

Whitaker, Amy; Kräussl, Roman

Working Paper

Blockchain, fractional ownership, and the future of creative work

CFS Working Paper Series, No. 594

Provided in Cooperation with:

Center for Financial Studies (CFS), Goethe University Frankfurt

Suggested Citation: Whitaker, Amy; Kräussl, Roman (2018) : Blockchain, fractional ownership, and the future of creative work, CFS Working Paper Series, No. 594, Goethe University Frankfurt, Center for Financial Studies (CFS), Frankfurt a. M., <https://nbn-resolving.de/urn:nbn:de:hebis:30:3-468036>

This Version is available at:

<https://hdl.handle.net/10419/182451>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



CFS Working Paper Series

No. 594

Amy Whitaker and Roman Kräussl

Blockchain, Fractional Ownership, and the Future of Creative Work

The CFS Working Paper Series

presents ongoing research on selected topics in the fields of money, banking and finance. The papers are circulated to encourage discussion and comment. Any opinions expressed in CFS Working Papers are those of the author(s) and not of the CFS.

The Center for Financial Studies, located in Goethe University Frankfurt's House of Finance, conducts independent and internationally oriented research in important areas of Finance. It serves as a forum for dialogue between academia, policy-making institutions and the financial industry. It offers a platform for top-level fundamental research as well as applied research relevant for the financial sector in Europe. CFS is funded by the non-profit-organization Gesellschaft für Kapitalmarktforschung e.V. (GfK). Established in 1967 and closely affiliated with the University of Frankfurt, it provides a strong link between the financial community and academia. GfK members comprise major players in Germany's financial industry. The funding institutions do not give prior review to CFS publications, nor do they necessarily share the views expressed therein.

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 June 2018

ABSTRACT

While record-making prices at art auctions receive headline news coverage, artists typically do not receive any direct proceeds from those sales. Early-stage creative work in any field is perennially difficult to value, but the valuation, reward, and incentivization for artistic labor are particularly fraught. A core challenge in studying the real return on artists' work is the extreme difficulty accessing data from when an artwork was first sold. Galleries keep private records that are difficult to access and to match to public auction results. This paper, for the first time, uses archivally sourced primary market records, for the artists Jasper Johns and Robert Rauschenberg. Although this approach restricts the size of the data set, this innovative method shows much more accurate returns on art than typical regression and hedonic models. We find that if Johns and Rauschenberg had retained 10% equity in their work when it was first sold, the returns to them when the work was resold at auction would have outperformed the US S&P 500 by between 2 and 986 times. The implication of this work opens up vast policy recommendations with regard to secondary art market sales, entrepreneurial strategies using blockchain technology, and implications about how we compensate creative work.

Keywords: Value creation, art market, property rights, blockchain, venture funding

I. INTRODUCTION

In 2017, Leonardo da Vinci's *Salvator Mundi* sold for \$450 million at Christie's New York. This 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 in 1980 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 receive any of the gains when their work sells at auction. Johns may have enjoyed a canonization of his reputation and indirect effect on the prices of his work, but no direct cut, owing to the peculiar nature of art as a singular, non-substitutable good.

Artists and regulators have tried to participate in the upside when their work is resold, whether through private contract or resale royalty.¹ This dilemma of how to capture this opportunity cost in resale markets for art actually masks a much larger problem with art markets: It is normalized in the field of art investment how little we actually understand about the value of art. To really analyze returns on a collector's investment in art, one must know what the collector initially paid for the work. Most studies of markets do not have that figure. Uncovering primary sales records detailed archival research and careful art historical analysis to match private gallery sales records (many of which are handwritten, in cursive) to publically available auction prices.

¹ In 1971, Seth Siegel and Bob Projansky proposed *The Artists Resale* which gave artists fifteen percent of the increase over the prior sales price, as well as control over exhibition, discounts, and so on. See <http://www.primaryinformation.org/product/siegel-and-projansky-the-artists-reserved-rights-transfer-and-sale-agreement/>. Regulatory attempts to include the artist when a work is resold at a financial gain are governed by regulation giving artists "resale royalties." Resale royalties systems 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).

This paper models art market returns using primary market data, and models in addition what the investment returns look like from an artist's point of view, as if the artist retained equity investment in his or her work. Because the data is so difficult to source, we initially face a severe restriction in the size of the data sample set. Yet our work offers an important correction of how we look at art markets and also has far-reaching implications for markets for creative labor in many fields.

Using data from Leo Castelli Gallery's papers in the *Archives of American Art*, we have found new data on the original sales prices of early works by the American artists Jasper Johns and Robert Rauschenberg. We use that data to propose a model in which artists retain fractional equity in their work at the point of first sale. The rationale for retained equity, as opposed to granted equity or royalty, is to model clearly the artist's role as an investor instead of as a recipient of welfare or subsidy as it is sometimes posited in criticisms of resale royalties (Rub, 2014).

The fractional shares parallel the function of resale royalties with more flexibility in structure. Once those equity shares exist, it is possible to create a secondary market in those shares, independent of the sale of the actual work of art. Such a system has not existed before, and would enable a diversifiable investment in art. The technology of the blockchain and general development in trade management software make this system timely.

In the longstanding system of art sales, when an artwork is sold in the "primary market," that is, for the first time, the artist typically consigns the work to a dealer. Only when an artwork has sold, the artist and dealer split the proceeds, usually fifty-fifty. When an artwork is subsequently sold in the "secondary market," that is, resold at any

point after the first sale, only the collector and the selling agent(s)—auction houses, galleries, private dealers—receive the proceeds of the sale (Ashenfelter and Graddy, 2003). In most cases, the artist is not paid again on the appreciation in value after the first sale. For instance, Rauschenberg's piece *Thaw* (1958) sold for \$85,000 in 1973 having been purchased in 1958 for \$900. Rauschenberg only received his original fifty percent share, or \$450 (Leo Castelli Papers, 1958). At the 1973 auction, Rauschenberg was in attendance and allegedly shoved and punched the collector, Robert Scull.²

Largely because they are heavily regulated, resale royalty schemes are often criticized for bureaucracy, costliness, and poor enforcement (Shiple, 2017). Yet if resale royalties are understood using the logic of the Coase theorem (Coase, 1960; Stigler, 1989), they are property rights that are divisible (Hansmann and Kraakman, 2002) and that can be traded independently at other times, not only when an artwork is sold (Whitaker, 2014). Thus, resale royalties set up the opportunity not only to benefit artists but also investors who wish to engineer a diversified exposure to a much wider array of artistic work than what would be practicable through the purchase of whole artworks.

