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2025003-EEF

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The Investment Performance of Classical Swedish Painters

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February 2025

Abstract

This paper studies the investment properties of paintings. It applies a hedonic regression model on a unique sample of more than 8,000 paintings by classical Swedish painters traded in the period 2010-2023. To address sample selection bias regarding sold and unsold paintings, it uses a Heckman correction. Despite some very high prices for paintings, the price index for the sample paintings underperforms well-used indexes for stocks, bonds, and real estate, while its volatility is much higher. The study shows that paintings of classical Swedish painters have a very limited role when constructing optimal investment portfolios.

Keywords:

Art investment, portfolio, hedonic pricing, Heckman correction, Swedish Masters

JEL:

D44, G20, G11, Z11

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The Investment Performance of Classical Swedish Painters

Highlights

- High art prices attract investor interest in paintings.
- Swedish Masters' paintings yield limited returns.
- In an investment portfolio, these paintings have no financial value added.

1. Introduction

Anders Zorn's masterpiece "Sunday morning" (Swedish: "Söndagsmorgon") sold for more than 32 million Swedish kroner during a live auction at Bukowskis, a Swedish auction house, in December 2021. That same month, the Dutch government announced that it was prepared to pay $198 million for "The Standard Bearer" by Rembrandt. In July 2020, a self-portrait by the Dutch master Rembrandt was sold at Sotheby´s for £14.5 million (*The Times*, July 21st, 2020), while this painting was sold in 2003 for £6.9 million. As Grimes (2021) notes, art has increasingly been regarded as both a medium of personal enjoyment and a sophisticated investment vehicle, drawing attention from private and institutional investors alike. Some suggest that the rise in art prices resembles a bubble, comparing it to Tulipmania of the 17th century (Ekelund et al., 2017). Nevertheless, the news of pricey art deals and examples of astounding profits some sellers gain create a salient image and foster a belief that artworks can be a profitable investment. Others contend it is a safe investment in times of crisis (Sun & Zhang, 2023; David et al., 2021; Öztürkkal & Togan-Egrican, 2020). With increasing wealth, there has been a noticeable growth in demand for art, and record-breaking prices for paintings were paid in auctions (Renneboog & Spanjers, 2013). Over the past decades, participants in the financial markets and empirically oriented academics have shown increased interest for arts as a research topic. Access to the Internet and online auctions of different art products has increased the number of market participants. The aggregate value of sold international fine art paintings in 2017 was 150 times the value in 1970 where buyers in the US, China and the U.K. represented 83% of the total aggregate value (Le Fur, 2020).

Prior empirical research has focused on risk and return characteristics for paintings in direct comparison with more traditional asset classes (Bialynicka-Birula, 2018; Campbell 2008; Goetzmann et al. 2011; Renneboog and Spaenjers 2013). When assessing art from a financial perspective, there are some specifics that have to be mentioned. First, it is impossible to know

the ‘true’ market value of an artwork, as there is no natural value that could be used as a benchmark (Goetzmann et al., 2011). Second, artworks have high transaction costs of about 10%-25% of the sale price, while such costs on stock market are less than 0.5% for most investors (Witkowska, 2014). Moreover, art, just like other luxury items, is aesthetically pleasing to people so that such pleasure dividend can be factored into the price (Mandel, 2009). Art markets are heterogenous and can be affected by economy-wide fundamentals (Renneboog and Spaenjers, 2013). In addition, there are specific risks associated with owning an artwork: The artwork can be damaged or stolen; the owner may be unsure of whether the painting is original; the dynamics of art trends over a longer period can render certain painters or art schools “unfashionable” and make their paintings lose value (Witkowska, 2014). In general, the econometric technique to compute returns from art paintings is the hedonic regression model. Here, the price of an art painting is related to a set of primarily binary characteristics, which reflect each painting’s attributes, usually complemented with year dummies.

The study of returns on art investment is more complex and inconclusive than the intuitive belief that art is a ‘good investment’. Previous studies on risk and return characteristics of art use samples of auctioned artworks over centuries-long periods and report that such investment has either inferior returns overall or its returns resemble characteristics of fixed-income securities but with far greater associated risks (Anderson, 1974; Baumol, 1986; Frey & Pommerehne, 1989). Moreover, some papers suggest that there are no benefits from diversification if art is added to a portfolio with stocks and bonds (Renneboog & Van Houtte, 2002; Stein, 1977; Worthington & Higgs, 2004). However, studies after more recent (and shorter) periods are much more optimistic regarding both returns and diversification effect of art (e.g., Li et al., 2022; Öztürkkal & Togan-Egrican, 2020).

Previous research indicates that masterpieces, i.e., artists greatest works, yield higher returns than more ordinary artworks, albeit with greater associated risks (Barre et al., 1994; Ma & Qi, 2023). Moreover, masterpieces can serve as more effective diversifiers and significantly increase a portfolio's yield compared to lesser-known works. This higher yield can be contributed to various factors (Ma & Qi, 2023). In the art market, like what is observed in traditional financial markets, investors often experience "anchoring effect" (Tversky and Kahneman, 1974), driving investors to assign higher premiums to high-priced artworks by renowned painters; the art investment field requires high capital and expertise, often barring ordinary investors from identifying valuable art. As such, investors turn to famous painters that they might know, hoping for stable returns. However, the art market has gradually shifted to an "institutional market" with the introduction of art funds and share trading (Frye, 2018). This change allows smaller investors to include renowned art in their portfolios; the limited supply of works from famous (often deceased) artists is expected to result in prices, which are stable and gradually increasing over time.

