

# EMPIRICAL ESSAYS ON THE ECONOMICS OF CREATIVE INDUSTRIES

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Empirical essays on the economics of creative industries

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# Abstract

Copyright is a crucial component of creative industries, particularly in the visual arts sector, as it balances the costs of limited access to creative works with incentives to create new works. This thesis begins with a concise overview of the existing economic copyright research, with a specific focus on empirical literature (**Introduction**). The thesis continues with three empirical essays that address multiple aspects of the economics of creative industries, specifically the visual arts sector and the economic effect of copyright law.

Chapter **1** examines a change in the legal framework of litigation risks around a particular art movement. Specifically, the chapter exploits a US higher-court decision on liability of market intermediaries on the trade of potentially infringing artworks. By using a difference-in-differences design and global auction records, the findings suggest a temporary decline in the total number of global auctions of affected artworks, a lower sales probability, and a relocation of related auctions to non-US houses. Chapter **2** provides quantitative evidence from digital museum collections on how the copyright status affects the availability and image resolution of digital images of artworks. The empirical results are based on data from digital platforms and Google reverse image searches and exploit a significant change of the US copyright law by applying a regression discontinuity design. The chapter provides evidence of a strong increase in the availability of digital surrogates once copyright expires and original artworks transition to the public domain. Furthermore, surrogates of public domain artworks made available by museums are of higher average image resolution quality compared with digitized artworks still protected under copyright laws. Finally, Chapter **3** studies the death effect on artists' exhibitions and commercial success in the secondary art market, using a novel panel dataset of exhibition histories and auction transactions. By applying an event study design to analyze the main results, the estimates reveal a short-term negative impact on exhibiting artworks. Next, the research provides robust evidence of a price premium for deceased artists compared with auction outcomes for living artists. Moreover, substantial heterogeneity exists in the treatment effects depending on the artist's age and reputation at death, which complements previous research using auction data.

**Keywords:** visual arts, copyright; museums; auctions; exhibitions; digitization; creative industries; public domain; liability; transaction costs.

**JEL Codes:** D44; L17; O31; O34; Z11



## Résumé

Le droit d’auteur est une composante essentielle des industries de la création, en particulier dans le secteur des arts visuels, car il permet d’équilibrer les coûts de l’accès limité aux œuvres de création et les incitations à créer de nouvelles œuvres. Cette étude commence par une présentation rapide de la recherche sur la dimension économique du droit d’auteur, notamment de la littérature empirique (**Introduction**). Elle se poursuit par trois articles empiriques qui abordent de multiples aspects de l’économie des industries de la création, en particulier le secteur des arts visuels et l’impact économique de la législation sur le droit d’auteur.

Le chapitre **1** examine un changement apporté au cadre juridique des risques de litiges concernant un mouvement artistique particulier. Plus précisément, il analyse une décision rendue par une haute juridiction américaine sur la responsabilité des intermédiaires du marché dans le cadre du commerce d’œuvres d’art potentiellement contrefaisantes. En utilisant un modèle de doubles différences et les registres de ventes aux enchères mondiales, les conclusions indiquent une diminution temporaire du nombre total de ventes aux enchères mondiales des œuvres d’art concernées, une probabilité de ventes plus faibles et une délocalisation des ventes aux enchères connexes vers des établissements situés hors des États-Unis d’Amérique. Le chapitre **2** contient des données quantitatives issues des collections numériques des musées sur la manière dont la situation en matière de droit d’auteur affecte la disponibilité et la résolution des images numériques d’œuvres d’art. Les résultats empiriques sont fondés sur des données provenant de plateformes numériques et des recherches d’images inversées sur Google et exploitent une modification importante de la loi américaine sur le droit d’auteur en appliquant un modèle de régression sur discontinuité. Il est démontré dans ce chapitre qu’il existe une forte augmentation de la disponibilité des substituts numériques après que le droit d’auteur a expiré et que les œuvres d’art originales sont tombées dans le domaine public. En outre, la qualité moyenne de la résolution d’image des substituts d’œuvres d’art tombées dans le domaine public et mises à disposition par les musées est supérieure à celle des œuvres d’art numérisées encore protégées par les lois sur le droit d’auteur. Enfin, le chapitre **3** étudie l’effet du décès sur les expositions d’artistes et leur succès commercial sur le marché secondaire de l’art, à l’aide d’un nouvel ensemble de données de panel recueillies lors d’expositions et de ventes aux enchères dans le monde entier. En appliquant un modèle d’étude d’événements pour analyser les principaux résultats, les estimations révèlent un impact négatif à court terme sur les expositions d’œuvres d’art. Ensuite, l’étude fournit des preuves solides d’une majoration de prix pour les artistes décédés par rapport aux résultats des ventes aux enchères pour les artistes vivants. En outre, il existe une hétérogénéité importante dans les effets du traitement selon l’âge et la réputation de l’artiste au moment de son décès, ce qui correspond aux recherches antérieures fondées sur des données de ventes aux enchères.

**Mots-clés:** art visuel; droit d'auteur; museum; enchères; exposition; digitization; industries créatives; domaine public; responsabilité; coût des transactions

**JEL Codes:** D44; L17; O31; O34; Z11

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# Introduction

This thesis comprises three essays that address multiple aspects of the economics of creative industries, specifically the visual arts sector and copyright law. Chapter 1 investigates the economic impact of legal uncertainty for market intermediaries, and the findings suggest negative consequences in the secondary art market for trading potentially copyright-infringing artworks. Chapter 2 explores the digitization of artworks from museum collections, and the findings suggest an increase in online availability and image resolution when artworks are no longer protected by copyright. Lastly, Chapter 3 examines the immediate postmortem impact on exhibiting and auctioning artworks. It discusses potential mechanisms of limited supply, rights negotiation with estates, and longer-term effects on the commercialization of artworks. Essentially, this thesis presents three empirical essays that aim to analyze economic effects in the creative economy, with a particular emphasis on the visual arts sector. While their primary focus is on this sector, the essays share the following key features: an extensive data collection process, primarily using custom-built web scrapers to extract novel data from the Internet, and the application of up-to-date econometric tools to quantify causal impacts. The purpose of this introduction chapter is to provide a concise overview of the emerging field of empirical copyright research, summarize the three chapters, and compile the underlying literature to which this thesis contributes.

Exclusive intellectual property rights temporarily granted to creators (e.g., copy-

right) are essential drivers of the creative industries, as they provide critical economic incentives to create and distribute new works (Giorcelli and Moser, 2020; Towse et al., 2001, 2008). Still, intellectual property policies also cater to other sources of incentives to create, such as the intrinsic motivation of creators, furthermore, they complement the various other types of public support, most notably cultural policies and private sector support (Towse, 2006). Cultural and creative industries significantly contribute to gross domestic product (GDP) in terms of their economic size, ranging from 2% to 11.2% (WIPO, 2021). In the US, for instance, these industries provide 6.2 % of all employment (UNCTAD, 2022), and copyright-intensive industries even account for a larger share of US employment than patent-intensive industries (Li et al., 2018). Moreover, according to the global art market study by McAndrew (2023), the global art sales market alone generated a trade value of 67.8 billion in 2023.

Despite the economic importance of these sectors, empirical research on the impact of copyright in them remains relatively scarce (Towse, 2011; Handke, 2011, 2012). Watt (2009) provides a meta-analysis and organizes the findings into the following helpful categories: the supply-side effects of copyright (i.e., royalty earnings, innovation incentives, collective management, creativity, and follow-on innovation); demand-side effects (i.e., piracy, copyright infringement, and consumer willingness-to-pay); and other aspects of copyright mechanisms (i.e., optimal copyright term, copyright expiration, and copyright breadth). The effects can be further divided into short-term (e.g., piracy and revenue-sharing) and longer-term consequences (e.g. follow-on innovation and cumulative creativity) (Handke, 2011).

Two primary areas of empirical research on copyright can be identified. First, scholars have investigated the book publishing industry, examining the effects of copyright on availability, pricing, and overall welfare implications (e.g., Heald, 2014;

Buccafusco and Heald, 2013; Heald, 2019, 2007; Nagaraj, 2018; Reimers, 2019; Li et al., 2018). These studies typically suggest an increased availability and lower price of creative works in the absence of exclusive copyright protection. As a consequence of lower competition levels under copyright protection, the dynamic impact of longer intellectual property rights terms may reduce overall welfare (Reimers, 2019).

Second, a substantial number of studies have addressed questions related to copyright and the music industry (e.g., Giorcelli and Moser, 2020; Oberholzer-Gee and Strumpf, 2007; Waldfoegel, 2012; Kretschmer and Peukert, 2020; Aguiar and Waldfoegel, 2016, 2018c,a). Literature on the digitization of the music industry has examined the negative impact of piracy on licensed consumption (i.e., sales) (e.g., Rob and Waldfoegel, 2007, 2006). In recent years, music streaming platforms such as Spotify and Apple Music and their growing online catalogs have generally exhibited substitution effects for music piracy, with less of an impact on revenues (e.g., Nguyen et al., 2014; Thomes, 2013; Aguiar and Waldfoegel, 2018a).

A significant limitation of copyright research and a severe constraint on the data available for new research is the absence of registration formalities in most national copyright laws and international treaties. Simply put, in contrast to patents and their registration process, copyright protection automatically applies from the moment of creation and the first "fixation" of the work, with no registration required for formal protection. This presents a challenge from an empirical research perspective. This thesis contributes to recent literature in economic copyright research, which has proposed novel and creative data collection processes and analyses thereof (e.g., Nagaraj, 2016, 2018; Reimers, 2019; Watson, 2017a,b), serving as inspiration for this thesis. Nevertheless, in each of the three essays, a conscious effort is made to carefully compile new data sources and explain the collection processes. The ultimate goal is to

make the data and collection files available to other researchers, allowing for replication and encouraging follow-up research. As a next step, in all chapters, up-to-date econometric tools and identification strategies are applied to examine causal effects. Moreover, the methodologies in the empirical framework sections include difference-in-differences designs, event studies, and regression discontinuity designs.

In the spirit of the mentioned articles, this thesis aims to contribute to and advance the stream of literature on copyright research in a field that has attracted less attention from scholars, namely the visual arts sector. The following paragraphs summarize the three chapters, the closely related literature, and the main findings.

**Chapter 1** examines the prominent *Cariou v. Prince* US higher court case, which focused on a copyright infringement dispute between two artists (Sarmiento and Haaften-Schick, 2013; Adler, 2016). The 2013 ruling extended infringement liability to market intermediaries, such as auction houses or galleries, increasing legal uncertainty in the art market and their exposure to liability risk (NewYorkTimes, 2011; Adler, 2016). The the main focus of the chapter is how changes in legal frameworks and litigation risks affect commercial trade around artistic reuses in appropriation art. Therefore, the study applies a difference-in-differences design to compare auction outcomes pre- and post-court ruling of copyright infringing, ‘appropriation’ artists who are affected by the change in law practice, base-lining them to a control group of similar artists.

The chapter contributes to the economic debate on the appropriate balance of copyright in cumulative creativity by suggesting that broad copyright might impede reuse and follow-on innovation (Heald, 2014; Nagaraj, 2016; Watson, 2017b; Reimers, 2019; Watson et al., 2023). However, well-balanced rights might help to increase

the total production of original works and remixes (Gans, 2015; McLeod and Di-Cola, 2011). Interestingly, the visual arts sector is an ideal angle for tackling these questions, as copying in art has become a central subject of contemporary art and a battleground for copyright (Adler, 2016; Evans, 2009; Ames, 1993; Irvin, 2005; Okpaluba, 2002; Schaumann, 2015). Generally, secondary art market outcomes have been extensively studied, therefore, the chapter also relates to this essential art auction literature (e.g., (Mei and Moses, 2001; Ashenfelter and Graddy, 2003, 2006, 2011; Beggs and Graddy, 2009)). Yet, only a few - if any - empirical studies have discussed the economic impact of indirect liability (Landes and Lichtman, 2003) and copyright infringement in the visual arts market in particular.

The study presented in this chapter finds robust evidence that the global auction trade of treated appropriation artists, at least temporarily, decreases and partially relocates to other, non-US jurisdictions following the decision. By using hedonic price models, the study examines critical artwork price characteristics but it does not find a systematic change in prices for post-periods. Notably, for artworks listed in auctions, the sales probability of potentially infringing (i.e., appropriating) artworks decreases in this period. The results highlight heterogeneity in the treatment, as effects are most pronounced for artists of a specific art movement that has pioneered appropriation techniques.

Next, **Chapter 2** explores the impact of the copyright or public domain status of a creative work on its distribution in the market. It investigates how the legal status of a physical artwork impacts the availability and quality (in terms of image resolution) of online museum collections. Specifically, the study employs a regression discontinuity and difference-in-differences design to estimate the online availability of artworks from US collections on digital platforms, leveraging a quasi-natural ex-

periment made possible by a significant change in US copyright law. The empirical analysis is built on a novel aggregated dataset of digitized artworks available in the online collections of museums. As a next step, for each identified artwork, *Google reverse image searches* are conducted to collect systematic information on digitized artwork images and their downstream reuse across the Internet.

The chapter adds to a growing body of literature, mostly focused on the book market, by suggesting that when works fall into the public domain, the supply of new copies increases (Biasi and Moser, 2021; Heald, 2020, 2014, 2007; Reimers, 2019; Flynn et al., 2019; Li et al., 2018; Buccafusco and Heald, 2013). By examining the visual arts sector, this chapter provides insights into a less studied creative sector. Two studies on the distribution of images are closely related to this research. First, Heald et al. (2015) find a negative relationship between copyright status and the use of photographic materials in the biographical entries of novelists and their appeal to readers on Wikipedia. Second, Nagaraj (2018) uses variation in the copyright status of magazines digitized under the Google Books project to measure reuse on Wikipedia. They find that copyright has a larger negative impact on the reuse of images compared with text. The research developed in this chapter expands and goes beyond this approach, by not only addressing status-induced supply changes, but also, for the first time, exploring the changes in the quality of supply depending on copyright status.

The causal evidence from Chapter 2 on the digitization of museum collections reveals a strong increase in the availability of digital ‘surrogates’ once copyright expires and original artworks transition to the public domain. Moreover, artworks and surrogates made available see numerous *downstream* reuses across the Internet. This indicates that online availability is of commercial and public value independent of

right status. Interestingly, the study also finds a negative relationship between the copyright status of an artwork and the average quality (resolution) of the digital surrogate image provided online.

Then, **Chapter 3** studies the death effect, as a signal of limited supply, on artists' exhibitions and commercial success in the secondary art market. Specifically, it examines the following questions: Is there a commercial afterlife for an artist and their artwork? How do the two important art markets - namely the auction and exhibition markets - react to such a signal? The chapter also discusses the underlying economic mechanisms, such as higher postmortem transaction costs, as right ownership and transfer might need to be renegotiated with the estate of the artist before new auctions and exhibitions can be set up. The study uses a dataset of worldwide exhibitions and auction outcomes of a random sample of 1,000 artists and employs a regression discontinuity- and event-study design to analyze commercial success in the auction and exhibition markets.

While the research adds to the general auction literature referred to in Chapter 1, the results contribute empirical evidence and provide new insights for the specific auction literature on death effects (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). These pioneering studies have found substantial heterogeneity in the treatment effect. For instance, Ursprung et al. (2021) disentangle the determinants of composite death effects, based on the age and reputation of artists at death. They find a negative relationship between age at death and auction prices, with a vanishing effect for artists who die at an old age. Once they control for reputation levels, artists dying young increases the market value of their artworks, particularly if they have already established a significant reputation. Chapter 3 adds insights

to an understudied field of the visual arts sector, namely museums and exhibitions. The study argues that museums are important price makers in auction markets, as they can help build an artist's reputation and visibility (Fraiberger et al., 2018). By curating and exhibiting works, museums provide crucial market signals of quality and trust to art markets as well impact the general price formation in auction markets, as they provide otherwise scarce information on the provenance and economic value of artworks (Li et al., 2022).

The empirical results from Chapter 3 indicate a negative effect of an artist's death on the number of exhibitions. However, this is a short-term effect and, approximately 10 years after the artist's death, exhibitions are back to pre-mortem levels. Moreover, the research provides robust evidence of a price premium for deceased artists compared with auction outcomes for living artists. Moreover, substantial heterogeneity exists in the "treatment" effects depending on the artist's age and reputation at death. The study implements an exogenous measure of reputation at death (from exhibiting at reputable venues) to test for more nuanced signals on auction markets. Notably, increases in postmortem prices are primarily driven by artists who die at a younger age and those with a lower reputation at death. In addition, the chapter explains the posthumous decline in exhibitions with increasing (legal) transaction costs for exhibiting artworks. For example, negotiations around artworks can be difficult and time-consuming, as the public and private interests of artists, heirs, and museums might diverge (Hecker and Karol, 2022). Thus, the death of an artist can lead to costly negotiations between exhibitors with heirs and estate management, and it may also involve postmortem contracting with multiple new parties (e.g., for establishing a foundation or processing the donation of artworks).

Finally, the **Conclusion** section summarizes and discusses future research paths

that could help to fill certain gaps in the literature.



# Chapter 1

## Intermediary liability and trade in follow-on innovation

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## 1.1 Motivation

Recent research has helped to understand artistic innovation and creativity over an artist's career (Galenson, 2010). Many innovations in arts are cumulative, with new artists being influenced by their predecessors and existing culture (Irvin, 2005; Schau-mann, 2015). Such an evolution goes back to Renaissance art, when artists were inspired by classical art and developed sequential artistic innovations building on the achievements of each other. And it is even more evident in contemporary art. In recent times, the appropriation art movement <sup>2</sup> is a prominent example of cumulative creativity and innovation (Landes, 2000; Ames, 1993; Welchman, 2013; Evans, 2009). Since the 1980s, appropriation artists have been "deconstructing and recontextualising" pre-existing materials by incorporating photographic sources, advertising materials and other types of artistic work into their new derivative artworks (Evans, 2009). By incorporating pre-existing material, they risk infringing the rights of other artists and rights holders. Copying in general has become a central subject of contemporary art because of the shifts in both the art itself and the available technology (Adler, 2016). This and many other examples exemplify the process of imitation and innovation in the figurative arts, which has played a significant role in the development of various art movements and styles. The economics of art history focuses on how market factors and institutional changes affect the creation and the trade of artworks. Dealers and collectors in art markets recognize that the most innovative art becomes the most valuable over time, with many novel uses of old genres and the creation of some new ones in the art of the twentieth century (Galenson, 2009a). Changes in intellectual property rules may have also affected the development of various art movements and styles throughout history, as laws impacted the production and diffusion of new art. The question of how changes in legal frameworks and litigation risks affected market value and commercial trade around artistic reuses in the

appropriation art is the main focus of this paper.

Intellectual property rights impact how much artists will create and can build on the work of their predecessors. Copyright laws balance economic incentives for both original and follow-on creators, but also provide incentives for commercialization and sales to market intermediaries and traders. Most countries grant artists exclusive rights to their work for a certain period of time. Under moderate copyright terms (copyright length), laws can generate incentives to create new original work, as documented in pioneering research on Italian opera under the Napoleonic Empire (Giorcelli and Moser, 2020). However, this also means that other artists must obtain permission or a license to reuse or build upon the work of their predecessors and may have to pay fees or royalties. Broader terms (copyright breadth) can impede cumulative creativity and limit follow-on innovation in various industries, including recorded music, book publishing, scientific production, and knowledge reuse on Wikipedia (Nagaraj, 2016; Watson, 2017a; Reimers, 2019; Biasi and Moser, 2016; Watson et al., 2023).

In recent years, the appropriation art movement has become a central battleground for copyright infringement cases (Adler, 2018). Not only artists, but galleries, auction houses, and museums alike have been held liable for infringing rights when reusing, selling, or exhibiting these works in art markets. Our research uses hedonic price-models, a difference in differences design, and data from online services to quantify the impact of the prominent *Cariou v. Prince* United States (US) court decision and changes in perceived fair use rules on the level of trade and commercial availability in Appropriation Art. In this defining case of appropriation art (Sarmiento and Haaften-Schick, 2013), the photographer Patrick Cariou sued the well-known appropriation artists Richard Prince and the Gagosian Gallery promoting the latter artist for copyright infringement, arguing that fair use did not apply to Prince's follow-on

artwork. As an exogenous shock to the art market, the 2013 court decision ultimately extended infringement liability to market intermediaries (Gagosian Gallery), thereby increasing legal uncertainty in the auction market. We find that the total number of global auctions declined following the decision and that some trade in Appropriation Arts temporarily relocated to jurisdictions outside the US due to concerns over contributory liability and legal uncertainty. The sales probability of artworks listed in auctions also decreased. Effects on auction trade and curation continue to hold after controlling for superstar artists.

This paper contributes to the understanding of how market institutions such as copyright affect artistic innovation and cumulative creativity in figurative arts. It adds to the individual-level determinants and greater artistic freedom in competitive markets for contemporary art discussed in the economic art history literature (Galenson, 2010). And, it confirms the effect of broader laws on cumulative creativity and follow-on innovation found in previous research (Nagaraj, 2016; Watson, 2017a; Reimers, 2019; Biasi and Moser, 2016; Watson et al., 2023). As we can show in this paper, under broader terms of copyright protection, extended liability rules can change the relative market value and growth potential of certain art movements and appropriating styles that rely heavily on older work. This in turn affects the general direction of the figurative arts and trade in those art movements. Some production and follow-on innovation with greater exposure to legal risk is likely to be redirected to alternative and lower-risk art genres and investment fields that rely less on the art of predecessors.

Second, the research shows that the impact of legal uncertainty in the copyright framework affects and "trickles down" on market intermediaries such as auction houses and galleries. Accordingly, causal findings corroborate the basic argument

developed in the theoretical literature (Wu, 2004; Landes, 2000). Similar to the direct effect of broader copyrights on reuses (Scotchmer, 1991; Murray and O'Mahony, 2007; Green and Scotchmer, 1995), legal uncertainty around indirect liability rules impedes commercial trade and limits curation around follow-on innovation (Landes and Lichtman, 2003). This is important to note for the creative and cultural sectors, as intermediaries such as museums, galleries, or auction houses are important gatekeepers in the art market.

Third, research results contribute to the larger debate about how the (complementary) fair use doctrine under US copyright law compares to (only) closed list of copyright exceptions in other countries, and whether fair use creates legal uncertainty because of its vague, standard-like nature (Beebe, 2008; Sag, 2012). In this paper, we provide first-hand quantitative evidence on the actual costs and market charges for imposing indirect liability on intermediaries within the fair use doctrine. In this way, our findings also add to the generic law and economics literature on resource allocation and transaction costs with its strong focus on theory development (Coase, 1960; Calabresi, 1960; Posner, 1972; Depoorter and Parisi, 2002a; Marciano, 2012).

Fourth, previous studies have documented how differences in national copyright laws can push trade to foreign jurisdictions as well as the broader economic effect of resale rights (Watt et al., 2014; Ginsburgh et al., 2005; Ginsburgh, 2005; Banternghansa and Graddy, 2011). In a similar vein, Landes and Lichtman (2003) argue that indirect liability creates incentives for online music platforms to shift services to jurisdictions that offer them more favorable rules. Our findings show that legal uncertainty around the fair-use doctrine, as reflected in US copyright judicial decisions, can force the relocation of auction sales to foreign jurisdictions with less uncertainty. To the best of our knowledge, this is the first study to document such an effect.

The chapter is structured as follows. Section 1.2 provides an overview of the economic literature and some legal background on the reuse of images in the visual arts. Sections 3.4 and 3.5 present the data and the empirical framework. Section 2.6 gives results and robustness checks. Section 2.7 discusses policy implications and section 2.8 concludes.

## 1.2 Previous Research and Legal Background

### 1.2.1 Literature Review

While quantitative studies in copyright economics focus on creative and cultural industries such as books, music, and movies (Reimers, 2019; Adermon and Liang, 2010; Aguiar and Waldfogel, 2018b; Towse, 2017; Giorcelli and Moser, 2020), relatively little research has been done on the scope of copyright and on the visual arts sector.<sup>1</sup> The role of copyright in the visual arts differs significantly from other sectors. First, there is likely lower demand for copies of visual artworks. Even at low prices, copies would be poor substitutes for original works and, traditionally, there is a limited market for print-multiples (Becker et al., 2000; Buccafusco et al., 2017). Second, there is a high premium value attached to the original artwork and ‘authenticity’ in general (Watt et al., 2014). In a similar vein, Landes and Levine (2006) argue that the general economic case for copyright protection is weakened for unique works such as paintings since the artist’s main income source is the first sale of the original work (in the absence of resale rights). Overall, for several reasons being copied seems less of a threat to visual artist’s work and the appropriation of value than it is for writers,

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<sup>1</sup>For example, Watt et al. (2014) develops economic theory in the visual arts describing how copyright can help artists exploit their works by creating a secondary market for copies and reproductions.

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composers, or performers in other sectors (Landes and Levine, 2006).

Still, there is an area of visual arts where copyright laws play a decisive role, namely, in *Appropriation Art*, where copying others' work is the modus operandi (Evans, 2009).<sup>2</sup> Therefore, rules on the scope of copyright also will need to coordinate between different generations of creators and balance the sharing of economic value over time when their work is 'sequential' in nature. There is an argument in the literature that copyright is sometimes overreaching in the scope it provides to original creators compared to their successors (Buccafusco et al., 2017). National and international laws and legal traditions treat these reuses of works differently, also in the visual arts. For example, in certain jurisdictions, moral rights enshrined in copyright frameworks might require successive artists to credit and have their reuses of (selected) original works 'authorized' ex-ante, and also have follow-on creations reviewed and approved by original creators. Practically, these grant the latter a veto option toward commercialization of the 'derivative' work, which aims to ensure the 'integrity' of the original work and its creator. In other jurisdictions, 'fair use' limits copyright protection and allows for unauthorized copying in circumstances that roughly try to adapt to economic efficiencies (Landes and Posner, 1989). It is worth

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<sup>2</sup>The concept of copying and using existing materials in art has evolved over time. Early 20th century avant-garde artists like Pablo Picasso incorporated objects from other artists into their works and collages as an archetypal conceptual innovation (Galenson, 2009a), while Marcel Duchamp repositioned ordinary objects (ready-mades) in the museum setting. The 1960s Pop Art movement saw the reuse of advertising materials and famous images like the Mona Lisa. Contemporary artists from the Pictures Generation like Sherrie Levine, Elaine Sturtevant, Louise Lawler, Cindy Sherman or Richard Prince have raised generic questions about originality and authenticity through their use of existing art in new works. For example, the famous *Cowboy Series* is emblematic of the artwork by Prince, where he rephotographed Marlboro's (older) advertisements (Phillips, 2021). Sturtevant reproduced artworks by contemporary artists which were visually indistinguishable from the originals, probably best known for her series titled *Warhol Flowers* (Artnet, 2021). In a similar vein, Levine photographed reproductions of the male photographer Walker Evans (titled *After Walker Evans*) and replicas of Duchamp's Urinal titled *After Marcel Duchamp*, partially because she wanted to highlight how female voices were undervalued in the art world (MET, 2021; Tate, 2021). Other forms of appropriation art practices include détournement, pastiche, rephotography, and parody (Evans, 2009).

noting in this context that copyright limitations in other jurisdictions may not be as "favorable" to appropriation art as the US fair use defense can be (Geiger, 2020; Lucas and Ginsburg, 2016). In particular, the latter doctrine has included in the US the concept of 'transformativeness' which should protect creativity by allowing to some extent new creative artwork building on pre-existing works (see the section 1.2.2 "Copyright Rules and the Reuse of Images" and Adler (2016)), based on the idea that this can safeguard artistic freedom and space to operate.

Landes and Lichtman (2003) were first to discuss the economics of indirect liability for infringement. From the perspective of the law, indirect (or contributory) liability is an alternative mechanism to rights enforcement. Direct infringers often rely on technology, services, and venues provided by other third parties and these parties can be held liable for "facilitating" infringement even when most of their sales are legitimate. As a consequence of indirect liability, for example, online hosting platforms might be asked to invest in and implement new enforcement and filtering technologies to comply with laws. Whether or not an indirect liability of intermediaries can provide a more effective route of enforcement than enforcing rights with direct infringers is not clear *ex-ante* and needs assessment.<sup>3</sup> Landes and Lichtman (2003) argue that the proper scope for indirect liability can be determined by weighing its costs and benefits against those associated with other plausible mechanisms for rewarding creators which replicates their general idea in other papers to fully account for the cost of maintaining the copyright system when defining its boundaries. Our research makes an important contribution to that discussion by providing quantita-

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<sup>3</sup>In a similar vein, according to (Landes and Lichtman, 2003), adjustments to the scope and duration of copyright protection can provide an alternative approach to imposing indirect liability because that also tailors the incentives to create and disseminate works. In general, there is vast empirical literature on the effects of different types of interventions and enforcement rules on the levels of infringement online and offline which due to space constraints we will not cover here. For an overview, see Danaher et al. (2017).

tive evidence on some of the actual costs and market charges for imposing indirect liability on intermediaries. Because they can also be held liable, they might be less willing to curate and offer reuses that are possibly infringing goods to buyers.

Moreover, this research contributes to the debate on the appropriate balance of copyright in cumulative creativity, suggesting that broad copyrights might impede reuse and follow-on innovation (Nagaraj, 2016; Watson, 2017a; Reimers, 2019; Biasi and Moser, 2016; Watson et al., 2023). Several of the underlying economic mechanisms around creative reuse deserve attention here. First, copyright incentivizes original creators to consider the additional value of productive reuses or ‘remixes’ downstream, without cannibalizing their own returns (Watson, 2017b). In this way, well-balanced rights might help expand the total output of original works and remixes (Gans, 2015; McLeod and DiCola, 2011).

Second, it may take the establishment of fair use rules or pre-set compensation schemes to overcome strategic hold-up and transaction costs problems around the efficient licensing of such reuses, in particular for productive rather than reproductive ones (Landes and Posner, 2003; Posner, 2004; Landes et al., 2003).<sup>4</sup> Put differently, the economic efficiency around fair use can include circumstances with high transaction costs in which the benefits to the copier are higher than the costs of negotiation with the upstream right holder (Landes and Levine, 2006). For example, Watson (2017b) argues that hip-hop artists reusing pre-existing recordings (i.e. digital sampling in music) spend excess information and search costs before they can enter negotiations over licenses with the relevant right holders. Thus, licensing together with sunk cost creates hold-up inefficiencies for potential reuses.

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<sup>4</sup>That said, e.g. visual artists rights associations and registries offer support for licensing to those who want to reproduce works of visual art, mostly reproductions of their artwork in e.g. books, postcards or merchandise (Posner, 2004).

Third, when downstream artists invest in creating a derivative work based on multiple sources, complementarities arise between original works (Watson, 2017b). As a result, right holders might individually charge higher licensing fees above the optimal level, so-called ‘royalty stacking’ increasing the cost of downstream reuses, an issue previously discussed in the context of patents (Farrell et al., 2007). In yet another paper, Watson (2017a) uses a matched-sample difference-in-differences design and reproductive ‘reuse’ instances as a quasi-exogenous shock to the music streaming of the original/underlying song. Using Spotify’s similarity algorithm, he finds that downstream reuses exhibit positive demand effects via advertising on the streaming of original songs, thereby moderating competition from reusing songs. These effects are larger for less prominent artists and first-time reuses of original songs. Both papers (Watson, 2017b,a) serve as an inspiration for the research design and methodological approach developed in this paper.

Reuses in appropriation art in particular are often productive rather than reproductive in nature. Hence, it is unlikely that, in this particular field of visual arts, downstream works do more harm to original works and will cannibalize their anticipated licensing revenues as in other sectors (Landes, 2000; Martin, 1985; Watson, 2017a). Rather it seems, based on the literature on cumulative creativity and copyright effects, artistic freedom to operate and reuse practices in Appropriation Arts could be affected by changes in legal frameworks, including judicial decisions. A similar situation might well apply to market intermediaries that are facing higher litigation and liability risks when trading possibly infringing reuses compared to other types of original artworks. Ultimately, this is the empirical question we want to address in this paper. In the following section, we briefly summarize basic legal concepts, in particular US fair use rules as applicable in the visual arts sector.

### 1.2.2 Copyright Rules and the Reuse of Images

As argued above, an important affirmative defense in US copyright law is the fair use doctrine (Landes and Levine, 2006). Fair use allows for unauthorized copying in circumstances that are roughly consistent with promoting economic efficiency (Landes, 2000). That said, fair use in these terms is fair when ‘the cost of transacting with the copyright owner over permission to use the copyrighted work would exceed the benefits of transacting’ ((Posner, 1992), p.69, and (Landes and Posner, 1989)). In broad terms, the fair use codified in section 107 of the US Copyright Act allows for fair use and reproduction of a copyrighted work for purposes such as criticism, comment, teaching, research, or news reporting and provides the four factors to be used in determining whether a particular use made of a work is a fair use (for an application to the visual arts, see (Schaumann, 2015; Adler, 2016, 2018; Whitaker, 2019)).

Other legal systems also include rules prescribing exceptions and limitations for the scope of copyright protection, such as the British right of ‘parody’, known as “fair dealing”, or the French ‘droit de citation’ (Depoorter and Parisi, 2002b). Also, Israel and South Korea currently have implemented limited fair use provisions (Watson, 2017a). Generally, scholars on fair use argue that the doctrinal complexity and legal uncertainty can result in higher intellectual property enforcement costs (Depoorter et al., 2019). The adaption of the open-ended standard of the copyright doctrine to technological advances is discussed in Depoorter (2008) and Menell (2002). Furthermore, Liu (2019) provides an empirical study of transformative fair use jurisprudence for all types of copyrighted works in the US

Certainly, when it comes to copyright law in the visual arts, the fair use doctrine

is the subject of a controversial debate based on US copyright jurisprudence. Appropriation art has been challenged in the US courts many times as an infringement of copyright of the ‘appropriated’ works (Agarwal, 2017).<sup>5</sup> As a landmark case (Adler, 2018) in fair use, scholars point out the decision of *Cariou v. Prince* in 2013. The artist Richard Prince *and* the Gagosian Gallery as the market intermediary were sued for copyright infringement by the photographer Cariou for incorporating altered versions of his photographs into Prince’s series of artwork (see e.g. (Francis, 2014)). The lower court ruled in favor of the upstream photographer Cariou and found that the whole artwork series was infringing the copyright in the original content. Interestingly, not only was Prince held liable for copyright infringement but the Gagosian Gallery was also found to have “vicarious and contributory” liability (Adler, 2016). The court stated that “*the Gagosian Defendants had the right and ability to ensure that Prince obtained licenses to use the Photos before they made Prince’s paintings available for sale*” .<sup>6</sup> As an exogenous shock in the art market, the Second Circuit found that fair use would not be applicable to the entire artwork series and created high legal uncertainty (Sarmiento and Haaften-Schick, 2013) on the “vicarious and contributory” liability for the market intermediaries, as we argue.

The higher court decision refined the fair use test in important ways that made it, arguably, more complicated – at least in the short term – to predict whether appropriation art is a copyright violation of the original artwork or not. Accordingly, it made the law even less predictable for artists and everyone involved in the trade and cura-

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<sup>5</sup>Among early appropriation art cases, in 1992 *Rogers v. Koons*, Koons was sued for transforming a photograph into a sculpture. Based on fair use, Koons argued that his sculpture should be privileged as a satirical comment or parody, but the court rejected this (Landes, 2000; Posner, 1992; Ames, 1993). Already at that time, the decision was not well received by artists because of their fear this might cripple appropriation art (Landes, 2000). The same artist, Koons, won the next case in 2006 (*Bloom v. Koons*) where the court held that the reusing work differed sufficiently from the original. For a detailed review of copyright fair use cases in the visual arts and the road to *Cariou v. Prince* see e.g. Adler (2016). A more recent case is the *Warhol v. Goldsmith* decision from early 2021, accessible here.

<sup>6</sup>Excerpt from *Cariou v. Prince*, 784 F. Supp. 2d 337, 98 USP.Q.2d 1318 (S.D.N.Y. 2011).

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tion of these works (Adler, 2018). Moreover, the decision undermined the importance of other fair use factors with its unclear boundaries and an increased emphasis on transformation (Agarwal, 2017). The mere possibility of fair use litigation would now threaten away artists and their intermediaries and so "fair use is broken" (Whitaker, 2019). In Adler (2016), the decision is described as the most urgent art law case, and it has brought a state of "panic" to the art world. What is more, the court decision also has not been well-received in the art scene, for instance, the New York Times had titled "one of the most closely watched copyright cases to rattle the world of fine art" and that it "set off alarm bells [...] in museums showing contemporary art" (NewYorkTimes, 2011).<sup>7</sup> In any case, this controversial and prominent court decision in 2013, has become the new boundary drawing case of copyright infringement and appropriation art and it substantially increased legal uncertainty and litigation risks (Sarmiento and Haaften-Schick, 2013).

We argue that there was a somewhat more complex market response as the decision is said to have increased overall legal uncertainty for downstream artists and derivative works on sale and in exhibitions. Hence, the role of fair use in the visual arts and how it affected behavior on markets, ultimately, is an empirical question we want to address. Accordingly, we can motivate the focus on trade intermediaries such as auction houses by the legal uncertainty these decisions induced in the legal framework and the broad publicity they received.

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<sup>7</sup>Some further voices from the art scene are represented in ArtNews (2014), among others, the Andy Warhol Foundation and Amy Goldrich, which framed the decision as "one of the most significant art copyright cases of recent decades" [...] and further argued that it was a positive outcome for appropriation artists and "those whose work may be sources for appropriation will likely be disappointed by this outcome". We also provide further evidence on the importance of the exogenous shock by analyzing google online searches in section 1.3.3.

## 1.3 Data and Empirical Framework

### 1.3.1 Data and Matching

The unique dataset is compiled from the ‘Art Genome Project’ and its hosting service Artsy (2019). The online matchmaker brings together reputable galleries, auction houses, and art buyers globally. Next to hosting thousands of artwork for sale online, it also presents educational material and, provided its mere scale, also serves as a ”reference” catalog on visual arts history to users. Its technology builds on a growing database containing more than 50’000 artists. The ‘Art Genome Project’ classifies, connects, and characterizes each of these artists with currently over 1’000 characteristics, so-called ‘genomes’ (Artsy, 2019). In this way, the ‘Art Genome Project’ is a classification system, manually conducted by art historians and data scientists.

As a first step, we identify and attribute artists to the field of Appropriation Art, based on the artist-level ‘appropriation’ genome recorded in the Artsy data. API queries result in 1’901 unique artists and their biographies, including information on place and year of birth and death, nationality, and current work locations.<sup>8</sup> As a second step, we survey the complete list of genomes and identify other genomes from the Art Genome Project indicating other types of reuse practices.<sup>9</sup> This provides additional information on other reusing genomes (other than the appropriation genome collected in the first stage) for the initial set of appropriation artists i.e. up to eight different ”genomes” around reuse practices can now be assigned to an individual artist of the first query. To create our control group of artists (”control artists”), we retrieve information on similar artists based on Artsy’s similarity algorithm and the

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<sup>8</sup>After initial registration, artist meta-data from the Artsy website can be accessed via the public application programming interface (API). Python code used in the paper will be provided online.

<sup>9</sup>According to (Artsy, 2019) close ‘genomes’ of ”appropriation art” are: contemporary conceptualism, engagement with mass media, layered images, mixed media, neo conceptualism, photographic source, the pictures generation, use of vintage imaginary.

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Art-Genome-Project nearest neighbor graphs (i.e. related artists, however, excluded all artists with one or more appropriation-close genome-information).<sup>10</sup> This gives us another 2’362 artists with a similar set of genomes as the one recorded for the initial set of appropriation artists. To sum up, our Artsy dataset contains 4’263 unique artists meeting one or more criteria (i) a tight definition of appropriation based on a single ”appropriation” genome, (ii) the first criteria plus a wider definition of appropriation based on multiple genomes associated with different reuse practices and (iii) being similar based on a vector calculation across all Artsy genomes, however, not meeting one of the first two criteria (control group).

Prominent artists in our data associated with the ”appropriation genome” include Jeff Koons, Elaine Sturtevant, Richard Prince, Andy Warhol, Roy Lichtenstein, Banksy, Damien Hirst, and Louise Lawler, among others. For well-known similar artists, the artsy algorithm identifies, for example, Andreas Gursky, Claes Oldenburg, Pablo Picasso, William Scott, and John Chamberlain. Less well-known artists in our similar (appropriation) group include Melissa Scott-Miller, John Sonsini, Mira Schor, Wanda Pimentel, and Shao Yinong (Steven Gagnon, Brad Faine, Joe Black, Lara Baladi, and Nancy Chunn). In general, ”similar” artists are not closely associated with appropriation and related artistic practices, but they will have very similar characteristics in terms of the various other genomes (Artsy, 2021). So, for example, a large set of genomes on artsy classifies artists and artworks according to their ”subject matter” which alone includes more than 200 different genomes (political events,

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<sup>10</sup>Artsy’s similar artists feature “continuously computes a K-nearest neighbor graph for artists using data from the Art-Genome-Project” (Artsy, 2020). The 1’000+ characteristics of artists include art historical movements, subject matter, and formal qualities, a detailed list is provided here (Artsy, 2021). We manually double-checked the ”appropriation” classification by comparing the queries with known and listed artists on e.g. Wikipedia, (Tate, 2021) or (Evans, 2009). Chapter 1.3.2 furthermore describes differences between appropriation artists and control artists on the artist-level, and chapter 1.3.3 compares outcomes (auction results) in both groups to make sure that the groups are sufficiently close based on objective criteria.

city scenes, figures from the back, body parts, bathers, decay, etc.). Similarly, artsy's category "materials" carries more than 40 genomes (wood, aluminum, glass, gold, ivory, paper, etc.), "medium and techniques" carries close to 200 genomes (fresco, linocut, miniature, panorama, spray print, trompe l'oeil, etc.), which are used to further classify artists and artworks. Using these very refined categories (16 in total) and based on the full set of genomes, we trust that the control group we chose is meaningful and fits well the treated group of appropriation artists, beyond the observable characteristics and information on artists and artworks from auction listings that we control for in the later analysis and turn to next.