Instead of resale royalties, we propose privately managed equity shares that originate at the point of first sale by being retained by the artists. The specific model proposed in this paper is for artists to receive a smaller percentage of the proceeds when their work is first sold and to retain a percentage of equity instead. In the basic case, instead of a fifty-fifty dealer-artist split, the split instead becomes fifty-forty-ten, with the artist taking forty percent cash and keeping ten percent equity. For instance, in the case of Rauschenberg's \$900 artwork *Thaw* (1958), the work would have sold for \$810 instead.

² A video of the Rauschenberg-Scull interaction exists and can be found in the Mandy Chang documentary *Mona Lisa Curse* (2008). Rauschenberg went on to start a foundation that lends instrumental support to the working lives of emerging artists.

The dealer would have still taken \$450, but the artist would have taken \$360 and retained the other \$90 as equity in the piece. Had Rauschenberg held that equity, he would have received \$8,500 from the 1973 sale, likely obviating his anger or sense of unjustness toward the collector Scull.

Because the fractional equity is retained at the first point of sale, our analysis is also the first to model investment returns on art using first-sale data. This data is difficult to access, even closely guarded as a trade secret. In contrast, most formal studies of art investment returns rely solely on publically available auction sales figures. Our combined approach using first-sale data, secondary market sales, and fractional ownership offers a significant improvement on the method by which art investment is modeled in general.

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

The aggregation of art prices in these indices has also been shown to mask a great deal of variability among returns on individual artworks (Spaenjers, Goetzmann, and Mamonova, 2015). The valuation of the individual artworks that comprise these indices is

highly idiosyncratic, set by appraisal characteristics such as size, condition, and provenance (McAndrew and Thompson, 2007), or by buyers in the room at an auction (Ashenfelter and Graddy, 2003). All of that is to say that when investment in art is so clearly subjective and variability between artworks so strong, fractional exposure and diversification become crucial not just under standard financial mean-variance analysis (Markowitz, 1952) but as a way of accounting for art's peculiar investment characteristics, notably lack of liquidity (Ang, Papanikolaou, and Westerfield, 2014), lack of divisibility, and absence of securitization.

Relative to these approaches, the innovation of this paper is that we document for the first time the entire evolution of returns on art starting from the primary market and show what artists forego in the secondary market. 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 value one's work helps to create.

We explicitly note that it is not our intention to show that returns on famous works of art generalize to other artists or other workers. Our study of Johns and Rauschenberg is determined by data limitation, but still an expansive methodological improvement over repeat sales methods. Repeat sales analysis is limited to a comparison of a first and second auction result. However, without the price when the work is first

sold into the primary market, crucial information is missing. Analyzing the return on art as an asset without the primary market price is analogous to analyzing the return on a venture capital investment by tracking performance from the IPO to a second point in time, without knowing the VC firm's private initial investment.

This approach opens up a new field of research by framing art market analysis as part of a study of creative labor. This work generalizes to solve numerous practical and challenging problems in management sciences more broadly by offering ways of modeling hybrid rent-investment pay in the gig economy. This structure of thinking more correctly assigns risk and return to workers. Methodologically, we are constrained in the data in this study. But rather than letting this useful conceptual work languish, we introduce this important conceptual structure so that further data-driven analysis across fields may follow.

This analysis of original objects of visual art provides a generalizable case for the assignment of value to the creators of early stage work in any field. These arguments extend to any kind of gig-economy labor and have the potential to shift basic assumptions about how markets in general model the pay for creative work. We may even come to see the payment of salary as anachronistic, and want to give all workers in value-creating jobs fractional equity in the value they create. Testing the applications in the art market through artist-dealer pilots can inform the development of this kind of thinking toward structures of compensation and analysis of opportunity costs on creation of value. The generalizable model covers investment in R&D expense with shared ownership of upside.

II. APPROACH

Using historical primary market sales prices and corresponding secondary market auction results, 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. 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.³

Because the data and the difficulty of sourcing it are so crucial to our study, we describe this process of data gathering and matching in some detail in the following. The auction data comes from our proprietary database of over three million complete auction returns dating back as far as 1850, the source for which is the auction houses’ own published catalogues for each sale. Our database generates 89 auction records for Jasper Johns paintings with auction results starting in 1970 going through 2016 and 363 Robert Rauschenberg paintings sales from the same period.⁴ We match these to the original sales data which contains records for 38 Johns sales and 61 Rauschenberg sales over the 1958-1963 period.⁵ We exclude works on paper, focusing on paintings and related mixed-

³ We rely primarily on the Jasper Johns catalogue raisonné (Bernstein, Colsman-Freyberger, Sweeney, and Zinn, 2016), and the archive of the Robert Rauschenberg Foundation (www.rauschenbergfoundation.org, 2018). Whereas some catalogues raisonnés simply list “private collection,” the Johns volumes list detailed collector and intermediary information as well as date of sale. Inclusion in the catalogue raisonné is particularly determinative for the market value of works of art, i.e., that the work is authentic.

⁴ Our records show no Johns and Rauschenberg auction results prior to 1970.

⁵ The pricing data comes from a variety of sources within the Castelli papers. These documents include: handwritten notes kept by Castelli and his staff (see Appendix 1a); the formal “registry,” that is, inventory, consignment, and sales record, for Rauschenberg (see Appendix 1b); price lists produced by the gallery,

media constructions. Because the artists, particularly Johns, made many works by the same name (e.g., “Target,” “Flag”), we fastidiously match the auction results and original sales data by “provenance” (series of collector name), dimensions, medium, sales date, and other factors, to arrive at the ten Rauschenberg works and nine Johns works in our study. The nineteen specific artworks we study have been selected because they appear both in Leo Castelli’s sales records from 1957 to 1963 and also in official secondary market auction results.⁶

To address our working hypothesis, namely that artists would be better off retaining equity in their work than investing in financial markets (e.g., equity and bonds), first we analyze returns on the individual artworks and from the perspective of a hypothetical collector who owned each work individually or all of the works by each artist.⁷ Then we analyze from the perspective of the artists as if they had retained ten percent equity in their own works. We calculate the artists’ return on retained equity for each work individually and for the artworks as a group.