For our study, we take a different approach. Rather than identifying individual master pieces, we identify master painters. That is, it is not so much about the exact underlying painting, as much as *who* painted it. We assume that any potential anchoring effect is linked to the artist rather than the exact painting. It is also a well-known fact that paintings from a deceased artist on average fetch a higher price that paintings from a living artist (Szyszka1 & Białowąs, 2019). However, for our sample, a similar limited supply from all artists is expected, as all artists in our sample are deceased.

In this regard, the case of Sweden master painters is highly interesting, as Sweden has produced many world renown master painters, such as Carl Larsson (1853–1919), who is known for his detailed and charming depictions of domestic life and his home in Sundborn. Or Anders Zorn (1860–1920), who is renowned for his portraits, nudes, and genre scenes, as well as his mastery

of watercolors. These painters (and many more) played significant roles in the development of Swedish art during the late 19th and early 20th centuries (Sjåstad, 2018). Therefore, this paper studies the attractiveness of investment in paintings by Swedish painters. We do so by investigating the investment return and asset allocation effect of including art works by Swedish painters in an otherwise Sweden focused investment portfolio. The contributions of this paper include: An extension to the current literature on art as an investment class, broadening the research related to portfolio theory. Next, most of the literature relies on a terminological approach for their thematic classification (Renneboog and Spaenjers, 2013; Le Fur, 2020; Garay, 2021) and usually excludes unsold paintings at auctions, which are likely to give a sample bias (Ma & Qi, 2003; Charlin & Cifuentes, 2017). Relying on a visual approach for thematic classification, and further controlling for the presence of both sold and unsold paintings in our sample, our approach strengthens scientific rigor and clarifies the methodological stance. Finally, this paper highlights the variations in allocations when considering master painters, further expanding on recent research in the field.

2. Data

Our study uses a unique dataset of paintings by Swedish painters from the late 19th and early 20th century. We analyze both sold and unsold works auctioned between 2010 and 2023 by Bukowskis, Stockholms Auktionsverk, and Uppsala Auktionskammare. This selection of auction houses ensures that only classical art from Swedish painters from this time period is included. Auctions typically occur bi-annually in June and December. We hand-collect detailed data on each painting from auction catalogues and websites, focusing on artist, painting, and sales characteristics. Descriptive statistics of the variables used are reported Table A1 in the Appendix. This also includes a balancing test, showing the significant differences observed

between sold and unsold paintings in the sample. Our method allows for a superior visual approach to thematic classification as argued by De Ridder et al. (2024). Paintings are excluded if the artist is unidentified, the technique is unclear, or if they involve combined works, textiles, door shields, etchings, and painted etchings, which have unique price dynamics (Holub et al., 1993). This results in a total sample of 8,549 paintings. The data of other conventional assets classes in the Swedish market (stocks, bonds, and real estate), are obtained from Refinitiv.

In addition to study the full sample of Swedish painters, we make a distinction between 'master' painters and 'non-master' painters. How a master painting is defined exactly is still an open question. Pesando (1993) uses the top 10 or top 20 percent most expensive paintings as a cut-off. Ashenfelter and Graddy (2003) use the top 20 percent most expensive paintings as a classification and the remaining 80 percent as non-master paintings. We deviate from these definitions by using and examining the characteristics of each artist. Specifically, to be classified as a master artist we require that the artist has received an exhibition reward (i.e., evaluated by a knowledgeable jury). We believe that an exhibition reward ("medal") captures and defines the skill of the artist much better than mere sample distribution features. We use two sources to identify these awards, namely Lilja & Andersson (1952) and Peder & Ingamaj (1991). The rationale for this selection is rooted in the belief that awards judged by expert juries reflect peer recognition of artistic excellence and cultural impact. Exhibition rewards provide an objective measure of an artist's professional validation during their time, offering a more reliable benchmark than subjective market dynamics or retrospective popularity. By focusing on awards, we ensure that our selection criteria align with historical standards of quality and achievement in the art community. Consequently, the sample includes 195 artists which can be classified as a "master artist" representing 38% of all painters in our sample, and 39.92% of all paintings included in our sample. The other asset data applied in this study is obtained from

Refinitiv and consist of the SIX Return Index (SIXRX), 10-year Treasury bonds, and a Swedish real estate index, representing the most popular investment choices for Swedish investors.

3. Research design

3.1. Hedonic pricing model

To appreciate the role of art in the investment portfolio, we employ the hedonic method. This allows us to control the quality of the sold item by identifying the 'shadow price' of each specific characteristic of the artwork, known as hedonic attributes, by regressing the (log) price on the number of the observable attributes.

Before computing and comparing the returns of art using the hedonic price index, it is necessary to consider the possibility of endogenous processes that can affect the results. It is important to identify all sources of endogeneity because they can bias the results in the same or opposite directions. In general, endogeneity can have different sources, but in our study, we identified two sources which we control for, namely measurement error and sample selection bias. Measurement error can affect the sample of artworks if the information on hedonic attributes is not collected correctly or has systematic omissions. For example, the way the theme of paintings is attributed usually is via a terminological approach – considering only the name of the painting to attach a topic to it (e.g., Renneboog & Spanjers, 2013). However, this may result in a systematic bias as a title is not very informative and many paintings are untitled or change title over the years (reference). Therefore, to eliminate such bias, we use the 'visual inspection' approach as detailed in De Ridder et al. (2024). The hedonic pricing model, while being considered the most standard approach when studying paintings (Kraeussl & Logher, 2010), does not come without concerns. Charlin & Cifuentes (2017) argue that relying solely on point estimates of returns to derive conclusions can be misleading. They further question the validity

of previous research, highlighting the elusive nature of the concept of return in the context of art markets. Despite these concerns, we argue that a hedonic pricing model is still useful for this type of data. Moreover, with the visual inspection, Heckman correction, and quality correction of the price index, we find the estimates produced highly informative.

