

Art Portfolios

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Abstract: Art market returns have previously been inferred from equally-weighted price indexes. By contrast, we examine the returns from art *portfolios*. We do this through detailed analysis of the art collection of economist John Maynard Keynes, supplemented by research on simulated portfolios based on auction prices. We document (1) substantial cross-sectional dispersion in portfolio returns, (2) performance that is predisposed to transaction-specific risk, (3) return skewness that causes most portfolios to generate below-average performance, (4) portfolio concentration that amplifies idiosyncratic risk, and (5) average returns that vary according to the purchase channel. We present implications for users of art price indexes.

Keywords: alternative investments; art; portfolios; price indexes; indivisible assets; concentration.

JEL codes: B26; C43; G11; G12; G14; Z11.

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I. Introduction

A significant portion of the assets of wealthy households is invested in art. There are 190,000 ultra high-net-worth individuals around the world, with assets averaging US\$100 million, 40% of whom collect art and other collectibles (Knight Frank (2017)). In the United States, the wealthiest individuals insure their artworks up to an average value of \$20 million (AIG (2016)). Given its dual nature as a consumption and an investment good, the motives for purchasing art are of course mixed. Hence, financial considerations are likely to be relevant for most collectors, even those who primarily buy art for personal pleasure (Lovo and Spaenjers (2016)). Historically, art has delivered a risk premium. Prior studies constructing art price indexes from auction results have estimated an excess return that is positive but substantially less than the equity risk premium.¹ This literature includes Baumol (1986), Goetzmann (1993), Mei and Moses (2002), Renneboog and Spaenjers (2013), and Korteweg, Kräussl, and Verwijmeren (2016).

However, such transaction-based price indexes may not accurately capture the investment experience of art buyers. First, in contrast to financial asset indexes, art indexes are not investable and no implementable strategy can replicate index returns. Second, art investment is lumpy and most collections—including those of great value—comprise a small number of items and are undiversified. Third, existing indexes give equal weight to each artwork and, in contrast to capitalization-weighted indexes, fail to be macroconsistent (Singer and Terhaar (1997), Sharpe (2007)). Fourth, while indexes aim to measure how a lump-sum investment would have grown over time, they reveal little about the realized performance of art buyers who typically spread their transactions over time. As Dichev (2007), Dichev and Yu (2011), and Hsu, Myers, and Whitby (2016) show, investors' money-weighted returns tend to lag index returns, but until now there has been no study of art investors' money-weighted returns.

The aim of this paper is to assess the risk-return characteristics of art by looking beyond the analysis of an aggregated price index. We do this by evaluating the characteristics of art portfolios of a realistic size. Ideally, our starting point would be a representative sample of art collection histories including purchase and sale prices for all portfolio constituents. Unfortunately, such data do not exist, not least due to the absence of detailed records on collectors' purchase transactions. Therefore, we approach the

¹ Between 1900 and 2016, the annualized real capital appreciation of the art index estimated by Goetzmann, Renneboog, and Spaenjers (2011), updated using the UK art market index of Artprice.com (2017), was 2.3%. This exceeds the real GBP return on UK Government bonds (1.8%) and on UK Treasury bills (1.0%) but is lower than the real return on UK equities of 5.5%; it also exceeds the real USD return on worldwide Government bonds (1.8%) and on worldwide Treasury bills (0.8%) but is lower than the real return on worldwide equities of 5.1% (Dimson, Marsh, and Staunton (2017)).

problem using two different—but complementary—strategies. First, we have been able to construct a long-run valuation history for one *actual art portfolio*, namely the collection assembled by the economist John Maynard Keynes, which is now owned by King’s College, Cambridge. Second, we examine whether the portfolio features we report for the Keynes collection are likely to be prevalent in other art portfolios. To do this, we simulate valuation histories of a large number of *hypothetical art portfolios*, using actual transaction prices for pairs of purchases and sales of the same work. In both settings, we study portfolio composition and performance, and the drivers of performance.

1.1. Actual art portfolio

It is well known that John Maynard Keynes (1883–1946) was an active investor in financial assets, and studies include Moggridge (1982), Fantacci, Marcuzzo, and Sanfilippo (2010), Chambers, Dimson, and Foo (2015), and Accominotti and Chambers (2016). Less well known is that Keynes became an enthusiastic and avid art collector. Keynes purchased artworks through various channels between 1917 and 1945, and bequeathed his entire art collection to King’s College upon his death the following year. This collection consists of over a hundred pieces by both Modern Masters (e.g., Braque, Cezanne, and Matisse) and friends and acquaintances of Keynes (e.g., Duncan Grant and Vanessa Bell). The collection has remained intact to the present day. For a majority of the works, we locate purchase prices and dates from Keynes’ own invoices and correspondence kept at King’s College together with a few purchase prices from alternative art historical sources. The archival records also contain multiple valuations and auction estimates post-dating Keynes’ death. Moreover, we are able to procure expert appraisals of market value for the important works in the collection at the end of 2013.

We use our hand-collected data to compute the total expenditures by Keynes on his collection over the period 1917–1946, and to estimate overall valuations for the years 1946, 1959, 1981, 1988, 2000, and 2013. The collection appreciated strongly over time: while Keynes’ total expenditures amounted to less than 13 thousand British pounds, the collection had an estimated market value of more than 70 million pounds at the end of 2013. This translates into a nominal internal rate of return (IRR) of 10.9% (6.2% in real terms). If Keynes had invested his outlays on art in UK equities instead, the year-2013 value of these investments would have been only 5% higher; the annualized underperformance relative to the equity market is only 0.1%. The collection performed especially well shortly after purchase, suggesting that Keynes was able to buy art at attractive prices.

Keynes’ art portfolio displays several interesting attributes that are likely to be representative of art portfolios in general. First, there is clear evidence of transaction-specific risk—a time-independent

random component in each purchase and sale price—in the art market. We compare estimated appreciation from purchase to the 1946 appraisal with subsequent appraisal-to-appraisal appreciation, and observe much more variation in the earlier period. Furthermore, we show that even appraisals—subjective estimates of *expected* transaction prices—exhibit substantial disparity between valuers.² Second, there is positive skewness in the cross-section of his artwork returns. In particular, we find that an important element in the long-term growth of the value of the art collection is the stellar performance of one item. Third, a striking feature of the Keynes collection is its high concentration: the ten most expensive purchases represent 80% of his aggregate expenditure on art. It follows that changes in the total value of the collection have been driven largely by price appreciation in the big-ticket items. Finally, the Keynes collection reveals the influence of the purchase channel on the cross-sectional variation in returns to art. In keeping with most art collector-investors, Keynes acquired pictures not only at auction, but also from artists, galleries, and dealers. Examining the performance of artworks between acquisition and Keynes’ death in 1946, we document lower annualized returns on works bought in the primary market.

Our dataset is almost unique. It is one of only two complete, or near-complete, financial records of an art collection from initial purchase to final valuation, and it is the sole dataset to include intervening valuations. The other is that of Victor and Sally Ganz, whose collection was largely sold in a high-profile auction at Christie’s that attracted attention because, as Vogel (1997) reported at the time, it was the largest private-owner art sale in history. The record-breaking Ganz sale gave rise to the only other research on returns realized from an actual art portfolio, namely the study by Landes (2000). The Ganz collection was selected with hindsight for research because of its extraordinary financial value at the time of resale. In contrast, the Keynes collection is less exposed to the criticism of *ex post* selection, since Keynes’ claim to fame is unrelated to his activities as an art collector.

A few recent studies focus on individual investors in other asset markets. Robinson and Sensoy (2016) explore the private equity investments of one large institutional limited partner in order to learn more about the liquidity properties of private equity cash flows. Their paper illustrates the value of examining a single portfolio when limitations arise with index data. Frazzini, Kabiller, and Pedersen (2013) analyze the determinants of Warren Buffett’s success, and connect to a debate on the “implementability” of academic factors. Similarly, we study the return drivers of an actual art investor’s portfolio, and discuss

² While the average predictive power of pre-auction price estimates has been studied previously (e.g., Louargand and McDaniel (1991), Bauwens and Ginsburgh (2000), Ashenfelter and Graddy (2003)), nobody has hitherto looked at differences of opinion across experts for the same artworks.

how the results change the current academic view on art as an asset class. Finally, Temin and Voth (2004) look at the trading behavior of one investor in the South Sea bubble in 1720. Their study shows how historical evidence can shed light on competing theories of stock market bubbles.

