The Economic Impact of Art Theft

A Quantitative Study of the Economic Effects of Art Theft on Art Prices and Returns

Master's Thesis

Cultural Economics and Entrepreneurship

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Abstract

Major art thefts attract massive amounts of media attention while the works that are taken are often worth vast sums of money. The media attention that follows is, in a way, free marketing for the artist and their works. Like in other commodity markets, when an organization makes major announcement, the market reacts. There is a supply and demand issue when artworks are stolen. Essentially theft reduces the supply of the artist's works. And so how do prices for other works by that artist react? Would they rise or fall? Is there a short or long term effect, supposing that there even is an effect?

In addressing these questions, statistical analysis using SPSS was employed to compare the compound annual returns from repeat sales of artworks as well as auction sales prior to and following a theft. This was done over a short term period (six months and five years) and a long term period (ten years and all known repeat sales) in which thirteen artists from twelve thefts were subjected to analysis.

The results showed evidence of a five year "theft effect" whereby compound annual returns and auction sales for the selected artist were higher than in the five years prior to the theft. This "theft effect" was contingent on the history of the work itself, the popularity of the artist, and if the artist had a high number of works previously stolen. However, it is possible for the "theft effect" to be overshadowed by the "death effect" of an artist and art market swings. The results from the analyses can have implications for art collectors, investors, auction houses, gallery directors, insurance companies and researchers.

Key Words: art theft, repeat sale, compound annual return, "theft effect", independent samples t-test, regression analysis

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I. Introduction

Many people enjoy hearing about a major art heist. Countless films and stories have been centered around the subject. In real life, they attract vast amounts of public interest and media coverage that bring exposure to the artist, the work(s) taken, the institution, and even the city or region where it took place. In a way, it is essentially free advertising for them to a mass audience. Art theft is believed to be a $50 million to $5 billion (US) annual industry (Lawrence, et al, 1988). Given these estimates, the media attention they receive and the frequency in which they occur, it would be difficult not to assume that art theft has a broader impact on the art market. This idea was the driving force behind the topic of this paper: to search for economic effects that art theft may have on prices and returns on artworks in the art market. Whether art is taken from public institutions such as museums or from private residences, collectors and all members of the art market are generally aware of these incidents, especially those that are published in the media. However, not all thefts are reported and so it is impossible to know what the true numbers are. In the United States, it is estimated that 20 to 30% of thefts are reported while in Europe approximately 15% are reported (Ibid).

In conducting research for this paper, no articles or books were found directly linking the economic effects of art theft to the value of works by the same artist or on the art market. Many resources exist separately on both topics, however little, if anything, appears to be written connecting art theft to the market value and returns of other artworks. It is not a secret that some works carry incredibly high monetary values. This is one of the main factors in their attractiveness towards thieves; they are physically light and relatively small objects that are often worth enormous sums of money. Following a major art theft, there is usually a massive amount of media interest that follows as well as a worldwide police investigation for the thieves and the works taken. The Internet and social media now have an ever increasing audience to whom these stories can reach.

The core of the research for this paper focuses on comparing the compound annual rates of return for repeat sales and auction prices of other works by artists prior to and following a well publicized theft over different periods of time (six months, five years, ten years, and all known repeat sales). The key research question to be addressed is that, following a major theft, what happens to auction prices and compound annual returns on repeat sales to other works by the same artist? By running the sampled data through independent samples t-tests and regression analyses, the main objective is to identify any signs of a "theft effect" either short or long term (or both), or positive or negative. Perhaps no such definitive effect will be found. The results of this paper will hopefully contribute to the growing body of literature regarding art markets and inspire future research on the topic of art theft and value. In writing this paper, one of the author's goals was to provide academics, art historians, members of the art world including galleries, museums, dealers, auction houses and insurance companies with an additional resource focused on the economic impact of art theft.

The structure of the paper is as follows: a literature review will discuss articles and texts related to art theft and methods of studying art prices. This will be followed by a discussion on the challenges of understanding and studying art theft. Two primary statistical experiments will ensue and the threats to their validity will be examined. This will be followed by a brief dialogue on how recovered art performs against the art market and financial markets. Legal concerns on the acquisition of stolen art will follow and the paper will end with the overall conclusions and references.

II. Literature review

Over the past several decades there has been increasing academic interest in the prices and economic performance of artworks. Because of the heterogeneity of art, depicting accurate models and patterns is exceptionally difficult compared to tracking homogenous commodities in the stocks and bond markets. These discrepancies have allowed for sociological perspectives and theories to further analyze the art market beyond prices and take a closer look at the social construction of value in art. Often when art or items with strong heritage are stolen, the cultural loss is far greater to the community than the financial loss. For example, a religious icon of St. Irene was stolen from a Greek Orthodox church in Queens, New York, in 1991 and upon its return it had been stripped of $800,000 worth of gold, jewels and other ornaments. Despite the physical monetary loss, the church was overjoyed with its return as it represented a unifying symbol of the congregation (Conklin 1994, pp. 16).

In measuring and tracking the monetary value of artworks, two statistical techniques are most popular: repeat sales regressions and hedonic price models. The repeat sales regression (RSR) technique has been used in several important art market studies by Baumol (1986), Goetzmann (1993), and Mei and Moses (2002). The technique uses auction records for artworks that have been sold more than once whereby indices and return percentages can be constructed. This is normally done by dividing the resale price by the initial price and then incorporating other factors like compound interest and currency conversion. Auction records are more commonly used than gallery sales due to availability since many auction houses allow their records to be publicly available. Mei and Moses (2002) used the RSR method to study the performance of masterpieces in which they found that expensive paintings tend to underperform the art market. Pesando (1993) found a similar result with prints. The main advantage behind the other popular technique, hedonic regression, is that it accommodates for "price-free" characteristics of objects, such as a size, subject matter, artist, etc. which repeat sales regressions cannot (Ginsburgh, et al, 2006). There are drawbacks to using both, however. For example, RSR's are downward biased from true portfolio returns because they use

geometric means rather than arithmetic means (Goetzmann & Peng, 2002). Geometric means are used to calculate growth rates over time (for example, compound interest). The arithmetic mean calculates the average value in a data set and is always greater than the geometric mean unless all of the numbers are equal (algebra.com). Hedonic regressions are also susceptible to misspecification of variables, which is a non-issue in repeat sales regressions (Ginsburg, et al, 2006).

Chanel, et al, (1996) make similar strong arguments for the advantages of hedonic models primarily because they can take into account more information, such as physical characteristics and prominence. They can also factor in single auction sales as well as repeat sales of artworks. The authors point out that there can be problems in obtaining accurate repeat sales data. Unless the artwork sold can be identified by its catalogue raisonné, there is the possibility the title of the work was incorrectly translated from its language of origin. Many works have commonly used titles such as "still life" or "nude", or its dimensions change because of poor record keeping. It is also important to note that the data from repeat sales come from public auctions and does not take into account private sales. Guerzoni (1994, as cited in Chanel, et al, 1996) observed that works may be privately bought and sold between auction sales, which could have an effect on future returns. These are all valid observations and obvious risks in employing repeat sales data.

Czujack (1997) studied the performance of Picasso paintings at auction from 1963 to 1994 using hedonic regression. As dummy variables, she used dimensions of the artwork, techniques and media, signature, the Zervos catalogue raisonné number, exhibitions they were in, resale prices, pre-sale estimates, salesrooms, countries of sale, and several other factors (but nothing involving art crime!). Agnello & Pierce (1996) also used hedonic regression to examine financial returns, price determinants and genre effects in American art investment from 1971 to 1992. Using a sample group of 66 American artists, they included dummy variables such as when the artwork was sold at auction, the auction house, when the artist was born and when/if he or she had died. Interestingly, the authors found that the four artists who

died during the period experienced positive real returns at auction. Likewise, so did the artists who were alive after 1992 (except for Kenneth Noland). The authors were particularly interested in seeing if the artist's choice in subject matter or styles of their paintings had any effect on the returns. The average nominal sample rate of return was 9.3% however they found that one can achieve higher rates if an investor chooses to purchase high-priced avant-garde, still life and figure paintings. The higher returns on expensive avant-garde art is in contrast to Pesando's (1993) findings that high priced works earn lower returns than low priced works.

Ekelund, et al, (2000) found that there is evidence of a "death effect" in the prices of artworks following the death of the artist. The authors wanted to examine if there was a "supply induced" demand effect, whereby from a material goods perspective, there would be certainty that an artist's production would effectively halt following their death. Using a sample of 21 Latin-American artists who died between 1977 and 1996, they found that auction prices for their works increased substantially following their death, but decreased soon after. Czujack (1997) also found that there was a "death effect" for three years following Picasso's death in 1973 when prices for his works at auction rose more rapidly than the art market. This is important to note as one of the thefts examined later involves works by Picasso that were stolen around this time. There is also a supply and demand issue when works are stolen from the market and so the experiments performed later in this paper will hopefully shed more light on this issue by seeing how collectors react following a theft.

Campos and Barbosa (2008) found that prominence of artworks were a major factor in determining prices as opposed to size and medium. In contrast, Rengers and Velthuis (2002) found that the size and material used and the age and place of residence of the artist were strong predictors of price. However, the authors ignored the possibility of theft or any other type of art crime had been inflicted on the artist's oeuvre. Instead the authors focused on three levels for price determinants: the work of art itself (physical characteristics), the artist (age, sex, and place of residence), and the gallery (location, institutional affiliation, and age).

Anderson (1974) noted that "The history of ownership of an artwork can have a surprisingly strong influence on prices realized at auction" (pp. 14). Works that come from a dealer's stock do poorly compared to works that come from a collector's special collection. This suggests that specific incidents or historical events play a role in the demand for an artwork. For example, the owner of a recovered stolen artwork may be granted greater attention from other collectors because of the tumultuous history involving the piece. Anderson (1974) also points out that collectors and museums give little, if any, thought to reselling a piece once it is acquired. A work may stay within a collection for generations before it is sold again. Compared to financial market products, the reselling rate is extremely low. However, other consumption benefits are incurred such as decorative and aesthetic-prestige services (Ibid). Upon calculating an average annual price appreciation of 3.3% on paintings sold at auction between 1780 and 1970, Anderson (1974) concluded that the most important factors in price determination were the year it was sold, its physical size and the reputation of the artist. He notes that there were periods of higher appreciation than others. For example, impressionist paintings appreciated at an annual rate of 18% between 1951 to 1969 and 10.4% for Old Masters. Interestingly, the place of the sale and whether the artist was alive at the time of the sale were deemed insignificant.

2.1 Studying Stolen Art

One of the most difficult challenges in conducting social science studies are sample selection methods. In art markets, essentially all artworks, people, institutions and even events are heterogeneous, thus further complicating sampling methods for quantitative experiments. Many artworks sold at auction are publicly known and contain measurable components such as prices and dates, however a significant amount of transactions remain private or are never made publicly known making true perfect measurements virtually impossible. Obtaining accurate information on art thefts is also very difficult. Many art thefts are never reported for several reasons: museums may choose not to for fear of exposing vulnerabilities of its premises to other potential thieves; thefts may also discourage potential donors who may feel that their donations will not be safe; collectors may not report thefts because it could be that the works

or antiques were illegally imported and thus the owners would rather not alert government authorities; reporting a theft may also reveal to authorities that the owner(s) or gallery had not been paying tax on their holdings; or publicizing a theft may also encourage thieves to smuggle the work out of the country. Similarly, a great deal of publicity might educate potential thieves on the high value of other works kept in the victimized museum or gallery. The lack of reporting increases the challenges that police face in tracking down the stolen art and the general low risk of getting caught is appealing to prospective thieves (Conklin 1997, pp. 261).

Tracking the resale prices for recovered stolen works and constructing an pricing index would have been an excellent way to look for trends in how a theft would affect a work's value. However there are several key reasons that would threaten the validity of the results. Firstly, the sample size of recovered works would be extremely small, perhaps even too small for statistical relevance. For example, the Federal Bureau of Investigation estimates recovery rates for works of art to be between 2 to 6 % (FBI, March 2012). Of these few recovered works, most of them are returned to their rightful owners and museums and may never see an auction block for centuries, if ever. This reduces the sample size to an incredibly small and essentially insignificant amount compared to the number of works on the market. Secondly, according to the FBI, hundreds of thousands of art crimes are reported annually, however only the high profile cases earn media attention. Many more are also unreported, as mentioned earlier. For example, in Italy each year there are between 20,000 to 30,000 thefts reported to authorities (Ibid). There would be obvious privacy and legal issues in obtaining reported thefts from law enforcement agencies thus making research into the field exceptionally challenging.

2.1.1 The Media Component

The media plays a crucial role in spreading information to audiences in the event of an art theft. Art theft often makes for entertaining reading but also helps to inform the public and members of the art world of the victimized works that have become "hot". Once photos of the artworks

have been distributed to news networks and other media channels, it becomes almost impossible for these stolen works to be sold on the legitimate market. Nairne (2011) believes that because of this, stolen art fetches a fraction, or around 10%, of its saleroom value on the black market. Dealers, auction houses, collectors, appraisers and law enforcement agencies would all be aware of these works and the artists who created them. Usually the media sensationalizes the highest profile thefts; those that involve works of abnormally high market value where huge risks are taken by the robbers to evade security systems and capture. Because the awareness of such events in the art world, it would seem logical to assume that they would have some kind of impact on prices and returns of works by the same artist or perhaps artists of the same genre. After all, the art market, in spite of its unique characteristics, still operates like other capitalist markets. When a Fortune 500 company makes a major public announcement, such as a new product line or a change in management, its share holders react and stock prices usually react. Hence, a theft is a different type of announcement to the art world. Potential market reactions to a major art theft are:

Major art theft -> Media Exposure -> Higher prices and returns for other works by the artist
Major art theft -> Media Exposure -> Lower prices and returns for other works by the artist
Major art Theft -> Media Exposure -> No change for other works by the artist

The purpose of the statistical experiments that are performed later in this paper is to determine which of the above scenarios show significant (or non-significant) differences in prices and returns for other works by the artist prior to and following an art theft. The results could have implications for participants in art markets such as collectors, dealers, auction houses as well as insurance companies.

Supposing thefts do have an impact on the art market, this begs the question of whether a major incident makes a mediocre artist more famous and how it would change the value of their artworks. Assuming theft does bring the artist to new audiences, would the degree of the increase in exposure be proportional to the change in the market value of their

works, whether positive or negative? The timing of the theft in relation to the perceived value of the artist's works at that time would also be taken into consideration in the motivational factors of the thieves. Art theft is a high risk, high reward activity, and so in weighing these factors, the targeted works would need to be worth around their peak market value.

2.1.2 MMFAI Index

Due to the infrequency of transactions for artworks, a different form of market index is required than indices used for stocks, bonds and commodities. Art and real estate are two similar types of goods in this regard. For example, to calculate an annual average price for artworks and real estate would be misleading as expensive or inexpensive works and properties would skew the results. To overcome this, a repeat sales regression calculates the compound annual return between repeated sales of the same art object or property, which is how the Mei Moses Fine Art Index (MMFAI) calculates their indices (for a detailed explanation behind the statistical techniques used in constructing the index, please refer to the methodology section of Mei & Moses' (2002) article, "Art as an Investment and the Underperformance of Masterpieces"). Much of the data in the proceeding statistical analyses was taken from the MMFAI. According to its website (artasanasset.com) the MMFAI currently contains approximately 30,000 price pairs for 20,000 works of art. The creators, Dr. Michael Moses and Dr. Jianping Mei, claim that it is the largest database for the financial returns of transparent transactions for individual works of art, to which it adds approximately 3,000 new pairs every year (artasanasset.com).