Usually, a fraction of the artworks at auction goes unsold, so we only observe prices for items that sold. This (incidental) truncation occurs because the prices of some observations are missing due to another process. This creates incidental truncation and sample non-randomness, leading to bias in the price index (Collins et al., 2009; Certo et al., 2016). To correct this, we use the Heckman (1979) two-step method. First, a probit model estimates the probability of artwork selling. Second, OLS predicts the dependent variable, incorporating the inverse Mill's ratio (IMR) to correct for sample selection bias. This method accounts for endogeneity due to sample selection (Angelini et al., 2022; Collins et al., 2009; Ekelund et al., 2013). In a regression framework, the Heckman two-step method can be expressed by the following set of equations:

$$\log(P_{i,t}) = \alpha + \beta X_{i,t} + \delta D_t + \lambda_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$s_{i,t} = \alpha + \beta X_{i,t} + \gamma Z_{i,t} + \omega_{i,t} \quad (2)$$

Where $X_{i,t}$ is a vector of attributes of each painting *i* in year *t*, D_t is a year dummy variable, $\lambda_{i,t}$ is the IMR capturing potential sample selection bias, $Z_{i,t}$ is the vector of exclusion restrictions, and $\varepsilon_{i,t}$ and $\omega_{i,t}$ are error terms. The dependent variable $s_{i,t}$ in equation (2) is a binary, equal to 1 if a painting is sold at auction. Table A.2 in the appendix shows the price impact of different characteristics using the Heckman model. The price impact of the different characteristics is also estimated for the subsamples of only master painters and non-master painters, defining as master painter as one who received an exhibition reward.

The coefficients on the time dummies obtained in (1) are used to construct the price index, as they are 'characteristic free' prices (see Triplett, 2003). However, the price index needs to be adjusted for quality. The reason behind it is that due to log-transformation, the index tracks the geometric mean of prices, while the arithmetic mean is of interest. The (corrected) hedonic price index is then given by:

$$HI^{*} = \exp\left[\widehat{\delta_t} + \frac{\widehat{\sigma_t}^2 - \widehat{\sigma_0}^2}{2}\right] * 100\% \quad (3)$$

where $\widehat{\sigma_t}^2$ and $\widehat{\sigma_0}^2$ are the estimated variances of the residuals of observations in periods *t* and *0*, respectively.

3.2.Minimum variance portfolio

A minimum variance portfolio, rooted in Markowitz's (1952) mean-variance model, is a popular strategy that uses diversification to minimize risk and maximize returns. Markowitz's model accurately defined risk and return, providing a theoretical foundation and quantitative tool for portfolio analysis. By combining assets, investors can attain the best risk-adjusted returns, especially in volatile markets. This strategy emphasizes diversification and effective portfolio construction, aiding informed investment decisions and enhancing overall portfolio stability, and serves as a benchmark for other portfolio methods. This strategy can help to obtain either the minimum variance portfolio; suitable for very risk-averse investors who prioritize stability over potential higher returns, or the tangency portfolio; Ideal for investors seeking the best possible trade-off between risk and return. Several previous studies have introduced art as an asset in portfolios, highlighting the complexities and nuanced role of art in investment portfolios. They pointed out that while art can diversify a portfolio, it is not ideal for return maximization due to its unique risk-return profile. Art generally generate lower returns than traditional asset classes like stocks and bonds and comes with certain risks such as

higher transaction costs, illiquidity, and market specific risks, making art a challenging investment (Renneboog & Spanjers, 2013; Mandel, 2009; Campbell, 2008; Goetzmann, 1993; Frey & Pommerehne, 1989).

4. Results

4.1. Descriptive statistics

Table 1 shows the descriptive statistics for the returns of each of the asset classes and their correlation coefficient with the art asset class. It shows that between 2010 and 2024, the average return of the equity index is by far the highest. The art indices show the lowest average. The standard deviation of the art indices is the highest and that of real estate is lowest. Interestingly, when considering master painters, the return decreases, albeit providing a slightly lower risk. Reversely, non-master painters provide a higher return at the cost of a higher risk. Overall, art seems to underperform on a risk-adjusted basis, rendering itself less relevant in an investment portfolio.

The bottom panel gives the correlation coefficients of the six indexes. The art indexes correlate high with the equity index, but low with the bond index and the real estate index. Art appears to have diversification potential due to the low correlation with government bonds and real estate. The higher correlation between art and the Swedish stock market can be attributed to their superior return performance compared to other assets during the sample period of this study. This phenomenon led to a substantial influx of capital into both markets, thereby increasing the prices and sizes of art and real estate assets.

Table 1: Descriptive statistics of returns.