1.2. Hypothetical art portfolios

In our study of the Keynes collection, we have tracked a complete collection over time together with the valuation history of its constituent artworks. This sidesteps the problem usually faced by researchers trying to estimate the performance of a set of artworks, namely that at each valuation date most values are unobserved (Korteweg, Kräussl, and Verwijmeren (2016)). Nevertheless, our work on Keynes is ultimately a clinical study of a single portfolio. In an ideal world we would like to examine many such portfolios, but the data do not exist.

Instead, we perform a historical simulation of many different portfolios. Artworks for our hypothetical art collections are sourced from a database of global auction purchase and resale price pairs over the period 1980–2015, from which we create portfolios by randomly sampling subsets of different sizes, ranging from 10 to 100 items. Associated average aggregated spending ranges from about \$2 million to about \$20 million. We measure the performance of each portfolio by computing its IRR. For each selected portfolio size, we then bootstrap 1,000 portfolios, yielding a distribution of returns. Even in the largest art collections (containing 100 works) there is a very substantial cross-sectional dispersion in portfolio returns, with a gap of at least 12 percentage points between the return on the 5% best-performing portfolios and the return on the 5% worst-performing portfolios. It is clear that portfolio diversification is less effective in the art market than in the stock market.

Following Kaplan and Schoar (2005), we estimate the public market equivalent (PME) for art portfolios. We find that nearly one in three small art portfolios and nearly one in six large art portfolios have an equity-beating PME of more than one. So even though art collections on average underperform the equity market, a substantial minority of art investors do better than they would have if they had invested in equities.

One source of variation in performance is the transaction-specific risk mentioned before. Art investors have no control over the bidding population at the time of resale, and resale prices may deviate from expectations. To evaluate the impact of this transaction-specific risk, we repeat our simulation exercise with average pre-sale estimates instead of transaction prices at the time of resale. We find that the variation in IRRs is still substantial, but much smaller than before. For example, for a 100-work

portfolio, the gap between the 5th and the 95th percentile of the estimated IRR distribution shrinks from about 12 to less than 7 percentage points. Similarly, when relying on estimates at resale to compute PME, it would appear that only 9 percent of 100-work portfolios outperform the equity market, compared to 18 percent when PMEs are computed using transaction prices.

Two additional factors—already discussed in the context of Keynes’ portfolio—contribute to the spread in portfolio returns that characterizes art investors’ exposure to idiosyncratic risk. First, there is the positive skewness in individual artwork appreciation, which manifests itself in both the increase in median IRRs as the size of the simulated portfolios grows and the underperformance of the median portfolio relative to the average IRR. Second, the average art portfolio is very concentrated; for example, an art collector buying 100 artworks at random would have spent on average \$19.1 million, but 28.8% of this amount would have gone to one work only.

This paper connects to a long tradition of papers looking at simulation-based hypothetical portfolios to evaluate the riskiness of stocks, starting with Evans and Archer (1968) and Latané and Young (1969). Turning to alternative asset classes, Fisher and Goetzmann (2005) compute IRRs in simulated portfolios of commercial real estate, using data on purchases and sales by institutional investors. Adopting their view that illiquid and indivisible assets should not be analyzed solely through the lens of price indexes, we follow a methodological approach similar to theirs.

The remainder of this paper is structured as follows. In Section II, we describe the two data sets used in our research. In Section III, we estimate the returns from the Keynes collection and make comparisons with art portfolios in more recent times. In Section IV, we explore the determinants of Keynes’ investment returns, and test the validity of our observations on a large sample of simulated art portfolios. In Section V, we conclude by summarizing our findings and discussing implications for the use of auction-based price indexes as a measure of art’s investment performance.

II. Data

In this section, we review the two datasets used in our study. First, we describe the hand-collected records used to evaluate the portfolio returns delivered by the Keynes art collection. Second, we present the data used in the simulations of the financial returns from investing in portfolios of artworks.

II.1. Actual art portfolio

Following the death of John Maynard Keynes in 1946, the ownership of his art collection passed to King's College, Cambridge. After his wife, Lydia Lopokova, died in 1981, King's College took physical possession of the collection, and the major items were housed at the University's Fitzwilliam Museum. The departure point for assembling our data is the memorandum on the Keynes collection prepared by Richard Kahn (1959), who had succeeded Keynes as the bursar of King's College in 1946. This document provides information on the artist, title, and size for all 135 pieces in the collection. The memorandum groups together artworks according to their year-1959 location. It includes 26 pictures held at King's College, 23 works on loan to the Fitzwilliam Museum, 85 in the Fitzwilliam picture reserve, and a portrait of Keynes by Duncan Grant on loan to Milo Keynes.

Table 1 summarizes the distribution of artworks by artist. In keeping with Keynes' personal passion for art as described in Appendix A, it is not surprising that the collection contains many works by Bloomsbury Group artists and friends such as Grant, Bell, and Roberts, and items by Impressionist and Post-Impressionist artists such as Braque, Cezanne, Degas, and Picasso.³ The table also shows whether the artist was included in the first edition of the influential art history textbook '*Art Through the Ages*,' published in 1926 (Gardner (1926)), and in the second, revised edition, published ten years later (Gardner (1936)). It becomes clear that many of the Continental European artists bought by Keynes were becoming internationally renowned around the time that he bought them.

[Insert Table 1 about here]

In 1983, the Fitzwilliam Museum organized the exhibition '*Maynard Keynes: Collector of Pictures, Books and Manuscripts*' displaying 85 out of the 135 works in the Keynes art collection. The exhibition catalogue (Scrase and Croft (1983)) provides detailed background information on each of these works. They are the major items—in terms of both artistic significance and monetary value—in the collection; for example, they account for 98% of the total value of the items estimated by Agnew & Sons in 1981 (cf. *infra*).

Having established the artworks in the collection, we search for the prices Keynes paid for its different constituents. Our information comes mainly from the invoices, correspondence, and other documents in *The Papers of John Maynard Keynes* at the King's College Archive, Cambridge (GBR/0272/PP/JMK). From this source, we match his recorded purchases with the artworks in the collection by comparing artist name, title, and year of creation. Further purchase prices are discovered from other sources. We

³ Two of the works were reattributed after 1959: the Courbet was later ascribed to Thomas Couture, whilst the drawing attributed to Ingres was later credited to "after Degas" and then to "Degas, after Ingres". We here use the initial attribution.

consult the relevant sales catalogues in the archives of Christie's and the National Art Library in London in the case of the three purchases made at Christie's and Sotheby's where the archived invoice fails to mention the artist or title of the work. In addition, the prices paid for his seven personal purchases at the Degas sales in March and April 1918 are recorded in catalogues filed in his personal papers. One price match was made through the accounts book of the London Artists' Association found in his personal papers. Three matches were estimated through Reid & Lefevre's (1935) catalogue accompanying an exhibition of William Roberts' work, for which we use the exhibition price of the works acquired by Keynes to liquidate the artist's debt (Roberts (1990)). Finally, David Scrase (2013) recalled that the cubist still life by Georges Braque was bought by Duncan Grant in a bookshop in Berlin in the early 1920s for 30 shillings, a purchase confirmed by Shone and Grant (1975) who do not record the price. In total, we are able to identify purchase prices for 73 out of the 135 works.⁴

Table 1 reports the number of purchase prices that we find for each artist. Many of the items for which we do not have a price are by artists in Keynes' social circle. There are, for example, 19 works by Duncan Grant and four by Vanessa Bell without any documentation on their purchase; Scrase and Croft (1983) state that at least a handful of these items were gifts. Other works without a purchase price have always had virtually no financial value, such as two photographs of frescoes by Signorelli, a map of the county of Sussex, and a number of anonymous oil paintings. A focus on the artworks for which we identified purchase prices should thus permit an accurate estimation of the evolution of the collection's overall value. This view is reinforced by the observation that items for which we have purchase prices accounted for more than 95% of the probate valuation of the collection in 1946 (cf. *infra*), and include all 23 works that were on view at the Fitzwilliam Museum shortly after Keynes' death. Furthermore, there is no reason to suppose that the availability of transaction information in Keynes' correspondence might be correlated with subsequent price appreciation, which mitigates concerns about selection bias in our return estimates.