As a second source, we compile trade data on auction outcomes from Artprice (2020). The Artprice database contains auction records on more than 12 m. artworks from around 6'000 houses worldwide and auctions since the 1960s (Artprice, 2020). First, for unique artists from our initial Artsy list, the Artprice database allows us to combine information on approximate production and the supply of works over time, i.e. we can establish the sales catalog of works for appropriation artists, the so-called *catalog raisonné*. We can match auction data for 1'025 appropriation artists (out of the total 1'901 artists) and another 1'162 control artists (out of the total 2'362 artists). Descriptives for matched and unmatched artists from Artsy samples yield very similar results.<sup>11</sup> Second, we gather additional information from Artprice webpages on the level of the individual artwork (for example, the work's title, size, medium, date of creation, price estimates, and "hammer prices") and the level of the auction house (for example, location and auction date). Notably, most auction markets are heavily

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<sup>11</sup>40 per cent of unmatched appropriation artists are born in the US, followed by many British, Chinese, and French-born artists. However, we observe fewer Chinese-born appropriation artists in matched samples. Roughly 33 (37) per cent of unmatched artists are female, and, on average, artists are 12 (7) years younger compared to matches in the appropriation sample (control group). Arguably, this suggests that some younger artists and recent artworks have not yet entered secondary markets and thus their actual market values might be less well covered in both samples.

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concentrated around a few superstars which also applies to Appropriation Art. Andy Warhol, Damien Hirst, and Roy Lichtenstein alone account for more than a quarter of all auctions recorded for appropriation (-close) artists.<sup>12</sup>

### 1.3.2 Descriptive Statistics

Table 1.1 gives a descriptive overview of the matched sample of appropriation artists compared to control artists. This dataset contains 171'573 auction results for appropriation artists and 198'073 auction results for artists in the control group, and thus a total of  $n = 369'646$  outcomes from art auctions recorded over a forty-year period since 1980. The way the data is structured, we can have multiple auction listings per artist in the same year, even when aggregating some of the information (e.g. the number of yearly auctions). As, among other things, we don't want to lose the more granular information on the level of the artwork and the auction (artwork medium, auction house name, location, etc.), we keep all observations for each artist-auction-year combination in the dataset. Note further that the panel is highly unbalanced, i.e. some artists in our sample may have no observations in a given auction year while some artists may have multiple auction records on the very same day.

On the one hand, appropriation artists were, on average, born in 1962 (figure 1.1) and female artists account for roughly one-fifth of the total sample. The average artwork was created in 1984 (figure 1.2). And, the data shows interesting cyclical and, if anything, weakly increasing trends in the production and supply of new works as

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<sup>12</sup>The economic literature on art auctions also discusses the so-called "master-piece effect" (Ashenfelter and Graddy, 2003) which relates returns from investment in paintings of well-known artists to those garnered from investment in less-known, second-tier artwork. The empirical evidence is ambiguous so far, ranging from a positive effect (De la Barre et al., 1994) to no or a negative effect of more investment in masterpieces (Ginsburgh and Jeanfils, 1995; Pesando, 1993; Ashenfelter and Graddy, 2003; Mei and Moses, 2001).

recorded in the auctions data. This is in line with our expectations as appropriation art is a relatively recent art movement. Furthermore, in three quarters of total auctions by appropriation artists lots were sold and traded at a mean (median) hammer price of 125'590 (5'000) USD (table 1.1, figure 1.3). Figure 1.2 shows that most of these artworks (medium) were multiple-prints (46 per cent) or paintings (22 per cent).

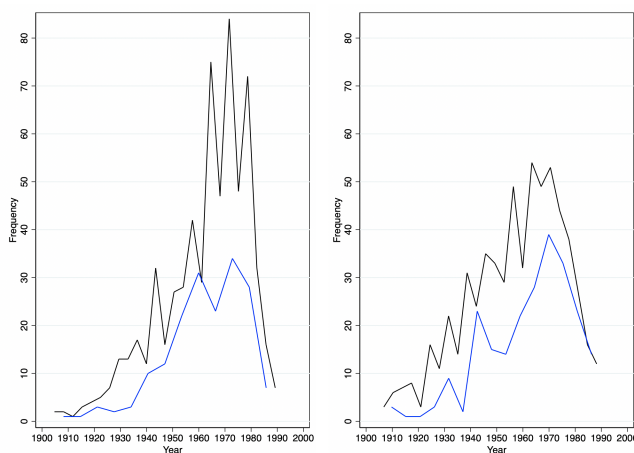


Figure 1.1: Panel Distribution of Artists' Year of Birth

Note: This figure shows the birth year of appropriation artists (left) and control artists (right) by their gender. The blue lines indicate female artists and the black lines represent male artists' birth year. The two figures are restricted to artists born in 1900 or later, 26 artists are excluded, ( $n=2'159$ ).

On the other hand, control artists in the control group were born, on average, in 1956, and female artists account for roughly one-fourth of the total (figure 1.1). Figure 1.4 compares total auctions of artworks by appropriation artists with those recorded for control artists throughout the observation period. There is an increasing trend in the total number of auctions for each group. This seems to be due to a higher fraction of younger artists entering auction markets as time progresses as well as, eventually, more complete data coverage of auctions over time in the underlying Artprice database. Average (median) hammer prices for control artists stood at 52'204 (3'030) USD (table 1.1 and figure 1.3). The difference in average auction prices

Table 1.1: Descriptive Statistics: Overall Distribution

	MEAN	SD	MIN	MAX	OBS
<b>Appropriation Artists</b>					
Artists-Level					
Birthyear	1962.35	17.21	1879	2010	840
Deathyear	1998.34	18.56	1927	2020	79
Female	0.22	0.42	0	1	876
G Mixed Media	0.35	0.48	0	1	1025
G Contemp. Conceptualism	0.24	0.42	0	1	1025
G Eng. with Mass Media	0.20	0.40	0	1	1025
G Layered Images	0.08	0.28	0	1	1025
G Neo Conceptualism	0.01	0.11	0	1	1025
G Photographic Source	0.13	0.33	0	1	1025
G Pict. Generation	0.01	0.12	0	1	1025
G Use of Vintage Img.	0.05	0.22	0	1	1025
Auction-Level					
Artwork Creationyear	1984.71	19.51	1854	2019	141527
Artwork Size m2	0.71	1.13	0	53.3	145476
Artwork Size m3	0.45	2.88	0	174.96	13416
Auction Year	2011.1	6.94	1983	2020	171573
Auction Estimate (low) USD	86745.83	1068082	0	1.27e+08	170248
Auction Estimate (up) USD	115903.5	1028728	0	7.00e+07	145924
Auction Hammer price USD	125590.3	1369431	-3	1.27e+08	121471
Lot Not Sold	0.26	0.44	0	1	171573
Number of Auctions**	434.48	632.279	1	2230	171573
% of US Auctions*	0.289	0.261	0	1	171573
<b>Control Artists</b>					
Artists-Level					
Birthday	1956.22	23.63	1875	1990	895
Deathday	1992.27	32.64	1771	2019	130
Female	0.27	0.44	0	1	960
Auction-Level					
Artwork Creationyear	1966.9	25.08	1869	2020	143256
Artwork Size m2	0.47	1.23	0	309.68	161619
Artwork Size m3	0.35	1.56	0	78.40	10316
Auction Year	2010.63	7.61	1983	2020	198071
Auction Estimate (low) USD	37328.79	713345.5	0	1.40e+08	196086
Auction Estimate (up) USD	56311.14	692166.7	0	5.91e+07	160171
Auction Hammer price USD	52204.96	911577.4	4	1.60e+08	141670
Lot Not Sold	0.255	0.44	0	1	198073
Number of Auctions**	893.34	1512.5	1	4406	198073
% of US Auctions*	0.248	0.268	0	1	198073

Note that \* and \*\* are computed as the year-level of "number of auctions" and "percentage of US auctions, and here shown on the artwork level, the panel data are highly unbalanced among dates and artists. (\*) The between standard deviation of appropriation (control) artists is 0.38 (0.39) and the within deviation is 0.11 (0.11) for the percentage of US auctions. (\*\*) The between standard deviation of appropriation (control) artists is 67 (113) and the within deviation is 245 (311) for yearly auctions.

when compared to appropriation artists is driven by a few outliers and superstars who achieve higher auction results constantly. We, therefore, log-transform the dependent variable "hammer price" in our estimates (for more details, also see section 1.3.3). Similar to the treatment group, in one out of four auctions for control artists, lots were not sold.

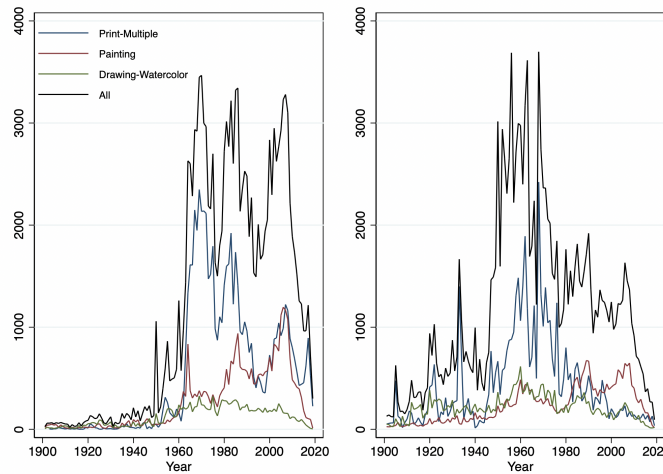


Figure 1.2: Panel Distribution of Artworks’ Year of Creation and Selected Artwork Medium

Note: This figure shows the total number of artworks (black line) and corresponding years of creation. The colored lines represent the distribution of selected artwork mediums. The left (right) panel presents appropriation artists (control artists). Samples are restricted to unique artworks (based on titles) and those created after 1900, ( $n= 221'892$ ).<sup>13</sup>

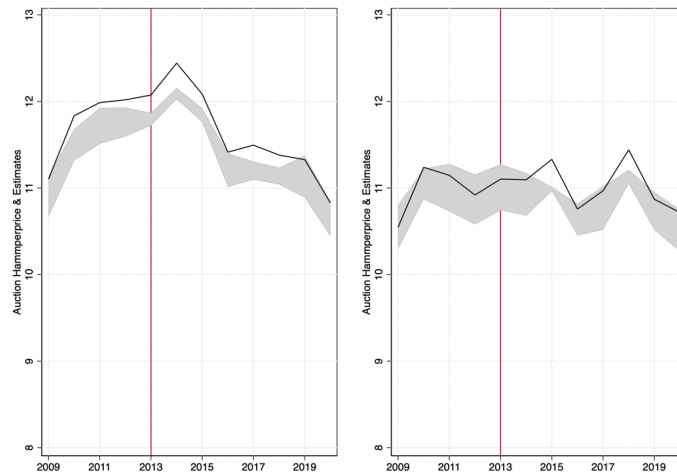


Figure 1.3: Panel Distribution of Auctions Hammer Prices and Price Estimates Ranges

Note: This shows the yearly log-transformed mean of the price-estimates ranges (grey-shaded area) and realized auction hammer prices (black line). The left (right) panel shows auction outcomes for appropriation (control group) artists.

Moreover, the highest percentage of appropriation artists originate from the US

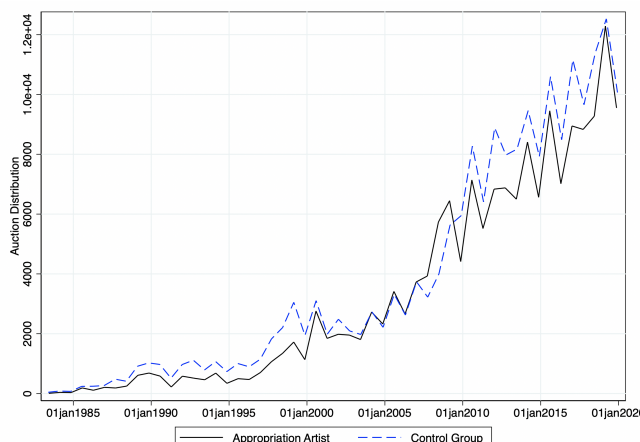


Figure 1.4: Panel Distribution of Auction Dates

Note: This figure shows the historic auction distribution (freq) of the total numbers of auctions for appropriation artists (black line) and control artists (blue dotted line), (n=369'646).

(31 per cent), followed by British (10 per cent), French (5 per cent), and German (5 per cent) artists. In terms of their work location, artists frequently reside in New York (US) (9 per cent), London (U.K.) (6 per cent), L.A. (US) (6 per cent), Berlin (Germany) (4 per cent) or Brooklyn (US) (4 per cent). Geographic origins and locations are comparable for control and appropriation artists and only a few data caveats apply.<sup>14</sup>

Once again, figure 1.4 shows an increasing trend of auction records over time. Most of the auctions take place in auction houses in the US (29 per cent), followed by houses in the U.K., Germany, and France. Moreover, the most prominent auction houses in our sample in terms of the total number of auctions are Christie's, Sotheby's, and Phillips (all of UK origin but with satellite houses around the world). The top ten auction houses for similar and appropriation artists are listed in table

<sup>14</sup>The highest percentage of artists in the control group mostly originate from the US (26 per cent), Great Britain (7 per cent), Germany (6 per cent) and France (4 per cent). In addition, control artists are most frequently located and working in New York (roughly 8 per cent), London (5 per cent), L.A. (5 per cent), Paris (4 per cent), and Berlin (3 per cent). Notably, figures warrant careful interpretation as some artists record more than one work location/residence and because location names are not fully harmonized across the data.

1.2, accounting for roughly 40 per cent of all records.

Table 1.2: Top 10 Auction Houses

Appropriation Artists		Control Artists	
Auction House	Observations	Auction House	Observations
Christie's	25,510	Christie's	26,054
Sotheby's	22,302	Sotheby's	20,953
Phillips	10,559	Bonhams	7,317
Bonhams	4,304	Phillips	5,016
Artcurial S.V.V.	3,676	Swann Galleries	3,877
Van Ham Kunstauktionen	2,471	Artcurial (S.V.V.)	2,934
Cornette De Saint CYR M.	2,309	Grisebach	2,110
Dorotheum	2,005	Lempertz 1,792	1,789
Lempertz	1,962	Mainichi Auction Inc.	1,757
Swann Galleries	1,962	Dorotheum	1,755
1,471 other houses	94,489	1,864 other houses	124,511

Note: This table shows the distribution of the top 10 auction houses (any country) by appropriation (left) and control artists (right). The last line gives total auctions/observations by all other houses.

By exploring museum collection and exhibition data around appropriation art and appropriation-close artworks, we provide further descriptive evidence on the public interest and continued market relevance of Appropriation Arts following the 2013 decision. For this purpose, we create a subsample of the top-500 appropriation artists (in terms of Artsy ranking) and manually link them to the Metropolitan Museum of Art New York (MET) collection database.<sup>15</sup> On the left-hand side, figure 1.5 shows the total yearly number of exhibitions of appropriation artworks in the MET Museum or artworks on loan to other museums. Overall, it shows an overall increasing trend. On the right-hand side, when taking a look at the total number of days these artworks were exhibited, trends are as well increasing but they seem slightly less pronounced for more recent years. In general, appropriation artworks are exhibited more often, but also for longer periods. In addition, based on the vast MET collection as one of

<sup>15</sup>The New York MET-collection database is the largest art museum in the US with a focus on contemporary art. Based on this step, we can identify 53 artists with a total of 178 artworks collected by the MET museum, and, web-crawling their recent artworks' exhibition history, results in a total of 702 exhibitions for them (exhibited in the MET or on loan to other museums).

the most important contemporary art collections in the US (if not the world), we find further support for the importance and continued interest in Appropriation Arts in recent years as more than 10% of our appropriation artists were found in the MET collection. Based on this descriptive evidence, the indirect liability of intermediaries such as museums<sup>16</sup> and arguably greater legal uncertainty in the copyright system does not seem to have systematically limited the availability and dissemination of possibly infringing artworks in these (public) spaces. Whether this result would continue to hold for museums in a multivariate setting or a more detailed, artwork-level analysis is an interesting endeavor we leave for future research.

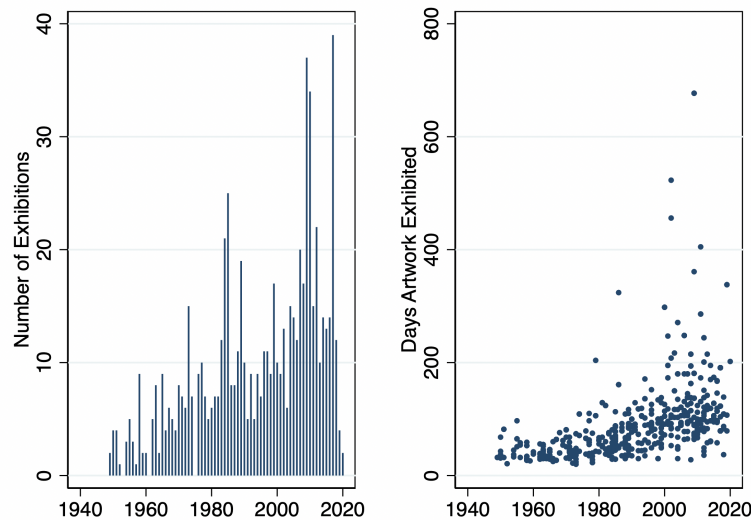


Figure 1.5: MET Appropriation Artwork Exhibitions

Note: This figure shows the total number of exhibitions (left) and the total number of days an artwork was exhibited (right) of appropriation art artworks (based on a top-100 subsample of artists) in the Metropolitan Museum of Art (MET) New York, (n= 521).

<sup>16</sup>Please refer, for instance, to the recent appropriation art copyright lawsuit where a work by the artist Jeff Koons has been removed from an exhibition in the Museum Pompidou in Paris (Artnet, 2017).

### 1.3.3 Empirical Framework

We begin the empirical section with a historic auction price analysis applying hedonic price models to artworks on sale. Based on a burgeoning number of empirical studies on art auctions (Mei and Moses, 2001; Ashenfelter and Graddy, 2003, 2006, 2011; Beggs and Graddy, 2009), we construct prices indices for our group of artists (appropriating artists and control artists), analyzing fixed components of the price functions as hedonic characteristics, and deploying the following type of multiple-dimension fixed effects (FE) regression models (Correia, 2019):

$$p_{itc} = \alpha + \mathbf{X}'_{itc} + \phi_I + \rho_Y + \mu_C + \epsilon_{itc}$$

where  $p_{itc}$  is the log-transformed auction hammer price of artwork  $i$ , at date  $t$ , and in country  $c$ . Moreover,  $\phi$  represents artist fixed effects,  $\rho$  auction year fixed effects and  $\mu$  country fixed effects. Finally, we capture in  $\mathbf{X}'$  several artwork-specific characteristics of interest, such as the artwork age at auction, artwork size, or artwork medium. We run separate regressions for the appropriation artists and the control group.

In the next step, our empirical strategy exploits the 2013 court decision on intermediary liability as an exogenous institutional shock using a differences-in-differences design (see also section 1.2.2 on "Copyright Rules and the Reuse of Images" where we discuss the importance of the court decision from an economic and legal point of view in greater detail), using the important hedonic characteristics of artworks as control variables. We, therefore, tighten our data sample for estimating our main results closely around the higher court decision with auction years dating from 2010 to 2020 to analyze short and medium secondary market reactions. In additional robustness checks, we estimate the main results based on 2007-2020 and longer time-frames. At

its core, while the decision may have changed what appropriation “practices” were considered exempt from litigation, it left the relevant liability question open and pending, increasing the perceived litigation risk for traders of artworks, and we are specifically interested in post-2013 changes. Based on Google trends data, figure 1.6 shows online searches for sets of google keywords, ”Cariou v. Prince” in the left panel (i.e. common ways to search for legal cases in the US). This gives rise to two interesting takeaways. First, in line with our empirical strategy, around the 2nd Circuit decision cutoff date in April 2013, we see a systematic and large spike in searches on Google. Second, we can compare search traffic around the decision to searches around the ”Rogers v. Koons” case, another prominent court decision (1992) that is frequently discussed by legal scholars in the context of appropriation art and fair use.<sup>17</sup>

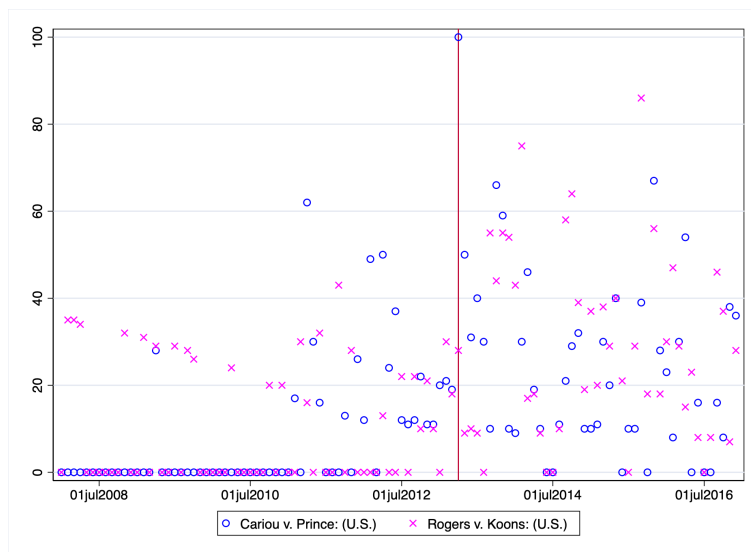


Figure 1.6: Google Search Volume: Cariou v. Prince

Note: This figure shows online searches in the United States between 2008 and 2016 for two sets of keywords: ”Cariou v. Prince” (blue circles) and relative to ”Rogers v. Koons” (pink crosses) around the 2013 court decision (red vertical line). Google search data are normalized.

<sup>17</sup>For more information, we discuss the court decision in footnote 5. While the interest in the ”Carou v. Prince” decision was never outpaced by Google searches around the ”Rogers v. Koons” case, we interpret the overall interest in a similar court case by that time as positively correlated with the importance of ”Cariou v. Prince”).

The identification strategy exploits two alternative differences-in-differences approaches to estimate the effect of the prominent *2013 Cariou v. Prince* court decision, a change in copyright jurisprudence, and on intermediary liability, so to speak Adler (2016). A differences-in-differences analysis is a common research design to estimate the causal effects of such a change in law practice or policy change (for an application to changes in copyright laws see, for example, Kretschmer and Peukert (2014); Watson (2017b)). A first strategy considers the global auction market for appropriation art as potentially treated<sup>18</sup> in the post-2013 period, and thus we control for auctions and artworks by control artists that we can identify based on the Artsy genome information. A second strategy compares only auctions for appropriation artworks in the US (treated group) to auctions of the same art movement outside the US (control group). We assume that artists themselves do not directly respond to a particular court decision in a copyright case by shifting "appropriation art practices", for example, by increasingly reusing non-infringing materials from the public domain in new artworks. This can be explained by the fact that, for most appropriation artists, knowingly appropriating (copyrighted) objects and images is at the very center of their artistic strategy and practices. A recent report on the visual arts sector in the US Aufderheide et al. (2014) states that "the artists we interviewed typically did not want to think about copyright as they made their work for fear of it interfering with their creativity", and "artists whose work had a political or social-commentary cast also were emphatic that typically unlicensed quotation from copyrighted work was a core part of artistic practice." This is anecdotal evidence that changes in core practices are very unlikely to occur. Therefore, we expect artists to be faithful to the

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<sup>18</sup>For the set of treated artists we have information on both a tighter definition of *Appropriation Art* artists and a wider definition of contemporary artists associated with or categorized as artists applying "appropriation" practices (including the appropriation-genome). Again, it is important to note that not all artworks in the group of treated artists will infringe copyright. But since not all rights around potentially copyright-infringing artworks are cleared, *potentially* infringing artists and artworks are equally important levels of the analysis to consider as the perceived risk of copyright litigation will still shift incentives to trade these artworks.

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original "conception" of the appropriation art (movement). Most importantly, however, the majority of artworks in our samples were created a long time before the court verdict. The mean year of creation for artworks by appropriation (similar) artists is 1984 (1966), respectively. So, we would expect the impact on changing practices, if any, to be negligible and limited to a few, more recently created artworks. Given the various copyright litigation cases against artists *and* the prominent contributory liability ruling in 2013, we expect responses to a change in the (visual art) fair use jurisprudence on *secondary market trade* of appropriation artworks.

An important task is to construct meaningful and precise dependent variables that will capture and reflect potential changes of (intermediary) liability around artworks. Here, we are interested in the short- or medium-term reactions on secondary art markets. In the first empirical setting, we make use of the fact that not all auctions result in a sales success, and hence, the auction houses will either report the hammer price or that the artwork has not been sold, i.e. 'lot not sold'. This is the case for roughly 30 per cent of all auction records, in both our treatment and control samples. We thus run logit models for the probability that an appropriation artwork is a sales success when compared to control artists and their auction successes before and after the event in April 2013. Arguably, a focus on immediate sales success captures the short-term effect of the policy change. If auction schedules only can be adjusted slowly to the changes in the legal environment and the supply of artworks is to a certain degree "sticky"<sup>19</sup>, we might well observe immediate demand responses via the observed changes in sales probabilities. The reactions on the demand side might well reflect general changes in perceived risks around artists and market values, also from a financial investors' point of view. Generally, with an increase in risks, costs to curate

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<sup>19</sup>For example, it is common practice to publish a pre-sale catalog with information on the auction items up for sale and houses are typically commissioning the work for sellers entering a contractual relationship with them (consignment agreement) that cannot be immediately be canceled. For standard practices at art auctions, see Ashenfelter and Graddy (2003).

and offer artworks might increase. For instance, auction houses might have to engage costly lawyers, or compensate other third parties involved in (potential) lawsuits. In *Cariou v. Prince*, initially, also the RCS MediaGroup which printed the exhibit catalog was sued for copyright infringement. As a consequence, auction houses might charge potentially treated artworks at higher commissions, and buyers are not willing to meet the desired auction reserve price anymore. Demand-side reactions therefore might capture insightful secondary market reactions, as we argue in our paper. In the medium term, however, auction houses and galleries will adjust their supply to the changes in potential litigation risks of hosting and selling appropriation artists, and these artworks might no longer (or less often) appear on the secondary market. In turn, another set of regressions focuses on the total number of auctions. Arguably, this captures the medium-term effects on the total trade of appropriating artworks which potentially include copyright infringing materials before and after the decision.

Finally, regressions take a closer look at the US market outcomes. Here, we focus on the percentage of artworks by an appropriation artist that is hosted in US auctions (relative to non-US auctions) compared to the percentage for a control artist and her works in the pre- and post-2013 periods. This effect might well capture whether or not appropriation artworks increasingly shifted to auction houses outside the US and other jurisdictions, and whether the changes in perceived litigation risks among secondary market intermediaries in the US led to a "relocation" of global trade in due course. To set up our baseline model more formally, let

$$Y_{it_c}^k = \alpha + \beta_1 Post_t + \beta_2 Treat_i + \delta(Treat_i \times Post_t) + \mathbf{X} + \mu_i + \phi_t + \gamma_c + \epsilon_{it_c}, \quad (1.1)$$

where  $Y_{it}^k$  are the outcome variables ( $k$ ) for auction results of artist  $i$  at date  $t$ .  $Treat_i$  identifies the group of treated appropriation artists and  $Post_t$  all auctions

scheduled after April 2013. The differences-in-differences coefficient of interest is captured by  $\delta$ . We include year fixed effects  $\phi_t$ , country fixed effects  $\gamma_c$ , artist fixed effects  $\mu_i$ , and a vector of hedonic artwork controls  $X$  (elicited from the hedonic art auction price regressions from the initial analysis) to the baseline model.

A second, alternative identification strategy limits the data to appropriation artists only and compares their US (treated) to non-US auctions (control group) before and after the prominent court decision. In this way, the strategy also addresses potential boundary and composition issues for treatment and control groups. Arguably, not all artists in the treatment group are incorporating copyright-protected material in each of their artworks, and the potential infringement of the derivative or the resulting work can only be considered an approximation. In a similar vein, some artworks and art practices by control artists might involve the reuse of already existing, original works created by other artists. This will make it harder to establish clear-cut boundaries between treatment and control groups.

Baseline models include artists and year fixed effects and, clustered standard errors at different levels or bootstrapped standard errors, taking into account the plausible auto-correlation in the data as discussed in Bertrand et al. (2004) for differences-in-differences estimations. The FE panel regressions allow us to observe the coefficient of interest,  $treat \times post$ , and we control for unobserved artist-specific and time-invariant heterogeneity as well as time trends in the auctions data with year FE. However, as being an appropriation artist (or not) is not a time-variant characteristic of the way our initial data is structured, we cannot separately report effects for our treated group coefficient *appropriation*. Furthermore, next to the baseline models, we include artwork-level specific controls (hedonic characteristics, such as artwork size, artwork medium, and artwork age at auction date) or auction-house-specific controls (top

auction houses<sup>20</sup> and sales country), or both in alternative model specifications. Furthermore, fixed effects and differences-in-differences estimators are based on the idea of time- or group-invariant omitted variables (Angrist and Pischke, 2008), and potential endogeneity could lead to incorrect inferences. Thus, unobserved time-variant heterogeneity in the group of treated artists might still be correlated with the error term. Given the quasi-experimental framework, our auction dataset, and various control variables, we assume that the potential omitted variable bias is less of a concern, and careful causal inference is appropriate.

### 1.3.4 Limitations

The overall data and empirical approach are not without limits. First, it is a difficult task to identify the group of treated artists. On the one hand, appropriation artists are not a heterogeneous group to identify, we are only able to approximate this group via genome records on the artist level publicly available in the Artsy data. I.e., unfortunately, we cannot explore the ‘appropriation level’ of individual artworks. On the other hand, artists and market intermediaries such as auction houses could perceive and deal with the potential litigation risks differently. Some agents have different risk attitudes at the outset and will respond more than others to changes in copyright frameworks. Accordingly, changes in their supply of these artworks might be more pronounced too.

Furthermore, based on the data, we are not able to identify the underlying original work that has been appropriated and fully establish the associated copyright status (and, accordingly, whether or not rights have been cleared). Such a strategy would

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<sup>20</sup>Based on the results from the hedonic price models, we control for the four biggest auction houses, as this effect captures most of the variation of auction house differences we found, and, furthermore, reporting practices across auction houses can vary (Ashenfelter and Graddy, 2003).

require artwork-level metadata and licensing records which are, unfortunately, not available to us. Survey evidence for practicing visual artists and nonartist professionals (art historians, museums, etc.) in the US visual arts sector suggests, however, that this is of limited concern for the analysis Aufderheide et al. (2014). Practicing artists are much less likely to pay copyright fees than nonartist professionals. They were reported to rarely or never (82 percent for artists vis-à-vis 40 percent for nonartist professionals) or frequently/ occasionally (17 percent for artists vis-à-vis 60 percent for nonartist professionals) clear rights and pay access fees to rightsholders before incorporating existing works Aufderheide et al. (2014). In addition, technological (digital) change may also affect reuse practices over time as it potentially impacts access and production costs when artists are appropriating existing materials. We seek to address some of these issues in the analysis.

Finally, monitoring of trade in secondary markets is limited to auction data as we do not have access to private sales data or sales on primary markets such as galleries, some of which are confidential or not collected on a systematic basis. Still, we trust that the auction data provide us with a representative, multi-year view of global markets for the appropriation art and artworks on sale by control artists.

## 1.4 Results

### 1.4.1 Hedonic Price Models

In this section, we employ a standard hedonic pricing approach to art auctions for both groups of artists. As shown in figure 1.3 and as discussed in the result section below, at large, auction prices do not systematically differ between the two groups. However, in this series of hedonic price models, we more comprehensively assess price

formation for artworks in both groups, by saturating models with country, year, and artist fixed effects to better understand auction results and their relation to artwork characteristics. We regress on the historic auction price outcomes for auctions held over the entire period between 1983 to 2020.

We present the hedonic price estimations in table 1.3 where the dependent variable is the log price of an artwork realized at an auction (i.e. "hammer price"). Model (1) includes artist, and year fixed effects, model (2) adds country fixed effects, and model (3) additionally controls for all auction houses in the data sample of appropriation artists, the same model structure applies for the control group of artists shown in model (4-6). Some insightful and reasonable differences in price formations can be noted. While outcomes for appropriation artworks provide for significant large positive coefficients of "audiovisual-multimedia" artworks, outcomes for control artists show the same direction of effects, effects render insignificant. The opposite holds for artworks created with the medium "lightings", where appropriation artists show negative effects, while this shows a positive sign in the control group outcomes. This, however, can be explained by the relatively small number of observations for this artwork medium type. Furthermore, it seems that artworks by appropriation artists achieve negative correlations of prices with the artwork medium "objects", while for the control artists sample we find a positive, however, insignificant coefficient.

Notably, appropriation artworks and control artworks share many common price characteristics as revealed in Table 1.3. The *artwork – size* and the *artwork – age* (at the auction) both yield positive effects on auction hammer prices, in line with e.g. results in (Beggs and Graddy, 2009). The same goes for different kinds of mediums. On the one hand, classical artwork mediums such as *paintings* (at the 0.001%-level) and *sculpture – volume* are both positively correlated with log-transformed prices.

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On the other hand, if several copies of an artwork exist, i.e. *print – multiple*, prices are negatively correlated for both groups.

Finally, auction outcomes for artworks traded at major auctioneers, for example, at Sotheby’s, Christie’s, Phillips, and Bonhams, are all highly positive and significantly correlated with the hammer price outcomes, again in line with recent work on hedonic pricing (Ashenfelter and Graddy, 2003; Beggs and Graddy, 2009). Although in models (3) and (6) we control for *all* auction houses with fixed effects, results suggest that they do not systematically differ where we capture the most important auction houses only and do not distinguish auctioneers (models 1,2,4 and 5).

Overall, models appear to be adequately specified and most controls yield estimates very much in line with the existing literature. This provides for insightful price analysis and helps us to better understand the auction results of both groups of artists. Indeed, this is not unexpected, as some of the literature on auction prices (for an overview, see for example Ashenfelter and Graddy (2003)) suggest that the heterogeneity of auction prices is best addressed by hedonic price models on the level of the individual artwork.<sup>21</sup> That is to say, the price composition of artworks is somewhat complex to analyze, and so we can expect to observe no direct price responses for traded artworks after the policy change as the effects cannot be studied based on a repeat sales panel for the very same artwork. In this way, data structures, ultimately, constrain our ability to further inspect price effects.

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<sup>21</sup>In particular, the same artwork can be traded in different countries and auction-houses. For example, given an artwork is titled differently or several multiple-prints of the ”same” artwork exist, as well as reporting standards vary between auction houses, in our large auction sample, it seems impossible to identify and manually verify the same artworks over time in our sample. Data samples used in hedonic price models are, moreover, typically hand-collected and often focus on listings of a single auction house or country, well-known artists and their catalog raisonnés, or they are restricted to a single medium (e.g. paintings).

Table 1.3: Hedonic Price Models

	(1)	(2)	(3)	(4)	(5)	(6)
	Appropriation Artists			Control Artists		
log(auction hammer price)						
(artwork size) <sup>2</sup>	0.273*** (6.92)	0.269*** (6.94)	0.266*** (7.21)	0.321*** (8.74)	0.315*** (8.70)	0.308*** (8.41)
audiovisual-multimedia	1.996*** (4.54)	1.893*** (4.46)	1.680*** (4.18)	0.938 (1.26)	0.770 (1.03)	0.989 (1.35)
ceramic	-0.278 (-0.79)	-0.260 (-0.72)	-0.290 (-0.84)	-0.748 (-1.74)	-0.785 (-1.86)	-0.858* (-2.12)
drawing-Watercolor	0.461* (2.31)	0.468* (2.25)	0.312 (1.53)	0.515 (1.11)	0.505 (1.10)	0.396 (0.89)
furniture	0.148 (0.95)	0.134 (1.40)	0.189 (1.67)	1.546* (2.56)	1.540** (2.58)	1.469** (2.61)
lightings	-0.487*** (-3.59)	-0.453*** (-4.67)	-0.443*** (-5.00)	1.119 (1.95)	1.154* (2.05)	1.058* (2.00)
objects	-0.946*** (-4.95)	-0.932*** (-4.03)	-0.881*** (-4.16)	0.830 (1.73)	0.797 (1.70)	0.642 (1.45)
painting	1.724*** (6.85)	1.716*** (6.79)	1.561*** (6.49)	1.761*** (3.73)	1.752*** (3.80)	1.625*** (3.61)
photography	-0.192 (-0.90)	-0.184 (-0.83)	-0.302 (-1.30)	-0.199 (-0.43)	-0.203 (-0.44)	-0.249 (-0.57)
print-multiple	-0.894** (-3.10)	-0.875** (-3.16)	-0.900*** (-3.67)	-1.258** (-2.94)	-1.267** (-3.01)	-1.214** (-3.01)
sculpture-volume	1.085*** (4.92)	1.091*** (4.89)	0.938*** (3.88)	1.037* (2.46)	1.018* (2.46)	0.920* (2.35)
tapestry	-1.036** (-3.07)	-1.018** (-3.14)	-1.008** (-3.10)	-2.114*** (-4.55)	-2.013*** (-4.38)	-1.998*** (-4.47)
artwork age at auction	0.00109 (0.38)	0.00132 (0.46)	0.00128 (0.46)	0.00951** (2.83)	0.00928** (3.02)	0.00764** (3.07)
phillips	1.093*** (17.24)	1.070*** (14.16)		0.969*** (12.17)	0.952*** (9.98)	
sothebys	1.356*** (19.89)	1.362*** (17.48)		1.242*** (13.57)	1.250*** (11.96)	
christies	1.153*** (16.45)	1.158*** (15.17)		1.027*** (10.63)	1.046*** (10.21)	
bonhams	0.496*** (4.73)	0.475*** (5.92)		0.362*** (5.73)	0.379*** (4.68)	
Year FE	✓	✓	✓	✓	✓	✓
Artist FE	✓	✓	✓	✓	✓	✓
Country FE	No	✓	✓	No	✓	✓
Auction House FE	No	No	✓	No	No	✓
Cluster SE	Artist	Artist	Artist	Artist	Artist	Artist
N	95533	95529	95332	89822	89819	89550
R <sup>2</sup>	0.651	0.659	0.696	0.624	0.633	0.684

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the historic analysis (1983-2020) of price formations of artworks by appropriation artists and control artists, as specified in chapter 1.3.3. Standard errors (SE) clustered at the levels specified.

Table 1.4: Descriptive Statistics: Pre/Post Samples

Variable	Appropriation Artist				Control Group			
	2010-2012 (pre)		2013-2020 (post)		2010-2012 (pre)		2013-2020 (post)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Birthyear*	1955.94	18.28	1959.05	18.54	1947.20	23.25	1950.36	22.93
Deathyear*	1996.59	19.78	1996.65	19.63	1994.19	21.17	1994.02	22.06
Female*	0.15	0.36	0.16	0.37	0.17	0.38	0.19	0.39
Artwork Age at Auction	25.83	17.94	27.39	19.34	44.65	24.36	47.49	25.43
Artwork Creationyear	1985.37	17.95	1989.06	19.44	1966.59	24.36	1968.97	25.47
Artwork Size m <sup>2</sup>	0.74	1.12	0.67	1.09	0.44	0.89	0.46	1.52
Artwork Size m <sup>3</sup>	0.50	2.17	0.39	2.29	0.41	1.97	0.30	1.49
Auction Year	2011.20	0.95	2016.48	2.00	2011.23	0.95	2016.45	2.00
Philipps	0.08	0.27	0.06	0.24	0.03	0.16	0.02	0.15
Christies	0.15	0.36	0.10	0.30	0.15	0.35	0.09	0.29
Sothebys	0.11	0.31	0.08	0.28	0.08	0.26	0.08	0.27
Superstar	0.40	0.49	0.42	0.49	0.45	0.49	0.38	0.49
Number Auctions**	132.02	133.90	127.51	129.50	121.13	1138.13	132.39	140.64
US Auctions	0.28	0.24	0.26	0.24	0.22	0.23	0.25	0.25
Hammer price (log)	8.79	2.15	8.38	2.21	8.17	1.91	8.04	1.97
Lot Not Sold	0.30	0.46	0.30	0.46	0.29	0.46	0.27	0.45
Obs Max.	29,551		84,610		35,513		96,930	

Note: Reported data is on artist-artwork-level and is based on a highly unbalanced panel of artists. The reported year-panel is based on estimates derived from baseline models. The post-periods include auction dates after the US court ruling of interest in April 2013. \* Averages reported based on the artist panel. \*\* Superstar-artist-year dummy excluded and separately reported in this table.

## 1.4.2 Intermediary Liability and Secondary Market Effects

As described in section 1.3.3, we estimate the causal impact of the higher court decision on liability of intermediaries on trade and availability of artworks by appropriation artists (treatment group) relative to a group of control artists and their works. As an exogenous shock, this decision changed the perceived litigation risk for market intermediaries.

We first turn to differences-in-differences models. For that purpose, we tighten the time frame with auction years 2010-2020 closely around the date of interest in 2013, as our DiD strategy tries to identify the short- to medium term effects of a change in copyright practice on secondary market effects. Table 1.4 provides summary statistics for our final estimation sample, showing sample characteristics before and after the court decision and samples by observational group (appropriation vs. control artists).