Our study of Johns and Rauschenberg is determined by data limitation, but still an expansive methodological improvement over repeat sales methods. Repeat sales analysis is limited to a comparison of a first and second auction result. However, without the price when the work is first sold into the primary market, crucial information is missing.

some annotated to show discounts (see Appendix 1c). We also use a letter the gallery sent Johns on September 1, 1959, listing all of the works sold in the years 1957, 1958, and 1959 (see Appendix 1d), as well as a comparable letter sent to Robert Rauschenberg detailing the list of collectors of his works up to 1962.

⁶ We observe ten artworks for Robert Rauschenberg, three with repeat sales, (see Table 1) and nine artworks for Jasper Johns, with one repeat sale (see Table 2). The auctions primarily take place in major sales at the two key auctions houses, Christie’s and Sotheby’s. All sales take place in New York except for one sale in Paris. The Paris sale is converted from French francs (at time of sale) to U.S. dollars. Numerous other works for which we have first-sale pricing data were resold subsequently but by private dealers. Rare sales in that group were announced in newspapers; we do not elect to include that data due to possible uncertainty in the figures.

⁷ 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.

Analyzing the return on art as an asset without the primary market price is analogous to analyzing the return on a venture capital investment by tracking performance from the IPO to a second point in time, without knowing the VC firm's private initial investment.

For example, the Rauschenberg artwork *Forge* (1959) was sold through 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%). Thus, using primary market data gives us meaningfully different figures, showing limitations of the repeat sales method. (See figure 1.)

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.⁸ But rather than consider these artists to be cherry-picked examples, owing to the artists' subsequent fame and success, we use them to make the case that equity ownership can provide important optionality to artists, diversification to investors, and liquidity options to both.⁹ Beyond the art market, this

⁸ Both artists were included in a group show in 1957 and had their first solo shows at the gallery in 1958.

⁹ A majority of the works in our sample are now in museum collections. (Jasper Johns holds the unusual claim to fame of having sold works directly from his first solo exhibition (1958) into the collection of the Museum of Modern Art (Bernstein et. al., 2016; Cohen-Solal, 2010). Some of those works were purchased by museums directly, while others were donated. The role of museums as collectors not only credentializes the art but also adds a significant structural complexity to modeling portfolio returns. If an artist holds ten percent equity in his or her own work at the time the work is donated, then according to U.S. tax regulations, that artist can receive a tax benefit equal to that person's rate of personal income tax (approximately 35%). On the one hand, the possibility of donation decreases the investment return on the artwork shares to roughly one third. On the other hand, there is a peculiar wrinkle in U.S. tax law that stipulates that artists can only donate their own artwork to a museum at the cost of the materials. If a Rauschenberg work had a \$2 million market valuation but was made out of fifty dollars of material, the artist himself could have, in his lifetime, only claimed a fifty dollar donation to a museum (creating roughly a \$17 tax benefit). Thus, a major advantage of the securitization of these artworks is that the artist would then be allowed to claim the full market value of the donation because it is a security and not an artwork. For the artworks we study, this museum complication arises a majority of the time. The number of works in museum collections—and therefore very unlikely to go to auction—creates a significant scarcity in the number of works for which we have primary sales data relative to the number of works for which we also have secondary market auction returns. While it is possible that the data therefore has a survivorship bias,

study shows the inability of a static price to capture the risks taken in making early-stage creative work in many other fields.

III. ANALYSIS

We analyze the return on artworks from a few distinct perspectives: the works individually; the entire group of Johns' works and Rauschenberg's works respectively, as if a hypothetical collector had bought each grouping, and then a portfolio representing ten percent of each artist's group of works, as if each artist had retained ten percent equity; and two portfolios that isolate the earliest works by each artist, to observe the significance, if any, of buying the artists' work at the very earliest opportunity.¹⁰ Throughout our analysis, we use value-weighted portfolios, as an equal weighting would be strongly affected by the significant range of initial gallery sales price, from \$150 to \$12,000. We find that each of these approaches dramatically outperforms the stock market and other standard investment classes.

For the artists' retained equity portfolios, we compare primarily to the S&P 500 index, and also offer comparison to U.S. three-month T-bills and 10-year Treasury bonds. Although in practice an artist who was paid the remaining ten percent in cash might spend that money on living expenses or reinvestment in future art, we model conservative comparison cases in which (a) the artist invests the ten percent in the S&P 500 index and

the reason the works are not going to auction is not that they are poor in quality but that they are already canonized, that they were kept by collectors' heirs, or that they were traded privately by dealers and not by auction houses.

¹⁰ That last group includes one portfolio for the four works by Johns that sold in 1958 and a separate portfolio for the four works by Rauschenberg that sold in 1959.

(b) an extreme conservative case in which the artist theoretically has no living expenses and invests the entire fifty percent from the sale of the artworks into the S&P 500.¹¹

Tables 1 and 2 presents the annualized financial returns on individual works of art.

.....
 Insert Table 1 about here

 Insert Table 2 about here

First, regarding the analysis of the nineteen individual artworks, their implied individual annual rates of return range from -5.73% to +37.41% for Rauschenberg (see Table 1) and from +20.92% to +40.90% (see Table 2) for Jasper Johns. For both artists the returns are relatively evenly distributed. We note that the negative average annual return (-5.73%) for a Rauschenberg work is the only negative return in the study.¹²

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 of well over one million percent, leading to some annualized ROIs of 30-40% over decades. The jump in nominal prices is notable. For instance, Table 2 indicates that in the case of Jasper Johns’ *Small Green Target* (1956) from an original purchase price of \$300 in 1958 to an auction “hammer price” of \$3,000,000 in 2004. The percentage gain in

¹¹ Because artworks are not “marked to market” or regularly and externally priced in the manner of public equities or other more liquid assets, we use auction sales and then infer an annual rate of return over the intervening years. In the few cases within our sample in which an artwork sold at auction twice, we model the return had the artist sold equity just after the first auction and then also just after the second auction.

¹² The reason for this negative rate in Table 1 is that the work was resold in November 2000 after only two years. That specific two year holding period, 1998-2000, would not have been optimal. There may have been a personal reason for reselling the work so quickly, since flipping a work so quickly is usually considered counterproductive.

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 2004.¹³

Second, we model the retained equity portfolio. Had Johns and Rauschenberg retained ten percent equity in these artworks, they would have had an opportunity cost, namely the ten percent of the purchase price (twenty percent of their fifty percent share) which they forego in exchange for the equity. We model this opportunity cost as the return they would have received if they had invested the foregone cash in the S&P 500 index, in 3-months Treasury bills, or in 10-year Treasury bonds. We find that in every case, both Johns and Rauschenberg would have outperformed equity markets very substantially by retaining the ten percent equity.