Year	(1) Coefficient	(2) HPI*	(3) Return – Art (%)	(4) Return – Art - Masters (%)	(5) Return – Art - Non-Masters (%)	(6) Return – Bonds (%)	(7) Return – Stocks (%)	(8) Return - Real estate (%)
2010	-	100						
2011	-0.195*** (0.064)	78.54	-21.46	-25.09	-21.57	16.89	-13.51	0.74
2012	-0.132** (0.065)	90.13	14.76	14.29	19.38	4.07	16.49	-1.29
2013	-0.015 (0.068)	103.32	14.63	12.60	18.40	-6.23	27.95	3.55
2014	-0.035 (0.064)	96.72	-6.38	1.00	-11.39	18.51	15.81	6.86
2015	0.203*** (0.071)	128.54	32.90	22.60	33.45	0.43	10.40	10.81
2016	0.211*** (0.069)	118.57	-7.76	-17.33	17.62	7.12	9.65	8.38
2017	0.092 (0.075)	122.38	3.21	9.04	-8.96	0.68	9.47	8.30
2018	0.162** (0.074)	116.85	-4.51	-0.48	-3.42	3.64	-4.41	0.00
2019	0.148** (0.073)	129.85	11.12	8.26	10.94	5.11	34.97	2.73
2020	0.299*** (0.065)	134.17	3.33	2.19	-1.01	2.08	14.83	6.57
2021	0.358*** (0.071)	157.31	17.25	10.21	37.94	-1.85	39.34	16.84
2022	-0.197*** (0.073)	88.13	-43.98	-46.28	-40.40	-16.24	-22.77	4.47
2023	-0.172*** (0.065)	81.10	-7.98	2.94	-20.84	5.69	19.19	-3.80
Average return (%)			0.39	-0.47	2.31	3.07	12.11	4.94
Risk (%)			19.44	18.73	23.07	8.92	17.72	5.55
Art			1	0.94	0.88	0.06	0.74	0.34
Art – Masters				1	0.71	0.14	0.75	0.17
Art – non-masters					1	-0.02	0.69	0.52
Bonds						1	0.08	-0.19
Stocks							1	0.30
Real estate								1

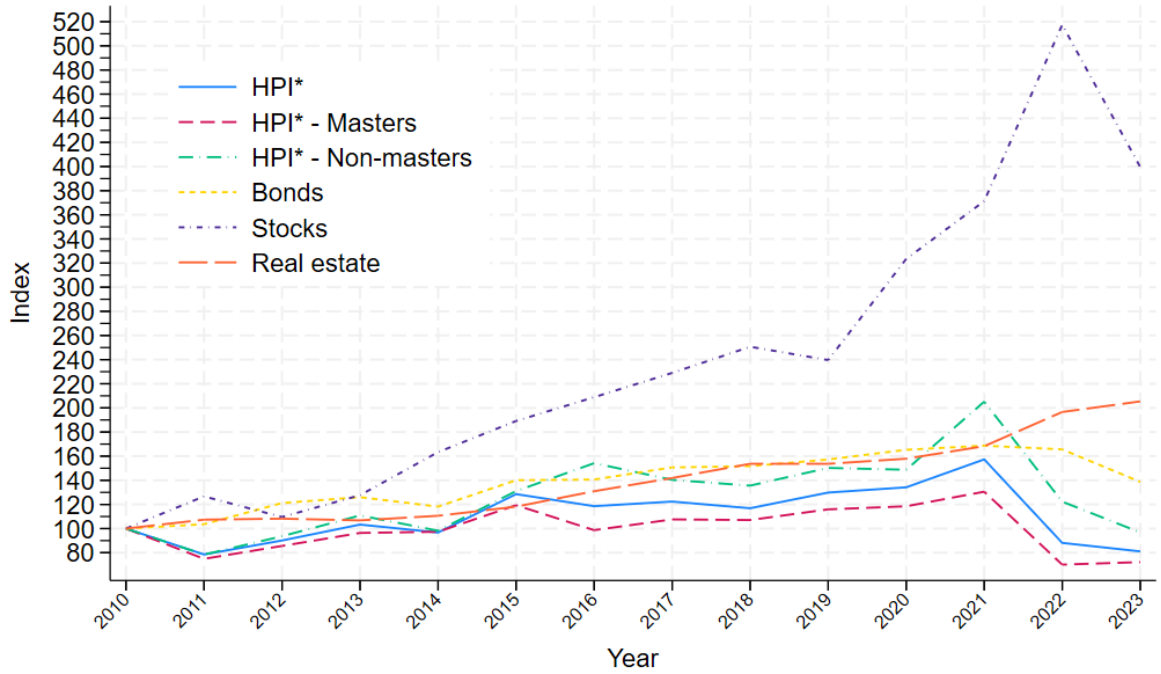
Notes: The bond returns are those of 10-year Swedish treasury bonds. The stock returns are those of the SIX Return Index (SIXRX). The real estate returns are those of the Swedish real estate market. The coefficients in column (1) show the coefficient of the year dummies from the Heckman model. Columns (2) highlight the index movement and yearly price real returns. At the bottom annualized arithmetic mean, standard deviation of art returns is reported, and the correlation between the asset and the Swedish art data. Data for the returns on 10-year Treasury bonds, SIX Return Index (SIXRX) and Real estate is obtained from Refinitiv. Robust standard errors are in the parentheses *** p<0.01, ** p<0.05, * p<0.10.

Column 1 and 2 in Table 1 gives the result of our calculation of the hedonic price indices and the conventional indices in the period (and individual years) studied. Table A1 in the appendix provides the descriptive statistics for all variables considered for the hedonic regression model, alongside a balancing test, providing evidence of the potential need for a Heckman selection model to control the presence of sample selection bias. Table A2 in the appendix, provides the

result of the Heckman model estimation for the art index as well as for the two subgroups considered in this study.

The art indexes constructed because of the estimations are displayed alongside the other indexes considered for our analysis in Figure 1 below. The art index and the two sub-indexes (master art and non-master art) all underperform compared to the equity index (SIX Return Index (SIXRX)), the bond index (10-year Swedish treasury bonds) and the real estate index (Swedish real estate).

