

**Czech University of Life Sciences Prague**

**Faculty of Economics and Management**

**Department of Economics**



**Bachelor Thesis**

**Art as an Alternative Investment Tool for Portfolio Diversification**

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## BACHELOR THESIS ASSIGNMENT

BcA. Ainur Akhmetova, BA

Economics and Management

Thesis title

**Art as an Alternative Investment Tool for Portfolio Diversification**

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### Objectives of thesis

The main objective of the thesis is to present a list of recommendations for potential investors wanting to diversify their portfolios with art as an investment tool and to outline portfolio diversification opportunities of including art in a mixed-asset investment portfolio.

### Methodology

The theoretical part will consist of an overview on an art market and its characteristics as well as the difficulties that it experiences. The empirical part will be mostly concerned with how art market operates among other financial markets and traditional tradable assets. That relationship will be explored by organizing time series data sets and examining the correlation and variance-covariance among the four selected assets (art, S&P 500 stocks, U.S. 10-year bonds and gold) and calculating an optimal share of each asset in a portfolio with a Markowitz Modern Portfolio Theory model.

## **The proposed extent of the thesis**

35 – 40 pages

## **Keywords**

art, portfolio diversification, investment, emotional assets, modern portfolio theory, risks and returns.

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## **Recommended information sources**

Kraeussl, Roman, and Robin Logher. "Emerging Art Markets." *Emerging Markets Review*, vol. 11, no. 4, 2010, pp. 301–318., doi:10.1016/j.ememar.2010.07.002

Renneboog, Luc, and Christophe Spaenjers. "Buying Beauty: On Prices and Returns in the Art Market." *SSRN Electronic Journal*, 2012, doi:10.2139/ssrn.1352363.

Smith, V. Kerry. *Estimating Economic Values for Nature: Methods for Non-Market Valuation*. Edward Elgar, 1996.

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## **Expected date of thesis defence**

2018/19 SS – FEM

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Electronic approval: 11. 3. 2019

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## **Declaration**

I declare that I have worked on my bachelor thesis titled " Art as an Alternative Investment Tool for Portfolio Diversification" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 12.03.2019

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## **Acknowledgement**

I would like to thank my supervisor doc. Ing. Mansoor Maitah, Ph.D. et Ph.D. for his support throughout the process of writing this thesis. Also, I am very thankful for my friends and family who believed in me and supported in all these years of studying.

## Umění jako alternativní nástroj pro diverzifikaci investičního portfolio

### **Souhrn:**

V neustále se měnícím finančním prostředí je diverzifikace investičního portfolio důležitější než kdy dříve. Investiční portfolio, které obsahuje různé druhy investic v různých odvětvích je správně diverzifikováno.

Tradiční aktiva jsou velmi často vzájemně provázána, například akcie a dluhopisy jsou vystaveny podobným faktorům rizika. Krize z roku 2008 donutila investory přemýšlet nad alternativními investičními nástroji, včetně tzv. emocionálních statků, mezi které řadíme hmotné umění, sběratelské předměty, vzácné kovy, vína apod. Tyto statky vykazovali historicky velmi malou náchylnost k fluktuaci finančních trhů. To vyvolává otázku, zdali umění v investičním portfolio minimalizuje celkové riziko bez toho, aby se snížila možná návratnost investic v porovnání s tradičními investičními nástroji jako jsou akcie, dluhopisy apod., které jsou často brány jako nejefektivnější za předpokladu standartních podmínek na finančním trhu.

Následující práce bere v potaz především hmotné umění a zabývá se riziky a návratností na dnešních trzích a jejím potenciálu k použití jako nástroje diverzifikace investičního portfolio. Hlavním cílem této práce je navrhnout řešení, jak optimálně rozložit investice v portfolio mezi tradiční a umělecké nástroje tak, aby došlo k maximalizaci zisku.

### **Klíčová slova:**

umění, diverzifikaci portfolio, investice, emocionální majetek, moderní teorie portfolio, Markowitzův model, rizika a výnosy

## **Art as an Alternative Investment Tool for Portfolio Diversification**

### **Summary:**

In the constantly changing financial environment, the importance of portfolio diversification is crucial as never. Technically, a portfolio that includes different kinds of securities for different kinds of industries is well-diversified. Nevertheless, traditional assets are often highly multicorrelated, as, for example, stocks and bonds, and are exposed to a similar amount of risk factors. The global crisis of 2008 was among the main reasons that pushed investors to consider alternative investment tools, including so-called emotional assets, among such are all forms of tangible art, collectibles, precious metals, wines, etc. Alternative assets, specifically art pieces, have historically shown little responsiveness to fluctuations in financial markets. That poses a question of whether including art in an investment portfolio would minimize the overall portfolio risks without compromising its returns associated with excluding conventional investment instruments such as stocks and bonds, which are often the most effective ones in terms of returns under stable market conditions. The following thesis takes tangible art as a main focus and explores its risks and returns on today's financial market and its potential to be used as an instrument for portfolio diversification. The main aim is to come up with suggestions on how to successfully optimize (maximize the returns and minimize the risks) an investment portfolio by including artworks along the traditional assets.

**Key words:** art, portfolio diversification, investment, emotional assets, modern portfolio theory, Markowitz model, risks and returns.

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## 1. Introduction

The concept of investment has long been an alternative to safe saving. Investopedia definition states that an investment is an act of putting money, time, effort or any other asset with a long-term goal to accumulate additional wealth from it. In other words, it usually implies popular investment vehicles such as securities, mutual funds, stocks, foreign currencies, etc. However, the financial crisis of 2008 has revealed the riskiness of investments, where one event in a separate market caused a breakdown in the entire financial system, affecting all kinds of assets, tradables, and investors<sup>1</sup>. In simple words, all economic crises regardless of their nature, have a potential to increase volatility for all kinds of markets and stock returns. The events of 2007-2008, together with common knowledge about market unpredictability, caused investors to look for a safer and alternative way to invest their money which would maximize the profit without increasing the risk. One way to do that without compromising a portfolio and without excluding conventional investment instruments such as stocks and bonds, which are often the most effective ones in terms of returns given that the economy is stable, is to diversify it.

Portfolio diversification is not a new concept. It is outlined in a Modern Portfolio Theory and is proven to be a foundation for a safe investment<sup>2</sup>. However, when hearing about diversification some only assume it being implemented within the available traditional assets. Technically, a portfolio that includes different kinds of securities for different kinds of industries is well-diversified. Nevertheless, traditional assets are often highly multicorrelated, as, for example, stocks and bonds, and are exposed to a similar amount of risk factors.

Market correlation has also increased as a result of expanding globalization, which has made investing even riskier.<sup>3</sup> Today equity and currencies are more correlated than ever since 2008<sup>4</sup>. In this ever-changing financial environment, the importance of smart

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<sup>1</sup> Fraser-Sampson, Guy. *Alternative Assets: Investments for a Post-Crisis World*. Wiley, 2011.

<sup>2</sup> Crawford, Graeme Frederick. *Portfolio Diversification: a Theoretical and Empirical Analysis*. University of British Columbia, 1970.

<sup>3</sup> Wurgler, Jeffrey. "On the Economic Consequences of Index-Linked Investing." 2010, doi:10.3386/w16376.

<sup>4</sup> Wang, Lu (2016) Asset Contagion Worse Than 2008 as Markets Held Hostage to Rates. Bloomberg. <https://www.bloomberg.com/news/articles/2016-09-08/asset-contagion-worse-than2008-as-markets-held-hostage-to-rates>. (Accessed 2019-01-18)

diversification is crucial as never, which is why investors now consider alternative investments, including so-called emotional assets, among such are all forms of tangible art, collectibles, precious metals, wines, etc.<sup>5</sup> The following thesis takes tangible art as a main focus and explores its risks and returns on today's financial market and its potential to be used as an instrument for portfolio diversification.

### **1.1. Objectives**

The main objective of the thesis is to present a list of recommendations for potential investors wanting to diversify their portfolios with art as an investment tool and to outline portfolio diversification opportunities of including art in a mixed-asset investment portfolio. This would be done by comparing art as an investment tool with traditional financial assets such as S&P 500 stocks, U.S. 10-year bonds, and gold, examining historical information regarding market trends and its correlation within financial markets and assessing the efficiency of including art in an investment portfolio.

### **1.2. Methodology**

The above would be done by calculating risks and returns based on data from public databases of auction houses, determining price indices and applying Markowitz portfolio optimization model, all to draw recommendations as to when it is a good idea to diversify one's investment portfolio with art, rationalize the expectations from art as an investment, and suggest efficient multi-asset investment model. The theoretical part will consist of an overview on an art market and its characteristics as well as the difficulties that it experiences. The empirical part will be mostly concerned with how art market operates among other financial markets and traditional tradable assets. That relationship will be explored by organizing time series data sets and examining the correlation and variance-covariance among the four selected assets (art, S&P 500 stocks, U.S. 10-year bonds and gold) and calculating an optimal share of each asset in a portfolio with a Markowitz Modern Portfolio Theory model.