In Tables 3 and 4, we see the same artworks from Tables 1 and 2, now considered from the retained equity standpoint. In the cases of these works that sold at auction twice, Tables 3 and 4 show alternative returns (e.g., Table 3, row 3a and 3b) from first sale to auction separately for the two auction results.¹⁴

.....
 Insert Table 3 about here

 Insert Table 4 about here

Table 3 shows that in the case of the Robert Rauschenberg’s work *State* (1958), the Castelli Gallery first sold the work in 1959 for \$300. Had Rauschenberg taken ten percent of the purchase price (\$30) as equity, that \$30 would have become \$44,000 in the

¹³ We simplify and impute a linear return at a constant compounding rate over the period of time between first sale and auction date. Our model also assumes that all primary sales took place on July 1 of each year.

¹⁴ For instance, when an artwork such as Rauschenberg’s *Forge* (1959) sold at auction twice, the first row (3a) shows the return from the original sale to first auction; the second row (3b) shows the return from the original sale to second auction.

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 \$2,417.10 over the same time period. If that \$30 had been invested in three-month U.S. T-bills or in ten-year U.S. Treasuries, the results would have been even worse than in the S&P comparison.¹⁵

The last column in each of Tables 3 and 4 shows the ratio of the return on the retained equity portfolio relative to the comparable investment in the S&P 500. In the case of Rauschenberg, the ratio ranges from 2.8 to 140.8. In the case of the artwork *Dry Run* (row 8), which had the only negative return, the overall return on the work since its original purchase still outperforms the S&P 500 by 3.6 times.

The Johns' retained equity portfolio (see Table 4) performs even more strongly than the Rauschenberg one. The worst performing of Johns' works, *Newspaper* (row 6), still returned 21.2 times the S&P 500 over the period. The best performing Johns' work, *Colored Alphabet* (row 7), returned 986.8 times the S&P 500. Even an investment the artist would have taken in his own future work, would seem to pale in comparison to the value realized by retaining equity in this very early work.¹⁶

By comparison, viewing these artists' work from a hypothetical collector's point of view also demonstrates similarly strong outperformance over equities markets. A

¹⁵ These figures all describe the opportunity cost of the retained equity at different levels of risk tolerance. Because the bond returns are so much lower and the artworks so clearly outperform the higher benchmark of the S&P 500, the remainder of portfolios in the paper are only compared to the S&P 500.

¹⁶ In an actual case of early-career artists being paid the full purchase price instead of retaining equity, the artists might have spent that \$30 that they did not retain as equity on consumption goods, on basic living expenses, or on reinvestment into future art. Regarding reinvestment in future art, it is possible that the \$30 could have been better invested in the artists' own work. Even from 1958 and 1959 through 1963, the prices for their art increase substantially. We note that it is theoretically possible for prices to continue to rise at an increasing rate in the future. We are not able to model non-linear growth rates in this study because we are imputing the linear average return from a single price-determination event (i.e., a future auction) and do not have a marked-to-market price for each year. The logic still applies, nonetheless, that the artist is equivalent to a growth-phase operating company that should reinvest earnings in research and development rather than pay stockholders dividends to reinvest in markets when the company's return on capital is higher than that of the market.

hypothetical art collector who purchased all ten of the Rauschenberg's works in our study directly from Castelli Gallery when they were first sold is given an index value of 100 in 1959. By 2016, after the last work of Rauschenberg is sold, that portfolio has an index value of 2.86 million (2,861,688). By contrast, the S&P index would have gone from 100 to 18,286. The Rauschenberg's works taken together outperform the S&P index by 156 times. A comparable hypothetical Johns portfolio indexed to 100 in 1958 (the first year of a Johns' sale with Castelli) to 2005 (following the last sale), would have grown to 16.1 million (16,124,098) by 2004. Over the same period, the S&P index would have gone from 100 to 10,177. The Johns' works taken together outperform the S&P by 1,584 times.

Lastly, to explore the venture capital aspect of how important it would have been to invest at the absolute earliest point, we create an individual artist's portfolio for each of Johns and Rauschenberg, including only the first four works in our sample, and assign a ten percent retained equity to each artist.¹⁷

.....
 Insert Table 5 about here

As one can see in Table 5, the returns relative to the S&P 500 become strong already by the 1970s.¹⁸ We find that if Rauschenberg had taken that ten percent as cash and invested it in the S&P 500 index, he would have taken \$340 and generated \$37,654 by 2007 (when the last work of those first four sold). By comparison, if Rauschenberg

¹⁷ These are four works by Rauschenberg in 1959 and four works by Johns clustered in 1958, the first years of their inaugural solo exhibitions, respectively (see Table 5).

¹⁸ The left side of Table 5 shows the portfolio for the four works by Rauschenberg that were sold in 1959. The right side shows the portfolio of the four works by Jasper Johns that were sold in 1958. We show the number of works in the portfolios (in columns 2 and 6) as starting at four and dwindling to one. The portfolio life ends when the last of the four works is sold at auction—in 2005 for Johns and in 2007 for Rauschenberg, respectively. (Because our indices run from July 1 to June 30, the end date is during the calendar year after the last auction sales, which were in 2004 and 2006, respectively.)

had retained \$340 worth of equity in his own artwork in 1959, that investment would have grown to \$7,145,000 by 2007. Comparably for Johns, he would have invested \$350 in the S&P index in 1958, growing to \$35,620 by 2005. That \$350 as retained equity would have generated \$9,730,000 by the end of the same period. For the four-artwork, inaugural year retained equity portfolio, Rauschenberg would have outperformed the S&P index 190 times over, and Johns would have outperformed it 273 times over. Even if the artists had taken 50% of the purchase prices and, instead of using this income to cover basic living expenses, had invested it in the S&P index, Rauschenberg's \$1,700 would have grown to \$188,272 and Johns' \$1,750 would have become \$178,098.

In addition, the success of the retained equity portfolio does not require all four of the works to have done well. Even retained ten percent equity in one of the works alone would have vastly outperformed the S&P. The returns on these early retained equity portfolios overall are perhaps best described as too large to graph.