Table 2 shows the annual time series of his expenditures between 1917 and his last known purchase in 1945, and also lists the most expensive purchase in each year. Consistent with the description of the evolution of the Keynes' collection in Appendix A, the table depicts two main bursts of buying: the years immediately following the end of the First World War and, especially, the mid-1930s. Both periods coincide with years in which Keynes' wealth grew strongly. Scrase and Croft (1983) argue that

⁴ Five of Keynes' purchases took place in French francs. In these instances, we convert the price to British pounds using either the exchange rate used by Keynes or a historical exchange rate from Mitchell (1988). Second, sometimes the disclosed purchase price covered the acquisition of more than one work. To determine the price of the individual items, we either use the breakdown mentioned in Keynes' correspondence, or otherwise divide the total price in equal parts.

Keynes' year-1919 purchases were paid for out of profits from the French edition of *'The Economic Consequences of the Peace'*. Skidelsky (2005) writes that, in 1919, Keynes "earmarked some of his first profits from currency speculation for buying pictures", and that by 1935 Keynes was again making profits on the stock market. The weighted average of the dates at which Keynes acquired his artworks (weighting each year by his outlay on artworks) is 1933, which is coincidentally a year in which Keynes made no purchases at all.

[Insert Table 2 about here]

After Keynes died in 1946, Percy Moore Turner undertook a detailed probate valuation. This document, provided to us by Professor Simon Keynes, grandnephew of John Maynard, includes valuations for 112 out of the 135 artworks in the collection. Following his death, large parts of the collection were valued multiple times. The reputable London art dealer Agnew & Sons (1959) valued 105 items in the collection for insurance purposes, and subsequently Agnew & Sons (1981) carried out a near-complete valuation, covering 131 out of the 135 artworks. An insurance valuation under the Government Indemnity Scheme (1988) covered the works lent by King's College to the Fitzwilliam Museum. The auction house Sotheby's (2000) carried out a new valuation for insurance purposes of 44 works, to which we were given access by King's College and the Fitzwilliam Museum.

We commissioned an open-market valuation from the art advisory and valuation firm Gurr Johns at the end of 2013. This resulted in valuation estimates for 27 important works. In addition, for the 15 works with the highest 1988 insurance valuations, representing more than 90% of the total estimated value in that year (cf. *infra*), we procured four more independent open market valuations from the art market research firm ArtTactic, the art advisory firm and valuer Dickinson, and each of the leading auction houses Christie's and Sotheby's. We provided each of the valuers with a copy of the 1983 exhibition catalogue, but we did not give them access to prior appraisals; nor did we inform them that we were seeking multiple estimates for the same pictures.

II.2. Hypothetical art portfolios

The underlying data for the portfolio simulations is from Auction Club, which holds information on over five million historical art auction transactions worldwide. Lovo and Spaenjers (2016) assemble the research database used in this study and, as well as price information for each successful transaction, they include details on the work (artist, title, medium, size, etc.) and channel (auction location, sale title, lot number, etc). Auction Club does not identify repeated trades of the same works, so Lovo and

Spaenjers match on artist, title, year of execution, and size. They exclude artist-title combinations with more than one year of execution or more than one size or for which there are two transactions within a 100-day period, and we further exclude transaction pairs with under a year between purchase and sale. We study initial purchases made at either Christie's or Sotheby's, but consider resales worldwide. The dataset starts in 1980. This yields 2,185 purchase-and-sale price pairs for 2,082 artworks by 1,183 artists, with an average interval between purchase and sale of 7.9 years.

Table 3 shows the yearly number of purchases and sales and also the yearly median price for both types of transactions. We use hammer prices (in US dollars) at auction and thus do not consider transaction costs, which vary between auction houses and over time. Pooling all years, the last row reports median purchase and resale prices of \$19,413 and \$30,000 respectively.⁵

[Insert Table 3 about here]

We simulate portfolios by randomly sampling subsets of all artworks in the data set. Our subsets are of different sizes, namely 10, 25, 50, and 100 artworks. For each portfolio size, we bootstrap 1,000 portfolios. Each simulated portfolio can be interpreted as capturing a hypothetical art buyer's experience in the global art market over the period 1980–2015. By construction, our hypothetical art collectors start investing in 1980 at the earliest, and have divested completely by the end of 2015.

III. Investor returns from art

In this section, we present estimates of investor returns from art. The term *investor* return indicates that we are measuring the gain (before transaction costs) accrued by the investor, which is typically expressed as a money-weighted return, rather than the investment return on an index, which is typically expressed as a time-weighted return. We first study how the Keynes collection has appreciated over time. We then analyze the hypothetical portfolios, which allow us to study the extent of variation in performance across investors.

III.1. Actual art portfolio

Starting with the 73 works for which we have purchase prices, we compute Keynes' aggregate nominal expenditure over the period 1917–1945. We also estimate the aggregate year-1946, year-1959, year-

⁵ Reflecting the skewed distribution of prices, the mean purchase and resale prices are \$196,026 and \$346,368 respectively; the annualized log return on resale has a mean of 6.0% and a median of 5.0%; the standard deviation of annualized log returns is 20.2%; and the return distribution has skewness of +1.16 and kurtosis of 23.0 (not reported in Table 3).

1981, year-1988, year-2000, and year-2013 valuations. For 2013 we start from the Gurr Johns valuations. For a number of artworks, typically those of lesser value where we do not have valuations for every time period, we impute valuations. Details on this procedure can be found in Appendix B.

Table 4 shows the resulting evolution of the estimated value of the Keynes collection. The 1917-45 valuation is the expenditure on—and hence the book value of—the collection. Based on his known expenditures, Keynes invested a total of £12,847 in his art portfolio. The year-2013 valuations reflect estimates of the resale value of the artworks at auction. However, the valuations conducted between 1946 and 2000 are slightly different in nature, and may not be unbiased estimates of market value. The year-1946 probate valuation is likely to have been a conservative one, as the extent of death duties payable on the picture bequest was not yet clear at that time. The year-1959, year-1981, and year-2000 valuations were prepared professionally for insurance purposes. Such insurance valuations typically reflect the cost of immediately replacing the artwork with a comparable object. The late-1980s insurance valuations for the Government Indemnity Scheme may have lagged market movements because of infrequent updating at a time when many segments of the art market rose dramatically.

[Insert Table 4 about here]

Table 4 shows that the collection grew in value from a total purchase price of £12,847 to an estimated open market value in 2013 of £70.9 million. As the table makes clear, the items for which we directly observe valuations—and thus do not rely on imputed numbers—account for more than 95% of the total estimated value of the collection at all valuation moments. The valuation of the collection is therefore robust to reasonable changes in the method of imputing missing values. The long-term returns from the Keynes collection are substantial. The IRR between acquisition and 2013 is 10.9% in nominal terms (6.2% in real terms).

The inflation-adjusted IRR appreciation of the Keynes collection was an annualized 10.1% between purchase and 1959. The collection's performance over the first decades greatly exceeds previous estimates of art market returns over the same period. For example, the index of Goetzmann, Renneboog, and Spaenjers (2011) shows an annualized real return of only 2.2% between 1933 (the value-weighted average purchase year in the Keynes collection) and 1959. As we report below, Keynes' purchases in the secondary market of works by modern artists underpinned this outperformance. Keynes was well connected, and often acted on the advice of informed artist friends. For example, Duncan Grant and Vanessa Bell convinced him to attend the Degas auction in Paris in 1918 and advised him to buy a Matisse and a Seurat in London in 1919, and Grant bought a Braque for him in Berlin in 1924. These

acquisitions were among Keynes' best-performing art investments. Horowitz (2011) asserts that informed insiders have the potential to outperform the average art investor, and Lerner, Schoar, and Wang (2008) claim that illiquid asset markets can yield profitable speculation opportunities for informed investors. Keynes appears to have recognized several such opportunities.

The collection continued to perform reasonably well as an investment after Keynes died. Based on the 1959 and the 2013 valuations, we conclude that the collection has appreciated at an annualized real rate of at least 4.2% over the last half century. This is in line with estimates of the performance of the market more generally over that period (see, for example, Renneboog and Spaenjers (2013)).

The table also compares the estimated value of the collection to two different benchmarks in 1946, 1959, 1981, 1988, 2000, and 2013. First, we compute the inflation-adjusted value of Keynes' art expenditures in each of these years by utilizing the UK inflation series from Dimson, Marsh, and Staunton (2002, 2017). The inflated book value figures in Table 4 reflect the valuations that would have been recorded if Keynes' artworks had merely kept pace with inflation.