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<sup>5</sup> Myers, R. (2010). The New Rules For Diversification. Wall Street Journal. 2010. <http://online.wsj.com/ad/article/financialplanning-diversification>. (Accessed 2019-01-18)

## Literature review

### 1.3. Traditional and alternative assets

Some of the most common traditional investment instruments are the following<sup>6</sup>:

- Securities, both basic and derived — tradable financial assets, such as common stocks and bonds (Investopedia);
- Shares — units of ownership of a corporation that usually yield dividends (Investopedia);
- Foreign currencies — currencies virtually traded on foreign exchange markets (Investopedia);
- Precious metals — classification of metals that have relative economic values (Investopedia).

Securities and shares are assumed to be the most popular investment instrument for governmental, corporate, and personal investing because of their rather high liquidity and easy access for trade<sup>7</sup>.

A well-diversified portfolio, as stated by Campbell<sup>8</sup> needs to have a mix of traditional and alternative assets, meaning, that in addition to securities and cash it should be comprised of assets from markets only loosely connected to financial ones.

To describe an alternative asset, it is any investment instrument except the traditional ones. The vague definition is due to a vast nature of alternative, sometimes called emotional, assets. Technically, anything of non-traditional nature can be considered an investment, from purchasing collectible items to investing your own time and effort with an intention to later derive some profit or benefit from it<sup>9</sup>. Alternative assets are rarely look at as independent investment instruments and usually compliment a portfolio of traditional assets with an intention to diversify it. Since alternative assets are normally not directly correlated to constantly volatile stock markets and are not a part of capital markets, as it was previously

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<sup>6</sup> Semenкова, E. (1997). Operations with financial instruments.. Moscow: Perspektiva.

<sup>7</sup> Smith, V. Kerry. *Estimating Economic Values for Nature: Methods for Non-Market Valuation*. Edward Elgar, 1996.

<sup>8</sup> Campbell, R. A. J., Koedijk, C. G., de Roon, F. A. (2008). Emotional Assets. Working Paper. Maastricht University and Tilburg University.

<sup>9</sup> Tammuni, A. (2015). The Art Of Alternative Investment – A New Asset Class. 5 September 2015. <http://themarketmogul.com/art-alternative-investment-new-asset-class/>. (Accessed 2019- 01-18)

mentioned and referenced to Campbell's research, by adding them to a portfolio it lowers the total risk and increases potential returns.

### **1.3.1. Emotional asset**

Alternative assets can be both tangible and intangible. Some most common examples of intangible assets are hedge funds and insurances, while tangible ones are a whole range of assets and commodities, most common of which are real estate and collectibles, though investing in real estate has become such a common practice these days that some would argue it is now a rather traditional investment instrument as well.<sup>10</sup>

The difference between alternative and emotional assets is hard to be defined. All emotional assets are alternative assets, too, but not all alternative assets are emotional assets. All alternative assets are intended to generate certain profit, regardless of their liquidity levels, and all alternative assets, with an exception of emotional ones, have intrinsic, easily calculated value by, for instance, being a part of a manufacturing process (e.g. gemstones) or having a dynamic market that determines prices (e.g. real estate)<sup>11</sup>. Emotional assets, however, do not possess any value because they do not hold industrial use and are only considered an asset upon recognition of aesthetic or pleasure factor, thus it is very subjective. Aside from aesthetics, emotional assets hold some other potential marginal uses, such as increasing one's social status or increasing a value of another commodity by leveraging on the status of emotional asset. Most important characteristic of emotional assets is that at least one from below criteria applies to them<sup>12</sup>:

- Uniqueness (e.g. art pieces);
- Limited edition (e.g. fine wines, antiques);
- Rareness (e.g. diamonds).

The above three are also among the price determinants in addition to the basic recognition of a commodity to be a valuable asset.

Because of the three above characteristics, each unit of emotional assets is unique in its risk ration and investment period because it has different utility and profitability

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<sup>10</sup> Tammuni, A. (2015). The Art Of Alternative Investment – A New Asset Class. 5 September 2015. <http://themarketmogul.com/art-alternative-investment-new-asset-class/>. (Accessed 2019- 01-18)

<sup>11</sup> R. Belk, « Collecting as luxury consumption : Effects on Individuals and Households », 1995

<sup>12</sup> Ollagnon, O. (2012), Emotional Asset as an Alternative Financial investment, HEC Paris

objectives. Additionally, emotional assets usually hold hidden maintenance costs which usually is not a case with traditional assets. For example, art pieces often require care and restoration to maintain their value<sup>13</sup>.

### 1.3.2. Portfolio diversification and MPT

The foundation idea of a portfolio diversification is efficient allocation of resources in a way that it would minimize the risks as much as possible. It is also an underlying concept of any economic problem, from production to individual consumption, which originated from an economic assumption of rationality, stating that individuals and entities are rational in their allocation of financial and human resources, and other.

Ever since the Modern Portfolio Theory was introduced, portfolio diversification has become a standard practice for investors and is now a crucial step in investment planning. The investment process, excluding cash return, can be divided into five main stages:

1. Deciding on investment assets/industries;
2. Analyzing respective markets;
3. Forming an investment portfolio in accordance with findings from Stage 2;
4. Revising a portfolio considering current market fluctuations;
5. Evaluation yielded returns.

The Modern Portfolio Theory (MPT), also called Markowitz Theory, is based on the assumption of rationality which opens a possibility to mathematically calculate the optimality of an investment portfolio. The main claim Markowitz made is that by choosing under correlated assets it is possible to significantly reduce the risks than an investment carries. Its mathematical depiction, together with the theory, earned a Nobel Prize in Economics in 1990.<sup>14</sup> Markowitz also coined terms “risk” and “returns” in the context of investment. According to MPT, returns are shown as mean probability distribution and risks as the standard deviation of possible values from the expected return, as shown in Figure 1.<sup>15</sup>

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<sup>13</sup> Fraser-Sampson, Guy. *Alternative Assets: Investments for a Post-Crisis World*. Wiley, 2011.

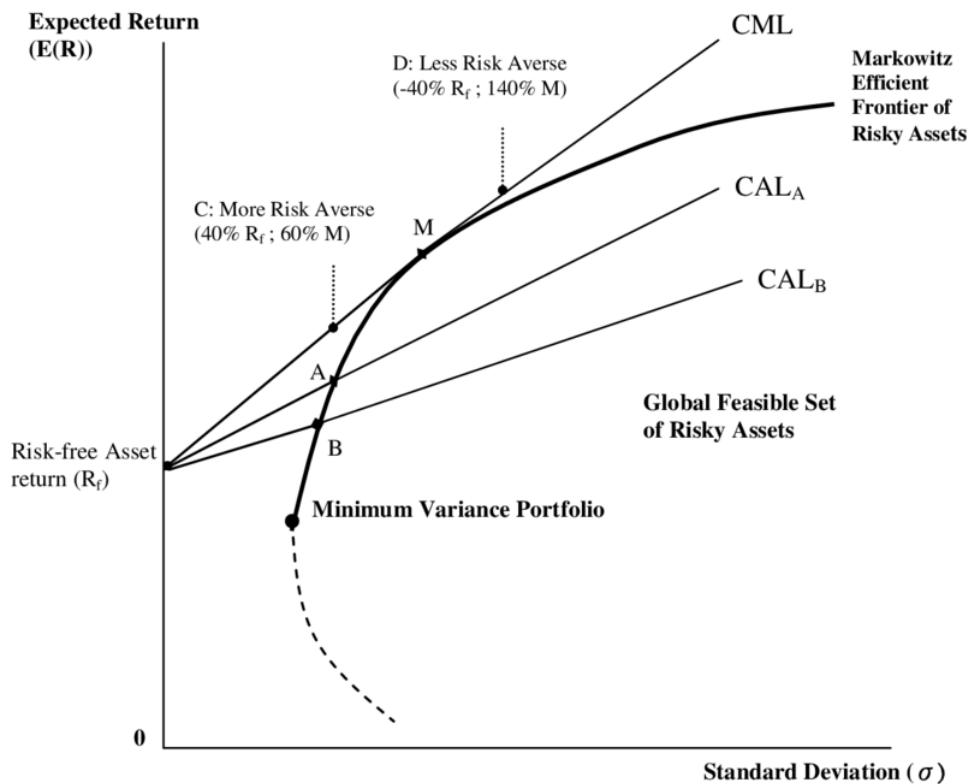
<sup>14</sup> Jacquier, Eric. “Modern Portfolio Theory.” *Portfolio Theory and Management*, 2013, pp. 23–45., doi:10.1093/acprof:oso/97801998

<sup>15</sup> Kasimov, U. (2005). Introduction into optimum portfolio.. Moscow: Ankil.

To conclude, a well-diversified investment portfolio has two key benefits to investors:

- Optimal combination of profitability and risk;
- Potential yield in both short- and long-term periods due to different liquidities.