For finding the price pairs used in the construction of the MMFAI, auction records were taken from Christie's and Sotheby's catalogues from all over the world dating back to 1925 (and beyond then, their predecessor firms). The New York Public Library, the Watson Library at the Metropolitan Museum of Art, and various online auction transaction websites for auction price histories are also consulted on a regular basis. "Bought-in" paintings at auction are not included as bidding would have not reached the reservation price. MMFAI organizes the repeat sales into the following major categories: American art prior to 1950, 19th Century and Old

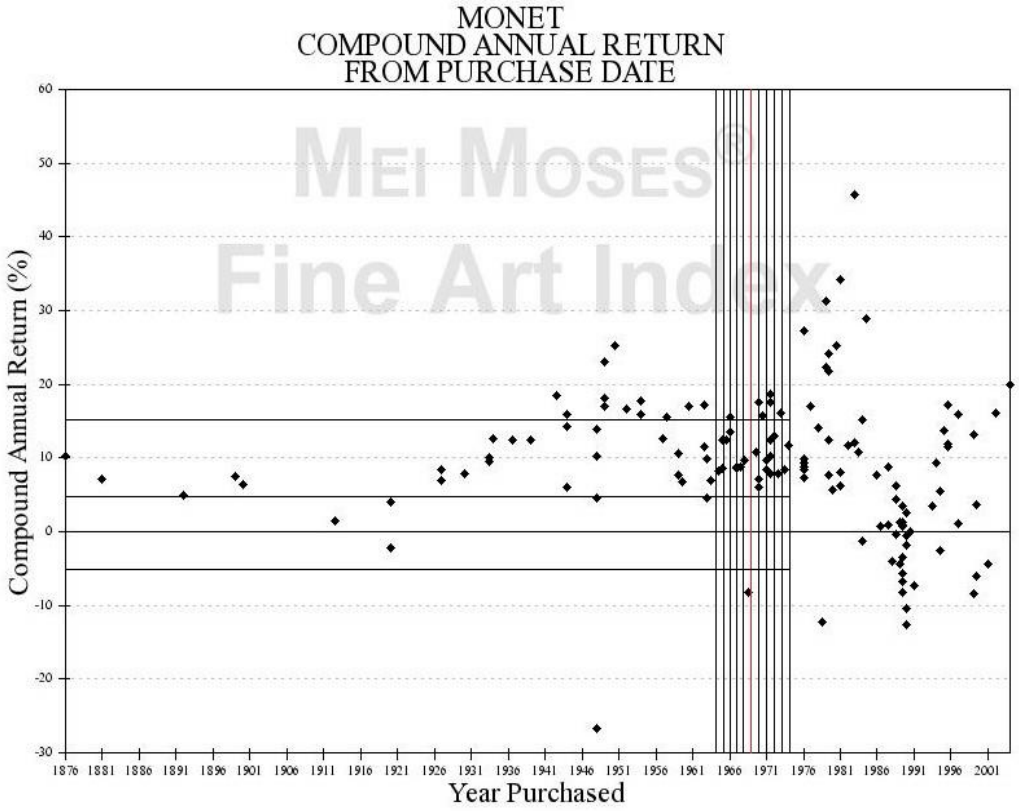
Master, Impressionist and Modern, Post War and Contemporary, Latin American, British after 1850, and Traditional Chinese works. If there had been another separate private sale for a piece, the creators claim to have used their best research to find the purchase price from any auction house anywhere in the world at any point in time. In doing so, they argue that this is the best approach to eliminating potential subjective sample bias.

A major strength of the MMFAI data is the length of time it covers. The indices are constructed in various time spans such as 10 years, 25, 50 and so on. The average length of time between a repeat sale is 22 years and the some objects have been resold up to seven times, with some of the earliest original purchases dating back to the 17th century. The MMFAI produces scatter plots for the compound annual return rates of the 150 artists with the most repeat sales. Historical prices and exchange rates are used to convert prices into the currency of the sale location based on information provided by Global Financial Data (globalfinancialdata.com). Global Financial Data was also the source for other financial indexes used in comparing the MMFAI to the U.S. based Standard & Poor's 500 total return index (S&P 500 TR) and the U.K based Financial Times All Shares total return index (FTAS-TR). The MMFAI has been lauded by financial investment companies and numerous media outlets. Asia News Network (China Daily) wrote, "Tracking the trading records of specific art pieces, the index (Mei Moses) is an objective guide for investors and is rated by Morgan Stanley as one of the 10 most important asset indexes in the world" (May 2012). MMFAI also releases monthly, quarterly and annual tracking reports for global art sales focusing on risk, returns and correlations between art and other asset classes (artasanasset.com).

2.1.3 Data Sources

In gathering data for the statistical analyses performed in this paper, the author of this paper subscribed to a one-year membership with the MMFAI. The compound annual returns (CAR's) from the scatter plots of the artists who were the target the high profile thefts selected for this paper constituted the data of several of the independent samples t-test and regression analyses

performed later. For consistency, all of the CAR's used by the MMFAI assume that all purchases were made on the last day of the year. Unfortunately, the scatter plots did not have an exportable data set thus each CAR had to be obtained "manually" by estimating its numerical value by examining the graphs. For example, below is a scatter plot of Monet's CAR's from which data was collected over a ten year period for a regression analysis (artasanasset.com):



A screen shot was taken of each scatter plot from the MMFAI website (artasanasset.com) and was then imported into Microsoft Paint where the lines were added. Each CAR was then estimated to the nearest tenth of a decimal and collected in a Microsoft Excel spreadsheet. It was a laborious task albeit a necessary one. Repeated emails and telephone calls to Mei, Moses, and their customer service department to request more accurate data went unanswered. Despite paying $250 (US) for a full year "Gold" membership, the author was very

unsatisfied with their service. As a result of the estimations, the degree for error increases likely to within a range of 5 to 10%.

The other source of data used in the analysis came from the Blouin Art Sales Index (artsalesindex.artinfo.com) which was used to collect one-time auction sale records. The website is user friendly, charges no fees for usage, and is very good at conducting advanced searches for sales records of specific artists, mediums of art, sale dates (which go back decades), sale locations, and so on. There is no accounting for repeat sales, however, although it would be possible to match some if desired.

2.2 Research Design

Two main experiments will be conducted in this paper to search for economic impacts of art theft; the first will examine how several important anecdotal cases of art theft may have affected the compound annual returns and auction prices of other works by the same artist and compare them before and after the theft using independent samples t-tests. Different periods of time will be covered; six months of auction prices for prints (before and after a theft), five years using auction prices and CAR's (pre- and post-theft), ten years (using CAR's), and all CAR's. Each test will only contain data concerning the specific artist. The hypothesis for this experiment is that a major theft would cause, on average, higher compound annual returns in the long term (ten year periods and all CAR's) and higher returns on repeat sales and auction prices in the short term (five year and six month periods). The second experiment reexamines three of the cases from the first experiment using linear regression. The selected cases were initially analyzed in ten year periods in the first experiment, however in the second the periods were shortened to five years to focus on any short term effects. The CAR's from each were used to calculate a line of best fit with the goal being to identify any changes in the slope pre- and post-theft.

2.2.1 Threats to Validity

There are several key threats to the validity of these experiments which are described below. Despite both experiments being slightly different in design, these threats can be applied to aspects of both.

a) Instrumentation

The primary method of measuring auction records is through monetary currencies. As mentioned earlier, MMFAI recalibrated the auction records to current values by using historical exchange rates and inflation rates from Global Financial Data. There is always the possibility, however, that the auction house, MMFAI or Global Financial Data may have incorrectly entered or made a miscalculation at some point. Concerning older auction record keeping practices, it may be impossible to verify the accuracy of the entries as we search farther back in time. It is important to note that a change in ownership or management of an auction house may affect how records are kept. For example, it might occur where the buyer's premium is included in the stated purchase price and other times only the hammer price may be listed.

b) Historical Events

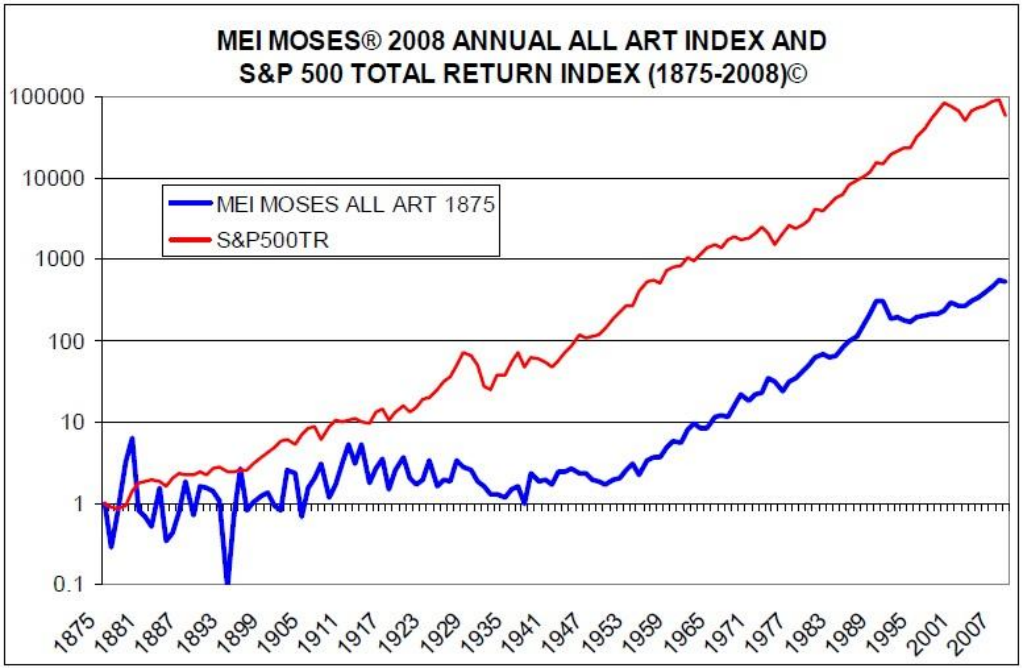
Historical events, especially those that are unrelated to the treatment we wish to examine (art theft in this case), can threaten the validity of experiments because they are often beyond the control of the researcher (Cook & Campbell, 1979). Below are examples that are both related and unrelated to the treatment.

i) Markets

Since artworks are a type of commodity that are traded in a market setting, they are also subject to economic factors which directly affect buyers and sellers. Some factors affect all markets while others are more market specific. The stock market collapse of 1929 which lead to the Great Depression of the 1930's impacted the entire global economy. When the economic situation began to improve after World War II, this also marked the beginning of a steady rise in the prices of artworks. Mei and Moses (2013) argue that prior to this boom there

was a larger supply of art relative to demand, despite that a few "robber barons" of the time were amassing huge collections. Following the Second World War, the world experienced growth in both the number of high net worth individuals and the wealth they accumulated. At this time the supply of artworks remained constant, or even decreased as a result of the robber barons, and thus higher wealth contributed to higher prices for artworks as well as growth in equities markets (Ibid).

Figure 1



(Graph obtained from Mei Moses Year End 2008 All Art Indexes)

In the figure above we can see a drop in both the MMFAI and the S&P 500 after 1929 with steady growth beginning around 1950. The oil crisis of the early 1970's can also be seen in drops in each market. The period of 1985 to 1990 saw the formation of a bubble in the art market which subsequently burst while the S&P 500 was relatively unaffected. The Mei Moses World All Art Index (MMWAAI) calculated that as a result of this bubble, the art market dropped nearly 30% in 1991 (artasanasset.com). The "dot com" crash of the late 1990's can also be seen to have affected the S&P 500 more so than the MMWAAI. Following the economic

recession of 2008, MMWAAI noted a decrease of 22.6% in the art market, the second largest decline since the Great Depression (Ibid).

ii) Artistic Movements

As seen with all forms of art, innovative players can create or change genres just as audience tastes can vary over time. Works by some artists may suddenly become popular with collectors after being considered unfashionable for extended periods. For example, paintings by Vincent van Gogh did not become desirable and appreciated until after his death and now he has his own museum in Amsterdam. Provided that artistic movements are a natural occurrence, it could happen that collectors would sell works considered to be out of fashion in order to purchase new works of art, hence creating a repeat sale. This may help in explaining why the average holding period for works of art, according to Mei and Moses, is 22 years (artasanasset.com).

c) Sample selection

The selection of the sample group can be one of the most challenging and controversial decisions in a quasi-experiment. There will always be opportunities for bias and sampling methods can vary. The first main experiment of this paper focuses on the effects of specific incidents of theft and their relation to other works by the same artist. These thefts are chosen in a somewhat arbitrary method with emphasis on historical importance to the art world and art market. It should be noted that all of the sampled artists from the thefts were male and European. Most of the thefts took place in Europe while one was in the U.S. and two were in Brazil. As a result, this paper therefore has a distinct Western bias in terms of sample selection. As well, the earliest theft in these experiments took place in 1966 and the most recent one in 2010. The theft of art and antiquities has been happening for centuries (and even millennia) and so the experiments and their results are more relevant to the modern day art market.

d) Mortality

Mortality "is a threat when an effect may be due to the different kinds of persons who dropped out of a particular treatment group during the course of an experiment" (Cook & Campbell,

1979, pp. 53). As mentioned in the literature review, Ekelund, (et al, 2000) found evidence of a "death effect" resulting in a short temporary rise auction prices for Latin American artists between 1977 and 1996. Similarly, Czujack (1997) found a similar "death effect" with Picasso's works in the three years following his death. Like the other threats to validity, this one also needs to be taken seriously. In fact, one of the thefts chosen for analysis involved Picasso's works around the time of his death. This is discussed in further detail later.

III. Experiment 1: Analysis of Pre- and Post-Theft Return Rates and Auction Prices

The purpose of this experiment is to determine if there are any long or short term economic effects to an artist's oeuvre following a major theft of their work(s). There are four parts to this experiment: Part 1 is designed to look for long-term effects of a major art theft on the compound annual returns of repeat sales from the same artist using all of their CAR's recorded in the MMFAI; Part 2 will examine slightly shorter long term effects using CAR's over the ten years prior to and following the theft; Part 3 will use auction prices from all auction houses around the world for the five years prior to and following a theft (and in one special case, CAR's from Renoir will be used to look at a particular theft from 2000). Part 4 will analyze auction sales for prints by Picasso from Christie's and Sotheby's in London, England, six months prior to and following a theft of his work(s). Independent samples t-tests using SPSS (version 21) will be used in all four parts.

It is important to note that all of the artists sampled for analyses had died prior to their respective theft and thus the possibility of the supply of new works by the artists effectively ceased. Therefore their entire oeuvre would be an absolute number thus reinforcing the economic principles of supply and demand. In theory, art theft reduces the supply of existing works which should increase demand and hence prices and returns for works by the same artist. This leads us to the hypothesis for the four parts of this experiment. Each part will test the same hypothesis that the art theft in question would have a positive effect on compound annual returns and auction prices for original works by the same artist. This "theft effect" will be tested for statistically significant differences between the independent sample groups at a 95% level of confidence in each of the four parts (six months, five years, ten years, and all repeat sales).

The most difficult challenge (and perhaps the most obvious potential source of bias) is the selection of a particular theft to be analyzed. The process used to select a theft involved several criteria:

- The works stolen would need to be of a considerable monetary value
- The theft itself must have received substantial media attention and be searchable on the Internet and in textbooks.
- The theft needed to be near a point in time where there would be enough CAR's and auction sales both before and after it so that a relevant statistical analysis could be conducted.

A major assumption regarding the thefts selected for analysis is that they received a generous amount of media exposure and "buzz" in order for them to be implanted in the minds of collectors and potential buyers, especially over the long-term. Some incidents may have gone unnoticed by collectors or they might not have been collecting around the time of the theft. Unfortunately, digitized print media archives are not yet very extensive and thus searching for articles on major thefts that happened more than fifteen years ago is quite difficult. For example, Google News Archive revealed a comprehensive amount of articles from many news outlets on high profile art thefts from the past ten to fifteen years. Repeat sales of artworks happen relatively infrequently and are dwarfed in comparison to the massive amount of single auction sales for artworks and prints. For studying the long term effects of art theft, a sufficient enough amount repeat sales would be needed to have occurred before and after a theft. Performing independent samples t-tests using CAR's to investigate "theft effects" for a theft that took place recently would not be an appropriate method. There is one exception in Part 3 of this experiment involving a theft that occurred in Stockholm in 2000 which is included in the short term (5 year) section. With the exception of the Stockholm theft, incorporating archived digital print media with CAR's over a long period of time would have been impractical at this point in time for statistical analysis. Hand collecting thousands, or tens of thousands of auction records beyond the year 2000 and up to the present is beyond the scope of this paper.

The CAR's as calculated by Mei and Moses were deemed most suitable for studying the long term economic effects while auction sales are better suited for short term effects. As more older print sources become digitized, incorporating media into the analysis of CAR's would become more of a realistic possibility.

3.1 - Part 1: Long term effects of art theft (all repeat sales)

3.1.1 Experiment Design

Using all of the artist's CAR's collected from the MMFAI scatter-plots, in which some date back to the 19th century up to just a few years ago, an independent samples t-test with a 95% confidence level was used to determine if any significant statistical differences exist in the sample group of CAR's by the targeted artist prior to and following a theft. Below are the three thefts selected for the first long term analysis.

