Blockchain, Fractional Ownership, and the Future of Creative Work

Amy Whitaker
Visual Arts Administration
New York University

Roman Kräussl
Luxembourg School of Finance
University of Luxembourg

January 2018
Revised February 2019

ABSTRACT

A core challenge in studying the real return on artists' work is the extreme difficulty accessing private records from when an artwork was first sold and thus relying on public auction data. In addition, artists do not typically receive proceeds after the initial sale. This paper, for the first time, uses archivally sourced primary market records to model returns on art and introduces a novel fractional equity structure for artists. We first model what would happen if the American artists Jasper Johns and Robert Rauschenberg had retained 10% equity in their work when it was first sold. Secondly, we model a portfolio return using data from the Betty Parsons Gallery and the Green Gallery. To add a portfolio analysis to the performance of "star" artists, we model the galleries as a fund invested in all of artworks sold, using auction sales as the realization event. We find that the individual Johns and Rauschenberg works would have vastly outperformed equities markets. The gallery portfolio still substantially outperforms the S&P, even including 20% transaction costs. Beyond the art market, our larger conceptual framework for retained fractional equity has broad implications for compensation of early-stage creative work in any field and for potential applications of blockchain technology.

Keywords: Value creation, art market, creative work, venture funding, property rights, blockchain, fractional equity, resale royalties

I. INTRODUCTION

In 2017, Leonardo da Vinci's *Salvator Mundi* sold for $450.3 million at Christie's New York. The chain of newsworthy, marquee art prices perhaps began in 1980 when Burton and Emily Hall Tremaine sold Jasper Johns' *Three Flags* to the Whitney Museum of American Art for $1 million, back then an astonishing sum, or in 1973 when a Robert Rauschenberg painting sold at auction for $85,000. Artists do not commonly receive any of the gains when their work sells at auction.

Artists and regulators have tried to effect participation in the upside when their work is resold, whether through private contract or resale royalty.[1] This attempt to include aritsts masks a larger problem in art markets: how little we understand about the value of art. Experts appraise single objects and scholars study overall market returns. But to really analyze returns on a collector's investment in art, one must at least know what the collector initially paid for the work. Analogous to a cost basis, this figure is not included in standard methods for the studies of art markets.

Typically studies of the investment returns on art are based on an index of artworks that have sold at auction. Methods of assembling art price indices include repeat sales (Anderson, 1974; Baumol, 1986; Frey and Pommerehne, 1989; Goetzmann, 1993; Mei and Moses, 2002, 2005), hedonic regression (Renneboog and Spaenjers, 2013), and hybrid methods (Korteweg, Kräussl, and Verwijmeren, 2016). These indices bear significant survivorship bias based on the selection of what works go to auction (Burton and Jacobsen, 1999). They also only track intermediary points in an artwork's pricing

[1] In 1971, Seth Siegelaub and Bob Projansky proposed *The Artists Resale* which gave artists fifteen percent of the increase over the prior sales price. Regulatory frameworks for "resale royalties" exist in over seventy jurisdictions including the European Union and grant artists a percentage, typically five to fifteen percent, of the increase in value when the artwork is resold in the secondary market (Petty, 2014; Whitaker, 2018). Resale royalties have been criticized as a subsidy to artists (Rub, 2014) or as a form of interference with price, however with limited observable effect on art markets (Banternghansa and Graddy, 2011).

history, that is, only once the artwork is already introduced into the secondary market. In contrast, a fractional ownership model would track the financial trajectory of an artwork from its first point of sale.

Although some fields such as book publishing, film, and music lend themselves to royalties because the creative work exists in multiple equal copies, our suggested model offers a new way of thinking about pay for creative work that could apply in those fields as well. We suggest recognizing creative workers as co-investors alongside the patrons, collectors, clients, and employers who purchase their work. Such a scheme transforms and democratizes not only access to art markets but much broader and less industry-specific access to a share in the future value one's work helps to create.

This approach opens up a new field of research by framing art market analysis as part of the study of creative labor. Our work generalizes to solve numerous practical and challenging theoretical problems in management sciences more broadly by offering ways of modeling hybrid rent/investment, or wage/property-right pay in the gig economy. We may come to see the payment of salary as anachronistic, and want to give all workers in value-creating jobs some fractional equity in the value they create. Beyond the art market, this study shows the inability of a static price to capture the risks taken in making early-stage creative work in many other fields.

II. APPROACH

Using historical primary market sales prices and corresponding secondary market auction results, we study initial sales records for both individual artists and whole galleries. First, we model what would have happened if the American artists Robert Rauschenberg

(1925–2008) and Jasper Johns (b. 1930) had retained ten percent equity in their work when it was sold via the eponymous Leo Castelli Gallery between 1958 and 1963. This time period covers the start-up phase of the artists' careers and of the gallery which Castelli founded in 1957.[2] We combine publically available auction data with private sales information culled from the Leo Castelli papers at the *Archives of American Art*, in Washington, D.C. (see Appendix). We corroborate those archival materials using other sources, including the Jasper Johns' "catalogue raisonné," which is the definitive and complete listing of the artist's body of work, and the Robert Rauschenberg Foundation's online archive.

We hypothesize that the artists would be better off foregoing some payment when their work is first sold in exchange for this retained equity, even considering the opportunity cost to the artist of having retained equity in artworks that did not resell at public auction.[3] To test this assumption, we add to our study of individual artworks a portfolio analysis that accounts for works the artists sold that did not later have realization events at auction. In our sample, many artworks did not resell at auction because they resold privately or in many cases were donated to art museums. Our inclusion only of auction sales is thus conservative.

Although some works in our sample were sold at auction a second time, we limit our study of retained equity in the individual artworks to the first auction resale. We reason that a simplified contract in which an artist retains equity would have the artist automatically cash in equity at first public resale. We separately consider repeat sales

[2] The choice of Johns and Rauschenberg specifically derives from data availability. The Castelli Gallery sales invoices are held by the family and are not yet included in the archives. Both artists were included in a group show in 1957 and had their first solo shows at the gallery in 1958.

[3] We note that our analysis ignores both carrying costs of owning art, i.e., insurance, climate control, storage, as well as any "aesthetic dividends" or other personal enjoyment of living with art. However, our fund-model analysis includes conservative estimates of transaction costs.

across all of our artist and gallery records, in order to consider the common repeat sales method of art investment analysis methodologically. We hypothesize that rates of return using primary sales will be markedly different from those using first and second ("repeat") auction records.

Secondly, in order to move beyond a "star" artist (Rosen, 1981) analysis inplied by the study of Johns and Rauschenberg, even though they would not have had the benefit of hindsight at the point of first sale, we introduce two further data sets containing larger selections of artworks. We use archivally sourced sales invoices from the Betty Parsons Gallery and the Green Gallery.[4] These mid-to-late twentieth-century New York dealers' files show a compelling portfolio nature. For example, Betty Parsons, whose eponymous New York Gallery ran from 1946 until 1983, sold paintings by Mark Rothko for $300 in 1950 that are now worth $100 million. Yet Parsons also sold, at comparable prices, works by artists such as Paul Feeley and Lyman Kipp for whom there is no discernable auction market. Our second gallerist, Richard Bellamy, ran the Green Gallery from 1960 to 1965, and was criticized in his time for having a "cacophonous mix" of artists based on his tireless visits to artists' studios (Rachleff-Burtt, 2017). This criticism of cacophony indicates substantial portfolio diversity.

III. ANALYSIS

We first analyze the individual artworks, then the portfolios of Johns' and Rauschenberg's works, and then the portfolios of the overall galleries. Throughout our

[4] The Betty Parsons papers are held in the Archives of American Art, Smithsonian Institution, in Washington, D.C. The Richard Bellamy Papers are held in the Archives of the Museum of Modern Art in New York. For the Parsons files, we used the chronological files of invoices. For the Bellamy papers, we used the general sales invoice files of the Green Gallery, which are organized by artist.

analysis, we use value-weighted portfolios, as an equal weighting would misrepresent the significant range of initial gallery sales price, from $150 to $15,000. We find that each of these approaches dramatically outperforms the stock market and other standard investment classes. Tables 1 and 2 presents the annualized financial returns on individual works of art.

……
Insert Table 1 about here
……
……
Insert Table 2 about here
……

Of approximately 130 works by Johns and Rauschenberg listed in the Castelli papers from 1958 to 1963, we match 9 works by Johns and 12 by Rauschenberg to later auction results. For the twenty-one individual artworks, their implied individual annual rates of return from primary sale to first auction range from +20.92% to +40.90% for Johns (see Table 1) and from 12.04% to +37.41% for Rauschenberg (see Table 2). For both artists the returns are relatively evenly distributed.