Table 1.5 presents baseline estimates for the dependent variable "number of auctions". For sake of clarity, the table only reports the coefficient of interest, and the interaction of the treatment group with the post-2013 period dummy. Models include fixed effects (artist, auction-year, and country fixed effects) and the panel/observation period is restricted to the years 2010-2020 inclusive (with the exception of model 6, using the overall panel period).<sup>22</sup> We estimate a robust negative effect of minus 63 to 67 auctions for our group of treated artists following years after the US court decision. We further note that using our preferred model specification (artist fixed effects and clustered standard errors at the artist level) estimates yield no significant effect. Clustering standard errors has a large impact on the significance, as we demonstrate in models 2 (on artwork-creation-year level) and 3 (on country level). We therefore carefully interpret this coefficient as weak evidence for a negative sign and direction of the effect. Although our preferred models are calculated with artist fixed effects, we can rule out potential bias on baseline results from so-called "superstar" artists experiencing a significantly higher number of yearly auctions, as descriptive statistics illustrate. We expect this to be an important influencing factor for our estimates and the total "number of auctions" we observe. This is because, for various reasons, the underlying economic mechanism also partially builds on the popularity and prominence of the artist at stake.<sup>23</sup>

Accordingly, models 4 to 6 re-run and presents model specifications, now using

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<sup>22</sup>Auction-specific controls include dummy variables for auctions at Phillips, Sotheby's, Christie's, and Bonhams. The specific shares of auction houses in total auctions are reported in table 1.2. Alternative models (not reported in the table, available upon request) yield similar results when adding more or different controls for auction-specific characteristics, i.e. controls for i) more auction houses than the top ones, ii) country-specific auction houses, or iii) combinations thereof.

<sup>23</sup>Arguably, superstars and their artworks often have higher commercial value and are more visible in markets, as descriptive statistics show. This might also ease monitoring and enforcement of predecessors' copyrights and increase the potential value in disputes that involve superstars. So, superstars, together with their traders, might be more likely to enter infringement proceedings, and, hence, trading their artworks could impose a higher liability risk on auction houses.

an outlier robust log-transformed dependent variable of artists' yearly number of auctions. We construct a superstar dummy and introduce in model (4) and (6) a triple-interaction  $treat \times post \times superstar$  (not reported). The coefficient of interest,  $treat \times post$ , stays negative even in this model specification (with a t-statistics of 1.95 in model 4).<sup>24</sup> Furthermore, model (5) is computed based on a smaller sample, excluding superstars from the estimation sample. Also here, the coefficient of interest stays robust and yields the expected negative coefficient. Moreover, once we widen the time frame to include all auctions between 1983 and 2020, including all fixed effects levels, and the triple-superstar interaction term, the coefficient continues to be negative, however, on a smaller magnitude of minus 0.0057 (model 6).

Table 1.5: Baseline Results: Number of Auctions

	(1)	(2)	(3)	(4)	(5)	(6)
	N auctions			log(N auctions)		
$Treat \times Post$	-62.78 (-0.61)	-66.58*** (-4.06)	-66.58*** (-5.90)	-0.0866 (-1.95)	-0.0844 (-1.91)	-0.00573 (-0.09)
Year FE	No	✓	✓	✓	✓	✓
Country FE	No	✓	✓	✓	✓	✓
Artist FE	✓	✓	✓	✓	✓	✓
Cluster SE	Artist	CreationY	Country	Artist	Artist	Artist
Timeframe	2010-2020	2010-2020	2010-2020	2010-2020	2010-2020	1983-2020
N	168544	168543	168543	168543	102110	257161
R <sup>2</sup>	0.971	0.977	0.977	0.976	0.927	0.958

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results for the dependent variable "number of auctions" model 1-3 and log(number of auctions) in model 4-6. All results are calculated as specified above. Model 5 using non-superstars, and model (4) and (6) a  $superstar \times treat \times post$  triple-interaction (not reported). All models include artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, Christie's, Bonhams). Standard errors (SE) clustered at the levels specified.

<sup>24</sup>The dummy variable "superstar" is constructed as the 75th percentile of the overall panel distribution of the "number of auctions" outcome variable. The dummy is one for an artist exceeding the threshold of 478 auctions, zero otherwise. Prominent artists classified in this way account for roughly one-fourth of auctions in the overall data, while the group of appropriation artists accounts for 57 percent of all auctions attributed to superstars. By this definition, for example, Andy Warhol, Roy Lichtenstein, Pablo Picasso, and Damien Hirst are considered superstars.

Table 1.6 reports logit and ordinary least squares (OLS) regression results for the dependent variable "lot not sold", i.e. a dummy variable for items listed but not sold at auctions. This dummy is 1 if the auction did not result in a sales success ("bought in"), and 0 otherwise. We, therefore, re-run our baseline results using an OLS regression model (1). As outlined in the empirical framework, the dependent variable should reflect short-term responses on the demand side, and we, therefore, are interested in the observation period to +/- 2 years around the court intervention (i.e. 2011-2015). In this way, we can rule out again possible bias in the estimates from the financial crisis. However, model (7) provides for a comparison using the longer time window and shows that the overall direction of effects does not change. Moreover, arguably, the composition of artworks included in auction samples could potentially change as a response to the court decision. In turn, this could also impact estimated sales probabilities around auctioned and curated artworks. To address this potential selection issue, we provide further descriptive evidence on pre/post observable characteristics of artworks. Descriptive statistics for each sample shown in table 1.4 indicate that, at large, sample composition does not change.<sup>25</sup> Ultimately, approximately three-quarters of the total artists in the estimation sample contribute to the identification of effects in our unbalanced panel, as they see auctions and are present in both, pre- and post-sample periods.

In all models of table 1.6 addressing short-term effects, the coefficient of interest is statistically significant at the 5%-level. This can be interpreted as follows: Artworks by treated appropriation artists have a higher probability of not selling in auctions run after 2013 as compared to control artists and their artworks on auction sale in the same period.

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<sup>25</sup>One notable exception is that fewer top auction houses (Philipps, Christie's, and Sotheby's) seem to curate and list artworks as their shares in samples decline after the decision. However, this pattern similarly applies to works by appropriation and control artists.

Models (2 and 3) show regression estimates using a logit model, and an estimated coefficient of around 0.13. Results are robust to the inclusion of year and country fixed effects as model (3) illustrates. When using additional fixed effects in models (4) to (7), our results continue to hold. The same applies when standard errors are clustered at artist- or artwork-creation-date levels (model 6). Further conditioning models on price estimates do not change results (estimates not reported). Given that, on average, one-fourth of the listed auctions in the treated and control samples do not result in sales success, we discuss the economic significance of our findings in the next paragraph.

At large, even smaller changes in sales success, as well as the changes in the total number of auctions, may have a significant effect on the overall value traded on art markets. Here, we are assuming that artworks did not find alternative sales channels other than the auctions we observe. Based on the ATTs and the estimated changes in the total number of auctions, we can provide a simple back-of-the-envelope calculation: Given that the median (appropriation) artwork sold after 2010 was auctioned for 4'500 US-Dollars and the treated group includes 1'025 unique artists, the plausible (annual) market value forgone due to artworks not being auctioned in this particular art movement or field is roughly 290-304 m. US-Dollars on a global level. However, this includes the possibility that some of the value forgone was invested in alternative art movements and went to other artwork auctions. Still, to put these numbers into context, auction sales for appropriation and control artists in our data amounted to a total of 2.36 b. US-Dollars in 2014. Moreover, the total sales volume from all public fine art auctions in the same year reached an estimated 24.2 b. US-Dollars globally, according to the Art Market Report 2020 (McAndrew, 2019).

Table 1.6: Baseline Results: Lot Not Sold

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lot not sold							
Treat $\times$ Post	0.0265* (2.57)	0.130* (2.53)	0.111* (2.25)	0.0219* (2.24)	0.0176* (2.08)	0.0176* (2.27)	0.00634 (0.64)
Year FE	No	No	✓	✓	✓	✓	✓
Country FE	No	No	✓	✓	✓	✓	✓
Artist FE	No	No	No	No	✓	✓	✓
Cluster SE	Artist	Artist	Artist	Artist	Artist	CreationY	Artist
Timeframe	2011-2015	2011-2015	2011-2015	2011-2015	2011-2015	2011-2015	1983-2020
N	75247	75244	75166	75245	74958	74958	257161
R <sup>2</sup>	0.0256	0.0226	0.0368	0.0433	0.0945	0.0945	0.0901

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results for the dependent variable "lot not sold". All models include artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, christies, bonhams). Model (2) and (3) using a logit model, model (1) and (4)-(7) using ordinary least squares (OLS). Standard errors (SE) clustered at the levels specified.

### 1.4.3 Relocation of trade

To reiterate, the main purpose of this paper is to analyze whether market intermediaries responded to the higher court decision on vicarious liability or not. Compared to previous results on worldwide auction trade volumes of treated artists, this section takes a closer look at a potential US auction market shift to non-US jurisdictions due to the prominent court decision in the US

More specifically, we deploy the relative share of US located auctions (in total auctions by the same artists) as the alternative outcome measure. Table 1.7 presents these baseline estimates. We observe negative and significant effects of around minus 0.0306 to minus 0.0385 in any model specification. When further adding country fixed effects (2), and year fixed effects (3) in the following models, the effect stays robust and consistent. It thus appears that, for appropriation artists in the treatment group, trade shifted toward non-US auction houses after 2013, when compared to control artists and their artworks on sale in auction houses outside the US

As we cannot fully rule out the possibility that we observe a different set of artists in pre- and post-periods,<sup>26</sup> we also calculate the differences-in-differences estimator based on the same exact sample of artists as before, i.e. 1'949 appropriation and control artist in total. The coefficient stays robust and negative for the reported OLS model (1) with no artist fixed effects, and once we include the superstar-triple interaction (not reported). We thus interpret estimates as a significant reduction and relocation of around 3 percentage points in the share of the US in total auctions among treated artists after the Second Circuit decision. Again, a simple back-of-the-envelope calculation reveals that this relocation shift equals an approximate annual

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<sup>26</sup>For example, there might be a potential selection bias from similar newcomer artists in Europe, first entering the panel post-2013.

auction market value of 29.4 m. US-Dollars. Again, to put estimates into context, our data suggest that total auction sales range between 1.46 b. and 2.36 b. US-Dollars from 2014 to 2019.

Table 1.7: Baseline Results: Percentage of US Auctions

	(1)	(2)	(3)	(4)	(5)	(6)
% of US Auctions						
Treat $\times$ Post	-0.0385** (-2.58)	-0.0306* (-2.40)	-0.0335** (-2.85)	-0.0335*** (-7.75)	-0.0335*** (-11.91)	-0.0416*** (-4.42)
Year FE	✓	✓	✓	✓	✓	✓
Country FE	No	✓	✓	✓	✓	✓
Artist FE	No	No	✓	✓	✓	✓
Cluster SE	Artist	Artist	Artist	Country	CreationY	Artist
Timeframe	2010-2020	2010-2020	2010-2020	2010-2020	2010-2020	1983-2020
N	168870	168870	168543	168543	168543	257161
R <sup>2</sup>	0.0978	0.360	0.883	0.883	0.883	0.862

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results for the dependent variable "percentage of US auctions" (yearly average). All results are calculated as specified above. All models include artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, Christie's, Bonhams). Standard errors (SE) clustered at the levels specified.

In an alternative, second identification strategy, we modify treatment and control groups and limit the treatment to appropriation artists and their auctions located in US houses. Arguably, auctions by appropriation artists in different jurisdictions might have been affected differently by the changes in the legal framework. We thus consider the auctions of appropriation artists in the US as treated as compared to auctions of *the same group of artists* auctioned in non-US houses. Although the prominent appellate decision in the case of visual arts has attracted broad attention in the appropriation art scene, in this second strategy, we hypothesize that the trade response is limited to or most impacted auction houses in the US within this particular group of artists.

Accordingly, table 1.8 shows regression results for the dependent variable "lot

not sold”. Both models are calculated with artwork- and auction-house-specific controls as in previous estimation models. And, we include year, artist and country fixed effects and cluster standard errors at the artist-level (model 1) and country-level (model 2). The results for the dependent variable ”lot not sold” reveal that US appropriation-art auctions (as compared to non-US ones) faced a lower probability of sales success post-2013, with a coefficient of 0.046. This effect is statistically significant at the 1%-level. This could well reflect the short-term demand shock and the changes in buyers/sellers’ perceived litigation risks after the appellate decision in 2013. Accordingly, the decision may have affected US auctions somewhat differently than those located in other countries.

As large auction houses with US headquarters may operate on multiple sites and across jurisdictions, subsidiaries outside the US could also have been exposed to legal changes and increased uncertainty. Anecdotal evidence suggests that Sotheby’s salesrooms in London, Hong Kong, and Dubai do not seem to engage in regulatory arbitrage. They are also governed by the laws of the state of New York as houses tend to choose the toughest laws to govern transactions which can enhance their international reputation (Shortland and Shortland, 2020). For this reason, we rerun alternative specifications inserting a dummy variable that identifies auctions located abroad but governed under the auspices of a US headquarter (results not shown). Still, our main findings continue to hold.

#### **1.4.4 Effect Heterogeneity**

So far, we have treated appropriation artists as a homogeneous group. However, the Artsy data also allow us to further distinguish and consider more fine-grained information on other closely related genres to appropriation art practices, i.e. genres

Table 1.8: Alternative Empirical Strategy: Appropriation Market Shift

	(1)	(2)
lot not sold		
$USAuction \times Post$	0.0460*** (3.87)	0.0460*** (5.23)
Year FE	✓	✓
Country FE	✓	✓
Artist FE	✓	✓
Cluster SE	Artist	Country
Timeframe	2011-2015	2011-2015
N	38346	38346
R <sup>2</sup>	0.101	0.101

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

Note: This table shows regression results for the dependent variable as defined in the baseline models. Samples are restricted to appropriation artists. All models are calculated with artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, Christie's, Bonhams). Standard errors (SE) clustered at the levels specified.

other than the unique appropriation genome, for each artist in the treated group. This allows us to next address plausible heterogeneity in the treatment effect. The distribution of genomes among the appropriation artists is presented in descriptive table 1.1. Based on (Artsy, 2019), we consider a set of eight related genomes for appropriation artists and interact these with the post-2013 period dummy to obtain ATTs for the different subgroups of the treated artists.

Table 1.9 reports model estimates for heterogeneous treatments. All models (1) to (3) replicate baseline specifications from previous sections. We run regressions on the most demanding models based on clustered standard errors at the artist level, including artist-, year- and country fixed effects. Again, model (1) accounts for the number of auctions and shows that all but one subgroup with related genomes are negatively affected by the court decision in 2013. The negative effect is largest for those artists that, next to the appropriation genome, are also categorized as/record the *Contemporary – Conceptualism* genome in the Artsy data. They see a loss of up to an average 92 auctions in the post-2013 period. Artists also associated with

Table 1.9: Baseline Results: Heterogeneity in the Treatment Effect

	(1)	(2)	(3)
	Number of Auctions	Lot Not Sold	% US Auctions
MixedMedia $\times$ Post	-2.096 (-0.03)	-0.0108 (-0.60)	-0.0272 (-1.72)
Contemporary Conceptualism $\times$ Post	-92.15 (-1.93)	0.0110 (0.49)	-0.0269 (-1.58)
Engagement With Mass Media $\times$ Post	-29.40 (-0.50)	-0.00684 (-0.49)	-0.0114 (-1.24)
Layered Images $\times$ Post	-82.61 (-1.79)	0.0298 (1.09)	-0.0238 (-1.82)
Neo Conceptualism $\times$ Post	-52.79 (-1.02)	0.0718 (1.05)	-0.0646** (-2.72)
Photographic Source $\times$ Post	58.37 (1.05)	0.00423 (0.23)	-0.0349*** (-4.75)
The Pictures Generation $\times$ Post	-76.94* (-2.24)	0.0692** (3.16)	-0.0565** (-2.65)
Use Of vintage Imagery $\times$ Post	-12.90 (-0.18)	-0.000394 (-0.01)	-0.0417 (-1.96)
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Artist FE	✓	✓	✓
Cluster SE	Artist	Artist	Artist
Timeframe	2010-2020	2011-2015	2010-2020
N	168543	74958	168543
R <sup>2</sup>	0.977	0.0946	0.884

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

Note: This table shows the regression results for the heterogeneity in the treatment effect for the three dependent variables of the baseline results. All models are calculated with artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, Christie's, Bonhams). Standard errors (SE) clustered at the levels specified.

the group of *Photographic – Source* are the clear exception as they are positively affected by holding this genome, i.e. their auctions increase by 58, even though the effect renders statistically insignificant. In a similar vein, estimates for heterogeneous treatments in model (2) using "lot not sold" as an outcome render mostly insignificant, and they do not always show the expected positive sign among all treated groups of artists. The heterogeneity of effects among treated appropriation artists is less pronounced when taking a look at the percentage of auctions located in the US (model 3). Notably, estimated effects in each of these subcategories stay robust and negative. In addition, the heterogeneity in the treatment effects shows one common

feature which we highlight in the next paragraph.

The pictures generation was an important, if not *the* most important US movement of appropriation artists. It most prominently featured artists like Richard Prince, Cindy Sherman, and Louise Lawler, among several others,<sup>27</sup> as outlined in the introduction section 1.1. For this more narrowly defined group of appropriation artists,<sup>28</sup>, the overall perceived litigation risk around this closed group of "art historic" peer-artists might be higher and, consequently, secondary art market responses could be stronger. This robustness check yields very similar and also more pronounced effects. Results for all three outcome variables confirm the overall direction of effects from baseline results and show coefficients are statistically significant throughout all models. Interestingly, relocation effects and the relative drop in the US auction share are more pronounced for this group of treated artists, showing a coefficient of minus 0.056 as compared to the group of control artists (and recalling baseline results of minus 0.0335)<sup>29</sup>. Moreover, the same applies to the probability that listed auctions do not sell, which brings up a positive coefficient of 0.069 (as compared to the baseline results of 0.0176). In sum, this section highlights that there is certain heterogeneity in treatment effects across models, but our main findings continue to hold for the different groups of appropriation artists as well as for a more narrowly defined sample of treated artists.

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<sup>27</sup>For an overview, please refer to this non-technical summary on wikipedia or an article from Artnews (2017).

<sup>28</sup>The artists from "The Pictures Generation" in our sample account for 2'134 auctions between 2010 and 2020, of which 61 percent were listed in auction houses in the US

<sup>29</sup>Note that, interestingly, "The Pictures Generation" is generally associated with artists based and worked in the 1980s in the US (Artnews, 2017), and 96 per cent of the recorded auctions are indeed from artists with US nationality while the remaining 91 auctions are from the artists Jack Goldstein (Canada born) and Thomas Lawson (British), both live(d) and work(ed) in the US

### 1.4.5 Robustness

In this section, we test the robustness of our baseline results to possible violations of the common-pre-trends assumption, which is central to differences-in-differences models. We rerun our preferred specifications of the models with several amendments in timing, pre-periods, and pre-trends. We present the main results from these more demanding tests in the following paragraphs. Notably, we include further pre-periods to analyze potential pre-trends in the two groups of artists.

Table 1.10 reports a first robustness check based on a placebo timing test. Based on the same set of control and dependent variables from our baseline models, we re-estimate models (1) to (3), however, with a placebo timing that is one year prior to the 2013 court decision and under a narrow observation period (2010-2013) to again rule out initial pre-treatment noise and financial crisis confounders. If our treatment and control groups follow similar trends in dependent variables before the 2013 changes, we should observe effects that are close to zero. Model (1) shows indeed a small mean effect size of minus 3 auctions that an appropriation artist received post 2012 when compared to the control group, which is close to zero (as compared to the minus 63 to 67 auctions observed in our baseline estimates). This indicates that we do not have a general trend driving our baseline results. Similar holds for the percentage of US auctions compared to non-US ones and sales success probabilities. For the former (2), the coefficient  $treat \times placebo_{timing2012}$  renders positive and insignificant (as compared to the negative significant effect in baseline estimates).<sup>30</sup> For the latter (3), we obtain a very small-sized effect that is statistically insignificant (as compared to the positive effect in baseline estimates). In general, these results,

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<sup>30</sup>The inclusion of the triple interaction term capturing the superstar effect (not reported) seems important for the percentage share of US auctions. Otherwise the shift of the 2012 coefficient is more pronounced.

together with additional robustness checks,<sup>31</sup> provides very solid results and allows for a more clear-cut interpretation of the common-trends assumptions and placebo tests. Again, a notable exception is the positive 2012 coefficient for the "percentage of US auctions" outcome. Here, we can observe an increase in the share of US auctions before the court decision. We will further address this potential issue in the event study design we discuss next.

Table 1.10: Robustness Check: Placebo Timing 2012

	(1) Number of Auctions	(2) % US Auctions	(3) Lot Not Sold
$Treat \times Post2012$	-3.655 (-1.08)	0.0162 (1.75)	0.00570 (0.41)
Year FE	✓	✓	✓
Country FE	✓	✓	✓
Artist FE	✓	✓	✓
Cluster SE	Artist	Artist	Artist
Timeframe	2010-2013	2010-2013	2010-2013
N	54333	54333	54333
R <sup>2</sup>	0.994	0.916	0.0986

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

Note: This table shows the placebo-timing regression results for the three dependent variables as defined in the baseline models. All models are based on ordinary least squares (OLS) regressions with artist, year, and country fixed effects and standard errors clustered at the artist level. All models are calculated with artwork-specific controls (age at auction, size, medium) and auction-house-specific controls (Phillips, Sotheby's, Christie's, Bonhams). Models include a superstar  $\times$  treat  $\times$  post triple-interaction (not reported). Standard errors (SE) clustered at the levels specified.

Building on the previous literature on differences-in-differences models (Autor, 2003; Roth, 2019), we next inspect if there is a significant difference (and trends) in outcome variables in periods before the treatment.

The event study results are presented and visualized in figure 1.7. We construct the event study with the (non-staggered) model by regressing on leads and lags with

<sup>31</sup>We also re-run our baseline models and placebo timing test by dropping 2012 observations from the sample to see whether the effects are driven by this particular year of auctions (not reported).

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the post-event time ( $t > 2013$ ), for the appropriation artists as treated units, and control artists serving as pure controls. All models include the most demanding specification using artist, artwork, auction-country, auction year and auction-house controls. Standard errors are clustered at the artist-level in models. The three panels in the left column show the "(log) number of auctions", mid column the "percentage of US auctions", and right column "lot not sold". For the sake of transparency, we report event study estimates for different samples. Top row panels are based on the overall sample, mid row ones are based on the non-superstar sample, and the bottom row panels are computed using "the pictures generation" as treated units only.

As argued above, estimated results for the log-transformed number of auctions in the first column are mixed. While the overall effect renders insignificant, estimates for the non-superstars confirm a valid pre-trend with close to zero coefficients for the years prior to the court decision. As coefficient estimates for lags indicate, treated units (appropriation artists) show a constant and significant negative decline in the yearly number of auctions after the verdict. This is important to note. Moreover, sample estimates for "the pictures generation" as treated artists also show an overall negative trend for post 2013 outcomes, albeit a negative pre-trend for years prior to the court decision must be acknowledged. Hence, we can only cautiously interpret the treatment as causal for the most demanding models, as some estimates indicate the presence of pre-trends for the 'most treated' group of artists.

At large, we observe heterogeneous treatment effects on the share of US auctions. Still, it must be noted that estimated effects render increasingly negative in post periods across all samples (mid column panels in figure 1.7). Arguably, as the placebo-timing test model (2) in table 1.10 indicated, the increase in the percentage of US auctions for the treatment group before treatment time ( $t_0$ ) could balance out

the significance of our differences-in-differences results obtained in the baseline model (table 1.7). In principle, this could justify the weakly significant pre-trends we observe in estimates. At large, however, results for the non-superstars and "the pictures generation" samples support the general pre-trend assumption and show consistently lower estimated coefficients throughout post periods. Although only two out of four coefficient estimates (leads) in the overall sample render insignificant and yield a close-to-zero effect in pre-periods, there is a clear common trend prior to the treatment observed for the non-superstars sample. As pre-trends in the most demanding specifications might effectively downward-bias the average treatment effect on the treated, we again cautiously interpret the coefficient of interest for this outcome variable as causal.

Finally, the right-hand column in figure 1.7 presents event study estimates for the outcome variable "lot not sold". Here, we can again observe a clear-cut zero effect prior to the court decision and a sudden upward jump in unsold auction probabilities for the treatment group in the first three years after the verdict.<sup>32</sup> Two out of four post-period coefficients (lags) show the expected statistically significant effects in the overall sample, while we observe insignificant estimates on slightly lower absolute levels for the non-superstar panel. Notably, estimates for "the pictures generation" again show a very consistent pattern of significant estimated post coefficients compared to pre-periods. As the common pre-trends assumption is supported for all lot-not-sold models, we interpret the differences-in-differences results for this outcome variable as causal.

While general robustness checks and event study results in particular, point to-

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<sup>32</sup>The coefficients are normalized around  $t_{-1}$  given the dependent variable "lot not sold" at the auction day-level.

wards a certain heterogeneity in the overall data sample, we are confident that main results and causal research claims continue to hold. In the next section, we discuss the policy implications of our findings.

## 1.5 Policy Discussion

The research indicates that doctrinal complexity and legal uncertainty around US fair use in the visual arts increased following the 2013 court decision. In this particular case, changes might not have helped to promote economic efficiency around licensing in the US (as intended by the fair use doctrine) because the criteria to apply fair use in the first place seemed less clear and laws seemed less predictable after the decision (Landes (2000), Adler (2016)). In this way, perceived litigation risks for artists and trade intermediaries have increased in due course.

We provide quantitative evidence on the costs and market charges for imposing indirect liability for infringement on intermediaries in the visual arts. Once their perceived litigation risk increases, this will affect the curation of works and selection into sales. Arguably, however, this research does not provide a comparative assessment of the effectiveness of indirect liability vis-à-vis other types of direct rights enforcement or changes in copyright's scope or length that would also modify incentives to reuse and disseminate artworks. And, it is not clear how much results generalize to other sectors of the creative economy. There is likely a distinction to be made between the criteria set up by automated filtering of millions of titles as in online music (for example, YouTube's content id system) and the manual selection and expert curation of a limited number of works for sale as in the visual arts. Even when copyright decisions, as we assume, do not cause creative practices by (appropriation) artists themselves to change, based on our findings, contributory liability and changes in perceived litiga-

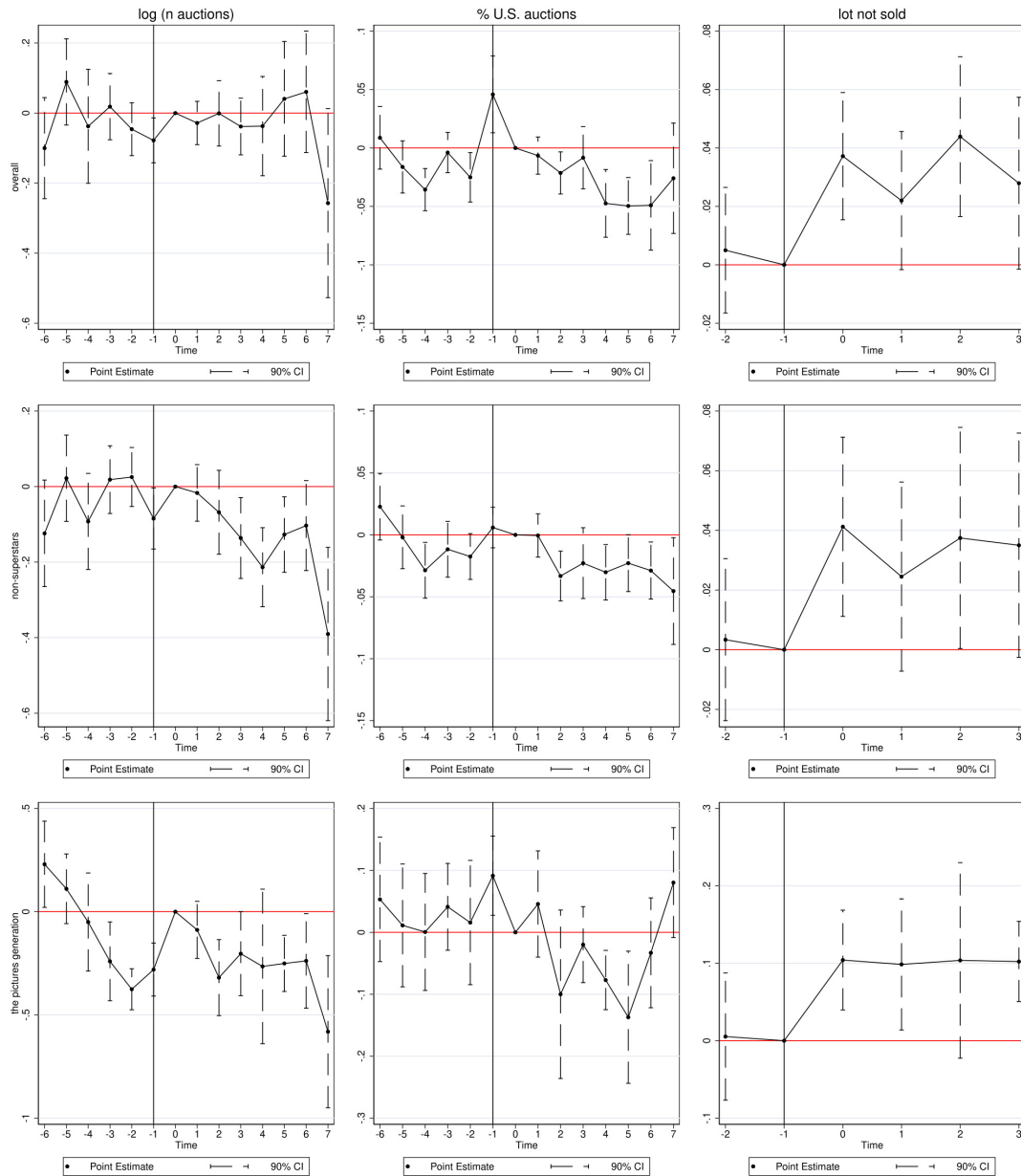


Figure 1.7: Event Study Analysis

Note: This figure shows the event study estimates for the coefficient of interest computed based on the baseline results. The three panels in the left column for the '(log) number of auctions', middle column the "percentage of US auctions, and right column "lot not sold". Top row is based on the overall sample, mid row based on the non-superstar sample, and the bottom row computed using only "the pictures generation" as treated units. We show point estimates and 90% confidence intervals. Coefficients are normalized around the base year 2013 (2012 for "lot not sold"). All models include artist, auction year, artwork, auction country, and auction house controls. Standard errors are clustered at the artist level.

tion risks temporarily limit the marketplace and auction showrooms made available to these artists because the relative sales value of their artwork (as compared to other non-infringing artwork) changes in due course. In the longer term, we would expect investment and growth of art market segments that involve follow-on innovation and that bear higher infringement risk to be restricted, if the nature of fair use is not evolving with new jurisprudence and risk perceptions are again changing.

Results also corroborate the idea that countries are competing over national legal frameworks and that firms and services are responding to the overall legal climate set up by national jurisprudence. Where laws and legal practices are not harmonized on an international level, intermediaries on global visual art markets such as auction houses will tend to migrate mobile "factors of production/services" to those jurisdictions that offer the most favorable conditions to them. This need not always be the case in visual art markets as evidence from previous research on resale rights suggests Banternghansa and Graddy (2009). Still, for the appropriation art case under scrutiny here, some sales value has shifted to places outside the US, with seemingly lower perceived litigation risks for auction houses and different sets of copyright rules in force.

In general, copyright protection not only ring-fences creators from unauthorized copying of others. Beyond the cases of authorized reuse and licensing, as we have shown with the data and extensive analysis, temporary uncertainty around fair use rules also restricts artists' unauthorized follow-on innovation in the context of visual arts, i.e. "transformative" and "productive" reuses of original artworks. While unauthorized (reproductive) copying seems much less of an issue in the visual arts, follow-on innovation is a growing policy concern with the changes and assemblage using new digital technologies and reuses of original artworks that are (also) protected

by copyright (cf. table 1.9). In this way, copyright rules also strike a delicate balance between new and older generations of artists and give them more or less freedom to operate and room to develop new reusing art practices in due course. The latter topic was not part of this investigation, but is an open issue and left to future research.

## 1.6 Conclusion

In this research, we show that there is a role for copyright in the visual arts, in particular in cases of follow-on innovation and in the appropriating arts, beyond the basic control over copying and reproductive uses. We investigate how the prominent 2013 *Cariou v. Prince* US court decision affected trade and availability in this sector. This decision arguably called into question prior assumptions about the application of fair use for some types of visual artworks and may have increased legal uncertainty concerning those works for market intermediaries. From an art historic perspective, results indicate that past legal framework changes have affected trade and relative market value in the appropriating arts. So, eventually, rules have also impacted the general direction of genre development and innovative practices in the figurative arts.

More specifically, quantitative findings on intermediary liability suggest that global auction trade in Appropriation Art, at least temporarily, decreases and partially relocates to other, non-US jurisdictions following the fair use decision. Moreover, for artworks listed in auctions, the sales probability of potentially infringing (appropriating) artworks decreases in this period. Effects are most pronounced for treated artists from the "Pictures Generation", an art movement that has pioneered appropriation techniques. Moreover, effects on auction trade continue to hold once we control for superstar artists, which, arguably, might have higher general visibility in markets, higher value in court disputes, and, accordingly, impose higher liability risk

on traders.

At large, back-of-the-envelope calculations reveal an estimated global market value of around 290-304 m. US Dollars forgone due to fewer artworks auctioned after the decision, while the total yearly auction sales volume, based on our data, ranges between 1.46 b. and 2.36 b. US-Dollars from 2014 to 2019. We interpret and relate our findings to a temporary increase in the perceived litigation risks in the visual art environment, in particular in terms of the contributory liability of intermediaries and the charges on global artwork trade by auction houses. Findings are robust against several alternative specifications and placebo testing.



## Chapter 2

# Digitization and Availability of Artworks in Online Museum Collections

This chapter is based on a paper co-authored by Alexander Cuntz and Paul J. Heald, that has been published in the WIPO Economic Research Working Paper Series, No. 75: <https://doi.org/10.34667/tind.48512>. An earlier version was presented by Matthias Sahli at the University of Neuchâtel, WIPO, University of Turin, Munich Summer Institute Conference (MSI), Society for Economic Research on Copyright Issues Annual Congress (SERCI), and European Policy for Intellectual Property Conference (EPIP).

CRedit authorship contribution statement: **Matthias Sahli:** conceptualization, data curation, formal analysis, methodology, writing, project administration. **Alexander Cuntz:** conceptualization, methodology, validation, writing. **Paul J. Heald:** conceptualization, validation, writing.

## 2.1 Motivation

How does the copyright or public domain status of a creative work affect its distribution in the market? Creative works are quasi-public goods, and most economic theorists of intellectual property law agree that some level of exclusivity may be required to incentivize the creation of non-excludable and non-rivalrous intangibles (Landes et al., 2003). However, once the creation of a work is adequately incentivized by a period of exclusivity, the need for additional protection to ensure the work's long-term commercialization and distribution is an open question subject to empirical investigation (Buccafusco and Heald, 2013).

The case for copyright protection of visual artworks is, as argued, weakened because most industry revenues are generated through sales of the physical works themselves, in contrast to income generated from mass-produced copies of musical works, movies, or books (Landes and Levine, 2006). Decades ago, no one could have anticipated the impacts of digitization on the use of creative works, such as the online availability of digital copies of (existing) artworks. Recent technological changes in the visual arts sector have challenged the economic role of copyright for the creation and distribution of digital artworks. In this thesis, through collecting data from museums and online collections, we examine the question of how copyright status affects the online availability of digital artwork images.

This study contributes to the question of how ex-post extended copyright protection affects the online distribution of new digital copies. The results are thus particularly relevant for policy debates on copyright and new uses of existing works in the digital age. The assumption that copyright law increases the availability of

(digital) copies of works has been adopted by the United States (US) Congress,<sup>1</sup> legal commentators (Bitton, 2011; Ginsburg et al., 2000) and the US Supreme Court in *Eldred v. Ashcroft*.<sup>2</sup> This question is complex in the context of the visual arts sector for the following reasons: On the one hand, artworks protected by copyright may have a higher likelihood of being digitized in the first place, as copyright also provides a potential source of income through the licensing of new digital uses. On the other hand, the digitization of artworks could increase exposure to the risk of infringement litigation. Relatedly, rights clearance and negotiations with copyright holders may generate transaction costs and could, in principle, impede digitization processes. Moreover, once digitized, digital surrogates of public domain artworks face a higher risk of being copied, as additional digital copies can be made at no cost; therefore, they provide little to no economic incentives for digitization in the first place. Nevertheless, whether artworks are digitized is mostly under the discretion and control of the owner of the original artwork. This study aims to shed light on these questions by collecting information on the availability and *quality* (in terms of digital image resolution) of artworks, and also by distinguishing between *upstream use* (e.g., the museum as the owner of the original artwork) and *downstream reuse* by third parties on the Internet.

By observing the distribution of artwork images (by famous artists) protected under copyright and in the public domain on USEUM, the “democratically-curated virtual museum” Useum, we leverage a quasi-natural experiment made possible by a

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<sup>1</sup>H.R. REP. NO. 105-452, at 4 (1998) (extending the term of copyright protection to existing works “would provide copyright owners generally with the incentive to restore older works and further disseminate them to the public.”); see also Excerpts of [former Patent and Trademark Commissioner] Bruce Lehman’s Statement Before Congress, September 20, 1995, available here (“[T]here is ample evidence that shows that once a work falls into the public domain it is neither cheaper nor more widely available than most works protected by copyright. One reason quality copies of public domain works are not widely available may be because publishers will not publish a work that is in the public domain for fear that they will not be able to recoup their investment or earn enough profit.”).

<sup>2</sup>537 US 186, 207 (2003).

significant change in US copyright laws in 1998. This allows us to causally identify a positive distributional effect of public domain status on the availability of digital artwork images. On average, the public domain status of artworks increases image availability on the platform by 34–42% compared with younger artworks still likely protected under US copyright laws. Moreover, we find that the average quality of public domain works is higher than that of their copyrighted counterparts (in terms of image resolution). In turn, term extensions in the US have led to a significant decline in online availability and image quality. They have likely also reduced the incentives for museums and similar stakeholders to digitize more recent artworks. Put differently, empirical findings for the visual arts sector confirm that the longer term of protection has not induced higher work reuse, as stipulated by advocates of the “under-exploitation” and “overuse” hypotheses (Buccafusco and Heald, 2013). The overall robustness of our findings is confirmed by separate placebo tests for a set of countries that have not seen a change in copyright laws around the cutoff, and also by tests for random assignment around the discontinuity addressing potential selection bias.

With this study, we contribute empirical evidence to the following three economic mechanisms around the digitization of cultural goods within the above-described legal environment. First, by engaging in new digital channels, museums might cannibalize some of their existing sources of revenue (Greenstein et al., 2013). For example, while digital consumption often stimulates onsite visits, it could also lead to a loss of ticket sales for the museum (Fernandez-Blanco and Prieto-Rodríguez, 2020). In addition, making collections available online might simultaneously have complementary and promotional effects, generate new demand, and create new sources of income for museums (e.g., revenue from the licensing of digital images). In turn, this could positively affect the museum’s sales, reputation, and turnover (Borowiecki and Navarrete,

2017; Bakhshi and Throsby, 2014).

Second, when museums create new digital goods and services, they have substantial control over their new digital uses and can act as gatekeepers of cultural goods with increasing importance. Our findings suggest that museums generally make public domain artwork images available in high resolution and for free (i.e., upstream digitization). This suggests that museums are less concerned about the aforementioned income losses. Next, we find that only a minority of museums actively seek to generate income by providing digital copies of copyrighted artworks.

Third, the transaction cost (Coase, 1960; Calabresi, 1960; Posner, 1972; Depoorter and Parisi, 2002a; Marciano, 2012) incurred by museums for copyright clearance as well as the attached risk and expected litigation cost might reduce the overall economic incentives to make digital images and artworks available to online audiences, independent of the actual copyright status. Our findings suggest that museums and digital platforms indeed react to the copyright status of the underlying artwork, and also that digital distribution decreases when artworks are potentially copyrighted. Nevertheless, the evidence demonstrates that some museums aim to digitize their collections irrespective of the copyright status of the original artworks. However, this effect may vary between public and private art institutions due to differences in their incentives, available resources, and overall mission. For instance, publicly funded art museums might place greater emphasis on cultural preservation compared with many for-profit private institutions. Clearly, more empirical research is required to further explore this particular aspect.

At this stage, it is noteworthy that while we are able to approximate the copyright status and publication year of the underlying physical artworks by their date

of creation <sup>3</sup>, the copyright treatment of digital copies of public domain works varies from jurisdiction to jurisdiction in two ways. <sup>4</sup> First, a jurisdiction could potentially recognize a new copyright in a digital surrogate. Most major jurisdictions like the US, United Kingdom (UK), and European Union (EU) find that digital copies of public domain works lack sufficient originality to be protected; however, the question is unsettled in some countries. More crucially, cultural institutions, independent of legal precedent, might sometimes claim ownership of digital surrogates and seek to control access to or license digital copies made from public domain works in their collections. This is a major difference, for example, between US and UK institutions, with UK museums being much more likely to lay claim to digital surrogates (Wallace, 2022). For this reason, some digital surrogates may “behave” like copyright works in the market, dampening the size of the positive public domain effects that we find. Given the difficulties of identifying two legal classes of digital surrogates, however, we assume in the remainder of the analysis that all digital copies of public domain works are in the public domain.