1) Dulwich Gallery, London, England - December 31, 1966.

During this robbery, thieves escaped with three Rembrandt paintings, including a portrait of Jacob de Gheyn III, three paintings by Rubens and one by Gerrit Dou and Adam Elsheimer (Rembrandt and Rubens are the artists to be analyzed in the experiment). This theft is of particular interest because it marked the first time Rembrandt's portrait of Jacob de Gheyn III was stolen. It has since been stolen and recovered three other times since then, in 1973, 1981, and 1983, making it the world's most frequently stolen painting according to the Guinness Book of World Records (Esterow, 2011). This frequency and notoriety of the painting would perhaps increase the chances of having some kind of long-standing effect on the public and collectors.

2) Cezanne, "Bouilloire et Fruits", Boston, Massachusetts - 1978.

In 1978, seven paintings were stolen from a private residence in Boston, Massachusetts, which made international headlines. One of these paintings included Cézanne's "Bouilloire et Fruits". Robert Mardirosian, a retired Massachusetts lawyer, was convicted in 2008 of possession of stolen goods (United States Dept. of Justice, 2010). The Cézanne was recovered in 1999 with the help of the Art Loss Register which worked closely with the FBI and Swiss authorities. Upon its recovery, the Cézanne painting was subsequently sold for $29.3 million. The other paintings were eventually found and returned to their owner in the ten years following the recovery of the Cézanne (Art Loss Register 2010). This particular theft was selected because the recovery of famously stolen artworks is a rare occurrence, and so the painting's recovery and subsequent auction sale in 1999 also drew a lot of media attention.

3) Isabella Gardner Museum, Boston, Massachusetts - March 18, 1990.

In what is considered the most prolific art theft in history (which also coincidentally took place in Boston), thieves broke into the Isabella Gardner Museum in Boston on March 18, 1990, taking thirteen pieces worth a present estimated value of $500-600 million USD (Esterow, 2009). Of the thirteen works stolen, five were drawings by Degas (who is the artist of interest for this analysis). Three works by Rembrandt were also stolen during the raid including his only seascape, however only two of his eighteen repeat sales occurred after this theft, which was deemed too small and disproportionate to warrant a t-test. Vermeer's "The Concert" was stolen during this raid. No arrests have been made since the theft and none of the works have been recovered, although in March, 2013, the FBI announced that they have identified the men involved in the crime (Valencia 2013).

3.1.2 Data Analysis

Below are the results from the independent samples t-tests using CAR's collected from the artists of the thefts described above.

1) Rembrandt van Rijn - Dulwich Picture Gallery - 1966

Table 1(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft	8	4.44	2.01
Post-Theft	10	5.65	1.56

From the group statistics table above we can see that there were 8 repeat sales prior to the 1966 theft and 10 following it. The CAR mean increased by 1.21 and the standard deviation decreased, indicating a tighter grouping of CAR's around the median. From this point of view, it appears as though there might be a connection between the theft causing a higher average return rate.

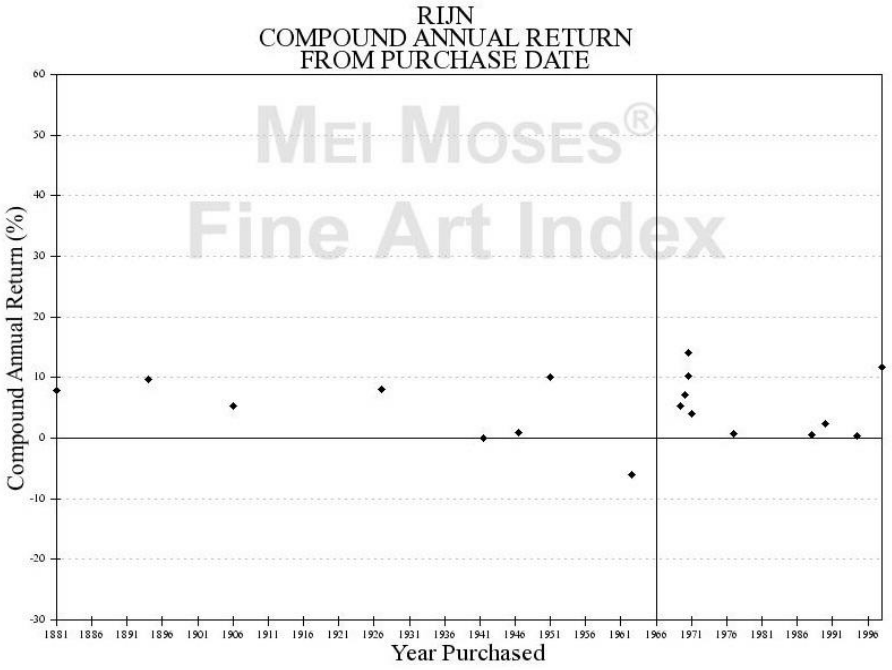
Table 1(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.73	-0.49	16	0.64	-1.21

In the second column in the table above, Levene's Test For Equality of Variances tests as to whether the conditions have the same or different amounts of variability between groups. A value greater than 0.05 indicates that the variability between the conditions is roughly the same ("Equal Variances Assumed"). A value lower than 0.05 tells us that the variability is not the same ("Equal Variances Not Assumed"), which can cause problems for interpreting the results (statistics-help-for-students.com). Fortunately, in this case the significance for the Levene's Test is higher than 0.05. The t-statistic helps in determining where the p-value is located on a normal distribution. The degrees of freedom is calculated by n - 2 because there is two sets of data. With a t-statistic of -0.49 and 16 degrees of freedom, the p-value is determined to be 0.64. Since the p-value is above the 0.05 confidence level threshold, we can conclude that there is not a statistically significant difference between the pre- and post-theft

sample groups. This t-test tells us that despite that the post-theft mean is higher than the post-theft mean, it has more to do with chance than the treatment (theft) having an effect on the post-theft mean. Below is the scatter plot obtained from the MMFAI of Rembrandt van Rijn CAR's (artasanasset.com). The vertical line represents the year in which the theft took place (1966).

Figure 2



2) Peter Paul Rubens - Dulwich Picture Gallery - 1966

Table 2(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft	18	7.06	1.53
Post-Theft	13	0.76	2.83

Prior to the Dulwich robbery, Rubens had 18 repeat sales for an average return rate of 7.06%. Following the robbery, he had 13 repeat sales for a mean of 0.76%, a decrease of 6.3%. The

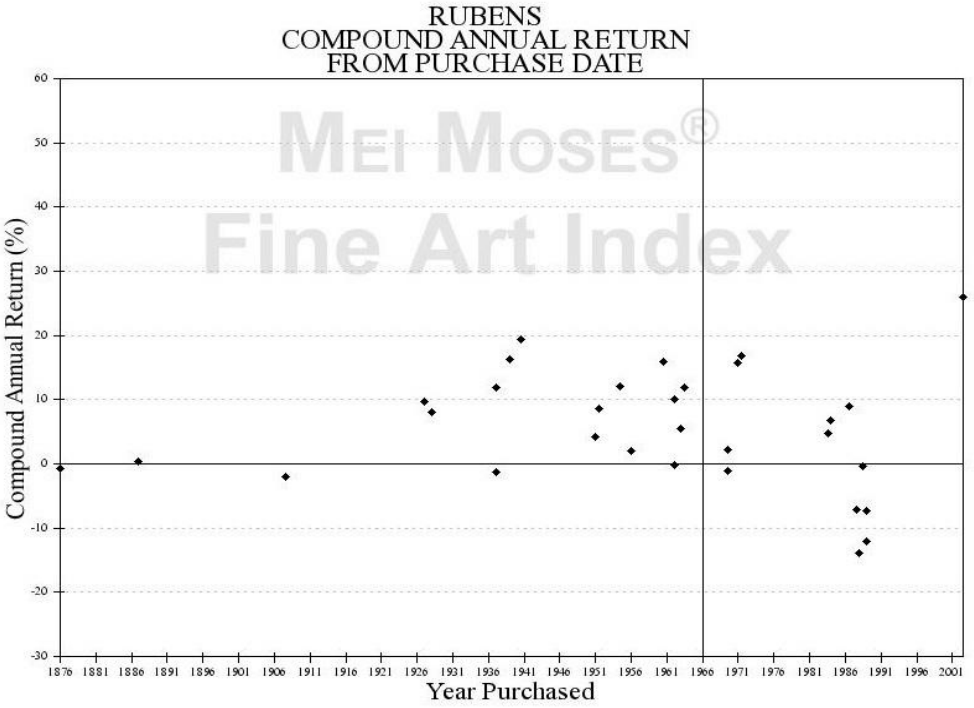
standard deviation also increased after the theft, indicating a wider distribution around the median. From these descriptive statistics, we can already see that the decrease in the mean following the theft is inconsistent with the hypothesis. The inferential statistic calculations below will identify if there was a significant difference in the relationship between the groups or if the difference in the means was due to chance.

Table 2(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.41	2.1	29	.04	6.3

The Levene's Test For Equality of Variances calculated a significance value of 0.414, and thus greater than 0.05, meaning that variance between both groups is about equal. The t-statistic of 2.1 and 29 degrees of freedom reveal a p-value of 0.04, which is less than 0.05 and therefore we can conclude that the difference between the groups is statistically significant. However, because the post-theft mean is substantially lower supports the argument that the theft was a factor in the decrease of the post-theft average return rate for Rubens' works. Below is the scatter plot of Rubens' compound annual returns (artasanasset.com).

Figure 3



3) Cézanne - "Bouilloire et Fruits", Boston - 1978

Table 3(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft	20	8.55	11.1
Post-Theft	19	3.98	8.13

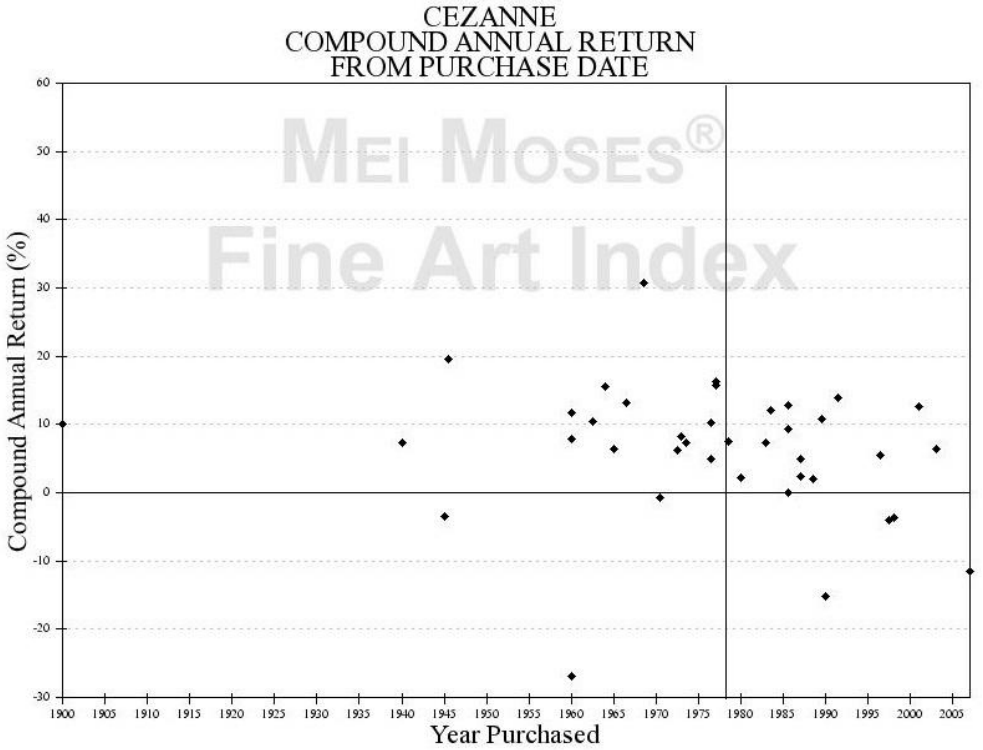
In the descriptive statistics table above, there were 20 repeat sales with an average return rate of 8.55% prior to the 1978 theft and 19 repeat sales following for an average return rate of 3.98%. The standard deviation decreased after the theft suggesting a slightly more compact grouping of CAR's around the median. Immediately upon looking at this table, we can see that the average return decreased following the theft which is inconsistent with the hypothesis. The t-test below will show if there is a significant difference between the groups.

Table 3(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	T	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.82	1.46	37	0.15	4.57

The Levene's Test For Equality of Variances calculated a significance value of 0.82 meaning that both the pre- and post-theft groups have a similar level of variance. The t-statistic of 1.46 and the 37 degrees of freedom reveal a p-value of 0.15 and thus greater than 0.05. Therefore we can conclude that there is not a significant statistical difference between the groups and that the difference in the means is most likely random. Below is a scatter plot of all of Cézanne's known CAR's according to the MMFAI (artasanasset.com).

Figure 4



4) Edgar Degas drawings - Gardner Museum, Boston - 1990

Table 4(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft	86	9.37	9.38
Post-Theft	32	7.1	7.38

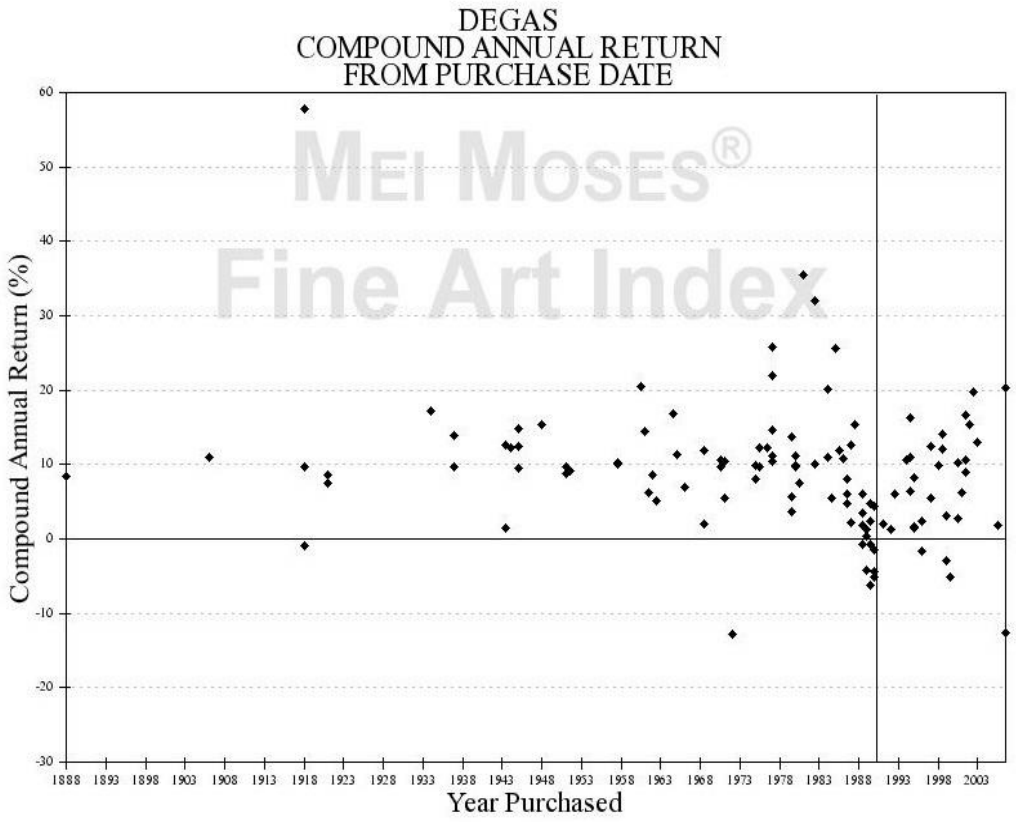
From the descriptive statistics above, we see that Degas had 86 repeat sales prior to the 1990 theft which have an average return rate of 9.37%. Following the theft, he had 32 repeat sales for an average return rate of 7.1%. The standard deviation decreased slightly following the theft, signifying more clustering of CAR's around the median. This theft is not exactly very close to the middle of Degas' repeat sales records, however the historical significance of the theft and the attention it received deemed it worthy of analysis.