Figure 1: Markowitz Efficient Frontier of Risky Assets



Source: Hodnett, Kathleen, and Heng-Hsing Hsieh. *Capital Market Theories: Market Efficiency Versus Investor Prospects*.<sup>16</sup>

By adding alternative, including emotional assets, Markowitz efficient frontier according to MPT is expected to shift upward as per Figure 1. The interpretation is that an investor can obtain the same amount of return while maintaining the same level of risk, or the same level of return but under a lower level of risk.

<sup>16</sup> Hodnett, Kathleen, and Heng-Hsing Hsieh. "Capital Market Theories: Market Efficiency Versus Investor Prospects." *International Business & Economics Research Journal (IBER)*, vol. 11, no. 8, 2012, p. 849., doi:10.19030/iber.v11i8.7163

#### 1.4. Art as a commodity

For this research, art will be defined as tangible piece of artwork, mostly a painting or a sculpture. As opposed to commodities and securities, artworks are heterogeneous and incomparable one to another. This makes it difficult to estimate the monetary price of a piece of art since an artwork's value is not determined by the production cost as with conventional commodities.<sup>17</sup> That is why, an artwork is basically worth what the buyer is offering and what the seller is willing to accept.<sup>18</sup> This approach aligns with the cases where paintings that were once worth nothing reach astronomical selling prices on the auctions. A price of 100 million USD is no longer something unheard of in art seller circles which proves that sky is indeed the limit.

Since art being a commodity is a rather unpredictable phenomenon, the main job of an investor is to determine which piece has the largest potential to grow in price. This also implies that an investor has some prior knowledge about the market or art history in general, or at least has the means to hire consultants to advice on investing. However, with art market growing in size and scope, and with the growing popularity of online to on-site auction houses such as Christie's which has made it easier for anyone with resources and interest to bid and buy, art investment becomes more and more available to the public.<sup>19</sup>

The essence of an artwork on a market is that its sale and purchase is an absolute gamble in regards to future yields. A seller can easily underestimate a piece and later watch it go exponentially un in price from the initial one, or, vice versa, a buyer can overestimate the offer and end up being unable to sell it for higher than the market price at the time of purchase. Therefore, there are four pieces of information to consider before buying or selling an artwork as per Figure 2:

1. Risks and Returns — as already explained in Chapter 2.1.3 about Modern Portfolio Theory, the optimum between risk and returns is what yields profit. It will be further explained in Chapter 2.3.

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<sup>17</sup> Sagot-Duvaouroux, Dominuque. "Art Prices." *A Handbook of Cultural Economics, Second Edition*, doi:10.4337/9780857930576.00011.

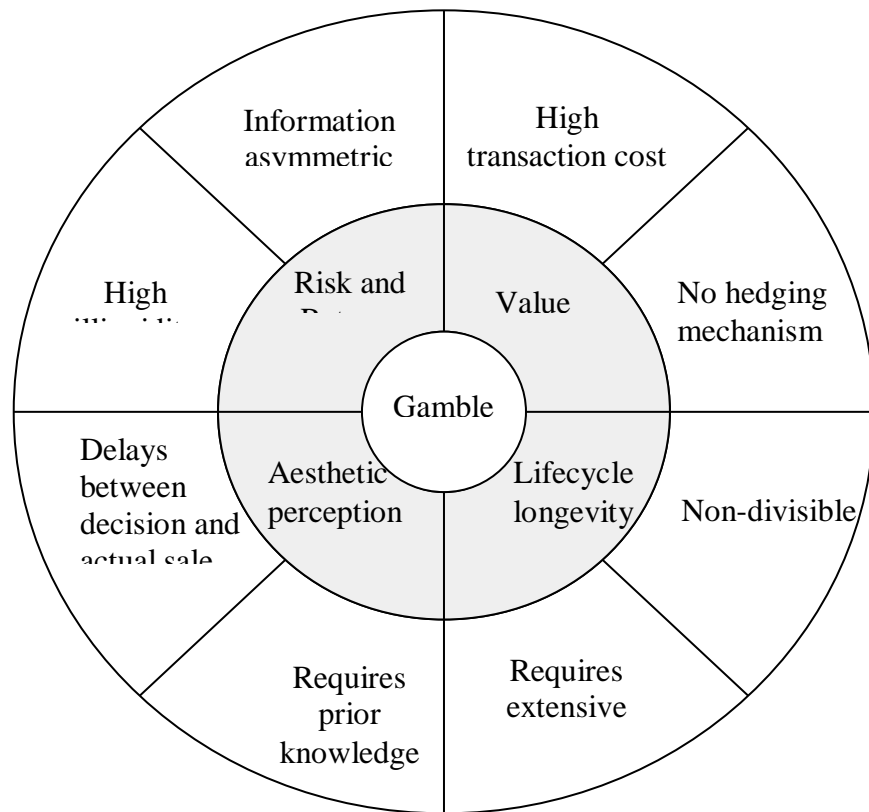
<sup>18</sup> Goetzmann, William N., and Matthew Spiegel. "Private Value Components, and the Winner's Curse in an Art Index." *European Economic Review*, vol. 39, no. 3-4, 1995, pp. 549–555., doi:10.1016/0014-2921(94)00061-4.

<sup>19</sup> Renneboog, Luc, and Christophe Spaenjers. "Buying Beauty: On Prices and Returns in the Art Market." *SSRN Electronic Journal*, 2012, doi:10.2139/ssrn.1352363.



2. Value — the heterogeneous nature of art makes it difficult to quantify a piece's value, it will be later explored in Chapter 2.2.2.
3. Aesthetic pleasure — it is impossible to quantify but is normally explained as marginal utility derived from owning an artwork.
4. Lifecycle longevity — it was already mentioned in previous chapters that owning an artwork, whether with an intent to then sell it or to keep it, requires maintenance which is an additional cost to original selling/purchasing price.

Figure 2: Main features of artworks as an investment



Source: interpreted from *Peculiarities of Selection of Investment Artworks*, Jureviciene et al.<sup>20</sup> and *Hedging the Art Market: Creating Art Derivatives*, Ralevski, Olivia.<sup>21</sup>

The above four points lead to at least eight potential concerns for investors about artworks' used as investment instruments:

1. Information asymmetry — because of uniqueness and heterogeneity of art, there are no rules of thumb and commonly accepted suggestions as to selling and buying art; the available information is rather case-oriented and does not reflect overall art market trends because there are none.

<sup>20</sup> Jurevičienė, Daiva, and Božena Kostecka. "Peculiarities of Selection of Investment Artworks." *Acta Oeconomica Pragensia*, vol. 2014, no. 5, 2014, pp. 71–88., doi:10.18267/j.aop.453.

<sup>21</sup> Ralevski, Olivia. "Hedging the Art Market: Creating Art Derivatives." *SSRN Electronic Journal*, 2008, doi:10.2139/ssrn.1304602.

2. High transaction cost — if a piece is bought at the auction, there is normally a so-called buyer's premium charged additionally to the hammer price as a commission, which could range anywhere from 10 to 40% of the original price. Outside of the auctions, art sale poses high transaction costs in regards to legal costs, consulting expenses, dealer commission, etc. <sup>22</sup>
3. Absence of hedging mechanism — potential risk of sale and purchase are not insured and thus are basically a gamble.
4. Non-divisible — one cannot sell or buy a painting in parts, meaning that a purchase is a commitment to its whole value.
5. Requires extensive capital — while, as mentioned already, auctions like Christie's offer paintings and sculptures for under US \$1,000 sometimes, normally an investor needs a lot of initial equity to make a purchase.
6. Requires prior knowledge — knowledge is among the few things that work in the unpredictability of the market, where the determinants of prices almost do not exist and thus a successful purchase depends on already existing knowledge about an artwork and pure luck.
7. Delays between decision and actual sale — both when investing and turning an investment back into cash, the transactional and legal part of the sale is time-consuming and it leads to next point.
8. High liquidity — unlike cash and most of securities, selling an artwork is time and effort consuming and thus it is not much liquid.

#### **1.4.1. Characteristics of Art Market**

Even though investment in artworks is not as clear-cut as investing in traditional assets, it has long been popular among investors because the yield that art brings is capital gain instead of just dividends as in case with, for example, shares. The history of art market goes back to 17th century, when rich European families commonly maintained their equity by distributing their capital, which we now call diversification, in a proportional way:  $\frac{1}{3}$  went towards all kinds of securities,  $\frac{1}{3}$  to real estate and another  $\frac{1}{3}$  to artworks, gemstones, collectibles,

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<sup>22</sup> Kraeusl, Roman, and Robin Logher. "Emerging Art Markets." *Emerging Markets Review*, vol. 11, no. 4, 2010, pp. 301–318., doi:10.1016/j.ememar.2010.07.002.

precious metals, etc.<sup>23</sup> Later at the end of the 19th centuries art auctions started appearing and the market has been growing ever since.