Second, we estimate the total portfolio value that would have accumulated if Keynes had invested in UK equities instead of art. We use data on the total returns from common stocks including reinvested dividends, also sourced from Dimson, Marsh, and Staunton (2002, 2017), and we assume the investment in equities mimics the amounts and timing of Keynes' actual art expenditures. Following Kaplan and Schoar (2005), we then compute for each year the PME (public market equivalent) ratio of the value of Keynes' investments in art to the value of the equivalent investment in equities. If Keynes had invested his outlays on art in the stock market, the year-2013 value of these investments would have been only about 5% higher, namely £74.6 million instead of £70.9 million from holding artworks (before making any adjustments for transactions costs). This implies a PME equal to 0.95, and hence an annual art-portfolio "alpha" (Phalippou and Gottschalg (2009)) relative to equities of -0.1% .⁶ For the art collection to have performed far better over the period than government bonds or Treasury bills and to have virtually matched the total return on equities, despite only ever being capable of delivering an aesthetic dividend, is a striking outcome (Dimson, Marsh, Staunton (2017)). The 1959, 1981, and 1988 valuations comfortably exceed the equity market benchmark. Even the 1946 probate valuation, which may have been biased downward, was close to the value of the hypothetical equity investment. It seems that only

⁶ The alpha (also sometimes called "excess IRR") is the constant to be added to the realized total equity returns to make the PME equal to one. It can be interpreted as a traditional asset pricing alpha if we assume that art portfolio returns follow the CAPM with a beta equal to one and a constant alpha (Phalippou and Gottschalg (2009)). Korteweg and Nagel (2016) and Sorensen and Jagannathan (2015) discuss methodological issues in using the PME criterion.

over the last 25 years has this benchmark equity portfolio started to outperform the actual art investments.

The overall return on Keynes' art portfolio is a sum-of-the-parts estimate, and incorporates no premium for the fact that it is an important collection both culturally and historically. The relatively high returns are explained not by the reputation of Keynes, but by the acuity (or in retrospect, good luck) of his purchases. His performance was certainly not index-like and his experience illustrates how actual portfolios can deliver very different outcomes.

III.2. Hypothetical art portfolios

We now compare the Keynes portfolio to the hypothetical portfolios. For each portfolio size, we have simulated 1,000 portfolios using our purchase-and-sale transaction pair data. Average aggregated spending ranges from about \$2 million for the 10-work portfolios to nearly \$20 million for the 100-work portfolios. We measure the performance of each sampled portfolio by assigning all cash flows to the end of the relevant year and then computing the internal rate of return (IRR). Panel A of Table 5 shows a number of statistics for the distribution of IRRs for each portfolio size. The median IRRs are between 6.9% and 7.3%. The panel shows substantial variation in performance across portfolios. For example, in the case of portfolios containing just 10 works, the five percent worst performing portfolios have an IRR of -2.8% or lower, while the five percent best performers have an IRR of 24.4% or better. Even for 100-work portfolios, there is a gap of 12 percentage points between the 5th and the 95th percentile of the IRR distribution. It is apparent that diversification across artworks and over time reduces idiosyncratic risk, but only slowly.⁷

[Insert Table 5 about here]

We also compute the Kaplan-Schoar (2005) PME for each portfolio as the ratio of the present value of all resale revenues to the present value of all cash expenditures, using the realized total return on the UK equity market as the discount rate. The results are reported in Panel C of Table 5. Previous research has documented that prices of art and other collectibles appreciate substantially less than equity markets in the longer run (Spaenjers (2016)). This is confirmed in our data; for example, for portfolios of all sizes from 10 to 100 works the median PME equals 0.77 or 0.78, indicating that the median art investor underperformed an equivalent investment in public equities by 22 to 23% over the portfolio's life. (This translates to a Phalippou-Gottschalg (2009) "alpha" of about -5%.) Furthermore, the spread of PMEs

⁷ Note that our hypothetical portfolios are already conditioned on a resale successfully taking place, which means that we may be underestimating true idiosyncratic risk.

from 0.29 to 1.79 is large. Clearly, this also means that some portfolios outperformed equities, and we therefore compute the probability of beating an investment in equities. Table 5 reports for each portfolio size the proportion of portfolios that have a PME above one. More than 30% of 10-work art portfolios actually exceed this threshold. Even among the portfolios of 100 artworks, 18.3% beat equivalent investments in the equity market.

IV. Determinants of art portfolio returns

The constituents of the Keynes collection are drawn from a narrow cross-section of artists and styles. It is clear that such preferences have had a substantial influence on the Keynes' portfolio returns. In this section, we extend our analysis by examining how transaction-specific risk, return skewness, concentration in art portfolios, and the transaction channel selected by the art investor can impact returns.

IV.1. Transaction-specific risk

Just like real estate prices (e.g., Case and Shiller (1987), Giacoletti (2016)), art purchase and sale prices may contain a transaction-specific random component that may reflect the fleeting preferences of buyers and transitory changes in market liquidity (Lovo and Spaenjers (2016)). By contrast, appraisals—subjective estimates of *expected* transaction prices—are less likely to be exposed to the randomness that characterizes actual transactions in the art market. Panel A of Figure 1 shows for each of the 73 artworks bought by Keynes the 1946 inflation-adjusted value of the purchase price on the horizontal axis and the 1946 valuation on the vertical axis. The least expensive purchases—in real terms—are located near the left of the scatterplot, and the most expensive are near the right. The least valuable items in 1946 are located towards the bottom of the chart, and the most valuable are near the top. Observations above the diagonal line represent artworks for which the probate valuation in 1946 was above the inflation-adjusted purchase price, and vice versa. Panel B repeats the same exercise post-1946. For both panels, artworks with large percentage returns plot well above the diagonal line.

[Insert Figure 1 about here]

In these two scatterplots, we are comparing (in Panel A) appraised values in 1946 to actual transaction prices at purchase, while after 1946 (in Panel B) the return estimates are based solely on appraised values. Especially for low- and middle-priced purchases, there is much more variation in estimated

returns up to 1946 than afterwards. This confirms that the initial purchases—all made in the period ending in 1946—exposed Keynes to transaction-specific risk that is not so apparent when we consider the post-1946 appraisals.

For further corroboration of these results, we revert to our simulations. While participants in an art auction can decide on their maximum purchase price *ex ante*, they have no control over the bidding population at the time of resale. We therefore repeat our simulation exercise using pre-auction estimates instead of transaction prices at the time of resale. Such estimates issued by auction houses are relatively accurate predictors of hammer prices on average (McAndrew and Thompson (2007)).

Panel B of Table 5 reports the range of IRRs when pre-sale estimates replace actual resale auction prices. We find that the variation in IRRs is still substantial, but far smaller than the range based on realized auction prices. For example, for a 10-work portfolio, the spread between the 5th and the 95th percentile of the estimated IRR distribution almost halves from 27 percentage points to 15 percentage points. Similarly, for a 100-work portfolio, the spread between the 5th and the 95th percentile of the IRR distribution goes from about 12 to less than 7 percentage points. In Panel D, we repeat the same exercise using PME. Now only 9 percent of 100-work portfolios outperform the equity market.

Some final insights on transaction-specific risk can be gleaned from valuations made by different appraisers at the same time. As explained earlier, for the Keynes collection we asked a total of five experts to value the collection's 15 pictures that were deemed to be the most important based on their 1988 valuation. The valuers worked to their normal (high) professional standards and carefully considered transactions in comparable items. In aggregate, the artworks being valued accounted for more than 90% of the collection's total value. We regard the five sets of appraisals as expected values of the different valuers' subjective distributions for the resale price of each item. Table 6 shows the spread of the valuations for each of the artworks (numbered from 1 to 15) from each of our five valuers (coded from A to E). In the last row of the table we report the sum of the estimated values for all 15 items in the table. In the right-hand columns, we report the median and mean of the five valuations, and the ratio of the highest-to-lowest-valuation spread to the median valuation. For each item, there is considerable disparity across valuers and the average spread-to-median ratio is frequently above one.⁸ So it is not just that transaction prices carry a random component; even subjective estimates of *expected* market values vary substantially.

⁸ One of the valuers provided us with a detailed list of auctions of comparable works for each of the selected items in the Keynes collection, but we do not find evidence of a negative correlation between the availability of price information and dispersion in valuations.