These numbers are not important as predictive but as markers of the opportunity cost to artists of the gap between what they are paid when a work first sells and the price later paid for that work at auction. We note this enormous opportunity cost not to imply that one should time travel to 1958 but that the artists created value the same way that the early investors and founders of Apple and Google did, but the artists did not own equity. They took risk and generated value, but the structure of the art market did not let them capture it. And typical art market investment analysis has never been able to show us the true scale of this gap. Our work is the first to ...This opportunity cost is even more significant considering that the artists and dealers have also shouldered the original costs of production as well.

IV. MANAGERIAL IMPLICATIONS

The main implication of our work is that modeling equity portfolios for artists changes the fundamental structure of art markets. Structurally, equity shares accurately reflect the artist's role as an early stage self-investor, akin to a start-up founder. The existence of these equity shares catalyzes the follow-on development of a secondary marketplace in which these shares can be traded, independent of while also pegged to the trade in the work of art itself. The capacity to trade those equity shares separately from the sale of the artworks is what opens up market-driven patronage for artists and diversifiable art funds for investors.

This system is more flexible, much less costly to oversee, and more compatible with technological management than resale royalties. One can think of the artists and the dealers as analogous to entrepreneurs and venture capital investors, covering early operating costs at significant risk before later investment returns become known.

While retaining equity may not benefit all artists financially, owning the shares creates vital optionality for artists on the occasions in which their early stage work leads to significant, or even modest, market gains. On the investment side, purchasers of the retained equity shares also may not always benefit. Yet the structural possibility of investing in fractional shares of artworks solves for two pernicious problems in art investing: liquidity and severability. The equity shares aid the liquidity challenge because they can be sold more readily and frequently than the original works of art.¹⁹ Additionally,

¹⁹ The equity shares have a significant liquidity advantage over the sale of whole artworks through major auctions that happen twice each year, or through private dealers whose methods are far slower than settlement in privately traded securities. Fractional shares also address the divisibility problem, meaning

investors in whole artworks must have a large overall portfolio to be able to diversify while purchasing whole works.

A system of fractional equity can help artists and investors alike. It gives artists access to investment returns their future careers help to create. It also gives artists access to market-driven patronage should they wish to sell shares onward to fund other projects. It gives collectors an ability to forego the complexity and high transaction costs of trading actual artworks, and also allows collectors to diversify their exposure to art. The fractional shares open up an art market possibility analogous to a stock investor's purchase of an exchange-traded fund (ETF) representing the S&P 500 instead of a whole share of each constituent company.

Many different variations are possible, including structures in which the dealer, who is a significant risk-taker in the early championing and distribution of the art, also participates in the equity. We note that this assignment of equity is not to incentivize artists in any application of labor economics, in the way a stock option might, but simply to correct the structural inequality between the price first paid to the artist and the value that work comes to have. That realignment structurally allows artists to share in the upside potential that their work creates (Whitaker, 2018).

The cases of the artists Jasper Johns and Robert Rauschenberg demonstrate the enormous opportunity cost to the artists in secondary markets. Although, in practice, artists set aside artworks from different periods of their careers that they or their estates later sell,²⁰ our suggested fractional equity approach provides a more flexible, adaptable,

that cutting a physical Johns' painting into pieces would destroy its value but one could in fact own a fraction of the painting through this securitization.

²⁰ In addition to the previously mentioned work that the Rauschenberg Foundation (<https://www.rauschenbergfoundation.org>) does in support of artists, the Joan Mitchell Foundation

and diversifiable tool, and also one that does not require the careful storage of large and valuable works of art.

Completely rethinking compensation and reward around creative work could dovetail well 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 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. In the case of managing fractional equity for art, the blockchain offers a key advantage in lowering the cost of vetting authenticity because the artworks can be issued directly from the artist's studio using the blockchain (Whitaker, 2018).

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. 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 up 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. As stated earlier, we did not intend this work, by any means, to extend to describe the likely trajectory of all artists in markets.

(<http://joanmitchellfoundation.org>) is also a noteworthy supporter of artists' grants and programs. Those foundations are supported by the artistic careers and sale of artworks, both by the artists themselves and others. Artists have often traded or given each other work, and have investments accordingly.

Our work here shows more simply what is possible, and given that large possibility, why the question of shared value matters.

A system of fractional equity has downside risk, of course, but it is not a leveraged asset within this study and so the floor is zero, or is the opportunity cost of foregone gains in other investments. There would surely be many cases in which artists retained equity and received no gains, therefore giving up cash at the moment of sale. Yet to see the potential of the outsize gains leads us to believe that this structural intervention in markets for creative work deserves serious consideration and that it is perhaps artists themselves who should decide whether to take the risk of retained equity. In practice and over time, artists might not even forego income to retain equity; prices might adjust upward.

We see several directions for future research. First, the magnitude of the degree to which the two artists' retained equity portfolios outperformed the market leads us to want to design more conservative tests. As such, we would model larger portfolios with more heterogeneous performance, such as artworks sold in group shows, or whole collections. Second, we plan to develop further the ways of modeling the tax implications of donations and the resulting possibility of asset value truncation through donation, and to build valuation models that take into account artists' costs of production. Third, through appraisal records, we plan to create more of a "mark to market" model rather than a linear imputed return. Finally, we intend to model a more dynamic portfolio construction, i.e., a portfolio with more buying and selling of art, which would start to describe the kind of investor behavior that would grow as fractional shares entered the market and trading in and out of them became relatively liquid.

Fundamentally, artists have a real claim on the added value in art investors' subsequent gains. Outside the arts, markets depend on innovation but lack systems to align rewards for creative risk with pay. 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 art 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 purpose of this study is broader than whether the artists receive a good investment return. The sheer act of assigning the equity is a structural alignment of price and value that generalizes beyond fine art, to represent ways of making the risks of research and development in early stage creative work in any field 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 the value created by labor, broadly defined. 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.
- Baumol, W. 1986. Unnatural value: Or art investment as floating crap game. *American Economic Review*, 76: 10–14.
- Bernstein, R., Colman-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.

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

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.

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*, forthcoming.