The tables show the enormous difference between the original sales prices, which start as low as $150, and the auction prices in the millions of dollars. We see percentage gains on individual works of well over one million percent, leading to some annualized ROIs of 30-40% over decades. For instance, Table 1 shows that Jasper Johns' *Small Green Target* (1956) rose meteorically from an original purchase price of $300 in 1958 to an auction "hammer price" of $3,000,000 in 2004. The percentage gain in nominal price for *Small Green Target* is 1,999,900%, for an annualized rate of return of 23.80%, for each and every year from 1958 to 2004.

In Tables 1 and 2, we offer a ratio of 10% of the auction hammer price to return on the opportunity cost of retained equity if invested in the S&P 500. For example, if Robert Rauschenberg had retained 10% equity in his work *State* (1958) when the Castelli Gallery first sold the work in 1959 for $300, the artist's $30 would have become $44,000 in the art market. By comparison, had Rauschenberg taken the $30 in cash in 1959 and invested it in the S&P 500, he would have received only $2,417.10 over the same time period. Works by Rauschenberg outperform the S&P 500 by between 2.75 and 156.36 times. Works by Johns outperform the S&P 500 by between 20.64 and 1,086.67 times. We still observe similar outperformance even with an assumption of 20% transaction costs.

We then consider the portfolio of artworks made by each of Johns and Rauschenberg over this period by including all of the artworks found in archival records but not matched to auction results. For each artist, we analyze the returns as represented by 10% of the first auction sale for the 9 Johns works and the 12 Rauschenberg works, compared to the opportunity cost of having retained equity in all the works sold (51 works for Johns and 80 works for Rauschenberg). We model this opportunity cost as invested in the S&P 500 at the time it was paid, and compare that to the 10% equity as realized in the first-sale auction. For the auction proceeds, some received as early as 1970, we reinvest those proceeds in the S&P 500 in order to represent a time value of money.

For Johns, we find that the retained equity portfolio, as reinvested in the S&P 500, would have by 2018 generated $17.16 million, as compared to $3.49 million if the 10% equity had been invested in the S&P 500 all along (see Figure 1). For Rauschenberg, the opportunity cost of retaining the 10% equity (as measured by S&P returns of that retained

amount, over time) would have been $949,000. The comparable auction proceeds on retained equity, with the S&P reinvestment, would have been $51.72 million, or 50 times higher (See Figure 2). We additionally model what would have happened if the auctions had entailed large transaction costs. At 20% transaction cost, Johns would still have had $13.73 million, almost four times the S&P return. With 20% transaction fees, that figure for Rauschenberg would have been $41.38 million, or 40 times the U.S. equities result.

……
Insert Figure 1 about here
……
……
Insert Figure 2 about here
……

We then extend this portfolio analysis to a mixed artwork grouping based on the sales invoices of the Betty Parsons Gallery and the Green Gallery.[5] For our final sample of 1,002 total sales records across both galleries (433 for Green and 569 for Parsons), we find 108 matching auction sales (48 for Green and 60 for Parsons). These sales span 1946 through 1981.

We first model the opportunity cost to retain 10% equity in all 1,002 artworks, relative to the gains from 10% of proceeds from the 108 auction sales. We then model the galleries as one collective venture capital fund. We hypothesize that, like a VC fund, an art gallery takes risks on a wider array of works and then makes some "home-run" returns, some mid-level returns, and some write-offs.

[5] We use sales invoices, as well as an internal gallery accounting file of the works sold by Betty Parsons for the artists Jackson Pollock, Mark Rothko, and Ad Reinhardt from 1948 to 1950. We note the difficulty of matching titles from invoices to auction results given the naming conventions of some artists, e.g., "No. 1, 1950" but also "No. 1, 1951" and innumerable artworks called "Untitled". (See Appendix 1e-1g for sample invoices from Betty Parsons Gallery and Green Gallery.)

When we analyze 10% of the auction hammer price as reinvested in S&P 500, we find that 10% equity investment in the artworks would have generated $43.32 million by 2018. The same original amounts invested in the S&P would have grown to $22.00 million (see Figure 3). We find that even with 20% transaction costs, the retained equity portfolio, reinvested in the S&P 500, would still have grown to $34.66 million.

……
Insert Figure 3 about here
……

When we model the Parsons-Green works as if a venture capital fund that "bought" as investments all of the artworks that were sold by the two galleries, we find that from 1946 to 2018 the fund grew to $448.81 million, relative to comparable S&P growth to $246.69 million. With 20% transaction cost as point of auction sale, the overall "fund" grew to $359.05 million (see Figure 4). Although this analysis duplicates the pattern of the combined-gallery retained-equity portfolio, it enables us to consider the overall balance sheet of the combined "firm." The balance sheet starts at -$350, hits its low point at -$7.70 million in 1988, and then reverses in 1989 to +$6.78 million (see Figure 4). The balance sheet grows to $202.12 million by 2018, below the value of the S&P investment comparison ($246.69 million).

……
Insert Figure 4 about here
……

Even with a portfolio in which only 10.8% of works resold, the returns to an artist or other early-stage risktaker notably outperform a substantial period of growth in U.S. equities. These returns are not predictive markers but still clear indication of the

opportunity cost of mispriced early-stage creative work. The artists and dealers in our study took risk and generated value, but the structure of the art market did not let them capture it.

Although the primary purpose of our analysis has been to test our hypotheses regarding returns on fractional equity for art, we note that because we are, to our knowledge, conducting the first analysis of art market returns using primary market data, we see that our own data allow an empirical comparison to other methods of art market return. We find that, in addition to indicating strong return on fractional equity, our introduction of primary sales data demonstrates empirical limitations of the repeat sales method so common in art market analysis. We take all of the repeat sales from Johns and Rauschenberg and from the Parsons and Green data, isolating 19 artworks with repeat sales, representing works by ten different artists. We find three different rates of return: (1) from primary sale to first auction (the rate used in our study of individual artists); (2) from first auction to second auction (the "repeat sale"); and (3) from primary sale to second auction, for completeness of information.

……
Insert Figure 5 about here
……

As shown in Figure 5, these rates of return vary dramatically. For example, the Rauschenberg artwork *Forge* (1959) was sold though Leo Castelli in 1959 for $1,000. This artwork was then sold at auction for $60,563 in June 1973 and in May 2007 for $6.2 million. The return varies substantially (1) from initial sale to first auction (34.06%), (2) between the repeat sales (14.63%), and (3) from initial sale to second auction (19.99%). Many other comparisons in our sample are much more dramatic. For the Agnes Martin

work *Desert Rain*, the repeat sales return is 7%, but the artwork has already increased in value by 73% from primary sale to first auction. For all 19 repeat sales when considered together, the geometric mean of primary market price to first auction is +18.35%, whereas the geometric mean of repeat sales is -7.56%. This difference is striking.

Although the repeat sales method has advantages in large data sets, our analysis indicates that repeat sales figures only describe that specific interval in an artwork's life and do not generalize to represent returns on art for those collectors who buy work from primary-market galleries or directly from artists. This discrepancy in the data dovetails with the larger hypothesis in this paper: that creative work demands a different vantage point on early-stage value.

IV. MANAGERIAL IMPLICATIONS

Although both Johns and Rauschenberg became among the most successful artists of their time, the works in our sample were sold very early on, as the larger value of their artistic output was only just becoming known. Similarly, Betty Parsons and Richard Bellamy, the founder of the Green Gallery, were risk-taking—some would say, visionary—art dealers. Parsons, herself was a practicing artist as well as the first dealer to sell work by Jackson Pollock and Mark Rothko. Contemporary art markets have received retroactive study. Yet our analysis shows that, as in almost any field, the outsize returns go to entrepreneurs and their earliest investors. As Parsons once told an interviewer, "A new work by a new artist is not history, it's the present" (De Coppet and Jones, 1984). The same could be said of any successful start-up.

Particularly in the case of Johns and Rauschenberg, it would be easy to dismiss these artists as cherry-picked examples, owing to the artists' subsequent fame and success. Yet the largest returns on their work are accounted for by the earliest investments made. The artists were their own first investors, having made artworks years before the works were sold. In addition, these dealers were early investors in the financial sense. Bellamy paid advances to artists in the 1960s who are now household names but who, at the time, were having artists' bill collectors write the gallery. Castelli paid his artists monthly retainers. In the archival correspondence, numerous collectors seemed to buy work as much as as form of patronage as investment; and the art investor Robert Scull, whose advantageous sale of a Rauschenberg work for $85,000 in 1973, actually was the personal financial backer of Green Gallery itself. Were it not for these acts of early-stage investment by artists, dealers, and collectors, much of this work might never have come into being. We see no reason why artists, and their early collaborators, should not have access to equity structures so common in other industries.

Although resale royalties have been criticized for interfering with markets, in fact our system of retained equity, for art and other early creative endeavors, structurally aligns price and value more dynamically and accurately by allowing creators of value to participate in upside. The existence of these equity shares as property rights (Coase, 1960; Stigler, 1989; Whitaker 2018) catalyzes the follow-on development of a secondary marketplace in which these shares can be traded independently. Such a system opens up market-driven patronage for artists and diversifiable art funds for investors. More broadly, the retained-equity approach shifts pay for creative work from consumption to investment,

and creates a secondary market for diversifiable investment in creative work via purchase of shares.