Figure 1: The art price index.
Figure 1 visualizes the movement of the art price index between 2010 and 2023. Each index tracks a €100 investment. The HPI* is the hedonic price index with a quality adjustment. The quality adjustment accounts for the fact that due to the log-transformation, the index tracks the geometric mean of prices, while the arithmetic mean is of interest (Triplette, 2003; Renneboog & Spanjers, 2013). A painter is considered a master if the painter has received an exhibition reward. The bonds are 10-year Swedish Treasury bonds. The stocks are the SIX Return Index (SIXRX). The real estate is the Swedish real estate market. The data for the bond, stock and real estate returns are obtained from Thomson Reuters Refinitiv.



4.2. Portfolio allocations

To evaluate the contribution of art as an asset class in an investor's portfolio, we construct different types of portfolios, considering two types of investors: An investor seeking the best possible trade-off between risk and return, and an investor who is very risk-averse and prioritizes stability over potential higher returns. The portfolios associated with the first type of investor is also known as the tangency portfolio, and aims to maximize the Sharpe ratio, and is, at least theoretically, considered the optimal portfolio for all investors. For the very risk-averse investor, we construct various minimum variance portfolios. This type of portfolio offers the lowest risk, but not necessarily the highest return. Previous studies such as Ma & Qi (2023) also construct portfolios, but only considers minimum-variance portfolios.

For each of the two types of investors, we construct various portfolios with and without the inclusion of art. For these calculations, a no-short selling constraint is applied. Since the underlying assets behind the art index – paintings – does not allow for short selling. We furthermore relax the assumption of the existence of a truly riskless asset, as in reality it is also affected by the uncertainty of inflation (Weil & Canner, 1997). The return-risk ratio is then calculated instead of the Sharpe ratio because of relaxing this assumption. In this analysis, we consider eight different portfolios for each of the investor types. We first consider a standard two asset portfolio with stocks and bonds. We then add real estate, and art in turn to the portfolio before considering a portfolio consisting of all four asset classes. We then consider the two subgroups of art, master and non-master art.

Table 2 reports the results of the portfolio allocation exercise. Panel A considers the optimal portfolio, for the investor seeking the highest return-risk ratio. Considering the initial portfolio of stocks and bonds, we find an expected return of 7.891% with an associated risk of 7.223%. With a return-risk ratio of 1.093, it represents an acceptable return-risk reward. We observe that art is never considered part of such a portfolio. While not unexpected, given the descriptive

evidence presented above, it is still interesting to observe that art would seemingly not be part of such a portfolio. Neither when considering the complete art set, nor when considering the subsets of master and non-master. The only gain of art (master and non-master alike) is observed in the reduced risk of the optimal portfolio, which has merit. With a return of 12.108%, the risk of this portfolio with the introduction of art would decrease from 2.629% to 2.277%. The return-risk ratio of 2.277 would be considered very well from an investor's point of view.

Panel B of table 2 considers the case for risk-averse investors. The portfolios constructed here aim to find the mix of assets which would result in the lowest variance of the resulting portfolio. The initial minimum variance portfolio consisting of stocks and bonds provide average returns of 4.71% with a volatility of 5.581%. The associated return-risk ratio of 0.844 indicates a suboptimal return on a risk-adjusted basis. However, the aim with this type of portfolio is not to maximize the return-risk ratio, but to minimize the variance. An investor adding a diversified stock of Swedish art would experience a large decrease in return relative to volatility, worsening the risk-adjusted return as observed by a return-risk ratio of 0.320. An investor with this portfolio would hold a modest amount of Swedish art, at 7.583%. An investor would also hold a modest amount of Swedish art in the cases of the master and non-master subsets, with holdings of 1.967% and 7.245% respectively. It is worth noting that by introducing real estate to any of the portfolios, it results in a large share of this portfolio being allocated to real estate. Art would not be part of any of such portfolios, similar to the case with the tangency portfolio construction. Despite art not being allocated in portfolios where real estate is present, the presence of art still provides a reduction in the overall risk. When comparing these portfolios, despite there being some diversification benefits in including art into a portfolio, the main benefits come from the inclusion of real estate. In the case of a portfolio with stocks and bonds, including art can be even harmful to the risk-adjusted return.

Table 2. Portfolio allocations including and excluding art

Asset class	(1) Bonds and stocks	(2) Bonds, stocks and real estate	(3) Bonds, stocks and art	(4) Bonds, stocks, real estate and art	(5) Bonds, stocks and master art	(6) Bonds, stocks, real estate and master art	(7) Bonds, stocks and non-master art	(8) Bonds, stocks, real estate and non-master art
Panel A: Tangency portfolio								
(1) Stocks	53.343	9.470	100	9.470	100	9.470	100	9.470
(2) Bonds	46.657	23.128	0	23.128	0	23.128	0	23.128
(3) Real Estate	-	67.403	-	67.403	-	67.403	-	67.403
(4) Art	-	-	0	0	0	0	0	0
Return (%)	7.891	5.184	12.108	5.184	12.108	5.184	12.108	5.184
Risk (%)	7.223	2.629	9.829	2.277	9.829	2.277	9.829	2.277
Return-risk ratio	1.093	1.972	1.232	2.277	1.232	2.277	1.232	2.277
Panel B: Minimum variance portfolio								
(1) Stocks	81.844	0	11.722	0	16.585	0	11.151	0
(2) Bonds	18.156	31.122	80.694	31.122	81.448	31.122	81.604	31.122
(3) Real Estate	-	68.878	-	68.878	-	68.878	-	68.878
(4) Art	-	-	7.583	0	1.967	0	7.245	0
Return (%)	4.711	4.355	1.449	4.355	1.999	4.355	1.518	4.355
Risk (%)	5.581	2.374	4.523	2.056	4.555	2.056	4.507	2.056
Return-risk ratio	0.844	1.835	0.320	2.118	0.439	2.118	0.337	2.118