Table 4(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	T	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.92	1.23	116	0.22	2.27

The Levene's Test For Equality of Variances calculated a significance value of 0.92, suggesting that both groups have similar variances, despite one group having a larger sample size than the other. The t-statistic of 1.23 and the 116 degrees of freedom account for a p-value of 0.22. Therefore we can conclude that there is not a statistically significant difference between both sample groups. Below is the scatter plot for all of Degas' recorded compound annual returns. It is worth noting that the impact of the art bubble from 1990 is quite evident from this graph (artasanasset.com).

Figure 5



3.1.3 Discussion - Part 1

From the four independent samples t-tests conducted above, none were consistent with the hypothesis: that a major art theft would increase the returns for all subsequent repeat sales over the long term for other works by the same artist. Only the result from the t-test for Rubens revealed a significant difference in the pre- and post-theft means, and the average return rate dropped substantially following the theft. This t-test presents argument in opposition to the hypothesis that art theft actually decreases future return rates (in the long term).

Table 5 - Summary: Part 1

Theft	N (pre-)	Mean (pre-)	N (post-)	Mean (post-)	Mean Diff	Levene's	T-stat	P val	Hyp
Rembrandt	8	4.44	10	5.65	-1.21	E.V.A.	-0.49	0.64	Rej.
Rubens	18	7.06	13	0.76	6.29	E.V.A.	2.1	0.04	Rej.
Cézanne	20	8.55	19	3.98	4.57	E.V.A.	1.46	0.15	Rej.
Degas	86	9.37	32	7.1	2.27	E.V.A.	1.23	0.22	Rej.

The Cézanne and Degas thefts also resulted in lower means following their respective thefts however the treatment did not appear to be a factor. Rembrandt had a positive mean increase following the 1966 Dulwich theft, however the t-test showed that this more likely due to chance. As a treatment, specific art thefts appear to have little long-term effect on the future return rates of works by the same artist following a major incident, with Rubens being an exception. In fact, if any effect is perceived, it is that theft will most likely diminish future returns judging by the difference in the pre-and post-theft means the Rubens' t-test result.

3.2 - Part 2: Long term effects of art theft (10 years)

3.2.1 Experiment Design

Similar to Part 1, this section will compare the CAR's of specific artists ten years prior to and after a major theft in which at least one of their works were stolen. Based on the results from previous part, it would appear that a single incident of theft does not have a lasting impact on returns of future repeat sales of the same artist. The purpose of this section is to restrict the periods before and after the theft to ten years in order to try and isolate any significant differences between the two groups of CAR's. The thefts from Part 1 were not suitable for this analysis as the number of recorded repeat sales for each artist was too low. Independent samples t-tests at a 95% confidence level will be used. Below are the thefts that will be the subject of the experiments.

1) Stephen Hahn Gallery, New York, New York - November 1969

In November of 1969, thieves stole seven paintings from the Stephen Hahn Gallery in New York City including works by Cassatt, Monet, Pissarro and Rouault (Monet and Pissarro are the artists selected for the t-tests). At the time, the paintings were estimated to be a combined value of around $500,000 USD (Chakelian, 2012). This particular theft frequently appears in articles discussing the greatest art thefts in history because it contains a certain twist of irony and humour. Just as the thieves were picking the locks to a door of the gallery, Stephen Hahn was discussing art theft in a conference meeting with the board of directors from the Art Directors Association of America. Following the theft he joked that the thieves had a "conservative" taste in art by not taking the abstract works in the gallery including one by Picasso (Ibid). This example of irony and Hahn's self-deprecating style of humour has had a lasting impression on art historians and media alike.

2) Palais des Papes, Avignon, France - January 31, 1976

In this instance of theft, thieves stole 118 works by Picasso from the Palais des Papes in Avignon, France. It was the single largest incident of theft involving his works (BBC, 2007). Picasso's works are frequently targeted by thieves as his pieces often command extremely high prices in the art market. This theft occurred less than three years after Picasso died, and as Czujack (1997) found that there was a rise in auction prices for his works in the three years proceeding his death, this stolen collection would have been worth an exceptionally high market value at the time.

3.2.2 Data Analysis

Below are the results from the independent samples t-tests conducted at a 95% confidence level for the CAR's of the artists selected above in the ten years prior to and following the theft.

1) Monet - Stephen Hahn Gallery, New York, New York - 1969

Table 6(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft (1959 - 1969)	18	9.55	5.62
Post-Theft (1969 - 1979)	36	13.04	7.66

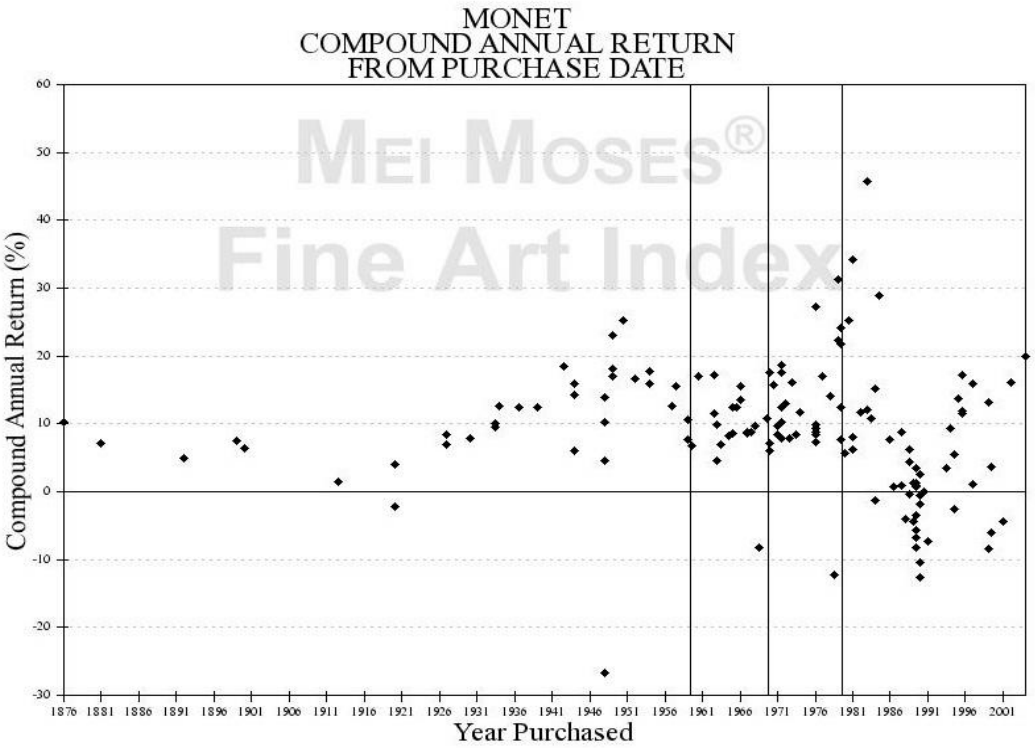
From the group statistics we can see that there were twice as many repeat sales in the ten years after the theft than before. The increase in the means post-theft is consistent with the hypothesis suggesting that works by Monet may have been in higher demand after this incident.

Table 6(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.17	-1.71	52	0.09	-3.48

The Levene's Test for Equality of Variances reveals that the variances between the groups were approximately the same. The t-statistic of -1.71 is relatively far from the mean on the normal distribution however we still conclude that the difference between the groups is not statistically significant, albeit it is very close. Supposing this t-test was performed again with a confidence level of 90%, then we could conclude that there is a probability of less than 10% (but higher than 5%) that the difference between the two groups would not be statistically significant. Below is the scatter plot of Monet's recorded CAR's. The vertical line in the middle indicates the year of the theft, 1969 (artasanasset.com).

Figure 6



2) Pissarro - Stephen Hahn Gallery, New York, New York - 1969

Table 7(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft (1959 - 1969)	16	8.91	6.46
Post-Theft (1969 - 1979)	27	12.09	5.67

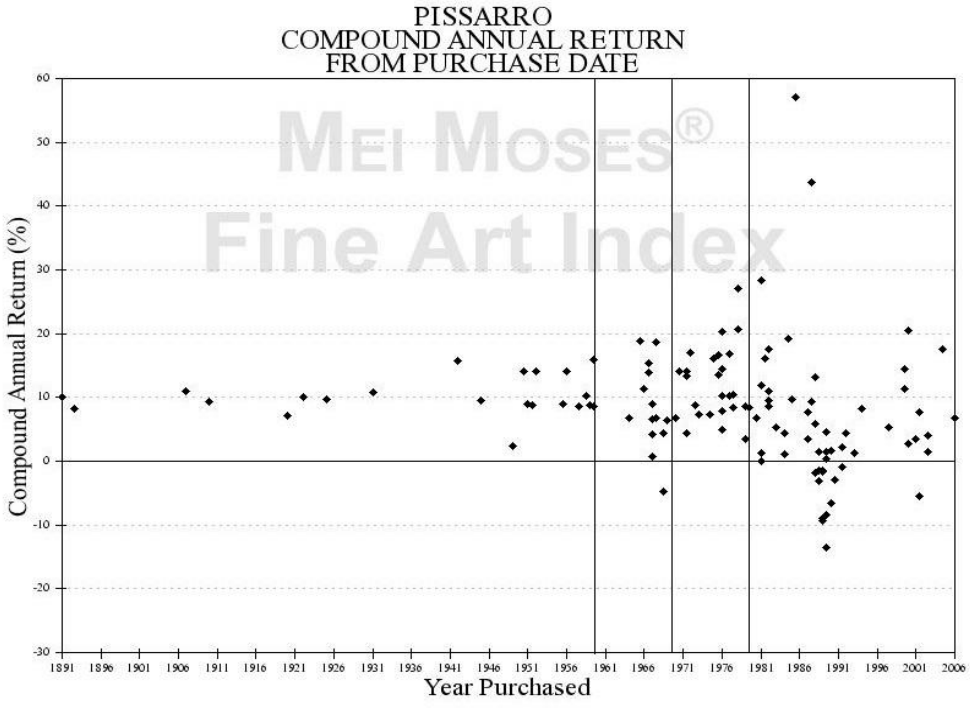
From the group statistics table above, there were 16 repeat sales prior to Pissarro's work being taken from the Stephen Hahn Gallery theft and 27 following it. The mean for the CAR's increased after the theft which is consistent with the hypothesis. The standard deviations of both groups is also relatively similar and stable.

Table 7(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.74	-1.69	41	0.10	-3.18

According the Levene's Test for Equality of Variances, the variance between both groups is around the same level. The t-statistic of -1.69 and the 41 degrees of freedom reveal a p-value of 0.10, and thus allowing us to conclude that there is not a statistically significant difference between the groups at a confidence level of 95%. However, similar to the previous t-test involving Monet, at a 90% confidence level, there would a statistically significant difference between the groups. Since the original hypothesis was intended to determine a significant difference at a 95% level of confidence, we must accept the null hypothesis, albeit the result was close to supporting the original one. Below is the scatter of Pissarro's CAR's as collected by the MMFAI (artasanasset.com).

Figure 7



2) Picasso - Palais des Papes, Avignon, France - 1976

Table 8(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft (1966 - 1976)	17	10.51	4.13
Post-Theft (1976 -1986)	50	12.11	8.05

From the group statistics we can see that there were a much higher number of repeat sales following the 1976 theft (50) than before (17) and that the average return rate also increased from 10.51 to 12.11%. This increase in the mean is so far consistent with the hypothesis. The table below will tell us if there is a significant difference between the group. As mentioned before, Picasso died in 1973 and thus his supply of new works effectively ceased. The large difference in the number of repeat sales before and after the theft as well as the increase in the average returns could be attributed more to his death in an attempt to achieve higher returns which is what Czujack (1997) found with his auction sales.

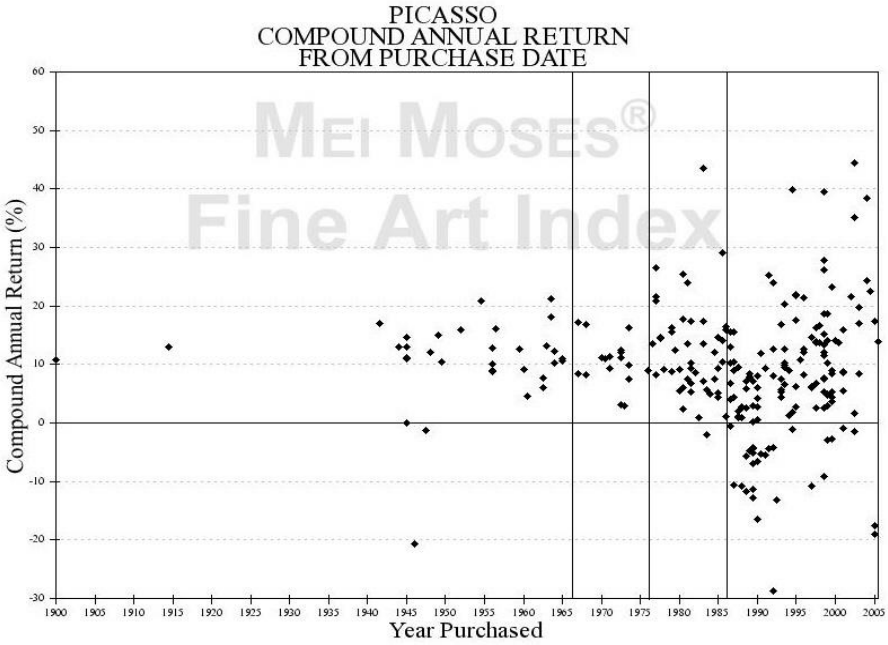
Table 8(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. NOT Assumed	0.04	-1.06	54.36	0.30	-1.6

In the t-test results above we can observe that significance level from the Levene's Test for Equality of Variances is less that 0.05, and therefore we do not assume that there is similar variance of the CAR's around their respective mean for each group. When conducting independent samples t-tests in SPSS, two rows of data appear in the output: one is for when equal variances are assumed, and the other is when they are not. In this case, since the difference in the variance within the groups is high, we read the bottom row of the SPSS output (these are in the table above). With a t-statistic of -1.06 and 54.36 degrees of freedom, the p-value for this t-test (0.30) is higher than 0.05 and therefore we can conclude that there is not a

statistically significant difference between the means of both groups. For the sake of curiousity, had we read from the top row of the SPSS output, the p-value was 0.44 and our conclusion would be the same. Below is scatter plot of Picasso's CAR's (artasanasset.com).

Figure 8



3.2.3 Discussion - Part 2

For each theft analyzed the pre- and post-theft sample groups did not show any statistically significant differences at a 95% level of confidence. Therefore the results fail to show that the treatment had any significant effect and thus failing to support the hypothesis, that higher returns for repeat sales would result following a theft within a ten year time period. Interestingly, however, was that the p-values for Monet and Pissarro were quite similar (0.09 and 0.10 respectively) and both works were taken in the same incident.

Table 9 - Summary: Part 2

Theft	N (pre-)	Mean (pre-)	N (post-)	Mean (post-)	Mean Diff	Levene's	T-stat	P val	Hyp
Monet	18	9.55	36	13.04	-3.49	E.V.A.	-1.71	0.09	Rej.
Pissarro	16	8.91	27	12.09	-3.18	E.V.A.	-1.69	0.10	Rej.
Picasso	17	10.51	50	12.11	-1.6	E.V.N.A.	-1.06	0.30	Rej.

Monet and Pissarro show similar figures in the means of the post-theft CAR's which both increased in the ten years following the theft. Interestingly, they were also both impressionist painters. If the t-tests were repeated for both artists with the confidence level set at 90%, then based on their p-values the mean of the post-theft CAR's for both artists would be significantly different than the mean of pre-theft CAR's. The fact that these results for these two artists are so similar may be due to coincidence, however they may also provide some evidence that the Stephen Hahn Gallery theft may have left an "impression" (excuse the pun) on collectors of impressionist works, and in particular those who collected Monet and Pissarro around this period of time.

In the Palais des Papes theft involving 118 works by Picasso, we can see in the table and scatter plot above that there was a flurry of buying and selling activity in the ten years that followed based on the number of post-theft repeat sales. However, as noted above, Picasso died in 1973 and thus it is possible that the increase in the average CAR's following the theft would have more to do with his death than the theft itself. As mentioned earlier, Czujack (1997) found an increase in auction prices for Picasso relative to the art market following his death which lasted for approximately three years. In fact, one may presume that this increase in auction prices did not go unnoticed by the thief who stole the 118 works. The "death effect" of three years is much shorter than the 10 year post-theft time span covered in this t-test, and effectively ended around the same time as the theft (1976). Despite that the post-theft mean is higher than the pre-theft mean, the p-value still indicates that there is not a significant difference between the pre- and post-theft CAR's.

