Efficiency Tests in the Art Market Using Cointegration and the Error Correction Model [†] [‡]

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WORKING PAPER

ABSTRACT

I aim to understand art prices and returns from a market efficiency point of view and we seek to understand whether the art market exhibits predictability or randomness. I tested the weak-form efficiency random walk using ADF and found that most of my time-series data are non-stationary; hence, they all possess randomness. I proceeded and tested my art data using cointegration and the Error Correction Model (ECM) by comparing them to non-risky and risky asset as well as an economic indicator. To be market-efficient, I cannot reject the null hypothesis and accept the alternative hypotheses of cointegrated data. Thus, the results are mixed – art market behaviour can be partly forecasted. I can predict the outcome of art using gold as a benchmark. Bonds are not useful predictors for the art market. Oil & gas as well as the GDP are good predictors of the general art market. The implications of market efficient are mixed. Art can be used as hedge when bundled with bonds. Portfolio diversification seems to be less favourable for the art market. The way to profit is to look at the returns of oil & gas, assuming other people do not possess this information. My study contradicted the academic belief of market efficiency in favour of practitioners. Subjected to scrutiny, my mixed results do not suggest fully abandoning the notion of efficiency in the art market.

Keywords: art investment, efficiency, random walk

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† To my mother.

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CHAPTER 1

INTRODUCTION

The following treatise attempts to answers the question of whether the art market is or is not predictable. If the art market is judged to be unpredictable, we can conclude that the market exhibits market efficiency. If it is judged to be predictable, then it violates the fundamental theory that financial assets such as art allow for abnormal profits and that publicly available information is not fully reflected on the art assets.

Proponents of art market efficiency have surfaced in the past decades. Louargand and McDaniel (1991), Ashenfelter and Graddy (2003) conducted notable studies in the auction market. They claim that the increase in liquidity, better information in art auction catalogues, globalisation, access to financing options, and the increase of participation in the auction markets are among the reasons that the art market has become more efficient than several decades ago, implying unpredictability or randomness (Louargand, McDaniel 1991). They also liken auction houses, which have become a highly organised and sophisticated market, to the stock market. For the secondary art markets however, Candela and Scorcu (2001) confirm the reliance of these markets on auction market data, and assert that auction market represents a good benchmark for the art world. In this case, for secondary market, one needs to look at the auction results to predict the outcome of this market, hence implying inefficiency (Candela, Scorcu 2001). Research conducted by

Ashenfelter and Graddy (2003) reveals that the auctioneers' estimates are extremely accurate and fair predictors of market prices.
The study of the efficient market hypothesis in the art market matters because it can answer the question of whether art is a good hedge against inflation or capital market downturns. The study can also answer whether or not mutual fund managers should include art assets in order to diversify their portfolio, deviating from a typical investment strategy of stocks and bonds. If a broad-based capital market becomes available to aid predictability of the market (that is if art and stocks are cointegrated or inefficient), then a passive manager can create an art index fund that can simply replicate the performance of this capital market. If this ever exists, art fund managers can use this tool to persuade would-be investors to invest in a sure-win-higher-return art market or in a portfolio with art components. Additionally, inefficient art markets only provide abnormal profit opportunities for people who possess this knowledge while less-informed investors lose. Lastly, studying the efficient market hypothesis can pave the way to the myth of academic views of an efficient market contrasting a practitioners' view of an inefficient market.

For these reasons, I investigate the global art market. I aim to understand art prices from a market efficiency point of view. I seek to understand whether the art market exhibits randomness or predictability. Applying the cointegration test popularised by Engle and Granger, I test the weak-form efficiency random walk using the Augmented Dickey-Fuller (ADF), followed by the cointegration or co-trending test for long-term relationship between variables, then finish with a search for an error correction model (ECM), which tracks the short-term forecast of the previous period in relation to its long-term equilibrium.

1.1 Art Market Background

1.1.1 Definition of art

For the purpose of this argument, I define art as a product of human creativity as well as a cultural product worthy of surviving and delivering psychological, sociological, and emotional messages from the past, present, and even centuries into the future. Here I will limit my definition of art to items such as paintings, drawings, modern art, post-war art, contemporary art, prints, sculptures, 19th century art, old masters, and photography. Absent from my definitions are antiques, stamps, porcelains, other collectible items, and other forms of art beyond the scope of this paper.

1.1.2 Reasons for collecting art

Psychological, sociological, and financial factors and motives drive the collection of art (Burton, Jacobsen 1999). Danet and Katriel suggested that psychologically, individuals collect art as a form of personal closure and satisfaction: a completion of a dream, and perhaps perfection (1989 cited Burton, Jacobsen 1999). Belk and Olmsted suggested that sociological factors spur art collecting: artworks could be a medium to achieve entry to upper societal status and to maintain social groups within the elite (1995, 1993 cited Burton, Jacobsen 1999). Finance-focused theories of art collection deal mainly with using art as a medium of investment.

Other motivations for collecting artwork can be traced to the inherent allure of art. Even deceased artists such as Michelangelo, da Vinci, Rodin, Warhol, Adams, and Gauguin maintain followings up to the present time. Art's appeal is universal, transcending across many different cultures, societies, ideologies, and political views. It has the ability to tell stories, express ideas, touch on a people's humanity, and preserve memories of the past. It can motivate non-conformist views, radicalise ideas or introduce new ones, and it can evoke powerful emotions. However, there are others who view the arts as wasteful endeavours worthy of financial cut-down from the public sectors. Whatever reasons for its allure, the proliferation of art remains and the search for an art benchmark continues.

The notions of art acquisitions become blurry when risk and return are added in the decision-making process. Because of the high risks and high prices associated with investment in pieces of art, many individuals and corporations are using these kinds of assets as an alternative investment. In August 2010, proceeds realised in various auction houses by the now-defunct Lehman Brothers were used to repay its mounting debts after its collapse in 2008 (Guardian 2010). Artworks are now becoming a vehicle to invest and diversify portfolios, repay debts, and retain family treasures and history.

Because of arts' importance in social, cultural, and economic life, it is worth researching evidence, if any, of market efficiency in the art market and common characteristics found in most financial assets. The following pages tackle the financial aspect of art investment and looks for evidence of predictability or non-predictability in art in comparison with other financial assets such as stocks, bonds, gold, and an economic indicator.