While retaining equity may not benefit all artists or other workers financially at a given point in time, owning the shares creates vital optionality on the occasions in which early stage work does lead to significant, or even modest, market gains. Furthermore, it remains the decision of artists to forego cash in order to retain equity. It is always possible the retained equity will be worth little. Yet the structural possibility of fractional shares of artworks solves for two pernicious problems of liquidity and severability in art investment, given the original nature of some artworks and the infrequent interval and transaction cost of much art trade.

The retained equity approach structurally allows artists and other early risk takers to share in the upside potential that their work creates. Workers invest resources early on, paying a price before value could possibly be known; fractional shares and not dollar amounts can most accurately represent that risk. A next phase of the overall labor economy may see a shift from wage to hybrid salary / retained equity pay. Rather than considering redistribution through tax and "universal basic income," we might see fractional equity models of shared ownership. The art world provides a test case in an industry with more discretely definable creative contribution and, in a field whose entire global size is less than Apple's 2018 quarterly revenues, some safer exploratory distance from larger levers of the economy.

This potential for restructuring compensation and reward around creative work aligns with the broadening adoption of blockchain technology. In addition to its applications to tracking the authenticity and provenance of artworks, the blockchain has

broad structural advantages for the management of fractional shares and theoretically low-transaction-cost trading. The distributed ledger (Nakamoto, 2008) and time-stamp on transactions (Haber and Stornetta, 1991) will likely lead to new methods of value creation and capture (Cohen, 2017), and decentralized clearing of transactions in financial networks (Csóka and Hering, 2017), in this particular case the clearing of trade in fractional shares. While fractional ownership using blockchain has received some attention in the arts (with companies such as Maecenas and Masterworks), these ventures purchase whole artworks on the secondary market, then selling off shares. In contrast, retained fractional equity shifts art from a collectibles market in which one can own all or part of an artwork, to a creativity economy, in which the original designation of shares corresponds to the risks taken. Using blockchain techniques, fractional equity can be assigned at the point of origination, that is, the artist's studio, both aiding authentication and reorienting market structures from point-to-point price increase to the creation of value.

Such a system also stands, over time, to reorient art markets to artists who gain market power if their studios, and not intermediaries, become the origination points for blockchain-enabled listing of works. At the least, this form of art market analysis using primary sales data includes artists and also demonstrates empirically the limitations of repeat sales and hedonic regression methods for art market returns. As more data becomes available, through the release of files from family heirs or galleries themselves, a new form of art market analysis can consider the earlier creative stages of art, and not only the later market expansions.

V. CONCLUSIONS

We undertook the analysis of whether fractional equity would outperform the art market because we observed the structural misalignment of price and value for early-stage creative work. We did not know at the outset that we would see such outsize performance. To outperform the market by a factor of five is handy; to do so by a factor of over 1,000 is suspicious. We acknowledge that we were working with the earliest work of two of the most well known American artists of the twentieth and twenty-first centuries. Even drawing in the Betty Parsons and Green Gallery files, we are by definition limited to the records already deemed worth keeping. Fortunately, those files have been kept somewhat intact. But more systematic, long-term collection of data from artists, as well as gallerists, would provide fertile testing ground for these innovative financial structures which may generalize well outside the arts. Particularly in fields such as cryptocurrency, in which initial coin offerings (ICOs) bear uncanny structural similarity to markets for art, and in jobs with intensive research and development undertaken at long-term risk, these systems can provide useful structures for compensation.

As stated earlier, we did not intend this work, by any means, to extend to predict success of artists. Despite pattern-recognition of past artistic success (Fraiberger et. al., 2018), the largest gains tend to transcend templates of the past. Our work, however, does seriously demonstrate what is possible. Given that large possibility, this structural intervention in markets of assigning retained equity for creative work deserves serious consideration, with larger data sets, more complex tax assumptions, and inclusion of costs of production.

We conclude by returning to the starting point of the data in this study, which was a handwritten notebook. In cursive handwriting in a small personal notebook, Leo Castelli recorded $300 sales that would go on to become multi-million dollar auction results. And before that, in poorly heated studios, the artists developed the work itself. The moment of value creation is, in its idiosyncrasy, markedly different from the moment of value capture as the work is later resold. The fractional equity model bridges the idiosyncratic starting point and possible stratospheric returns, while offering tools for diversified investment and democratized access to markets for art.

The sheer act of assigning equity is a structural alignment of price and value that generalizes beyond fine art, to represent ways of making the risks of any research and development conform to the market's ability to assign value. Ultimately, our model solves for the central difficulty of pricing—that is, accurately reflecting the value of—early-stage creative work. Value can be more flexibly, and in the long run more accurately, assigned as a fraction than a dollar amount. Thus, these now famous artworks have something crucial to tell us about labor and the central tension between market efficiency and market reliance on innovation. These artists underscore the necessity of seeing early-stage creative work as an act of investment. The blockchain enables a future of work in which anyone can have fractional ownership of the upside they help to create.

REFERENCES

Anderson, R. C. 1974. Paintings as an investment, ***Economic Inquiry*** 12(1): 13–26.

Ang, A., Papanikolaou, D., & Westerfield, M. 2014. Portfolio choice with illiquid assets. ***Management Science,*** 60: 2737–61.

Ashenfelter, O., & Graddy, K. 2003. Auctions and the price of art. ***Journal of Economic Literature,*** 41: 763–86.

Banternghansa, C. & Graddy, K. 2011. The impact of the Droit de Suite in the UK: An empirical analysis. ***Journal of Cultural Economics,*** 35: 81-100.

Baumol, W. 1986. Unnatural value: Or art investment as floating crap game. ***American Economic Review,*** 76: 10–14.

Bernstein, R., Colsman-Freyberger, H., Sweeney, C., & Zinn, B. S. 2016. *Jasper Johns: Catalogue Raisonné of Painting and Sculpture* [Volume 2: Paintings, 1954-1970]. New York: The Wildenstein Plattner Institute and New Haven, CT: Yale University Press.

Burton, B. T., & Jacobsen, J. P. 1999. Measuring returns on investments in collectibles. ***Journal of Economic Perspectives,*** 13: 193–212.

Coase, R. H. 1960. The problem of social cost, ***Journal of Law and Economics,*** 3: 1-44.

Cohen, B. 2017. The rise of alternative currencies in post-capitalism, ***Journal of Management Science***, 54:739-746.

Cohen-Solal, A. 2010. *Leo and His Circle: The Life of Leo Castelli.* New York: Knopf, 443-447.

Csóka, P. & Herings, J. J. (2018) Decentralized clearing in financial networks, ***Management Science,*** forthcoming.

De Coppet, L. & Jones, A. 1984. *The Art Dealers*. New York: Clarkson N. Potter (Crown), 26.

Fraiberger, S., Sinatra, R., Resch, M., Riedl, C., & A.L. Barabási, 2018. Quantifying reputation and success in art, ***Science,*** 362: 825-829.

Frey, B. S. & Pommerehne, W.W. 1989. *Muses and markets: explorations in the economics of the arts.* Oxford, England: Blackwells.

Ginsburgh, V. (2007) The economic consequences of droit de suite in the European Union, *Recent Developments in Cultural Economics* (R. Towse, ed.). Cheltenham, UK: Edward Elgar, 384-393.

Goetzmann, W. N. 1993. Accounting for taste: Art and financial markets over three centuries, ***American Economic Review***, 83: 1370–76.

Haber, S. & Stornetta, W. S. 1991. How to time-stamp a digital document, ***Journal of*** Cryptology, 3(2): 99-111.

Hansmann, H., & Kraakman, R. 2002. Property, contract, and verification: The *numerus clausus* problem and the divisibility of rights, ***Journal of Legal Studies,*** 31: 373-420.

Korteweg, A., Kräussl, R. & Verwijmeren, P., 2016. Does it pay to invest in art? A Selection-corrected returns perspective. ***Review of Financial Studies***, 29: 1007-1038.

Leo Castelli Gallery records, circa 1880-2000, bulk 1957-1999. ***Archives of American Art***. Washington, D.C.: Smithsonian Institution.

Mandel, B. R. 2009. Art as an investment and conspicuous consumption good. ***American Economic Review,*** 99: 1653–63.

Markowitz, H. 1952. Portfolio selection, ***Journal of Finance*** 7(1): 77-91.

McAndrew, C., & Thompson, R. 2007. The Collateral Value of Fine Art. ***Journal of Banking and Finance,*** 31: 589-607.

Mei, J., & Moses, M. 2002. Art as an investment and the underperformance of masterpieces. ***American Economic Review,*** 92: 1656–68.

Mei, J. & Moses, M. 2005. Vested interest and biased price estimates: Evidence from an auction market. ***The Journal of Finance***, 60: 2409–2435.