[Insert Table 6 about here]

Within each column of the table, the rank order of valuers is not always the same. (Spearman's rank correlation coefficients between the different sets of valuations range from 0.77 to 0.93, with a mean of 0.87.) Consequently, the aggregate valuation of all 15 selected artworks, depicted at the foot of the table, has a smaller dispersion in valuations. Replacing the Gurr Johns valuations used earlier with the average valuations across the five different valuers for each picture does not materially change our estimate of the long-term performance of the collection. For example, the IRR between purchase and 2013 would be reduced—but by less than 0.3%.

IV.2. Return skewness

A close study of the Keynes collection points to the importance of recognizing the role of positive outliers in driving overall performance. One item has a year-2013 valuation of £20 million, as compared to a purchase price of £1.50, and realized an annualized nominal return of 20.2% (15.4% in real terms). Without this single work, the IRR on Keynes' art portfolio since purchase would be lower by 0.4%. We do not discern negative outliers of such magnitude. More generally, if we consider the annualized real returns between 1946 and 2013 on the items in the Keynes collection, we find a coefficient of skewness that is equal to 0.76. Figure 1 highlights the importance of skewness in returns. The three assets that added most to portfolio value are identified by solid black dots in each of the panels. The contribution to overall portfolio performance is of course driven both by the initial investment and by the return.

Turning to the simulated portfolios in Panel A of Table 5, an interesting pattern in the distribution of IRRs is that the median return is below the average, but grows with the size of the simulated portfolios. This is a consequence of the positive skewness in the distribution of returns for individual artworks resulting in smaller portfolios having a lower probability of including one of the “winning lottery tickets”. Therefore, their median IRR is lower. Nonetheless, a portfolio with a small number of constituents may be lucky and bag a winner, and relatively rare events like this drive the considerable variation observed in the simulated portfolio returns.

IV.3. Portfolio concentration

Keynes' art portfolio has always been highly concentrated. The ten most expensive purchases accounted for 80% of his total investments. In 2013, two works account for more than half of the value of the entire collection, while the 10 most valuable items make up 91% of the total value. This implies that, today, changes in the total value of the Keynes collection are largely driven by changes in the market value of a

few artists, such as Braque, Cezanne, Matisse, Picasso, and Seurat. Conversely, what happens to all the lesser-known artists—for example, whether they disappear completely from the secondary market—is not an important driver of returns.

In Table 7, we compare the Keynes artworks with several well-known collections, namely those accumulated by Victor and Sally Ganz, the Detroit Institute of Arts, and the British Rail Pension Fund (“RailPen”). The Ganz estate was a private collection of 20th century art, including artists such as Pablo Picasso and Jasper Johns; in 1997 the sale of 114 works raised \$207 million, as compared to the original outlay of \$764,000 (Landes (2000)). The Detroit Institute of Art collection was valued by Christie’s (2013) after the city found itself in financial difficulty; Christie’s estimated the collection of 2,773 pieces of the then city-owned artwork to be worth between \$454 million and \$867 million, with one Bruegel the Elder estimated at \$100–\$200 million. The British Rail Pension Fund (“RailPen”) decided in the 1974 financial crisis to buy art as an inflation hedge, acquiring 2,506 artworks for £41 million during 1974–80; the final item was sold in 2003 and the collection achieved net proceeds of £170 million with an IRR of 11.3% (3.7% per year in real terms). A list of all works and their costs and realization values was shared with us by the Railways Pension Trustee Company Limited. For all these collections, less than 10% of all works account for more than 75% of the total value.

[Insert Table 7 about here]

For the simulated portfolios, the last two columns of Panel A of Table 5 shows the average total purchase value (in nominal USD) for each simulated portfolio size, and the relative importance of the most expensive purchase in this total value. The high concentration is striking. For example, an art collector buying 100 artworks at random would on average have spent \$19.1 million, but 28.8% of this amount would have gone to one work only. This concentration of portfolios is of course one of the reasons why even relatively large portfolios exhibit substantial variation in performance.

The concentration revealed for these actual and simulated art collections corroborates the fact that the concentration of the Keynes art collection is a characteristic shared with other art portfolios. The indivisibility and illiquidity of these expensive works presents a challenge to any art owner wishing to rebalance, diversify or liquidate—partially or wholly—an art collection, and it amplifies the importance of transaction-specific risk.

IV.4. The impact of purchase channel

All existing empirical studies of art index returns make use of auction price data. However, approximately 50% of artworks are bought outside of auction (McAndrew (2016)). “Older” art can also trade privately through dealers (the non-auction secondary market), and “fresh” art will typically be bought directly from the artist or through a gallery (the primary market). An interesting question therefore is whether the choice between these three purchase channels affects the cross-section of individual artwork returns.

Like other buyers, Keynes acquired some art through auction houses such as Christie’s and Georges Petit, but he was equally active in the private secondary market through dealers such as Goupil and Wildenstein as well as smaller players. He also bought works on the primary market, either at galleries or through the London Artists’ Association. In Panel A of Table 8, we first compare annualized real returns between purchase and 1946 according to the purchase channel and then move to a regression setting in Panel B.⁹ In examining the importance of the purchase channel, we need to take account of two other possible drivers of the cross-section of returns, which serve as control variables in Panel B. First, we study the impact of whether Keynes knew the artist personally or not.¹⁰ Keynes’ activity in organizations like the London Artists’ Association showcases the importance he attached to backing artists. In a 1940 letter included in his personal papers, Keynes commented on three purchases as Sotheby’s as follows: “I was supporting the market for three old friends whom I endeavoured to keep going over a period of years at very large cost to my own income”, and Skidelsky (2005) remarks that his personal purchases were often made “out of loyalty” to his friends. Second, we look at whether the reputation of the artist affected returns. We measure reputation by whether the artist was included in a well-regarded art history textbook (Gardner (1926)) written in the early years of Keynes’ career as a collector; see Table 1.

[Insert Table 8 about here]

⁹ Somewhat atypically, a few of the auction acquisitions are not secondary market purchases: at the sale of Degas’ collection in Paris in 1919, Keynes also bought works by Degas himself. However, to focus on the sale mechanisms in the art market, we group these acquisitions alongside other auction purchases. A few commercial galleries were active on both the primary and the secondary market. In cases where it is not clear how to classify the non-auction purchases, we assume acquisitions to be secondary market transactions if the work was more than a few years old at the time of purchase, or if we have evidence of a non-gallery owner prior to Keynes’ acquisition.

¹⁰ We consider the following artists to be part of Keynes’ social circle: Bell, Coxon, Davidson, Derain, Dobson, Fry, Grant, Hitchens, Picasso, Pitchforth, Porter, Roberts, and Sickert. Keynes met Derain and Picasso at a party that he co-hosted with Clive Bell and Duncan Grant in 1919, when the artists were in London with the Ballets Russes, for whom they designed sets and costumes. (Picasso would also draw Lydia Lopokova, dancer at the Ballets and later Mrs. Keynes, on multiple occasions.) Yet, Picasso and Derain were arguably much less close to Keynes than the others in the list above, and classifying them outside of Keynes’ social circle would magnify the return difference documented in Panel A of Table 8.

The results in Panel A show that Keynes realized the highest initial returns on art bought at auction, and to a lesser extent on art bought through dealers. Most of this was art by (Post-)Impressionist artists from continental Europe, such as Braque, Cezanne, Degas, Picasso, Renoir, and Signac (and predecessors like Courbet and Delacroix), some of whom were already sufficiently recognized to be included in an art history textbook. Acquisitions in the primary market and of works by lesser-known artists that were friends and acquaintances turned out to be much less profitable financially.

Our regression results are reported in Panel B. We cluster standard errors on the level of the artist. The first column shows that estimated annualized real returns are strongly significantly lower for purchases in the primary market even when we control for Keynes' social connections and for the reputation of the artist. The second column shows that this result is robust to controlling for five-year purchase period dummies that capture variation in the average price level in the art market at the time of acquisition.

The panels of Table 8 also repeat the analysis for the period 1946–1959. As expected, we see much less variation in returns, and the purchase channel no longer helps to explain the variation in price appreciation over this later period. Furthermore, the regression's R-squared is lower than before.