1.2 The Global Art Market

1.2.1 The Allure of Trend Analysis

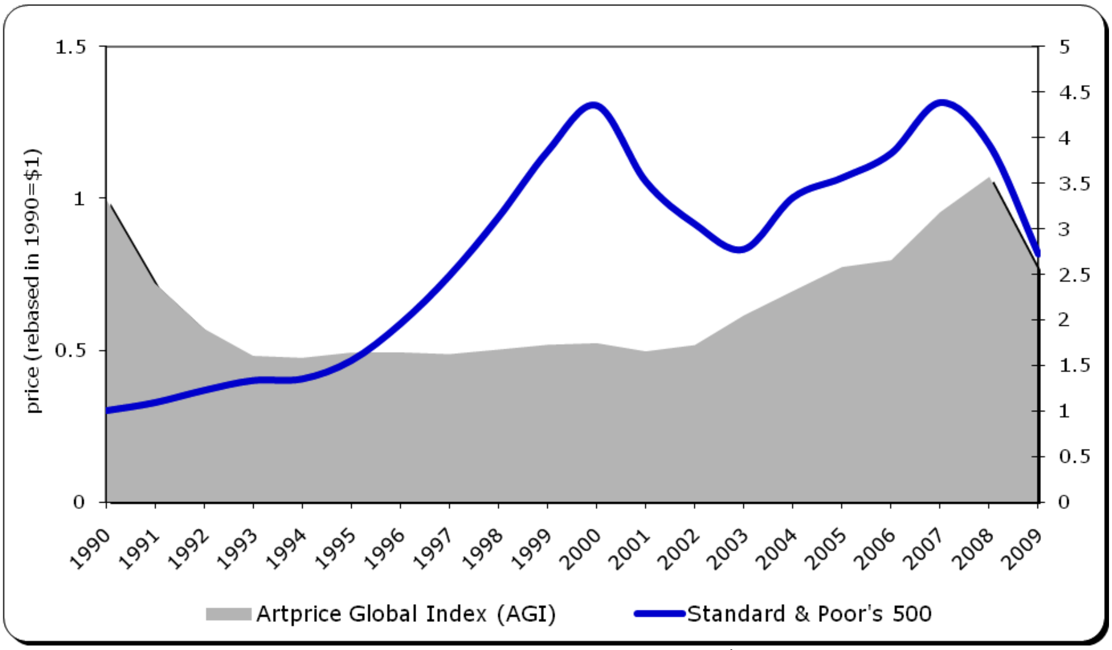

Figure I: Price Levels Rebased to $1 in 1990

The art market is not immune to global distress. Timing of distress varies between the financial market and the AGI. Looking closely at the twenty-year prices from Artprice™ ***(please refer to Figure I)***, the art market experienced its first crash in 1991 losing 39% of its value. This was attributed to the art market's delayed reaction to the 1987 stock market crash and the 1990 worldwide economic recession (Slate Magazine 2008). During this time however, the S&P 500 experienced an 8% growth in their index. The following year, the art index suffered another loses at 26% when compared to the previous year, while the S&P 500 continued its rise at 11%. The AGI went positive for the first time in 1995, when return was at 4% while the S&P grew again at 13%.

During the art boom, prices can skyrocket. In one case, newly-minted billionaires from Russia went into a buying frenzy at major auction houses in London in 2007 (Spear's Wealth Management Survey 2009). The beginning of 2008 saw a massive decline in the index mostly attributed to the art bubble, caused mainly by the Russian oligarchs and wealthy Japanese citizens, who flooded the art market with an unprecedented amount of money (Artprice 2009; Spear's Wealth Management Survey 2009). During boom times - usually when ideas of art investment becomes more mainstream - more people are excited to invest in different forms of art. Scholars such as Goetzmann (1993) and Chanel et al. (1995), found the relationship of the stock market and the art market to be a one-way street; that is, when the stock markets are booming, the art market follows, but never the opposite. Renneboog and Van Houtte (2002) further noted that when wealthy collectors amass monies from the stock market, the demand for art increases.

A good start in my trending analysis is to look at ***Figure I***. My graphical illustration shows both the AGI and S&P 500 are on the opposite ends of the spectrum in terms of prices. If I believe that there exists a reliable benchmark that investors can use in making art investment decisions, the market will never be the same again. Investors will try to beat the market if patterns not already captured by the current prices of art exist. The weak-form hypothesis as described by Bodie et al. (2009), asserts the fact that trend analysis such as the one above is unproductive. Looking at graphs alone, however, is not sufficient to analyse whether variables are cointegrated or possessing random walk characteristics. To get to the root of the matter, formal tests of market efficiency are performed in the preceding sections **(*please refer to Chapter 5 Research Methods and Results*)**.

1.2.2 Art Trading Centres

New York and London are centres for art trading followed by Paris, and to some extent China, which includes the Hong Kong market (Sotheby's 2010). The art market is estimated to be 0.1 percent of the total financial and physical capital of the developed world (Burton, Jacobsen, 1999). Furthermore, The Fine Art Fund Group Limited, a London-based art investment mutual fund company, estimated the market to be around $3 trillion (personal communication, 7 April 2010). In the US alone, the arts sector contributes $5 billion in the economy every year, figures derive mostly from admissions tickets to galleries and theatres (Throsby 1994).

In ***Table I***, Skate Press (2009) estimated the market to be around $2 billion worldwide using a narrow set of publicly traded arts-related companies. On top of the list is Sotheby's, which dominates the segment at 65% with market capitalisation of $1.3 billion. Absent from this list is the privately held Christie's International Plc, a direct competitor of Sotheby's.

Table I: Publicly Traded Art-related companies - Data in USD and as of November 2009

Name	*Listing*	*Share price ($)*	*Market Cap ($ millions)*
Sotheby's	NYSE	18.97	1277
Artprice	Paris	14.53	91
Artnet	Franfurt	6.97	39
Collectors' Universe	NASDAQ	8.82	75
Mallett	London	127.16	18
Finarte Casa d'Aste	Milan	0.28	14
Gruppo FMR	Milan	7.38	26
Camera Work	Frankfurt	6,748.00	270
Art Vivant	Tokyo	2.78	43
Seoul Auctions	Seoul	2.28	38
Shinwa Art Auction	Tokyo	212.58	13
Stanley Gibbons	London	232.02	58
Total			**1962**

Source: Skate Press, November 2009

In terms of market players, auction houses such as Sotheby's and Christie's dominate the market, a market that is controlled and in which art is appraised, prepared, and sold. However, over fifty percent of the arts are sold on the secondary art dealers' market, a market that is uncontrolled and unregulated (The Financial Times 2010). High Net Worth Individuals (HNWI), people with financial resources of more than £5 million, and corporate are collectors cannot be ignored in calculating the overall value of the market. Both have resources to buy and sell and they usually possess the most extensive collections not available for public viewing. Deutsche Bank, a German-based investment bank, owns over 56,000 pieces of art worldwide (Deutsche Bank 2009). Museums, art galleries, private collectors, private wealth management companies, art advisory groups, and art-specific mutual funds complete the list of the market players. Because auction houses are regulated with publicly available sales data, I am limited to the use of their data to analyse the market efficiency of the art market.