Nakamoto, S. 2008. Bitcoin: A peer-to-peer electronic cash system, Working Paper, https://bitcoin.org/bitcoin.pdf, accessed January 9, 2018.

Petty, E. M. 2014. Rauschenberg, royalties, and artists' rights," ***William and Mary Bill of Rights Journal,*** 22: 977-1009.

Rachleff-Burtt, M. 2017. *Inventing Downtown: Artist-Run Galleries in New York City, 1952-1965.* New York: Prestel and Grey Art Gallery.

Rauschenberg Foundation, *Archive, https://www.rauschenbergfoundation.org/art/search-archives,* accessed January 7, 2018.

Renneboog, L., & Spaenjers, C. 2013. Buying beauty: On prices and returns in the art market. ***Management Science,*** 59: 36–53.

Rosen, S. 1981. The economics of superstars. ***The American Economic Review,*** 71: 845-858.

Rub, G. A. 2014. The unconvincing case for resale royalties. ***Yale Law Journal Forum***, https://www.yalelawjournal.org/forum/the-unconvincing-case-for-resale-royalties, accessed January 7, 2018.

Shipley, D. E. 2017. *Droit de suite*, copyright's first sale doctrine and preemption of state law, ***Hastings Communications and Entertainment Law Journal,*** 39: 1-42.

Spaenjers, C, Goetzmann, W. N. & Mamonova, E. 2015. The economics of aesthetics and record prices for art since 1701, ***Explorations in Economic History***, 57: 79-94.

Stigler, G. J. 1989. Two notes on the Coase theorem, ***Yale Law Journal***, 99(3): 631-633.

Whitaker, A. (2014). Ownership for artists. In M. Mandiberg et. al. (Eds.), *The Social Life of Artistic Property*. Hudson, NY: Publication Studio.

Whitaker, A. (2018). Artist as owner not guarantor, ***Visual Resources,*** 34(1), 48-64.

Table 1. Annualized Return on Investments: Jasper Johns

Original sales data for works sold by Castelli Gallery 1959-1963, combined with first-auction hammer prices and given gain, loss, and annualized return on investment (ROI.)

No.	Artwork	Sold at Castelli Gallery	Price USD	Sold at Auction	Hammer Price USD	Gain USD	Percentage Gain	Annualized ROI	10% of Gallery Price	Invested in S&P 500	10% of Auction Hammer Price	Ratio Auction Hammer Price / S&P 500 Investment	Ratio AHP (-20%) / S&P 500 Investment
1	Small Green Target (1956)	1958	150	Sotheby's NY, November 9, 2004	3,000,000	2,999,850	1,999,900%	23.80%	15	1,503.30	300,000.00	199.56	159.65
2	Grey Numbers (1957)	1958	350	Christie's NY, November 9, 1988	260,000	259,650	74,186%	24.31%	35	561.57	26,000.00	46.30	37.04
3	White Flag (1955)	1958	2,000	Christie's NY, November 9, 1988	6,400,000	6,398,000	319,900%	30.43%	200	3,208.95	640,000.00	199.44	159.55
4	Tennyson (1958)	1958	1,000	Sotheby's NY, November 18, 1970	70,000	69,000	6,900%	40.90%	100	246.96	7,000.00	28.34	22.68
5	Target (1958)	1959	200	Sotheby's NY, November 10, 1986	280,000	279,800	139,900%	30.29%	20	233.53	28,000.00	119.90	95.92
6	News-paper (1957)	1959	450	Christie's NY, May 7, 1997	600,000	599,550	133,233%	20.92%	45	2,907.44	60,000.00	20.64	16.51
7	Colored Alphabet (1959)	1959	175	Christie's NY, May 3, 1989	3,200,000	3,199,825	1,828,471%	38.91%	17.50	330.26	320,000.00	968.93	775.15
8	False Start (1959)	1960	1,000	Sotheby's NY, November 10, 1988	15,500,000	15,499,000	1,549,900%	40.50%	100	1,426.38	1,550,000.00	1,086.67	869.33
9	Gray Rect-angles (1957)	1963	12,000	Sotheby's NY, November 10, 1988	3,900,000	3,888,000	32,400%	25.59%	1,200	12,035.42	390,000.00	32.40	25.92

Table 2. Annualized Return on Investments: Robert Rauschenberg

Original sales data for works sold by Castelli Gallery 1959-1963, combined with first-auction hammer prices and given gain, loss, and annualized return on investment (ROI).

No.	Artwork	Sold at Castelli Gallery	Price USD	Sold at Auction	Hammer Price USD	Gain USD	Percentage Gain	Annualized ROI	10% of Gallery Price	Invested in S&P 500	10% of Auction Hammer Price	Ratio Auction Hammer Price / S&P 500 Investment	Ratio AHP (-20%) / S&P 500 Investment
1	State (1958)	1959	300	Sotheby's NY, May 14, 1998	440,000	439,700	146,566%	20.62%	30	429.92	44,000.00	102.34	81.88
2	Thaw (1958)	1959	900	Sotheby's NY, October 18, 1973	85,000	84,100	9,344%	37.41%	90	230.42	8,500.00	36.89	29.51
3	Forge (1959)	1959	1,000	Pierre-Marie Rogeon Paris, June 27, 1973	60,563 (255,000 FF)	59,563	5,956%	34.06%	100	256.02	6,056.30	23.66	18.92
4	The Red Painting (1954)	1959	1,200	Christie's NY, November 8, 1983	420,000	418,800	34,900%	27.17%	120	843.45	42,000.00	49.80	39.84
5	Forecast (1960)	1960	1,400	Sotheby's NY, November 18, 1970	19,000	17,600	1,257%	28.53%	140	307.36	1,900.00	6.18	4.95
6	Nettle (1960)	1960	3,200	Christie's NY, May 4, 1993	650,000	646,800	20,213%	17.55%	320	9,002.70	65,000.00	7.22	5.78
7	Rebus (1955)	1961	2,800	Sotheby's NY, November 10, 1988	5,750,000	5,747,200	205,257%	32.12%	280	3,677.31	575,000.00	156.36	125.10
8	Glider (1962)	1963	7,500	Christie's NY, November 14, 1995	750,000	742,500	9,900%	15.28%	750	20,681.43	75,000.00	3.63	2.90
9	Calendar (1962)	1963	7,500	Christie's NY, May 13, 2015	2,741,000	2,733,500	36,447%	12.04%	750	99,755.42	274,100.00	2.75	2.20
10	Dry Run (1963)	1963	4,000	Sotheby's NY, November 17, 1998	900,000	896,000	22,400%	16.53%	400	19,663.08	90,000.00	4.58	3.66
11	Exile (1962)	1963	3,500	Sotheby's NY, November 9, 2010	7,100,000	7,096,000	202,757%	17.43%	350	25,756.53	710,000.00	27.57	22.05
12	Overcast II (1962)	1964	7,500	Christie's NY, November 9, 1979	170,000	162,500	2,167%	22.52%	750	1,688.51	17,000.00	10.07	8.05

Figure 1: Jasper Johns Portfolio of All Works: Comparing Returns on 10% Retained Equity in Artworks Against 10% of Sales Price Invested in S&P 500

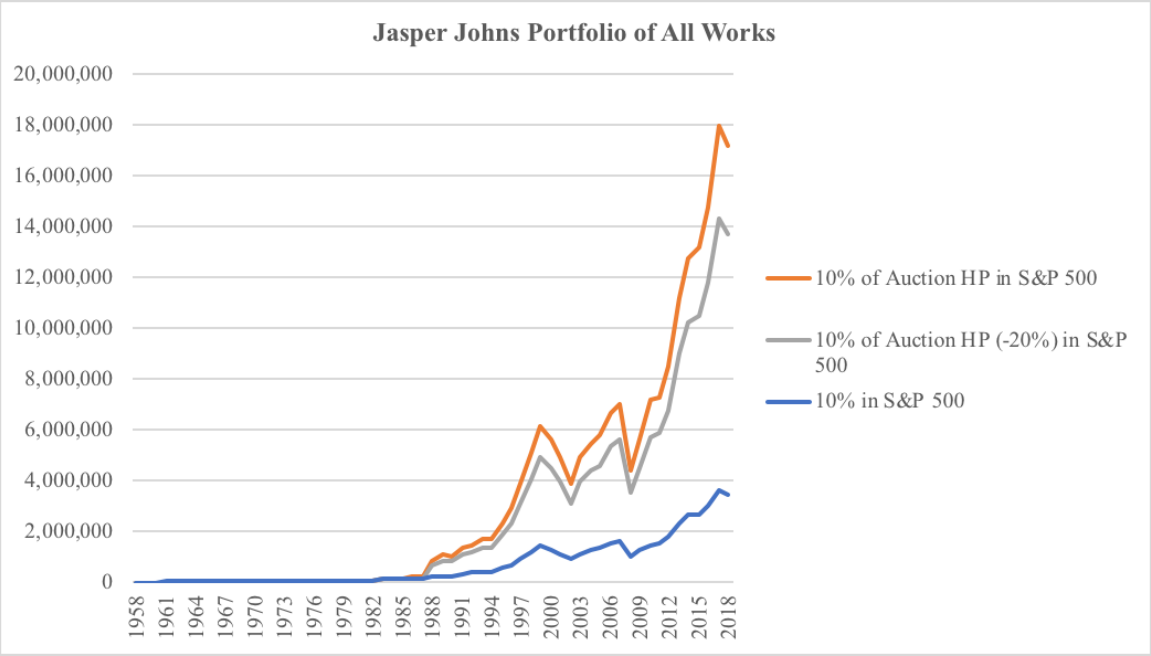


Figure 2: Rauschenberg Portfolio of All Works: Comparing Returns on 10% Retained Equity in Artworks Against 10% of Sales Price Invested in S&P 500