This chapter is structured as follows: section 2.2 reviews the related literature, while section 2.3 contextualizes the change in law. Then, section 2.4 describes the data, while section 2.5 outlines the empirical strategy. Next, section 2.6 presents the main empirical findings and section 2.7 discusses the policy implications. Lastly, section 2.8 concludes the chapter.

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<sup>3</sup>It is common practice among US museums to approximate and calculate the term of copyright protection based on the date of *creation* (and not “publication,” as stipulated in technical copyright laws) of the underlying artwork. According to the “Tech Tutorial: Digital Copyright and Privacy” of the American Alliance of Museums, “works created before 1923 should be considered in the public domain,” while “for works created after 1923, museums may need to seek permission to use the image” (American Alliance of Museums, 2014). Consequently, what we observe might be considered a “perceived” public domain status, strictly from a legal standpoint.

<sup>4</sup>c.f. section 2.5 for more details.

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## 2.2 Literature Review

A growing number of studies, most of them looking exclusively at book markets, conclude that when works fall into the public domain, the supply of (digital or physical) copies increases (Biasi and Moser, 2021; Heald, 2020, 2014, 2007; Reimers, 2019; Flynn et al., 2019; Li et al., 2018; Buccafusco and Heald, 2013). Several studies take advantage of changes in copyright protection to measure distributional effects. Biasi and Moser (2021) measure increases in the use and availability of German science texts before and after a UK World War II (WWII) declaration that they were no longer protected by copyright. Heald (2007) and Reimers (2019) found that US books from the same approximate era (1910s-1930s) moved from out-of-print to in-print significantly more quickly after they fell into the public domain. These results have been replicated for UK and Canadian book markets (Heald, 2020). Li et al. (2018) observed a similar positive public domain effect after a change in the UK copyright term length was made in the 19th century. The only study taking a random sample of titles in-print on the Amazon.com virtual bookshelf found a positive effect in availability associated with public domain status (Heald, 2014).

Relatedly, Flynn et al. (2019) found that public domain books were more likely to be offered as digital rentals by libraries than similarly situated copyrighted books. And in one of the few studies not involving books, Heald (2009); Heald et al. (2012) found that public domain musical works were just as likely to be used in movie soundtracks as their copyrighted counterparts.

Only two studies that we are aware of touch on the distribution of images. While researching the value of public domain images on Wikipedia, Heald et al. (2015) searched biographical entries of bestselling novelists for photographic images of the

authors. They found that between 80-90% of the Wiki pages of authors born before 1880 had photographs while between 40-50% of the pages for authors born after 1920 contained a photograph of the writer. Given that (at the time of the study) works published before 1923 were in the public domain, the results suggested that the existence of a public domain photograph increased the likelihood that an image of the author would be found on his or her Wiki page. The finding is particularly interesting because presumably fewer photographs of older authors are likely to exist. Nagaraj (2018) uses variation in copyright status of issues of Baseball Digest magazine by Google Books to measure the reuse on Wikipedia. The author found, among others, that copyright has a larger negative impact on image reuse compared to text.

Although several studies measure the distributional effects of public domain status, only one study has explored the potential effect of legal status on quality. In a human subject experiment, Buccafusco and Heald (2013) compared the quality of audiobooks made from bestselling copyrighted and public domain titles, finding that copyrighted and public domain titles attracted readers of equal quality. Although the authors suggest that copyright ownership may not be necessary to assure quality control, the relationship between the legal status of a work and the quality of a new version of the work remains an interesting and wide-open question.

## **2.3 Changes in the law and the economic incentives for museums**

In this section, we present an overview of the 1998 Copyright Term Extension Act, outlining the discussions and reasoning behind the extended term of protection. Next,

we describe the potential implications of this change in copyright law for museums and their artwork digitization endeavors.

The US copyright term has been extended several times. Laws from 1831 provided for a 28-year period and a 14-year renewal term, which was extended to a renewal term of 28 years in 1909. In the 1976 Act, works still under copyright protection gained an additional 47 years of protection (for a total of 75 years of protection, although not for works that had already entered the public domain). Thus, for artworks published in 1923, copyright would have expired in 1998. Turning to the focus of this study, the 1998 Sonny Bono Copyright Term Extension Act (hereinafter “the 1998 Copyright Act”) added another 20 years of protection for creative goods published between 1923 and 1978 (the term for works published after 1978 is life-of-the-author plus 70 years); for more legal details and a history of copyright law in the US, see e.g., Gifford (1999). As a result, the 1998 Copyright Act created a sharp discontinuity in copyright protection for works published before and after 1923 (Reimers, 2019). The 1998 Copyright Act, which introduced a substantial change in US copyright laws, incorporated four provisions that focused on a new infringement exemption, audio-visual works, transfer of right, and term extension (Gifford, 1999). The empirical identification strategy and other aspects of the law changes are explained in further detail in section 3.5.

In the literature, it is well documented that many stakeholders in copyright-related sectors lobbied the US Congress before the reform and advocated for an extension of the term (McAllister, 1998). Our empirical research addresses some of the key arguments presented by industry stakeholders and academic scholars in congressional hearings. Similar to Buccafusco and Heald (2013), we outline some of the economic justifications for term extension that were made and formulate testable hypotheses

based on our empirical research questions. First, the exclusive rights granted by copyright laws incentivize the creation of creative goods (Giorcelli and Moser, 2020). Considering that this study focuses on works that were already created and affected retrospectively, our research does not touch upon this crucial question; however, it does consider the effect of law changes on the distribution of works. Second, two economic rationales that favor a term extension for already created creative works were at the center of the public debate at the time – namely the “under-exploitation” and “overuse” hypotheses (Buccafusco and Heald, 2013):

*“H1: Works in the public domain become less available to consumers because there is a reduced (or no) economic incentive for the (digital) exploitation of those works once works transition to the public domain.”* This hypothesis draws from the law and economic literature on creative works as quasi-public goods which, once created, can be reproduced at minimal or no costs by others (Landes, 2000). While this argument is less of a concern for the original artwork itself (Landes and Levine, 2006), museums may not engage in producing digital surrogates thereof.

Archives and libraries expressed concerns that no new works would enter the public domain for 20 years, a matter explicitly addressed in the 1998 Copyright Act’s “new infringement exception” for the final 20 years of any copyright: “[A] library or archives, including a nonprofit educational institution that functions as such, may reproduce, distribute, display, or perform in facsimile or *digital form a copy* or phonorecord of such work, or portions thereof, for purposes of preservation, scholarship, or research.”<sup>5</sup> This exemption may align with the aforementioned hypothesis. Arguably, we should not observe any differences in the availability of digital artworks of copyright protected vis-a-vis artworks in the public domain. However,

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<sup>5</sup>See Sonny Bono Copyright Term Extension Act § 104(2) and Gifford (1999)

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this argument is weakened for several reasons. The exemption might not apply to private and for-profit institutions and is explicitly tailored to non-profit museums that aim to make their collection publicly accessible, such as for cultural preservation purposes. Next, and more crucially, the same provision asserts that this exemption will *not* be applicable if the copyright holder demonstrates that, among other factors, their work is subject to “normal commercial exploitation” or “a copy of the work can be procured at a reasonable price” (Gifford, 1999). Hence, if there is commercial interest in the copyrighted artwork, one can also argue in the opposite direction and expect a positive effect on the distribution of copyrighted artworks (e.g., through the sale and licensing of digital copies by the copyright owner), especially in the case of for-profit museums.

In contrast, museums may hesitate to make copyrighted artworks available to the public, even in the case of non-profit institutions with educational or preservation objectives, due to the risk of copyright infringement and the potential cost of litigation. Existing literature on the book market that compares the availability and pricing of copyrighted and public domain (digital) books has documented significant effects on both availability and prices (Li et al., 2018; Heald, 2009, 2014, 2019), which hints at substantial welfare implications of the 1998 Copyright Act (Reimers, 2019). In essence, the impact of copyright on the digital availability of artwork appears inconclusive, which underscores the need for empirical examination.

The second hypothesis (*H2*) stipulates that *once creative works fall into the public domain, a risk exists of their overuse (or misuse)*. Imagine the millions of reuses of the famous artwork “Mona Lisa” by the Italian artist Leonardo da Vinci, which might negatively impact the social and economic value of the original artwork. <sup>6</sup>

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<sup>6</sup>see e.g., TheGuardian (2017), or the Mona Lisa campaign for a budget airline (TheDrum, 2023)

This “tragedy of the commons” argument has been made by (Liebowitz and Margolis, 2004) with reusers of public domain works “producing at their own optima, [and] not taking into account possible effects on other producers.” As argued, the allocation of rights and ownership can manage this problem. Additionally, once a digital copy of an artwork exists, reduced transaction costs for public domain reuses (Posner, 1972; Depoorter and Parisi, 2002b) in terms of copyright clearance and expected litigation risks potentially encourage reuse beyond the “optimal level.” However, this idea is based on the assumption that creative works have an “exhaustive and finite” value, as opposed by Buccafusco and Heald (2013). By collecting a sample of commercially and non-commercially driven reuses of digital artworks, we can test whether older public domain artworks are reused more or less often. This result can be used as an approximation to test for the overuse hypothesis, considering the different qualities (image resolution) of digital surrogates made available depending on the status of rights.

In sum, our empirical research examines what is likely to happen – in distributional, reuse, and quality terms – with digital artworks when the underlying work transitions to the public domain. The studies cited above suggest that digital images of artworks should become more widely distributed when the underlying artwork falls into the public domain and might face a risk of overuse. However, the hypotheses are weakened by several aspects relevant to the museum context and the availability of visual artworks. Note that this context is somewhat different to the purely commercially driven logic of book or music markets. Museums that physically possess a public domain artwork in their collection are under no obligation to produce a digital image of it for public consumption. They can act as gatekeepers with control over access to the only tangible copy of the work. Nonetheless, beyond commercial interest, many museums also have a public (dual) mission to preserve cultural heritage and make it

available to the general public. Indeed, public museums increasingly adopt policies for making their digitized content publicly available, even when there are few economic incentives to do so from a non-profit perspective (Vickery and Wunsch-Vincent, 2006; Bertacchini and Morando, 2013). Moreover, from a quality (and not availability) perspective, (private) museums might strategically choose to only release lower-quality images to maintain consumer interest in visiting the museum and the physical work exhibited on site, or to earn additional income from the licensing of higher-resolution images to recover digitization costs. This again calls for an empirical investigation in this particular industry.

## 2.4 Data

### 2.4.1 Raw data and estimation sample

To address our empirical question, we extract data from two large online platforms in the visual art market Useum and Artnet. The raw data collected from *Useum* contains information on the individual artwork and artist-level as well as providing for rich information on user ratings (e.g. page views, followers and likes). The data includes information on the artwork title and year of creation, as well as information on the place of birth and years of birth and death of the artists, while short biographies are available for more popular artists. Furthermore, the *Useum* data provides links to original image sources such as the museum collection urls or *Wikidata* pages.<sup>7</sup> As a second step, we webscrape and collect additional information from Artnet, as artist information on *Useum* is sometimes incomplete or hard to extract.

In general, *Useum* is a digital art platform with more than one million followers.

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<sup>7</sup>Examples include "Vincent van Gogh - The Starry Night" from the Museum of Modern Art, or "Pablo Picasso - Les Femmes d'Alger" originally hosted on Wikidata pages.

It considers itself the "world's art museum that brings together art museums, galleries, artists and art lovers". The service operates an integrated mapping of artworks hosted on *Wikimedia Commons*, which automatically collects artwork information and digital surrogates from the latter platform. Moreover, as "crowd-sourced art museum" (Useum, 2022), users on the *Useum* platform also contribute new artworks to the online catalogue of digital surrogates. First, artists themselves (or their agents) contribute surrogates to the platform by uploading their own artworks or by selling ancillary products on the *Useums'* webshop against a small commission fee to the service (e.g., mugs or t-shirts showing their artworks)<sup>8</sup>. Second, the *Useum* service also engages with art historians that voluntarily contribute new works to the collection, mostly for educative purposes. And, third, general users also contribute and discover new digital surrogates by engaging with like-minded peers and "art-lovers" online, and by rating, liking or tagging artworks hosted on the service. Most artworks in the *Useum* collection provide for a link to the original source of digital surrogates, which redirects users to original museum websites or *Wikidata* pages. More details on the data collection process can be found in the Appendix A.

The raw *Useum* data represents artworks from 1'286 museums located in 59 countries. Most institutions are resident in the United States (22 %), the Netherlands (21 %) and the United Kingdom (13 %). For a full list of countries represented in the data and for the top-20 list of museum venues, please refer to table A4 and table A5, respectively. The raw data consists of more than 130K popular artworks created by 15'780 artists.<sup>9</sup> Digital artwork images have received more than 56,6M page views

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<sup>8</sup>More information on the commercial service can be found here [Link].

<sup>9</sup>We collect additional information on the year of artist death and the year of creation of the artwork. This is required to calculate the copyright term and approximate the copyright status of artworks. Data extraction from *Artnet* results in a total sample of 353'739 unique artists where information is complete. Based on an exact, non-fuzzy matching procedure which minimizes the problem of potential false-positives, we complement missing information on artists for a total of 72'709 artworks in our initial *Useum* data. We cannot attribute artworks to an artist (name) for

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and 59'827 likes from service users. Analogously, museums on the platform have received a total of 46,6M page views and 56'829 likes since the launch of the *Useum* platform in 2012 to the point of data collection (2021). In this context, it's important to acknowledge that the artworks analyzed from this dataset tend to represent more renowned and popular artists and not the overall population of artworks (selection bias). Figure 2.1 provides examples of such digital surrogates, for example of artworks by Wassily Kandisky and Mark Rothko posted on *Useum*. Most prominent artists in the raw data and in terms of the total number of digitized artwork (N) include Peter Paul Rubens (692), Edvard Munch (657), Anthony van Dyck (605), Auguste Renoir (543), Claude Monet (517) and Vincent van Gogh (510) (see table A5 for the top-20 list of artists). Artists are distributed and represented across different museums around the world. For instance, the 657 artworks attributed to Dutch artist Peter Paul Rubens are associated with 126 different museums in our raw data. On average, artists were born in 1760 and died in 1827 (mean). In terms of their popularity on the platform, the average artist has received a total of 3'662 page views and 18 likes (mean). Overall, the average digital artwork has received (standard deviation in brackets) 0.41 likes (2.53) and 365 page views (1173.8) since the launch of the *Useum* platform.

For the estimation, we narrow down the *Useum* data to include only artworks coming from museum collections in the US, UK and the EU. And, we further limit the sample to artworks created between 1910 to 1940. Table 3.3 lists descriptive statistics for this smaller estimation sample used in the baseline regression discontinuity design (RDD) and difference-in-differences (DID) estimations. Between 1910 and 1940, the average artwork creation year is 1918. Given the relevant public domain cutoff year is

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around 12 percent of the total sample, i.e. most artists are recorded as "unknown" or "anonymous" in the data.

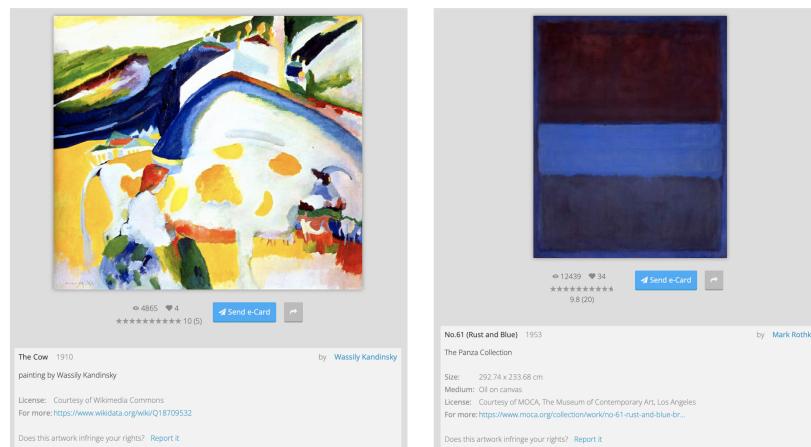


Figure 2.1: Useum Example - Museum of Contemporary Art Los Angeles and Wikimedia Commons

Note: This figure illustrates two digital surrogate examples from the Useum Webpage originating from different sources: the painting by Wassily Kandinsky (*The Cow*, 1910) via Wikimedia Commons (left) and a painting by Mark Rothko (*No. 61 Rust and Blue*, 1953) via the Museum of Contemporary Art Los Angeles (right). The examples further illustrate the artwork-level information (likes, views, ratings) and Useum-page information (buy or download options). The bottom panel lists important artwork- and artist-level information such as size, medium, © or licensing information.

in 1926 (for artworks in US museum collections), we observe that roughly 84 percent of artworks are created before this year. Overall, the average artwork has received 431 page views, average artist has received around 54K page views, and the average museum has received 706K page views since the launch of the *Useum* platform in 2012 until the point of data collection (2021). Roughly 70 percent of the curated observations in the sample are associated with museums in the EU and the UK, the remainder is from US museums by definition of the sample. The average number of observed artworks in a given country and year of creation (log) is around 44 (3.35) artworks. Finally, the average number of observed artworks per artist in a given year of creation (log) is around 3.5 (0.73) artworks. The next section introduces the complementary data on the downstream and upstream reuse of digital surrogates.

Table 2.1: Summary Statistics

Variable	Before 1926		After 1926	
	Mean	SD	Mean	SD
Artwork date	1915.97	4.467477	1932.369	4.269737
Public domain	0.99	.0884647	.6801909	.466681
Death year	1933.306	12.24018	1944.278	11.26506
Artwork views	426.59	1512.669	457.3365	1519.991
Artist views	54993.69	113451.6	53313.43	97136.39
Museum views	614344	1362341	1195887	2218405
EU UK dummy	.6949076	.4604984	.7004773	.4583225
N country	49.68905	37.18562	11.45107	8.736929
log(N country)	3.478483	1.088615	2.06098	.962152
N artist	3.531278	4.924565	3.367397	6.007613
log(N artist)	.759522	.8917698	.6073791	.8935353

Note: Summary statistics for the  $n = 5,276$  observed artworks in the EU, UK and US between artwork creation year 1910 to 1940. The dependent variable "N country/ artist" and "N country/ artist (log)" are the yearly number of digitized artworks in a given country/ of an artist, the logarithmic transformation respectively.

## 2.4.2 Data on Downstream and Upstream Reuses of Digital Images

We rely on an approach pioneered by Erickson et al. (2018). The authors track online reuse of images found on Wikimedia Commons and apply an automated reverse-image search on *Google*, systematically recording and categorizing by type of source and reuse. Drawing on a random sample of 10K images on Wikimedia, they find more than 54K downstream uses of the images and estimate a total value of the Wikimedia Commons Images universe based on an average (non-commercial and commercial) royalty license fees of around overall 28.9 billion USD (see also Heald et al. (2015) for a valuation approach).

Thus, similar to the approach in Erickson et al. (2018), we can identify online reuses based on our data. Our initial sample of artworks on *Useum* includes, in most cases, an image reference URL source and we therefore can apply a *reverse Google*

*image search* to identify possible up- and downstream reuses of an image in our data. This step requires extensive data management and manual inspection of the data quality. We focus on the US estimation sample of artworks created between 1910 to 1940. Limitations and data caveats are discussed in greater detail in the appendix. We gather the data in two consecutive steps. First, as the *reverse Google image search* requires a concise link to the image (i.e. a *.JPG – link*), we construct an automated web-scraper to collect image links on the initial webpage of the artwork image, using *python’s seleniumwebdriver* package. Second, using the detailed image links, we query and simulate a human-search in the *reverse Google image search* engine to collect search results, i.e. all links listed on ”pages with the matching images”. It is important to note that we exclude results (links) obtained from searches of visually similar images.

We define an ”upstream” reuse of an original artwork when the digital surrogate is associated with the museums’ web page and assume the museum is the original source of the digital image. This is because the museum acts as a gatekeeper owning the physical artwork and has some discretion over quality and image resolution of the digital surrogate derived from the artwork. Put differently, we identify online reuses in the total sample of reuses where the surrogate of the artwork is likely the digitized image made available by the museum on its website. We consider all other reuses as ”downstream” when surrogates are created and sourced from another service, entity or individual such as a commercial platform or another Internet source, and there is no indication the museum owns the underlying artwork. Practically, we approximate and distinguish upstream from downstream reuses based on the top-level domain information provided for related webpages (cf. the pie chart in figure 2.9), which works well as a common denominator for base-URL of museum websites in our data (e.g. *.lacma.org*; *.dia.org*; *.clevelandart.org*; and so on). Lastly, we perform a non-fuzzy

text-match with outcomes of the google searches and reuses of digital images. We find that out of the 88'607 links obtained from Google, 1'789 were upstream uses directly linked on the museum website. 1'494 upstream uses are obtained from artworks created before 1926 while 292 are from artworks created  $\geq 1926$ .<sup>10</sup>

Overall, starting from an initial list of 1594 artworks hosted from *Useum*, and a subsample of 1349 artworks where the direct and functioning .JPG URL can be verified,<sup>11</sup> we obtain a total set of 88'607 upstream and downstream reuses (cf. table for these works 2.2). An average (median) artwork sees reuses on 66 (42) pages, with 191 artworks creation year  $\geq 1926$  and 1158 artworks created before 1926.<sup>12</sup> Finally, for each reuse of a digitized artwork, we further enrich data on reuses and collect detailed information on image quality, i.e. pixel  $\times$  pixel information on the resolution of images.

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<sup>10</sup>These 1'789 upstream uses derive from 103 (567) unique artworks created after (before) 1926. There are several reasons why we lose artworks when we filter for upstream uses only. On the one hand, the google reverse image search might does not show the overall "universe" of reuses for technical/ algorithmic reasons (e.g. IP addresses) or misleading/ incorrect metadata behind the JPG URLs or on the websites. On the other hand, not all museums feature artworks on their website, and some changed upload policies or use other image libraries. We have reached out to several museums that confirmed this; e.g. the METMuseum updated how they identify public domain images and some MET images on Wikimedia were added before the updated policy. As a consequence, there "is a difference between what is available on the MET website and what is on Wikimedia" (Mail correspondence April 2022). The Cleveland Museum of Art also continuously updates works to Wikimedia, and: "public domain works might have multiple entries in Wikimedia due to AMICO, Artstor and any other image library from 15 years ago that tried to aggregate museum collections" (Mail correspondence April 2022).

<sup>11</sup>The loss of the remaining 245 artworks during this procedure is likely due to dis-functional direct .JPG URLs, "hard-to-scrape" pages, no initial direct URL or other errors and we expect no systematic error.

<sup>12</sup>Which is true by construction as our initial source of data *Useum* is a downstream-use itself and thus we know artworks were reused at least once and as a consequence should appear in a reverse google image search.

Table 2.2: Summary Statistics: Google Downstream/ Upstream Use

Variable	Before 1926		After 1926	
	Mean	SD	Mean	SD
Artwork date	1916.024	4.202358	1932.605	4.642898
Quality (pixel $\times$ pixel)	698941.6	1816344	790340.9	1793988
log(Quality)	12.52377	1.316987	12.59962	1.351164
Low quality dummy	.6514375	.4765184	.6407169	.4798069
Domain (.org) Dummy	.1267598	.3327059	.1217909	.3270554
Domain (.com) Dummy	.5242732	.4994138	.5048786	.4999935
Upstream dummy	.0201872	.1406411	.0202062	.14071

Note: This table shows the descriptive statistics of the upstream- and downstream-uses obtained from a google reverse image search with artwork creation year between 1910 and 1940. The dummies "domain" and "upstream" are derived from semi-fuzzy text-analysis methods on the base-URLs.  $N = 88'607$ .

## 2.5 Empirical Framework

In the empirical strategy, we implement a regression discontinuity design (RDD) as pioneered in the literature (Imbens and Lemieux, 2008; Angrist and Pischke, 2008; Lee and Lemieux, 2010). We follow and build on previous work in copyright economics evaluating the impact of the US copyright on the reuse of music (Watson, 2017a), as well as the impact on prices and the availability of books once works transition to the public domain (Reimers, 2019; Heald, 2007). To provide causal evidence, we exploit exogenous variation in copyright status introduced by the 1998 copyright term extension in US laws. The design allows us to causally identify treatment effects in a non-experimental setting. The "1998 Copyright Term Extension Act" extended the copyright protection for an additional 20 years for works that were still under protection at that time, from 75 years to 95 years of copyright protection from the date of publication. Given that the data is collected in 2021, the copyright reform creates a sharp, exogenous discontinuity in the copyright status of artworks copyrighted before and after 1926 that were still in copyright at the time of the reform and assuming all formalities in laws were met (e.g. initial registration and potential

renewal of copyright at the US Copyright Office).<sup>13</sup> It is important to note that under pre-1978 US law, the length of a copyright is calculated from the moment of "publication". However, as we only observe the year of artwork creation, we use this point in time as an imperfect cutoff between public domain and copyright protection in the present analysis. This seems the best possible approximation with our data for an econometric design exploiting the copyright and public domain status of artworks.<sup>14</sup> Because territorial copyright reform mostly affected creative works located in the United States, we limit the main data sample for the RDD results to artworks created between 1910-1940 and artworks originating from US museums.<sup>15</sup>

Most jurisdictions in our sample take the artist's year of death as the point of departure to calculate copyright terms and grant artists between 50 to 95 post mortem

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<sup>13</sup>Under the 1909 copyright law, works copyrighted in the US before 1978 were subject to a renewal system, see (USCO, 2006). Registration and renewal records in a searchable format are only digitized for works copyrighted after 1978. According to our information, there is not systematic card catalogue information digitized for pre 1978 records and not searchable for unique titles (considering the fact that many artworks are titled "sans titre, no title, etc." gathering systematic evidence is not possible). Museums seem to consider the date of creation to be the relevant year for calculating the 95-year copyright term, see 14 and (AAMD, 2017). Nevertheless, it is possible that certain artworks have already entered the public domain, yet we might still "treat" them as copyrighted. As a result, our empirical estimations may underestimate the "true" public domain effect.

<sup>14</sup>"Publication", an extremely complicated term of art. The Copyright Office has stated that mere display of a work of visual art in a gallery does not constitute publication, but sale at auction or inclusion of an image of the work in a printed book or catalog (or a post card or magazine?) does constitute publication (US Copyright Office, "Publication," please see here [Link]). Early 20th century case law left the matter unsettled, with at least one prominent case finding display in a gallery could constitute publication of a painting (Gerhardt, 2011). Interestingly, museums seem to consider the date of creation to be the relevant moment for calculating the 95-year copyright term, perhaps because that date is far easier to discern than the date of first display, sale, or inclusion in a catalog, book, or museum- or gallery-printed publication. Although there is no support in the law for calculating the US copyright term from the date of creation, the institutions in our study seem to use it as a rule of thumb, agreeing on a synthetic copyright term based on norms rather than technical law.

<sup>15</sup>It is worth noting that the 1998 Extension Act also applied to the protection of foreign works (see, for instance, Heald (2007)). Permissible within the framework of the *Berne Convention*, the US (as other contracting parties) will not discriminate between the protection granted to foreign vis-à-vis domestic works. For example, this means that some foreign works might have transitioned to the public domain in their "home country", but they will continue to be protected under US copyright laws.

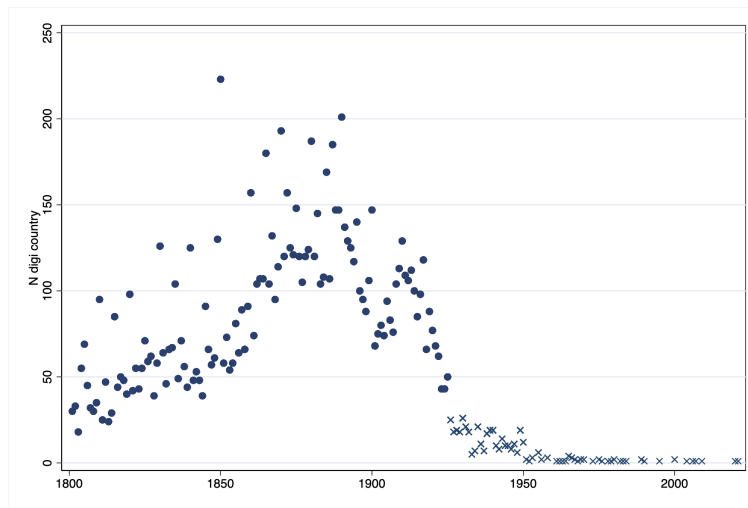


Figure 2.2: Number of Digitized Artworks: Raw Data

Note: This figure shows the "raw data" for the number of yearly digital artworks found on *Useum*. The data includes digital artwork surrogates from museums in the US for artworks created between 1800 and 2021. The crosses symbolize the cut-off creation year in 1926 and later where artworks are under copyright protection while the blue dots represent numbers of artworks in public domain.

years of protection. However, in the RD design, we focus on the US legal framework and, accordingly, the date of publication of the original artwork as approximated by the date of creation. Notably, this generates within-artists variation in copyright status for original artworks in US museum collections. So, original artworks created by the same artist before 1926 could potentially be in public domain, while original artworks created after this cutoff will likely remain under copyright, assuming formalities in laws were also met. In the RD design, the assignment to the treatment (public domain) follows a known rule. As shown in figure 2.2, we observe a discontinuity in the raw data for creation dates of original artworks. Thus, we formally construct the "forcing" variable (Lee and Lemieux, 2010) of *artwork* indexed by artist  $i$  in creation year  $t$  as:

$$PublicDomain_{it} = \begin{cases} 0 & \text{if } artwork_{it} \geq 1926 \\ 1 & \text{if } artwork_{it} < 1926 \end{cases}$$

where 1926 is the known threshold-year for copyright protection in the US (in 2021 for works that were likely in copyright and subject to the 98 term extension) of the discontinuous function of the creation year of an original  $artwork_{it}$ . This leads to the regression equation we used to compute the results:

$$Y_{it} = \alpha + \delta PublicDomain_{it} + (creationyear_{it})^k + \rho_I + \mu_M + \mathbf{X}'_{it} + \epsilon_{it} \quad (2.1)$$

with the effect of interest captured in  $\delta$ , the effect of a public domain status (of the original artwork) on its digital availability, and  $(creationyear_{it})^k$  is the artwork creation year (and polynomial functions  $k$ ). We add artist fixed effects (FE)  $\rho$  and museum fixed effects  $\mu$  to the regression. We restrict this regression to available artworks of museums located in the United States that potentially could be affected by the copyright reform and tighten the observation window for artworks created around the cutoff in 1926. In our setting, the so-called forcing (or running) variable (Lee and Lemieux, 2010) is the year of original artwork creation and our dependent variable ( $Y_{it}$ ) is the log-transformed number of digitized artworks from a given creation-year (on the aggregated country- or artist-level) that we observe online from US museums.

Lee and Lemieux (2010) summarize important checkpoints for the causal identification to hold. As noted in their paper, estimates can be biased if individuals are able to manipulate the "assignment variable". This is not a concern in our setting as the reform in 1998 was implemented retrospectively for artworks created in 1923 and later that were still in copyright at the time of the term extension, and so it did not affect

the incentives to create new artworks back then.<sup>16</sup> We provide robustness checks in section 2.6.3 and further inspect in section 2.6.4 if we can observe discontinuities in other observable artwork characteristics around the cutoff date.

As an additional robustness check, we exploit variation in copyright status between the previous results on artworks availability in US museums compared to digital artworks from EU and UK museums<sup>17</sup>. As the above described empirical framework suffers from the limitation that we don't know the true number of available artworks created before/ after 1926, we leverage the fact that we observe artworks of museums in several countries around this time. In a difference-in-differences design we compare the differences in number of available artworks (artist-/ country-level) closely around 1926 of artworks from US museums compared to EU/ UK countries (i.e., museums).

This approach follows Watson et al. (2023) who exploit variation in a song's copyright status between US and UK availability on different distribution channels. Due to the unavailability of panel data measuring the artwork's availability before *and* after copyright expiry, we construct these additional robustness results. Although this framework relies on a cross-country control group (i.e. the countries need to have similar growth paths in dimensions, which is a stronger assumption and there is variation in post-mortem term protection in EU/ UK countries), we can learn and approximate by how much public domain status increases (or decreases) the availability of artworks in US museums. Similarly to (Watson et al., 2023), if we continue to estimate the same effect direction as in the RDD models, the differences-in-difference

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<sup>16</sup>It is important to note that there were no other relevant changes in copyright laws in this time period (Reimers, 2019).

<sup>17</sup>With the data at hand, the comparison of US to EU and UK availability seems to be the most adequate counterfactual, based on numbers of available artworks in this time-period, that the EU+UK serves several cross-country counterfactual-trends (22 in our data), that the EU+U.K. rely on post-mortem copyright protection term, and the fact that the Useum platform is based in the UK.

estimator can confirm the validity of our main results compared to a control group of artists and museums. We therefore run the following type of difference-in-differences equation:

$$Y_{itc} = \alpha + \delta \text{PublicDomain}(US)_{it} \times US + \phi_I + \gamma_T + \beta_C + \mathbf{X}'_{it} + \epsilon_{itc} \quad (2.2)$$

where we again look at the number of available artworks  $Y_{itc}$  on the country- and artist-level, but in several museums in several countries.  $Y_{itc}$  is thus the number of observed artworks (log) for artist  $i$ , in creation year  $t$  and in museum country  $c$ . The coefficient of interest is captured in  $\delta$  which compares pre- 1926 availability (public domain in the US) of artworks in US museums compared to museums in the EU and the UK. We again add museum, year, and country fixed effects  $(\phi, \gamma, \beta)$  to the regressions.

## 2.6 Estimation and Results

### 2.6.1 Availability of Digital Artworks from Museums in the US

We now turn to the results of the identification strategy outlined in section 2.5. With table 2.3 we introduce our preferred econometric specification, with results based on the dependent variable on the artist panel-level, i.e. the artists- "yearly number of digitized artworks". These results point towards a positive coefficient around 0.294 to 0.355 for the (log-transformed) dependent variable with statistically significant results in all model specifications with additional covariates. This structure allows us to also add to the regressions artists' fixed effects (cf. model (4) to (6) of table 2.3), coefficients are based on the within-estimator that controls for unobserved

artist-specific and time-invariant heterogeneity. In model (6) we introduce several fixed effects (museum and artist) to control additionally for museum-level differences of making artworks digitally available. In the appendix A of this thesis we report additional results based on the country-level and adopt a Poisson pseudo-maximum likelihood estimator.

Table 2.3: RDD: Availability (Artist-Level) (log)

	log(N artworks Artist)					
	(1)	(2)	(3)	(4)	(5)	(6)
Public Domain	0.325* (2.48)	0.355** (2.74)	0.338* (2.40)	0.325* (2.53)	0.331* (2.56)	0.294* (2.19)
Artwork creation year	2.051 (0.91)	1.959 (1.07)	1.737 (0.97)	-0.333 (-0.18)	-0.418 (-0.23)	-0.119 (-0.07)
(Artwork creation year) <sup>2</sup>	-0.000535 (-0.92)	-0.000510 (-1.07)	-0.000452 (-0.97)	0.0000842 (0.18)	0.000106 (0.22)	0.0000283 (0.06)
artist views		0.00000239*** (5.29)	0.00000216*** (4.26)			
museum views		6.22e-08 (1.26)	0.0000159 (1.04)		3.00e-08 (1.47)	0.0000150 (1.27)
artwork views		0.00000998 (0.59)	0.0000151 (0.92)		-0.00000109 (-0.09)	-0.00000442 (-0.37)
N	1592	1566	1566	1335	1313	1290
Cluster SE	Artist	Artist	Artist	Artist	Artist	Artist
R <sup>2</sup>	0.0445	0.234	0.365	0.633	0.631	0.658
Artist FE	No	No	No	✓	✓	✓
Museum FE	No	No	✓	No	No	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results based on the formula specified in chapter 2.5 and the dependent variable is the (log) year-artist-level number of digitized artworks in model 1-6, restricted to museums in the US and artworks created between 1910 to 1940. Model 4-6 are calculated based on artist fixed effects, and model 6 incorporates museum fixed effects. Standard errors (SE) clustered at the levels specified.

Figure 2.3 further illustrates the above discussed results. The graphical approach is able to show the discontinuity in the function of artwork creation years as an approximation to the actual year of first publication. The portfolio of available artworks based on the artist-level increases sharply for those created before 1926 and presumably are in public domain in the US as of 2021.

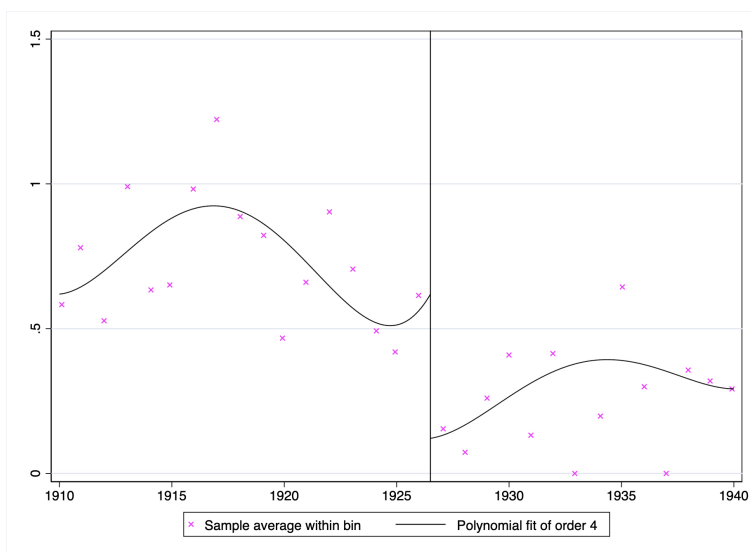


Figure 2.3: RDD: Digitized Artworks (log) (Artist-Level)

Note: This figure shows the (log) yearly number of digitized artworks on the artist-level and year of artwork creation date. The sample is restricted to years 1910-1940 and museums in the US. The crosses represent sample average within bin and the line a polynomial fit of order 4. Standard error are clustered at the artist-level. The x-axis line denotes the copyright cut-off point in 1926.5.

In table 2.4 we present results based on the counter of number of yearly available artworks on the artist-level. Using the non-log transformation of the dependent variable can eventually help us to better understand the magnitudes of the coefficients, that we will discuss afterwards. Overall, the public domain status of artworks (i.e. being created and likely published just before 1926) stays also here significant (at the 5%-level) positive of around 0.987 and 1.313 in the same model specifications as previous (1-5). We only lose statistical significance after including in model (6) both fixed effects (museum and artist).

Lastly, we balance our artist-level data on the right-hand- and left-hand-side around the cutoff year in 1926 around observed artists. One could argue that we estimate with sample selection bias of different artists entering or exiting the pre- and post-1926 sample and possibly observe a biased public domain effect.<sup>18</sup> In con-

<sup>18</sup>This topic is also discussed in section 2.6.4 "random assignment around the discontinuity and

Table 2.4: RDD: Availability (Artist-Level)

	N artworks Artist					
	(1)	(2)	(3)	(4)	(5)	(6)
Public Domain	1.258* (2.35)	1.402* (2.53)	1.313* (2.36)	1.078* (2.23)	1.125* (2.27)	0.987 (1.91)
Artwork creation year	14.20 (1.45)	14.02 (1.74)	13.78 (1.65)	8.398 (1.58)	8.264 (1.55)	9.412 (1.80)
(Artwork creation year) <sup>2</sup>	-0.00369 (-1.46)	-0.00364 (-1.74)	-0.00358 (-1.65)	-0.00219 (-1.58)	-0.00215 (-1.56)	-0.00245 (-1.81)
artist views		0.00000838*** (3.49)	0.00000770** (2.95)			
museum views		0.000000281 (1.39)	0.0000422 (0.85)		0.000000111 (1.21)	0.0000485 (1.23)
artwork views		0.0000865 (0.81)	0.000110 (1.09)		0.0000696 (0.85)	0.0000490 (0.65)
N	1592	1566	1566	1335	1313	1290
Cluster SE	Artist	Artist	Artist	Artist	Artist	Artist
R <sup>2</sup>	0.0429	0.229	0.338	0.665	0.666	0.694
Artist FE	No	No	No	✓	✓	✓
Museum FE	No	No	✓	No	No	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results based on the formula specified in chapter 2.5 and the dependent variable is the year-artist-level number of digitized artworks in model 1-6, restricted to museums in the US and artworks created between 1910 to 1940. Model 4-6 are calculated based on artist-panel fixed effects, and model 6 incorporates museum fixed effects. Standard errors (SE) clustered at the levels specified.

sequence, we exclude artists who did not have at least one observation post 1926 in our US sample. We observe 112 artists with artworks created and likely published after 1926. In the new (balanced) panel, artists had on average 2.4 artworks (median 2), with a standard deviation of 1.84 artworks, and we observe 247 artworks created in or after 1926 while 385 artworks of the same artists were found prior the cutoff year.

Table 2.5 presents estimates based on the balanced panel. We again look at the counter of created artworks (artist-year-level) using the same model-specifications as before. We continue to estimate also in the artist-balanced panel positive significant coefficients. This sample increases the estimated dummy of available public domain artworks from around 0.382 (model 6) to 0.68 (model 2). This demonstrates that

placebo tests”.

our sample, the estimated public domain coefficient, is also robust against using the balanced artist-panel compared to the previous results (cf. table A2 model (6) 0.424). We visualize this result in figure 2.4. Also for the artist-balanced panel, results demonstrate a sharp discontinuity in the artwork creation year around 1926.