CHAPTER 2

STUDY PURPOSE AND ORGANISATION

2.1 Purpose

Few have written about art market efficiency in relationship to other assets such as gold and bonds (as proxies for non-risky assets), oil & gas (as proxy for risky asset), and GDP (as an economic indicator). The fundamental question of this thesis attempts to answer the predictability of the art market. If the art market is not predictable, I can conclude that the market exhibits efficiency. If it is predictable, then it violates the fundamental theory that art assets allow for abnormal profits and that publicly available information is not fully reflected on the assets. Efficiency in this context also means the existence on the randomness of art prices - that is, the price paid for art is driven by supply and demand and not by any other external factors. What is difficult to examine is the artwork's fundamental value or true value, which is beyond the scope of this paper. Rather, I will seek to answer whether or not the market exhibits some form of efficiency, inefficiency, combinations of both, or not at all.

The concept of art market efficiency is important because it can limit speculations, curb excitement over up-and-coming artists, and eliminate risky belief that art investors can beat the market as long as they have the necessary information to analyse the future – a notion that can drive the market to a sudden upswing and eventually to an economic bubble period.

We have seen this occurrence in 2007 when a majority of top-value paintings at Sotheby's and Christie's in London were sold to Russian billionaires at prices remarkably higher than their fundamental value (Spear's Wealth Management Survey 2009). The same bubble phenomenon occurred in the 1990s when Japanese millionaires started selling artwork hit by the real estate bubble at home, which flooded the art market of inexpensive artwork (Hiraki et al. 2009). These events do not prove that the buyers exhibited speculative behaviours or were overexcited with their purchases. External shocks are unavoidable, but overall, an efficient art market can absorb these shocks, and eventually revert it back to its normal state.

2.2 Organisation

This treatise is organised into six chapters. In Chapter 1, I introduce the art market to the reader. Chapter 2 covers the purpose and organisation of the research. In Chapter 3, a survey of existing literatures related to this topic is presented. Chapter 4, data sources were established so the reader can understand where the sources of study originate and understand what they represent in the art arena. In Chapter 5, an econometrics framework, model, and linkages are discussed. Lastly, in Chapter 6, a conclusion and further study are presented.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

The literatures behind market efficiency have been tested mainly in securities market such as debt and equity, foreign exchange, and commodity markets but the literature testing market efficiency in the context of the art market is scarce. According to Keane (1985), for the securities market to be efficient, they must possess characteristics such as homogeneity, taste independence, and location-independence, and must exhibit an information machinery which supports it. In terms of testing efficiency, "tests of the art market predominantly focus on equilibrium asset pricing, underperformance of masterpieces, and the violation of the law of one price" (Erdős, Ormos 2010:1063). Other scholars tested market efficiency in the art market in terms of declining price anomaly in auction markets, survivorship bias, irrational exuberance, mean reversion, and auction houses as price setters.[1]

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[1] Art investment, according to Locatelli-Biey Zanola (2002, p.66) has been studied by the following scholars: "paintings (Anderson, 1974; Stein, 1977; Buelens and Ginsburgh, 1993; de la Barre et al., 1994; Chanel, 1995; Chanel et al., 1996; Mossetto and Lazzaro, 1996; Agnello and Pierce, 1996; Candela and Scorcu, 1997; Renneboog and Van Houtte, 1998; Agnello and Pierce, 1998; Locatelli-Biey and Zanola, 1999b), prints (Pesando, 1993), violins (Ross and Zondervan, 1989), wine (Nerlove, 1995; Combris et al., 1997; (Burton and Jacobsen, 2001), antique furniture (Graeser, 1993), photos (Pompe, 1996) and sculpture (Locatelli-Biey, Zanola 2002)."

3.2 Previous Tests in Art Market Efficiency

3.2.1 Equilibrium Asset Pricing

On eBay.com, a popular internet-based auction website, Bajari and Hortaçsu (2003) empirically demonstrated by using coin auction dataset that waiting for last-minute bidding produces equilibrium. Although the eBay auction format is not the same as the English auction format, a type of auction where the opening amount is announced at the beginning and bidders bid in increasing order (a staple of Sotheby's and Christie's), one thing is certain: the ability to update the proxy bid on eBay before the auction ends attracts last-minute bidders. The behaviour of bidding at the last minute, they added, hides the private valuation of a bidder to other participants, while the opposite is not true for early bidders.

In another study, Pesando (1993) explained equilibrium asset pricing in the context of returns. He claimed that in a well-functioning capital market, the return of art is equal to the equilibrium of similar assets with identical risk minus storage and insurance costs (Pesando 1993). Therefore, in order for the art market to be efficient, investors must not gain excess return on the basis of available information. Furthermore, McAfee and Vincent (1993) described that equilibrium in the art market happens only when auction prices decline due to the existence of risk-averse bidders.[2]

[2] Similar equilibritum findings were recorded by Beggs and Graddy (1997) and Gérard-Varet (1995) in the visual art markets.

3.2.2 Declining Price Anomaly

Beggs and Graddy (1997) empirically studied the final bid price for contemporary, impressionist, and modern arts relative to auctioneer's presale estimate. During the entire auction process, they found that "the price received relative to the estimate for later items in an auction should be less than the price relative to the estimate for earlier items" (Beggs, Graddy 1997:544). The study answers the question of whether auctioneers deliberately place auction items in increasing, decreasing, or mixed order of value. In their study, auctioneers balance the desire of its clienteles, as "some clients don't like objects at the end of the sale or at the very beginning" (Beggs, Graddy 1997:547). Also auctioneers need to create excitement from bidders while maintaining the auctioneers' goal of maximising the final bid prices of items in auction (Beggs, Graddy 1997). Common practice by major auction houses are to order items strictly by values; morning sessions are valued higher than the afternoon sessions, and less valuable artworks are distributed in both auction sessions (Beggs, Graddy 1997). Ordering by value relative to presale estimate produces price decline of approximately 3.5% while "ordering an auction from highest to lowest value is an optimal strategy for an auctioneer" (Beggs, Graddy 1997:562). In different kinds of auctions, price direction is predictable—"declining prices do not occur in every auction or every art auction, but they appear to be an important effect that the auction mechanism has on price" (Ashenfelter, Graddy 2003:783).[3]

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[3] Similar to artworks, declining price anomaly was also documented in real estate - in particular, identical condominium units in the Princeton, New Jersey, USA (Ashenfelter, Genesove 1992), wine auctions with identical lots (McAfee, Vincent 1993) (Ashenfelter 1989), rose flower auctions (Berg, Ours & Pradhan 2001), and cattle auctions (Engelbrecht-Wiggans, Kahn 1999).