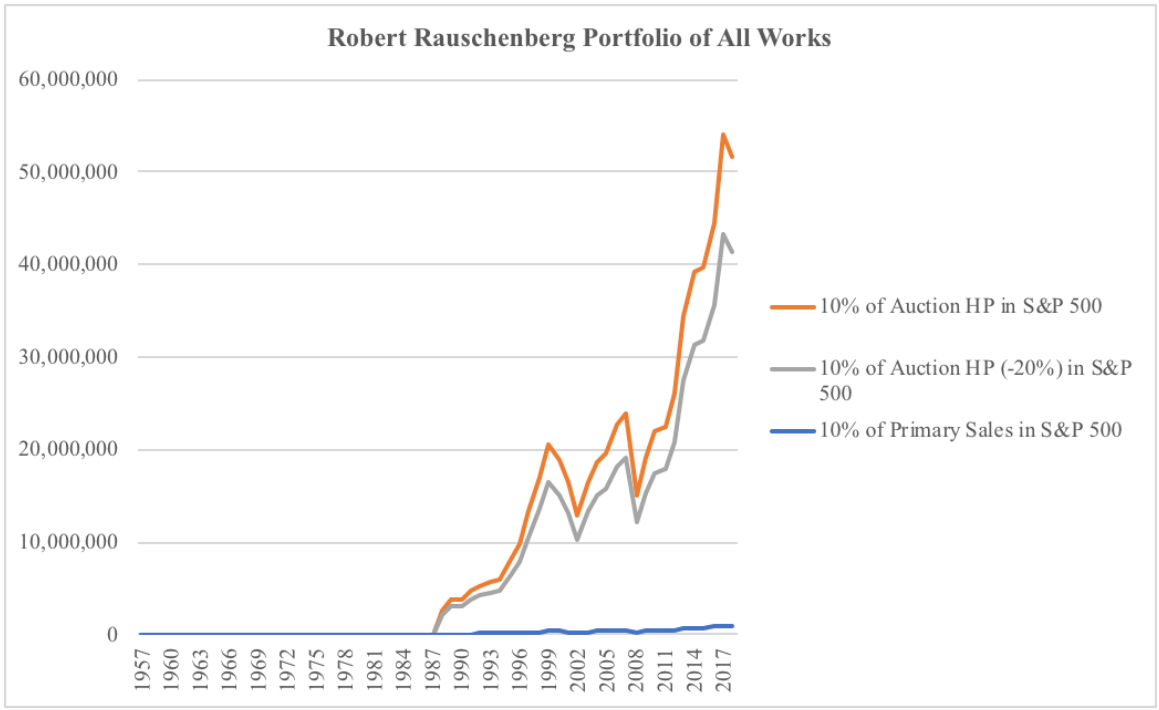


Figure 3: Parsons-Green Returns of 10% Retained Equity
10% of Auction Hammer Price Reinvested in S&P 500, as Compared to 10% of Sales Price Invested in S&P 500

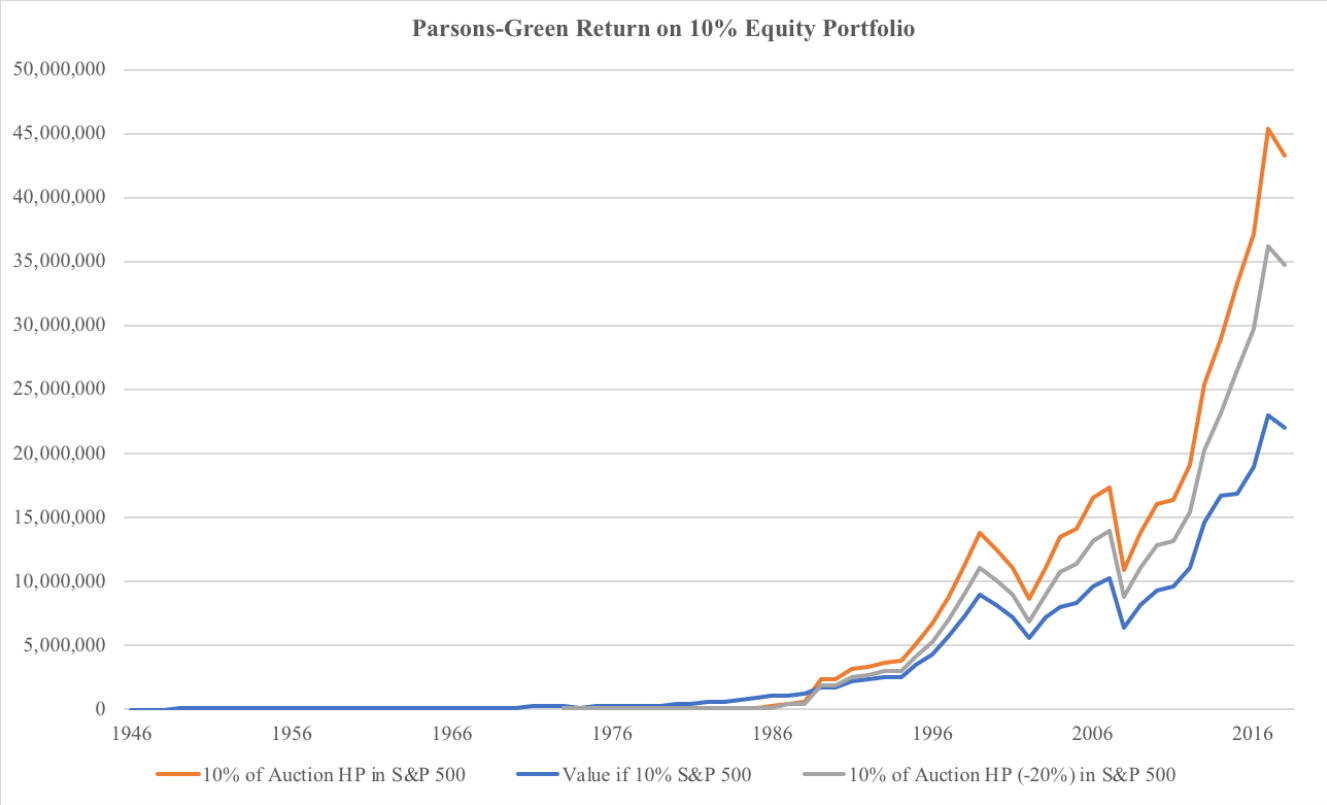


Figure 4: Parsons-Green Model Fund Returns with Balance Sheet
Auction Sales modeled as realization events and shown with and without 20% transaction costs, tracked by balance sheet of all art investments