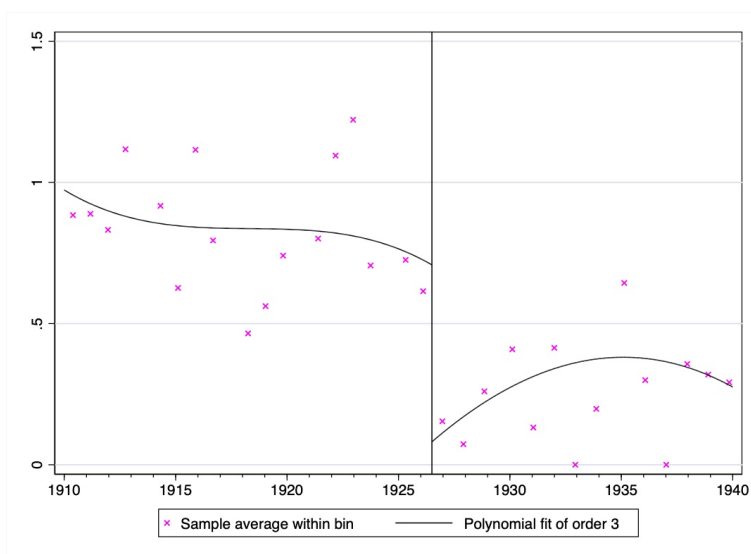


Figure 2.4: RDD: Digitized Artworks (log) (Artist-Level Balanced-Panel)

Note: This figure shows the yearly number of digitized artworks (log) on the artist-level and year of artwork creation date. The panel is balanced around artists who had at least one observation post 1926. The sample is restricted to years 1910-1940 and museums in the US. The crosses represent sample average within bin and the line a polynomial fit of order 3. Standard error are clustered at the artist-level. The x-axis line denotes the copyright cut-off point in 1926.5.

## 2.6.2 Effect Size and Magnitude

Overall, we identify a positive effect of public domain years on available (popular) artworks by year of artwork creation. Our preferred estimates on the artist-level in table 2.3 estimate a coefficient of observed artworks (log) in creation years 1926 or earlier of 0.355 (model 2) to 0.294 (model 6), all statistically significant at the 5%-level. Results indicate an increase of about 34 to 42% artworks (by artist) with creation years 1910-1926 compared to creation years 1927-1940. In table 2.4, we estimate an increase of around 1 to 1.4 artworks by artist that are more available by these creation

Table 2.5: RDD: Availability (Artist-Level ) (Balanced)

	N artworks Artist					
	(1)	(2)	(3)	(4)	(5)	(6)
Public Domain	0.645 (1.83)	0.686* (2.26)	0.587 (1.77)	0.418* (2.22)	0.429* (2.47)	0.382* (2.02)
Artwork creation year	-0.000534 (-0.02)	0.00425 (0.24)	0.00365 (0.21)	-1.063 (-0.39)	-0.976 (-0.36)	-0.0141 (-0.01)
(Artwork creation year) <sup>2</sup>	0 (.)	0 (.)	0 (.)	0.000274 (0.39)	0.000251 (0.36)	0.00000105 (0.00)
artist views		0.00000179*** (4.55)	0.00000193*** (6.43)		0 (.)	0 (.)
museum views		9.01e-08 (1.77)	0.000198*** (4.04)		2.57e-08 (0.61)	0 (.)
artwork views		-0.0000325 (-1.57)	-0.0000293 (-1.54)		-0.0000214 (-1.08)	-0.0000324 (-1.85)
N	632	628	628	580	577	556
Cluster SE	Artist	Artist	Artist	Artist	Artist	Artist
Pseudo R <sup>2</sup>	0.0566	0.0917	0.1253	0.1721	0.1721	0.1846
Artist FE	No	No	No	✓	✓	✓
Museum FE	No	No	✓	No	No	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the Poisson regression results based on the formula specified in chapter 2.5 and the dependent variable is the year-artist-level number of digitized artworks in model 1-6, restricted to museums in the US and artworks created between 1910 to 1940. Model 4-6 are calculated based on artist fixed effects, and model 6 incorporates museum fixed effects. Standard errors (SE) clustered at the levels specified.

years (cf. table 3.3 with a yearly average of artworks by an artist that lies around 3.5 artworks in the overall estimation sample). We emphasize that we do not observe the entire catalogue of crated artworks of observed famous artists (or even more desirable: a sample of artists with the entire catalogue of existing (original) artworks, information on digital surrogates, and on artworks *not* digitized). Present numbers represent yearly averages calculated by artists and by year of creation. Previous results also point towards a clear cut positive effect of public domain years with the attempt to balance the panel on the artist level (cf. table 2.5). We challenge the effect size of our results with robustness checks, and test for random assignment around the discontinuity (to identify potential selection biases).

### 2.6.3 Robustness

In this section, we carry out a number of robustness checks and refine specifications from baseline models. A later section 2.6.4 will deal with identifying assumptions imposed by the RD design such as the random assignment of covariates around the discontinuity. In addition, the later section introduces separate placebo tests for a set of countries that do not see a change in copyright laws around the cutoff.

We recognize pre- and post-trends in figure A1 that could potentially bias our results. While the data shows a clear cut-off point around the year 1926, the treatment effects we estimate could nevertheless be driven by changes in digitization practices, changes in the compositions of museums in our sample, or other sources of potential bias. To address this issue, we run another set of model specifications and test for robustness of our results.

A robustness check is shown in figure 2.5 and table 2.6. We rerun and estimate regression from baseline models now further narrowing down time windows. For the panel on the left-hand side of figure 2.5 and models (1) and (3) in table 2.6, windows and samples are tightened further to artworks created between 1923 and 1927. Estimates give us the "local treatment effect". This shows that we can isolate out the copyright effect as artworks created between 1923 to 1926 continuously move to the public domain from 2018 onwards (see, for example, Heald (2007)). To be precise, an artwork created and likely published in 1923 had a maximum potential copyright protection of 95 years (once the 1998 copyright reform went into force, granting some artists 75+20 years of protection). So, it has moved, at the latest, in the public domain on January 1, 2019, while artworks created in 1924 and likely published shortly after entered the public domain at the latest in 2020, and so on. For this narrower

time window, we should not observe any discontinuity in available artworks created between 1923 to 1925 compared to artworks created in 1926 or 1927 (which is not the case), even when, hypothetically speaking, other factors than copyright protection would explain the sharp drop in availability at the cut-off point in 1923.<sup>19</sup> The immediate sharp increase of public domain works in figure 2.5 is scrutinized by the estimates. The effect size of the log-transformed yearly number of digital surrogates is 0.54 (which compares to the 0.8 in the baseline using the wider 1910-1940 window) and the effect continues to be significant in this specification (cf. model (1)). In terms of the total number of digitized works (log) on the artist-level in model (3), we cannot estimate significant results. Given the low number of observations using the fixed effects models at the cutoff, this can be expected.

To further verify our findings, we look at the longer time window of artworks created between 1800 and 1960 and re-estimate models (2) and (4) in table 2.6. Notably, the right-hand panel of figure 2.5 shows a smooth function in the number of digitized public domain artworks created and likely published between 1800 and 1926 and again a sharp drop at the cutoff. The wider window strongly accentuates size and direction of the estimated effects, as the yearly, log-transformed number of digital surrogates on the country-level increases to 1.7 in model (2) and stays statistically significant at the highest level. All results point towards a positive effect and causal impact of a public domain status on the availability of digitized popular artworks in the US. Our results continue to hold when we run the same estimates in model (4) on the artist-level. The effect of a public domain status on availability (i.e. number of digitized artworks artists (log) observed) increases to 0.36 and becomes statistically

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<sup>19</sup>For example, one could argue that museums never digitized artworks created after 1923 for whatever reason, or that the copyright term for these artworks ended much earlier as their copyright was not renewed after an initial period of protection and so formalities were not met. Similarly, art historic reasons may play a role, or data providers may have systematically excluded artworks created after 1923. However, none of the above arguments seems very convincing.

Table 2.6: RDD: Availability (Bandwidth)

	log(N artworks Country)		log(N artworks Artist)	
	(1) at cutoff	(2) large sample	(3) at cutoff	(4) large sample
Public Domain	0.536*** (20.42)	1.724*** (24.18)	-0.139 (-0.41)	0.360** (2.76)
Artwork creation year	253.4*** (16.43)	0.00120 (1.84)	142.6 (0.79)	0.000907 (1.31)
(Artwork creation year) <sup>2</sup>	-0.0658*** (-16.43)	0.000000515 (1.76)	-0.0371 (-0.79)	-0.000000349 (-0.99)
Artist views	0 (.)	0 (.)	0 (.)	0 (.)
Museum views	0.00000617 (1.14)	-0.00000234 (-0.42)	0.0000918 (1.63)	0.0000130 (1.62)
Artwork views	0.000000367	-0.00000705*	-0.0000395***	-0.00000406
N	92	15128	92	14987
R <sup>2</sup>	0.979	0.730	0.860	0.586
Cluster SE	Artist	Artist	Artist	Artist
Artist FE	✓	✓	✓	✓
Museum FE	✓	✓	✓	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results based on the formula specified in chapter 2.5. Model (1) and (2) use the log-transformed yearly number of artworks in the US as the dependent variable while model (3) and (4) continue with the log-transformed dependent variable on the artist-level. Model (1) and (3) are based on a sample with artwork creation dates between 1923 to 1927 and model (2) and (4) based on the overall creation year sample. Standard errors (SE) clustered at the levels specified.

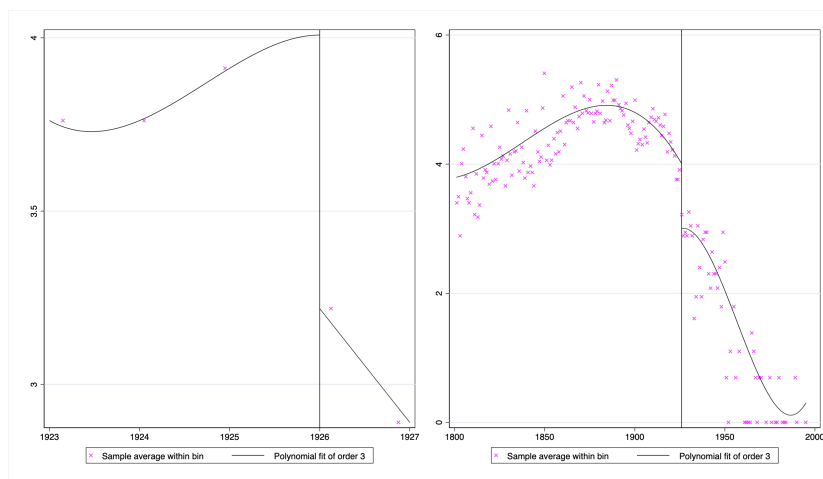


Figure 2.5: RDD Timeframe: Digitized Artworks (log)

Note: This figure shows the yearly number of digitized artworks (log) and year of artwork creation date (country-level). The sample is restricted to years 1923-1926 (left) and 1800-2000 (right) and museums in the US. The crosses represent sample average within bin and the line a polynomial fit of order 3. Standard error are clustered at the artist-level. The x-axis line denotes the copyright cut-off point in 1926.

significant. Finally, in the Appendix A, we conduct additional robustness checks based on alternative placebo cut-off years, which strongly support the validity of our results and approximation of the copyright term via the date of artwork creation (cf. figure A2).

#### **2.6.4 Random assignment around the discontinuity and placebo tests**

To further establish causal identification, we also visualize RDD effects for all covariates and observable characteristics we used to compute main results. The causal path is supported if, and only if, covariates do not show a discontinuity in their function. Hence, we plot each covariate in a separate graph as shown in figure 2.6, using a polynomial fit of order three and a triangular kernel function to weigh observations (Cattaneo et al., 2019). The distribution of likes (left) and page views (right) for artists in the top panels shows a heterogeneous pattern in terms of their popularity, but, notably, there is no discontinuity at the cutoff year in 1926. For museums (mid panels) and artworks (bottom panels), likes and page views show, if anything, a weakly increasing trend in popularity. So, at large, more recently created artworks seem more popular and they are also more often part of collections held by more popular museums. Despite these correlations, in none of the above panels do we observe a sharp discontinuity at the cutoff with regard to observable characteristics and the popularity of artworks, artists and museums, which alternatively could explain the drop in availability. This finding clearly supports our identification strategy.

As a next step, we provide a series of placebo tests by applying the same empirical strategy on digitized artworks for museums located in countries other than the US. We select and reduce the sample to artworks and museums located in France and the

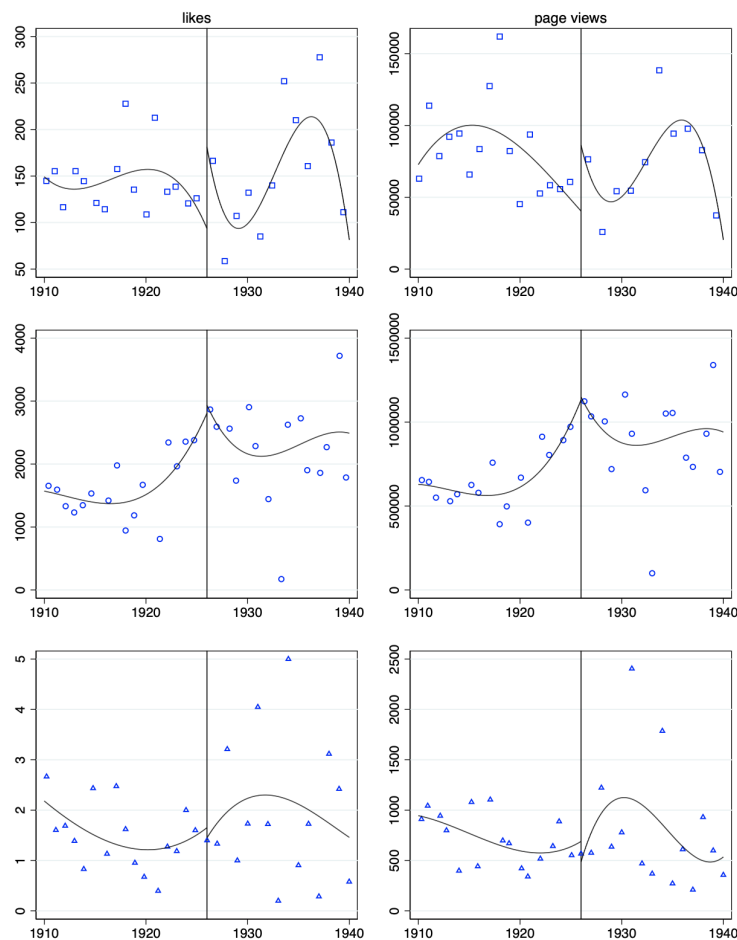


Figure 2.6: RDD: Covariates Artwork Characteristics

Note: This figure shows the characteristics of artists (top, square), museums (mid, circle) and artworks (bottom, triangle) of likes (left) and page-views(right) from US museums. The time frame is of artworks creation years between 1910 and 1940. The x-axis line denotes the copyright cut-off point in 1926. The symbols represent sample average within bins and the lines a polynomial fit of order 3. Standard errors are clustered at the artist-level.

United Kingdom which do not see a change in copyright laws at the cutoff year in 1926. Copyright laws in France and the United Kingdom provide copyright protection for 70 years after the death of the original artist. At the time of data collection (2021), artworks by artists that *died* before 1951 were thus considered to be in the public domain in both countries. Placebo tests do not require that artworks created around the cutoff point in 1926 are all in public domain or protected under copyright. Rather, placebo tests might confirm that there is no discontinuity in the function

around the cliff date, and we therefore should not observe a sudden jump in number of digitized artworks in museum collections located either in the United Kingdom or France.

Table 2.7 shows the results for the placebo timing test in the UK (left) and France (right). The models are constructed as before, with (2 and 4) and without (1 and 3) inserting covariates to specifications. The dependent variables are yearly number of digitized artworks (log), and we stay on the country-level as we observe a relatively small number of observation in these samples. The time window is again tightened around the cutoff date (1910-1940). For the UK sample, we estimate an effect of 1.18 on the available digitized public domain artworks. Although the size of the effect is as large (or even larger) than the predicted effect using the US sample, it renders statistically insignificant. Moreover, the result for the U.K builds on a relatively small sample of 137 artworks only (compared to the main results with a max of  $n = 1605$ ). The opposite is true for artworks held by French museums, with estimates shown in models (3) and (4). When we add controls, there is a negative effect of minus 0.3 in the number of digitized artworks created before 1926 and becoming available online. Again, this effect is statistically insignificant, i.e. there is no statistically traceable discontinuity in the artwork creation-year function. So, placebo sample regressions further corroborate the validity and robustness of our empirical strategy.

Regression results are illustrated in figure 2.7. The left-hand panel shows results calculated based on the UK sample, the right-hand panel based on the French sample. Yearly sample average bins are plotted as grey dots and we overlay a line of polynomial fit of order 3. The figure confirms estimated results from table 2.7 as we cannot detect a discontinuity at the 1926 cutoff upon visual inspection.

Table 2.7: RDD: Availability (Artist-Level) (Placebo sample)

	UK sample		France sample	
	(1)	(2)	(3)	(4)
Public Domain (US)	0.882 (1.32)	0.806 (1.14)	1.377 (1.52)	1.096 (1.25)
Artwork creation year	-7.831 (-0.65)	-11.90 (-0.81)	-13.43 (-0.90)	-17.75 (-1.15)
(Artwork creation year) <sup>2</sup>	0.00203 (0.65)	0.00309 (0.81)	0.00347 (0.89)	0.00459 (1.15)
museum views		-0.00000112 (-0.51)		-0.000000943** (-2.83)
artwork views		-0.0000496 (-1.91)		0.0000693 (0.30)
N	281	280	384	360
R <sup>2</sup>	0.014	0.021	0.107	0.122
Cluster SE	Artist	Artist	Artist	Artist
Artist FE	✓	✓	✓	✓

$t$  statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results for the placebo sample including museums from the United Kingdom (left) and France (right) with the threshold year as specified in chapter 2.5, and a artwork creation time-frame around 1910-1940. The dependent variable is constructed as the yearly number of available artworks on the artist-level. Artist fixed effects are included in all models. Standard errors (SE) clustered at the levels specified.

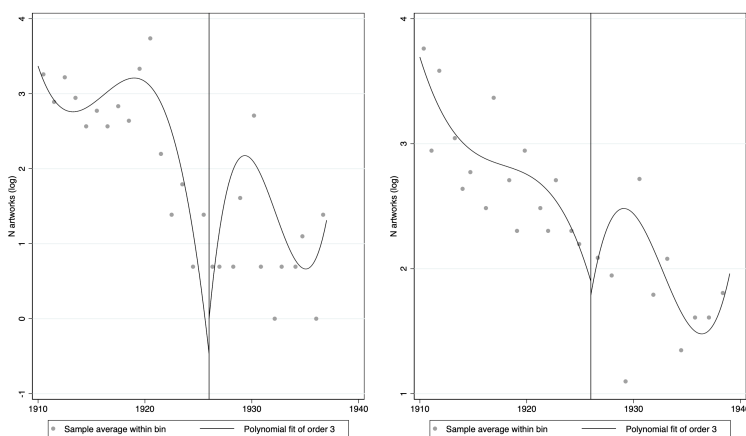


Figure 2.7: RDD: Digitized Artworks Placebo Sample

Note: This figure shows the yearly number of digitized artworks (log) and year of artwork creation date. The sample is restricted to years 1910-1940 and museums in the United Kingdom (left) and France (right). The dots represent sample average within bin and the line a polynomial fit of order 3. Standard error are clustered at the artist-level. The x-axis line denotes the placebo cut-off point in 1926.

### 2.6.5 Difference-in-differences

We present in this section the difference-in-differences regression results, calculated based on equations explained in chapter 2.5. The underlying idea is to construct a counterfactual trend of other museum and country available artworks compared to the discontinuity in public domain status of artworks in US museums. The interaction of  $PublicDomain(US) \times US$  captures pre- and post-public domain years (again around artwork creation years 1910 to 1940) with a counterfactual trend of UK and EU museums and countries that do not have a sudden change in copyright status (calculated on the artwork creation year). The benchmarked jump measures by how much availability changes once artworks fall into public domain relative to other museums in the EU and the UK.

In table 2.8 we run the set of regressions on the artist level (model 1-5), and include from model 1 onwards artist fixed effects, using fixed effect models. The dependent variable is constructed as the number of artworks of artist  $i$ , in year  $t$  and in country  $c$ . Our results continue to hold and stay robust and statistically significant at the 1%-level (except for model 1). The difference-in-differences coefficient is 2.059 (standard error 0.9) in model 2 and accentuates in model (5) using all fixed effects and control variables to 2.182 (standard error 0.9).

Finally, compared to previous sections, we address potential sample selection biases by balancing the panel on the artist-level. In order to calculate the difference-in-differences we balance the panel around artists in the counterfactual trend (EU and UK) by limiting to artists we observe with at least one observation post 1926. We estimate in table 2.9 the same model specification as before, using the new artist-balanced panel. We note that the estimated coefficient is throughout statistically significant

Table 2.8: difference-in-differences: Availability (Artist-Level)

	N artworks (artist)				
	(1)	(2)	(3)	(4)	(5)
Public Domain (US) $\times$ US	1.460 (0.950)	2.059** (0.988)	2.224** (0.962)	2.155** (0.911)	2.182** (0.913)
museum views					0.0000592 (0.0000590)
artwork views					0.0000733 (0.0000658)
<i>N</i>	4032	4032	4032	3956	3902
adj. $R^2$	0.567	0.635	0.648	0.656	0.657
Cluster SE	Artist	Artist	Artist	Artist	Artist
Artist FE	✓	✓	✓	✓	✓
Year FE	No	✓	✓	✓	✓
Country FE	No	No	✓	✓	✓
Museum FE	No	No	No	✓	✓

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the difference-in-differences regression results, specified in section 2.5, for artworks created between 1910-1940 from US and EU + UK museums. Standard errors (SE) clustered at the levels specified.

and positive regarding the upwards jumps of available artworks in US museums compared to EU and UK museums around the 1926 cutoff. The effect accentuate from 2.96 (model 1) artworks per artist per year in US museums to roughly 3.6 (in model 2-5) (compared to previous results in table 2.8 of around 1.46 to 2.22). To illustrate these results, we run an event study design, again using the restricted sample of -/+ 15 years to-/from public domain in the US, i.e. 1926= time treat 0, and to artworks in the US (treated) and EU and UK (counterfactual) using the balanced-panel. In figure 2.8 we present the event study plot. Note that effect direction of this event study design in the figure is reversed given the normalization around 0 and coefficients of *post* creation year 1926 compared to pre-years (previous results compared coefficients of public domain years, i.e. pre 1926 compared to the baseline post 1926 years). We observe common pre-1926 years availability of artworks in US museums and artworks hosted in EU plus UK museums, with a sudden drop for non-public domain years in US museums. The results are computed with the (log) artists yearly number of

digitized artworks as dependent variable. For artists in the US, we observe a decrease in available digital artworks (log-transformed dependent variable) of artworks not in public domain, compared to available artworks in the EU and UK around the same time-periods, with statistically significant negative coefficients for years following the public domain cut-off year. Results are also robust against using country specific artwork creation year trends (not reported).

Table 2.9: difference-in-differences: Availability (Artist-Level) (Balanced)

	N artworks (artist)				
	(1)	(2)	(3)	(4)	(5)
Public Domain (US) $\times$ US	2.962*** (1.086)	3.619*** (1.078)	3.601*** (1.051)	3.554*** (0.925)	3.594*** (0.909)
museum views					0.000964*** (0.000290)
artwork views					0.0000949 (0.0000779)
<i>N</i>	1640	1640	1638	1582	1549
adj. $R^2$	0.469	0.633	0.638	0.648	0.650
Cluster SE	Artist	Artist	Artist	Artist	Artist
Artist FE	✓	✓	✓	✓	✓
Year FE	No	✓	✓	✓	✓
Country FE	No	No	✓	✓	✓
Museum FE	No	No	No	✓	✓

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the difference-in-differences results, specified in section 2.5, for artworks created between 1910-1940 from US and EU + UK museums, based on a balanced panel that only includes artists who had at least one observation in the counterfactual group post 1926. Standard errors (SE) clustered at the levels specified.

## 2.6.6 External Validity

As an interim conclusion, we note that all our estimates point toward a clear-cut positive effect of artworks which recently fell into public domain vis-à-vis artworks with creation years subject to possible copyright protection. One major question is, to what extent these results generalize to global availability. We thus address the external validity of our results in a systematic matter. First, we manually inspect the data set and compare to the available information directly accessed on the museum

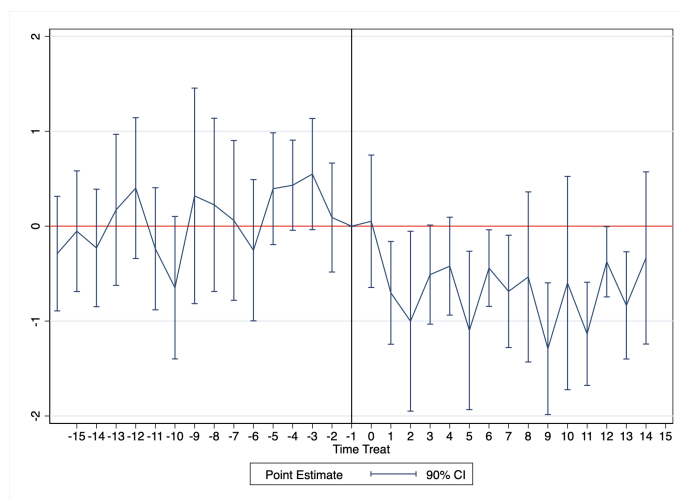


Figure 2.8: Dynamic difference-in-differences

Note: This figure shows the difference-in-differences event study plot with the yearly number of artworks (log) on the artist-level. The sample is restricted to  $-/+$  15 years around the year 1926. Time treat = 0 in year artwork creation year 1926. The sample is restricted to artworks in US museums (treated) and EU and UK museums (counterfactual). The counterfactual trend is balanced around artists who had at least one observation post 1926. The coefficients are normalized around  $t-1$ . The event study is based on an ordinary least squares (OLS) model with artist, creation year, museum, and country fixed effects and controls for artwork-, and museum-likes.  $N= 1'641$ .

webpages, we contact selected museums worldwide, and we benchmark our data set with alternative data sources. Second, we hypothesize and discuss what other factors could potentially influence and restrict external validity. Third, we tentatively discuss and disentangle "availability" from "digitization" effects. Finally, section 2.4.2 provides additional evidence on image quality using an alternative source of data.

As preparatory work, we conduct extensive desk research on the available data sources around digital museum collections to better understand the representativeness of our data. Examples of sources we have considered are listed on Wikipedia, lists on Github covering US museums (such as larger public data sets from MET or MoMA), and data collected by the Openartdata initiative. Initially, we also evaluate several alternative digital artwork sources such as Artstor (via JSTOR) and image licensing sources such as Gettyimages, or Scala Archives. These data sources, however, are

biased towards pure commercial interests (in terms of artwork content and copyrights on the digital surrogates), or they focus on non-contemporary art (i.e. they contain historic art collections with artworks which are in the public domain for a long time). Taken together, all of the above data sources would not allow us to build a similar empirical framework. In contrast, our *Useum* data sample seems reasonable in terms of coverage and variety of popular museums and artists, even though certain data caveats apply. With the data at hand, we can only observe reuses of popular digital artwork surrogates that the *Useum* platform directly sources from museum websites, *Wikidata* repositories, or images crowd-sourced and uploaded to the platform by individual users (selection bias of popular artworks and artists). Accordingly, we cannot describe the entire universe and overall population of digitized artworks in museum collections. In other words, digital surrogates of less popular original artworks still exist online or offline, but are not made available on the platform. Similarly, the museum might consider alternative digital channels to make digitized artworks available. Eventually, globally operating platforms and alternative channels such as *Wikimedia Commons* are challenged in many copyright jurisdictions to comply and interpret legal rules in a particular way, and policies around them may have changed over time<sup>20</sup>. To add yet another level of complexity, imagine an upload of a photograph that has been directly taken from a copyrighted artwork hosted in a US museum or from a book. This image could be considered elsewhere as in the public domain, or vice versa. Such digital artwork surrogates are often made available online, but they are not digitized and made available by the museum itself. However, these images should not be considered for our research purposes.

In the appendix A and based on more extensive desk research, we furthermore provide and summarize information on available and digitized artwork images by se-

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<sup>20</sup>Some Wikidata policies to be found here [Link] or there[Link].

lected US museums in the estimation sample (used to compute baseline results), some of which are images we cannot observe on the *Useum* platform. We manually inspect online collections and search GitHub repositories for selected museums, essentially, to better understand potential bias in our data sample, in particular as concerns the availability of digital artwork surrogates that are still under copyright protection. The exercise supports the general validity of our data. By comparing artworks in the estimation sample to the larger and arguably, more complete data universe from selected museum collections, we can show that our data (of popular artists) displayed on *Useum* represent approximately 1 to 35 percent of the total online collections held by selected museums. Where our data only identifies very low numbers or no artwork images created after 1926, we are indeed able to replicate this finding directly through the museum website, as access to copyrighted works is restricted, no images are available, there is no download option to the image (i.e., not shareable), or the image is displayed in thumbnails only (i.e., image resolution is very low). We are therefore confident that our data constitutes a representative sample for the online availability of popular artwork images hosted in US museums.

Notably, however, while we can identify the status effect on online availability, our approach can only approximate the effect of status changes on *digitization*, since we cannot observe the overall population of digitized artworks from museum collections with the present data. In other words, a digital surrogate of an original artwork might still exist somewhere online, but, for some reason, it does not become available on the *Useum* platform. In addition, any substantive claim on digitization effects would need to account for the selection of artworks into digitization. For example, such a comparison would require even richer information on the *entire* physical collection held by the museum and the dynamics and costs associated with the digitization process and artwork reproduction.

Finally, one could argue that the validity of our results is limited due to certain geo-blocking practices, given that IP-addresses from different countries might qualify for different digital access and territorial image availability. We tackle this question by inspecting the data on three different levels. First, geo-blocking seems not to be an issue for the Useum data and related results. Based on a random sample of artworks and IP-addresses hosted in different countries, we found no differences in image access and availability. Second, we are aware of some geo-blocking practices and potential bias regarding Google reverse image searches and their downstream reuses. In some cases, the search results were restricted or deviated when using different IP-addresses. While we cannot fully rule out this source of bias for downstream searches, this is less of a concern for our estimates as we further distinguish between upstream reuses using direct museum-URLs to compute results. Hence, the third level of potential geo-blocking and territorial availability bias could originate directly from the curation of museums. We directly reached out to selected museums and collected qualitative evidence.<sup>21</sup> Despite the fact that US-style fair use and the low-resolution/high-resolution distinction would not protect the US museums from liability in the EU, none of the museums engaged in any geo-blocking of European digital visitors. This lack of concern about facing a negative judgment in an EU court apparently comes from reliance on the Second Circuit decision in *Sarl Louis Feraud, Int'l v. Viewfinder, Inc.* (2007) which refused to enforce a French copyright judgment on first amendment grounds (Guehenno, 2009). After *Sarl Louis*, museums, perhaps wrongly, appear unconcerned about potential liability for illegal distribution in the EU.

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<sup>21</sup>In section 2.6.7 we describe the qualitative evidence and information collected from a number of US museums, among others, the Cleveland Museum of Art, the Cincinnati Art Museum, the Museum of Fine Arts (Boston), the Guggenheim, and The Art Institute of Chicago.

In sum, our estimates for the effect on right status on "digital availability" should generalize well as we can build the core analysis on a sample of popular online artwork surrogates hosted by US museums. At a minimum, the external validity is limited to online availability on the *Useum* service only (based on their own criteria of artwork selection), but this seems less likely. Based on the above discussion and additional verification of the sample using other sources, it seems we meaningfully capture the public domain effect as applicable for many US museums. In the next section, we provide additional context and shed further light on our findings by looking at image reuse and upstream quality of digital surrogates made available online.

### 2.6.7 Image Reuse and Upstream Quality

In this section, we first follow a descriptive and visual approach discussing the sample obtained from the "google reverse image searches", as described in subsection 2.4.2 and in the Appendix A, before we turn to estimation models.

### 2.6.8 Upstream and Downstream Reuses

Again, we start with a list of 1349 unique artworks from *Useum* and that hold a direct and functioning .JPG URL. This results in a total of 88'607 upstream and downstream reuses of digitized artworks (cf. table 2.2). For each reuse, we also observe detailed pixel  $\times$  pixel information which gives us a good proxy for image quality. On the artwork-level, we find substantial online reuses for all artworks in our sample, with an average (median) reuse on 66 (42) webpages, 191 unique artworks created  $\geq$  1926 were found, and 1158 unique artworks created before 1926.<sup>22</sup> On the level of

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<sup>22</sup>It is true that, by construction, our sample and initial source of data *Useum* is in itself a "downstream" reuse of a digital image. Thus it appears artworks were reused at least once, and as a consequence should always appear in a reverse google image search.

museums, our sample contains a variety of 45 museums in total, while 17 museums contribute to the results of artworks created after 1926.

With an average reuse rate on 66 pages, artworks show an impressive amount of reuses on the web (compared to the downstream reuse rate of Wikimedia images on 5.4 pages found by Erickson et al. (2018)). If we compare reuses by artwork creation year, we do not detect significant reuse differences (averages) for artworks created before or after 1926. Recall that we started with an unbalanced distribution of artwork creation years, and, as a result, more reuses should appear for older artworks by construction. Hence, a comparison based on an unbalanced sample might not be helpful. Similarly, at first sight, we cannot detect systematic differences in image quality for reuses of artworks around the cutoff year in 1926, based on their average quality (pixel  $\times$  pixel). This can be explained after a closer look at the sample. The data reveals that 52 percent of the "downstream" use is commercially driven (cf. the pie chart in figure 2.9 with the domain ending text-analysis) and it is noteworthy that these downstream uses often report misleading (image quality) information<sup>23</sup>. For instance, many commercial vendors, such as poster-sellers or interior design pages offer downstream reuses of digitized artworks in high-resolution.<sup>24</sup> This information, however, is misleading as the artwork itself (e.g. sold on a poster) is not shown in high resolution, while the product on sale shows the high-quality image. In other instances, misleading downstream image quality shows a high-resolution image that is protected by a watermark, or a high-resolution image scan (e.g. from a book), which can, strictly seen, not be considered a high-quality version of digitized artworks.

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<sup>23</sup>Which was the case for more than 80 percent of the commercial downstream uses, based on a random sample

<sup>24</sup>Examples for such commercial downstream activities, to name two out of many, are Redbubble or Alamy.

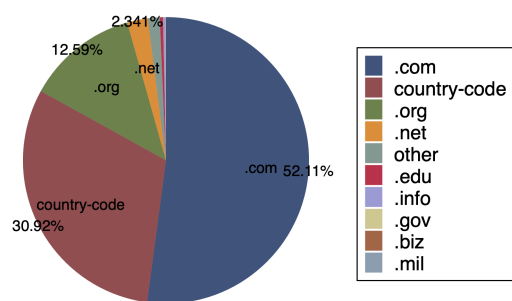


Figure 2.9: Number of Reuses by Artwork Creation Year

Note: This figure shows the percentage of google downstream use links found by a reverse google image search for US artworks created between 1910 to 1940 by domain-addresses based on a link-text-analysis. Legend in descending order of occurrence. N=88'607.

So, upon visual inspection of the google search sample, if any, we observe a slightly higher reuse rate for younger artworks, where reused images are of equal resolution quality. Results are interesting per se, as digital artworks are highly reused, on a commercial and non-commercial basis, with a more detailed analysis being required to conclude on the overall downstream activities. But it is worth recalling, again, that we observe initially fewer artworks in our sample being created after 1926 than before.

## 2.6.9 Image Quality of Upstream Works

In order to better describe the image resolution quality, we now filter the google-image search results by using "upstream reuses" only, which generates another useful subsample of the data, as described in subsection 2.4.2 and in the online Appendix A. So here, again, we define an upstream use as artworks made available directly on the museum website. Put differently, we assume that the museum owns and digitizes the artwork, and therefore also controls and governs the initial image resolution (i.e. quality) of the digital surrogate.

Interestingly, the Association of Art Museum Directors (AAMD) defines/ recom-

mends in their "Guidelines for the use of copyrighted materials and works of art by art museums" what could be considered as low-/ high-resolution images in terms of fair use: "While the one-quarter screen and 560 x 843 pixels dimensions should be well within accepted norms of fair use for online collections, the application of the law of fair use to digital images as well as technology itself is constantly evolving" (AAMD (2017), p.12). Based on this information we define a threshold line of high-/ low-quality images below or above the pixel  $\times$  pixel quality line of 472'080. This allows us to combine and research on availability *and* quality of upstream works.

We now visually inspect the upstream reuse sample and the detailed information on pixel  $\times$  pixel image quality. Figure 2.10 plots the image resolution of reusing digitized artworks and the creation year of original artworks, with an horizontal red line indicating the threshold line for high resolution images (pixel  $\times$  pixel  $\geq$  472080) and the vertical red line is plotted at the year 1926. Since average quality is driven by a few outliers with a very high image resolution, we exclude a total of 80 upstream images in this figure. The descriptive evidence now shows a clear pattern and distribution for image resolution and original artwork creation years. While public domain artworks show overall a broader (i.e. higher) distribution of image quality, the clear cut line of low-/high-resolution images is more clearly identified for digital artwork surrogates and reuses, where the original artwork is still protected under copyright. In total, only around 32 images on the right-hand side of the cut are available in high-quality in the upstream sample, and at the same time, many museums seem to make these artworks available in low-quality only. We interpret this finding as evidence for a fair use practice of museums for making artworks available that remain copyright protected.

This interpretation of results finds further support from qualitative research. We

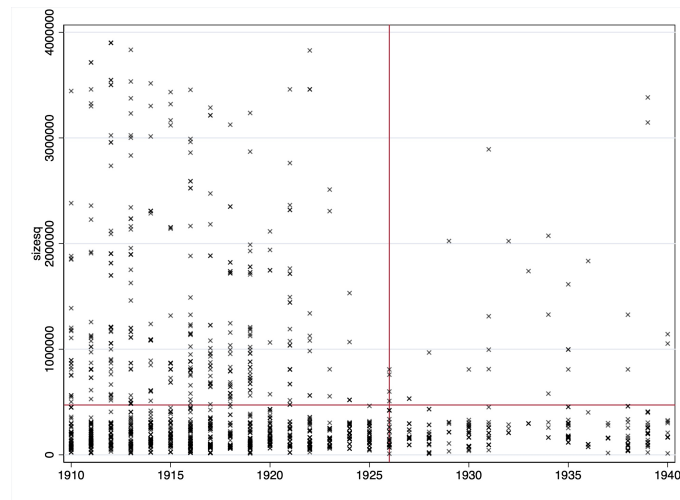


Figure 2.10: Upstream Use and Image Resolution

Note: This figure shows the distribution of museum upstream use links found by a reverse google image search for US artworks created between 1910 to 1940. A cross represents an upstream image (opacity set at = 60 %). The horizontal red line indicates the threshold line for low-/high resolution images (pixel  $\times$  pixel  $\geq 472'080$ ) and the vertical red line is plotted at 1926.5. The figure is restricted to observations with image resolution  $< 4'000'000$ .  $N = 1'709$ .

contacted several larger museums in the US, namely, the Cleveland Museum of Art, the Cincinnati Art Museum, the Museum of Fine Arts (Boston), the Guggenheim, and The Art Institute of Chicago. They all report to rely heavily on the US fair use doctrine in making a distinction between the uploading of low-resolution thumbnails without permission and the making available of high resolution images. For example, the Cincinnati Art Museum stated that it will sometimes contact a copyright owner, but it was “often able to reproduce images for educational purposes without seeking permission,” while The Art Institute of Chicago “relies heavily on fair use.” The Cleveland Museum of Art digitizes everything without permission and makes its entire digitized collection available in low resolution form without seeking permissions. Moreover, the Museum of Fine Arts in Boston provided the foundation for the distinction made between high and low resolution images, explaining that it “releases some thumbnail-size images of copyrighted works under fair use, in accordance with the guidelines recommended by the Code of Best Practices in Fair Use for the Vi-

sual Arts, published by the College Art Association in February 2015.” This Code of Best Practices draws the same line between low resolution (no permission needed) and high resolution images (permission needed). None of the museums contacted would upload high resolution protected images without permission of the copyright owner. Interestingly, when asked, none expressed concern that online access would result in reduced traffic and fewer visitors to their facilities. Accordingly, it seems that cannibalization of sales through digital channels and the potential negative effect on commercial activities of the museum was not a consideration.

Next, we turn to estimations and address the econometric question whether public domain works are generally available in higher image resolution than digital surrogates of artworks still under copyright. In table 2.10, we regress a public domain dummy variable (i.e. one if the artwork is created before 1926, zero otherwise) on image quality as measured by image resolution, using the upstream sample. Model 1 reports our baseline, model 2 introduces year fixed effects and clustered standard errors at the museum-level (our relevant level of upstream analysis), model 3 adds museum fixed effects and control variables, model 4 clusters standard errors at the artist creation-year, and model 5 reports estimates using a log-transformed outcome variable that is robust to outliers in the sample. The coefficient of interest *PublicDomain* shows a positive sign in all model specification, and introducing clustered standard errors (at the museum-level) makes the coefficient statistically significant (model 2), and stays robust (but insignificant) also after including both fixed effects in model (3). Clustered standard errors at the artwork creation date (model 4) provides in the same model specification significant positive effects. Using the log-transformed quality outcome in model 5, we lose the statistical significance, but the direction of the effect does not change. We conclude that, at the minimum, we have weak evidence that public domain works are made available in higher pixel resolution by museums (i.e. upstream

users) than digital surrogates of artworks still protected under copyright.