When looking at the market trend of the past few decades, we can say that art market is now rather fast-growing. One of the reasons for that is the globalization, under which the market increased from US \$20 billion in 2004 to US \$45 billion in 2016.<sup>24</sup> Moreover, over the past four decades, which means even before the peak of globalization, the average annual return on art investment is reported to be 10%.<sup>25</sup> This of course did not go unnoticed by the investors, especially given the common belief that art market has little to no correlation to other financial markets trading traditional assets. In 1987, right after the Wall Street stock prices drastically fell overnight, Vincent van Gogh's *Irises* was sold for US \$54 million which was an absolute record selling price for an artwork in the world.<sup>26</sup> Similarly, according to Velthuis' research, after the financial crisis of 2008, when Dow Jones index went 370 down on the 5th of February, Sotheby's — one of the world's largest artwork brokers — continued to smoothly work, selling over US \$231 million worth of work on that same day. It is important to mention that art market did experience disruption in 2008, but the consequences were not nearly as severe as for the financial market. Some researches even suggests that the sinking might not be caused by the crisis itself, but rather by the overheated market of contemporary art which increased 8 times between the years of 2003 and 2007.<sup>27</sup> Because of overloaded market, investors' confidence fell as a result of unpredictability and huge increase in options and the market fell by almost 40%, according to Velthuis. Still, the majority of research available on the topic suggests that over the past few decades there was almost no relationship detected between art market and stock market. In her book *Fine Art and High Finance*, McAndrew concluded that all sectors of the art market show consistent low or even negative correlation with other financial indices which makes for an attractive investment opportunity with low risk.<sup>28</sup>

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<sup>23</sup> Jurevičienė, Daiva, and Božena Kostecka. "Peculiarities of Selection of Investment Artworks." *Acta Oeconomica Pragensia*, vol. 2014, no. 5, 2014, pp. 71–88., doi:10.18267/j.aop.453.

<sup>24</sup> Pownall, R.A.J. (2017). TEFAF Art Market Report 2017. The European Fine Art Fair Maastricht

<sup>25</sup> Korteweg, A., Kräussl, R. and Verwijmeren, P. (2013). Research: Is Art a Good Investment? <https://www.gsb.stanford.edu/insights/research-art-good-investment> (Accessed 2017-05-29)

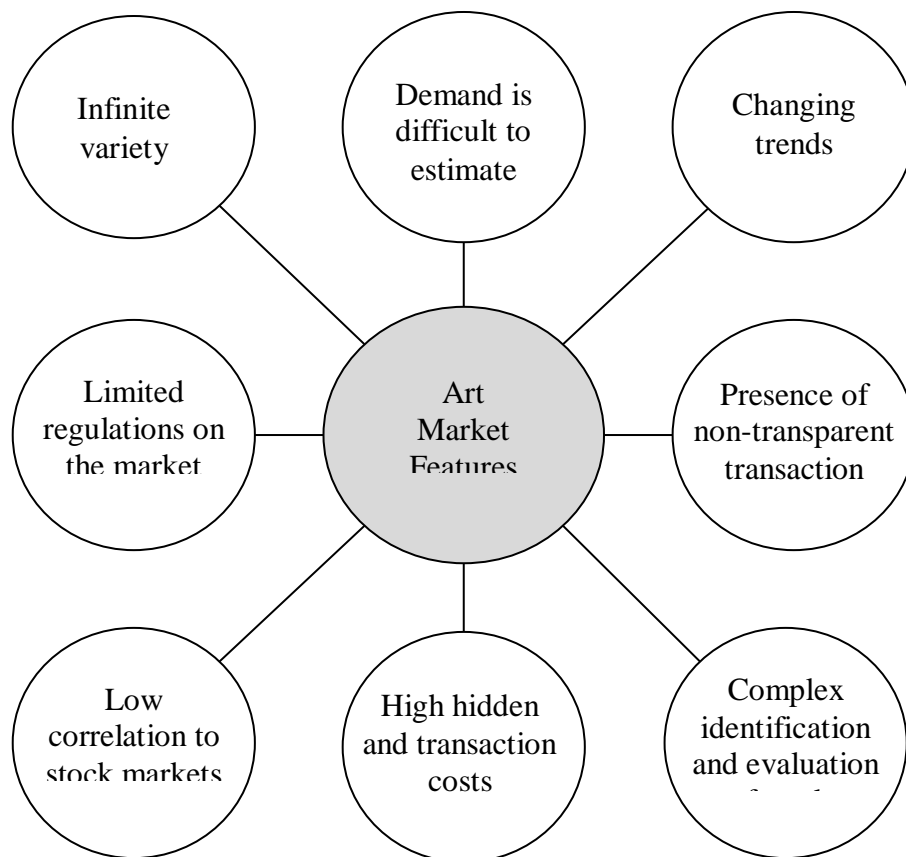
<sup>26</sup> Velthuis, O. (2008), Accounting for taste: Olav Velthuis on the economics of art, Artforum International Magazine, Inc.

<sup>27</sup> Velthuis, O. (2008), Accounting for taste: Olav Velthuis on the economics of art, Artforum International Magazine, Inc.

<sup>28</sup> McAndrew, Clare. *Fine Art and High Finance: Expert Advice on the Economics of Ownership*. p. 28, Bloomberg Press, 2010.

Respectively to artwork characteristics in Figure 2, below is the graph (Figure 3) showing main characteristics of today's art market.

*Figure 3: Main features of art market*



*Source: interpreted from Art Investment Funds and Financial Centres, Beaulieu, Paul<sup>29</sup>*

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<sup>29</sup> Beaulieu, P. Art Investment Funds and Financial centres: Opportunities for development, Deloitte, 2008.

## 1.4.2. Price determinants

The factors affecting the price of an artwork can be generally divided into three categories: artwork-related, artist-related, and external ones.<sup>30</sup>

### 1.4.2.1. Artwork-related

Size is considered to be one of the key artwork-related price determinants, though it is rather relative. Many researches suggest that there is a positive correlation between artwork dimension and its price, but there also seems to be a decreasing marginal rate present — a point at which an increasing size shows a much lower effect on price.<sup>31</sup> That mostly happens because individual buyers and investors prefer reasonably sized artworks over larger ones because the former are easy in storage and transportation, while larger ones are more likely to be bought by galleries.

Another determinant is technique, according to Valsan et al. Usually oil paintings are more expensive than watercolor and acrylic ones, and canvas paintings are normally more expensive than those on paper and board. As per above, oil canvas paintings are usually valued the most on art markets. However, today technique is mostly on the preference of the buyer and does not reflect production cost as it did in previous centuries. One of the reasons why oil canvases are so valued, aside from production cost, is their durability and longevity of life cycle.<sup>32</sup>

Artistic quality is perhaps one of the major price determinants and it refers to work's recognition in the art world (e.g. by critiques, art houses, etc.). While it is rather subjective, for investment purposes one can easily identify whether or not a painting has high appraisal from the members of the art world.<sup>33</sup>

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<sup>30</sup> Adamowska, W., 'Is art such a good investment? Investing in fine art on the international and Polish auction market', 2008.

<sup>31</sup> Sagot-Duvaurox, Dominique. "Art Prices." *A Handbook of Cultural Economics, Second Edition*, doi:10.4337/9780857930576.00011

<sup>32</sup> Valsan, Calin, and Robert Sproule. "Reservation Prices and Pre-Auction Estimates: A Study in Abstract Art." *SSRN Electronic Journal*, 2007, doi:10.2139/ssrn.886744.

<sup>33</sup> Anderson, R.C. (1974), 'Paintings as an Investment', *Economic Inquiry*, 12(1): 13-26.

Authenticity and presence of artist's signature on a painting is one of the major price determinants. This is supported by observation that when the authenticity of an artwork is being doubted, its price immediately goes down.<sup>34</sup>

Poor condition of an art piece can lower its hammer price by up to 80%, thus overall a higher quality of a painting in terms of its condition drives up the price.<sup>35</sup> Also, mentions in international publications and presence on exhibitions throughout history usually increases the price of an artwork.<sup>36</sup>

The subject of the artwork also affects its price, but it is difficult to generalize because buyer preferences and art fashion trends change over time. Time of creation is another factor, yet its effect is also rather lose — older paintings do not necessarily cost more and the time of creation merely represents the artistic era in which an artwork was created which is up to buyer's preference and does not have an overall market pattern.<sup>37</sup>

#### **1.4.2.2. Artist-related**

In his research, Velthuis claims that an artist is more of a determinant of price than any artwork-related factors.<sup>38</sup> According to him, works by famous artists are characterized by a much higher price than those in a particular style or technique. However, while the name of the artist is directly correlated to its price, the other determinants, such as his or her gender, age, or nationality did not show a connection with the hammer price as per Velthuis' research. There is, however, a so-called *death effect*, where a painting becomes more expensive once it's author passes away due to the supply becoming limited.<sup>39</sup>

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<sup>34</sup> Sagot-Duvaurox, D., Pflieger, S. and Rouget, B. (1992), 'Factors Affecting Price on the Contemporary Art Market', in Towse, R. and Khakee, A. (eds.), *Cultural Economics*, Springer-Verlag, Berlin and Heidelberg: 91-102.