3.2.3 Underperformance of Masterpieces

Test for efficiency, in most art investment literature, involve testing the underperformance of masterpieces. Masterpieces are considered to be the most outstanding, expensive, and exquisite artworks of a creative artist or crafts man (WordNet Princeton University 2010). Year after year, various auction houses report record prices for masterpieces, creating widespread belief from the investing public that its returns are higher than the average (Frey, Pommerehne 1989). If the art market is efficient, masterpieces can not be less susceptible to market downturns compared to other assets; this also means that masterpieces can not have higher-than-expected returns for a given period of risk than lower-priced and lower-valued artists (Pesando 1993). In the sculpture market, using over 27,000 auction samples between 1987 and 1995, Locatelli-Biey and Zanola (2002) found that expensive portfolio of sculptures performed better compared to the inexpensive portfolio in the period she studied. Furthermore, when she controlled for independent variables using hedonic regression to control for production (i.e. old, modern, and contemporary), country of birth, type of media used (i.e. marble, bronze, and ivory), multiplicity (unique having less than nine copies produced), dimension, shape, and period, it appears that Italian sculptures - the benchmark in this study - command a 35% higher premium compared to the German, 33% to the French, and 25% for both English and American sculptures (Locatelli-Biey, Zanola 2002). In terms of media, marble commands a 13% higher premium compared to the benchmark bronze (Locatelli-Biey, Zanola 2002). Sculptures with fewer multiple copies command higher premium due to supply and demand and uniqueness of the item. Lastly, larger sculptures command 42% higher premium than smaller sculptures (Locatelli-Biey, Zanola 2002).

Scholars Mei and Moses (2002) tested the proposition of art investors gaining substantial return from the best artworks by well-established artists. According to Mei and Moses (2002, p.1663), “a common advice given to their clients by art dealers is to buy the best artworks they can afford.” However, their study produced the opposite conclusion, whereby a 10 percent increase in purchase price for American artworks lower future annual returns by 0.1 percent. Both scholars suggested that investors should avoid buying expensive artworks as masterpieces tend to under-perform at auctions. They argue that the concept of “underperformance of masterpieces is similar to the small firm effect documented by Chan and Chen… where small firms with lower market capitalization tend to achieve excess returns not justified by their risk based on single factor market models” (1998 cited Mei, Moses 2002:1664).

Supporting Mei and Moses findings, Pesando (1993) tested the market for modern prints (only the top 10% and 20% of its class) of the likes of Picasso and Chagall—artists generally classified to have produced quality artwork, in mostly good saleable condition and of uniform quality. There is difficulty in tracking price changes for artworks over time. For prints, however, they are “often published in editions of 50-100 or more, several impressions of the same print may be offered for sale at auction in a single season” (Pesando 1993:1070), resulting in a large repeat sales sample. Using repeat sales regression of identical prints, Pesando (1993) estimated a semi-annual index between 1977 and 1992, he found that his constructed portfolio only returned 1.51 percent, lower than the annual rate of returns of US stocks or long-term bonds.

3.2.4 Survivorship and Selection Biases

Survivorship and selection bias in the art market is well documented. Auction houses, in particular, are selective on the works they sell in auction and minor works with no potential for sale are not accepted (Goetzmann 1996). Moreover, less expensive and less in-demand artworks usually drop out of the auction (Ashenfelter, Graddy 2003); hence, publicly available art indices such as Artprice™ do not sufficiently represent the general art market because only the best artworks make it to their samples. Due to survivorship and selection biases, calculated returns result in an upward trend (Renneboog, Spaenjers 2010), which can affect my test of market efficiency in relation to other financial assets. They explained that for the most part, new artists will suffer from this exclusion.

3.2.5 Irrational Exuberance

The appreciation of masterpieces can be compared to buyers' behaviour most commonly referred to as "irrational exuberance," where prices paid exceed that of the fundamental value of the artworks, pushing art prices to the highest level (Pesando, Shum 2007). In Velthuis (2005) book titled *Talking Prices*, buyers of artworks tend to interpret price as an indicator of artistic value. In the stock market, even without evidence, buyers assume that the most expensive stocks are the best stocks to buy (Shiller 2005). When information is not readily available, "investors, their confidence and expectations buoyed by past price increases, bid up stock prices further, thereby enticing more investors to do the same, so that the cycle repeats again and again, resulting in an amplified response to the original precipitating factors" (Wilson-Anastasios 2009:10). The book Londongrad by Mark Hollingsworth and Stewart Lansley described how Russian billionaires conquered the London art market at the peak of the art market in 1997, driving the art market into a buying frenzy (Spear's Wealth Management Survey, 2009).

Behaviourists contend that investors do not process information correctly and that most of them are irrational decision makers: even when information is at their fingertips, they still make imperfect decisions (Bodie, Kane & Marcus 2009). Therefore, proponents of market efficiency may contend that when irrational and rational art investors are put together in the market, the market suddenly becomes efficient. This concept raises more questions than answers because it assumes the existence of 50/50 irrational and rational thinkers in the market.

3.2.6 Mean Reversion

Study conducted by Mei and Moses found similar mean reversion effect in the art market, particularly for masterpieces, the same phenomenon Fama and French (1988), Poterba and Summers (1988), and Bondt and Thaler (1985) studied for stock prices. Art that outperformed the market previously, such as expensive masterpieces, tend to underperform in the future while the reverse is true for underperforming artworks having reversing or positive performance in the future (Mei, Moses 2002). To further illustrate, Bondt and Thaler (1985) created portfolios of winners and losers and found the losing stocks have earned 25% after 36 months—hence, "portfolios of prior "losers" are found to outperform prior "winners."

3.2.7 Law of One Price

According to Pesando and Shum (2007, p.267), "the law of one price dictates that no significant price differences persists, in the absence of regulatory or other barriers that may make it costly for buyers or sellers to exploit price differences—hence, no price differences should exist for prints sold at different auction houses, especially if the auction houses are in the same geographic market." Violation of the law of one price persisted for modern prints during the period 1977-1992 at Sotheby's and Christie's, in the same geographic location of New York City—the former commanding 14% higher premium than the latter (Pesando 1993). Contrary to Pesando and Shum, Mei and Moses (2002) found no violation in the law of one price in New York for the 1900-2000 sample period—there is a fraction of a difference between prices realised at Christie's and Sotheby's for American and impressionist paintings, but they claimed that Old Masters at Sotheby's commanded higher prices than when sold at Christie's. These price differences may be due to the size of the auction house—Sotheby's in New York tend to attract a larger audience of out-of-towners, mostly foreigners, who bid aggressively compared to Americans (Pesando 1993).