Notes: Panel A displays the tangency portfolio, representing the portfolio with the highest possible return-risk ratio. Panel B displays the minimum variance portfolio, representing the portfolio with the lowest possible variance. The bond returns are those of 10-year Swedish treasury bonds. The stock returns are those of the SIX Return Index (SIXRX). The Real estate returns are those of the Swedish real estate market. The art returns are those from the corrected Hedonic price index (HPI*). The columns present different minimum variance portfolio constructions. It is assumed that no short selling is allowed for either portfolio. The table reports the return-risk ratio rather than the Sharpe ratio, as the assumption about the existence of a truly riskless asset is relaxed. Robust optimization is constructed by subtracting the standard deviation of each asset from the average return of each asset.

4.3. Robustness analysis

So far, the findings suggest that artworks play little to no role when an investor seeks to maximize their return-risk ratio and play a modest role for the risk-averse investor. Given the artworks limited supply the actual proportion of artworks in an investors' portfolio may not be that high. We therefore impose several limits on the amount of artwork an investor can hold in their portfolio. Appendix A.3. displays that imposing limits of 5% and 1% on artwork holdings, does not change the overall return-risk composition of the portfolio. However, there is a change in the case of the risk-averse investor, as art does not enter the portfolio for the investor seeking to maximize the risk-adjusted return.

For the estimation of the hedonic regression model, we apply a Heckman correction to control for the potential sample selection bias. Appendix A.4. shows the portfolio allocation based on a hedonic pricing model without the quality correction. Equation (3) is therefore reduced to:

$$HI^{*} = \exp\left[\widehat{\delta_t}\right] * 100\% \tag{4}$$

The lack of quality correction does not alter the results for the tangency portfolio, but some changes are observed for the minimum variance portfolio. Small changes in the optimal holdings of art are seen for the three portfolios where art has already entered (column (2), (6) and (7) in table 2.). Notably, a small holding of 1.356% of paintings by master artists are now seen as optimal for the risk-averse investor, when considering creating a portfolio with bonds, stocks, real estate and masters' paintings.

5. Conclusion

High-profile art transactions paint a rosy picture of the potential of investing in art. Furthermore, some consider art to be a 'safe haven' in times of crisis. However, most prior research suggests that art is not really a competitive asset class compared to conventional ones like stocks, bonds, and real estate. Nevertheless, for some local financial markets, it appears that during some time periods art can help improve investment portfolio performance. Therefore, we investigate the potential of Swedish paintings using a sample of Swedish classical art sold at auction between 2010-2023 for the investment portfolio. We study auctions at the three main auction houses in Sweden during the period 2010-2024 using a hedonic regression model and applying a Heckman correction to address the sample bias as not all paintings brought to the auction get sold.

The results of our analysis are highly revealing. Despite some high-profile cases of expensive paintings, such as Anders Zorn's "Sunday morning" (Swedish: Söndagsmorgon") for more than SEK 32 million in December 2021 or August Strindberg's "The Wave V" (Swedish: "Vågen V") for approximately SEK 84 million in June 2022, and some price spikes in the art market, the art index of 8,000+ sample paintings consistently and significantly underperform conventional asset classes. The correlation between art indices and conventional financial market indices suggests that there is some diversification potential. Including Swedish art in a traditional portfolio of stocks and bonds would likely lead to lower returns for an investor focused on maximizing profitability. In the case of the risk-averse investor, adding a small proportion of art to one's portfolio can be beneficial when art is considered as part of the available portfolios given its unique risk-return profile. In contrast to previous studies, we opt for studying the effect of masters rather than master pieces. However, the results do not reveal any (positive) master effect, when an investor seeks to maximize returns. The subsample of

master painters reveals a lower risk-adjusted return, and, in the case of a risk-averse investor, the optimal portfolio would contain less art from master painters.

We conclude that investing in Swedish Master painters may not be very profitable from a financial point of view. However, as with all art, beauty is in the eye of the beholder.

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Appendix A.1. Hammer price descriptive statistics and balancing tests

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total		Not sold		Sold		
Variables	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Difference in means (5–3)
Price (SEK 000)	247.7	1,189	n/a	n/a	247.7	1,189	n/a
Artist characteristics:							
Unsigned	0.050	0.218	0.051	0.221	0.049	0.217	-0.002
Painting characteristics:							
Surface (cm^2)	4,05	4,96	4,519.16	5,373.23	3,900.48	4,816.94	-618.68***
Surface squared	4.10e+07	1.80e+08	4.93e+07	1.92e+08	3.84e+07	1.76e+08	-1.09e+07**
Mixed	0.0643	0.245	0.053	0.224	0.068	0.252	0.015***
Oil	0.734	0.442	0.746	0.436	0.730	0.444	-0.016
Pastel	0.0256	0.158	0.028	0.165	0.025	0.156	-0.003
Watercolor	0.177	0.381	0.173	0.379	0.177	0.382	0.004
Theme:							
Landscape	0.295	0.456	0.260	0.439	0.307	0.461	0.047***
Animal	0.125	0.330	0.110	0.313	0.129	0.336	0.019**
Nude	0.0142	0.118	0.014	0.119	0.014	0.118	-0.000
Object	0.0972	0.296	0.097	0.295	0.097	0.296	0.001
People	0.0688	0.253	0.081	0.272	0.065	0.246	-0.016**
Portrait	0.227	0.419	0.261	0.440	0.216	0.412	-0.045***
Still life	0.0404	0.197	0.043	0.203	0.039	0.195	-0.004
Urban	0.132	0.339	0.134	0.340	0.132	0.338	-0.002
Sales characteristics:							
Auktionsverket	0.367	0.482	0.407	0.491	0.354	0.478	-0053***
Bukowskis	0.370	0.483	0.356	0.479	0.374	0.484	0.019
Uppsala Auk.	0.263	0.440	0.237	0.425	0.271	0.445	0.034***
December	0.499	0.500	0.465	0.499	0.509	0.500	0.044***
Fraction sold at previous auction	0.757	0.0570	0.756	0.058	0.758	0.057	0.001