3.3 - Part 3: Short term effects of art theft (5 years)

3.3.1 Experiment Design

The purpose of Part 3 of this experiment is to shorten the period of time to five years (pre- and post-theft) in an effort to isolate any potential short term "theft effects". Five famous incidents of theft will be examined in this section, all of which took place after 2000. The first four will be studied using auction prices for paintings and works on paper (prints and other forms of media such as sculptures were not included) that were collected from auction houses worldwide using the Blouin Art Sales Index. The fifth one will measure the change in CAR's for a theft that took place in Stockholm in 2000 involving two works by Renoir. Despite that repeat sales happen far less frequently than single auction sales, Renoir is ranked second in the MMFAI's list of artists with the most repeat sales having 232 as of 2008 (artasanasset.com) and thus he was deemed to have enough within a five year time span (before and after the theft) to warrant a relevant statistical analysis. It should be noted that all of the five thefts below involved paintings being stolen with the exception of Munch's "Scream" which is a work on paper. For this reason, the auction records in the sample groups for the 2004 Munch theft include both paintings and works on paper.

Like in Parts 1 and 2 of this experiment, independent samples t-tests will be applied to each case. Since all of the thefts in this section took place more recently than all of the cases previously examined, there is a stronger basis to assume that the dissemination of information through the media regarding these incidents was wider and more accessible with the aid of the Internet. All five cases can quickly be found and read about with a simple search. If any of the results from the t-tests show significant differences between the means of the sample groups, this could suggest that media related technology played a role in affecting the post-theft auction prices and returns on the artists' other works. Below are the thefts to be examined.

1) Van Gogh Museum, Amsterdam, Netherlands - December 8, 2002

On December 8, 2002, thieves climbed to the roof of the Van Gogh Museum in Amsterdam and through a skylight repelled down and took two works by van Gogh: "Congregation leaving the reformed church in Nuenen" and "View of the sea at Scheveningen". The museum staff could not put an immediate market value at the time, however the artist's works had recently been selling for tens of millions of Euros. It was initially thought that they were stolen for a private collector or for ransom. Neither were insured nor have they been recovered (Clements 2002).

2) Munch Museum, Oslo, Norway - August 22, 2004

Edvard Munch's "The Scream" and "Madonna" were both stolen from the Munch Museum on August 22, 2004 (Lyall 2004). They were later recovered but it was the second time in ten years that a version of "The Scream" had been stolen. Four original versions of "The Scream" exist, three of which are in museums. In 2012 the fourth version (the only one in private hands) sold for a record $107 million USD at Sotheby's in New York ($119,922,500 including the buyer's premium) and was won by an anonymous telephone bidder. The theft in 2004 brought a tremendous amount of publicity and without a doubt helped to spread the importance of the work to a mass audience. This particular theft and subsequent record auction sale in 2012 was one of the inspirations for the topic of this paper.

3) Museu de Chacara do Ceu, Rio de Janeiro, Brazil - February 24, 2006

On February 24, 2006, during the annual Carnival celebrations in Rio de Janeiro, Brazil, gunmen stormed the Museu de Chacara do Ceu taking works by Picasso, Monet, Matisse, and Dali's "The Two Balconies" (Dali is the focus of this t-test). The thieves escaped into the large crowd outside while a samba band marched down the street playing music. The works were considered to be the most valuable in the museum and staff at the time could not put an estimated market value on them (Thompson 2006).

4) E.G. Burhle Foundation, Zurich, Switzerland - February 11, 2008

In what was considered to be the largest art robbery in Switzerland's history, and one of the largest in Europe, three armed robbers stole four masterpieces which included Cézanne's "Boy in the Red Waistcoat", Monet's "Poppy Field at Vetheuil", Van Gogh's "Blooming Chestnut Branches" and Degas' "Ludovic Lepic and his Daughters" (Sturcke 2008). The paintings were believed to be worth a combined £84 million. Out of the five thefts examined in this section, this was the most recent one. For the purposes of this t-test, Cézanne is the artist in question.

5) National Museum, Stockholm, Sweden - December 22, 2000

On December 22, 2000, thieves broke into Sweden's National Museum in Stockholm stealing a self-portrait by Rembrandt and two paintings by Renoir, "Young Parisian" and "Conversation", worth an combined estimate of $30 million USD. They escaped by boat and distracted police at the time of the break in by setting two cars on fire in distant parts in the city. It was thought that they acted on commission for a private collector (BBC News, 2000). Of the five thefts to be examined in this section, this is the only one that will use Renoir's CAR's from the MMFAI for the t-test. This particular incident often appears on "greatest art heists" lists primarily due to the pieces involved and the methods used for distraction and escape.

3.3.2 Data Analysis

Below are the results from the independent samples t-tests using auction records and CAR's collected from the artists of the thefts described above.

1) Van Gogh - Van Gogh Museum, Amsterdam, Netherlands - 2002

Table 10(a) - Descriptive Group Statistics

Group	Auction Sales	Mean (USD)	Std. Deviation
Pre-Theft (1997 - 2002)	16	$6,871,228.50	8,342,818.72
Post-Theft (2002 - 2007)	29	$4,542,081.86	12,317618.15

For this independent samples t-test, only auction sales for paintings by van Gogh were included in the analysis. The Blouin Art Sales Index lists 16 paintings by Van Gogh sold at auction houses worldwide in the five years prior to the theft for an average price of $6,871,228.50 USD. Following the theft 29 works were sold at an average price of $4,542,081.86 USD. Based on these results we can see that the average price fell after the theft which is inconsistent with the hypothesis.

Table 10(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.76	0.67	43	0.50	$2,329,146.64

According to the results from the t-test above, the Levene's Test for Equality of Variances indicates that there the variance of both groups is similar. The t-statistic of 0.67 tells us that within the normal distribution the p-value is 0.50, and therefore we can conclude that there is not a statistically significant difference between the groups. The differences in the means are more likely due to chance.

2) Munch - Munch Museum, Oslo, Norway - 2004

Table 11(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (1999 - 2004)	45	$501,479.04	1,194,894.13
Post-Theft (2004 - 2009)	56	$2,386,563.29	6,578,760.68

For this t-test the sample groups were expanded to include both paintings and works on paper. Munch's "Scream" is a work on paper and since this type of medium was stolen, other works on paper created by Munch were included in the analysis. It should be noted that the record setting auction sale of "The Scream" happened eight years after this particular theft and is not included in the post-theft sample of auction prices. The pre-theft sample mean of $501,479.04 is lower than the post-theft mean of $2,386,563.29 which is consistent with the hypothesis. The standard deviation of the post-theft group is much higher suggesting more variation amongst the sample around the median.

Table 11(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. NOT Assumed	0.01	-2.10	59.48	0.04	-1,885,084.24

Based on the results from the t-test, the Levene's Test of Equality of Variances found that the variances between the groups do not appear to be similar, which is a likely testament to the difference between the standard deviations between the sample groups. Because of this, the second row of the SPSS output table applies to this scenario. The t-statistic of -2.10 is far enough away from the mean of the normal distribution to produce a p-value of 0.04. Therefore we can conclude that there a statistically significant difference between both sample groups which supports the original hypothesis.

3) Dali - Museu de Chacara do Ceu, Rio de Janeiro, Brazil - 2006

Table 12(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (2001 - 2006)	54	$397,421.37	573,563.28
Post-Theft (2006 - 2011)	47	$1,381,509.47	3,350,527.12

For this independent samples t-test, only paintings by Dali were included in the sample groups. The pre-theft group contained 54 auction records for an average sale price of $397,421.37 while the post-theft sample group containing 47 records had an average price of $1,381,509.47. The increase in the post-theft mean is consistent with the hypothesis. Also note that the standard deviation was much higher in the post-theft sample group which suggests a wider range of auction prices.

Table 12(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. NOT Assumed	0.00	-1.99	48.35	0.05	-984,088.10

The Levene's Test for Equality of Variances confirms a difference in the variances between the groups, in which the difference in the standard deviations also implies. Like the previous theft, this leads us to use the second row of results produced by SPSS. The t-statistic (-1.99) is relatively far from the mean of the normal distribution to purport a p-value of 0.05. Because the p-value is at the 0.05 level of significance, we can conclude that there is a statistically significant difference between the sample groups and therefore supports the hypothesis.

4) Cézanne - E.G. Burhle Foundation, Zurich, Switzerland - 2008

Table 13(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (2003 - 2008)	25	$5,479,482.52	7,251,791.96
Post-Theft (2008 - 2013)	23	$3,353,422.65	4,378,830.06

For this particular theft involving one of Cézannes paintings, 25 auction records were collected for the pre-theft sample group with an average price of $5,479,482.52. In the five years following the theft, 23 auction sales for his paintings took place for an average price of

$3,353,422.65. The decrease in the average price is inconsistent with the hypothesis, although it is worth pointing out that the size of the sample groups were relatively small and subject to influence from outliers. The higher standard deviation in the pre-theft group can also attest to this.

Table 13(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.106	1.216	46	0.23	2,126,059.87

Despite the difference in the standard deviations above, the Levene's Test for Equality of Variances shows a significance value greater than 0.05, therefore indicating that a similar variance exists in each group. The t-statistic of 1.216 and 46 degrees of freedom reveals a p-value of 0.23. Because the p-value is greater than 0.05, we can conclude that there is not a significant difference between the pre- and post-theft sample groups.

5) Renoir - National Museum, Stockholm, Sweden - 2000

Table 14(a) - Descriptive Group Statistics

Group	CAR's	Mean (%)	Std. Deviation
Pre-Theft (1995 - 2000)	25	7.11	11.96
Post-Theft (2000 - 2005)	10	21.09	16.48

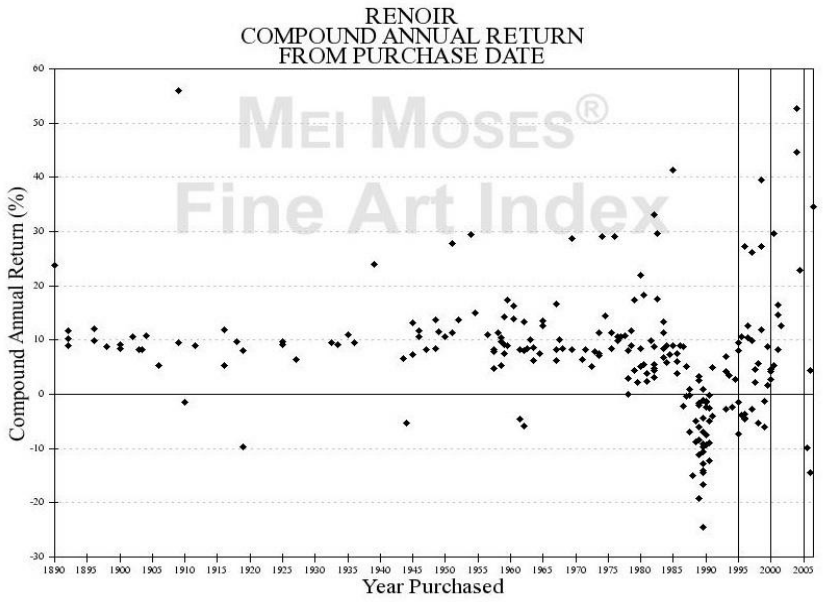
This is the only t-test of this section that used CAR's over the five year period prior to and after this particular theft involving Renoir in 2000. Renoir had 25 repeat sales in the five years prior to the theft for an average of 7.11%. Following the theft, 10 repeat sales occurred for a higher average of 21.09%. So far, this result is consistent with the hypothesis and the t-test results below will tell us if there is a difference between the sample groups.

Table 14(b) - Independent Samples Test Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.20	-2.8	33	0.01	-13.98

The Levene's Test for Equality of Variances shows a similar level of variance in each group, even though the standard deviation was higher in the post-theft group. The t-statistic of -2.8 is far enough away from the mean on the normal distribution so that the p-value is 0.01. Therefore, we can conclude that there is a significant difference between the two groups which is consistent with the hypothesis. Originally, this theft was meant to be included in Part 2, however it was moved to Part 3 for two reasons: firstly, Renoir's CAR's only go up to 2008 and thus the collection of post-theft CAR's would have been shorter than ten years; secondly, the CAR's from around the early 1990's were extremely low as a result of the art bubble. Because of these reasons, the results of a test spanning ten years before and after the theft would have been severely biased. As we can see in the scatter plot below, by 1995 Renoir's CAR's had somewhat stabilized. The period between 1995 and 2000 saw several negative CAR's for Renoir's works, while in the five year period after, there were all CAR's were positive. Since the t-test revealed a significant difference between the groups, there is reason to suggest here that the theft in question was a causal factor for the higher average CAR's. Below is a scatter plot of Renoir's compound annual returns (artasanasset.com)

Figure 9



3.3.3 Discussion - Part 3

Based on the five cases examined in this section, three (Munch, Dali and Renoir) showed evidence of a "theft effect" based on the fact that the post-theft auction prices and average compound annual returns were higher than the pre-theft ones which the t-tests showed to be significantly different. While the treatment did not seem to impact auction prices of the artists from the other two thefts, these findings suggest that there might be a short term "theft effect" of five years whereby CAR's and auction sales are greater relative to CAR's and sales before the theft.

Table 15 - Summary: Part 3

Theft	N (pre-)	Mean (pre-)	N (post-)	Mean (post-)	Levene's	T-stat	P val	Hyp.
VG	16	6,871,228.50	29	4,542,081.86	E.V.A	0.67	0.50	Rej.
Mun	45	501,479.04	56	2,386,563.29	E.V.N.A.	-2.10	0.04	Acc.
Dali	54	397,421.37	47	1,381,509.47	E.V.N.A.	-1.99	0.05	Acc.
Céz	25	5,479,482.52	23	3,353,422.65	E.V.A.	1.22	0.23	Rej.
Ren	25	7.11 (CAR)	10	21.09 (CAR)	E.V.A.	-2.8	0.01	Acc.

In the case of the Munch theft, there are a few interesting characteristics that might help distinguish a stronger "theft effect" from the other cases. For example, as mentioned before, a version of Munch's "The Scream" had previously been stolen in 1994. For another version of it to be taken again and the media attention that followed could reinforce the importance of the work in the minds of collectors. In advertising, Berlyne (1970) devised a two-part theory regarding repetition effects (Berlyne, 1970, as cited in Campbell & Keller, 2003, p. 292). The first part, often referred to as "wearin", involves the habituation of the message to the viewer whereby they may feel hostile and uncertain to it at first. "Initial levels of message repetition serve as increases of positive habituation by reducing negative responses to the novel stimulus, thus increasing effectiveness at lower levels of repetition" (Cox & Cox, 1988, as cited in Campbell & Keller, 2003, p. 292-293). The second part, referred to as "wearout", occurs when continued repetition brings tedium and the message begins to lose its effectiveness (Anand & Sternthal 1990, Blair & Rabuck 1998, Calder & Sternthal 1980, as cited in Campbell & Keller, 2003, p. 293). With regards to art theft, because it is such a random and infrequent occurrence, it is very unlikely any piece would be stolen frequently enough cause "wearout" on the public's conscience. However, a repeated theft of an object (in this case, a different version of the same work) may be enough to trigger a "wearin" effect and demand would increase as a result. Despite being stolen four separate times, Rembrandt's portrait of Jacob de Gheyn III, still sits in the Dulwich Picture Gallery in London and since it was never privately bought or sold (nor will it likely ever be) we can only speculate on its potential monetary fluctuations.

It is unlikely that Berlyne's (1970) theory could explain the significant difference in Dali's and Renoir's t-tests above. Research did not reveal that any of those works had ever been stolen prior to their thefts. Since these works belong to a public institution, they are unlikely to see an auction block in the foreseeable future. On the other hand, Dali ranks in third place on Art Loss Register's list of artists with the most stolen works with 468 registered items (to see the list of the 24 artists with the most registered stolen works, please see Appendix A). It is possible that thefts involving his works prior to the Rio de Janeiro incident had some effect on prospective collectors. Similarly, Renoir, is number twelve on the ALR's list with registered

items. Such a high number could suggest that media exposure from prior thefts made a lasting impression on collectors. Interestingly, neither Cézanne nor van Gogh are on the list and thus were likely less frequently targeted and received less relative media exposure.