In terms of transatlantic differences, similar findings in the violation of the law of one price were recorded for German expressionist prints, which were sold 14 percent higher than the average price in the United States than in Germany (Pesando 1993). In all of Pesando and Shum's studies, New York sales taxes were ignored as well as import duties like VAT. Ignored in Pesando's analysis is the "Droit de Suite," an addition to the copyright laws of France, Germany, and Italy. Droite de Suite or art proceeds right is "a technique originally designed to furnish artists and sculptors with some portion of the increase in the value of their works when they are resold" (Price 1968:1333). Because of the exclusion of taxes and other fees associated with the purchase and acquisition of artworks, comparisons between auction houses within regional and transatlantic locations can be misleading to researchers.[4]

3.2.8 Auction Houses As Price Setters

Common misconceptions can trigger confusion in even the most seasoned participants—unfamiliarity with the terminologies and the way in which the system works can trigger frenzy, reading misleading cues and data, and misassumptions of a cheap buy, among others. Empirical studies show that auction houses can influence prices and buyer's behaviour (Wilson-Anastasios 2009). People rely on auction results as indicator for the value of art (Mei, Moses 2002). Stiglitz further noted that "price serves a function in addition to that usually ascribed to it in economic theory: it conveys information and affects behaviour" (1987 cited Wilson-Anastasios 2009:9). It is important to note the importance of competitive bidding—in essence setting the price/valuation for artworks, which is then used by buyers as guide for their own valuation or appraisal. In a perfectly competitive market, according to Wilson (1977, p.517), "the sale price converges almost surely to the "true value" as the number of bidders increase." For auctioneers, "they perform a filtration function for many buyers" (Wilson-Anastasios 2009:17); only the best artworks tend to get accepted in auction houses as these institutions rely mostly on commissions. Auction houses have the authority to affect buyers' behaviours and establish prices: "the auction institution itself, with commissions, experts, pre-sale estimates, reserve prices, and sequential

[4] A similar finding on the violation of the law of one price was also documented in wine auctions market (Ashenfelter 1989).

sales, can have a profound influence on the price of art” (Ashenfelter, Graddy 2003:776).

CHAPTER 4

DATA

4.1 Introduction

I use the Artprice^{TM} Global Index (AGI). The index covers the period July 1990 (the period when the index first started at base price of $100) to December 2009. Artprice^{TM} is a France-based company currently trading on Paris Euronext under the ticker PRC. They own one of the largest databases of fine art and catalogue auctions in the world. They provide price levels on drawings, paintings, photographs, prints, sculptures, and watercolours. Absent from the AGI index are data for antiques and furniture. Artprice^{TM} indices used in my analysis are constructed using repeat sales regression (RSR).

Hedonic price regression (HPR) typically tracks individual artists (e.g. Rembrandt), which are not covered on this paper. Artprice^{TM} data are drawn from over 3,600 auctioneers covering almost 5.4 million auction results (Artprice 2009).

The company also provides sub-indices for paintings, prints, sculptures, photographies, drawings, Old Masters, 19th Century, modern art, post-war, and contemporary art. The logarithm of the painting sub-index is highly correlated with the logarithm of the AGI at 99.20% (***please refer to Table II for results***). Other sub-indices also have high correlations with the art market (in descending order): drawings and modern art both 98%, post war art at 97%, contemporary art at 96%, and prints and sculptures both at 92%. 19th Century art is correlated at above the 80% mark while Old Masters and photographs have correlation with the AGI at above 70% mark. It is not surprising based on the correlation table that paintings drive the general market followed by drawings, modern, post war, and contemporary arts. Paintings, according to Erdős and Ormos (2010), have the highest market share and they tend to command higher prices compared to other forms of art. The company also provides regional sub-indices for the USA, UK, and France art markets. The logarithm of the USA Art Index is highly correlated to the AGI at 82% followed by the UK Art Index at 79%, and lastly by the France Art Index 70% (***please refer to Table II for results***). It is not surprising that the results highlighted the US domination in the art market followed by the UK and France - three countries where the auction markets flourish. Therefore, the use of AGI suffices to analyse the general nature of art market's predictability in relation to other assets.

Table II: CORRELATION of Artprice ™

AGI and other art categories	*Correlation*
Paintings	99%
Drawings	98%
Modern Art	98%
Post War Art	97%
Contemporary Art	96%
Prints	92%
Sculptures	92%
19th Century Art	89%
Old Masters	78%
Photographies	73%
AGI and regional subindices	*Correlation*
USA Artprice ™ Index	82%
UK Artprice ™ Index	79%
France Artprice ™ Index	70%

Note 1: All prices are logged.

Note 2: AGI = Arprice ™ Global Index

4.2 Potential Bias and Data Limitations

Artprice^{TM} publishes their art indices on a quarterly basis. Therefore, it is difficult to test the true nature of randomness of data when the data itself is scarce or limited. As previously discussed, one characteristic of an efficient market is the elaborate information support that feeds the market. Also Artprice^{TM} only started in July 1990; they have only been tracking the art market movements in the past 20 years. In statistics, data size matters. Artprice^{TM} also suffers from its limited scope as it only tracks auction-related art prices from around the world. Auction prices are a narrow representation of the market. Majority of arts sold does not even reach the radar of auction houses, which tend to sell mostly blockbusters. The data also suffers from a form of selection bias, in which the outcomes observed have been pre-selected by the auctioneers in favour of sure winners. After all, auction houses are in the business of making profit; therefore, a sure winner guarantees a jump in their overall revenues. Absent from my data are sales derived from secondary markets, underground activities, and other sales not tracked by Artprice^{TM}. There is also the issue of survivorship biased as discussed by Ashenfelter and Graddy (2003) and Goetzmann (1996) where only the best artworks are included in the index.

Further bias of Artprice^{TM} is the exclusion of transaction costs, which are very important deal breakers in art acquisitions. Transaction costs include auction fees, sales commissions, storage fees, direct and indirect taxes increase (VAT), and overall increase the costs of art acquisitions (Renneboog, Van Houtte 2002).

4.3 Repeat Sales Regression (RSR) vs. Hedonic Price Regression (HPR)

For collectible items such as artworks, two common methods of index creations are usually employed namely: Repeat Sales Regression (RSR) and Hedonic Price Regression (HPR). HPR is used to regress the independent variable on art's various characteristics (i.e. dimension, techniques, signature, age, material, etc.). On the other hand, RSR pools data from repeat sales, a method common to the art and real estate markets. The art index is constructed using RSR.

RSR and HPR, both methods used by Artprice™, suffer from sample selection biases. Ashenfelter et al. (2003) criticized the various indices created by scholars—most indices returning positive and there seems to be an inability for scholars to measure non-quantifiable values such as aesthetics. Using HPR, Barre et al. (1994) found most auction houses performed well since 1980—attributed mostly to avoiding selling minor painters to concentrate mostly on sure winners. Using RSR, Beggs and Graddy (2008) found unsold auction items to sell less than their predicted value the second time they return to the market.

When the two indices are compared, RSR tend to be more biased compared to HPR. Observations derived from RSR are small—it takes years to observe repeat sales. Similarly, art indices are heavily focused on American and European locations leaving other regions without representation (Hodgson, Vorkink 2004). The two regressions tend to capture largely the high-end portion of the art market. This is likely true as auction houses obtain their revenue from commissions. Depending on the type of data available, Ginsburgh et al. (2006) laid out specifics and the pros and cons of using one method over the other. Regardless of which type of regressions to use, both methods suffer from data selection bias. RSR and HPR are fully explained in ***Appendices I and II***.