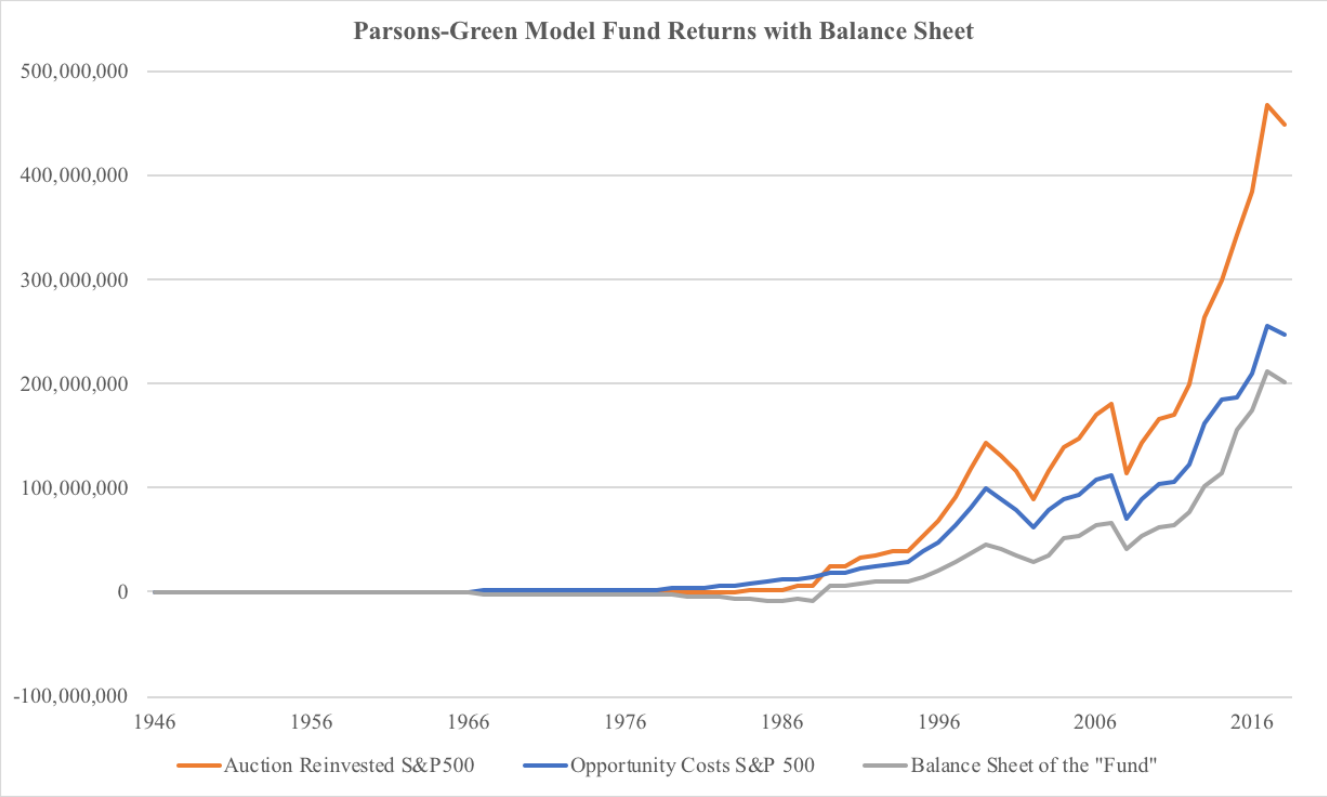
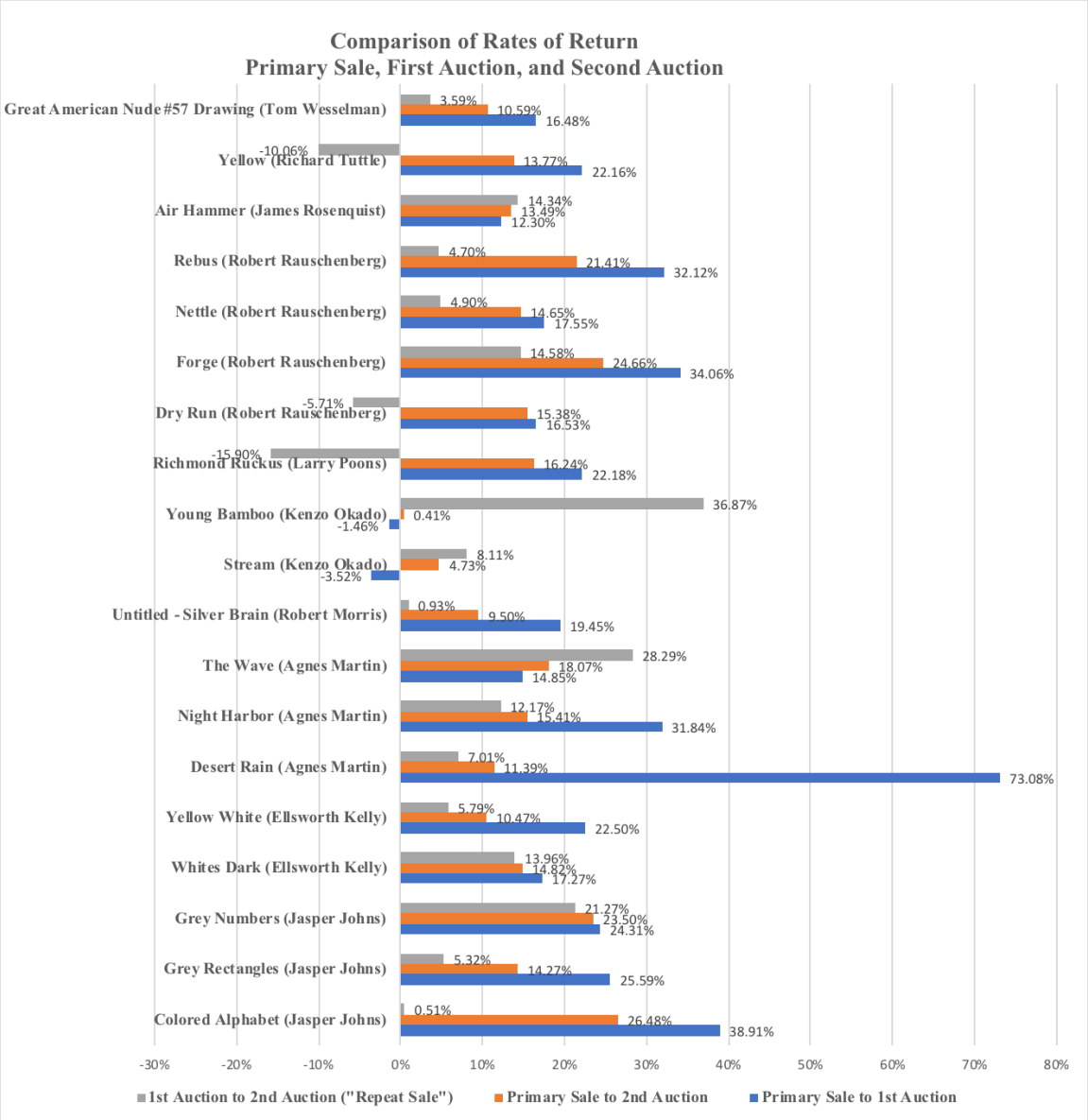


Figure 5. Comparison of Repeat Sale to Primary Sale Rates of Return
All artworks (Castelli, Parsons, and Green Galleries) with repeat sales, showing the rate of return from primary sale as substantially different from repeat (1st to 2nd auction) rate commonly used in art investment analysis

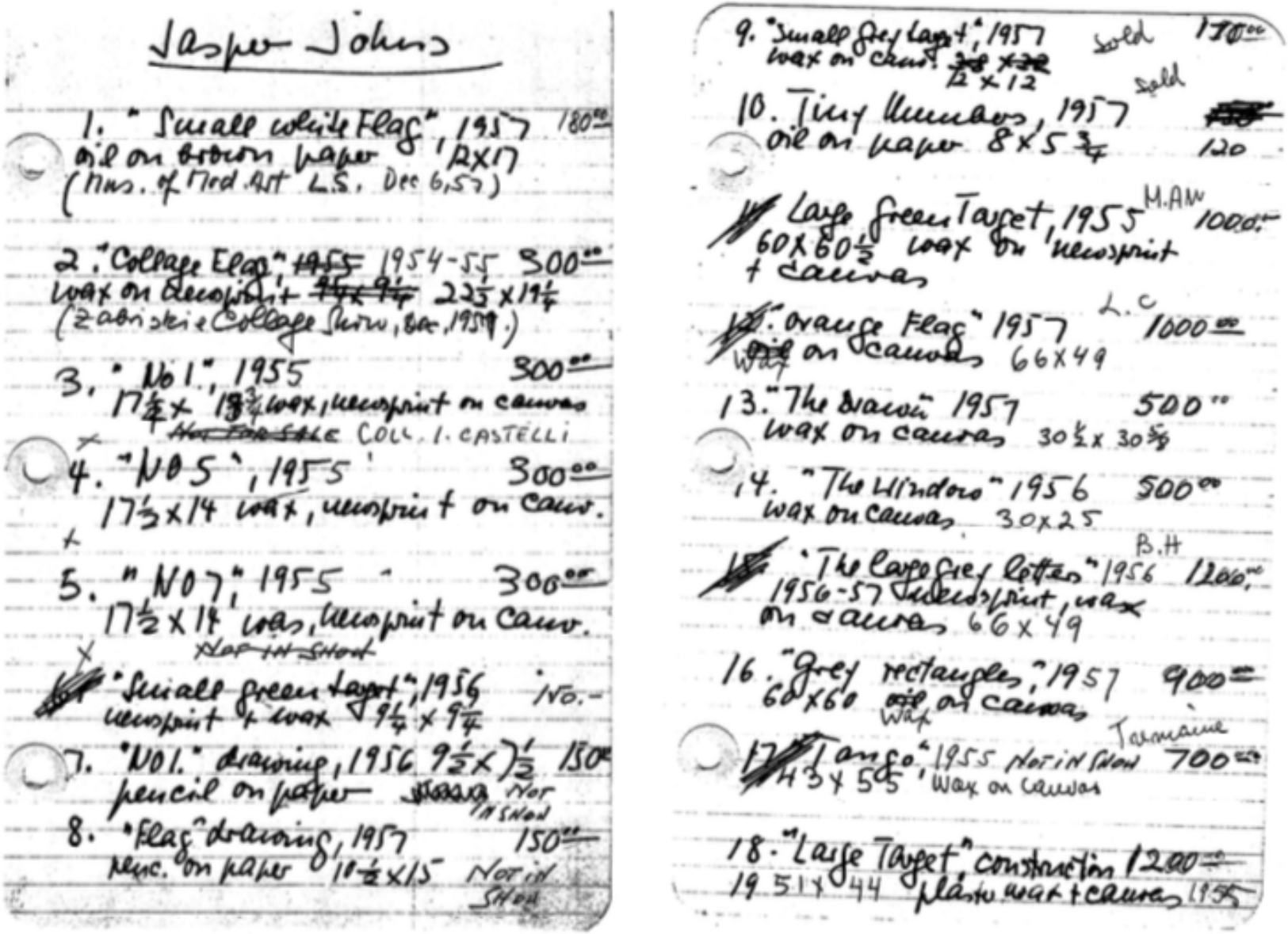


APPENDIX: Samples of Data Sources

1a. Leo Castelli Notebook, 1957-1959 (excerpt)

Leo Castelli Papers, Archives of American Art, Washington, D.C.