Table 2.10: Upstream Use and Image Resolution

	Quality				log(Quality)
	(1)	(2)	(3)	(4)	(5)
Public Domain	279892.1 (1.37)	403952.0* (2.25)	312118.1 (1.48)	312118.1*** (4.38)	0.122 (0.28)
artwork views			35.04 (1.70)	35.04 (0.95)	0.0000751*** (5.59)
artist views			-1.950*** (-3.86)	-1.950** (-2.81)	-0.000000631* (-2.37)
museum views			0.0160 (0.67)	0.0160 (0.54)	5.27e-08*** (4.24)
N	1734	1734	1734	1734	1734
R <sup>2</sup>	0.00108	0.0225	0.582	0.582	0.324
Year FE	No	✓	✓	✓	✓
Museum FE	No	No	✓	✓	✓
Cluster SE	No	Museum	Museum	Creation year	Museum

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the upstream use estimates on image resolution (pixel  $\times$  pixel) from US museums between 1910-1940. The public domain dummy denotes artworks created before 1926. Standard errors (SE) clustered at the levels specified.

## 2.7 Policy Discussion

This study tested two hypotheses. First, our empirical results strongly suggested a positive distributional effect of public domain status on the digital availability of the artwork. Consequently, we were able to reject the “under-exploitation” hypothesis ( $H1$ ). As we have outlined, this can be attributed to the cultural preservation missions of many museums (Bertacchini and Morando, 2013), which aim to make their entire public domain collections publicly accessible. Moreover, museums have less (or no) economic incentives to exploit digital artworks, unlike stakeholders in more commercially driven copyright sectors, such as the book publishing market. Next, we tested the “overuse/ misuse” hypothesis and, based on our empirical findings, we could neither fully accept nor reject it ( $H2$ ). More than 50% of the 88K downstream reuses of digital surrogates are commercially driven, regardless of the copyright status

of the underlying artwork. As evidenced by our results, even artworks in the public domain are offered on reuse platforms for sale, such as high-resolution images being licensed by commercial vendors. This could potentially indicate suboptimal levels of reuse (or misuse) of digital artworks produced by public museums. However, determining the optimal level of reuse that would not harm the incentives for digitization in the first place is challenging, and estimation was beyond the scope of this study. Overall, our findings can inform the latest policy discussions as follows:

International treaties such as the Berne Convention provide the advantage of much-desired international standards (Hatch, 1989) and legal certainty; however, they simultaneously reduce the flexibility of national policymakers. Nevertheless, our study is relevant to several ongoing international controversies. Many countries are considering extending their term of copyright protection beyond the Berne/ TRIPS<sup>25</sup> minimum of life-of-the-author plus 50 years. Moreover, the US and the EU are negotiating with trading partners to extend copyright terms for existing works, usually for an extra 20 years of protection in free trade agreements (Buccafusco and Heald, 2013). As part of the newly revised trade agreement between Canada, the US, and Mexico (USMCA 2020), Canada agreed to increase its term of copyright protection for 20 years to both existing and prospective works.<sup>26</sup>

Consistent with previous studies in various book markets, we found that copyright term extension reduces public access to works. In the case of digital versions of museum artworks, we found a negative distributional effect. Among artworks produced in roughly the same era, public domain works are more likely to become available on

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<sup>25</sup>The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), World Trade Organization (WTO).

<sup>26</sup>Guidance requested commissioned by the Canadian government predicted that the extension would have a negative effect on the availability of older book titles in Canada (Heald, 2020).

digital platforms than copyrighted works. This is suggestive of a positive impact on consumer surplus. In addition, we are the first to find a positive association between the public domain status of the underlying artwork and the average image quality of the digital surrogate. Our research adds significantly to the growing consensus among academics concerning the potential cost of copyright term extensions. However, an overall assessment of welfare implications requires an analysis of consumer demand and a comparison of consumer and producer surpluses, along with a consideration of counterfactual regimes (Reimers, 2019). Regrettably, such an analysis was unfeasible with our data.

In addition, our research bears on the desirability of expanding fair use exceptions to copyright, which is currently under consideration in several jurisdictions.<sup>27</sup> A permissible fair use essentially casts a single aspect of a work into the public domain. For example, when an American museum uploads a low-resolution image of a copyrighted painting to its website, it would treat that version of the work as if it were in the public domain. The result of the assertion of fair use by US museums has led to an increase in the public accessibility of art and tens of thousands of downstream reuses of these works. Relatedly, our findings speak to the role of industry coordination and explicit standard setting around fair use rules and how it may limit museums' exposure to litigation risk. Assuming a possible fair use exception in laws is not so broad as to impair the initial incentive to create a work, we find little economic reason not to endorse the fair use doctrine. In general, our research may support the notion that copyright exceptions can be used to address the high transaction costs

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<sup>27</sup>The US grants users broad fair use rights compared with countries that limit user exceptions to fair dealing. Fair use narrows the scope of rights afforded to copyright owners, yet countries such as Canada, Israel, Malaysia, Singapore, and South Korea have adopted the more permissive US approach. Others, such as Australia, Ireland, and South Africa, are openly considering increasing the scope of users' exceptions (Sutton, 2016). Countries that accede to US demands to increase their copyright terms may seek to offset any potential negative effects of term extension by increasing user exceptions.

that sometimes stand in the way of the efficient distribution of works (Gordon, 1982).

## 2.8 Conclusion

In this study, based on a novel dataset of digitized museum collections, we have provided quantitative evidence for a causal relationship between the online availability of digital images and the copyright status of the underlying artwork using a regression discontinuity design. To the best of our knowledge, this research study is among the first to provide quantitative evidence in this area. We exploited the recent extension of copyright terms in the US as a quasi-natural experiment to demonstrate that, on average, the public domain status of an artwork in the US increases image availability online by 34–42% for artworks by an average artist in the sample. Our results regarding museums largely confirm findings on public domain effects from previous research on music and books.

Furthermore, our core findings are robust against a series of placebo tests, random assignment around the discontinuity, and the use of an alternative difference-in-differences design. While our results might arguably not generalize to the universal availability of artwork images on the Internet, they continue, at a minimum, to hold and are relevant for the increase in availability observed on USEUM, Wikimedia, and similar large digital platforms for popular artists and artworks.

We further demonstrated that digital images made available online see a large total number of reuses upstream and downstream, which indicates that their availability is of high public value independent of the copyright status. Moreover, we are also the first to provide empirical evidence regarding the average quality of images

(resolution) made available upstream by museums (as part of their digitized collections) and depending on the right status. Here, our findings suggest that industry practices and expressed norms might also help to make images available at a lower resolution when artworks are still protected under copyright.

Whether artworks that move into the public domain will observe an increase in availability (upstream digitization and downstream reuse) is unclear, since copyright can provide economic incentives for the digitization of original artworks and online distribution of digital surrogates. Thus, our empirical results can help to inform the current debate on copyright and new uses of existing works in the digital age, as well as how the extension of the copyright term affects the distribution and availability of creative works on the Internet.



## Chapter 3

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

This chapter is based on a paper co-authored by Alexander Cuntz, that has been published in the WIPO Economic Research Working Paper Series, No. 76: <https://doi.org/10.34667/tind.48525>. An earlier version was presented by Matthias Sahli at the WIPO research seminar series in 2023.

CRedit authorship contribution statement: **Matthias Sahli:** conceptualization, data curation, methodology, formal analysis, writing, project administration. **Alexander Cuntz:** conceptualization, methodology, validation, writing.

### 3.1 Motivation

How does the death of an artist affect the exhibition market and auction prices? Death is a clear signal of scarcity to the market (Ursprung et al., 2021). A natural end to the production of new art and scarcity in supply clearly affect the visual arts market. The empirical literature on postmortem effects has primarily focused on the auction market and found a positive relationship between prices and postmortem transactions (e.g., Pénasse et al. (2021)). However, this signal may not affect artists and other art markets equally. Whether death yields similar effects on the exhibition market is an open empirical question, which we address in this study.

We argue that one important factor that likely influences exhibitions are transaction costs immediately following an artist’s death. As evidenced by legal studies on postmortem rights (Benhamou, 2017, 2018), complexity increases typically because several fields of laws are involved, such as copyright, inheritance, and contract law. Additionally, the applicable law varies from one jurisdiction to another and might change for artworks lent to another museum and country. In fact, exhibiting a work to the public (even if it is owned by or lent to a museum) is legally organized in various ways, including the right to exhibit, physical ownership, and exceptions or limitations to exclusive rights (Benhamou, 2018). Subotnik (2015) describes the “costs of the [copyright] postmortem term” as a combination of search costs, dead-hand control, and stewardship by the living. Based on the qualitative evidence that we collect, lengthy and complex renegotiations (or disputes) over property or copyright between artists’ heirs, foundations, and exhibitors are frequently observed. When an artist passes away, estates or their representatives may face challenges in navigating the complex legal landscape, leading to delays or even cancellations of exhibitions. However, on an aggregated level, our study is able to quantify the impact of such

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transaction costs in the exhibition market.

We develop several economic hypotheses based on related literature, which we then aim to test empirically. A primary focus is the interplay between the exhibition and auction markets, which contributes insightful results to existing empirical literature on auction prices and death (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). Exhibitors play a crucial role in price formation in auction markets. Due to their prestige as institutions, they can significantly contribute to building an artist's reputation and visibility (Fraiberger et al., 2018). Furthermore, as knowledgeable curators, they provide essential market signals of quality and trust to the art markets. On the one hand, by curating artworks, exhibitors not only promote the artists but also affect the prices at auction markets by providing scarce information on provenance and the economic value of artworks (Li et al., 2022).<sup>1</sup> On the other hand, exhibitors are price takers in the auction markets (Pommerehne and Feld, 1997).<sup>2</sup> Lastly, if an increase in transaction costs postmortem negatively affects the exhibition market, this could result in a decreased public visibility of the artist's works and potentially affect the market value. We aim to understand some of the dynamics between the exhibition and auction market as follows:

Besides conducting a separate empirical investigation of postmortem effects on both markets, our empirical approach includes the development of an exogenous measure of reputation *at the time of death* and the expansion of existing studies on death

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<sup>1</sup>Typically, artworks on loan for an exhibition across prestigious venues experience an increase in market value, as noted by an anonymous museum expert.

<sup>2</sup>Museums, for instance, are rarely buyers, as most of their new artwork acquisitions are donations from wealthy individuals, and they often cannot compete with private bidders in auction markets. Moreover, exhibiting costs are likely to increase with higher auction prices, as the cost of insuring artworks (which accounts for a large portion of the total exhibition costs) rises with higher market valuations (Amsellem, 2013), as suggested by an anonymous museum expert.

effects and reputation in auction price formation (Ursprung et al., 2021; Ursprung and Wiermann, 2011). We explore the effect of exhibiting at reputable venues and impacts on auction prices postmortem. First, a testable hypothesis examines different artists' age at death. A sudden death serves as an exogenous "shock" to the art market, likely causing heterogeneous effects, as we will outline. We hence add to the literature on creativity and age (Galenson and Lenzu, 2016; Galenson, 2009b, 2006; Graddy and Lieberman, 2018) by demonstrating that age at death is a critical factor for the postmortem commercialization and *exhibition* of artworks. Second, we differentiate between low- and high-reputation artists (derived from exhibition data) at various ages at death. We expect the most significant negative postmortem price effect to be observed for artists who die at an older age *and* have a relatively low reputation at death due to the prevalence of negative expected profits. Conversely, dying at a relatively young age combined with an already established high reputation could drive future expected profits upwards, leading buyers to be willing to pay higher prices on the secondary market postmortem.

By analyzing a dataset of 22,000 exhibitions from a random sample of 1,000 popular artists, we obtain the following findings: Compared with living artists, deceased artists have fewer exhibitions on average. However, this negative and causal effect is temporary. Specifically, using regression discontinuity and event study designs, we observe a steady increase in exhibitions over the years leading up to an artist's death, followed by a sharp but short-lived decline postmortem. Our results are robust, accounting for the inclusion of artist, exhibition decade, and country-specific fixed effects (FEs), as well as clustered standard errors at the artist level. We also conduct placebo timing and outcome tests, which confirm our main findings. We provide supportive evidence that the temporary increase in legal transaction costs following an artist's death negatively affects the exhibition market. Next, using he-

donic price models, we examine over 30,000 auction transactions involving the same artists, where traceable, and find a significant increase in postmortem auction prices. We observe substantial heterogeneity in this treatment effect when we examine the age at death and use our exogenous measure of reputation at the time of death. The strongest signal from the exhibition market is for artists who die at a relatively young age and never reach a high reputation, which even leads to a significant decrease in postmortem auction prices.

The remainder of the chapter is structured as follows: Section 3.2 summarizes the literature, section 3.3 discusses the mechanisms and hypotheses, and section 3.4 presents the data. Next, section 3.5 outlines the empirical strategy, and then the results are presented in section 3.6. Then, section 3.7 provides a discussion of the results, and finally, section 3.8 concludes the chapter.

## 3.2 Related Literature

The postmortem effects on the art market have 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 postmortem art market prices. Ursprung et al. (2021) use a regression discontinuity design and difference-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 price of artworks of 21 Latin American artists who died between 1977 and 1996, but prices seem to decrease again in the medium to 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.

### 3.3 Theory and Mechanism Discussion

This section summarizes potential driving effects of postmortem exhibitions and auction prices; then, it develops hypotheses based on the related literature, which are tested in the remainder of this study.

A first potential mechanism is promotional effects and media coverage around death. Arguably, this mechanism seems well suited to explaining a temporary increase in exhibitions by certain groups of artists as well as a positive effect on auction prices. We anecdotally explore the mechanism and investigate Google search traffic around death for a subsample of artists.<sup>3</sup> The search data (not reported) indicate that relative search volumes increase around death for artists in the top 20. However, higher traffic is limited to the two to three months before and after their death. Additional explorations using Google's n-gram data indicate that book mentions of

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<sup>3</sup>We restrict the overall sample to artists who have died since 2004, as Google search data are only available from 2004.

artists tend to decline after death. As media and book coverage around artists do not systematically increase in postmortem years, we conclude that this mechanism cannot explain a large portion of the variance.

Second, the basic argument of scarcity in supply (Ursprung and Wiermann, 2011) would predict a positive postmortem effect on auction prices and likely also on exhibitions. However, postmortem market outcomes might vary for different ages at death, as evidenced by several studies (Galenson and Lenzu, 2016; Galenson, 2009b, 2006; Graddy and Lieberman, 2018). As artists grow old, their death becomes more predictable. Therefore, we conduct an in-depth study of age at death as an underlying mechanism that explains a significant portion of the variation in postmortem auction prices *and* exhibition patterns. A sudden death clearly serves as an exogenous “shock” to the art market. Exhibitors could make strategic use of this signal to attract more visitors and increase their profits in differentiated product markets. The same holds true for sellers and auction prices. Ursprung et al. (2021) describe a positive effect of death (on auction prices), which disappears when the artist dies at an old age. Overall, this leads to the following two hypotheses: *H1a: The death of an artist typically has a positive effect on exhibitions and auction prices*, and *H1b: it is negatively correlated with age at death, with a diminishing effect for artists who die old*.

In the next step, we develop two market-specific hypotheses. Hypothesis *H2* will focus on the auction market, while in the following paragraph we will formulate a hypothesis *H3* specific to the exhibition market. When artists die young, their career might not yet have reached a peak, which could frustrate collectors’ hopes of making future profit and negatively affect the demand side for auctions (Ursprung and Wiermann, 2011). Moreover, an untimely death may well prevent some artists from fully entering the (top) exhibition market, and postmortem exhibitions decrease at a faster

pace compared with established artists. As our study is one of the first to combine exhibition outcomes with auction market results, we can build a measure of reputation at death (derived through artists exhibiting at reputable museums) and combine this information with the observed auction hammer prices. Given that provenance information plays a critical role in determining auction prices (Li et al., 2022), the exhibition effect that we observe could impede the exchange of information and market signals (Etro and Stepanova, 2021). The measure we build will likely have a large impact on the observed postmortem auction outcomes, and we extend the previous hypothesis as follows: On the one hand, *H2a: artists who pass away relatively early with a high reputation at death will likely have a larger postmortem price premium compared with low-reputation artists.* On the other hand, a strong negative signal to auction markets is *H2b: artists who pass away at a very old age, with a low reputation, which in turn results in a lower postmortem price premium compared with high-reputation artists.*

The final related mechanism involves a rise in short-term (legal) transaction costs, focusing on museums that aim to exhibit works immediately following an artist's death.<sup>4</sup> Death could require costly negotiations for museums and other exhibitors with heirs as the new owners of artworks, estate management, and postmortem contracting with multiple parties (e.g., establishing a foundation or processing the donation of artworks). It should be noted that exhibiting an original artwork (even if it is owned by or loaned to a museum) is, from a legal point of view, not straightforward. Some countries consider the right to exhibit (i) as part of the exclusive rights of the

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<sup>4</sup>As outlined, postmortem prices are likely to increase after death, and insurance costs (a specific type of transaction cost) for a museum loan to an exhibition will also rise. Insurers will charge fees depending on the current valuation of artworks on auction markets (Amsellem, 2013). Note that insurance costs make up for the gross of exhibition cost. Unfortunately, we are unable to directly observe insurance costs for exhibitions. In the longer run, this effect might break even (or become negligible), as more popular (superstar) artists also generate high income for the museum (e.g., through ticket sales and merchandising).

copyright owner; (ii) as an exception or limitation; or (iii) physical ownership to encompass the right. For a detailed legal overview, see Benhamou (2018).

Moreover, negotiations around artworks can be difficult and time-consuming as the public and private interests of artists, heirs, and museums might diverge (Hecker and Karol, 2022).<sup>5</sup> Death can also require the transfer and clearance of various other types of rights granted to the original artist and other parties (e.g., the postmortem right of publicity, moral rights, and other rights, as applicable). As the legal literature indicates, this can give rise to dead-hand control problems in the case that rights are not transferable (Rub, 2021). It also raises important questions regarding legacy stewardship when legacy planning has been poorly performed or is challenging for other reasons (Gilden, 2019). Subotnik (2015) describes the “costs of the [copyright] postmortem term” as a combination of search costs, dead-hand control, and stewardship by the living.<sup>6</sup> Furthermore, Benhamou (2017) describes the complex legal issues as a combination of several legal frameworks, such as copyright, inheritance, and contract law, in addition to the fact that the governing law varies across jurisdictions depending on the geographical location and movement of the work.<sup>7</sup> Overall, one would expect these transaction costs to be likely to only increase temporarily. Once all copyrights and related rights are cleared and stewardship by heirs and foundations is properly established, transaction costs are likely to decrease to pre-death levels. Therefore, our last hypothesis (*H3*) states that *(legal) transaction costs have*

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<sup>5</sup>For example, taxation rules and other postmortem regulations around estates can force artists’ estates to sell off artworks quickly to cover tax obligations (Li et al., 2022). Also, public and not-for-profit museums typically focus on the preservation of cultural heritage and may be less guided by commercial motivation.

<sup>6</sup>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 the transferability of moral rights in some jurisdictions may exacerbate the issues.

<sup>7</sup>In the context of posthumous replications of works. However, exhibiting artworks sometimes also requires the replication of a work (e.g., in a catalogue).

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*short-term negative effects on the exhibition market.*

## 3.4 Data Collection

### 3.4.1 Exhibition data

The online host-service "Artist-Info" is an independent 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). According to their webpage, Artist-Info comprises information on up to 192,200 unique artists and 219,850 exhibitions, although most artists have incomplete birth and death years. The primary dataset is obtained through web-scraping artist searches.

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.<sup>8</sup> The random sample represents nearly 3% of artists from the dataset with known birth and death years and up to 10% of overall exhibitions from Artist-Info. Moreover, the sample of artists we selected tends to represent relatively popular artists.<sup>9</sup> We have set the birth year threshold at 1900 for a primary reason: the data quality for exhibitions held before 1900 is insufficient due to incompleteness. Furthermore, this allows us to facilitate a comparison of artistic works from roughly the same era, specifically Modern and Contemporary Art periods.

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<sup>8</sup>Regrettably, web-scraping the entire data was not possible. After contacting the data host, we received a list of 35,918 artists with known birth *and* death years. Due to data access limitations and the inability to target the entire data, we drew a random sample of 1,000 artists (June 2022). Based on this list we employed a semi-automated web scraper that accessed all individual artist web pages and obtained the exhibition information accordingly. Two artists were dropped from the final sample due to unclear or missing birth and death year information. Moreover, two "studio/conglomerate" were excluded. Consequently, we excluded a total of 4 artists ( $N = 115$  exhibitions).

<sup>9</sup>This information is based on a visual inspection of the data, conversations with the data host, and consultations with several art experts.

Additionally, to calculate the main results, we have used fixed effects for artist and exhibition decades (cf. section 3.5).

Table 3.1 presents the summary statistics at the artist exhibition year-level. An initial query of the random sample of 1,000 artists yielded historical data of 996 artists for 21,020 unique exhibitions. These exhibitions took place between 1916 and 2022, with an average exhibition year of 1986. The majority (90%) of artworks were displayed in venues located Europe and US. Most exhibitions in our panel feature male artists, with female artist exhibitions as low as 12 percent.<sup>10</sup> The most popular artists in terms of total exhibitions in our 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 3.3.

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.<sup>11</sup> Figure 3.1 displays the distribution plots for our primary variable of interest, postmortem determinants. 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 postmortem. We offer separate summary statistics for relevant pre- and postmortem variables in table 3.3.

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

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<sup>10</sup>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.

<sup>11</sup>It should be noted that the summary statistics in table 3.1 are presented at the exhibition year-level, while average years of birth and death are calculated at the artist-level.

Table 3.1: Summary Statistics: Exhibitions

Variable	Mean	Std. Dev.	Min	Max
Birthyear	1923.833	13.82562	1900	1963
Deathyear	1998.466	14.69634	1930	2022
Exhibition years to/-from Death	-12.21465	23.42416	-79	88
Age at death	74.63268	14.83023	22	106
log (reputation at death+1)	5.574331	2.679631	0	9.35
Exhibition year	1986.251	21.39027	1916	2022
Female	.12158	.32681	0	1
Solo exhibition dummy	.2705994	.4442801	0	1
Postmortem dummy	.3106565	.4627734	0	1
Log(y n exhibitions)	1.065821	.9263888	0	4.09

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. "log(reputation at death)" is an approximation of artist's reputation right before death as the sum of a ranking of exhibitions in prestigious museums (logged). The construction of the variable is described in section 3.6.6. Most exhibitions took place in Germany (36 percent), the United States (30 percent), Italy (7 percent), and France (6 percent). On average, artists had between 1 and 60 exhibitions per year (mean 4.7 and median 3). N= 21,020.

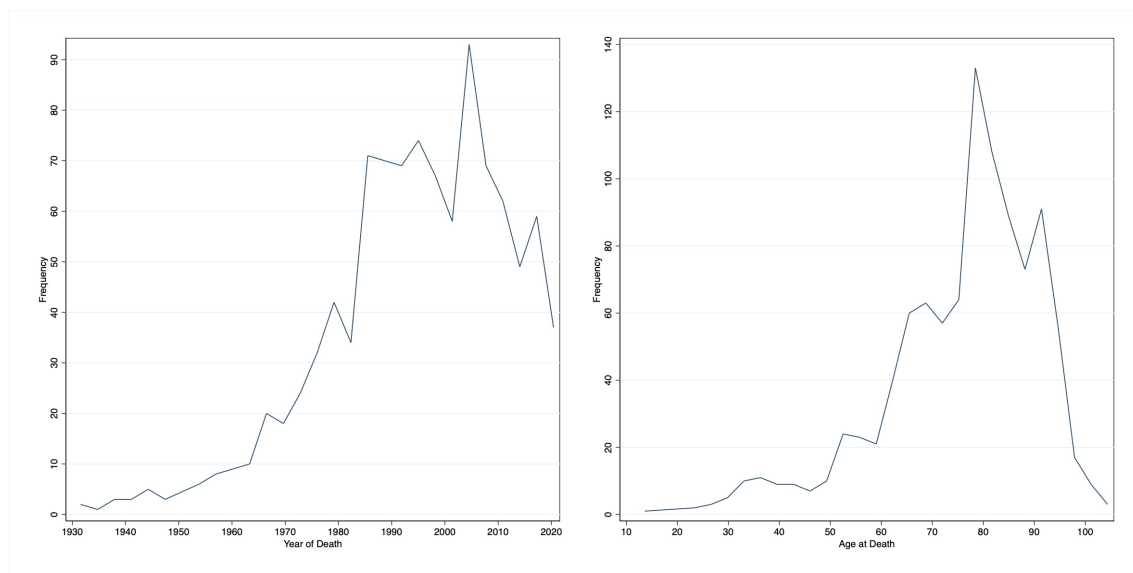


Figure 3.1: Exhibitions: distribution of death year and age at death

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

Table 3.2: Summary Statistics: Exhibitions by Living Artists and Postmortem

Variable	Living Artists		Postmortem	
	Mean	SD	Mean	SD
Exhibition year	1978.08	19.95	2004.38	10.62
Exhibition years to/-from Death	-24.35	16.07	14.71	11.89
Female	.11	.31	.15	.36
Solo exhibition dummy	.28	.45	.24	.43
log(y n exhibitions)	.99	.83	1.23	1.09

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

Table 3.3: 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 3.5 and 3.6.

more than 20 thousand exhibitions in total. Within this sample, over 30 percent of exhibitions are run after death.

### 3.4.2 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.<sup>12</sup> The 33,043 auctions took place in years 1986 to

<sup>12</sup>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

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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 postmortem. The final data set is described in table 3.4.

To further illustrate results, figure 3.2 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 3.3, we combine and visualize both data sources, exhibitions and auctions, for the 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.<sup>13</sup>

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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.

<sup>13</sup>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.

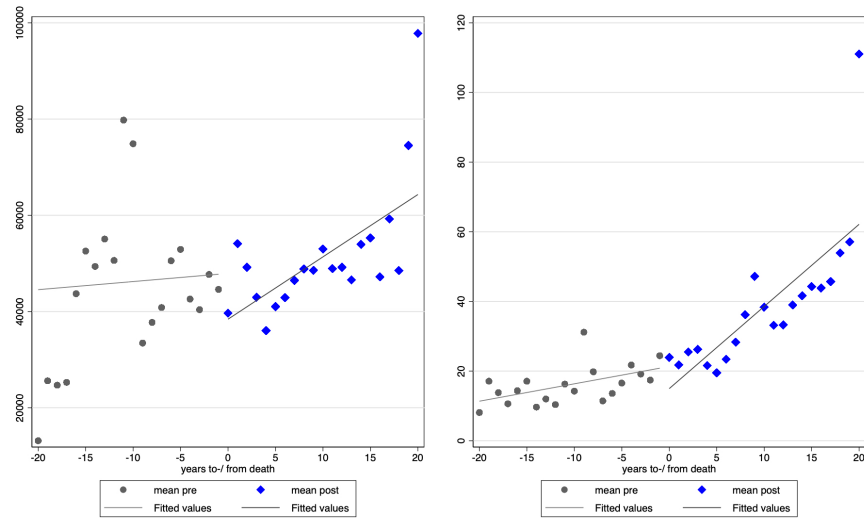


Figure 3.2: Auctions: Descriptives

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

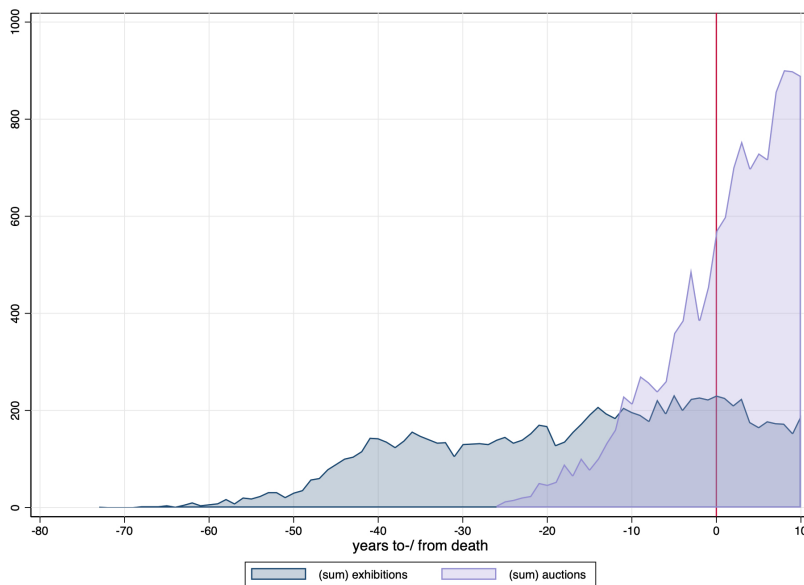


Figure 3.3: Auctions and Exhibitions: Descriptives

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 3.4, and death year < 2013.

Table 3.4: Summary Statistics: Auctions

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

## 3.5 Empirical Framework

### 3.5.1 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 (RDD) and fixed effects models to calculate the heterogeneity in postmortem effects. Our main set of results focuses on the postmortem 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  $c$ :

$$y_{it} = \alpha + \sum_{j=2}^J \beta_j (\text{Lead } j)_{it} + \sum_{k=1}^K \delta_k (\text{Lag } k)_{it} + \mu_I + \phi_T + \gamma_C + \theta_M + \epsilon_{itcm}, \quad (3.1)$$

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- $(\mu)$ , exhibition country  $(\gamma)$ , exhibition year (or decades  $\phi$ ), and museum  $(\theta)$  fixed effects.

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

$$y_{it} = \alpha + \beta_1 \text{postmortem}_{it} + (\text{timetotreat}_{it})^k + \mu_I + \phi_T + \gamma_C + \theta_M + \epsilon_{itcm}, \quad (3.2)$$

However, we construct the treatment variable as a dummy equals one for post death exhibition years,  $\text{postmortem}_{it} = 1 [t \geq \text{PostMortem}_{it}]$  to capture the overall effect. The forcing variable (Lee and Lemieux, 2010; Cattaneo et al., 2019),  $(\text{timetotreat})$ , is constructed as a continuous function of time periods to-/ from death (cf. table 3.1). In various models of the baseline results, we allow for polynomial functions ( $k$ ) of  $\text{timetotreat}$ . 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 postmortem exhibition outcomes.

### 3.5.2 Auctions

To further validate results, we study the relationship between an artist’s death and the impact on secondary market auction sales. We use fixed effect models that incorporate hedonic characteristics of the artworks being sold, so called ”hedonic pricing regression”, with the advantage of including information of all sold items compared to ”repeat sales models” (Li et al., 2022). The auction results are estimated as follows:

$$\ln(\text{price})_{i,a,t} = \alpha + \delta \text{postmortem}_{i,a,t} + \mathbf{X}'_{i,a,t} + \rho_T + \phi_M + \theta_V + \mu_A + \epsilon_{i,t,a} \quad (3.3)$$

$$\text{notsold}_{i,a,t} = \alpha + \delta \text{postmortem}_{i,a,t} + \mathbf{X}'_{i,a,t} + \rho_T + \phi_M + \theta_V + \mu_A + \epsilon_{i,t,a} \quad (3.4)$$

where artwork  $i$  by artist  $a$  is auctioned at date  $t$ . We regress on the natural logarithms of hammer prices (USD)  $\ln(\text{price})_{i,a,t}$ , and the probability of unsold items, where  $\text{notsold}_{i,a,t}$  equals one if the auctioned object did not result in a sales success (”bought in”), and zero otherwise.<sup>14</sup> In both models, the vector  $\mathbf{X}'$  captures the broad range of hedonic characteristics of the artwork.<sup>15</sup>  $\rho_T$ ,  $\phi_M$ ,  $\theta_V$  and  $\mu_A$  cap-

<sup>14</sup>In line with the existing auction literature, approximately 34 % of the auctions in our dataset do not result in successful sales (cf. table 3.4)

<sup>15</sup>Given the structure of the data, we perform a string-search in the artwork name based on popular 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).

ture auction year, auction month, auction house, and artist fixed effects. Finally,  $\delta_{postmortem}$  is a dummy indicator variable equal to one for auctions that take place postmortem, zero otherwise.  $\epsilon_{i,t,a}$  represents in both equations the error term.

### 3.5.3 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 postmortem exhibition records.<sup>16</sup>

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

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<sup>16</sup>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.

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 3.6.6, we manually inspect the data. First, it seems that exhibitions reported on [artist-info.com](http://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 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 panel data is capable to address most of the above data limitations, and allows to apply high-standard econometric tools, e.g. by including fixed effects for artists, countries and exhibition years.

## 3.6 Results

### 3.6.1 Event Study: Short- and long-run Death Effects

We now present the results based on the empirical framework outlined in section 3.5. In a next step, we explore the implications of these findings in greater detail and examine their connection to our hypothesis in section 3.7.

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 (3.1). 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 3.1), and we therefore control for the year (or decades) of exhibition.<sup>17</sup> 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 3.4. 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.

At large, figure 3.4 also reveals findings for a wider time window, models including

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<sup>17</sup>Section 3.6.3 discusses the robustness of these results in detail.

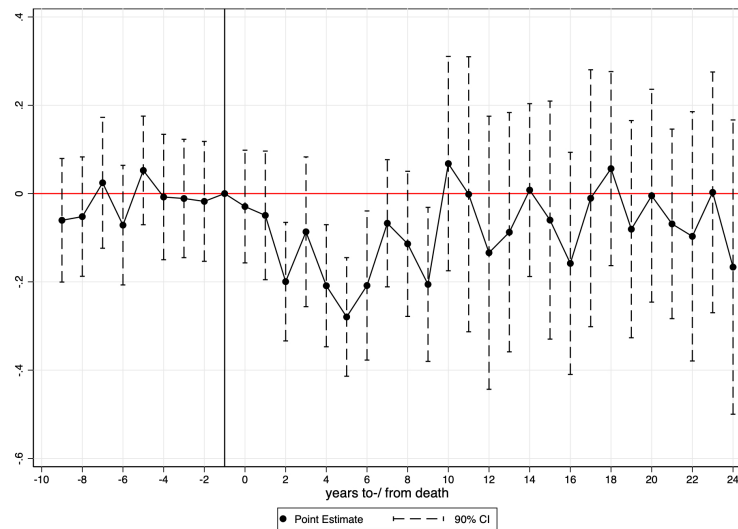


Figure 3.4: Exhibitions: long-term event study exhibitions to-/ from death

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.

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 remain statistically insignificant afterwards.

### 3.6.2 Exogenous Discontinuity in Death Effects

Table 3.5, featuring models (1) through (3), presents the basic regression discontinuity design (RDD) results as outlined in equation (3.2). In all models, the postmortem effect consistently exhibits a negative relationship. In the baseline model (2), we ob-

serve a negative effect of approximately -0.0797. By introducing quadratic and cubic *timetotreat* forcing variables in model (3), the coefficient stays robust at -0.0785. The estimates stay robust against using an interaction term of the forcing variable with the treatment dummy *postmortem* (not reported). Moreover, model (1) underscores the importance of selecting an appropriate bandwidth ([-20,20]) for the estimates, as the coefficient of postmortem exhibition becomes statistically significant at the 1%-level. We discuss and report different estimation bandwidths in the following paragraph (and robustness section) in greater detail.

Table 3.5: RDD: Postmortem Exhibitions

log(N exhibitions)	(1) bandwidth [-20,20]	(2) Full Sample	(3) Full Sample
postmortem	-0.157** (-2.97)	-0.0797 (-1.17)	-0.0785 (-1.31)
timetotreat	0.0148*** (3.80)	0.00364 (1.27)	0.00384 (1.34)
(timetotreat) <sup>2</sup>			-0.0000165 (-0.76)
(timetotreat) <sup>3</sup>			-0.000000211 (-0.40)
N	9177	18694	18694
R <sup>2</sup>	0.780	0.705	0.705
Artist FE	✓	✓	✓
Exhibition Decade FE	✓	✓	✓
Country FE	✓	✓	✓
Museum FE	✓	✓	✓
Cluster SE	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 3.5. The depended variable is the log-transformed yearly number of exhibitions (artist exhibition year level). *postmortem* is a dummy equal 1 for exhibitions after the artist's death (zero otherwise) and *timetotreat* a continuous variable of exhibition years to-/ from death. Model (1) is based on estimation sample using a bandwidth of 20 years to-/ from death of artists. Standard errors (SE) clustered at the levels specified.

In figure 3.5, 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 out-

comes following their death. While pre-periods follow an increasing and almost linear trend, the postmortem coefficients drop sharply following the first nine exhibition years after the event.

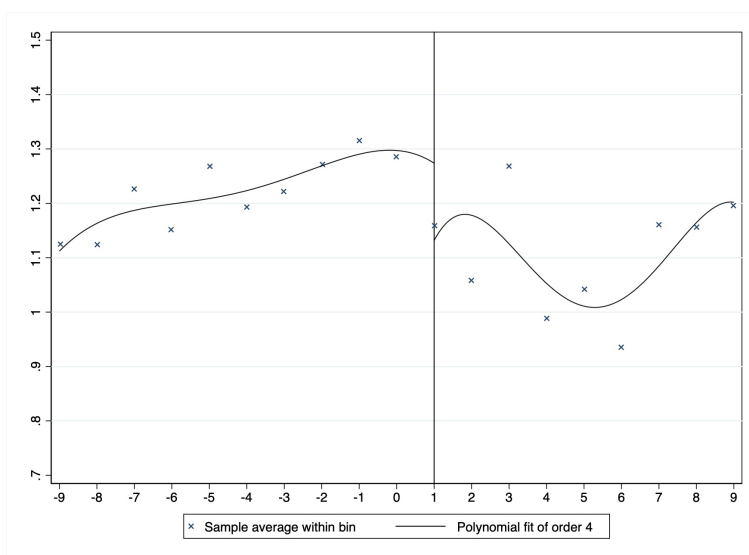


Figure 3.5: Exhibitions: RDD plot

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 postmortem 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 2-3). However, this effect may not be unassailably robust when choosing longer (or shorter) sample periods.

### 3.6.3 Robustness

To ensure the validity of our results and identification strategy, we conduct various robustness checks. As shown in figure 3.6 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.

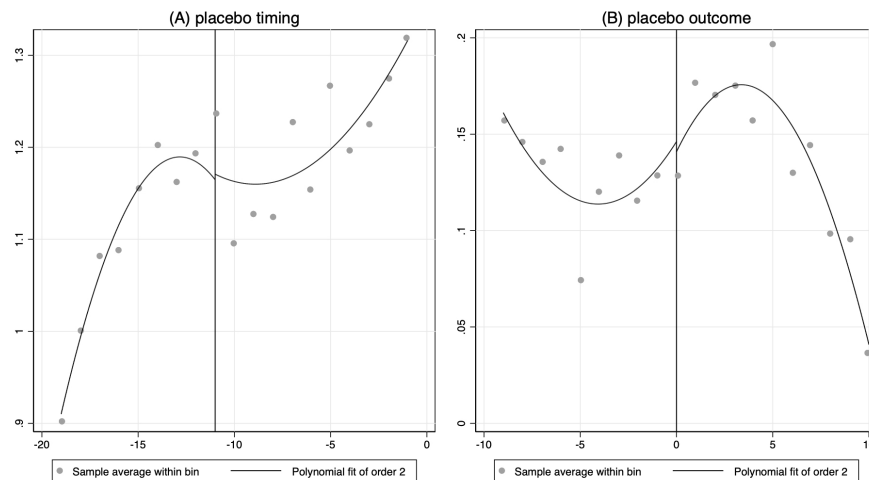


Figure 3.6: Exhibitions: placebo timing and outcome

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.

In the regression discontinuity plot of figure 3.6 panel (B), we look at exhibitions by female artists as a placebo outcome variable (dummy) and test if gender composition 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. 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 3.5, now excluding artists with only pre-mortem observations from the sample. Figure 3.7 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 postmortem exhibitions in this more robust sample.

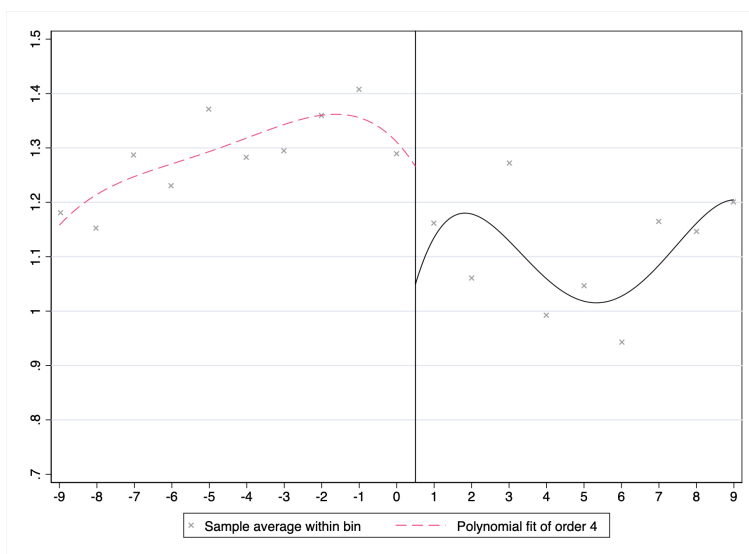


Figure 3.7: Exhibitions: robust pre-post balance

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 postmortem.

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 3.3). 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).<sup>18</sup>

Recent applied econometric literature has focused on the consistency of staggered adopted 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 3.8 (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).<sup>19</sup> By doing so, we further address the potential bias of the staggered adoption of the treatment in our estimates. The short-term negative postmortem exhibition outcomes are also confirmed when using this robust estimator, as illustrated in figure 3.8 (right panel).

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<sup>18</sup>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.

<sup>19</sup>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).