4.4 Benchmark Data

4.4.1 Proxy for Non-risky Assets

I have chosen gold and USA 3-month Treasury Bills as proxy for my analysis. The choice of Treasury Bills is obvious. A majority of investors largely view it as the least risky compared to other existing assets. It is Government-backed and few countries have suffered bankruptcy in history. It is also the most liquid asset after cash.

Gold, on the other hand, is a type of precious metal. Throughout history, gold has been used as means for monetary exchange. At some point, gold was the standard in which the total money issued to the public represented some reserve of gold by one government. Study conducted by Chua and Woodward (1982) found gold as effective hedge against inflation particularly for investors in the US.

4.4.2 Proxy for Risky Asset

For risky assets, I chose oil & gas - chosen because of its effect on global prices. The previous movements of the prices of oil & gas have directly impacted the livelihood of people - in particular, transportation usage and heating.

4.4.3 Proxy for an Economic Factor

I chose the USA GDP (Gross Domestic Product) as proxy for the world's economy. As of 2009, the largest economy in terms of GDP is the United States at $14.3 trillion and followed by Japan at $5.1 trillion.[5] Most economists use data derived from the GDP as good measurement of the health of the economy.

[5] World Bank at www.worldbank.org.

CHAPTER 5

RESEARCH METHODS AND RESULTS

5.1 Introduction

This paper takes testing the art market efficiency further by comparing it with other assets most commonly traded in the financial market and an economic indicator. I will sub-divide the testing into three main categories, namely: the art market versus non-risky assets, the art market versus risky asset, and the art market versus an economic indicator. The results answer market efficiency in a global context using the Artprice^{TM} Global Index (AGI).

The first test can be performed using the weak-form efficiency or the random walk test using the Augmented Dickey-Fuller (ADF) test. For the art market to exhibit randomness, I cannot reject that Artprice^{TM} art indices are non-stationary. In this case, I cannot reject the null hypothesis H_0 of random walk behaviours. The second test seeks to find cointegration amongst different asset classes and see how art follows certain trends and directions. To be market efficient, I cannot reject the null hypothesis and accept the alternative hypotheses of cointegrated data. Finally, I test to determine an Error Correction Model (ECM), which determines the short-run relationships or forecasts between a pair of variables.

I begin the art market efficiency test using a test for cointegration. In simple terms, cointegration in econometrics refers to two or more time-series variables having common stochastic trend – which implies reciprocal influence of one variable to the other in the long term (Brooks 2008). This is an important test, as it reveals whether the art market shares the same behavioural pattern when compared to other assets or areas of concern. The cointegration test has become a standard for testing linear rational expectations such as modelling of stock prices (Timmermann 1995). As previously studied by Okunev et al. (2000, p.254), "the presence of cointegration is important in as much as it will ensure that any significant evidence of Granger causality between the markets is not spurious and short term in nature, as would be the case if no cointegration is noted." According to Brooks (2008, p.343), "if the markets are frictionless and functioning efficiently, a financial asset is expected to be contemporaneously correlated and not to be cross-autocorrelated." To illustrate further, according to Koop (2006, p.168), the idea behind cointegration is that "if two assets are close substitutes for one another, then their prices should not drift too far apart."

According to Stock and Watson (1988, p.1097), "an economic or physical theory might predict that the variables contain common trends, and a test for these trends would be a test of this implication of the theory." Therefore, if cointegration between two variables is rejected (e.g. AGI and gold), I assume that the art market follows a random walk (weak-form efficiency test), inferring an efficient market.[6]

[6] The most common methods for testing for cointegration when data is non-stationary are the Johansen test (Johansen 1988), the Engle-Granger test (Engle, Granger 1991), and the Engle-Yoo test (Engle, Yoo 1987). Alternately, the Phillips-Ouliaris Cointegration Test (Phillips, Ouliaris 1990) and Stock and Watson's tests for common trends (Stock, Watson 1988) can also be used.

For the purpose of this study, demonstration will be limited to the Engle-Granger Test. The Engle-Granger cointegration approach is a good choice when compared to a pair of time-series such as an art market and another index such as gold. This method also allows us to easily compare the long-run components of a pair of time-series and eventually I can discuss some form of equilibrium between the two using the ECM.

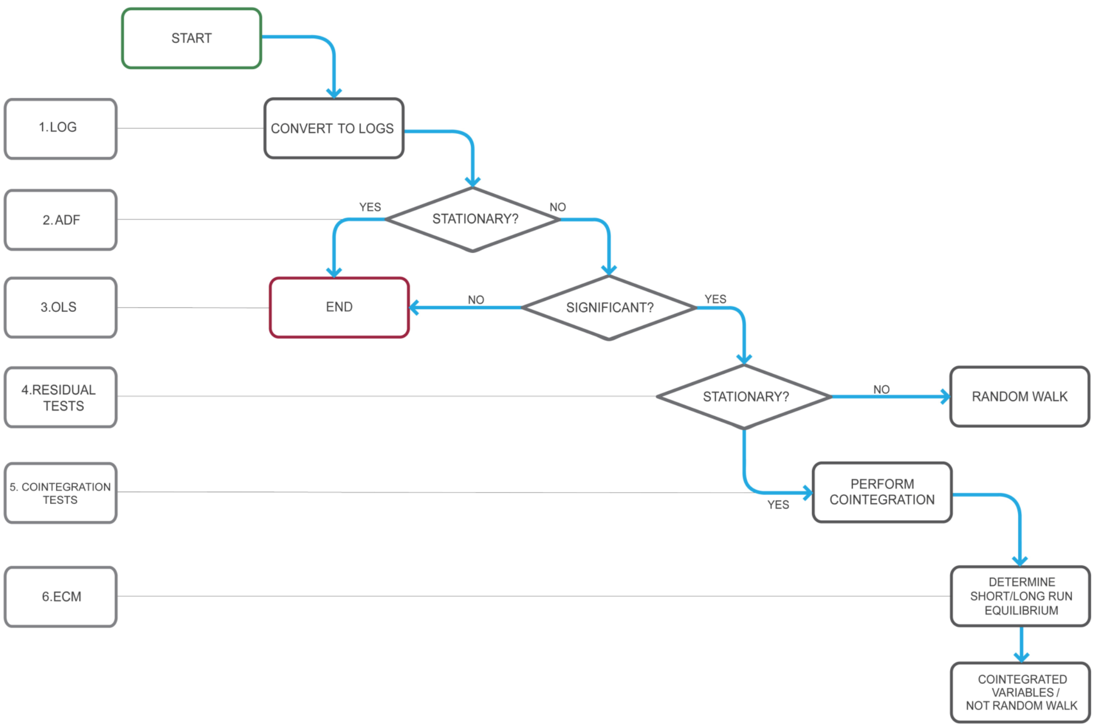

Figure II: Test of Market Efficiency Using Cointegration and ECM

The figure above shows a flowchart of expectations in enabling testing for cointegrated or non-cointegrated variables.