Figure 1: Robert Rauschenberg's *Forge*: Different returns by primary-market and repeat-sales methods

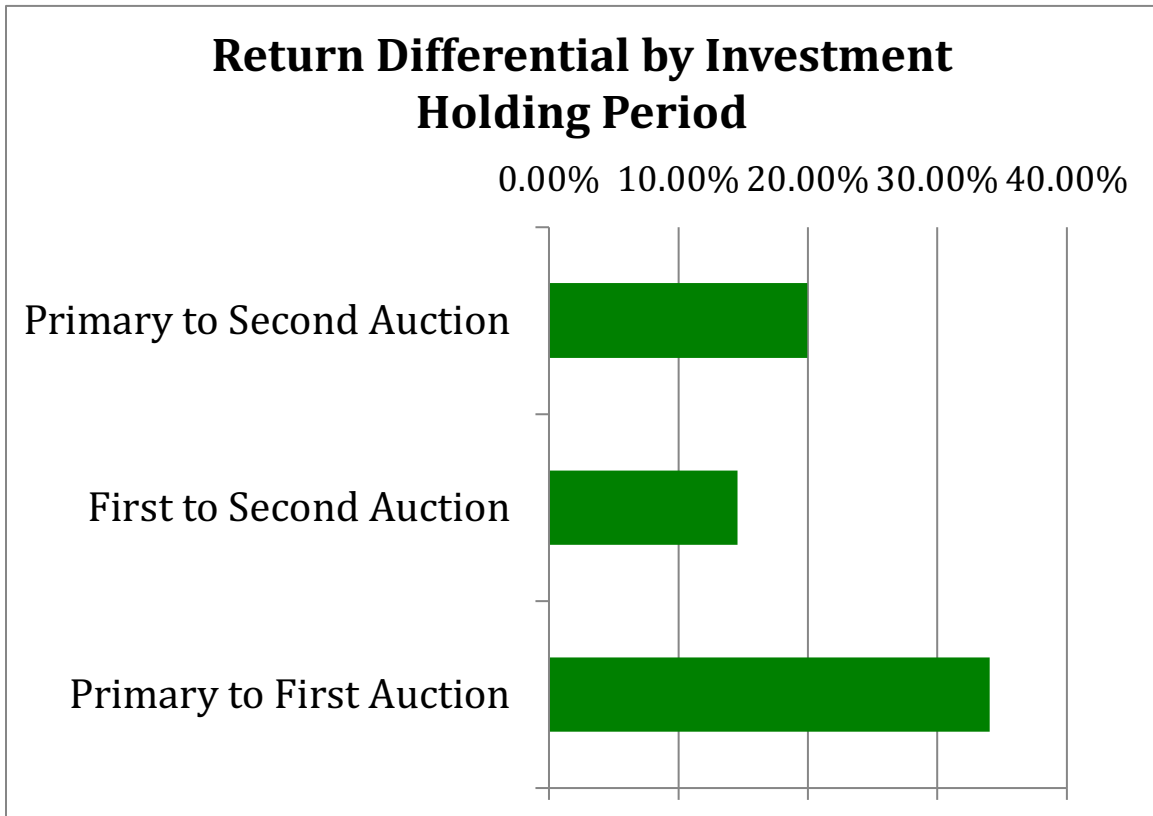


Table 1. Annualized Return on Investments: Robert Rauschenberg

Original sales data for works sold by Castelli Gallery 1959-1963, combined with 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	Resold at Auction	Hammer Price USD	Gain or Loss USD	Percentage Gain	Annualized ROI
1	State (1958)	1959	300	Sotheby's NY, May 14, 1998	440,000	439,700	146,566%	20.62%					
2	Thaw (1958)	1959	900	Sotheby's NY, October 18, 1973	85,000	84,100	9,344%	37.41%					
3	Forge (1959)	1959	1,000	Pierre-Marie Rogeon Paris, June 27, 1973	60,563 (255,000 FF)	59,563	5,956%	34.06%	Christie's NY, May 16, 2007	6,200,000	6,139,437	10,137%	14.63%
4	The Red Painting (1954)	1959	1,200	Christie's NY, November 8, 1983	420,000	418,800	34,900%	27.17%					
5	Rebus (1955)	1961	2,800	Sotheby's NY, November 10, 1988	5,750,000	5,747,200	205,257%	32.12%	Sotheby's NY, April 30, 1991	6,600,000	850,000	14.78%	5.74%
6	Glider (1962)	1963	7,500	Christie's NY, November 14, 1995	750,000	742,500	9,900%	15.28%					
7	Calendar (1962)	1963	7,500	Christie's NY, May 13, 2015	2,741,000	2,733,500	36,447%	12.04%					
8	Dry Run (1963)	1963	4,000	Sotheby's NY, November 17, 1998	900,000	896,000	22,400%	16.53%	Christie's NY, November 15, 2000	800,000	-100,000	-11.11%	-5.73%
9	Exile (1962)	1963	3,500	Sotheby's NY, November 9, 2010	7,100,000	7,096,000	202,757%	17.43%					
10	Overcast II (1962)	1964	12,000	Christie's NY, November 9, 1979	170,000	158,000	1,317%	18.83%					

Table 2. Annualized Return on Investments: Jasper Johns

Original sales data for works sold by Castelli Gallery 1959-1963, combined with 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	Resold at Auction	Hammer Price USD	Gain USD	Percentage Gain	Annualized ROI
1	Small Green Target (1956)	1958	150	Sotheby's NY, November 9, 2004	3,000,000	2,999,850	1,999,900 %	23.80%					
2	Grey Numbers (1957)	1958	350	Christie's NY, November 9, 1988	260,000	259,650	74,186%	24.31%	Christie's NY, November 11, 2003	4,700,000	4,400,000	1,708%	21.26%
3	White Flag (1955)	1958	2,000	Christie's NY, November 9, 1988	6,400,000	6,398,000	319,900%	30.43%					
4	Tennyson (1958)	1958	1,000	Sotheby's NY, November 18, 1970	70,000	69,000	6,900%	40.90%					
5	Target (1958)	1959	200	Sotheby's NY, November 10, 1986	280,000	279,800	139,900%	30.29%					
6	Newspaper (1957)	1959	450	Christie's NY, May 7, 1997	600,000	599,550	133,233%	20.92%					
7	Colored Alphabet (1959)	1959	175	Christie's NY, May 3, 1989	3,200,000	3,199,825	1,828,471 %	38.91%					
8	False Start (1959)	1960	1,000	Sotheby's NY, November 10, 1988	15,500,000	15,499,000	1,549,900 %	40.50%					
9	Gray Rectangles (1957)	1963	12,000	Sotheby's NY, November 10, 1988	3,900,000	3,888,000	32,400%	25.59%					

Table 3. Returns on 10% Retained Equity Portfolio: Robert Rauschenberg

Comparison of the investment return the artist would have received by retaining 10% equity in his artworks vs. investing the cash. The right-most column, 10% of the hammer price, is the investment return on the equity. We highlight the comparison to the S&P.