V. Conclusion and discussion

Our main findings can be summarized as follows. Historically, the Keynes art collection provided long-term returns that rival the total return (including reinvested income) from the stock market. We also examine the performance of hypothetical art portfolios based on realized prices for artworks bought at Christies and Sotheby's, and we find substantial variation in performance across portfolios. Because of the variation in performance, a significant minority of art portfolios—more than 30% for 10-work portfolios—beat an equity market benchmark. Second, both the Keynes analysis and the simulations show that transaction-specific risk plays an important role in determining portfolio performance. It is clear that portfolio returns are sensitive to factors that are specific to the time and place related to the transaction. Third, because of the positive skewness in individual artwork returns, larger portfolios have a higher median return. Small portfolios suffer an increased probability of missing the winning lottery tickets. However, it should also be recognized that positive skewness may have the effect of making underdiversification *attractive* to certain investors (Goetzmann and Kumar (2008)). Preference for positive skewness on the part of investors may even be seen as a reason for the low returns to art on average (Barberis and Huang (2008)), in the same way that it might partially explain the low returns to

private equity (Moskowitz and Vissing-Jørgensen (2002)). Fourth, another factor contributing to the high idiosyncratic risk of art portfolios is that they tend to be very concentrated. In other words, the art market appears to be “granular” (Gabaix (2011)): it may have the same level of diversification as an *equally-weighted* portfolio of only a small number of artists. This is similar to, but may be even more extreme than, the manner in which a supposedly well-diversified market portfolio of 8,000 stocks may be equivalent in risk to an equally-weighted portfolio of not more than 20 firms (Malevergne, Santa-Clara, and Sornette (2009)). Fifth, the returns realized on purchases at auction may differ in a systematic way from the returns realized on acquisitions through other channels. In particular, the difference in performance relative to primary market purchases may be substantial.

Our results have a number of implications for the interpretation of transaction-based art price indexes. First, reflecting the positive skewness in returns, a majority of art investors can be expected to underperform the index. Art indexes may therefore be less suitable for capturing the typical art investor’s experience than asset-class indexes in the market for traded financial assets. Second, art indexes fail to illuminate the riskiness of art investment. Unlike stock market investors, who can acquire a diversified portfolio of assets, art collectors are dealing with indivisible and unmarketable assets. Art indexes may be of limited value as a guide to asset allocation; portfolios simply exhibit too much variation in performance around benchmark returns for this application. Third, if a relatively small set of superstar artists make up a disproportionately large fraction of the value of the art market portfolio, a price index that tracks the works of those artists can be expected to capture rather accurately the evolution of the market portfolio—and also of collections containing a large number of superstar artists. This is especially true because the demand for the most expensive art contains a systematic component linked to wealth and income inequality and the demand for luxury consumption (Goetzmann, Renneboog, and Spaenjers (2011)). One issue, however, is that most art price indexes are equally-weighted instead of value-weighted. The more concentrated the asset category, the larger the potential for a discrepancy between the returns as estimated by an equally-weighted index and the returns to the market portfolio. Equally-weighted indexes have the additional drawback that they are particularly hard to interpret in the context of indivisible assets. Finally, indexes solely based on auction transactions may again not accurately capture the average collector’s realized returns. This is especially pertinent to collectors of very recent art, where the primary market is important.

Appendix A. Keynes the art collector

In this appendix, we outline Keynes' development as an art collector. His development as a financial investor is chronicled elsewhere (Chambers and Dimson (2013)).

Keynes' time as a student in Cambridge demonstrates his early interest in fine art. In a 1905 paper entitled 'A Theory of Beauty', the 22-year old writes: "A fit object is one the contemplation of which ought to give rise to a state of mind which is good" (Skidelsky (2003)). In the same year, while in Paris, Keynes visits the Louvre five times, as well as the modern collections at the Palais du Luxembourg (Dostaler (2007)). His first small art purchases follow quickly; Scrase and Croft (1983) write that these acquisitions are "inspired either by personal acquaintance with the artist or by the example set by the behavior of his family and friends". He continues his self-education in the visual arts, and in 1911 becomes a member of the Contemporary Arts Society (Scrase and Croft (1983)), for which he would later act as a buyer.

Keynes also plays a prominent role in the Bloomsbury Group through which he maintains close associations with such British painters as Duncan Grant and Vanessa Bell as well as Roger Fry, the influential art critic and inventor of the term "Post-Impressionism". Indeed, it is these three friends who give him the idea of attending the first sale of the private collection of Edgar Degas in Paris in 1918, with a view to acquiring Impressionist and Post-Impressionist artworks at knock-down prices for the British Treasury, but also to buy some for his personal collection (Munro (2003)). Keynes makes his first major purchases, namely a Cezanne and a Delacroix, at the sale. Cezanne's 'Apples' soon becomes an "object of pilgrimage" (Dostaler (2007)) for his Bloomsbury friends. In the following six years, he makes significant acquisitions of paintings by Matisse, Seurat (a study for 'La Grande Jatte'), Renoir, and Cezanne, and drawings by Degas, Modigliani, and Picasso. In many cases his artist friends seem to play a key role in "inducing" Keynes to buy (Shone and Grant (1975)). Nonetheless, Keynes' friends are not always impressed by his personal tastes. Shone and Grant (1975) write that Keynes "attempted to speak and pronounce upon painting on occasion with an authority that was ill-founded". Clive Bell found his judgment of works of art "lamentable", and when Keynes buys a painting upon his own initiative in 1924, his friends remark that it is "the worst picture that Cezanne ever painted" (Skidelsky (2005)).

His second wave of major acquisitions follows in the years 1935 and 1937, when Keynes purchases works by Renoir, Picasso, Braque, and Cezanne. Some are bought at the auction houses Sotheby's and Christie's, while others are purchased through art dealers such as Agnew, Wildenstein, and Reid & Lefevre. The Cezanne picture 'L'Enlèvement', bought for £3,500 in 1935, is the most expensive acquisition Keynes ever makes, equivalent to about 25 percent of the aggregate lifetime cost of his art purchases. Either side of this later period, Keynes does not make major foreign acquisitions. During the second half of the 1920s and the early 1930s, Keynes concentrates on becoming a patron of British artists, largely through the London Artists' Association, an organization established in 1926 whose mission was to provide promising artists with a guaranteed income. In these years, he buys works from friends and acquaintances he admired, such as Duncan Grant, Vanessa Bell, William Roberts, Raymond Coxon, and Walter Sickert. After 1937, and until his death in 1946, Keynes again limits his purchases to a few works by British artists.

Keynes certainly loved the arts, but there is more to his art collecting than an insistence that "wealth should not be hoarded but spent on civilized living" (Skidelsky (2005)). Indeed, Skidelsky questions "how much he really enjoyed pictures, as opposed to the idea of owning them, and supporting those who painted them". Hence, it is no surprise to find that Keynes "was also motivated in his purchases by the idea of art as an investment" (Scrase and Croft (1983)). Accordingly, he wrote that there is "a slight mystery about the prices" of paintings and that "the element of investment may not be entirely absent after all" (Dostaler (2007)). Furthermore, despite no evidence of an actual disposal, his correspondence shows that he considered selling certain artworks, so he definitely had a sense of his reservation prices.

Appendix B. Imputation of missing values

If we observe both an earlier and a later valuation, we impute a value by using the median proportion of price appreciation between the two outer dates that is realized by the middle date. For example, among the works for which we have valuations in 1981, 1988 and 2000, a median of 37.5% of the 1981–2000 appreciation is realized by 1988, and we use this to impute a year-1988 value for cases where we have a year-1981 and a year-2000 valuation. For one work, a change in attribution leads to a reduced valuation, and for that item we use geometric interpolation to impute its intervening value.

If we only have a later valuation, which is the case for a handful of works in 1946 and 1959, we use the observed median price ratio between the earlier and the later date to impute a value. If we only observe an earlier valuation, which is often the case in the later years, we update the last available valuation using inflation data from Dimson, Marsh, and Staunton (2002, 2017). We take this conservative approach because items that are no longer valued may have underperformed the other constituents of the Keynes collection.

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Table 1. Artists in the Keynes collection

This table reports on the composition of the art collection bequeathed by John Maynard Keynes upon his death in 1946. It shows the number of items acquired by Keynes and (in parenthesis) the number of purchase prices recorded for each artist. The last two columns indicate whether the artist was referenced in the 1926 and 1936 editions of the art history textbook *Art Through the Ages* (Gardner (1926, 1936)). More information on our data collection procedure is in the text of this paper.

