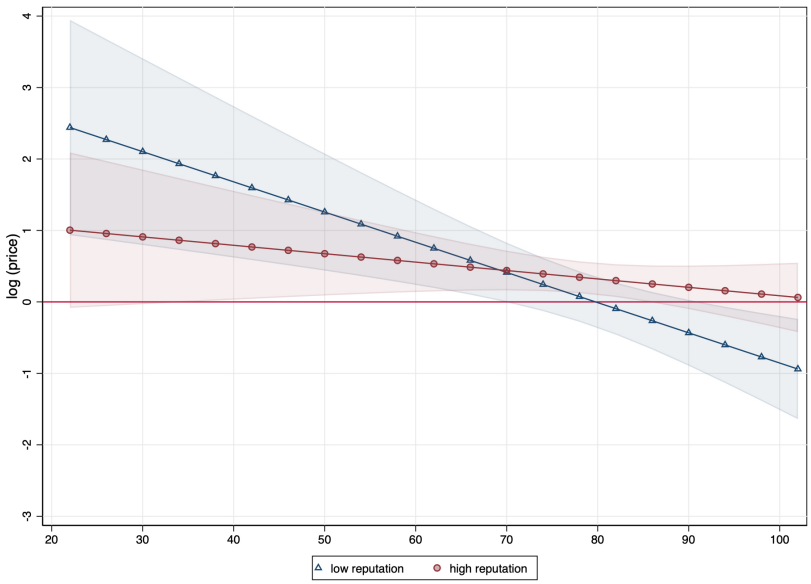

Figure 12: Auction price: marginal effects posthoumously across repuation and age at death

Note: This figure shows the average marginal effects for the overall death effects for different levels of 'age at death', divided in two samples of artists, high and low reputation at death. The dependent variable is (log) price of auctions. The model includes artist, year and month fixed effects and hedonic controls of the artwork/ transaction characteristic. Standard Errors are clustered at the artist-level.

In sum, auction prices seem to consistently increase post mortem. Artists who pass away at a younger age experience a higher price premium, with effects diminishing for older artists. Interestingly, artists with a lower reputation at the time of death see higher post mortem price premium.

6 Mechanism Discussion

In this paper, we can establish a causal negative short-term effect of death on exhibitions, and a positive price premium on secondary auction markets. Still, we find substantial heterogeneity in the treatment effect, the effect being subject to age and reputation of the artist at death.

Effect direction changes for younger dying and more reputable visual artists. Both groups see an increase in the number of post mortem exhibitions. In the following paragraphs, we describe three different economic mechanisms that can help explain our estimates.

A first potential mechanism is promotional effects and media coverage around death. Arguably, this mechanism seems well suited to explain a temporary increase in exhibitions of certain groups of artists. We anecdotally explore the mechanism and investigate google search traffic around death for a subsample of artist.[22] Search data (not reported) shows that relative search volumes increases around death (for artists in the top 20). However, higher traffic is limited to 2-3 months before and after death. Additional explorations using google's n-gram data indicate that book mentions of artists tend to decline after death. As media and book coverage around artists do not systematically increase in post mortem years we conclude that this mechanism cannot explain the rise in exhibitions, at least among more reputable artists.

A second explanation is complementary market effects. Here the basic intuition is that higher secondary market prices drive up insurance and hence exhibition cost. Insurers will charge fees depending on the current valuation of artworks on auction markets (Amsellem, 2013). As post mortem prices are likely to increase after death, insurance cost for a museum loan to an exhibition will rise as well. Note again that insurance cost make up for the gros of exhibition cost. While we cannot directly observe insurance cost for exhibitions, we focus on changes in complementary auction markets to further validate this mechanism. Again, figure 11 shows robust findings for an event study with logged average auction prices achieved in years before and after death. They provide supporting evidence for this mechanism. We can document a clear increase in post mortem auction prices, in line with the literature (Ursprung et al., 2021) and consistent (at least in the short-term) with the argument that insurance will rise and make new exhibitions more costly after death. [23] In the longer run, this effect might break even, as more popular (superstar) artists also generate high income for the museum (through tickets sales, merchandising, etc.), as discussed in the introduction of this study.