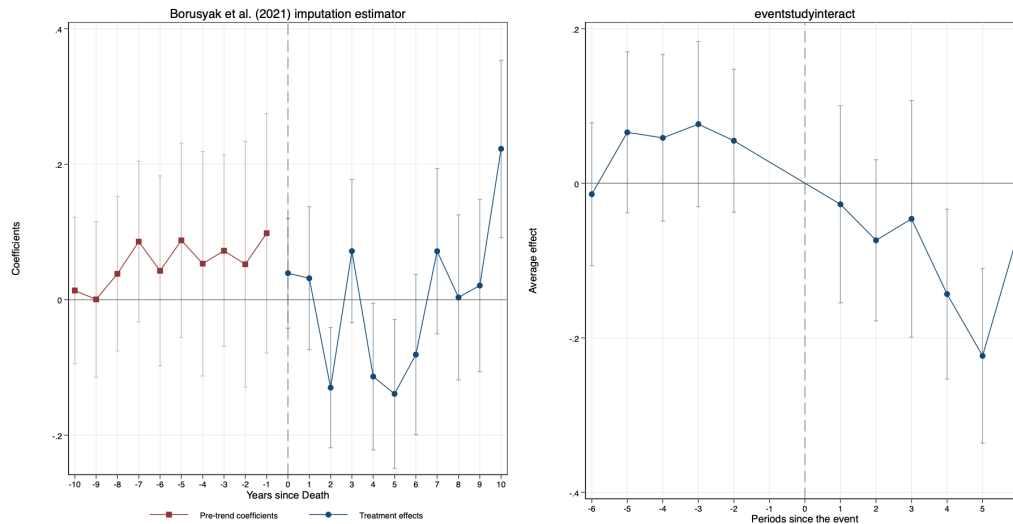


Figure 3.8: Exhibitions: pre-trend testing imputation approach and eventstudyinteract

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).

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). The outcome reveals a continuous increase in the share of exhibiting artists in the years leading up to an artist's death (not-reported). 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 postmortem depreciation effect.

### 3.6.4 Age at Death

Both panels in figure 3.1 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 estimates and introduce a variable "age at death" that we interact with the postmortem dummy.

The results of this analysis are presented in table 3.6. Interestingly, the overall coefficient of post-death exhibition outcomes now consistently turns positive (around 0.416 to 0.515). As discussed in the previous section, our findings in the overall career cycle sample are not robust (and significant), 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. Consistent with prior literature in art auctions and cultural economics, age at death appears to be relevant in explaining postmortem outcomes. In model (1) we estimate a statistically significant negative effect for the interaction coefficient of interest "*postmortem*  $\times$  *ageatdeath*" (-0.00812). The effect stays robust after controlling for museum and exhibition country fixed effects in model (2), and for polynomial functions of *timetotreat* in model (3).<sup>20</sup> We interpret this result as follows: with an increase in age at death, artists appear to be more negatively affected by postmortem exhibition outcomes than artists who die young. In other words, our results suggest no (or a 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.

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<sup>20</sup>We perform an outlier-robustness check, similar to the one reported in section 3.6.3, 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 important in the regressions. However, the results are robust to excluding exhibitions by Andy Warhol.

We visualize the results discussed above. In figure 3.9, 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.

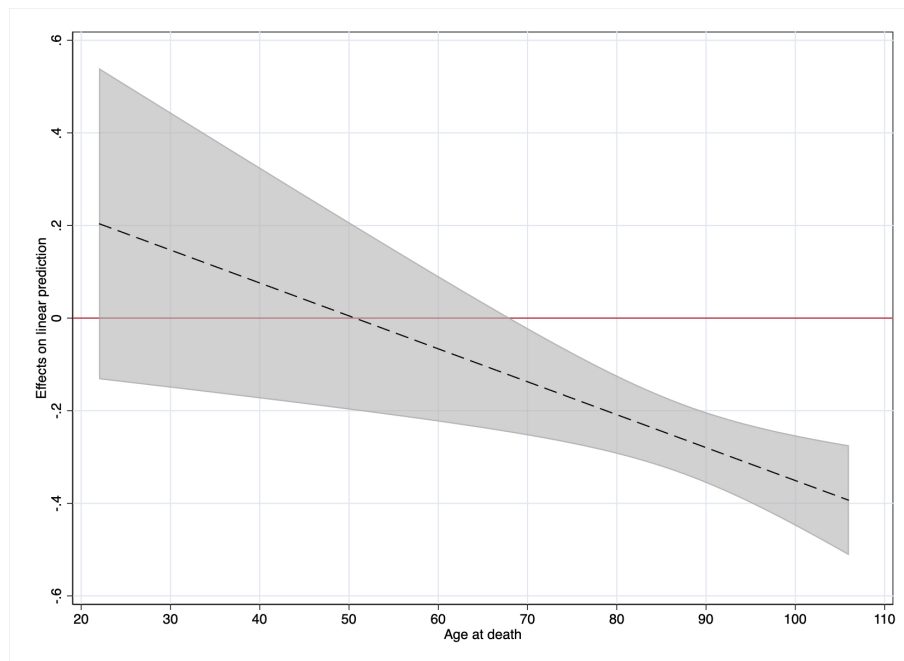


Figure 3.9: Exhibitions: postmortem effect marginal effects age at death

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.

### 3.6.5 Auction Results

In this section, we present the estimation results obtained from the sample of matched artists, for whom auction data is available. Our aim is to enhance our understanding

Table 3.6: RDD: Postmortem Exhibitions (age at death)

	(1)	(2)	(3)
<hr/>			
log(N exhibitions)			
postmortem	0.515 (1.55)	0.416 (1.41)	0.512 (1.74)
postmortem $\times$ <i>ageatdeath</i>	-0.00812* (-2.11)	-0.00701* (-2.01)	-0.00822* (-2.29)
timetotreat	0.00123 (0.46)	0.00483 (1.88)	0.00523 (1.94)
(timetotreat) <sup>2</sup>			-0.0000479* (-2.12)
(timetotreat) <sup>3</sup>			-0.000000448 (-0.78)
N	20796	18694	18694
R <sup>2</sup>	0.644	0.706	0.707
Artist FE	✓	✓	✓
Exhibition Decade FE	✓	✓	✓
Country FE	No	✓	✓
Museum FE	No	✓	✓
Cluster SE	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 3.5. The depended variable is the log-transformed yearly number of exhibitions (artist exhibition year level). *postmortem* is a dummy equal 1 for exhibitions after the artists death (zero otherwise) and *timetotreat* 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. Standard errors (SE) clustered at the levels specified.

of the impact of artists' deaths on their exhibition frequency by examining the auction hammer prices and the probability of unsold auctions for these artists. We begin by estimating hedonic price regressions and subsequently incorporate an approximation of the artists' reputations, as inferred from their exhibition histories, into the auction estimates.

The key findings regarding auction prices are summarized in table 3.7. All models incorporate artist fixed effects, and standard errors are clustered at the artist level. In model (1) of table 3.7, the dummy variable for auctions held after an artist's death is statistically significant and positive, indicating a positive correlation between the 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 hammer prices ( $\exp(0.152) - 1$ ).<sup>21</sup> Figure 3.10 illustrates the previously discussed estimates and shows the increasing trend of auction hammer prices posthumously (across all 20 estimated lags). Moreover, the graph shows an increasing pre-treatment trend, though statistically insignificant.

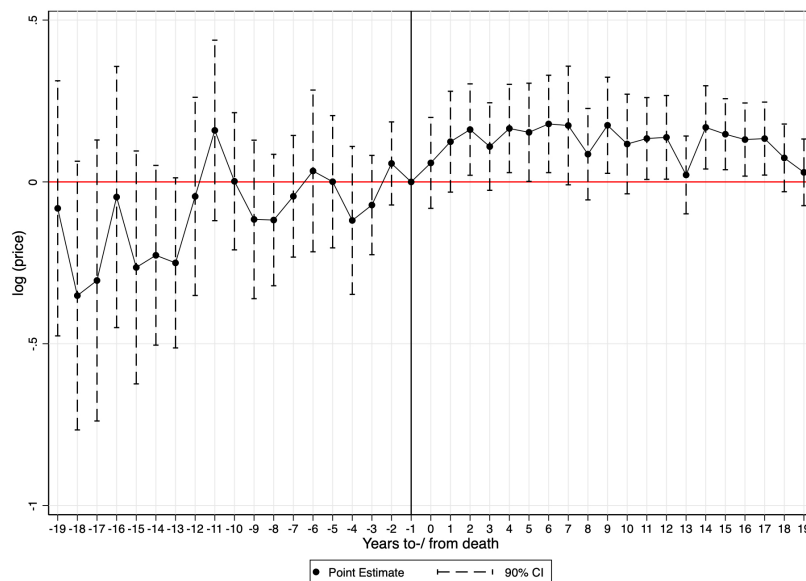


Figure 3.10: Auctions: Event study auction price years to-/ from Death

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 3.8 estimates the same type of models (model 4 using a Logit

<sup>21</sup>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 on canvas are highly statistically positively 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 hammer prices.

Table 3.7: Auction Price

	(1)	(2)	(3)	(4)
<hr/>				
log(auction price)				
postmortem	0.613*** (5.71)	0.711*** (6.75)	0.175* (2.02)	0.152* (2.06)
<b>artwork</b>				
size m <sup>2</sup>		0.0504*** (6.40)	0.0565*** (7.77)	0.0538*** (7.64)
abstract		-0.367*** (-3.48)	-0.341*** (-3.55)	-0.173* (-2.30)
landscape		-0.140* (-1.99)	-0.103 (-1.39)	-0.0748 (-1.25)
nude		-0.0955 (-0.76)	-0.0493 (-0.46)	-0.0582 (-0.70)
portrait		-0.0633 (-0.56)	-0.0887 (-0.97)	-0.129 (-1.71)
still life		-0.259* (-2.50)	-0.171 (-1.65)	-0.0808 (-0.97)
untitled		-0.140* (-2.31)	-0.154** (-2.87)	-0.186*** (-4.07)
<b>medium</b>				
oil		0.129 (1.83)	0.192** (2.82)	0.205** (3.14)
acryl		-0.0756 (-1.03)	-0.0860 (-1.61)	-0.0406 (-0.75)
canvas		0.360*** (6.15)	0.278*** (5.61)	0.240*** (5.20)
board		-0.00230 (-0.03)	-0.0343 (-0.46)	-0.0350 (-0.51)
mixed media		-0.254** (-2.98)	-0.218** (-2.77)	-0.141 (-1.83)
paper		-0.276** (-2.94)	-0.313*** (-3.38)	-0.309*** (-3.59)
<b>auction house</b>				
christies		0.474*** (6.39)	0.606*** (10.23)	
sothebys		0.927*** (9.12)	0.778*** (9.07)	
bonhams		0.299*** (4.04)	0.154* (2.33)	
N	22011	20923	20923	20818
R <sup>2</sup>	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 regression results for the dependent variable ( $\log$ )*hammerprice* (US dollars). 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.

regression) but for the probability of auctions not being sold.<sup>22</sup> We observe a statis-

<sup>22</sup>Typically, this occurs when the buyer does not meet the sellers reserve price (i.e. lower price estimates), sometimes referred to as "bought in".

tically significant negative effect of auctions not being sold posthumously, but after including all auction house, year and month fixed effects, the significance disappears. In sum, auction sales were more successful in years when the artist already deceased.<sup>23</sup>

### 3.6.6 Auction Results and Reputation at Death

The empirical evidence thus far suggests a clear positive relationship between auction hammer prices and the death of artists. To account for heterogeneity in the treatment, we will incorporate information about the exhibition histories of the artists into the auction price estimates. Recent research by Li et al. (2022) emphasizes the importance of including auction house-specific reputation measures into the price estimates. However, measuring reputation can be challenging and might introduce certain endogeneity issues. In the following, we propose a reputation measure based on the exhibition dataset. This additional step contributes to the existing literature on auction price formation by creating an artist reputation measure that relies on an exogenous source of information.

As a first step, we make use of the work by 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.<sup>24</sup> Next, we sum up the rankings of

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<sup>23</sup>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.

<sup>24</sup>Our primary variable is constructed as follows: We rank the reputation of each exhibition on a scale from 0 to 100, where 100 represents the Museum of Modern Art (highest reputation), 99 corresponds to the Guggenheim, and so on, with 2 being the Francois Pinault Foundation, 1 the Whitechapel Gallery (lowest reputation), and 0 representing all other museums in our data. Subsequently, we manually search for exhibitions at the Venice Biennale, a highly prestigious venue

Table 3.8: Probability not sold

	(1)	(2)	(3)	(4)
not sold [0,1]	OLS			Logit
postmortem	-0.233*** (-4.25)	-0.244*** (-4.42)	-0.0170 (-0.59)	-1.144*** (-4.48)
<b>artwork</b>				
size m <sup>2</sup>		0.00126 (1.80)	0.000213 (0.27)	0.00805* (2.08)
abstract		0.0135 (0.56)	0.0444* (2.03)	0.114 (0.91)
landscape		-0.00975 (-0.48)	0.00161 (0.09)	-0.0229 (-0.19)
nude		0.00579 (0.24)	0.0197 (1.34)	0.0203 (0.15)
portrait		0.0604** (2.63)	0.0433* (2.15)	0.335** (2.76)
still life		0.0209 (0.89)	-0.00117 (-0.06)	0.129 (1.17)
untitled		-0.0384** (-3.11)	0.000180 (0.01)	-0.190** (-2.90)
<b>medium</b>				
oil		-0.0516 (-1.80)	-0.0359* (-2.21)	-0.297* (-2.00)
acryl		-0.0148 (-0.69)	-0.0152 (-0.96)	-0.0454 (-0.40)
canvas		-0.00770 (-0.35)	0.00286 (0.39)	-0.0689 (-0.51)
board		-0.0203 (-0.98)	-0.00151 (-0.14)	-0.106 (-0.96)
mixedmedia		-0.0284 (-1.34)	-0.0246 (-1.39)	-0.105 (-0.93)
paper		0.00162 (0.09)	0.00658 (0.50)	-0.0179 (-0.20)
<b>auction house</b>				
christies		-0.192*** (-5.00)		
sothebys		-0.139*** (-3.55)		
bonhams		-0.0121 (-0.36)		
N	33318	31935	31751	31709
R <sup>2</sup>	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 regression results 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 exhibitions to calculate the approximated "reputation" up to the artist's death, 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 3.1 and table 3.3).

resulting in a variable (logged) of reputation at death ( $\log(\text{reputationatdeath})$ ).

Table 3.9: Auction price and probability not sold: age and exhibition reputation at death

	(1)	(2)	(3)	(4)
	log(auction price)			not sold [0,1]
postmortem	0.259** (2.71)	0.687 (1.15)	1.353* (2.31)	-0.593* (-1.98)
postmortem $\times$ <i>reputationatdeath</i>	-0.0000949*** (-3.41)		-0.000112*** (-4.06)	0.0000330** (2.63)
postmortem $\times$ <i>ageatdeath</i>		-0.00617 (-0.92)	-0.0130* (-2.02)	0.00652 (1.93)
N	20923	20923	20923	31935
R <sup>2</sup>	0.654	0.653	0.654	0.273
<b>Hedonic Controls</b>	✓	✓	✓	✓
Artist FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results for the dependent variable  $\log(\text{auctionprice})$  (US dollars, 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".  $\log(\text{repatdeath})$  is the artists total of exhibition reputation, explained in detail in section 3.6.6. Standard error are clustered at the artist-level.

In table 3.9, 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 postmortem (model 4), even after controlling for reputation and age at death. Here, both the reputation and age coefficients exhibit a positive relationship with the postmortem dummy.

We graphically illustrate these effects in figure 3.11, 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.

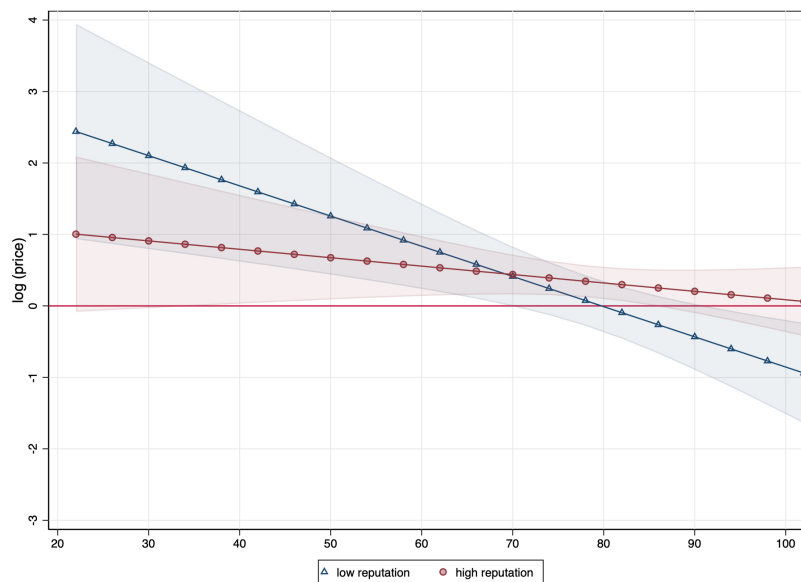


Figure 3.11: Auction price: marginal effects posthumously across reputation and age at death

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 ( $\log(\text{reputationatdeath}) > 0$ ) and low ( $\log(\text{reputationatdeath}) = 0$ ) reputation at death. The dependent variable is (log) price of auctions (US dollars). 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 increase postmortem. Artists who pass away at a younger age experience a higher price premium, with effects diminishing for older

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artists. Interestingly, we estimate highest postmortem prices for artists who died young with relatively low reputation.

### 3.7 Discussion

Related to the scarcity-in-supply argument (Ursprung et al., 2021), we predict in hypothesis *H1a* a positive posthumous effect in both auction and exhibition markets. While we observe a clear general increase in auction prices posthumously (*H1a* accepted for the auction market), the pattern exhibited by the exhibition market is less clear (*H1a* rejected for exhibitions). We observe a causal decrease in exhibitions roughly five to ten years following an artist's death.<sup>25</sup> Next, our analysis investigates for heterogeneity in the treatment and develops hypotheses based on different signals to the markets by comparing artists who die young with those who die old (hypothesis *H1b*). Our results indicate a significant negative effect for artists who die at an older age, with an observed increase (though insignificant) in exhibitions for younger artists. Furthermore, the evidence we provide suggests that the postmortem auction price premium is substantially driven by younger dying artists. We find evidence of a clear negative correlation between age at death and market signals to exhibitions and auction prices, which allows us to accept hypothesis *H1b* in both markets.

As our study is one of the first to combine exhibition outcomes with auction market results, we contribute new empirical evidence on market complementarities. Our study adds nuanced insights to existing research on postmortem auction prices (Agnello and Pierce, 1996; De Silva et al., 2022; Ursprung and Wiermann, 2011; Ur-

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<sup>25</sup>We document a clear increase in postmortem auction prices, which likely makes new exhibitions more costly after artists' death since insurance costs correlate with auction prices. If this mechanism solely explains the decrease in postmortem exhibitions, then a more stable decrease would be expected. However, disentangling this effect with our data is challenging, and it likely correlates in both directions (i.e., the described positive impact of superstar exhibitions on museum revenue).

sprung et al., 2021) by introducing an exogenous measure of reputation into auction estimates. We utilize variations in the reputation of exhibiting venues to create an approximated level of reputation *at the time of death*. In addition to noting the negative correlation between age at death and postmortem prices, we observe the following: Unsurprisingly, artists with higher reputations (at death) consistently exhibit positive auction price effects across all ages at death. However, contrary to our prediction in hypothesis *H2a*, we do not find a stronger increase for high-reputation artists who pass away early compared with low-reputation artists. In fact, the highest positive price premium is estimated for young artists who die with a low reputation at death. This could likely be explained by the baseline differences in auction prices, with buyers expecting higher future profits from investing in artists who have not reached the peak of their reputation (i.e., an expected postmortem increase in reputation).<sup>26</sup> Furthermore, we find supporting evidence for hypothesis *H2b*: The strongest negative signals sent to auction markets are from artists who pass away at an older age with a relatively low reputation. In other words, when artists never reach high reputation levels during their (long) career, buyers interpret this negatively and expect smaller future profits, which in turn adversely affects postmortem auction prices.

Lastly, we discuss the possibility of short-term legal transaction costs (Benhamou, 2017) that arise immediately after an artist's death and affect the exhibition of artworks. We find supporting evidence for hypothesis *H3*. The pattern of a causal but short-term effect leads us to associate observed effects with the described transaction costs. However, these costs are difficult to measure directly, and systematic data are currently either unavailable or confidential.

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<sup>26</sup>Indeed, the average pre-death auction price for low-reputation artists dying before the age of 70 years is US\$11,000, compared with US\$77,000 for high-reputation artists.

Generally, with fewer exhibitions being curated posthumously, fewer signals are sent to auction markets regarding quality and trust, especially since provenance information becomes available only gradually after death. This may amplify or offset some of the observed postmortem effects in auction markets. Given the significant role of provenance information in determining auction prices (Li et al., 2022), the reduced exhibition activity that we observe could impede the exchange of information and market signals (Etro and Stepanova, 2021). Additionally, complex legal structures, such as copyright, inheritance, and contract law, can temporarily increase postmortem transaction costs, which our results point to. This study contributes to the literature and ongoing policy discussions on costs of the postmortem term (Benhamou, 2018, 2017; Stern, 2003). Considering or anticipating relevant transaction costs related to exhibitions and sales postmortem might have positive economic implications. From a policy perspective, measures that help to mitigate the negative short-term impacts immediately following an artist's death, such as targeted policy interventions (specifically for reducing search costs and dead-hand control issues or improving stewardship by successors induced by postmortem rights (Subotnik, 2015)), could be most efficient. However, this study does not perform an overall welfare assessment or evaluate the specific impact of different postmortem granted rights on the exhibition and auction market. For an overall evaluation, one should consider for example the longer-term impact of copyright, such as possible positive effects on incentives to create (Giorcelli and Moser, 2020), alongside the imposed transaction costs when copyrights change owners. Nevertheless, this study adds empirical evidence to an aspect that may have been previously overlooked.

In addition, this study has managerial implications in specific areas, such as for art galleries and foundations, who act as heirs to an artist's oeuvre. It suggests that auction transactions and prices tend to increase postmortem, particularly for lower-

reputation artists who die relatively young. Adopting professional legacy stewardship practices (or explicit instructions by the artist for the beneficiaries Subotnik (2015)) can be beneficial for the commercialization *and* curation of an artist’s oeuvre after their death. Moreover, our results contribute to the debate on the longer-term preservation and management of cultural institutions, whether public or private. As studies such as (Topaz et al., 2019; Kizhner et al., 2021) have identified, we find key determinants of postmortem curation in the visual arts sector, demonstrating a significant impact of younger artists. A relatively higher reputation (via exhibitions) achieved during an artist’s lifetime, as our findings demonstrate, has an overall positive effect on postmortem auction prices. Additionally, artists who die young tend to experience an increase in postmortem exhibitions. This aligns with the literature’s assertion that institutional career paths significantly influence the success of visual artists in their later career stages (Fraiberger et al., 2018).

### 3.8 Conclusion

This paper investigates the commercial afterlife of artists, particularly the effect of artist death on museum exhibitions and auction art markets. Using a regression discontinuity and event study design, we are able to identify the causal effect of death on artist appearances in museum shows based on exhibition records spanning several decades. Moreover, 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 that we reveal is somewhat more nuanced.

Compared with living artists, deceased artists see fewer exhibitions on average, and arguably their artworks are less well preserved and represented after death. However, this exclusion effect is short-lived, and approximately 10 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.

A complementary analysis of auction outcomes for the same artists reveals a positive price premium and a reduced likelihood of non-sales after death. We find robust evidence of a significant price increase of approximately 19% postmortem, even after we account for age and reputation at death. Next, we implement an exogenous measure of reputation at death (from exhibiting at reputable venues) to test for more nuanced signals on auction markets. Notably, increases in postmortem prices are primarily driven by artists who die at a younger age and those with a lower reputation at death. More research is required to obtain an enhanced understanding of the interdependencies between complementary markets.

We have developed, tested, and discussed possible mechanisms that describe postmortem market outcomes in exhibitions and auctions. Our findings confirm the existence of short-term legal transaction costs that negatively affect postmortem exhibitions. Policy measures that specifically address postmortem transaction costs immediately after death related to search costs, dead-hand control, or legacy stewardship (Subotnik, 2015) can have positive economic impacts.



# Conclusion

This thesis has presented three empirical essays on different aspects of the economics of creative industries. Copyright policy is a crucial component in the development of the creative and cultural sectors, and copyright industries significantly contribute to a country's GDP, ranging from 2% to 11.2% (WIPO, 2021). Nevertheless, empirical research on this topic is relatively scarce (Towse, 2011; Handke, 2011, 2012). This conclusion chapter summarizes the three essays, which aim to enhance and provide new insights on empirical copyright research, particularly in application to the visual arts sector.

Chapter 1 elaborates on how a prominent higher court ruling in the US that has extended copyright infringement and liability to market intermediaries has affected trade in the secondary art market. The chapter explains that this decision has increased legal uncertainty for market intermediaries concerning a specific type of artwork. The quantitative findings of the study suggest that the global auction trade of artists affected by the court decision - at least temporarily - decreased and partially relocated to other non-US jurisdictions. Moreover, for artworks still listed in auctions, their sales probability decreased after the court ruling. Thus, as demonstrated in the chapter, market intermediaries respond to changes in liability rules and higher exposure to litigation risk.

Chapter **2** examines digitized museum collections and investigates what happens with digital surrogates when the corresponding original artwork is in the public domain, compared with copyrighted artworks. The study leverages a quasi-natural experiment enabled by a significant change in copyright law in the US. When works are no longer under copyright protection, their online availability and accessibility for a worldwide audience are significantly promoted. Notably, museums themselves supply higher-quality products to markets and make digital images available in a higher image resolution once the original artworks are in the public domain. Next, the chapter provides a comprehensive analysis of the downstream reuse of digitized artworks on the Internet. The analysis demonstrates that artworks were reused an average of 66 times (both commercially and noncommercially) on the Internet, indicating that their availability is of high public value - independent of their rights status.

Chapter **3** explores the commercial afterlife of artists by examining the effect of an artist's death on the number of exhibitions and secondary market outcomes pre- and post-death. This analysis is interesting for at least two reasons. First, the chapter advances empirical research on "finite supply signals" in a market that has been largely understudied and where data are particularly scarce, namely global museum exhibitions. Furthermore, the research provides complementary empirical analysis on auction market outcomes after death. Second, the study contributes to understanding how changes in (legal) transaction costs (e.g., uncertainties over rights negotiation and the quality of estate management) can affect these markets. The empirical results suggest that deceased artists have fewer exhibitions in the first 10 years after their death. This effect may trickle down to the cultural preservation and postmortem visibility as well as the value of the artist's oeuvre. Moreover, the study finds robust and significant evidence for a positive price premium in auction results for deceased artists. Consistent with existing literature, the estimated results reveal substantial

heterogeneity in this treatment effect, with age and reputation at the time of death being prominent explanatory variables.

Clearly, the three chapters open up new areas for future research. While some of these ideas are directly addressed in the chapters, I highlight some possible extensions of the present research as follows. First, the level of analysis used to compute the results in Chapter 1 is at the artist-level. However, copyright infringement cases are typically based on single artworks (or series thereof)- a fact that future research could exploit. This is challenging for several reasons, for example, not all artworks are uniformly titled, and researchers may be confronted with a reporting bias across auction houses or museums for tracing the artworks over time. However, such a method would allow one to conduct repeated-sales models and follow changes in the value of a given artwork over time. Moreover, it might be interesting to closely study the replacement or advertising effect of appropriation and artistic reuse on the sales of the original artwork, as other research has done for music sampling (Watson, 2017b). On a more general note, Chapter 1 analyzes the increase in litigation risks faced by market intermediaries in a specific area of the visual arts, namely trading in the secondary art market. However, a recent lawsuit found not only the artist (Jeff Koons) but also the museum (Centre Pompidou) guilty of copyright infringement, leading to extended liability for the museum, the publishing house, and the artist's company for reproducing the work (Artnet, 2017, 2021). Therefore, a similar study to that presented in Chapter 1 could extend the scope of greater legal uncertainty in the copyright system across other art markets and intermediaries, such as museums and galleries<sup>27</sup>. In a similar vein, the monitoring of the art trade is often limited to auc-

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<sup>27</sup>Most recently, the US Supreme Court ruled in a copyright infringement case against the artist Andy Warhol. This controversial decision has also sparked discussions among experts in the context of copyright law and the challenges posed by images generated through artificial intelligence (AI) technology (Wired, 2023; NewYorkTimes, 2023). This area remains yet another topic for future research in this context.

tion data, as private sales data or data on sales on primary markets (e.g., galleries) are often confidential and difficult to collect on a systematic basis. The provision of solutions for overcoming these challenges could represent an area that remains for future research.

Chapter **2** presents a more nuanced analysis at the artwork level, addressing some of the challenges highlighted above. However, the primary data collected for this study are mostly derived from crowd-sourced digital platforms such as *Useum* and *Wikidata*, which may be subject to reporting biases. To enhance the external validity of the obtained results, future research could use data directly reported across digitized museum collections, as exemplified in the appendix of this thesis. Such data could potentially expand the research and increase the general applicability of results regarding how copyright impacts digitization efforts and the managerial decisions of cultural institutions. Furthermore, Chapter **2** touches on the balance between the costs of limited access due to copyright and the incentives to innovate and makes use of new technology and distribution channels. A more detailed welfare assessment could be conducted by examining changes in consumer and producer surplus in the visual art market, inspired by the study by Reimers (2019) on the publishing industry. This area could be explored in greater detail in future research.

Chapter **3** discusses several plausible mechanisms related to the posthumous commercialization of artworks, both in the context of legacy stewardship and postmortem public policies. Subsequent studies could expand on this analysis, focus on the effects of changes in legal frameworks, and investigate how changes in transaction costs caused by the death of an artist may differently affect art exhibitions. Furthermore, future research could expand on the efforts to connect the auction art market with important information, namely from galleries and exhibitions. The analysis in Chapter

**3** describes the posthumous-increase in insurance and exhibiting costs for museums. This finding complements the literature on provenance information as a signal of quality and trust in price formation on auction markets (Li et al., 2022). However, further research is required to understand the interdependencies between these complementary markets in greater detail.



# Appendix

## A Appendix Chapter 2

### A.1 Additional regression results

Table A1 shows the results of the regression discontinuity estimates using the dependent variable on the country-level (log). The table reports 6 different models. In the first model, we present a RDD regression that estimates the effect of artworks created before/ after the threshold year on the number of digital available artworks in a given year. The second column introduces covariates (2) and clustered standard errors at the museum-levels (3). Model (4) estimates the RDD model with artist fixed effects, model (5) with museum fixed effects and model (6) incorporates both fixed effects respectively.

The effect of public domain status is statistically significant and positive throughout RDD models. The size of the effect ranges from 0.751 to 0.819. The models suggest a significant positive impact on the digital availability of artworks hosted on the platform when works fall into public domain. This applies for artworks in US museums created before 1926. Model (1) is based on RDD model and shows a positive effect of around 0.814 for the coefficient of interest. This coefficient is a dummy variable that is one if the artwork was created before 1926, i.e. '*PublicDomain*' holds,

zero otherwise. The same coefficient stays robust and highly statistically significant at the 99%-level in Model (2), once we include the covariates that aim to control for artworks popularity. Coefficient estimates are robust to the inclusion museum-level clustered SEs, artist-, and museum fixed effects. While the very aggregated level of the dependent variable hints towards a more refined econometric specification, we can interpret the results as an aggregated and positive correlation of public domain artworks available.

Table A1: RDD: Availability (Country-Level)

	log(N artworks Country)					
	(1)	(2)	(3)	(4)	(5)	(6)
Public Domain	0.814*** (28.47)	0.819*** (28.13)	0.819*** (30.32)	0.776*** (25.48)	0.792*** (32.69)	0.751*** (22.05)
Artwork creation year	-2.904*** (-6.46)	-2.889*** (-6.34)	-2.889*** (-7.12)	-2.572*** (-3.89)	-2.766*** (-6.19)	-2.317*** (-4.91)
(Artwork creation year) <sup>2</sup>	0.000742*** (6.34)	0.000738*** (6.22)	0.000738*** (7.00)	0.000655*** (3.80)	0.000706*** (6.07)	0.000589*** (4.79)
artist views		1.01e-08 (0.18)	1.01e-08 (0.24)		8.54e-09 (0.24)	
museum views		6.75e-09 (1.08)	6.75e-09 (0.99)	1.27e-08 (1.93)	-0.00000190*** (-10.33)	0.00000123 (1.07)
artwork views		-0.00000141 (-0.33)	-0.00000141 (-0.53)	-0.000000717 (-0.13)	-0.00000118 (-0.44)	-0.00000185 (-0.78)
N	1605	1566	1566	1313	1539	1290
R <sup>2</sup>	0.914	0.914	0.914	0.924	0.919	0.928
Cluster SE	Artist	Artist	Museum	Artist	Museum	Museum
Artist FE	No	No	No	✓	No	✓
Museum FE	No	No	No	No	✓	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the regression results based on the formula specified in chapter 2.5 and the dependent variable is the year-country number of digitized artworks (log), restricted to museums in the US and artworks created between 1910 to 1940. Standard errors (SE) clustered at the levels specified.

Figure A1 visualizes the results from the corresponding model specification in table A1. It shows a sharp discontinuity in the availability of digital artworks around the cliff year in 1926, with the yearly sample average bins illustrated as pink crosses and plotting a black line with polynomial fit of order 3. Upon visual inspection, figure A1 largely supports our identification strategy.

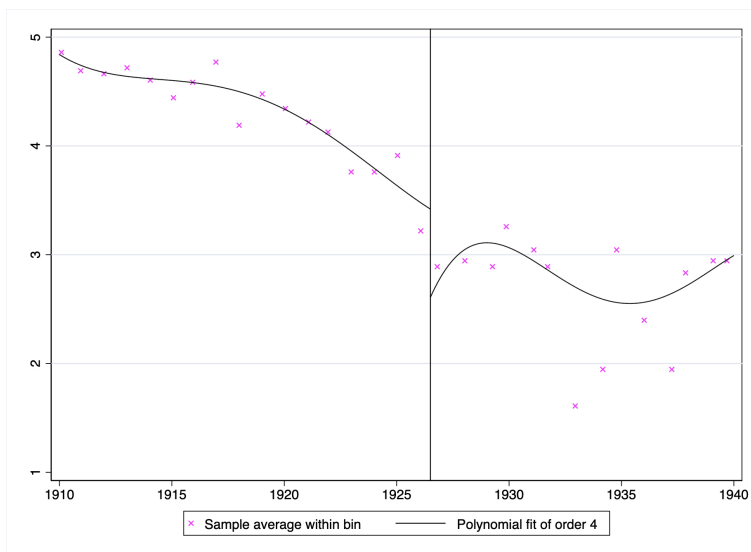


Figure A1: RDD: Digitized Artworks (log) (Country-Level)

Note: This figure shows the yearly number of digitized artworks (log) and year of artwork creation date. The sample is restricted to years 1910-1940 and museums in the US. The crosses represent sample average within bin and the line a polynomial fit of order 4. Standard error are clustered at the artist-level. The x-axis line denotes the copyright cut-off point in 1926.5.

As our dependent variable from the previous results is a counter, we adopt furthermore in table A2 Poisson (1-3) and a Poisson pseudo-maximum likelihood model (4-6) with both fixed effects (model 6) (Correia et al., 2020). We continue to estimate throughout significant positive effects of public domain years in otherwise the same model specifications. Including artist-fixed effects halves the coefficient to around 0.85 (model 3) to 0.445 in model (4) on-wards but stays robust against including museum-fixed effects in model (5-6).

Moreover, in table A3 we present additional differences-in-differences regressions based on a straight forward setting of yearly available artworks in the US compared to the EU and UK museums, pre and post 1926 (i.e. public domain status in the US). The interaction term continues to replicate our positive public domain coefficient from the previous results, with a yearly upwards jump of around plus 50-54 available

Table A2: RDD: Availability (Artist-Level) (poisson)

	N artworks Artist					
	(1)	(2)	(3)	(4)	(5)	(6)
Public Domain	0.797** (2.76)	0.847** (3.16)	0.851** (3.21)	0.446** (2.86)	0.455** (2.92)	0.424** (2.71)
Artwork creation year	0.00818 (0.63)	0.0130 (1.03)	0.0172 (1.36)	2.886 (1.49)	2.848 (1.47)	2.777 (1.56)
(Artwork creation year) <sup>2</sup>				-0.000752 (-1.50)	-0.000742 (-1.48)	-0.000724 (-1.57)
artist views		0.00000220*** (5.01)	0.00000196*** (4.05)			
museum views		9.80e-08 (1.59)	0.0000158 (0.91)		2.85e-08 (1.26)	
artwork views		0.0000243 (1.31)	0.0000260 (1.91)		0.00000952 (1.04)	0.00000248 (0.28)
N	1592	1566	1566	1335	1313	1290
Cluster SE	Artist	Artist	Artist	Artist	Artist	Artist
Pseudo R <sup>2</sup>	0.0258	0.1157	0.1724	0.3052	0.3049	0.3172
Artist FE	No	No	No	✓	✓	✓
Museum FE	No	No	✓	No	No	✓

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the Poisson regression results based on the formula specified in chapter 2.5 and the dependent variable is the year-artist-level number of digitized artworks in model 1-6, restricted to museums in the US and artworks created between 1910 to 1940. Model 4-6 are calculated based on artist panel fixed effects, and model 6 incorporates both fixed effects. Standard errors (SE) clustered at the levels specified.

artworks of US museums in post 1926 years. We control in this table again for year-fixed effects (model 2), add country-fixed effects (model 3) or combine multiway-fixed effects including museum-fixed effects in model (4).

Finally, in the empirical framework section, we discuss potential issues relevant to the approximation of the copyright status of the underlying artwork and conclude that by looking at artwork creation years, we are only able to approximate the public domain status (instead of artwork publication year). In additional robustness checks, we re-run the main estimations based on artworks from US museums, but now choose alternative placebo cut-off *years*. Our results continue to hold if (and only if) a significant jump only appears in 1926, while estimations the hypothetical, alternative cut-off years remain statistically insignificant. As shown in Figure A2, this is in-

Table A3: Differences-in-Differences: Availability (Country-Level)

	N artworks (country)				
	(1)	(2)	(3)	(4)	(5)
Public Domain (US) $\times$ US	49.80*** (4.918)	50.30*** (4.597)	54.35*** (4.181)	53.44*** (4.149)	53.48*** (4.238)
artist views					0.00000219 (0.00000356)
museum views					0.000170 (0.000213)
artwork views					0.000196* (0.000111)
<i>N</i>	4762	4762	4762	4762	4660
adj. <i>R</i> <sup>2</sup>	0.661	0.780	0.883	0.887	0.886
Cluster SE	Country	Country	Country	Country	Country
Year FE	No	✓	✓	✓	✓
Country FE	No	No	✓	✓	✓
Museum FE	No	No	No	✓	✓

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the differences-in-differences results, specified in section 2.5, for artworks created between 1910-1940 from US and EU + UK museums. Standard errors (SE) clustered at the levels specified.

deed the case. In both specifications (*placebo 1921* with a different time-frame (left) and *placebo 1925* with the same time-frame (right)), we estimate a clear continuous function of (log) digitized artworks and creation years. Based on these results, we conclude that our approximated public domain year is not biased against a generic status 'misclassification' problem, and museums (and platforms) are very likely to consider the year 1926 as the relevant approximation year.

## A.2 Useum

We briefly explain the web-scraping process hereafter that was built in order to obtain data from the provider Useum. We first created 'element scroll down' and 'parallel link' selectors in order to address the thousands of museums' websites with a delay of 2 seconds each. In a next step, each of these links were processed and museum-level meta-information (country, followers ...) were stored in a 'csv' file. Subsequently, a second 'element scroll down' selector collected all links of the museums' artworks.

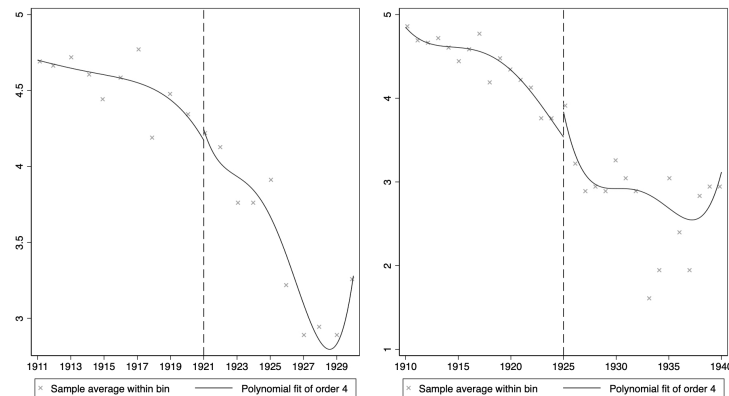


Figure A2: RDD: Digitized Artworks (log) Placebo Years

Note: This figure shows the (log) yearly number of digitized artworks on the US-level and year of artwork creation date. The sample is restricted to years 1910-1930 (left) and 1910 to 1940 (right) and museums in the US. The placebo cut-off year is set at 1921 (left) and 1925 (right). The crosses represent sample average within bin and the line a polynomial fit of order 4. Standard error are clustered at the artist-level.

Similarly, each of these links contained artwork-level information (artist, title, creation year...). The selectors of museum-artwork-links are shown in figure A3 to illustrate the idea of the scraping logic.