3.4 - Part 4: Short term effects of art theft (6 months)

3.4.1 Experiment Design

The purpose of the Part 4 is to look for short term effects of a major theft on auction prices for prints using independent samples t-tests six months prior to and following the theft. Prints by Picasso are the choice subject of this section since he often sells many at auction in short periods of time, thus lending themselves well for statistical analysis. Auction prices for prints were collected from the Blouin Art Sales Index for Christie's and Sotheby's auction houses in London, England. Prints were the medium of choice because there is more continuous market activity for them compared to other mediums, like paintings and sculptures. Prints that were "bought in" at auction were not included in the sample groups. Changes in compound annual returns on repeat sales of Picasso's prints were not provided by the MMFAI nor were found elsewhere. The two thefts selected for analysis took place at the Sao Paulo Museum of Art on December 20, 2007, in Sao Paulo, Brazil, and at the Museum of Modern Art in Paris, France, on May 20, 2010. In the first theft, Picasso's "Portrait of Suzanne" was stolen along with Candido Portinari's "O Lavrador de Café", while in the second theft Picasso's "Pigeon aux Petits Pois" was taken as well as works by Matisse, Braque, Modigliani, and Léger. Both thefts received substantial amounts of global media attention.

3.4.2 Data Analysis

Below are the results from the independent samples t-tests using Picasso's auction records for print sales sold at Christie's and Sotheby's auction houses in London, England.

1) Sao Paulo Museum of Art, Sao Paulo, Brazil - December 20, 2007

Christie's London

Table 16(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (19/6/07 to 19/12/07)	58	$59,180.72	95,178.13
Post-Theft (20/12/07 to 20/6/08)	32	$56,049.84	74,475.81

In the six months prior to the Sao Paulo theft, 58 Picasso prints were sold at Christie's London for an average price of $59,180.72. Following the theft, 32 prints were sold for an average price of $56,049.84. The standard deviation decreased slightly indicating a tighter grouping sale prices around the median. Immediately we can see that the average price decreased after the theft which is inconsistent with the hypothesis.

Table 16(b) - Independent Samples Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.62	0.16	88	0.87	3,130.88

The Levene's Test for Equality of Variances reveals that there is approximately equal variance between the pre-and post-theft sample groups. The t-statistic of 0.161 and 88 degrees of freedom gives a p-value of 0.873 which allows us to conclude that there is not a significant statistical difference for Picasso's print prices before and after the theft. Therefore, the treatment does not appear to have any effect, at least at Christie's auction house.

Sotheby's London

Table 17(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (19/6/07 to 19/12/07)	31	$19,448.58	21,078.71
Post-Theft (20/12/07 to 20/6/08)	23	$18,583.04	15,801.09

Sotheby's auction house in London sold 31 Picasso prints prior to the Sao Paulo theft for an average price of $19,448.58 and a standard deviation of 21,078.71. Following the theft, 23 prints were sold for an average price of $18,583.04 and a standard deviation of 15,801.09. Similar to the Christie's auction sales above, the average price for the prints decreased which is inconsistent with the hypothesis.

Table 17(b) - Independent Samples Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.68	0.17	52	0.87	865.53

The Levene's Test shows that the variances of the groups are generally equal. The p-value of 0.869 is greater than 0.05 and therefore we can conclude that there is not a statistically significant difference between the group means for Picasso's print prices before and after this theft. These findings are also inconsistent with the original hypothesis that a theft would cause an increase in short term print prices at auction.

2) Museum of Modern Art, Paris, France - May 20, 2010

Christie's London

Table 18(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (19/11/09 to 19/5/10)	22	$23,574.95	18,375.12
Post-Theft (20/5/10 to 20/11/10)	20	$29,157.45	48,100.35

In the six months prior to the 2010 theft of the Museum of Modern Art in Paris, there had been 22 Picasso prints sold at Christie's London for an average price of $23,574.95. In the six months following the theft, 20 Picasso prints were sold for an average price of $29,157.45. This increase is consistent with the hypothesis of the experiment.

Table 18(b) - Independent Samples Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.07	-0.51	40	.61	-5,609.49

The results from the independent samples t-test indicate that the variances are about equal, although the result from the Levene's Test is very close to 0.05. The t-statistic of -0.51 which is close to 0, results in a p-value of 0.61. This allows us to conclude that there is not a statistically significant difference between the groups and that the increase in the average price for prints after the theft is more likely due to chance.

Sotheby's London

Table 19(a) - Descriptive Group Statistics

Group	N	Mean (USD)	Std. Deviation
Pre-Theft (19/11/09 to 19/5/10)	14	$38,512.64	42,850.95
Post-Theft (20/5/10 to 20/11/10)	58	$126,226.15	337,829.46

In the six months prior to the Paris heist, Sotheby's London sold 14 Picasso prints for an average price of $38,512.64 which had a standard deviation of 42,850.95. After the theft, 59 prints by Picasso were sold for an average price of $127,161.74 and had a standard deviation of 334,981.57 suggesting a wide range of auction prices around the mean. What is worth noting is the significantly higher mean for prints sold following the theft. This part, at least, is consistent with the hypothesis.

Table 19(b) - Independent Samples Results

	Levene's Test	t-test For Equality of Means			
	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
Equal Var. Assumed	0.18	-0.96	70	0.34	-87,713.51

The Levene's Test shows that the variance between the groups is about equal. The t-statistic of -0.96 is relatively close to 0, and at 70 degrees of freedom the p-value is 0.34. Therefore we can conclude that there is not a significant difference between the sample groups. This result is a bit of a surprise given the large mean difference between the sample groups, but after running the t-test again the p-value still stands. The pre-theft sample group was quite smaller and contained only one print sale that sold for six figures. The post-theft sample group had seven prints which sold for six figures and two that sold for seven figures. In spite of the groups not being significantly different from each other, this p-value is the lowest of the four t-tests in this section of the experiment. Therefore the results from the t-test suggest that the increase in the average price after the theft is most likely due to chance.

3.4.3 Discussion - Part 4

Based on the four independent samples t-tests above, the results show with a 95% confidence level that neither theft was a factor influencing short term auction sales for prints by Picasso at Christie's nor Sotheby's auction houses in London. However, we cannot say for certain if this is the case for all artists and at all auction houses. Picasso is already a very well known artist and has produced an enormous body of work.

Table 20 - Summary: Part 4

Theft	N (pre-)	Mean (pre-)	N (post-)	Mean (post-)	Levene's	T-stat	P val.	Mean Diff	Hyp
Sao P. Ch.	58	59180.72	32	56049.84	E.V.A.	0.16	0.87	3130.88	Rej.
Sao P. S.	31	19448.58	23	18583.04	E.V.A.	0.17	0.87	865.52	Rej.
Paris Ch.	22	23574.95	20	29157.45	E.V.A.	-0.51	0.61	-5609.49	Rej.
Paris S.	14	38512.64	58	126,226.15	E.V.A.	-0.96	0.34	-87,713.51	Rej.

For the purposes of this experiment, using prints may not have been the most appropriate method for examining short term effects as they were not the same medium as the type of works stolen. Since the items taken were original works, it would seem logical that the market would respond more strongly to the same type of medium. However, to try to quantitatively measure short term changes of artworks would be a different type of challenge in itself. For this experiment, selecting a theft involving Picasso prints being stolen might have been a better choice. Generally speaking, however, artists who produce prints tend to do so in far larger numbers than original works, thus a "theft effect" involving prints would likely have a proportionately smaller effect on prices and returns. It is also worth mentioning that the p values (0.87) were identical for Christie's and Sotheby's around the time of the Sao Paulo theft. This might be a coincidence or perhaps even help to illustrate how little the buyer's at each auction house were impacted by the Picasso theft in Brazil.

3.5 Conclusions: Experiment 1

Out of the four sections of this experiment, only Part 3, which used periods of five years before and after a theft demonstrated evidence in support of the hypothesis, that an art theft would produce higher auction prices and compound annual returns for works by the same artist. Three of the five artists examined in this section, Munch, Dali and Renoir showed evidence of this "theft effect". In addition, the "theft effect" appears to be dependent on the absolute number of the artist's works that are stolen (as is the case with Dali and Renoir according to the Art loss Register) and the frequency in which a work is stolen (Munch's "The Scream" being taken twice). The high absolute numbers of registered stolen might also suggest higher frequency rates of theft, however no information theft frequency was found during the research. Higher theft frequency would bring more media attention and thus support Berlyne's (1970) "wearin" theory.

The long term t-tests (ten years and "All CAR's") appear to show that a single incident of art theft has a limited long term sustainable effect on auction prices and returns on other works

by the same artist. Artists who are famous around world, or otherwise considered "superstars" have their works more frequently targeted by thieves and thefts of their works seem to appear in the media every few years. Even what widely regarded as the most significant art theft in history, the Gardner Museum heist in Boston in 1990, did not produce any long term effects on returns for works by Degas, one of the artists whose works were taken in the raid. Although around the same time as this incident the art market crashed as a result of an inflated pricing bubble. Such an historical event and resulting market drop likely overshadowed any "theft effect".

Based on Berlyne's (1970) two-part advertising theory, we cannot rule out the possibility that collectors and audiences may suffer from "wearout" as a result of frequent art thefts. For Picasso, the "wearout" theory may have already taken hold. He is ranked first on the Art Loss Register's list of artists with the most registered stolen works with 821 (which is 353 more than Dali). There is a strong possibility that the frequency in which his works are stolen "washes away" any lingering "theft effect" and that buyer's are to experiencing "wearout".

The most promising avenue for future research based on these case studies would be to examine more thefts in shorter time spans, namely around three to five year periods, and search for significant differences between the sample group means. For example, if the periods examined in Part 2 were shortened to five years instead of ten, then we might have found similar results involving CAR's like the Renoir theft in 2000. The same might follow for the thefts in Parts 1 and 4 with regards to original works and prints. There are all sorts of combinations with regards to periods of time (two, three, four, five years) although these are beyond the scope of this paper. The next experiment, however, will pursue this idea more and run a regression analysis on the two thefts from Part 2 with shortened time periods from ten to five years.

IV. Experiment 2: Pre- and Post-Theft Regression Analysis for CAR's

The purpose of this experiment is to determine if any changes occur in the linear regressions of the pre-theft and post-theft CAR's of the three artists who were targeted in Part 2 of the previous experiment. In building on the evidence of a five year "theft effect", the thefts from Part 2 of the previous section will be reexamined using the artists CAR's shortened to five year periods, pre- and post-theft, instead of ten. CAR's for the selected artists were deemed to be a more rational unit of analysis in comparison to auction prices because the variance of the possible rates for CAR's is lower than auction prices which can have an extremely wide range. The three artists from Part 2 of the previous section, Pissarro (1969), Monet (1969) and Picasso (1976) each had a substantial enough amount of CAR's to perform a linear regression analysis and will be the subjects of the analyses below. The regression analysis will also include a line of best fit for the CAR's as well as provide a linear equation for we which we can use to "predict" future CAR's. For this experiment what we are most interested in is the difference between the pre- and post-theft slope of the line of best fit, which might offer some insight into any possible "theft effect" based on changes in the slope of the line. The equation of the line is y=bx+a. The components of the equation are:

y= CAR (dependent variable)
b= Slope of line
x= Time (independent variable)
a= Y-intercept

The results from Part 2 of the previous section showed for each of the three thefts analyzed that there was not a significant difference between the pre- and post-theft CAR's over ten year periods. Shortening the periods to five years and administering a line of best fit before and after a theft could contribute more evidence to the "theft effect" theory that art theft does have an impact on CAR's and auction prices. Similar to the hypothesis of the previous section, the hypothesis for the following tests is that the slope of the line of best fit, "b", of post-theft

linear regression equation will be higher in numerical value than the slope of the pre-theft regression equation. In other words, a major art theft would have a positive impact on average compound annual returns in the five years following the theft. Version 21 of SPSS will be used again for the regression analyses

4.1 Data Analysis

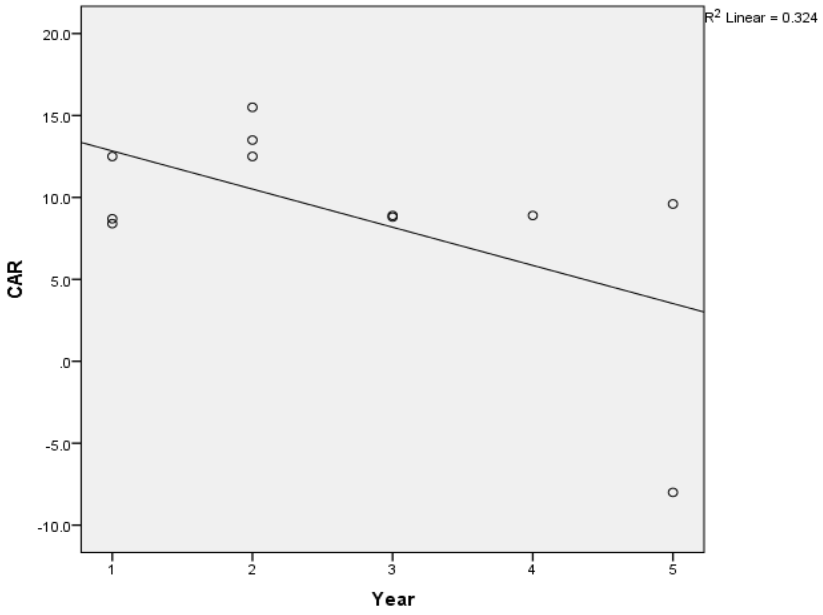
The results from the linear regression analysis are displayed below.

1) Monet - Stephen Hahn Gallery, New York, New York - November 1969

Pre-theft: 1965-1969

Displayed below is a scatter plot of the compound annual returns for repeats sales of work by Monet five years prior to the Stephen Hahn Gallery theft. Note that the years are numbered from one to five. This was done as a simple way for SPSS to compute a regression in a five year period. In this instance, year "1" is actually 1965, year "2" 1966, etc.

Figure 10 - Compound Annual Returns: Monet 1965 - 1969



Regression Analysis

Table 21(a) - Model Summary

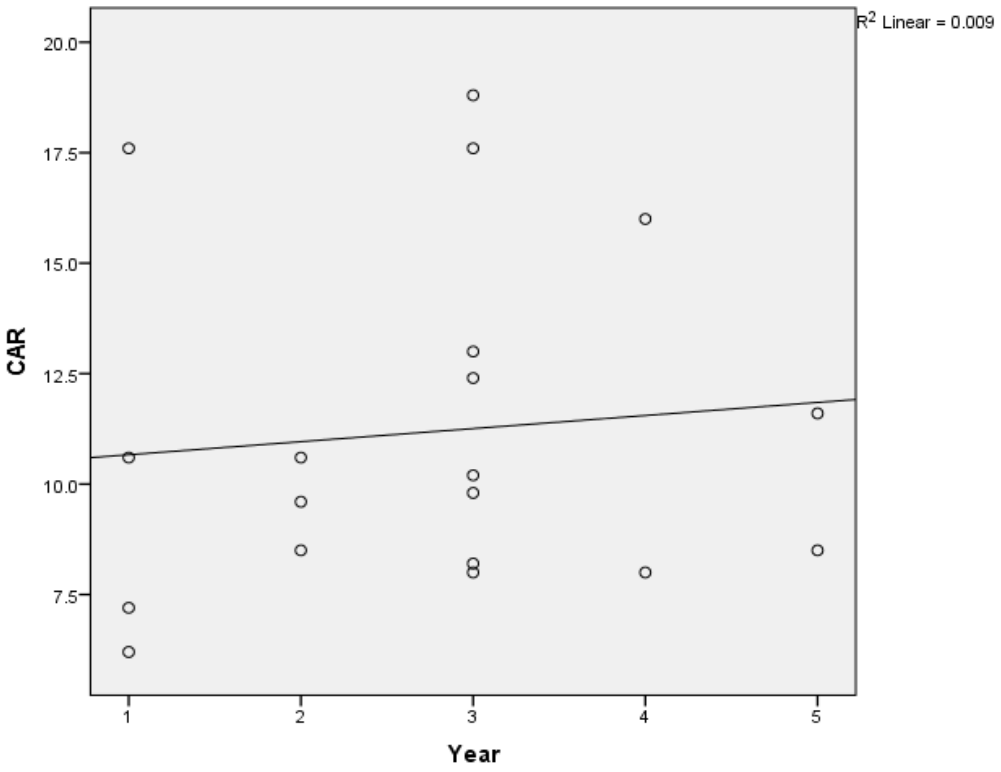
R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.57	0.32	5.32	15.17	-2.33	Y= -2.33X + 15.17

The table above contains the results from the linear regression analysis. "R" represents the correlation coefficient (0.57 in this case). "R Square" is simply the square of "R" (0.57^2) which is also known as the coefficient of determination and tells us how well the regression equation fits the data. Essentially it is the proportion of variance in the y-variable as seen through the x-variable. Numbers that are close to "1" indicate a good fit. In this case, the "R Square" of 0.32 suggests a moderate fit. The Standard Error of the Estimate is similar to standard deviation in that it is a measure of variability. It indicates how much inaccuracy will result from predictions using the linear model. Smaller numbers indicate higher accuracy (how2stats.com, 2011). In this case, the Standard Error of the Estimate is 5.32, which suggests a moderate amount of variability for predictions. The y-intercept is 15.17 although in the scatter plot above it appears to be less than 15. This is because it would cross the y-axis at year "0". In any case, we are more interested in the slope, -2.33, which tells us that, on average, Monet's CAR's were declining prior to the Stephen Hahn Gallery theft.