Sample pages from a personal notebook of Castelli, containing handwritten records of early Jasper Johns sales.



Jasper Johns

1. "Small white Flag", 1957 180.00
oil on brown paper 8 x 17
(Mus. of Mod Art L.S. Dec 6,57)

2. "Collage Flag" ~~1955~~ 1954-55 300.00
wax on newsprint ~~11 x 9¼~~ 22⅝ x 19¼
(Zabriskie Collage Show, Dec. 1959.)

3. "No 1", 1955 300.00
17½ x ~~13¾~~ wax, newsprint on canvas
~~Not for SALE~~ COLL. I. CASTELLI

4. "No 5", 1955 300.00
17⅓ x 14 wax, newsprint on canv.

5. "No 7", 1955 300.00
17½ x 14 wax, newsprint on canv.
~~Not in Show~~

~~6.~~ "Small green target", 1956 No.-
newsprint + wax ~~9¼ x 9¼~~

7. "No 1" drawing, 1956 9½ x ~~)½~~ 150
pencil on paper ~~Not in Show~~ Not in Show

8. "Flag" drawing, 1957 150.00
penc. on paper 10½ x 15" Not in Show

9. "Small grey target", 1957 sold 150.00
wax on canv. ~~18 x 22~~ 12 x 12

10. Tiny Numbers, 1957 sold ~~150.00~~
oil on paper 8 x 5¾ 120

~~11.~~ Large green Target, 1955 M.AW 1000.00
60 x 60½ wax on newsprint + canvas

~~12.~~ "Orange Flag" 1957 L.C 1000.00
~~Oil~~ Wax on canvas 66 x 49

13. "The Drawer" 1957 500.00
wax on canvas 30½ x 30⅝

14. "The Window" 1956 500.00
wax on canvas 30 x 25

~~15.~~ "The Large Grey Letter" 1956 B.H 1200.00
1956-57 newsprint, wax
on canvas 66 x 49

16. "Grey rectangles", 1957 900.00
60 x 60 ~~oil~~ Wax on canvas

~~17.~~ Tango" 1955 Not in Show Jasper Johns 700.00
43 x 55 Wax on canvas

18. "Large Target" construction 1200.00
19 51 x 44 plaster wax + canvas 1955

APPENDIX: Samples of Data Sources
1b. Registry for the Artist Robert Rauschenberg
Leo Castelli Papers, Archives of American Art, Washington, D.C.
The Castelli Gallery's Internal Ledger for Loans and Sales of Rauschenberg's Work.

ROBERT RAUSCHENBERG

Date of Consignment	Description	No.	Price	OUT Date	To Whom	Date of Return
2/28/58	' Factum II ' (Eisenhower) 62" x 35 1/2" ,1957	18	800	4/17/58	'Festival of Two Worlds', Spoleto	9-10-58
2/28/58	' Hazard ' 85" x 37 1/4" ,1957	19	1600			
2/28/58	'Satellite' with pheasant, 80" x 42 1/2",1955	20	1200	6/58 2/3/59	NEWPORT FESTIVAL - R.R	
2/28/58	'Interior' with man's hat 45" x 46 1/2" 1956 M.F.S	21	800 00	12/ /58	AFA ART and The FOUND OBJECT	
2/28/58	' Rebus ' 8' x 12' 1955	22	2800	5/58	R.R	
2/28/58	'Memorandum of Bids 59" x 45"	23	750	10/8/58 3	Returned to RR	3/2/59
2/28/58	' The Bed ' Construction, with pillow and quilt 74" x 31" , 1955	24	1600	4/17/58 10/8/58 12/5/58 5/1/59	'Festival of Two Worlds', Spoleto R.R. from RR 'ART AMOTHE FOUND OBJECT' - AFA - to RR (H Modlat) DOCUMENTA II - Kassel, Germany	9-10-58
2/28/58	'S A F' 20"x 24"	25	300			

APPENDIX: Samples of Data Sources
1c. 1962-1963 Price List for the Artist Robert Rauschenberg
Leo Castelli Papers, Archives of American Art, Washington, D.C.
A Castelli Gallery price list for works by Rauschenberg, including handwritten annotation of a discount.

ROBERT RAUSCHENBERG

Price List For 1962-63 Paintings

TITLE	SIZE	SQUARE INCHES	PRICES
Express	120" x 72"	8640 sq. "	$15,000.-12,00(
Overcast I and Overcast II	98" x 72"	7056 sq. "	$7500.
Almanac, Glider, Calendar	96" x 60"	5760 sq. "	$6000.
New Colored w/combine	82" x 48"	3936 sq. "	$6000.
Buffalo, Brace, Sundog, etc.	60" x 60"	3600 sq. "	$4500.
Junction	61½" x 45½"	2798 sq. "	
Cove , Dry Run	72" x 36"	2592 sq. "	$4000.
Vault, Exile, Echo, Crocus, Payload	60" x 36"	2160 sq. "	$3500.
Tadpole	50½" x 30¼"	1527 sq. "	~~$3000.~~ 2500.00
Renasence	36" x 36"	1290 sq. "	$2500.
Umbrellas	36" x 24"	864 sq. "	$1800.

APPENDIX: Samples of Data Sources
1d. Letter from the Castelli Gallery to Jasper Johns with List of Sales
Leo Castelli Papers, Archives of American Art, Washington, D.C.
A full list of Jasper Johns works sold by the gallery from 1957-1959, with collector name.

1 September 1959

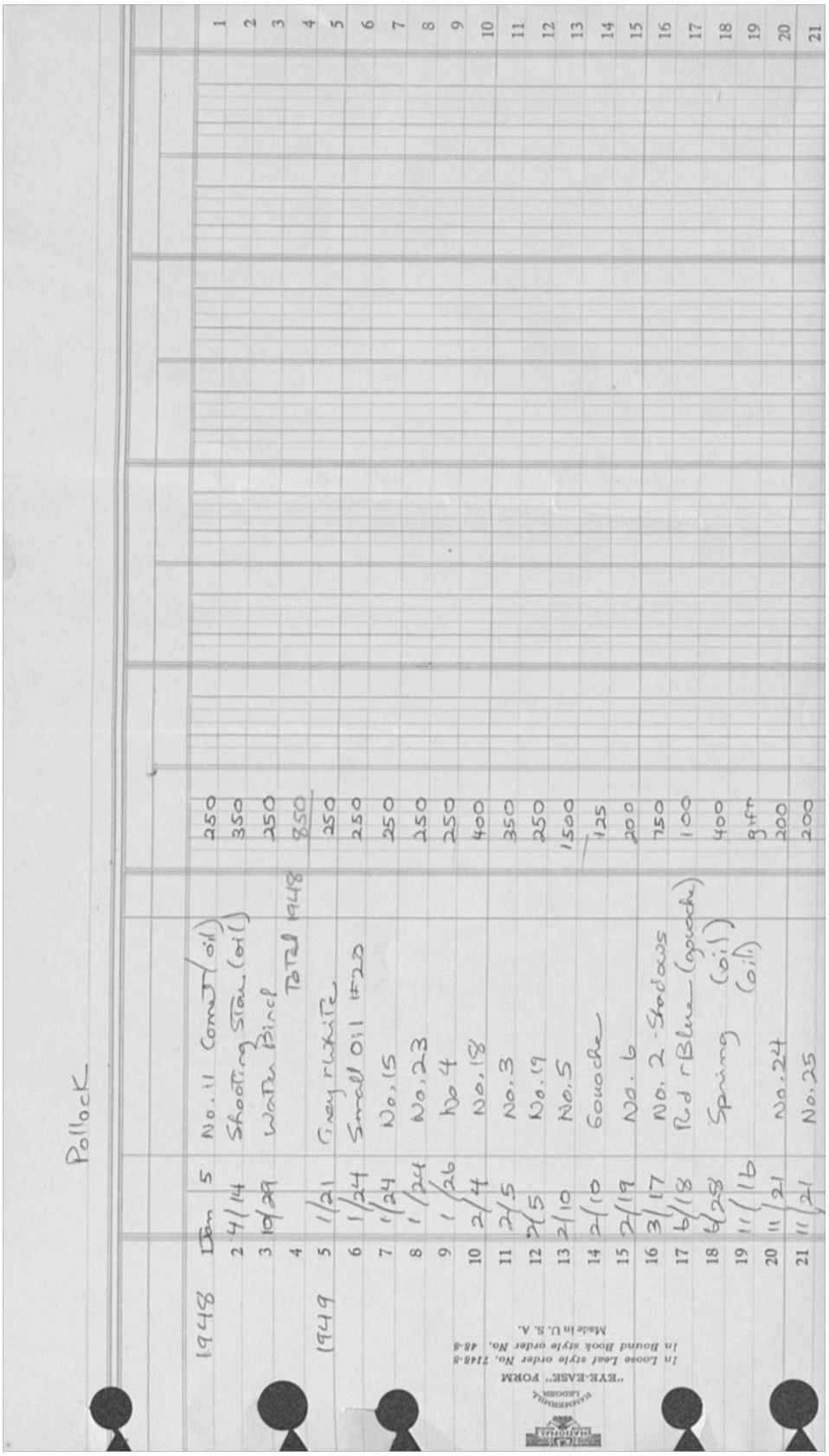
Mr. Jasper Johns
128 Front Street
New York , N.Y.