The final baseline scraped data set contained three levels of information beginning with the webscraperstarturl and artworklinkhref; on the museum-level: museum\_name; museum\_country; museum\_views; museum\_likes; museum\_follower; museum\_about museum\_url; on the artist-level: artist\_link; artist\_linkhref; artist\_country; artist\_bio; artist\_views; artist\_likes; and on the artwork-level: artwork\_name; artwork\_date; artist\_name; artwork\_description; artwork\_likes; artwork\_views; artwork\_license; artwork\_link; artwork\_download; artwork\_buy.

### A.3 Artnet

More than 340 thousand artists are listed on Artnet. Here, we extract only information relevant to the artist'-level to complement our main data set. The data allow

Table A4: Country Table (overall)

Country	N Artworks	Country	N Artworks
United States	27,934	Greece	145
Netherlands	27,050	Taiwan	95
United Kingdom	17,433	Vatican City	85
Germany	11,970	Serbia	64
France	8,457	Belarus	62
Spain	5,325	Romania	50
Austria	4,462	Ukraine	49
Poland	4,100	Peru	44
Denmark	3,999	Latvia	35
Russia	3,573	Cuba	33
Norway	2,782	China	30
Italy	2,121	Slovenia	20
Belgium	1,766	Azerbaijan	19
Sweden	1,291	South Africa	17
Ireland	1,063	Israel	13
Australia	689	Bulgaria	12
Canada	595	Egypt	10
Argentina	567	Malta	9
Finland	526	Iran	8
Brazil	501	Lithuania	8
Portugal	495	Colombia	5
New Zealand	490	Philippines	5
Hungary	435	Croatia	3
Japan	373	India	3
Estonia	321	Monaco	3
Switzerland	311	South Korea	3
Slovakia	247	Costa Rica	1
Mexico	207	Liechtenstein	1
Czech Republic	156	Malaysia	1
Armenia	151		

Note: This table shows the overall distribution of digitized artworks sorted by countries.

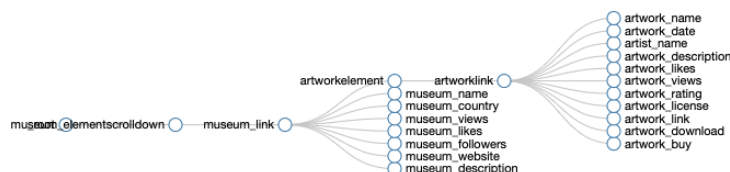


Figure A3: Webscraper Graph

Note: This figure shows the graph of the scraping-process of the webpage Useum (starting from August 18. 2021).

for the construction of more comprehensive information on artists' nationality and year of death as, in some cases, this information was not available from the original

Table A5: Top 20 Venue and Artist Table (overall)

Top Museum Venue	N	Top Artist	N
jksmuseum.nl/en	17,731	Peter Paul Rubens	692
pinakothek.de/en	7,749	Edvard Munch	657
metmuseum.org	6,188	Anthony van Dyck	605
nationaltrust.org.uk	5,240	Auguste Renoir	543
rct.uk	3,513	Claude Monet	517
smk.dk	3,255	Vincent van Gogh	510
museodelprado.es/en	3,019	Rembrandt	503
mnw.art.pl/en	2,934	Jean-Baptiste-Camille Corot	458
culturalheritageagency.nl/en/cultural-h	2,759	James Tissot	455
hermitagemuseum.org	2,641	Leo Gestel	430
belvedere.at	2,247	Paul Cézanne	403
khm.at/en	1,976	David Teniers the Younger	400
npg.org.uk	1,864	Camille Pissarro	363
nasjonalmuseet.no/en/	1,844	John Singer Sargent	325
tate.org.uk/visit/tate-britain	1,836	Jan Ciagliński	324
dia.org	1,746	Jozef Israëls	323
mfa.org	1,741	J M W Turner	294
amsterdammuseum.nl/en	1,739	Lucas Cranach the Elder	287
britishart.yale.edu	1,727	Jan van Goyen	269
louvre.fr/en	1,380	Jan Brandes	264

Note: This table shows the overall top-20 museum venues (link) and artist names.

data source. If available, we match the list of artists from Artnet based on a non-fuzzy text-matching process (i.e. we only used the exact name and surname match) and identify 86'519 artists' nationalities and 72'709 death years from the unbalanced *Useum* data set ( $n = 130'223$ ).

#### A.4 Google reverse image search

In this subsection, we explain the data collection process for the 'reverse google image search'. This required several steps, each of it with some error-potential for search results. First of all, in order to search for google-images one need a detailed URL link to the image (i.e. the .JPG URL and not the corresponding Wikimedia-page). Based on the artwork-links listed on *Useum*, we therefore constructed an automated web-scrapers in *Python* and the selenium web-driver that opened each of the artwork image webpages and searched for the '.JPG' link of the artwork. We also manually

Table A6: External Validity of Data: Manual inspection for selected museums and GitHub repositories by US museums, creation year 1910-1940

Museum	Observed Data on Useum	Information for selected museums websites and GitHub repositories	≈ %
metmuseum.org	358 artworks, 27% post 1926	Filter by 1900-present on museum website: 4.773 results (paintings), with 2.9% open access (139 artworks). Their collection data on GitHub brings up a total of 1,021 paintings for the exact period 1910 to 1940, with 43% created after 1926. For 56% of the total paintings in the overall period the data also provides for a wiki data url. Only 10(2) paintings in the pre(post) 1926 period are classified as public domain.	35%
imamuseum.org	117 artworks, 30% post 1926	1088 objects 20th CE (all objects, including e.g. textile art) on the museum website. Sample of post 1926: "This image is not available online larger than a thumbnail to protect the copyright of its creator(s)". Their collection data on GitHub brings up a total of 364 paintings for the exact period 1910 to 1940, with 39% created after 1926. For 55% of the total paintings an image url is provided. Only 77(9) paintings in the pre(post) 1926 period are classified as public domain, all other relate rights to artists and artist estates.	32%
barnesfoundation.org	87 artworks, 0 post 1926	358 Results paintings found between 1910-1940. 16% post 1926. 3 in public domain, all other copyright restricted access, not downloadable or not shareable. Mid-image resolution.	18%
guggenheim.org	81 artworks, 23% post 1926	For artworks from the 1920ies, 115 artworks are available. Low resolution, potentially downloadable.	nA
mfa.org	72 artworks, 3% post 1926	466 artworks online between 1910-1940. Download option also for post 1926 artworks possible in low-resolution. High resolution request \$50.	15%
nga.gov	61 artworks, 10% post 1926	452 paintings between 1910-1940 (408 with images). Of which 198 post 1926, 3 paintings with download option.	13%
moma.org	60 artworks, 20% post 1926	597 (527) paintings between 1910-1940 listed on museum website (GitHub). 331 (283) post 1926 on museum website (GitHub). Mid-level resolution, no download option on museum website. 91% of total period with thumbnail url on GitHub, 92% for post 1926.	11%
slam.org	59 artworks, 15% post 1926	170 paintings 1900-present. Potential download option in low-resolution, also for post-1926 artworks.	min. 34%
artgallery.yale.edu	51 artworks, 6% post 1926	2740 paintings 20th century. Post 1926 paintings available. Selected sample all thumbnails only.	nA
artic.edu	44 artworks, 20% post 1926	423 paintings between 1910-1940. 28 paintings are in public domain.	10%
harvardart museums.org	43 artworks, 0% post 1926	2087 paintings 20th century. All post 1926 creation date samples non-downloadable thumbnails or "no image available".	nA
dma.org	36 artworks, 3% post 1926	3228 objects on museum website (all objects 20th CE). All samples of post 1926 objects in low-resolution and no download option. Their collection data on GitHub brings up a total of 171 paintings for the exact period 1910 to 1940, with 60% created after 1926. For 96% of the total paintings an thumbnail image url is provided. Only 40(13) paintings in the pre(post) 1926 period are classified as public domain, 3(11) are held under non-exclusive license, all other relate rights to artists and artist estates.	21%
npg.si.edu	34 artworks, none post 1926	Their collection data on GitHub brings up a total of 239 paintings for the exact period 1910 to 1940, with 50% created after 1926. For 96% of the total paintings an image url is provided, some of which are thumbnail or low resolution only.	14%
crystalbridges.org	19 artworks, none post 1926	292 paintings on museum website (1910-present). Low-mid image resolution. Their collection data on GitHub brings up a total of 62 paintings for the exact period 1910 to 1940, with 58% created after 1926.	30%
...	...	...	...

External Validity of Data: Manual inspection for selected museums and GitHub repositories by US museums, creation year 1910-1940 (continued)

Museum	Observed Data on Useum	Information for selected museums websites and GitHub repositories	≈ %
...	...	...	...
clevelandart.org	19 artworks, 10% post 1926	234 paintings between 1910-1940 as listed in GitHub collection, 45% are post 1926. 28(2) paintings from the pre(post) 1926 periods are available under a CC0 license and provide for an image/jpg url. Of those created in the pre(post) 1926 periods, classified as under copyright and that hold a data entry on right ownership, 17(34)% refer to the Artists Right Society (ARS) as the owner/representative, all others refer to artist estates. 72(69)% of copyrighted works for each period do not have an ownership entry on GitHub.	8%
americanart.si.edu	8 artworks, 25% post 1926	Unknown # artworks on website. Sample post 1926 available in high-resolution, download option. Non-commercial reuse permitted, up to \$200 fees for other types of use here. Their collection data on GitHub brings up a total of 1,303 paintings for the exact period 1910 to 1940, with 71% created after 1926. For 96% of the total paintings an image url is provided.	0-1%

Note: The summary table lists notes on observed Useum data and manual inspection of selected US museum online collections and GitHub repositories (e.g. <https://github.com/american-art/>), searched for "paintings" and artwork creation years 1910-1940, where applicable. Last column indicates the ≈ percentage of the online collection we observe. Last website accessed: September 2022.

checked for the quality of the search results by inspecting the .JPG image and if it corresponded to the URL page. This was of high quality for the Wikipedia pages (where 93 percent of original link-source originated from). Unfortunately, as some of the remaining webpages (e.g. a museum webpage) also cross-linked other (JPG) images on the artwork-page, we manually curated the .JPG ending to the corresponding artwork of interest. In some cases, the browser automated framework opened an old, broken or non-correct artwork-link. In most of the cases, this lead to an 'error'- link and we excluded the results from this query.

Next, we made use of the Google image search (by URL) function which allows users to find related images. For our research purpose, we only focused on 'Pages that include matching images', and not 'Visually similar images' results, see for an example this [Link] search query. More information of a reverse image search can be found here [Link] or there [Link]. This step was automated with a cloud-based

webscraper, emulating a human search, that extracted each of the search result domains. In order to not trigger a DDOS attack pattern, one can randomly change time intervals between the search queries, and the webscraper is capable of detecting CAPTCHA is served by a website and automatically resumed scraping using different IP addresses. Also here, we manually checked the search results to better understand if we extracted all possible links of the search queries.

To further illustrate the data collection process, we provide an example for an individual artwork. We observe on an artwork by Henry Ossawa Tanner created in 1913 on Useum, which gives us the reference to the artwork as hosted on Wikimedia. Next, we search for the URL to the .JPG Image, and query the URL on the 'Google reverse image search engine'. We collect all links from search results obtained, and can track reuses of the same exact image on various commercial or non-commercial websites, as shown here [Link]. This process is automated and repeated for all the artworks contained in our US sample.

This data collection has limitations and bears potential risks for errors. For example, the .JPG link of the digital image we find might not reveal a direct link to the original artwork. So, in some instances, the link refers to a thumbnail of another artwork appearing on the same webpage, which eventually links to another artwork, and so Google searches would return URLs of downstream reuse of that artwork. However, for the vast majority of images, we can observe a Wikimedia link of 'good quality', with relatively 'clean' underlying metadata on artworks and direct links. This makes us confident that the data obtained does not suffer from systematic errors.

Eventually, to check the quality of our google reverse image search, we investigated for the duplicates of the google results in our data. If we find many duplicates,

this could hint towards a wrong JPG URL source, and as a result, the google image searched for will provide incorrect results. On the one hand, an example for such a incorrect results (that we excluded) was that the original artwork link led (incorrectly) to the main museum page. As a result, the JPG URL search found an incorrect image on the main page, and the google image search was repeated several times for the very same (incorrect) image. On the other hand, in most of the cases, duplicates of google search results can also be correct, as results directed to e.g. an 'overview' page that listed several artwork images we searched for. An example is the Wikidata sum of all paintings of the Yale University Art Gallery collection, the Wikimedia list of paintings by Paul Klee, and a myriad number of commercial vendors of art-prints. Overall, we observe the large share of 77 percent of unique Google links, and 95 percent of links appear at a maximum three times in our data set. If we apply a *very* conservative standard of uniqueness of data, we can be confident that at least in 95 percent of our downstream data we can be sure that we found the correct start-image URL and the corresponding 'correct' google reverse image search results.

Overall, we started with a list of 1594 artworks from *Useum*, and obtained for 1349 unique artworks functioning direct .JPG URLs with a total of 88'607 upstream- and downstream-uses and artwork average (median) uses of 66 (42) pages.

# Bibliography

- AAMD (2017). Guidelines for the use of copyrighted materials and works of art by art museums, url: <https://aamd.org/sites/default/files/document/guidelines>. last retrieved: 27 nov. 2023.
- Adermon, A. and Liang, C.-Y. (2010). Piracy, music, and movies: A natural experiment. working paper.
- Adler, A. (2016). Fair use and the future of art. NYUL Rev., 91:559.
- Adler, A. (2018). Why art does not need copyright. Geo. Wash. L. Rev., 86:313.
- Agarwal, P. (2017). Appropriation art: Copyright infringement or fair use? Indian Journal of Intellectual Property Law, 8:61–90.
- Agnello, R. J. and Pierce, R. K. (1996). Financial returns, price determinants, and genre effects in american art investment. Journal of Cultural Economics, 20(4):359–383.
- Aguiar, L. and Waldfogel, J. (2016). Even the losers get lucky sometimes: New products and the evolution of music quality since napster. Information Economics and Policy, 34:1–15.
- Aguiar, L. and Waldfogel, J. (2018a). As streaming reaches flood stage, does it stimulate or depress music sales? International Journal of Industrial Organization, 57:278–307.
- Aguiar, L. and Waldfogel, J. (2018b). Netflix: global hegemon or facilitator of frictionless digital trade? Journal of Cultural Economics, 42(3):419–445.
- Aguiar, L. and Waldfogel, J. (2018c). Quality predictability and the welfare benefits from new products: Evidence from the digitization of recorded music. Journal of Political Economy, 126(2):492–524.
- American Alliance of Museums (2014). <https://www.aam-us.org/wp-content/uploads/2018/01/digital-copyright-and-privacy.pdf>. last accessed 22.05.23.

- Ames, E. K. (1993). Beyond rogers v. koons: A fair use standard for appropriation. Columbia Law Review, 93(6):1473–1526.
- Amsellem, R. (2013). International touring exhibitions: Toward a profitable business model for exhibitions? The Journal of Arts Management, Law, and Society, 43(1):36–57.
- Angrist, J. D. and Pischke, J.-S. (2008). Mostly harmless econometrics: An empiricist’s companion. Princeton university press.
- Artist-Info (2021). Artist-info. url: <https://www.artist-info.com>. retrieved 12.04.21.
- Artnet (2017). Artnet news. url: <https://news.artnet.com/art-world/jeff-koons-pompidou-lose-copyright-infringement-case-887324>. retrieved 16.11.20.
- Artnet (2021). Artnet. url: <http://www.artnet.com/artists/sturtevant/>. retrieved 05.01.21.
- ArtNews (2014). Artnews url: <https://www.artnews.com/art-in-america/features/landmark-copyright-lawsuit-cariou-v-prince-is-settled-59702/>. last visited 12.01.21.
- Artnews (2017). The pictures generation artnews. url: <https://www.artnews.com/art-in-america/features/photo-play-63269/>. retrieved 20.12.2021.
- Artprice (2020). Artprice database. url: <https://artprice.com>. retrieved 20. march 2020.
- Artsy (2019). The art genome project. url: <https://www.artsy.net/about/the/art-genome-project> and <https://www.artsy.net/categories>. retrieved 21.10.19.
- Artsy (2020). The art genome project. url: <https://developers.artsy.net/v2/docs/artists>. retrieved 20. march 2020.
- Artsy (2021). The art genome project. url: <https://www.artsy.net/categories>. last visited 05.01.2021.
- Ashenfelter, O. and Graddy, K. (2003). Auctions and the price of art. Journal of Economic Literature, 41(3):763–787.
- Ashenfelter, O. and Graddy, K. (2006). Art auctions. Handbook of the Economics of Art and Culture, 1:909–945.
- Ashenfelter, O. and Graddy, K. (2011). Sale rates and price movements in art auctions. American Economic Review, 101(3):212–16.
- Aufderheide, P., Jaszi, P., Bello, B., and Milosevic, T. (2014). Copyright, permissions, and fair use among Visual artists and the academic and museum visual arts communities: An issues report. College art association.

- 
- Autor, D. H. (2003). Outsourcing at will: The contribution of unjust dismissal doctrine to the growth of employment outsourcing. Journal of labor economics, 21(1):1–42.
- Baker, A. C., Larcker, D. F., and Wang, C. C. (2022). How much should we trust staggered difference-in-differences estimates? Journal of Financial Economics, 144(2):370–395.
- Bakhshi, H. and Throsby, D. (2014). Digital complements or substitutes? a quasi-field experiment from the royal national theatre. Journal of Cultural Economics, 38(1):1–8.
- Banternghansa, C. and Graddy, K. (2009). The impact of the droit de suite in the uk: An empirical analysis. C.E.P.R. Discussion Papers, CEPR Discussion Papers, 35.
- Banternghansa, C. and Graddy, K. (2011). The impact of the droit de suite in the uk: an empirical analysis. Journal of cultural economics, 35(2):81–100.
- Becker, G. S., Landes, W. M., and Murphy, K. (2000). The social market for the great masters and other collectibles. Social Economics: Market Behavior in a Social Environment.
- Beebe, B. (2008). An empirical study of u.s. copyright fair use opinions, 1978-2005. University of Pennsylvania Law Review, 156:549–624.
- Beggs, A. and Graddy, K. (2009). Anchoring effects: Evidence from art auctions. American Economic Review, 99(3):1027–39.
- Benhamou, Y. (2017). Posthumous replications: Rights and limitations, notion of original and copies. Kunst & Recht, pages 149–168.
- Benhamou, Y. (2018). Revised report on copyright practices and challenges of museums. Available at SSRN 3449290.
- Bertacchini, E. and Morando, F. (2013). The future of museums in the digital age: New models for access to and use of digital collections. International journal of arts management, 15(2):60–72.
- Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How Much Should We Trust Differences-In-Differences Estimates?\*. The Quarterly Journal of Economics, 119(1):249–275.
- Biasi, B. and Moser, P. (2016). Effects of copyrights on science: Evidence from the wwii book republication program. American Economic Journal: Microeconomics.
- Biasi, B. and Moser, P. (2021). Effects of copyrights on science: Evidence from the wwii book republication program. American Economic Journal: Microeconomics, 13(4):218–60.

- Bitton, M. (2011). Modernizing copyright law. Tex. Intell. Prop. LJ, 20:65.
- Borowiecki, K. J. and Navarrete, T. (2017). Digitization of heritage collections as indicator of innovation. Economics of Innovation and New Technology, 26(3):227–246.
- Borusyak, K. and Jaravel, X. (2017). Revisiting event study designs. Available at SSRN 2826228.
- Borusyak, K., Jaravel, X., and Spiess, J. (2021). Revisiting event study designs: Robust and efficient estimation. arXiv preprint arXiv:2108.12419.
- Buccafusco, C., Bechtold, S., and Sprigman, C. J. (2017). The nature of sequential innovation. Wm. & Mary L. Rev., 59:1.
- Buccafusco, C. and Heald, P. J. (2013). Do bad things happen when works enter the public domain?: Empirical tests of copyright term extension. Berkeley Technology Law Journal, pages 1–43.
- Calabresi, G. (1960). Some thoughts on risk distribution and the law of torts. Yale Lj, 70:499.
- Cattaneo, M. D., Idrobo, N., and Titiunik, R. (2019). A practical introduction to regression discontinuity designs: Foundations. Cambridge University Press.
- Clarke, D. and Schythe, K. (2020). Implementing the panel event study.
- Coase, R. H. (1960). The problem of social cost. Journal Law and Economic, 3:144.
- Coase, R. H. (1972). Durability and monopoly. The Journal of Law and Economics, 15(1):143–149.
- Correia, S. (2019). Reghdfe: Stata module to perform linear or instrumental-variable regression absorbing any number of high-dimensional fixed effects.
- Correia, S., Guimarães, P., and Zylkin, T. (2020). Fast poisson estimation with high-dimensional fixed effects. The Stata Journal, 20(1):95–115.
- Cuntz, A. and Sahli, M. (2023). Intermediary liability and trade in follow-on innovation. Journal of Cultural Economics, pages 1–42.
- Danaher, B., Smith, M. D., and Telang, R. (2017). Copyright enforcement in the digital age: Empirical evidence and policy implications. Commun. ACM, 60(2):68–75.
- De Chaisemartin, C. and d’Haultfoeulle, X. (2020). Two-way fixed effects estimators with heterogeneous treatment effects. American Economic Review, 110(9):2964–2996.

- 
- De la Barre, M., Docclo, S., and Ginsburgh, V. (1994). Returns of impressionist, modern and contemporary european paintings 1962-1991. Annales d’Economie et de Statistique, pages 143–181.
- De Silva, D. G., Kosmopoulou, G., Pownall, R. A., and Press, R. (2022). Posthumous trading patterns affecting artwork prices. Oxford Economic Papers, 74(2):453–472.
- Depoorter, B. (2008). Technology and uncertainty: the shaping effect on copyright law. U. Pa. L. Rev., 157:1831.
- Depoorter, B., Menell, P., and Schwartz, D. (2019). Research Handbook on the Economics of Intellectual Property Law: Vol 1: Theory Vol 2: Analytical Methods, volume 1. Edward Elgar Publishing.
- Depoorter, B. and Parisi, F. (2002a). Fair use and copyright protection: a price theory explanation. International Review of Law and Economics, 21(4):453–473. 17th Annual Conference of the European Association of Law Economics, Ghent, Belgium, September 2000.
- Depoorter, B. and Parisi, F. (2002b). Fair use and copyright protection: a price theory explanation. International Review of Law and Economics, 21(4):453–473.
- Ekelund, R. B., Ressler, R. W., and Watson, J. K. (2000). The “death-effect” in art prices: A demand-side exploration. Journal of Cultural Economics, 24(4):283–300.
- Erickson, K., Perez, F. R., and Perez, J. R. (2018). What is the commons worth? estimating the value of wikimedia imagery by observing downstream use. In Proceedings of the 14th International Symposium on Open Collaboration, pages 1–6.
- Etro, F. and Stepanova, E. (2021). Art return rates from old master paintings to contemporary art. Journal of Economic Behavior & Organization, 181:94–116.
- Evans, D. (2009). Appropriation. Mit Press.
- Farrell, J., Hayes, J., Shapiro, C., Sullivan, T., Ganglmair, B., Froeb, L., Werden, G., Lemley, M., Shapiro, C., and Elhauge, E. (2007). Do patent holdup and royalty stacking lead to systematically excessive royalties? supra, 74(47):603.
- Fernandez-Blanco, V. and Prieto-Rodríguez, J. (2020). Museums. In Handbook of Cultural Economics, Third Edition. Edward Elgar Publishing.
- Flynn, J., Giblin, R., and Petitjean, F. (2019). What happens when books enter the public domain?: Testing copyright’s under use hypothesis across australia, new zealand, the united states and canada. University of New South Wales Law Journal, The, 42(4):1215–1253.

- Fraiberger, S. P., Sinatra, R., Resch, M., Riedl, C., and Barabási, A.-L. (2018). Quantifying reputation and success in art. Science, 362(6416):825–829.
- Francis, J. (2014). On appropriation: Cariou v. prince and measuring contextual transformation in fair use. Berkeley Tech. LJ, 29:681.
- Galenson, D. (2006). Artistic capital. Routledge.
- Galenson, D. (2009a). Conceptual revolutions in twentieth-century art. Working Paper 15073, National Bureau of Economic Research.
- Galenson, D. W. (2009b). Old masters and young geniuses: The two life cycles of human creativity. Journal of Applied Economics, 12(1):1–9.
- Galenson, D. W. (2010). Understanding creativity. Journal of Applied Economics, 13(2):351–362.
- Galenson, D. W. and Lenzu, S. (2016). Pricing genius: The market evaluation of innovation. Journal of applied economics, 19(2):219–248.
- Gans, J. S. (2015). Remix rights and negotiations over the use of copy-protected works. International Journal of Industrial Organization, 41:76–83.
- Geiger, C. (2020). Geiger, fair use through fundamental rights in europe, the cambridge handbook of copyright limitations and exceptions.
- Gerhardt, D. R. (2011). Copyright publication: An empirical study. Notre Dame L. Rev., 87:135.
- Gifford, C. N. (1999). The sonny bono copyright term extension act. U. Mem. L. Rev., 30:363.
- Gilden, A. (2019). The social afterlife. Harv. JL & Tech., 33:329.
- Ginsburg, J. C., Gordon, W. J., Miller, A. R., and Patry, W. F. (2000). The constitutionality of copyright term extension: How long is too long? Cardozo Arts & Ent. LJ, 18:651–701.
- Ginsburgh, V. (2005). The economic consequences of droit de suite in the european union. Forthcoming Economic Analysis and Policy.
- Ginsburgh, V. et al. (2005). Droit de suite. an economic viewpoint. The modern and contemporary art market, pages 45–53.
- Ginsburgh, V. and Jeanfils, P. (1995). Long-term comovements in international markets for paintings. European Economic Review, 39(3-4):538–548.
- Giorcelli, M. and Moser, P. (2020). Copyrights and creativity: Evidence from italian opera in the napoleonic age. Journal of Political Economy, 128(11):4163–4210.

- 
- Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. Journal of Econometrics, 225(2):254–277.
- Gordon, W. J. (1982). Fair use as market failure: A structural and economic analysis of the betamax case and its predecessors. J. Copyright Soc’y USA, 30:253.
- Graddy, K. and Lieberman, C. (2018). Death, bereavement, and creativity. Management science, 64(10):4505–4514.
- Green, J. R. and Scotchmer, S. (1995). On the division of profit in sequential innovation. The RAND Journal of Economics, 26(1):20–33.
- Greenstein, S., Goldfarb, A., and Tucker, C., editors (2013). The Economics of Digitization. Edward Elgar Publishing.
- Guehenno, C. (2009). Recent development online. FORDHAM L. REV., 2537:2546.
- Handke, C. (2011). Economic effect of copyright: The empirical evidence so far. Report for the National Academies of the Science, Rotterdam.
- Handke, C. (2012). A taxonomy of empirical research on copyright-how do we inform policy? Review of Economic Research on Copyright Issues, 9(1):47–92.
- Hatch, O. G. (1989). Better late than never: Implementation of the 1886 berne convention. Cornell Int’l LJ, 22:171.
- Heald, P., Erickson, K., and Kretschmer, M. (2015). The valuation of unprotected works: a case study of public domain images on wikipedia. Harv. JL & Tech., 29:1.
- Heald, P. J. (2007). Property rights and the efficient exploitation of copyrighted works: An empirical analysis of public domain and copyrighted fiction bestsellers. Minn. L. Rev., 92:1031.
- Heald, P. J. (2009). Does the song remain the same-an empirical study of bestselling musical compositions (1913-1932) and their use in cinema (1968-2007). Case W. Res. L. Rev., 60:1.
- Heald, P. J. (2014). How copyright keeps works disappeared. Journal of Empirical Legal Studies, 11(4):829–866.
- Heald, P. J. (2019). The effect of copyright law on access to works. In Research Handbook on the Economics of Intellectual Property Law, pages 605–615. Edward Elgar Publishing.
- Heald, P. J. (2020). The impact of implementing a 25-year reversion/termination right in canada. J. Intell. Prop. L., 28:63.

- Heald, P. J., Shi, P., Stoiber, J., and Zheng, Q. (2012). More music in movies: what box office data reveals about the availability of public domain songs in movies from 1968-2008. Review of Economic Research on Copyright Issues, 9(2):31–54.
- Hecker, S. and Karol, P. J. (2022). Posthumous Art, Law and the Art Market: The Afterlife of Art. Routledge.
- Imbens, G. W. and Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. Journal of econometrics, 142(2):615–635.
- Irvin, S. (2005). Appropriation and authorship in contemporary art. The British Journal of Aesthetics, 45(2):123–137.
- Kizhner, I., Terras, M., Rumyantsev, M., Khokhlova, V., Demeshkova, E., Rudov, I., and Afanasieva, J. (2021). Digital cultural colonialism: measuring bias in aggregated digitized content held in google arts and culture. Digital Scholarship in the Humanities, 36(3):607–640.
- Kretschmer, T. and Peukert, C. (2014). Video killed the radio star? online music videos and digital music sales. CEP Discussion Papers, (1265).
- Kretschmer, T. and Peukert, C. (2020). Video killed the radio star? online music videos and recorded music sales. Information Systems Research, 31(3):776–800.
- Landes, W. and Lichtman, D. (2003). Indirect Liability for Copyright Infringement: Napster and Beyond. Journal of Economic Perspectives, 17(2):113–124.
- Landes, W. M. (2000). Copyright, borrowed images, and appropriation art: An economic approach. Geo. Mason L. Rev., 9:1.
- Landes, W. M. and Levine, D. B. (2006). The economic analysis of art law. Handbook of the economics of art and culture, 1:211–251.
- Landes, W. M. and Posner, R. A. (1989). An economic analysis of copyright law. The Journal of Legal Studies, 18(2):325–363.
- Landes, W. M. and Posner, R. A. (2003). Indefinitely renewable copyright. U. Chi. L. Rev., 70:471.
- Landes, W. M., Posner, R. A., et al. (2003). The economic structure of intellectual property law. Harvard university press.
- Lax Martínez, G., Raffo, J., and Saito, K. (2016). Identifying the gender of pct inventors. WIPO Economic Research Working Papers 33, World Intellectual Property Organization - Economics and Statistics Division.
- Lee, D. S. and Lemieux, T. (2010). Regression discontinuity designs in economics. Journal of economic literature, 48(2):281–355.

- 
- Li, X., MacGarvie, M., and Moser, P. (2018). Dead poets' property—how does copyright influence price? The RAND Journal of Economics, 49(1):181–205.
- Li, Y., Ma, X., and Renneboog, L. (2022). In art we trust. Management Science.
- Liebowitz, S. J. and Margolis, S. (2004). Seventeen famous economists weigh in on copyright: The role of theory, empirics, and network effects. Harv. JL & Tech., 18:435.
- Liu, J. (2019). An empirical study of transformative use in copyright law. Stan. Tech. L. Rev., 22:163.
- Lucas, A. and Ginsburg, J. (2016). Copyright, freedom of expression and free access to information (comparative study of american and european law). RIDA, 249.
- Maddison, D. and Jul Pedersen, A. (2008). The death effect in art prices: evidence from denmark. Applied Economics, 40(14):1789–1793.
- Marciano, A. (2012). Guido calabresi's economic analysis of law, coase and the coase theorem. International Review of Law and Economics, 32(1):110–118. The Economics of Efficiency and the Judicial System.
- Martin, S. M. (1985). Museum copyright licensing agreements and visual artists. Colum.-VLA JL & Arts, 10:421.
- Martínez, G. L., de Juano-i Ribes, H. S., Yin, D., Le Feuvre, B., Hamdan-Livramento, I., Saito, K., and Raffo, J. (2021). Expanding the world gender-name dictionary: Wgnd 2.0.
- McAllister, B. (1998). <https://www.washingtonpost.com/archive/politics/1998/10/15/a-capital-way-to-stop-a-headache/386a62d8-21fa-4f87-94ff-2c0ffc73f3e4>. a capital way to stop a headache. last retrieved oct. 24, 2023.
- McAndrew, C. (2019). Global art market report, art basel and ubs, basel. url: <https://theartmarket.artbasel.com/> . last retrieved nov. 27 2023.
- McAndrew, C. (2023). The art basel and ubs global art market report. url: <https://theartmarket.artbasel.com/> . last retrieved nov. 27 2023. Basel: Art Basel.
- McLeod, K. and DiCola, P. (2011). Creative license: The law and culture of digital sampling. Duke University Press.
- Mei, J. and Moses, M. (2001). Art as an investment and the underperformance of masterpieces: Evidence from 1875-2000. American Economic Review, pages 1–37.
- Mei, J., Moses, M., and Zhou, Y. (2022). Residual variance and asset pricing in the art market. Journal of Cultural Economics, pages 1–33.

- Menell, P. S. (2002). Envisioning copyright law's digital future. NYL Sch. L. Rev., 46:63.
- MET (2021). Met url: <https://www.metmuseum.org/art/collection/search/267214>. last visited 06.01.21.
- Murray, F. and O'Mahony, S. (2007). Exploring the foundations of cumulative innovation: Implications for organization science. Organization Science, 18(6):1006–1021.
- Nagaraj, A. (2016). Does copyright affect reuse? evidence from the google books digitization project. Evidence from the Google Books Digitization Project (May 8, 2016).
- Nagaraj, A. (2018). Does copyright affect reuse? evidence from google books and wikipedia. Management Science, 64(7):3091–3107.
- NewYorkTimes (2011). <https://www.nytimes.com/2012/01/01/arts/design/richard-prince-lawsuit-focuses-on-limits-of-appropriation.html?pagewanted=all>. last retrieved 27. nov. 2023.
- NewYorkTimes (2023). Ruling against warhol shouldn't hurt artists. but it might. url: <https://www.nytimes.com/2023/05/19/arts/design/warhol-prince-supreme-court-copyright.html>. last retrieved 27. nov. 2023.
- Nguyen, G. D., Dejean, S., and Moreau, F. (2014). On the complementarity between online and offline music consumption: the case of free streaming. Journal of Cultural Economics, 38:315–330.
- Oberholzer-Gee, F. and Strumpf, K. (2007). The effect of file sharing on record sales: An empirical analysis. Journal of political economy, 115(1):1–42.
- Okpaluba, J. (2002). Appropriation art: Fair use or foul? Cutting Across Media: Appropriation Art, Interventionist Collage, and Copyright Law.
- Pénasse, J., Renneboog, L., and Scheinkman, J. A. (2021). When a master dies: Speculation and asset float. The Review of Financial Studies, 34(8):3840–3879.
- Pesando, J. (1993). Art as an investment: The market for modern prints. American Economic Review, 83(5):1075–89.
- Phillips (2021). Phillips. url: <https://www.phillips.com/article/13963582/re-contextualizing-commercialism-richard-prince-s-cowboy-series>. retrieved 05.01.21.
- Pommerehne, W. W. and Feld, L. P. (1997). The impact of museum purchase on the auction prices of paintings. Journal of Cultural Economics, 21:249–271.

- 
- Posner, R. A. (1972). *Economic analysis of law* (boston. MA: Little.
- Posner, R. A. (1992). When is parody fair use? *The Journal of Legal Studies*, 21(1):67–78.
- Posner, R. A. (2004). Transaction costs and antitrust concerns in the licensing of intellectual property. *J. Marshall Rev. Intell. Prop. L.*, 4:i.
- Reimers, I. (2019). Copyright and generic entry in book publishing. *American Economic Journal: Microeconomics*, 11(3):257–84.
- Rob, R. and Waldfogel, J. (2006). Piracy on the high c's: Music downloading, sales displacement, and social welfare in a sample of college students. *The Journal of Law and Economics*, 49(1):29–62.
- Rob, R. and Waldfogel, J. (2007). Piracy on the silver screen. *The Journal of Industrial Economics*, 55(3):379–395.
- Roth, J. (2019). Pre-test with caution: Event-study estimates after testing for parallel trends. *Department of Economics, Harvard University, Unpublished manuscript.*
- Rub, G. A. (2021). The challenges of posthumous moral rights. In *Posthumous Art, Law and the Art Market*, pages 21–31. Routledge.
- Sag, M. (2012). Predicting fair use. *SSRN Electronic Journal.*
- Sarmiento, S. M. and Haaften-Schick, L. v. (2013). *Cariou v. prince: Toward a theory of aesthetic-judicial judgments.* *Tex. A&M L. Rev.*, 1:941.
- Schaumann, N. (2015). Fair use and appropriation art. *Cybaris Intell. Prop. L. Rev.*, 6:112.
- Schmidheiny, K. and Siegloch, S. (2019). On event study designs and distributed-lag models: Equivalence, generalization and practical implications. *CESifo Working Paper.*
- Scotchmer, S. (1991). Standing on the shoulders of giants: Cumulative research and the patent law. *Journal of Economic Perspectives*, 5(1):29–41.
- Shortland, A. and Shortland, A. (2020). Governance under the shadow of the law: trading high value fine art. *Public Choice*, 184.
- Stern, C. E. (2003). A matter of life or death: The visual artists rights act and the problem of postmortem moral rights. *UCLA L. Rev.*, 51:849.
- Subotnik, E. E. (2015). Copyright and the living dead?: Succession law and the postmortem term. *Harv. JL & Tech.*, 29:77.

- Sun, L. (2021). Eventstudyinteract: Stata module to implement the interaction weighted estimator for an event study.
- Sun, L. and Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. Journal of Econometrics, 225(2):175–199.
- Sutton, M. (2016). <https://www.eff.org/deeplinks/2016/02/murky-waters-international-copyright-law>. last retrieved nov. 19, 2023.
- Tate (2021). Tate url: <https://www.tate.org.uk/art/art-terms/a/appropriation>. last visited 06.01.21.
- TheDrum (2023). Ad of the day: Mona lisa escapes for a long overdue easyjet holiday. url: <https://www.thedrum.com/news/2023/07/25/ad-the-day-mona-lisa-escapes-and-gets-long-overdue-easyjet-holiday>. last retrieved 28. nov. 2023.
- TheGuardian (2017). <https://www.theguardian.com/artanddesign/2017/oct/22/marcel-duchamps-moustachioed-mona-lisa-sells-for-750000-dollars>. the guardian mona lisa. last retrieved nov. 21, 2023.
- Thomes, T. P. (2013). An economic analysis of online streaming music services. Information Economics and Policy, 25(2):81–91.
- Topaz, C. M., Klingenberg, B., Turek, D., Heggeseth, B., Harris, P. E., Blackwood, J. C., Chavoya, C. O., Nelson, S., and Murphy, K. M. (2019). Diversity of artists in major us museums. PloS one, 14(3):e0212852.
- Towse, R. (2006). Copyright and artists: a view from cultural economics. Journal of economic surveys, 20(4):567–585.
- Towse, R. (2011). What we know, what we don’t know, and what policy-makers would like us to know about the economics of copyright. Review of Economic Research on Copyright Issues, 8(2):101–120.
- Towse, R. (2017). Economics of music publishing: copyright and the market. Journal of Cultural Economics, 41(4):403–420.
- Towse, R. et al. (2001). Creativity, incentive and reward. An economic analysis of copyright and culture in the information age.
- Towse, R., Handke, C., and Stepan, P. (2008). The economics of copyright law: a stocktake of the literature. Review of economic research on copyright issues, 5(1):1–22.
- UNCTAD (2022). Creative economy outlook. url: [https://unctad.org/system/files/official-document/ditctsce2022d1\\_en.pdf](https://unctad.org/system/files/official-document/ditctsce2022d1_en.pdf). unctad. united nations. last retrieved 27. nov. 2023.

- Ursprung, H., Zigova, K., et al. (2021). The ultimate coasian commitment: Estimating and explaining artist-specific death effects. Technical report, ULB–Université Libre de Bruxelles.
- Ursprung, H. W. and Wiermann, C. (2011). Reputation, price, and death: An empirical analysis of art price formation. Economic Inquiry, 49(3):697–715.
- USCO (2006). <https://www.copyright.gov/circs/circ15.pdf>. last retrieved nov. 19, 2023.
- Vickery, G. and Wunsch-Vincent, S. (2006). Digital broadband content: public sector information and content. Organization for Economic Cooperation and Development. Retrieved October, 24:2023.
- Waldfoegel, J. (2012). Copyright protection, technological change, and the quality of new products: Evidence from recorded music since napster. The journal of law and economics, 55(4):715–740.
- Wallace, A. (2022). A culture of copyright. Arts and Humanities Research Council.
- Watson, J. (2017a). Copyright and the production of hip-hop music. Technical report, Working Paper.
- Watson, J. (2017b). What is the value of re-use? complementarities in popular music. Complementarities in Popular Music (September 1, 2017) .NET Institute Working Paper, (17-15).
- Watson, J., MacGarvie, M., and McKeon, J. (2023). It was 50 years ago today: Recording copyright term and the supply of music. Management Science, 69(1):351–376.
- Watt, R. (2009). An empirical analysis of the economics of copyright: how valid are the results of studies in developed countries for developing countries? The Economics of Intellectual Property, page 65.
- Watt, R. et al. (2014). The basic economic theory of copyright. WATT, Richard. Handbook on the Economics of Copyright. Cheltenham, UK: Edward Elgar, pages 9–24.
- Welchman, J. C. (2013). Art after Appropriation: Essays on Art in the 1990s. Routledge.
- Whitaker, A. (2019). Shared value over fair use: Technology, added value, and the reinvention of copyright. Cardozo Arts & Ent. LJ, 37:635.
- WIPO (2021). The economic contribution of the copyright industries. World Intellectual Property Organization Geneva, Switzerland.

## References

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- Wired (2023). The andy warhol copyright case that could transform generative ai. url: <https://www.wired.com/story/andy-warhol-fair-use-prince-generative-ai/>. last retrieved 27. nov. 2023.
- Wu, T. (2004). Copyright's communications policy. Michigan Law Review, 103(2):278–366.