Artist	No. of items	No. of prices	Referenced 1926	Referenced 1935
Atkin	2	0	-	-
Baynes	2	0	-	-
Bell	6	2	-	-
Braque	2	2	-	yes
Brzeska	1	0	-	-
Bussy	1	1	-	-
Calligan	3	0	-	-
Cezanne	4	4	yes	yes
Courbet	1	1	yes	yes
Coxon	3	2	-	-
Daumier	2	0	yes	yes
Davidson	1	1	-	-
Degas	4	4	-	yes
Delacroix	3	3	yes	yes
Derain	3	2	-	yes
Dobson	1	1	-	yes
Friesz	1	1	-	yes
Fry	2	2	-	yes
Gore	2	2	-	-
Grant	27	8	-	-
Hall	1	0	-	-
Hitchens	3	1	-	-
Ingres	1	1	yes	yes
Knight	1	1	-	-
Lhote	1	1	-	-
Lurcat	1	1	-	-
Malkine	1	0	-	-
Marchand	1	1	-	-
Matisse	1	1	yes	yes
Modigliani	2	2	-	yes
Moore	3	0	-	-
Picasso	4	3	yes	yes
Pitchforth	2	1	-	-
Porter	4	1	-	-
Renoir	2	2	yes	yes
Roberts	14	13	-	-
Seurat	1	1	-	yes
Sickert	4	3	-	-
Signac	1	1	-	yes
Smith	1	0	-	-
Swanwick	1	0	-	-
Taylor	1	0	-	-
Wiertz	1	0	-	-
Woolfe	1	0	-	-
Unknown / N.A.	11	3		
Total artists	45	32	8	17
Total items	135	73	18	35

Table 2. Keynes' annual art purchases in nominal GBP

This table shows the number of purchases (for which we have price data) by John Maynard Keynes between 1917 and 1945. It also shows Keynes' expenditures, in nominal British pounds, and his most expensive acquisition for each year. More information on our data collection procedure can be found in the text of the paper. The table also shows some key events in Keynes' life.

Year	No. of purchases	Expenditure (£)	Most expensive acquisition, its cost, and purchase channel
1917	1	10.0	Duncan Grant, 'The kitchen', £10, Omega Workshops
1918	2	448.7	Cezanne, 'Still life with apples', £370.5, First Degas sale
1919 Keynes publishes 'The Economic Consequences of the Peace'			
1919	12	776.3	Seurat, 'Study for La Grande Jatte', £400, Chelsea Book Club
1920	6	510.1	Renoir, 'A young boy', £285.9, Galerie Vildrac
1921	0	—	
1922	4	253.3	Sickert, 'The bar parlour', £125, London Group
1923	0	—	
1924 Keynes becomes bursar of King's College, Cambridge			
1924	5	846.6	Cezanne, 'Uncle Dominique', £600, Goupil Gallery
1925	0	—	
1925 Keynes marries Lydia Lopokova			
1926	2	11.6	Dobson, 'Nude back view', £8.4, London Artists' Association
1927	3	84.0	Duncan Grant, 'Still life, flower and jug', £63, London Artists' Association
1928	4	170.4	William Roberts, 'Labourers', £100, London Artists' Association
1929	0	—	
1930	2	42.0	Raymond Coxon, 'Village street', £31.5, London Artists' Association
1931	8	46.6	William Roberts, 'Boy wearing a sun-hat', £15.8, London Artists'
1932	2	55.3	William Roberts, 'Lord and Lady Keynes', £50, commissioned
1933	0	—	
1934	3	282.5	Vanessa Bell, 'Interior with figures', £157.5, Reid & Lefevre
1935	5	4,003.6	Cezanne, 'L'enlèvement', £3,500, Reid & Lefevre
1936 Keynes publishes 'The General Theory of Employment, Interest and Money'			
1936	1	22.0	Lurcat, 'Still life, flowers in vase with sea in background', £22, Reid & Lefevre
1937	8	4,953.7	Cezanne, 'Undergrowth', £3,000, Wildenstein
1938	3	157.5	Three works by William Roberts, £52.5 each, Reid & Lefevre
1939	0	—	
1940	0	—	
1941	0	—	
1942	0	—	
1943	1	78.8	Spencer Gore, 'The toilet', £78.8, Redfern Gallery
1944	0	—	
1945	1	94.5	Duncan Grant, 'Cattle in a shed', £94.5, Ernest Brown & Phillips
1946 Keynes dies at the age of 62			

Table 3. Simulated portfolios: annual transactions and median price levels

This table summarizes the yearly number of purchases and sales in our study, accompanied by the median US dollar transaction prices. More information on our data collection procedure can be found in the text of this paper.

Year	No. of purchases	Median price (\$)	No. of sales	Median price (\$)
1980	70	5,731		
1981	83	8,755	5	5,698
1982	73	5,500	8	14,965
1983	78	6,723	17	8,000
1984	84	7,631	21	16,500
1985	99	8,250	36	30,000
1986	90	11,999	37	23,500
1987	110	15,757	35	24,500
1988	122	19,225	60	15,000
1989	137	29,106	65	11,000
1990	102	25,216	52	16,611
1991	62	12,500	68	25,000
1992	70	17,144	49	12,513
1993	84	32,220	51	25,000
1994	90	17,218	48	24,000
1995	83	20,965	63	29,308
1996	92	27,788	76	58,629
1997	69	47,500	83	42,488
1998	59	34,230	84	39,413
1999	76	30,778	93	36,289
2000	70	57,500	76	49,044
2001	52	45,405	89	36,379
2002	51	40,000	74	48,927
2003	45	49,496	81	74,117
2004	36	45,013	114	69,734
2005	35	30,000	134	38,810
2006	28	37,699	150	15,746
2007	45	75,000	110	100,000
2008	30	95,000	77	46,897
2009	14	50,747	41	51,500
2010	11	34,227	38	34,560
2011	20	37,709	49	57,500
2012	12	60,832	54	384,693
2013	3	10,468	58	352,790
2014			45	877,481
2015			44	1,989,671
1980-2015	2,185	19,413	2,185	30,000

Table 4. The value of the Keynes collection, PMEs, and IRRs to 2013

This table shows the total expenditure (or book value, BV) of John Maynard Keynes' art collection over the 1917–45 period; the 1946 probate valuation (PV); estimates based on insurance valuations (IV); one of which (the 1988 estimate) was under the UK Government's Indemnity Scheme; and the open market valuation (OMV) undertaken in 2013. % Observed directly is the proportion of the valuation that is based on explicit price estimates for individual artworks. Inflated BV refers to the book value inflated by movements in the UK Retail Price Index from the date of purchase onward. Following Kaplan and Schoar (2005), PME is the public market equivalent, defined as the ratio of the value of the art collection to the value of investments in the UK equity market that mimic the timing and magnitude of Keynes' art investments. The last two columns report the nominal and real (inflation-adjusted) IRR measured from initial purchase. More information on the data can be found in the text; UK inflation and equity returns are from Dimson, Marsh, and Staunton (2002, 2017). All values and returns are estimated in British pounds.

Year	Valuation	Estimated value (£000)	% Observed directly	Inflated BV (£000)	PME	Nominal IRR (%)	Real IRR (%)
1917-45	BV	13	100.0	13			
1946	PV	31	95.9	16	0.96	6.2	5.1
1959	IV	383	99.4	27	2.43	12.2	10.1
1981	IV	4,002	100.0	170	2.11	11.8	6.7
1988	IV	11,302	95.9	239	1.48	12.3	7.1
2000	IV	41,167	97.1	373	1.04	12.1	7.2
2013	OMV	70,858	98.5	549	0.95	10.9	6.2

Table 5. Investment performance from simulated art portfolios, 1980–2015

This table shows a number of statistics computed over the distribution of percentage returns generated by 1,000 simulations of portfolios of different sizes using our purchase-and-sale transaction pair data. The statistics are the median, the mean, and the 5th, 25th, 75th, and 95th percentiles. Panel A reports IRRs based on transaction prices for sales, while Panel B reports IRRs based on pre-auction estimates for sales. The last column of Panels A and B shows for each portfolio size the mean proportion of the total portfolio allocated to the largest purchase. Panel C reports PME_s based on transaction prices for sales, while Panel D reports PME_s based on pre-auction estimates for sales, where PME is the ratio of the present value of all resale revenues to the present value of all cash expenditures, using the realized UK equity market returns as the discount rate, following Kaplan and Schoar (2005). The last column of Panels C and D reports for each portfolio size the proportion of positive PME_s larger than one. All panels are based on auction transaction prices for purchases. More information on our procedure can be found in the paper.