Notes: The total sample consists of 8,594 paintings, spread over 513 different painters. Of the paintings in the sample, 6,513 were sold during action. All variables are binary with Yes = 1, expect Surface and Surface square. Column (7) is the result of a regression where each variable is regressed on a dummy for sold, equal to 1 if the painting was sold at auction, and 0 otherwise. All paintings are classified by visualization of each painting. Hammer prices are expressed in 2020 prices in Swedish Krona (SEK), where we use the consumer price index from Statistics Sweden as a deflator. Data reflects objects sold at three auction houses over the period 2010 to 2023. We use robust standard errors. *** p<0.01, ** p<0.05, * p<0.10.

Appendix A.2. Price impact on Swedish classical paintings

Variable	(1) Second Stage	(2) First-stage Probit	(3) Second Stage - Masters	(4) First-stage Probit – Masters	(5) Second Stage – Non-Masters	(6) First-stage Probit – Non-Masters
Artist characteristics:						
Unsigned (Yes=1)	-0.350***	-0.047	-0.379***	-0.040	-0.270**	-0.061
	(0.084)	(0.078)	(0.105)	(0.094)	(0.131)	(0.139)
Painting characteristics:						
Surface (cm^2)	0.000***	-0.000**	0.000***	-0.000***	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Surface squared	-0.000***	0.000	-0.000***	0.000***	-0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Technique (Base type: Oil)						
Mixed	-1.217***	0.042	-1.501***	-0.008	-0.661***	-0.076
	(0.081)	(0.088)	(0.105)	(0.104)	(0.113)	(0.140)
Pastel	-1.037***	-0.172	-1.111***	-0.079	-0.946***	-0.464**
	(0.107)	(0.109)	(0.135)	(0.127)	(0.171)	(0.226)
Watercolor	-0.278***	-0.063	-0.311***	-0.062	-0.178**	-0.037
	(0.062)	(0.062)	(0.083)	(0.079)	(0.088)	(0.100)
Theme (Base theme: Landscape)						
Animal	0.018	-0.105	0.184*	-0.011	-0.187*	-0.175
	(0.072)	(0.074)	(0.096)	(0.097)	(0.107)	(0.119)
Nude	0.258*	0.175	0.662***	0.176	-0.716***	-0.063
	(0.155)	(0.161)	(0.180)	(0.188)	(0.263)	(0.284)
Object	-0.003	-0.076	0.017	-0.115	-0.034	-0.002
	(0.055)	(0.058)	(0.072)	(0.074)	(0.085)	(0.095)
People	-0.097	-0.203***	0.005	-0.124	-0.226**	-0.326***
	(0.069)	(0.068)	(0.090)	(0.087)	(0.103)	(0.111)
Portrait	0.049	-0.117**	0.172**	-0.069	-0.111	-0.181**
	(0.055)	(0.054)	(0.071)	(0.068)	(0.082)	(0.089)
Still life	-0.083	-0.091	-0.109	0.133	-0.027	-0.198
	(0.114)	(0.122)	(0.179)	(0.241)	(0.145)	(0.163)
Urban	0.095**	0.014	0.154**	-0.024	0.011	0.044
	(0.047)	(0.050)	(0.061)	(0.064)	(0.072)	(0.080)
Auction house (base Auktionsverket)						
Bukowskis	0.350***	0.011	0.375***	0.042	0.297***	-0.024
	(0.033)	(0.034)	(0.044)	(0.044)	(0.049)	(0.056)
Uppsala Auktionskammare	0.002	0.105***	-0.059	0.087*	0.062	0.137**
	(0.035)	(0.037)	(0.046)	(0.048)	(0.051)	(0.061)
Winter sale dummy (December)						
December	0.077***	0.048*	0.048	0.042	0.120***	0.051
	(0.027)	(0.029)	(0.035)	(0.037)	(0.039)	(0.047)
Exclusion restrictions and selection parameter:					-0.270**	-0.061
Fraction sold at previous auction		-0.360		-0.460	(0.131)	(0.139)
		(0.299)		(0.385)		(0.486)
Lambda	0.131***		0.152***		0.063***	
	(0.017)		(0.023)		(0.023)	
Constant	2.669***	0.831**	2.639***	0.796*	2.827***	0.611
	(0.287)	(0.359)	(0.307)	(0.415)	(0.149)	(0.392)
Observations	8,594	8,594	5,163	5,163	3,431	3,431

Notes: The total sample consists of 8,594 paintings, spread over 513 different painters. Of the paintings in the sample, 6,513 were sold during action. All variables are binary with Yes = 1, expect Surface and Surface square. The dependent variable is the log of hammer price in SEK at 2020 price levels for column (1), (3) and (4). The dependent variable for column (2) and (5) is a dummy variable equal to 1 if the painting was sold at auction, and 0 otherwise. The Heckman model is estimated via Maximum Likelihood. Lambda refers to the inverse Mills ratio. Artist fixed effects and Year dummies are included in estimation of the regression models, but not reported. Due to the large number of painters in our sample, artist with less than 15 paintings in our sample are grouped together as "Other painters". Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10.