Dear Jap,

Here is a complete list of paintings sold through the gallery. Your first sale begins in 1957:

	' No. 11 '	Donald Peters
	' Flag ' (drawing)	Kramarsky
1958:		
	' Small Target' (drawing)	Mrs. Thomas Watson
	' Small Green Target '	Mr. and Mrs. John Jakobson
	' Tango '	Mr. and Mrs. Burton Tremaine
	(Pastel) ' Flag '	Mr. and Mrs. Donald Peters
	' Flag Above White '	Mr. and Mrs. Henry Epstein
	' White Target '	James Thrall Soby
	' Book '	Alfred Barr, Jr.
	' Grey Numbers '	Dorothy Miller
	' Large Grey Letters '	Ben Heller
	'No. 7 '	Dr. and Mrs. Charles Hulbeck
	' Green Target ' ' White Numbers '	The Museum of Modern Art, New York
	' Grey Flag '	Dr. James Holderbaum
	' Target with Four Faces '	Museum of Modern Art, New York

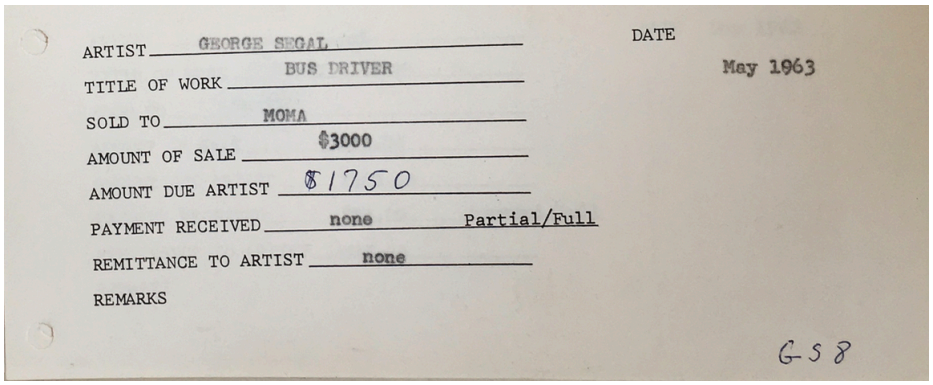
APPENDIX: Samples of Data Sources
1e. Betty Parsons Sales Summaries: Pollock, Reinhardt, and Rothko, 1946-1955
Betty Parsons Papers, Archives of American Art, Washington, D.C.



Pollock

1948	Jan	5	No. 11 Comet (oil)	250	
	2	4/14	Shooting Star (oil)	350	
	3	10/29	Water Bird	250	
	4		Total 1948	850	
1949	5	1/21	Gray ruckite	250	
	6	1/24	Small Oil #20	250	
	7	1/24	No. 15	250	
	8	1/24	No. 23	250	
	9	1/26	No 4	250	
	10	2/4	No. 18	400	
	11	2/5	No. 3	350	
	12	2/5	No. 19	250	
	13	2/10	No. 5	1500	
	14	2/10	Gouache	125	
	15	2/19	No. 6	200	
	16	3/17	No. 2 - Sadness	750	
	17	6/18	Red rBlue (gouache)	100	
	18	4/28	Spring (oil)	400	
	19	11/16	(oil)	9ft	
	20	11/21	No. 24	200	
	21	11/21	No. 25	200	

APPENDIX: Samples of Data Sources
1f. Sample Invoice, Green Gallery
Richard Bellamy Papers, Archives of the Museum of Modern Art, New York, NY

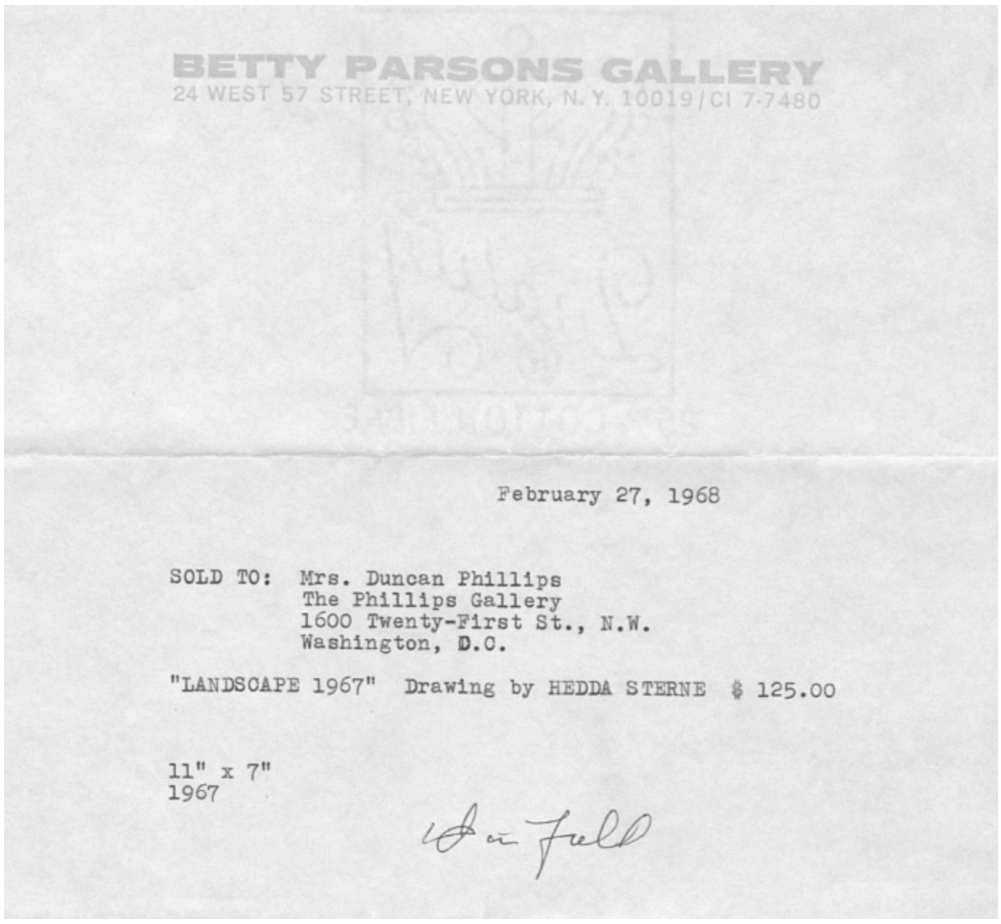


ARTIST GEORGE SEGAL
TITLE OF WORK BUS DRIVER
SOLD TO MOMA
AMOUNT OF SALE $3000
AMOUNT DUE ARTIST $1750
PAYMENT RECEIVED none Partial/Full
REMITTANCE TO ARTIST none
REMARKS

DATE May 1963

G-58

APPENDIX: Samples of Data Sources
1g. Sample Invoice, Petty Parsons Gallery
Betty Parsons Papers, Archives of American Art, Washington, D.C.



BETTY PARSONS GALLERY
24 WEST 57 STREET, NEW YORK, N.Y. 10019/CI 7-7480

February 27, 1968

SOLD TO: Mrs. Duncan Phillips
The Phillips Gallery
1600 Twenty-First St., N.W.
Washington, D.C.

"LANDSCAPE 1967" Drawing by HEDDA STERNE $ 125.00

11" x 7"
1967

Hedda Sterne