Post-theft: 1970 to 1974

Below is the scatter plot and line of best fit for Monet's CAR's in the five years following the theft. Immediately we can see that the slope of the line is positive and trending upwards, and is thus consistent with the hypothesis.

Figure 11 - Compound Annual Returns: Monet 1970-1974



Regression Analysis

Table 21(b) - Model Summary

R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.10	0.01	3.88	10.37	0.30	Y= 0.30X + 10.37

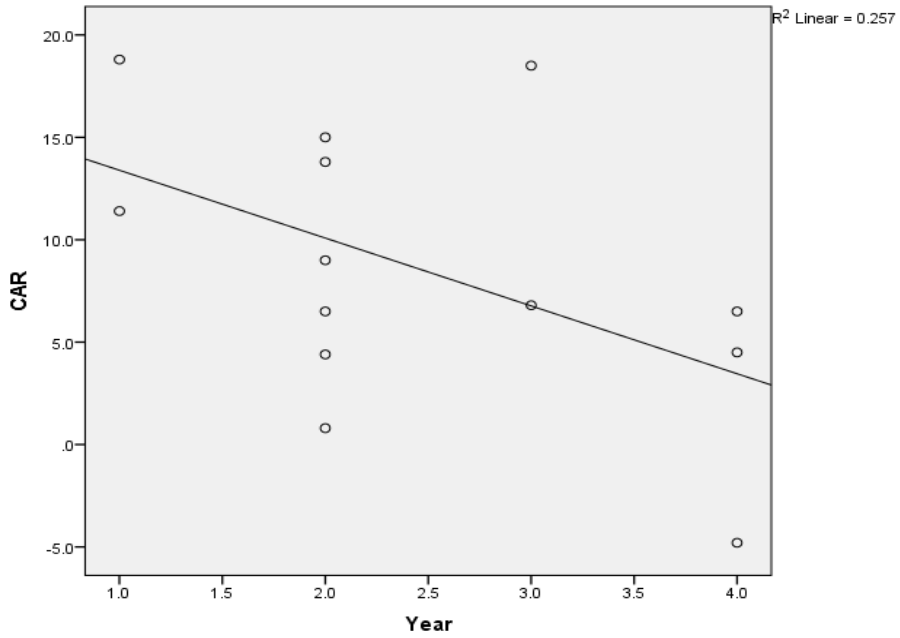
The R coefficient of 0.01 provides for a relatively low R Square of 0.01, suggesting a high amount of variation of CAR's along the y-axis, which is quite apparent in the scatter plot above. The Standard Error of the Estimate of 3.88 is lower than the pre-theft estimate, suggesting a more accurate regression despite the lower R Square. The y-intercept is 10.37 and the linear equation has a positive slope of 0.30. Because the slope is higher (by 2.62) and in fact positive compared to the pre-theft's negative slope, we can reject the null hypothesis and presume that compound annual returns for Monet's repeat sales were increasing in five year post-theft period.

2) Pissaro - Stephen Hahn Gallery, New York, New York - November 1969

Pre-theft: 1965-1969

Below is a scatter plot and line of best fit of the CAR's for Pissarro in the five years prior to the Stephen Hahn Gallery theft. We can immediately see that the slope of the line is negative.

Figure 12 - Compound Annual Returns: Pissarro 1965-1969



Regression Analysis

Table 22(a) - Model Summary

R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.51	0.26	6.18	16.71	-3.31	Y= -3.31X + 16.71

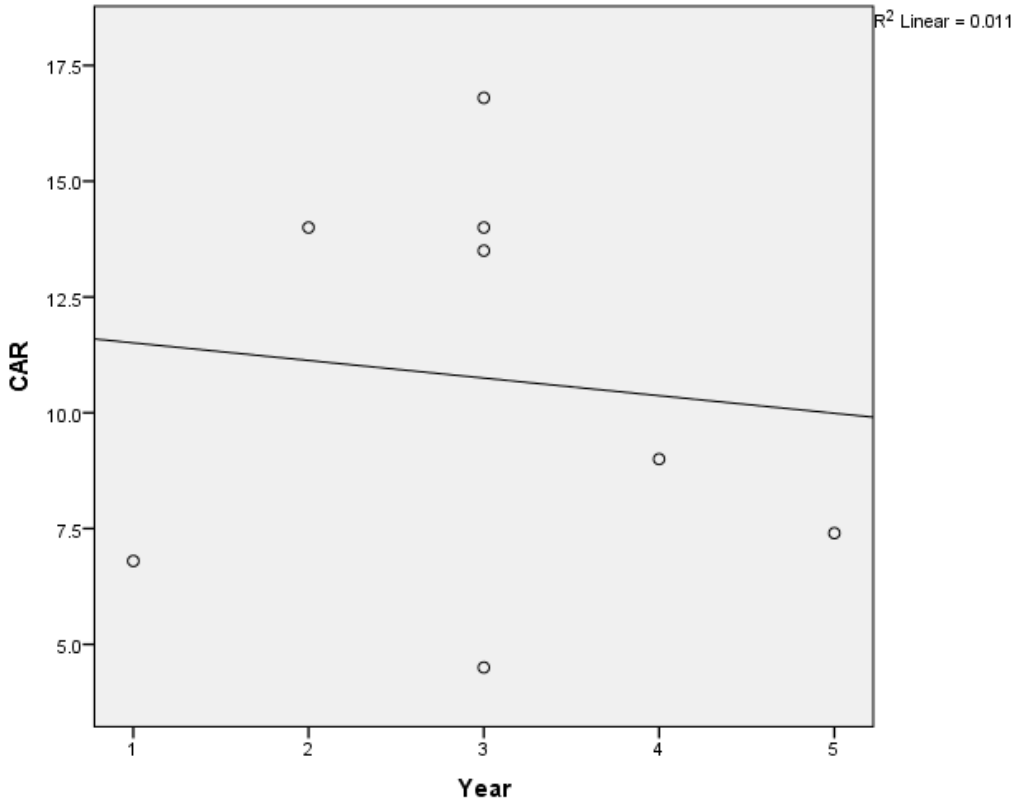
The R correlation coefficient of 0.51 provides a moderate "R Square" coefficient of 0.26, which tells us that there is some variance around the line of best fit. The Standard Error of the Estimate is 6.18 which is higher than either of Monet's suggesting that predictions using the

linear equation would be more prone to inaccuracies. The y-intercept is 16.71 the slope of the equation is -3.31, proposing that Pissarro's CAR's were declining prior to the theft.

Post-theft: 1970-1974

Below is a scatter plot and line of best fit of Pissarro's CAR's in the five years following the Stephen Hahn Gallery theft.

Figure 13 - Compound Annual Returns: Pissarro 1970-1974



Regression Analysis

Table 22(b) - Model Summary Table

R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.10	0.01	4.71	11.89	-0.38	Y= -0.38X + 11.89

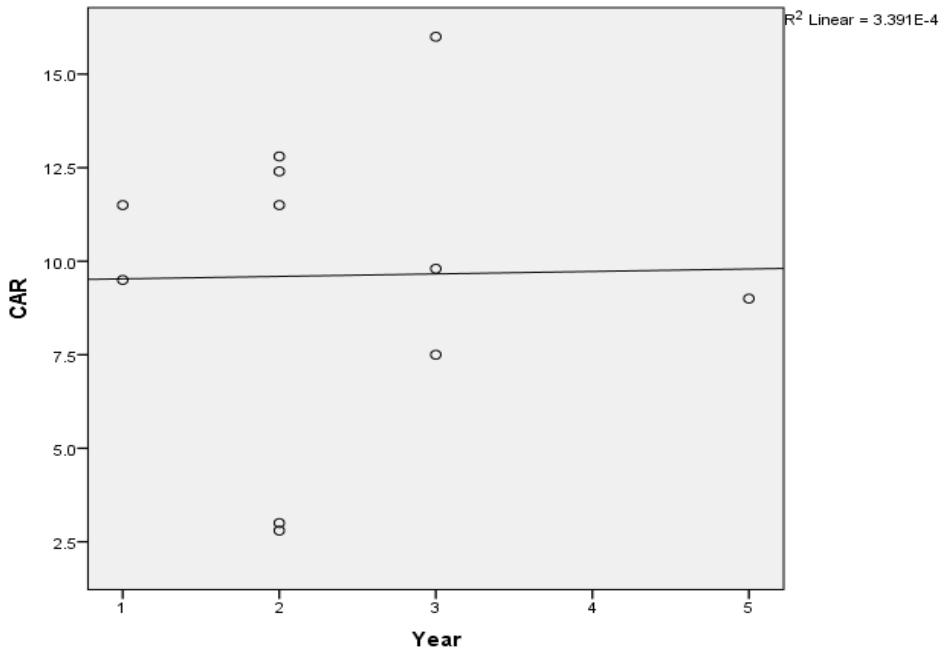
The R correlation coefficient of 0.10 provides an R Square coefficient of 0.01 suggesting a high amount of variation of CAR's along the line of best fit. Despite this, the Standard Error of the Estimate of 4.71 is lower than the pre-theft estimate alluding to more accurate predictions from the linear equation. The slope of the equation, -0.38, is higher than the slope of the pre-theft equation by 2.93 and is therefore technically consistent with the original hypothesis. What is disconcerting, however, is that the post-theft slope is still negative, meaning that repeat sale returns were, on average, still declining in the five years following the theft. Regardless, these results can still provide evidence of a positive "theft effect" in support of the hypothesis.

2) Palais des Papes, Avignon, France - January 31, 1976

Pre-theft: 1971-1975

Below is a scatter plot and line of best fit for Picasso's CAR's in the five years prior to the Palais des Papes theft where 118 of his works were stolen.

Figure 14 - Compound Annual Returns: Picasso 1971-1975



Regression Analysis

Table 23(a) - Model Summary Table

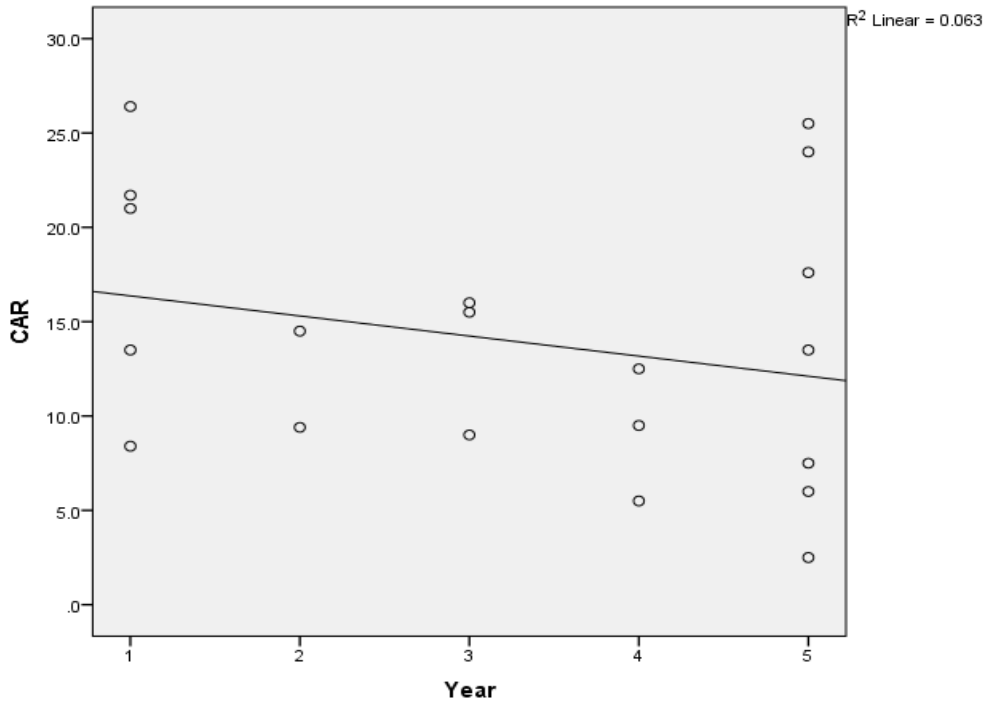
R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.02	0.00	4.23	9.46	0.07	Y= 0.07X + 9.46

The R correlation coefficient of 0.02 provides an R Square coefficient of 0.00 meaning that there is a very high level of variance amongst the CAR's in this five year period. Despite this, the Standard Error of the Estimate, 4.23, falls within the average range of previous estimates and suggests that the linear equation would provide at least some accuracy in predicting future returns. The linear equation has a slope of 0.07 and a y-intercept of 9.46. Part 2 of the previous experiment discussed the impact that the "death effect" (Czujack 1997) had on Picasso's auction prices following his death in 1973. It was also mentioned in the literature review section that Czujack (1997) used hedonic regression in determining this. As we can see in the scatter plot above, Picasso's highest CAR of 16% was in the year of his death, 1973. He died in April of that year (picasso.com) and while we do not know the precise date of the repeat sale, and given that his death was relatively early in the year, the sale likely occurred sometime after. In any case, the slope of the line of best fit is positive, albeit not by very much, suggesting that average returns on repeat sales were increasing around the time of his death and up to the 1976 theft.

Post-theft: 1976 - 1980

Below is the scatter plot and line of best for Picasso's CAR's in the five years following the 1976 theft. We can immediately see that the slope of the line is negative and is thus inconsistent with the hypothesis.

Figure 15 - Compound Annual Returns: Picasso 1976 - 1980



Regression Analysis

Table 23(b) - Model Summary Table

R	R Square	Std. Error of Estimate	Y intercept	Slope	Equation
0.25	0.06	6.94	17.43	-1.06	Y= -1.06X + 17.43

The R correlation coefficient of 0.25 gives an R Square coefficient of determination of 0.06 signifying a high amount of variance from the sampled CAR's along the line of best fit. The Standard Error of the Estimate, 6.94, is also quite high, suggesting that there would be much inaccuracy in predicting future returns using the linear model. This can be partially explained by the range of returns in years one (1976) and five (1980). The line of best fit has a y-intercept of 17.43 and a slope of -1.06. Since the slope of the line of best fit was lower than the pre-theft slope, we can conclude that this result is inconsistent with the original hypothesis. Supposing that this particular theft in fact had no impact on the post-theft CAR's, this result could perhaps be used to expand Czujack's (1997) findings of a "death effect" in that average returns were

decreasing relative to his **other works** following his death. Czujack (1997) found that the "death effect" increased auction prices for his works for three years relative to the **art market** using hedonic regression. In this regression analysis, we see a similar result using repeat sales.

4.2 Conclusions: Experiment 2

The results from the regression analyses for two of the three artists of interest, Monet and Pissarro, show evidence of supporting the hypothesis, that an artist's CAR's for their other works will, on average, increase in the five years following a major theft of his or her works. After the Stephen Hahn Gallery theft, both Monet and Pissarro had a higher slope in the linear regression equation for the five post-theft years. This would suggest that demand (and hence returns from repeat sales) from collectors and the art market grew in the five years following the theft. Part 2 of Experiment 1 showed that there was not a significant difference at a confidence level of 95% between the sampled CAR's in the ten years before and after the theft. Recalling the p-values from those t-tests (0.09 for Monet and 0.1 for Pissarro), at a confidence level of 90% the sample groups would have been significantly different thus hinting at the possibility of a "theft effect". By applying a regression analysis for a five year period, pre- and post-theft, we can see that there was a positive increase in the slope of the line of best fit following the thefts and therefore adding to the evidence that a short term "theft effect" of five years does in fact exist.