Appendix A.3. Minimum variance portfolio with imposed limits on art

Asset class	(1) Bonds and stocks	(2) Bonds, stocks and real estate	(3) Bonds, stocks and art	(4) Bonds, stocks, real estate and art	(5) Bonds, stocks and master art	(6) Bonds, stocks, real estate and master art	(7) Bonds, stocks and non-master art	(8) Bonds, stocks, real estate and non-master art
Panel A: Minimum variance portfolio with 5% art limit								
(5) Stocks	81.844	0	13.914	0	16.585	0	13.322	0
(6) Bonds	18.156	31.122	81.059	31.122	81.448	31.122	81.678	31.122
(7) Real Estate	-	68.878	-	68.878	-	68.878	-	68.878
(8) Art	-	-	5	0	1.967	0	5	0
Return (%)	4.711	4.355	1.704	4.355	1.999	4.355	1.729	4.355
Risk (%)	5.581	2.374	4.527	2.056	4.555	2.056	4.512	2.056
Return-risk ratio	0.844	1.835	0.377	2.118	0.439	2.118	0.383	2.118
Panel B: Minimum variance portfolio with 1% art limit								
(5) Stocks	81.844	0	17.308	0	17.358	0	17.190	0
(6) Bonds	18.156	31.122	81.692	31.122	81.642	31.122	81.810	31.122
(7) Real Estate	-	68.878	-	68.878	-	68.878	-	68.878
(8) Art	-	-	1	0	1	0	1	0
Return (%)	4.711	4.355	2.100	4.355	2.097	4.355	2.104	4.355
Risk (%)	5.581	2.374	4.549	2.056	4.555	2.056	4.544	2.056
Return-risk ratio	0.844	1.835	0.462	2.118	0.460	2.118	0.463	2.118

Notes: Panel A displays the minimum variance portfolio, with an additional restriction of a maximum art holding of 5%. Panel B displays the minimum variance portfolio, with an additional restriction of a maximum art holding of 1%. Portfolios without art, or previous art being held below the imposed limit, is unaffected. The bond returns are those of 10-year Swedish treasury bonds. The stock returns are those of the SIX Return Index (SIXRX). The Real estate returns are those of the Swedish real estate market. The art returns are those from the corrected Hedonic price index (HPI*). The columns present different minimum variance portfolio constructions. It is assumed that no short selling is allowed for either portfolio. The table reports the return-risk ratio rather than the Sharpe ratio, as the assumption about the existence of a truly riskless asset is relaxed. Robust optimization is constructed by subtracting the standard deviation of each asset from the average return of each asset.

Table A.4. Portfolio allocations without quality adjustment

Asset class	(1) Bonds and stocks	(2) Bonds, stocks and real estate	(3) Bonds, stocks and art	(4) Bonds, stocks, real estate and art	(5) Bonds, stocks and master art	(6) Bonds, stocks, real estate and master art	(7) Bonds, stocks and non-master art	(8) Bonds, stocks, real estate and non-master art
Panel A: Tangency portfolio								
(9) Stocks	53.343	9.470	100	9.470	100	9.470	100	9.470
(10) Bonds	46.657	23.128	0	23.128	0	23.128	0	23.128
(11) Real Estate	-	67.403	-	67.403	-	67.403	-	67.403
(12) Art	-	-	0	0	0	0	0	0
Return (%)	7.891	5.184	12.108	5.184	12.108	5.184	12.108	5.184
Risk (%)	7.223	2.629	9.829	2.277	9.829	2.277	9.829	2.277
Return-risk ratio	1.093	1.972	1.232	2.277	1.232	2.277	1.232	2.277
Panel B: Minimum variance portfolio								
(9) Stocks	81.844	0	15.002	0	17.110	0	12.553	0
(10) Bonds	18.156	31.122	79.754	31.122	80.928	30.317	79.364	31.122
(11) Real Estate	-	68.878	-	68.878	-	68.327	-	68.878
(12) Art	-	-	5.243	0	1.962	1.356	8.082	0
Return (%)	4.711	4.355	1.832	4.355	2.077	4.307	1.586	4.355
Risk (%)	5.581	2.374	4.540	2.056	4.553	2.052	4.516	2.056
Return-risk ratio	0.844	1.835	0.404	2.118	0.456	2.099	0.351	2.118

Notes: Panel A displays the tangency portfolio, representing the portfolio with the highest possible return-risk ratio. Panel B displays the minimum variance portfolio, representing the portfolio with the lowest possible variance. The bond returns are those of 10-year Swedish treasury bonds. The stock returns are those of the SIX Return Index (SIXRX). The Real estate returns are those of the Swedish real estate market. The art returns are those from the Hedonic price index without the quality adjustment (HPI). The columns present different minimum variance portfolio constructions. It is assumed that no short selling is allowed for either portfolio. The table reports the return-risk ratio rather than the Sharpe ratio, as the assumption about the existence of a truly riskless asset is relaxed. Robust optimization is constructed by subtracting the standard deviation of each asset from the average return of each asset.

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