<sup>35</sup> Singer, L.P. and Lynch, G.A. (1997), 'Are Multiple Art Markets Rational?', *Journal of Cultural Economics*, 21(3): 197-218.

<sup>36</sup> Wieand, K., Donaldson, J. and Quintero, S. (1998), 'Are Real Assets Priced Internationally? Evidence from the Art Market', *Multinational Finance Journal*, 2(3): 167-187.

<sup>37</sup> Anderson, R.C. (1974), 'Paintings as an Investment', *Economic Inquiry*, 12(1): 13-26, 2005,

<sup>38</sup> Velthuis, O. "Chapter 7. Symbolic Meanings of Prices." *Talking Prices*, doi:10.1515/9781400849406.158.

<sup>39</sup> Czujack, C. and Martins, M.F.O. (2004), 'Do art specialists form unbiased presale estimates? An application for Picasso paintings', *Applied Economics Letters*, 11(4): 245-249.

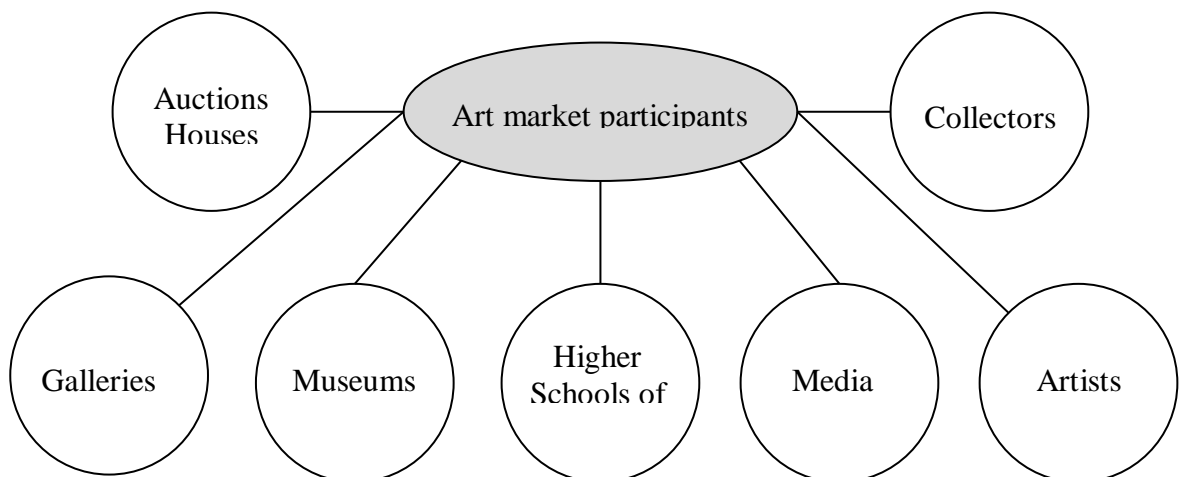
### 1.4.2.3. External factors

Most external economic factors that influence the art market have already been mentioned before. The most important conclusion from existing literature is that artworks are not much affected by fluctuations in economy and remain a rather stable market. However, expert opinions, changing fashion trends, and legislation changes, among few, also have a potential to influence artwork prices but are not well-studied because of their constantly changing nature.

### 1.4.3. Purchase and sale

The traditional cluster of art market participants is shown in Figure 4:

Figure 4: Traditional art market participants



Source: interpreted from *Peculiarities of Selection of Investment Artworks*, Jureviciene et al.<sup>40</sup>

All the above parties directly or indirectly influence the price of artworks as well. Auction houses remain to be the most common mediators of art sale deals, but their specialization is usually very segmented. Among the largest ones are Christie's and Sotheby's already previously mentioned.<sup>41</sup>

<sup>40</sup> Jurevičienė, Daiva, and Božena Kostecka. "Peculiarities of Selection of Investment Artworks." *Acta Oeconomica Pragensia*, vol. 2014, no. 5, 2014, pp. 71–88., doi:10.18267/j.aop.453.

<sup>41</sup> Jurevičienė, Daiva, and Božena Kostecka. "Peculiarities of Selection of Investment Artworks." *Acta Oeconomica Pragensia*, vol. 2014, no. 5, 2014, pp. 71–88., doi:10.18267/j.aop.453.



#### 1.4.4. Peculiarities of market performance

The market performance of art as an investment tool, such as its risks and returns, will be further examined in the practical part of the thesis, but there are some phenomena related to art market that has already been studied that need to be considered later in order to obtain accurate and valid conclusions.

First of all, the holding period of an artwork seems to have an immense effect on its price, but many researches disagree with one another on whether the effect is negative or positive. For example, Candela and Scorcu argued that a short holding period does not compensate for the high initial payment spent on acquiring an artwork, and they suggest to hold a purchase for seven to ten years before selling it.<sup>42</sup> On the other hand, many researchers agree that high returns can only be obtained within short periods.<sup>43</sup> In general, there seems to be no consensus on whether holding period actually increases a potential price of an artwork, but it is something to consider when outlining the recommendations for investing in art.

Another thing to take into consideration is so-called *masterpiece effect*. While acquiring an artwork that is objectively considered to be a masterpiece, whether as it is or because of its author, seems like a lucrative opportunity to gain profit on its return, numerous research shows that so-called masterpieces almost never outperform their original price nearly as much as it is expected by investors.<sup>44</sup> There is, however, another side of research which claims that the *masterpiece effect* of underperformance is only the case for contemporary art, and that classical artworks, such as European impressionism, only goes up in price.<sup>45</sup> The ambiguity of research suggests a risky nature of investing into so-called masterpieces.

Another outlier on art market is called *burned painting anomaly*, which is when a price of an artwork goes significantly down if it is not being sold on an auction where it is

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<sup>42</sup> Candela, G. and Scorcu, A.E. (1997), 'A Price Index for Art Market Auctions: An Application to the Italian Market of Modern and Contemporary Oil Paintings', *Journal of Cultural Economics*, 21(3): 175-196.

<sup>43</sup> Frey, B.S. and Pommerehne, W.W. (1989a), 'Art Investment: An Empirical Inquiry', *Southern Economic Journal*, 56(2): 396-409

<sup>44</sup> Pesando, J.E. (1993), 'Art as an Investment: The Market for Modern Prints', *American Economic Review*, 83(5): 1075-1089.

<sup>45</sup> Ashenfelter, O. and Graddy, K. (2003), 'Auctions and the Price of Art', *Journal of Economic Literature*, 41(3): 763-787.

exhibited. A study from Beggs and Graddy suggests that if a painting is not bought on an auction once, its price will decrease for as much as 33% on a next auction.<sup>46</sup> That is because, as it was mentioned in Chapter 2.2.2.3, experts' opinion is a huge driver behind art prices, and an unsold piece sends a negative message as to its market value.<sup>47</sup> This is important to consider because a poorly defined demand for an artwork possess a huge risk to an investor, not only because it might increase the holding period because of inability to sell it, but also because it carries a risk of being sold at a lower price than expected.

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<sup>46</sup> Ashenfelter, O. and Graddy, K. (2006), 'Art Auctions', in Ginsburgh, V. and Throsby, D. (eds.), *Handbook of the Economics of Arts and Culture*, Elsevier, North Holland, Amsterdam: 909-945.

<sup>47</sup> Anderson, R.C. (1974), 'Paintings as an Investment', *Economic Inquiry*, 12(1): 13-26.

## **2. Empirical research**

To understand market behavior of art prices and respective returns and make recommendations on how to diversify an investment portfolio with art pieces, the procedure is to be divided into three steps:

1. Introduction of data sets — time series of artprice index is the most important dataset, from which volatility and mean return is to be calculated and then compared with the same measurements of traditional asset groups that are most commonly present in one's portfolio, such as stocks (S&P 500), bonds (U.S. treasury), and gold.
2. Correlation analysis — once expected returns are calculated for each of the asset categories (art, stocks, bonds and gold), the percentages are to be organized in a correlation matrix to assess historical correlation between art market and the other three and thus assess how shocks in other markets would affect art prices and returns.
3. Asset allocation for a portfolio — having calculated the returns on art investment and knowing the intercorrelation among the markets and thus potential risks, optimal portfolio weighting will be presented.

### **2.1. Time series data sets**

#### **2.1.1. Artprice Index**

For the price index of art, the Artprice Global Index (AGI) published by Artprice <sup>TM</sup> was chosen as the most all-encompassing index, since it covers the data from over 4,000 auction houses and uses repeat sales methodology. What it shows is a change of prices over a scale with a percentage base year, which in this case is 1998. Though the time series covers a period of twenty years, it is still a rather short-term sample as for the art market, where holding period often reaches a decade. The reason we use index instead of price/returns on investment is because art market is very heterogeneous as it was already explained in theoretical overview and it is impossible to generalize for the whole market. Artprice index takes a bundle of different arts and artists and concludes from there, which shows a maximized representation of a market as a whole.