Steps to a successful cointegration tests are as follows:

Step 1: Converts all prices into returns using the logarithm function.

Step 2: Tests for ADF or the RW Testing; asks questions about whether the test reveals non-stationary variables using the 95% rejection criteria.
Step 3: Runs the OLS and asks questions to determine if independent variable X is statistically significant.
Step 4: Tests residuals: stationary or non-stationary?
Step 5: Perform cointegration if residuals are stationary.
Step 6: Determine an Error Correction Model.

5.2 Data Transformation

Before proceeding to the actual tests, I must transform my variables into its respective logarithm values ***(please refer to Figure II, Step 1)***. ***Appendix III*** shows how to transform prices into log returns.

5.3 Random Walk (RW) Test Using the Augmented Dickey-Fuller (ADF) Method – a weak-form efficiency approach

5.3.1 Introduction

Many time series variables exhibit trend behaviour and they are relevant to the study of market efficiency. According to Fama (1970), to be efficient, an asset should follow a random walk. In this case, the direction and prices of art should not be predictable. Investors must not profit from information already available. The most common test for market efficiency is the random walk test or the ADF test (sometimes called unit root test). I seek to find randomness (this case, in the art market) by indirectly testing the presence of random walk using heteroskedasticity (Malpezzi 1999). The use of the extended or augmented version of the Dickey-Fuller test is to include lags intended to clean up serial correlation.[7]

(Please refer to 1.2.1 The Allure of Trend Analysis). Looking at historical graphs alone is not sufficient. It is essential to determine and compare whether the art market and other assets I am using exhibit randomness, are non-stationary, or have a unit root. In statistical jargon, this means that the variable exhibits trend behaviours, long memory, and even cyclicality, with its joint probability distribution dependent on the time.

Let us formally introduce the RW test using ADF. The null and alternative hypotheses under the ADF are as follows ***(please refer to Figure II, step 2)***:

$$H_0 : \rho = 1 \approx I(1)$$

$$H_1 : \rho < 1 \approx I(0)$$

Where:

$$\theta = \rho - 1$$

$$\Delta Y_t = \alpha + \theta Y_{t-1} + \varepsilon_t$$

An $I(1)$ series contains one unit root and is non-stationary, which can be interpreted as a random walk series. Non-stationary series is the first requirement to proceed to cointegration testing. To carry out the test at the 5% significance level for unit root *t-test* with no time trend, I reject if

[7] Refer to Introductory Economitrics, A Modern Approach by J. Wooldridge (2009)

$t_\theta < -2.86$ (Banerjee et al. 1993). When p-values are given, I can ignore the t-statistics table. For example, if p-value is greater than 5%, I fail to reject a unit root – the test means my test data does not provide strong evidence against H_0 (e.g. AGI and gold). To proceed to cointegration tests, I cannot reject the random walk null hypothesis H_0.[8]

5.3.2 RW Test Results

(Please refer to Table III). The unit root tests are not able to reject $I(1)$ non-stationary data for the AGI, that is p-value > 5%, which implies randomness in my data as explained earlier. Likewise for non-risky assets $I(1)$ non-stationary cannot be rejected for gold and US 3-month Treasury Bills. Oil & gas and the USA GDP are non-stationary.

Table III RANDOM WALK OR UNIT ROOT TESTS

Adjusted Dickey-Fuller (ADF)	*5% critical value*	*t-stat*	*p-values*
Artprice™			
AGI	-2.8996	-1.8979	0.3317
Non-risky assets			
Gold	-2.8996	1.5386	0.9993
US tbills	-2.9012	-2.7823	0.0657
Risky asset			
Oil and gas	-2.8996	-1.4506	0.5532
Economy			
US GDP	-2.9012	-1.8179	0.3692

Legend:
All logged variables
~~Strikethrough~~ are stationary variables

[8] The test type we used is ADF at level test for unit root – intercept included – and using Schwarz Info Criterion lag length automatic selection with maximum lags of eleven.

In my random walk test demonstrations, I ignored transaction costs and other relative costs associated with the art market and other share prices. As noted by Goetzmann (1993, p.25), random walk "is valid only to the extent that profitable timing strategies are allowed by transactions costs, and if superior returns may be obtained on alternative investments." Furthermore, the weak-form approach is not sufficient as test for predictability of the art market. As observed by Kwiatkowski et al. (1992, p.159), "standard unit root tests fail to reject the null hypothesis of a unit root for many economic time series. That is, most economic time series, including the art indices, possess randomness or unpredictability. However, as observed by Summers (1986), we cannot ignore the low power of ADF in predicting randomness (Summers 1986). The end result is the difficulty of rejecting a false random walk by using ADF approach (Erdős, Ormos 2010).[9]

Therefore, I must proceed to testing for cointegration to test for predictability of the art index (instead of the stand-alone RW tests) by comparing this to other benchmarks or assets. Note that non-stationary $I(1)$ data is required before cointegration test can be performed.

5.4 Run an OLS of the Logarithm of Y on X

Given the linear equation ***(please refer to Figure II, step 3)***,

$$Y = \alpha + \beta X$$

[9] The random walk test can also be tested using the variance ratio test as described by Poterba and Summers (1988) and Erdős and Ormos (2010).

Where Y and X are the dependent and independent variables respectively and α and β are the constant term and coefficient of regression. The independent variable (also called explanatory variable) must be statistically significant at the 95% critical level, that is, it's p-values must be less than 5% to accept statistically significant variable ***(please refer to Figure II, step 3)***.

If OLS determines a statistically significant variable, the residuals of the OLS regression must be saved.

OLS results are captured on ***Section 5.8 Results on Cointegration and ECM Tests***.

5.5 Perform ADF Test on Residuals

The Engle-Granger method uses the Adjusted Dickey-Fuller (ADF) to test whether the residuals of the dependent variable (e.g. $Y=AGI$) and independent variable (eg. $X=gold$) have unit roots or are stationary ***(please refer to Figure II, step 4)***. If their residuals are stationary $I(0)$, both have a cointegrating relationship, which implies inefficiency or predictability. As Koop (2006, p.153) noted, "if you add two things with a certain property together the result generally tends to have that property."

The results from the OLS **(*from Section 5.4)*** produce residuals where I can test for pair-wise stationary variables.