[22] We restrict the overall sample to artists dying after 2004 as Google search data is only available as of 2004.

[23] If this mechanism is the only one to explain fewer exhibitions post mortem, we expect to observe a more pronounced decline in exhibitions for younger artists who have a higher postmortem price premium. However, this does not appear to be the case in our analysis. As younger dying- and low reputation artists negatively correlate with auction prices before the death (not reported), this objection is might simply explained by differences in baselines of pre-mortem prices.

The last related mechanism is transaction cost. Death can require costly negotiations of museums and other exhibitors with heirs as the new owners of artworks, estate management and post mortem contracting with multiple parties (for example, establishing a foundation or processing the donation of artworks). Negotiations around artworks can be difficult and time-consuming as public and private interests of artists, heirs and museums might diverge (Hecker and Karol, 2022).[24] Death can also require the transfer and clearance of various types of rights granted to the original artist and other parties (for example, post mortem right of publicity, copyright and other rights, as applicable). As shown in the legal literature this can give rise to dead-hand control problems in the case rights are not transferable (Rub, 2021) and it raises important questions on legacy stewardship when legacy planning was poorly performed or is challenging for other reasons (Gilden, 2019).[25] Transaction cost after death typically must be incurred before new exhibitions can be installed. These various types of transaction cost may add to the higher insurance cost issue described above. However, transaction cost are difficult to measure and systematic data is currently unavailable or confidential. Total transaction cost are likely to increase after death and at least partially will explain the negative short-term effect on exhibitions we document.

7 Conclusion and future research

This paper investigates the commercial afterlife of artists, in particular the effect of artist death on museum exhibitions and secondary art markets. Using a regression discontinuity and event study design, we can identify the causal effect of death on artist appearances in museum shows, based on global exhibition records spanning several decades. We find some support for the basic idea that "ars longa, vita brevis" and that there is posthumous commercial value in visual artworks, even though the empirical pattern we reveal is somewhat more nuanced.

Compared to living artists, deceased artists see fewer exhibitions on average, and arguably

[24] For example, taxation rules and other post mortem regulation around estates can force artists' estates to sell off artworks quickly to cover tax obligations (Li et al., 2022). At the same time, public and not-for-profit museums typically focus on the preservation of cultural heritage and may be less guided by commercial motivation.

[25] For example, letting artists posthumously control the use of the works they created can lead to dead-hand control problems (Rub, 2021). Relatedly, clearing long-term and posthumous rights often entails significant transaction costs. The restrictions on transferability of moral rights in some jurisdictions may exacerbate the issues.

their artworks are less well preserved and represented after death. However, this exclusion effect is short-lived and roughly ten years after death, exhibition numbers are back to pre-death levels. We find substantial heterogeneity in the treatment. In line with previous literature, this is due to the age and reputation of the artist at death.

Complementary analysis of auction outcomes for the same artists reveals a positive price premium and reduced likelihood of non-sales after death. We find robust evidence of a significant price increase of approximately 16 to 19 percent post mortem, even after accounting for age and reputation at death. Notably, increases in post mortem prices are primarily driven by artists who die at a younger age and those with lower reputation at death.

As we have argued in paper, the temporary posthumous decline in exhibitions is an outcome of higher insurance and exhibiting costs museums are facing after the death of the artist. This is likely due to the observed posthumous increase in secondary market prices we also document in line with the previous research (Ursprung et al., 2021). In itself, this is an interesting finding as provenance information - including information on past exhibitions - is also a signal of quality and trust in the price formation on auction markets (Li et al., 2022). After death, as we have shown, this information temporarily becomes less readily available. Clearly, more research is needed to better understand interdependencies between complementary markets.

The other plausible mechanism we identify and discuss is transaction costs. This mechanism, although described in aggregated form, might best explain our temporary but significant drop in exhibitions following the death of artists. These findings raise interesting questions about the posthumous commercialization of artworks and legacy stewardship in light of public policies. This is another important area of study left for future research.

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