*Table 1: Quarterly data of Artprice Price Indices with Base 100 in January 1998*

Date of index calculation	Global Index (USD)	Date of index calculation	Global Index (USD)
01/01/1998	100	01/10/2008	171
01/04/1998	108	01/01/2009	160
01/07/1998	107	01/04/2009	139
01/10/1998	103	01/07/2009	158
01/01/1999	107	01/10/2009	132
01/04/1999	103	01/01/2010	181
01/07/1999	105	01/04/2010	170
01/10/1999	110	01/07/2010	175
01/01/2000	117	01/10/2010	149
01/04/2000	114	01/01/2011	208
01/07/2000	109	01/04/2011	191
01/10/2000	111	01/07/2011	224
01/01/2001	102	01/10/2011	191
01/04/2001	114	01/01/2012	193
01/07/2001	103	01/04/2012	158
01/10/2001	104	01/07/2012	176
01/01/2002	104	01/10/2012	166
01/04/2002	111	01/01/2013	194
01/07/2002	109	01/04/2013	176
01/10/2002	112	01/07/2013	200
01/01/2003	120	01/10/2013	183
01/04/2003	134	01/01/2014	196

01/07/2003	136	01/04/2014	184
01/10/2003	138	01/07/2014	200
01/01/2004	136	01/10/2014	187
01/04/2004	154	01/01/2015	201
01/07/2004	148	01/04/2015	164
01/10/2004	148	01/07/2015	167
01/01/2005	158	01/10/2015	149
01/04/2005	169	01/01/2016	153
01/07/2005	165	01/04/2016	139
01/10/2005	160	01/07/2016	152
01/01/2006	162	01/10/2016	135
01/04/2006	167	01/01/2017	152
01/07/2006	176	01/04/2017	137
01/10/2006	165	01/07/2017	148
01/01/2007	168	01/10/2017	137
01/04/2007	202	01/01/2018	154
01/07/2007	194	01/04/2018	140
01/10/2007	175	01/07/2018	145
01/01/2008	217	01/10/2018	120
01/04/2008	199	01/11/2018	151
01/07/2008	211	n/a	n/a

*Source: consolidated from Arprice Annual Reports 1998-2018<sup>48</sup>*

<sup>48</sup> Artprice <sup>TM</sup>, artprice.com, Annual Reports 1998-2018 (Collecting and Investing in Art)

### 2.1.2. S&P 500 stock

Now, for comparison it is chosen to use S&P 500 stock which reflects market capitalization some 500 largest corporations trading on different stock markets such as NYSE, NASDAQ, etc. On the other hand from Artprice index, below table shows the prices instead of the indices but that ultimately does not matter since the comparison between the two and others will be done through the deviation metrics and not nominal prices. Since S&P 500 is a closely observed trading, the historical data for it is widely available and it is possible to follow the same time series of quarterly reports 1998-2018 as in Artprice index. This will ensure the accuracy of final comparison. S&P 500 is American stock and the values are in US dollars, accordingly.

*Table 2: Quarterly data of S&P 500 stock market price*

Date of index calculation	Price (USD)	Date of index calculation	Price (USD)
01/01/1998	970.43	01/10/2008	1164.17
01/04/1998	1101.75	01/01/2009	902.98
01/07/1998	1133.84	01/04/2009	793.59
01/10/1998	1017.01	01/07/2009	920.82
01/01/1999	1229.22	01/10/2009	1054.91
01/04/1999	1286.36	01/01/2010	1116.56
01/07/1999	1372.70	01/04/2010	1171.22
01/10/1999	1282.70	01/07/2010	1031.09
01/01/2000	1469.25	01/10/2010	1143.48
01/04/2000	1498.57	01/01/2011	1257.61
01/07/2000	1454.59	01/04/2011	1329.47
01/10/2000	1436.52	01/07/2011	1320.64
01/01/2001	1320.28	01/10/2011	1131.21

01/04/2001	1160.32	01/01/2012	1258.85
01/07/2001	1224.42	01/04/2012	1408.46
01/10/2001	1040.93	01/07/2012	1362.32
01/01/2002	1148.07	01/10/2012	1440.91
01/04/2002	1147.39	01/01/2013	1426.18
01/07/2002	989.82	01/04/2013	1569.18
01/10/2002	815.28	01/07/2013	1609.78
01/01/2003	879.82	01/10/2013	1682.41
01/04/2003	848.17	01/01/2014	1845.85
01/07/2003	974.52	01/04/2014	1873.95
01/10/2003	995.96	01/07/2014	1962.29
01/01/2004	1111.92	01/10/2014	1971.43
01/04/2004	1126.21	01/01/2015	2058.89
01/07/2004	1140.83	01/04/2015	2067.62
01/10/2004	1114.57	01/07/2015	2067.71
01/01/2005	1211.92	01/10/2015	1919.65
01/04/2005	1180.58	01/01/2016	2038.19
01/07/2005	1191.32	01/04/2016	2056.62
01/10/2005	1228.81	01/07/2016	2099.34
01/01/2006	1248.29	01/10/2016	2164.33
01/04/2006	1302.88	01/01/2017	2251.57
01/07/2006	1270.06	01/04/2017	2362.34
01/10/2006	1335.81	01/07/2017	2431.38
01/01/2007	1418.03	01/10/2017	2521.19
01/04/2007	1420.82	01/01/2018	2683.72
01/07/2007	1504.66	01/04/2018	2633.44

01/10/2007	1527.29	01/07/2018	2704.94
01/01/2008	1467.96	01/10/2018	2926.29
01/04/2008	1326.41	01/11/2018	n/a
01/07/2008	1276.68	n/a	n/a

Source: consolidated from Yahoo Finance Historical Price reports 1998-2018<sup>49</sup>

### 2.1.3. United States 10-Year Bond

Being traded on NYSE, U.S. 10-years bond is a debt obligation issued by the U.S. treasury which has a maturity of ten years after it is issued. It pays a fixed rate and a face value once matured. For this metrics, yield was chosen as the most available one as opposed to price since the bond pays on maturity and over the holding period generates only interest/ Once again, the choice of index, price or yield can be arbitrary since they all reflect the same — changes in value over the same period of time and will be compared not as nominal values, but as variances.

Table 3: Quarterly data of the United States 10-Years Bond Yield

Date of index calculation	Global Index (USD)	Date of index calculation	Global Index (USD)
01/01/1998	5.516	01/10/2008	3.97
01/04/1998	5.82	01/01/2009	2.851
01/07/1998	5.494	01/04/2009	3.119
01/10/1998	4.603	01/07/2009	3.482
01/01/1999	4.653	01/10/2009	3.388
01/04/1999	5.35	01/01/2010	3.588
01/07/1999	5.902	01/04/2010	3.659

<sup>49</sup> GSPC Historical Prices | S&P 500 Stock." Yahoo! Finance, Yahoo!, Accessed on 26 Feb. 2019



01/10/1999	6.028	01/07/2010	2.905
01/01/2000	6.662	01/10/2010	2.603
01/04/2000	6.218	01/01/2011	3.374
01/07/2000	6.04	01/04/2011	3.29
01/10/2000	5.761	01/07/2011	2.792
01/01/2001	5.112	01/10/2011	2.116
01/04/2001	5.336	01/01/2012	1.795
01/07/2001	5.055	01/04/2012	1.919
01/10/2001	4.244	01/07/2012	1.47
01/01/2002	5.046	01/10/2012	1.694
01/04/2002	5.089	01/01/2013	1.985
01/07/2002	4.459	01/04/2013	1.673
01/10/2002	3.895	01/07/2013	2.588
01/01/2003	3.966	01/10/2013	2.552
01/04/2003	3.84	01/01/2014	2.644
01/07/2003	4.41	01/04/2014	2.646
01/10/2003	4.297	01/07/2014	2.562
01/01/2004	4.134	01/10/2014	2.335
01/04/2004	4.51	01/01/2015	1.639
01/07/2004	4.491	01/04/2015	2.035
01/10/2004	4.029	01/07/2015	2.187
01/01/2005	4.132	01/10/2015	2.146
01/04/2005	4.2	01/01/2016	1.923
01/07/2005	4.282	01/04/2016	1.835
01/10/2005	4.557	01/07/2016	1.45
01/01/2006	4.519	01/10/2016	1.825

01/04/2006	5.057	01/01/2017	2.466
01/07/2006	4.988	01/04/2017	2.289
01/10/2006	4.604	01/07/2017	2.296
01/01/2007	4.814	01/10/2017	2.377
01/04/2007	4.628	01/01/2018	2.712
01/07/2007	4.733	01/04/2018	2.955
01/10/2007	4.473	01/07/2018	2.962
01/01/2008	3.597	01/10/2018	3.149
01/04/2008	3.734	01/11/2018	n/a
01/07/2008	3.958	n/a	n/a

Source: consolidated from Daily Treasury Rate reports 1998-2018, U.S. Department of the Treasury<sup>50</sup>

#### 2.1.4. Gold

Gold is chosen as the most popular investment out of all other precious metals, it is one of the most common instruments for diversifying one's portfolio since it is a standard for currency equivalent and is considered to be a liquid asset.