No.	Artwork	Price USD Gallery	10% of Gallery Price	Invested in S&P 500	Invested in 3-month T-bills	Invested in 10-year Treasury bonds	Hammer Price USD at Auction	10% of Auction Hammer Price	Ratio Auction Hammer Price / S&P 500 Investment
1	State (1958)	300	30	2,417.10	289.20	443.70	440,000	44,000.00	18.2
2	Thaw (1958)	900	90	169.20	177.30	159.30	85,000	8,500.00	50.2
3a (until first secondary sale)	Forge (1959)	1,000	100	254.00	182.00	174.00	60,563	6,056.30	23.8
3b (until second secondary sale)				11,075.00	1,296.00	2,333.00	6,200,000	620,000.00	56.0
4	The Red Painting (1954)	1,200	120	882.00	543.60	422.40	420,000	42,000.00	47.6
5a (until first secondary sale)	Rebus (1955)	2,800	280	4,082.40	1,671.60	1,638.00	5,750,000	575,000.00	140.8
5b (until second secondary sale)				5,154.80	1,898.40	1,999.20	6,600,000	660,000.00	128.0
6	Glider (1962)	7,500	750	24,900.00	5,887.50	7,170.00	750,000	75,000.00	3.0
7	Calendar (1962)	7,500	750	96,525.00	8,902.50	20,160.00	2,741,000	274,100.00	2.8
8a (until first secondary sale)	Dry Run (1963)	4,000	400	27,424.00	3,608.00	4,436.00	900,000	90,000.00	3.3
8b (until second secondary sale)				21,992.00	3,956.00	5,460.00	800,000	80,000.00	3.6
9	Exile (1962)	3,500	350	25,557.00	4,137.00	8,960.00	7,100,000	710,000.00	27.8
10	Overcast II (1962)	12,000	1,200	3,576.00	3,120.00	1,968.00	170,000	17,000.00	4.8

Table 4. Returns on 10% Retained Equity Portfolio: Jasper Johns

Comparison of the investment return the artist would have received by retaining 10% equity in his artworks vs. investing the cash. The right-most column, 10% of the hammer price, is the investment return on the equity. We highlight the comparison to the S&P.

No.	Artwork	Price USD Gallery	10% of Gallery Price	Invested in S&P 500	Invested in 3-month T-bills	Invested in 10-year Treasury bonds	Hammer Price USD at Auction	10% of Auction Hammer Price	Ratio Auction Hammer Price / S&P 500 Investment
1	Small Green Target (1956)	150	15	1,526.55	183.30	303.15	3,000,000	300,000.00	196.5
2a (until first secondary sale)	Grey Numbers (1957)	350	35	726.95	227.15	227.15	260,000	26,000.00	35.8
2b (until second secondary sale)				3,397.80	415.10	687.75	4,700,000	470,000.00	138.3
3	White Flag (1955)	2,000	200	4,154.00	1,298.00	1,298.00	6,400,000	640,000.00	154.1
4	Tennyson (1958)	1,000	100	279.00	170.00	159.00	70,000	7,000.00	25.1
5	Target (1958)	200	20	241.80	109.20	104.60	280,000	28,000.00	115.8
6	Newspaper (1957)	450	45	2,825.10	414.45	579.15	600,000	60,000.00	21.2
7	Colored Alphabet (1959)	175	17.50	324.28	110.08	116.56	3,200,000	320,000.00	986.8
8	False Start (1959)	1,000	100	1,847.00	610.00	597.00	15,500,000	1,550,000.00	839.2
9	Gray Rectangles (1957)	12,000	1,200	15,648.00	6,756.00	6,528.00	3,900,000	390,000.00	24.9

Table 5. Rauschenberg and Johns Retained Equity Portfolios for Each Artist's First Four Sales at Castelli
As if the artists had retained 10% equity vs. not retained equity and also invested the entire 50% cash in the S&P index.

Year	RR Artworks in Portfolio	Value if RR's 10% invested in S&P 500	Value if RR's all (50%) invested in S&P 500	RR 10% at auction	JJ Artworks in Portfolio	Value if JJ's 10% invested in S&P 500	Value if JJ's all (50%) invested in S&P 500	JJ 10% at auction
1958					4	350	1,750	0
1959	4	340	1,700	0	4	392	1,961	0
1960	4	341	1,706	0	4	394	1,968	0
1961	4	432	2,160	0	4	498	2,492	0
1962	4	394	1,970	0	4	454	2,272	0
1963	4	483	2,415	0	4	557	2,786	0
1964	4	562	2,812	0	4	649	3,244	0
1965	4	632	3,161	0	4	729	3,646	0
1966	4	569	2,845	0	4	656	3,282	0
1967	4	705	3,523	0	4	813	4,064	0
1968	4	781	3,903	0	4	901	4,503	0
1969	4	716	3,582	0	4	826	4,132	0
1970	4	742	3,709	0	4	856	4,279	0
1971	4	847	4,237	0	3	977	4,887	70,000
1972	4	1,006	5,032	0	3	1,161	5,804	70,000
1973	4	862	4,312	0	3	995	4,974	70,000
1974	3	639	3,195	85,000	3	737	3,685	70,000
1975	3	875	4,377	85,000	3	1,010	5,049	70,000
1976	3	1,084	5,420	85,000	3	1,250	6,252	70,000
1977	3	1,008	5,042	85,000	3	1,163	5,816	70,000
1978	3	1,074	5,370	85,000	3	1,239	6,195	70,000
1979	3	1,273	6,364	85,000	3	1,468	7,342	70,000
1980	3	1,677	8,384	85,000	3	1,934	9,672	70,000
1981	3	1,598	7,990	85,000	3	1,843	9,217	70,000
1982	3	1,924	9,622	85,000	3	2,220	11,100	70,000
1983	3	2,354	11,772	85,000	3	2,716	13,579	70,000
1984	3	2,499	12,496	505,000	3	2,883	14,414	70,000
1985	2	3,280	16,399	505,000	3	3,783	18,917	70,000
1986	2	3,886	19,431	505,000	3	4,483	22,415	70,000
1987	2	4,112	20,560	505,000	3	4,744	23,718	70,000
1988	2	4,792	23,961	505,000	3	5,528	27,640	70,000
1989	2	6,301	31,504	505,000	3	7,268	36,342	70,000
1990	2	6,108	30,540	505,000	1	7,046	35,230	6,730,000
1991	2	7,954	39,772	505,000	1	9,176	45,880	6,730,000
1992	2	8,550	42,751	505,000	1	9,863	49,316	6,730,000
1993	2	9,403	47,013	505,000	1	10,847	54,233	6,730,000
1994	2	9,528	47,639	505,000	1	10,991	54,954	6,730,000
1995	2	13,072	65,360	505,000	1	15,079	75,397	6,730,000
1996	2	16,037	80,184	505,000	1	18,499	92,497	6,730,000
1997	2	21,345	106,725	505,000	1	24,623	123,114	6,730,000
1998	2	27,394	136,971	945,000	1	31,601	158,004	6,730,000
1999	1	33,117	165,584	945,000	1	38,202	191,011	6,730,000
2000	1	30,126	150,632	945,000	1	34,753	173,763	6,730,000
2001	1	26,556	132,782	945,000	1	30,634	153,172	6,730,000
2002	1	20,722	103,610	945,000	1	23,904	119,520	6,730,000
2003	1	26,599	132,993	945,000	1	30,683	153,416	6,730,000
2004	1	29,455	147,277	945,000	1	33,979	169,893	6,730,000
2005	1	30,878	154,390	945,000	1	35,620	178,098	9,730,000
2006	1	35,698	178,491	945,000				
2007	1	37,654	188,272	7,145,000				