No. of works	Median	Mean	P5	P25	P75	P95	Mean largest investment (%)
<u>Panel A: IRRs (%) based on transaction prices for purchases and transaction prices for sales</u>							
10	6.9	8.3	-2.8	2.9	12.0	24.4	55.5
25	6.9	8.1	-0.5	4.0	10.3	21.5	44.3
50	7.2	8.0	0.8	4.5	10.4	18.0	35.5
100	7.3	7.5	1.9	5.0	9.6	13.8	28.8
<u>Panel B: IRRs (%) based on transaction prices for purchases and pre-sale estimates for sales</u>							
10	6.5	6.6	-0.9	3.8	9.3	14.5	54.6
25	6.5	6.6	1.2	4.5	8.8	12.6	41.2
50	6.5	6.6	2.2	5.1	8.3	10.9	32.9
100	6.7	6.5	3.2	5.4	7.8	9.6	24.8
% of PME_s > 1							
<u>Panel C: PME_s based on transaction prices for purchases and transaction prices for sales</u>							
10	0.77	0.89	0.29	0.55	1.10	1.79	30.7
25	0.77	0.85	0.35	0.59	0.99	1.57	24.5
50	0.78	0.82	0.41	0.60	0.99	1.36	24.0
100	0.78	0.79	0.43	0.63	0.94	1.19	18.3
<u>Panel D: PME_s based on transaction prices for purchases and pre-sale estimates for sales</u>							
10	0.77	0.83	0.29	0.57	1.02	1.58	26.5
25	0.76	0.80	0.39	0.60	0.96	1.37	22.1
50	0.76	0.78	0.45	0.63	0.92	1.21	16.3
100	0.76	0.76	0.43	0.66	0.88	1.06	8.9

Table 6. Disagreement between valuers of the Keynes collection, as at 2013

This table shows the range of year-2013 valuations, the median and mean for each work, and the spread of valuations across the five independent art valuers expressed as a percentage of the median valuation for each work. The 15 artworks were selected from the Keynes collection according to their year-1988 value. At the bottom of the table we show totals for the 15 artworks. All values are expressed in thousands of British pounds. More information can be found in the text of this paper.

Item	Valuer A	Valuer B	Valuer C	Valuer D	Valuer E	Median	Mean	Spread/Median(%)
1	350	350	300	321	250	321	314	31
2	350	450	250	385	450	385	377	52
3	350	500	250	994	700	500	559	149
4	1,000	400	400	802	300	400	580	175
5	500	750	500	577	850	577	635	61
6	1,200	900	300	1,123	400	900	785	100
7	1,250	1,100	500	1,123	250	1,100	845	91
8	1,000	1,750	700	770	850	850	1,014	124
9	1,800	1,350	1,000	2,566	1,250	1,350	1,593	116
10	3,500	2,250	600	1,123	1,750	1,750	1,845	166
11	8,000	4,500	2,500	7,057	4,000	4,500	5,211	122
12	5,000	4,500	2,500	5,774	12,500	5,000	6,055	200
13	4,500	9,000	5,000	7,699	12,500	7,699	7,740	104
14	20,000	9,000	4,000	7,699	2,500	7,699	8,640	227
15	18,000	17,500	25,000	27,267	17,500	18,000	21,053	54
Total	66,800	54,300	43,800	65,281	56,050	56,050	57,246	41

Table 7. Concentration of actual portfolios

This table lists the number of artworks that cumulatively represent various proportions of the total value of Keynes collection in 2013; the Victor and Sally Ganz collection in 1997; the Detroit Institute of Art collection in 2013; and the British Rail Pension Fund in 2003. The data are respectively from this paper; Landes (2000) and Auction Club; Christie's (2013) and Woodham (2013); and the Railways Pension Trustee Company Limited. The final row in each panel is the total number of artworks that comprise each collection. More information on these valuations can be found in the text.

% of portfolio value	Keynes	Ganz	Detroit	Railpen
25	1	2	2	11
50	2	3	3	48
75	5	8	12	202
90	10	13	43	539
95	16	16	81	827
99	27	< 35	< 1,741	1,455
100	73	114	2,773	2,506

Table 8. Cross-sectional variation in performance

Panel A of this table shows the median, equally-weighted average, and value-weighted average annualized return, in real British pounds, between purchase and 1946 and between 1946 and 1959, for the Keynes collection as a whole and for different subsamples. Panel B runs a set of ordinary least squares regressions explaining annualized real returns. Standard errors are clustered at the artist level.

Panel A. Comparison of annualized real returns (%)

	N	From purchase to 1946			From 1946 to 1959		
		Median	EW avg.	VW avg.	Median	EW avg.	VW avg.
All	73	-2.4	-1.9	-1.3	12.7	14.4	14.5
Auction	21	7.3	7.2	8.2	13.8	13.3	15.6
Secondary market excluding auction	12	2.3	1.8	-0.5	16.8	17.1	14.7
Primary market	40	-5.9	-7.8	-12.1	12.3	14.2	10.5
No social interactions with artist	38	4.5	4.2	0.0	12.5	13.3	14.2
Social interactions with artist	35	-4.8	-7.0	-9.9	13.2	15.3	17.6
Artist not in year-1926 textbook	58	-4.5	-4.9	-7.5	12.6	13.6	14.4
Artist in year-1926 textbook	15	7.3	9.8	0.1	18.3	17.7	14.6

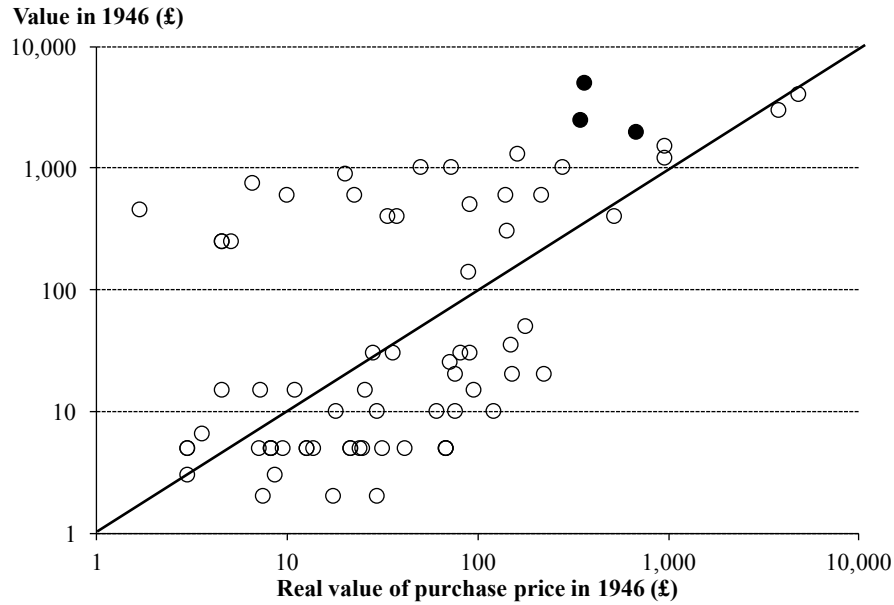
Panel B. Regression of annualized real returns on purchase channel and other variables

	From purchase to 1946	From purchase to 1946	From 1946 to 1959
Secondary market excluding auction	-0.098 (0.060)	-0.058 (0.068)	0.032 (0.031)
Primary market	-0.103 *** (0.037)	-0.108 *** (0.034)	0.006 (0.038)
Social interactions with artist	-0.060 (0.043)	-0.021 (0.046)	0.040 (0.025)
Artist in year-1926 textbook	0.104 * (0.061)	0.103 (0.068)	0.049 (0.033)
Five-year purchase period dummies?	No	Yes	No
N	73	73	73
R ²	0.25	0.66	0.08

Figure 1. Investment performance of individual artworks in the Keynes collection

Panel A shows for each artwork in the Keynes collection the real (i.e., year-1946) value of the purchase price, against the horizontal axis, and the year-1946 value, against the vertical axis. Panel B repeats the analysis using year-1946 and year-2013 valuations. All values are expressed in British pounds. Observations above the diagonal line have appreciated in real terms over the relevant period. The three assets that added the largest amount to portfolio value are identified by solid black dots in each of the panels. Data on UK inflation come from Dimson, Marsh, and Staunton (2002, 2017).

Panel A. Between purchase and 1946



Panel B. Between 1946 and 2013