Table 4: Quarterly data of Gold Price per ounce (28.349 grams) in US dollars

Date of index calculation	Global Index (USD)	Date of index calculation	Global Index (USD)
01/01/1998	289.264	01/10/2008	812.815
01/04/1998	308.558	01/01/2009	857.726
01/07/1998	292.874	01/04/2009	892.663
01/10/1998	296.595	01/07/2009	934.272

<sup>50</sup> "U.S. Department of the Treasury." *History of the Lincoln Cent*, Daily Treasury Long Term Data, 1998-2018, Accessed on 26 Feb. 2019

01/01/1999	287.333	01/10/2009	1043.511
01/04/1999	282.62	01/01/2010	1119.575
01/07/1999	256.198	01/04/2010	1148.475
01/10/1999	311.562	01/07/2010	1196
01/01/2000	284.59	01/10/2010	1343.19
01/04/2000	279.961	01/01/2011	1360.475
01/07/2000	282.152	01/04/2011	1474.431
01/10/2000	270.405	01/07/2011	1568.526
01/01/2001	265.934	01/10/2011	1667.893
01/04/2001	260.75	01/01/2012	1656.095
01/07/2001	267.707	01/04/2012	1648.539
01/10/2001	283.322	01/07/2012	1592.784
01/01/2002	281.764	01/10/2012	1746.348
01/04/2002	302.862	01/01/2013	1671.886
01/07/2002	313.567	01/04/2013	1485.905
01/10/2002	316.748	01/07/2013	1284.348
01/01/2003	356.864	01/10/2013	1314.402
01/04/2003	328.208	01/01/2014	1243.068
01/07/2003	350.765	01/04/2014	1299.175
01/10/2003	379.093	01/07/2014	1312.989
01/01/2004	414.495	01/10/2014	1223.565
01/04/2004	404.85	01/01/2015	1249.333
01/07/2004	398.441	01/04/2015	1198.253
01/10/2004	420.21	01/07/2015	1131.58
01/01/2005	424.08	01/10/2015	1157.123
01/04/2005	429.14	01/01/2016	1095.655

01/07/2005	424.745	01/04/2016	1241.452
01/10/2005	470.107	01/07/2016	1337.429
01/01/2006	549.433	01/10/2016	1268.929
01/04/2006	611.853	01/01/2017	1192.648
01/07/2006	633.093	01/04/2017	1267.15
01/10/2006	586.648	01/07/2017	1235.1
01/01/2007	630.352	01/10/2017	1280.677
01/04/2007	680.008	01/01/2018	1332.809
01/07/2007	665.266	01/04/2018	1335.332
01/10/2007	754.48	01/07/2018	1238.064
01/01/2008	887.784	01/10/2018	1214.726
01/04/2008	911.6	01/11/2018	1221.275
01/07/2008	941.167	n/a	n/a

*Source: consolidated from World Gold Council reports 1998-2018*

## 2.2. Correlation matrix and its interpretation

Now that input data for each four investment assets is structured, we can construct a correlation matrix for art and other traditional assets. From the correlation coefficients we can conclude whether changes on one market are anyhow interrelated to changes in another markets, and thus asses risks connected to interdependence.

*Table 5: Correlation matrix for above mentioned assets*

	<i>Artprice Index</i>	<i>S&amp;P 500</i>	<i>US 10-year bond</i>	<i>Gold</i>
<i>Artprice Index</i>	1			
<i>S&amp;P 500</i>	0.136950176	1		
<i>US 10-year bond</i>	-0.529314453	-0.483320402	1	
<i>Gold</i>	0.650778177	0.513506197	-0.88775573	1

*Source: calculated from data in Tables 1-4.*

If we assume that a high correlation, positive or negative, is to be shown where the correlation coefficient is higher than [0.8], then only gold and U.S. 10-Year Treasury Bonds express such interrelationship. Art comes closest with gold which has a solid reason behind it — gold is the money equivalent and thus has a direct influence on both real and nominal value of money. On the other hand, artprice index exhibits a very low correlation with S&P 500 price. Since stocks remain among the most popular investment vehicles and S&P 500 reflects a large market capitalization, it is a subject to financial volatility and seasonal and cyclical fluctuations. Having low correlation with S&P 500 for an art market means that not only it only slightly related to the stock market, but also that it is rather safe from any economic crises or anomalies. From this we can conclude that since S&P 500 is highly responsive to economic fluctuations and Artprice index is not correlated to S&P 500, art enjoys a safety from risks and price shocks that happen as a result of economic downturns.

### 2.3. Markowitz portfolio optimization (MPT) model

As explained in Chapter 2.1.2, optimal portfolio diversification refers to a strategy of allocation of investments into assets in a way that it maximizes returns and minimizes risks associated with it. Risk and returns are the two key units in portfolio optimization. Now that we assessed the risk of investment in previous chapter through correlation approach, we need to understand the returns. To do it with a Markowitz Mean Variance approach as explained in theoretical part, we will need to outline constraints and comply appropriate data sets.

#### 2.3.1. Variance-covariance matrix

The first constraint is that variance (which we also refer to as risk) of a portfolio overall needs to be minimized. Another constraint is that the amount of money allocated among the four assets cannot be larger than 1, that is not more than 100%. Now for the data sets, we will need stock prices from which we can calculate returns and then build covariance matrix.

*Table 6: Returns on Art, S&P 500, U.S. 10-year bond and gold*

	Returns on Art	Returns on S&P 500	Returns on US 10 YR Bond	Returns on gold
1998	4.5	26.67	14.92	-6.3
1999	6.25	19.53	-8.25	11.7
2000	12.75	-10.14	16.66	23.7
2001	5.75	-13.04	5.57	26.81
2002	9	-23.37	15.12	23.96
2003	32	26.38	0.38	21.74
2004	46.5	8.99	4.49	4.97
2005	63	3	2.87	17.12
2006	67.5	13.62	1.96	23.92
2007	84.75	3.53	10.21	31.59

2008	99.5	-38.49	20.1	3.41
2009	47.25	23.45	-11.12	27.63
2010	68.75	12.78	8.46	27.74
2011	103.5	0	16.04	11.65
2012	73.25	13.41	2.97	5.68
2013	88.25	29.6	-9.1	-27.79
2014	91.75	11.39	10.75	-0.19
2015	70.25	-0.73	1.28	-10.01
2016	44.75	9.54	0.69	9.12
2017	43.5	19.42	2.8	7.21
2018	39.75	-6.24	-0.02	-1.54

*Source: consolidated from Yahoo Finance for S&P 500, US 10-year bond and gold<sup>51</sup>; for artprice interpreted from Table 1 to reflect between current index and base year Artprice index.*

For variance-covariance matrix first it is needed to calculate mean returns, which are computed as a regular arithmetic average:

*Table 7: Average returns on Art, S&P 500, U.S. 10-year bond and gold*

	Returns on Art	Returns on S&P 500	Returns on US 10 YR Bond	Returns on gold
Average Returns	52.5	6.157143	5.084762	11.05333

<sup>51</sup> Historical Prices | Yahoo! Finance, Yahoo!, Accessed on 26 Feb. 2019

The formula of standard deviation is as in Equation 1.

*Equation 1: Standard deviation*

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

X — observed values

X bar — average value

n — number of observations

For each of the assets, standard deviation is as following:

*Table 8: Standard deviation for each asset:*

	Art	S&P 500	US 10 YR Bond	Gold
SD	32.32800643	17.30224	8.646404	15.08067

First, we will do the calculation inside the brackets:

$$(X - \bar{X})$$

The results are in Table 9 below.