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 180⁰⁰
oil on brown paper 8' x 17'
(Mus. of Mod. Art L.S. Dec 6, 57)
2. "Collage Elap", 1955 1954-55 300⁰⁰
wax on decoprint + ~~9 1/4 x 9 1/4~~ 22 1/2 x 19 1/4
(Zabriskie Collage Show, Oct, 1959)
3. "No 1", 1955 300⁰⁰
17 1/2 x 18 3/4 wax, decoprint on canvas
Not in show
4. "No 5", 1955 300⁰⁰
17 1/2 x 14 wax, decoprint on canvas
5. "No 7", 1955 300⁰⁰
17 1/2 x 14 wax, decoprint on canvas
Not in show
6. "Small green target", 1956 No.-
decoprint + wax 9 1/4 x 9 1/4
7. "No 1" drawing, 1956 9 1/2 x 7 1/2 150⁰⁰
pencil on paper Not in show
8. "Flag" drawing, 1957 150⁰⁰
pencil on paper 10 1/2 x 15 Not in show

9. "Small grey target", 1957 sold 170⁰⁰
wax on canvas ~~9 1/4 x 9 1/4~~ 12 x 12
10. "Tiny numbers", 1957 sold
oil on paper 8 x 5 3/4 120
11. "Large green target", 1955 M.A.W. 1000⁰⁰
60 x 60 1/2 wax on decoprint + canvas
12. "Orange flag", 1957 L.C. 1000⁰⁰
oil on canvas 66 x 49
13. "The dragon", 1957 500⁰⁰
wax on canvas 30 1/2 x 30 3/8
14. "The windows", 1956 500⁰⁰
wax on canvas 30 x 25
15. "The capogrey letters", 1956 B.H. 1200⁰⁰
1956-57 decoprint, wax on canvas 66 x 49
16. "Grey rectangles", 1957 900⁰⁰
60 x 60 oil on canvas
wax
17. "Tango", 1955 Not in show Taimaine 700⁰⁰
43 x 55 wax on canvas
18. "Large target" construction 1200⁰⁰
19. 51 x 44 plants 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	Date	OUT 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'	19	1500			
	85" x 37 1/4", 1957					
2/28/58	'Satellite' with pheasant, 80" x 42 1/2", 1955	20	1200	6/58	NEWPORT FESTIVAL - R.R.	2/3/59
2/28/58	'Interior' with man's hat 45" x 46 1/2" 1956 N.F.S.	21	800 ⁰⁰	12/58	A.F.A. ART and THE FOUND OBJECT	
2/28/58	'Rebus' 18" x 12" 1955	22	2800	5/58	R.R.	
2/28/58	'Memorandum of Bid' 59" x 45"	23	750	10/8/58	Returned to BR	3/2/59
				3		
2/28/58	'The Bed' Construction, with pillow and quilt 74" x 31", 1955	24	1600	4/17/58	'Festival of Two Worlds', Spoleto	9-10-58
				10/8/58	R.R.	
				12/58	from RR 'ART AND THE FOUND OBJECT' - A.F.A. - to RR	
				5/1/59	(M. M. M.) DOCUMENTA II - Kassel, Germany	
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

<u>TITLE</u>	<u>SIZE</u>	<u>SQUARE INCHES</u>	<u>PRICES</u>
Express	120" x 72"	8640 sq. "	\$15,000.-12,000
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 30½"	1527 sq. "	\$3000. 2500 ⁰⁰
Renasence	36" x 36"	1290 sq. "	\$2500.
Unbrellas	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
' Tange '	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 '	The Museum of Modern Art, New York
' White Numbers '	
' Grey Flag '	Dr. James Holderbaum
' Target with Four Faces '	Museum of Modern Art, New York

Recent Issues

All CFS Working Papers are available at www.ifk-cfs.de.

No.	Authors	Title
593	Petrus Ferreira, Roman Kräussl, Wayne R. Landsman, Maria Nykyforovych, and Peter Pope	Reliability and Relevance of Fair Values: Private Equity Investments and Investee Fundamentals
592	Volker Brühl	<i>Clearing of euro OTC derivatives – a milestone on the road to a Capital Markets Union in Europe</i>
591	Günther Gebhardt and Zoltán Novotny-Farkas	<i>Comparability and predictive ability of loan loss allowances – The role of accounting regulation versus bank supervision</i>
590	Enikő Gábor-Tóth and Dimitris Georgarakos	<i>Economic Policy Uncertainty and Stock Market Participation</i>
589	Christos Koulovatianos, Jian Li, and Fabienne Weber	<i>Market Fragility and the Paradox of the Recent Stock-Bond Dissonance</i>
588	Volker Brühl	<i>Clearing of euro OTC derivatives post Brexit - an analysis of the present cost estimates</i>
589	Christos Koulovatianos, Jian Li, and Fabienne Weber	<i>Market Fragility and the Paradox of the Recent Stock-Bond Dissonance</i>
588	Volker Brühl	<i>Clearing of euro OTC derivatives post Brexit - an analysis of the present cost estimates</i>