Table 24 - Summary: Experiment 2

Artist	Pre-theft Slope	Post-theft slope	Difference	Hypothesis
Monet	b= -2.33	b= 0.30	2.63	Accepted
Pissarro	b= -3.31	b= -0.38	2.93	Accepted
Picasso	b= 0.07	b= -1.06	-1.13	Rejected

Regarding the case of the 1976 Picasso theft, we have already discussed how the artist's death is likely a source of bias for finding evidence of a "theft effect". Given the evidence

obtained so far of a five year "theft effect", the results from this particular regression analysis would suggest that a "death effect" is stronger and thus has more influence on CAR's and auction prices compared to a "theft effect". This would make sense since death is a permanent one-time event. Thefts can occur anytime and at any frequency. The theft of an artwork is in itself a type of death since it disappears and the probability of it being recovered is extremely low. The impact of a theft of one artwork relative to an artist's entire oeuvre is just a fraction of the impact of the loss of the creator. Both a famous artist's death and a theft of their work(s) receive a great deal of publicity. Although it is beyond the scope of this paper, a death is probably more widely reported in the media than a theft and would likely have a more lasting impact on the audience.

V. Does Recovered Art Beat the Market?

The previous two experiments were designed to compare prices and returns of other works by the same artist before and after a theft. Although examples are extremely scarce, recovered art does occasionally find its way to auction houses or is purchased through private transactions following its recovery. Several examples below illustrate the reactions of the art market to recovered works. While these examples are not repeat sales, their valuations and estimates prior to and following the thefts were obtained and used to calculate the compound interest between them.

One case involves two paintings by J.M.W . Turner, "Light and Colour" and "Shade and Darkness" which were stolen from Schrin Kunsthalle in Frankfurt, Germany, in 1994. At the time of the theft, the works were valued at £24 million and upon their recovery in 2002 they were then valued at £36 million (Nairne 2011). The annual compound interest rate over this eight year period is a nominal rate of 5.2% (mathisfun.com). The average annual rate of inflation over the same period in the United States was 2.47% (usinflationcalculator.com). From this information, we can derive the real rate of return for the Turner works to be only 2.73% (real rate of return = nominal rate - inflation).

While no existing auction sale record of Munch's "The Scream" could be found prior to its theft in 1994, experts estimated its market value to be at least $70 million (USD) at the time of its theft (Nairne 2011, p. 202). Taking this amount and its record setting auction sale of $120 million (USD) in 2012, the annual compound interest over the 18 year period was a nominal rate of 3.02% (mathisfun.com). The average annual rate of inflation over the same period in the United States remained at 2.47%. This provides a low real rate of return of only 0.58% Given that it is the most expensive painting ever sold at auction, this result is quite surprising. To provide some perspective on how these two works compare to other studies, Ashenfelter and Graddy (2002) compiled a list of estimated returns on art investments from various academic papers.

Table 25 - Return on Art Investments (Compiled by Ashenfelter and Graddy, 2002)

Author	Sample	Method	Nom. Return	Real Return
Anderson (1974)	1780-1960: Art	Hedonic	3.30%	2.60%
	1780-1970: Art	Repeat Sales	3.70%	3.00%
Stein (1977)	1946-1968	Random Sampling	10.50%	
Baumol (1986)	1652-1961: Art	Repeat Sales		0.55%
Frey and Pommerehne (1989)	1635-1949	Repeat Sales		1.40%
	1950-1987	Repeat Sales		1.70%
Buelens and Ginsburgh (1992)	1700-1961	Hedonic		0.91%
Pesando (1993)	1977-1991: Prints	Repeat Sales		1.51%
Goetzmann (1993)	1716-1986: Art	Repeat Sales	3.20%	2.00%
Barre, et al. (1996)	1962-1991: Masters	Hedonic	12%	5%
Barre, et al. (1996)	1962-1991: Other	Hedonic	8%	1%
Chanel, et al. (1996)	1855-1969	Hedonic		4.90%
Chanel, et al. (1996)	1855-1969	Repeat Sales		5%
Mei and Moses (2002)	1875-2000: Art	Repeat Sales		4.90%

It is clear that the annual compound interest return rates (nominal and real) of the Turner paintings and "The Scream" are neither drastically higher or lower than the rates above but fall amongst these other rates. The real rate of return for "The Scream" (0.58%) is only slightly higher than the real rate of return found by Baumol (1986) of 0.55%, the lowest of the real return rates. It is important to note that some of the return rates from the table above cover long term periods and that the art market can experience swings (high and low). These rates also encompass many different genres of art as well as masterpieces and inexpensive works. Mei and Moses (2002) found that masterpieces generally underperform the market. They estimated that every 10% increase in purchase price results in a decrease of future annual returns of 0.1% for American artworks (1941-2000), 0.06% for Impressionist pieces (1941-2000), 0.12% for Old Masters (1900-2000), and 0.1% for all works (1875-2000). Below is a scatter plot and line of best fit for purchase prices and returns for Old Master artworks (Mei & Moses, 2002):

Figure 16

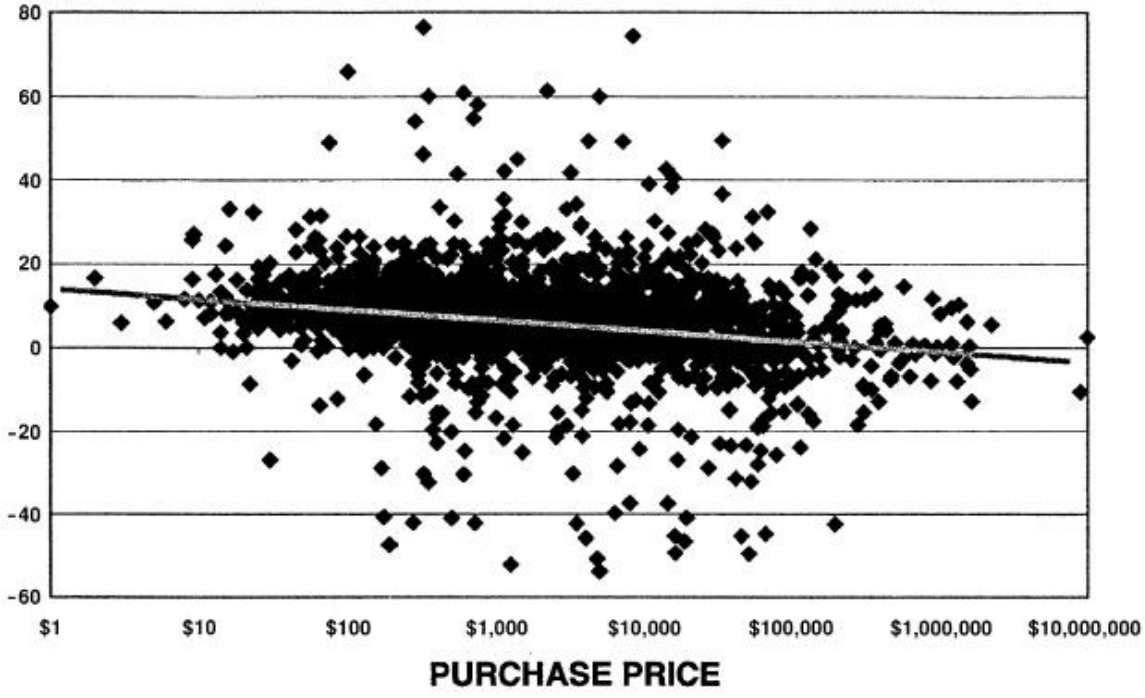


FIGURE 3. OLD MASTER PAINTINGS RESALE RETURNS

Note: The left-hand-side axis is in percentages.

Based on the recovered Turner painting (which fall under the Old Masters category), we can see that their expected nominal rate of return of 5.2% is higher than the average expected return on other Old Master paintings sold for at least $1 million. In fact, the graph above shows that the average rate of return becomes negative around the $1 million mark. "The Scream" is considered to be an abstract expressionist artwork and though Mei and Moses (2002) do not offer any performance measures for this category, based on their other findings we can assume that masterpieces in this category would also underperform the market. Given its positive nominal rate of return of 3.02%, it would likely beat other artworks in a similar price range, albeit since this work set the current auction price record for most expensive work sold at auction, we do cannot justifiably compare it to any other works in the same pricing category. It should also be mentioned that "The Scream" exceeded its estimated auction sale price of $80

million (US) by 50% when it was put to auction in 2012 (Locker 2012). Similarly, Cézanne's recovered work "Bouilloire et Fruits" was expected to sell for $14.6 - $19m (USD) upon its recovery and subsequent auction. It sold for $29.3m, 54% higher than $19m and 100% higher than $14.6m (Le Goff, no date).

Dr. Raichel Le Goff claims that "a painting always sells when there is a 'story' attached to it" (Ibid). The "stories" in these examples provide some evidence that returns on recovered art do perform better than the art market average as well as their auction estimates. However, when compared to financial markets, the Turner paintings and "The Scream" do not fare as well. The table below illustrates this comparison.

Table 26 - CAR's for Turner's and "The Scream" Compared to Financial Market Returns

	Annual Growth Rates				
	Turner's	Scream	DJIA	S&P 500	NASDAQ
Jan. 1, 1994 to Dec. 31, 2002	5.20%	N.A.	9.28%	7.31%	6.21%
(adjusted for inflation: 2.47%)	2.73%	N.A.	6.81%	4.84%	3.74%
Jan. 1, 1994 to Dec. 31, 2012	N.A.	3.02%	6.74%	6.06%	7.59%
(adjusted for inflation: 2.47%)	N.A.	0.58%	4.27%	3.59%	5.12%

(Financial market rates were determined from measuringworth.com)

As we can see, neither the Turner's nor "The Scream" would provide higher annual returns (nominal or real) than the Dow Jones Industrial Average, the S&P 500 or the NASDAQ. Strictly speaking from an investment perspective, these examples suggest that acquiring a recovered work would not be a wise investment given the financial market alternatives. However, what the rate of return on artworks fail to quantitatively measure is the consumption value and utility that they provide to the owner. Although this discussion is beyond the scope of this paper, it is very unlikely that the anonymous bidder who purchased "The Scream" did not do so purely for investment purposes. Rather, he or she purchased an artwork with a tremendous amount of social and prestige value to it as well as an interesting story.

VI. Legal Disputes

Occasionally, when stolen art reappears there is a legal dispute over its ownership. After a work is stolen, it may pass through several different owners from legitimate transactions whereby the origins of the work were unknown to the buyer. In a sense this "washes away" the accountability of the current owner who believed that they acquired the work through good faith. In common law countries like the U.S. and Great Britain, purchasers cannot acquire good title from thieves. The Latin term for this is "Nemo dat quod non habet" (no one can give what they do not have). However in France, Switzerland and Japan, which practice civil law, purchasers are more favoured than owners (Burnham, as cited in Conklin, 1994, pp. 271).

A recent case in Alexandria, Virginia, U.S., involved a good faith buyer who unknowingly purchased a stolen Renoir from a flea market for $7. After the purchaser, Marcia Faqua, had the work authenticated, she opted to sell it at auction only to have the sale postponed when it was discovered that the work was previously stolen from the Baltimore Museum of Art in 1951. An insurance claim of $2,500 was paid by an insurance company shortly after its theft. Currently the museum, the insurance company, and Ms. Faqua are in court proceedings to determine who rightfully owns the painting. The auction house Ms. Faqua planned to use first expected the work to fetch around $75,000. However, an appraiser hired by the FBI valued the work at $22,000 because Renoir's works had recently fallen out of fashion, but more importantly due to questions regarding its ownership and the possibility that it had been stolen (Barakat, 2013). It is justifiable that potential legal disputes would lower the demand (and value) for artworks with controversial origins. No rational person would knowingly purchase potentially stolen goods or willingly become embroiled in court battles. The examples above involving the Turner's, "The Scream" and the Cézanne avoided such disputes because they were returned to their rightful owners. Following their recovery, "The Scream" and the Cézanne drastically exceeded their pre-auction estimates. With legal controversy a non-issue, these works were free to perform accordingly with market demand.

VII. Conclusions

In this paper we have looked at the economic performance of artworks by famous artists following major thefts of their works since the middle of the twentieth century. Compound annual returns on repeat sales and auction records of artworks were employed in statistical analyses in an effort to determine any noticeable "theft effects" over different periods of time (six months, five years, ten years, and all known repeat sales). There are rare occasions when recovered art is sold again and the performance of a few of these cases were compared to previous art market studies as well as financial markets over the same period of time.

The results from the statistical analyses from the two main experiments show evidence of a short term five year "theft effect" whereby average auction prices and compound annual returns for works by the artist rose relative to their sales in the five years prior to the theft. The results from the long term experiments (ten years and longer) were less convincing and only one artist, Peter Paul Rubens, had a negative decrease in the average CAR following the 1966 Dulwich theft which was found to be statistically significant.

Several basic economic concepts inspired the hypotheses for both experiments. Firstly, there is a supply and demand issue regarding art theft. Essentially, theft reduces the supply of artworks by the artist leaving fewer resources available to the market, it should, in theory, cause an increase in demand, especially if the artist is well known and whose works are desirable. This concept would be felt even more prominently in this study since all of the selected artists had died prior to the thefts of their works. Secondly, the media attention which normally ensues following a high profile theft would provide free marketing for the artist to wide audience. This would draw more attention from collectors and the public to the importance and scarcity of the artist's works and potentially increasing the market value of their works.

In performing the data analysis two statistical techniques were employed using SPSS (version 21). The first experiment involved independent samples t-tests on compound annual returns and auction sales of the selected artist before and after a major theft of their works. This technique was chosen over paired-sample t-tests because the artworks in each sample group are different. With the date of the theft being the "line" dividing the two sample groups, significant differences in the means of each could be sought. The second experiment used regression analysis in a similar way to the independent samples t-tests; an analysis was performed for the compound annual returns for artists in the five years before and also after a theft. The differences in the slope of both linear equations provided suggestions of how the market reacted to the theft of the artist's works. The final section of the paper took a few notable examples of recovered artworks and compared the compound annual interest to other studies on art markets as well as financial markets over the same period. This was done to offer perspective on the possible economic and investment performance of recovered art.

Access to accurate data on compound annual returns was limited as a result of Mei, Moses, and their customer service department being unresponsive in requests for data. Because of this, data had to be estimated based on the scatter plot graphs for individual artists that was provided on their website. The Art Loss Register was also contacted however they were unable to provide a detailed list of registered stolen items for certain periods of time. Obtaining detailed data on thefts from law enforcement agencies obviously poses privacy issues as well. Information on private art sales is extremely difficult to acquire and thus auction data was used. In general, sales and other types of art market data are less consistent compared to financial markets where stocks, bonds and other commodities are relatively easy to track and analyze more comprehensibly.

For future research, the sample of art thefts could be expanded to include more incidents. Similarly, different combinations of periods of time could also be explored. An interesting, yet hypothetical, research design would be to match all of the artworks in the MMFAI with the recovered artworks from the Art Loss Register. From this, a clearer picture on

the performance of recovered art could be formed. No data on the frequency of thefts for specific artists was found during the research. Such information would be a useful variable to implement in an analysis. Realistically speaking, for the artists that experienced a "theft effect" as described in this paper, an interesting exercise would be to perform a one-sample t-test on their pre- and post-theft CAR's to the Mei Moses "All Art" Index during the same time periods to provide perspective on how the CAR's experiencing "theft effect" perform in comparison to the art market.

Appendix 1

The Art Loss Register's list of 24 artists with the most registered stolen works - March 1, 2013

Name	ALR Rank	# Works
Picasso, Pablo	1	821
Lawrence, Nick	2	556
Dali, Salvador	3	468
Miro, Joan	4	429
Chagall, Marc	5	328
Levine, David	6	343
Warhol, Andy	7	301
Rijn, Rembrandt van	8	274
Reinicke, Peter	9	252
Nunez del Prado, Marina	10	245
Durer, Albrecht	11	219
Renoir, Pierre Auguste	12	185
Curtis, Edward Sheriff	13	167
Stolnik, Slavko	14	158
Teniers, David II	15	153
Corinth, Lovis	16	145
Rubens, Peter Paul	17	142
Matisse, Henri	18	140
Appel, Karel	19	135
Calder, Alexander	20	131
Barye, Antoine-Louis	21	131
Schiele, Egon	22	127
Daumier, Honore Victorin	23	126
Pesne, Antoine	24	121

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