*Table 9: Deviations from mean for returns on Art, S&P 500, U.S. 10-year bond and gold*

	Returns on Art	Returns on S&P 500	Returns on US 10 YR Bond	Returns on gold
1998	-48	20.51286	9.835238	-17.3533
1999	-46.25	13.37286	-13.3348	0.646667
2000	-39.75	-16.2971	11.57524	12.64667
2001	-46.75	-19.1971	0.485238	15.75667
2002	-43.5	-29.5271	10.03524	12.90667



2003	-20.5	20.22286	-4.70476	10.68667
2004	-6	2.832857	-0.59476	-6.08333
2005	10.5	-3.15714	-2.21476	6.066667
2006	15	7.462857	-3.12476	12.86667
2007	32.25	-2.62714	5.125238	20.53667
2008	47	-44.6471	15.01524	-7.64333
2009	-5.25	17.29286	-16.2048	16.57667
2010	16.25	6.622857	3.375238	16.68667
2011	51	-6.15714	10.95524	0.596667
2012	20.75	7.252857	-2.11476	-5.37333
2013	35.75	23.44286	-14.1848	-38.8433
2014	39.25	5.232857	5.665238	-11.2433
2015	17.75	-6.88714	-3.80476	-21.0633
2016	-7.75	3.382857	-4.39476	-1.93333
2017	-9	13.26286	-2.28476	-3.84333
2018	-12.75	-12.3971	-5.10476	-12.5933

Moving on, we need to square the results in Table 9 and obtain the sum, which is a matrix operation. Since there are four assets in this calculation, the final matrix will be of size 4 x 4. For the calculation, matrix multiplication of transpose matrix of deviations from mean (Table 9) and a regular matrix of deviations from mean (Table 9) is run and the following results are obtained:

	Art	S&P 500	US 10 YR Bond	Gold
Art	20902	-522.295	548.39	-2511.15
S&P 500	-522.295	5987.349	-1867.08	-1045.19
US 10 YR	548.39	-1867.08	1495.206	449.0377

Bond				
Gold	-2511.15	-1045.19	449.0377	4548.533

The last step to obtain a variance-covariance matrix will be to compute the bottom part of the equation and to divide the above results by n-1, which in this case is 20 since there are 21 observations. The results are as follows:

*Table 10: Variance-covariance matrix*

	Art	S&P 500	US 10 YR Bond	Gold
Art	1045.1	-26.1148	27.4195	-125.557
S&P 500	-26.1148	299.3674	-93.3542	-52.2593
US Bond	27.4195	-93.3542	74.7603	22.45188
Gold	-125.557	-52.2593	22.45188	227.4267

The highlighted in green cells show the variances of returns of each asset. The off diagonal values are covariances between the assets, the signs indicating positive or negative correlation.

### 2.3.2. Optimization of portfolio

The formula of return of portfolio is as Equation 2.

*Equation 2: Return of Portfolio*

$$R_p = \sum_{i=1}^N w_i R_i$$

Where w is weight of an asset and R is return from an asset. Since we have average returns for each of four of our assets, what needs to be calculated is weight. Weight, also sometimes called share, is the proportion of money that an investor is willing to allocate to obtaining a

particular asset. As mentioned in chapter where we calculated variance-covariance matrix, a constraint here is 1, meaning there is 100% of budget at our use and that is why a fraction of 100% will be allocated to each of four assets in this portfolio.

The idea of optimization, as discussed in Chapter 2.1.2 is about allocating available budget in a way that would maximize the returns. To calculate the optimal proportions, we will use Microsoft Excel add-in Solver, which calculates an optimal value for a formula which we will compose and with constraints mentioned in Chapter 3.3.1.

First, we need to outline the formulas for portfolio return and variance that will then be processed with Solver. For Portfolio return, we use matrix multiplication approach of all average returns of four assets (Table 7) and wights which we yet do not know and they will be determined with the Solver. For portfolio variance, we also use matrix multiplication — transpose weights (unknown) are multiplied by a multiplication of a variance-covariance matrix (Table 10) and weights (unknown). When we input the above formulas to Solver, one objective and one constraint need to be considered:

1. Objective is to minimize portfolio variance
2. Constraint is that the sum of weights of four assets has to equal 1.

Once that is done and Solver executes the formula, the output is as follows:

*Table 11: Solver output of weights (shares)*

	Weights
Art	0.025489173
S&P 500	0.275697485
US 10 YR Bond	0.585617804
Gold	0.113195539
Constraint	1

By allocating above fractions of budget into the four assets, it would give us the following optimal portfolio variance:

$$\text{Portfolio Return} = 7.264605$$

$$\text{Portfolio variance} = 21.28379$$

By squaring the portfolio variance, we can obtain portfolio standard deviation per Equation 1:

$$\text{Portfolio SD} = 4.613436$$

What this result tells us is that by investing 11.3% of our budget in gold, 58.6% in U.S. 10-year bond, 27.6% in S&P 500 stocks, and 2% into art we would have had a minimized variance (risk). Such a portfolio would give us an average return of 7.3% and a variance of 21.3%.

### 3. Conclusion

The objective of this thesis was to assess the efficiency of including art as an investment tool in a multi-asset investment portfolio. For this research, a multi-asset portfolio is defined as one containing three common traditional assets: stocks (S&P 500), bonds (U.S. 10-year treasury bond) and precious metals (gold). The ultimate goal was to assess how can an investor add art as a vehicle to a portfolio with above three traditional assets while maximizing the returns and minimizing the risks.

From the theoretical part we learned that since art is a very heterogeneous commodity, it is difficult to estimate its value and return in monetary terms. This is why for the data set it was decided to take a Artprice Global Index (AGI) reported by Artprice — French art database running from 1987 which provides a large chronology of historic data. Artprice uses a bundle of 700,000 artists and 6,300 auction houses which lessens the problem of heterogeneity. The works of Korteweg, McAndrew and Velthuis suggest that art pieces in general yield stable returns and carry little risk as long as they follow the pattern of art and artist-related price determinants explained in 2.2.2. Literature review on main features of the art market was consolidated in 2.2.1, and from there were derived some of the main challenges connected to art market and investing into arts, the main ones among them are:

- Impossibility to estimate and predict demand for art,
- Rather low liquidity of artworks as assets,
- High hidden costs associated with asset maintenance,
- Constantly changing trends on the market.

For the empirical part, the approach to portfolio optimization was divided into two sections — risks and returns. Risks were first calculated by assessing the intercorrelation among the markets of four assets. For this, quarterly time series metrics covering periods 1998-2018 for each asset were comprised from various sources, standardized and organized into a correlation matrix. The conclusion derived from the output correlation matrix (correlation coefficients) is that art has a moderate correlation with U.S. 10-year bonds (negative -0.5) and with gold (positive 0.6), and very weak correlation with S&P 500 (positive 1.3). All three results support the statements from literature review that art market is rather weakly correlated to most of common assets markets, which means that it is not very responsive to changes in traditional markets. This is especially important under

conditions of shocks and crises, take 2008 crisis as an example, where a fall of stock market would have little to no influence on art market.

In terms of returns, Markowitz Portfolio Theory, also known as Modern Portfolio Theory (MPT) was used as a pattern for calculation. Yearly historical returns covering 1998-2018 for each asset were comprised in a table which later served as a matrix for computation. The final goal of this return assessment was to calculate an optimal proportion of budget allocation into four assets — art, S&P 500 stocks, U.S. 10-year bond, and gold in order to minimize the risks. Since risk in arithmetic terms is variance, variance-covariance table was first calculated. Then an output matrix was used to come up with a formula and restriction for Solver in order to calculate optimal weights (shares) of each asset in a portfolio. In the output, it was established that with a time series of returns that we used a maximized return would be 7.3% and a minimized variance would be 21.3%, which for the record is a quite high variance in investing terms. To meet the above return and risk criteria, an investor would need to allocate 11.3% of the budget to investment in gold, 58.6% to the U.S. 10-year bond, 27.6% in S&P 500 stocks, and 2% into art. According to this calculation, the share of art in a portfolio is rather small even though art, according to historical data, has the highest average return among the four assets — 52.5% as opposed to 6.2% return on S&P 500, 5.1% return on U.S. 10-year bond and 11.1% return on gold. Given that from the correlation matrix we established that the risks associated with fluctuations in other asset markets are low, we can conclude that the reason that the mathematical output for art share is only 2% is mostly due to its high standard deviation (SD). As seen in Table 8, art has four times the SD of the U.S. 10-year bond and twice as much SD as that of S&P 500 and gold. While the mean returns on art are very high and the risks associated with external shocks are low, the unpredictability of the market and thus its large instability from one art piece to another, from one period to another, gives an investor little certainty as to the potential returns.

To sum up all the findings, the below recommendations can be suggested to someone interested in investing into art:

- Incorporating art into a portfolio is a good diversification tool which protects a portfolio from seasonal and global shocks, such as unexpected shocks and crises.
- Choosing art pieces for a portfolio requires an extensive knowledge foundation of art and artist-related price determinants, as well as art market phenomenon, such as masterpiece effect and burned painting anomaly.

- Over the holding period, an art piece can either greatly appreciate in price in case of rise in its popularity or due to a long holding timespan which makes a painting an antiquity, or greatly depreciate in case of poor maintenance.
- Given the above, the holding hidden cost of art as an investment cannot be neglected and needs to be considered upon accumulation of an asset, which also increases a face value of a payment.
- The value of such an emotional asset as art is not always a subject to experts' opinion and sometimes can appreciate as its aesthetic utility grows in the eyes of a particular buyer, and thus investing in small and medium-priced artworks often has a larger potential of yielding returns with minimized risks than investing into pieces with sky-high hammer prices.
- The art market overall is stable in its average metrics, such as average return, but is very unstable in regards to variance — returns have no trend line and differ greatly from one reporting period to another. This is why it is important to consider not only the historic data available but also the current trends and most importantly demand for a particular art asset.
- Given the high standard deviation and relying on the research overviewed and conducted in this thesis, a wise proportion of budget allocated towards art in a multi-asset investment portfolio would be  $< 5\%$ .

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