5.5.1 Residuals Test Results

Table IV: RESULTS OF RESIDUALS TESTS

Residuals test using ADF	*t-stat*	*p-value*
Non-risky assets		
AGI on Gold	-3.0622	0.0026
AGI on US bonds*	-2.3432	0.0194
Gold on AGI	-1.4315	0.1409
US bonds on AGI	NA	NA
Risky asset		
AGI on Oil & Gas	-5.6208	0.0000
Oil & Gas on AGI	-5.2527	0.0000
Economy		
AGI on USA GDP*	-3.2270	0.0016
USA GDP on AGI	-3.5496	0.0006

Test critical @ 5% level = -1.9451

Legend:

** US bonds used as proxy for the world's bonds market*

(Please refer to Table IV). When AGI is regressed on gold, the pair is cointegrated. That is, there is a cointegrating relationship between the price of AGI and the price of gold. Therefore, I reject the null hypothesis H_0 of non-stationary residuals. However, the reverse is not true. When gold is regressed on AGI, their residuals are not stationary (p-value > 5% ~ 0.1409). AGI and US bonds data are co-trending while the reverse cannot be tested because of the lack of significance of the influence of AGI on US bonds (***complete OLS results in Section 5.6***).

Oil & gas does not wander off in opposite direction with the AGI for very long; therefore, the pair is cointegrated. The reverse is also cointegrated when oil & gas becomes the dependent variable.

When AGI is regressed on GDP (or the reverse), both pairs are cointegrated. When the world's biggest economy is healthy, we can infer that people tend to buy artworks (the reverse statement is also true).

5.6 Engle-Granger Cointegration Test, a Residuals-based Approach

Below is the Engle-Granger method of parameter estimation in cointegrated systems, ***(please refer to Figure II, step 5)***, as described in Brooks' (2008) *Introductory Econometrics for Finance*:

The null and alternative hypotheses under cointegration are as follows:

$$H_0 : \hat{\varepsilon}_t \approx I(1)$$

$$H_1 : \hat{\varepsilon}_t \approx I(0)$$

Under the null hypothesis, the regression residuals have a unit root, $I(1)$, which implies non-stationary residuals. While under the alternate hypothesis, the residuals are stationary, $I(0)$. Therefore, for the art market to be market-efficient, I cannot reject the null hypothesis and accept the alternative hypotheses of cointegrated data.

The cointegration goal is to test to have Y and X both non-stationary, notation $I(1)$, and the residuals, ε , stationary, notation $I(0)$.[10] The logic here is simple: when two variables are non-stationary, it makes sense to assume that its residuals are also non-stationary. If residuals are stationary, the series of non-stationary $I(1)$ cancels out to produce a stationary $I(0)$ error. Moreover, the spurious regression problem vanishes when the residuals of non-stationary variables are stationary, $I(0)$. If residuals are stationary, both variables are said to be cointegrated, which implies trending behaviour and inefficiency. Please refer to ***Section 5.8*** for results and analysis.

5.7 Error Correction Model (ECM)

As mentioned above, cointegration tests give out the long-run relationship between variables. ECM on the other hand concerns the short-term relationship ***(please refer to Figure II, step 6)***. That is, I attempt to find other assets, which can aid us in forecasting the direction of changes in the art market.

The Granger Representation Theorem or Granger Causality Test states that if Y and X are cointegrated, I can further estimate the short-run relationship between variables using the error correction models (ECM) or sometimes called the equilibrium correction model.

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[10] Note that if one variable is stationary and the other is non-stationary, the regression is spurious, a regression that is plausible but misleading or false. Likewise, if both variables and its residuals are non-stationary, the regression is also spurious.

In simplest term, the ECM for cointegrated variables can be estimated:

$$D(\mathrm{Y}) = \varphi + \lambda e(-1) + \omega_1 D\mathrm{Y}(-1) + \omega_2 D\mathrm{X}(-1) + \mu_t$$

where:

$D(\mathrm{Y})$ is the difference of the dependent variable.

$\lambda < 0$ and is the ECM coefficient, which describes the speed of adjustment back to equilibrium.

$e(-1)$ is the lag of the long-run equilibrium model with λ as its coefficient.

$D\mathrm{Y}(-1)$ is the lag of the difference of Y.

$D\mathrm{X}(-1)$ is the lag of the difference of X.

ω_1 and ω_2 coefficients of the short-run relationship.

μ_t is the error from the regression model with Y and X.

5.8 Results on Cointegration and ECM Tests

From ***Section 5.4***, the OLS output becomes my estimated potentially cointegrating equation. In this section, I advance my discussion of the linear relationships between Y and X, when residuals are stationary ***(please refer to Section 5.5 for residuals tests results)***. Cointegration implies that I do not need to worry about misleading regression results. I can use the OLS results to interpret my long run multiplier and use ECM to find the short-term relationship between variables.

5.8.1 Cointegration and ECM Test Results for Non-Risky Assets

Table V: COINTEGRATION AND ECM TEST RESULTS FOR NON-RISKY ASSETS

Regression Equation ✪		*Coefficient*	*t-stat*	*p-value*
AGI on Gold	α	0.7733	1.4608	0.1482
	β	0.5572	6.2329	0.0000
AGI on US bonds*	α	4.1959	81.0117	0.0000
	β	-0.0709	-2.0356	0.0453
Gold on AGI	α	1.7944	2.2709	0.0260
	β	1.0222	5.1924	0.0000
US bonds on AGI	α	4.6226	1.8226	0.0723
	β	-0.8576	-1.3300	0.1875

ECM ✜		*Coefficient*	*t-stat*	*p-value*
AGI on Gold	intercept	-0.0091	-0.9086	0.3666
	ε(-1)	-0.1378	-1.8432	0.0694
	DY(-1)	-0.1320	-1.1287	0.2628
	DX(-1)	0.3318	2.2268	0.0291
AGI on US bonds*	intercept	-0.0021	-0.2036	0.8392
	ε(-1)	-0.0597	-1.0428	0.3005
	DY(-1)	-0.1788	-1.9550	0.0545
	DX(-1)	0.0581	2.6900	0.0089
Gold on AGI	intercept	NA	NA	NA
	ε(-1)	NA	NA	NA
	DY(-1)	NA	NA	NA
	DX(-1)	NA	NA	NA
US bonds on AGI	intercept	NA	NA	NA
	ε(-1)	NA	NA	NA
	DY(-1)	NA	NA	NA
	DX(-1)	NA	NA	NA

Legend:

✪ *Regression equations:* $Y = \alpha + \beta X$ *and* $X = \alpha + \beta Y$

✜ *ECM equation:* $D(Y) = \alpha + \lambda\varepsilon(-1) + \omega_1 DY(-1) + \omega_2 DX(-1) + \mu$

** US bonds used as proxy for the world's bonds market*

5.8.1.1 The Art Market Perspective for Non-Risky Assets

(Please refer to Table V). I begin my analysis with the influence of the returns of gold to the AGI. A 1% increase in gold's returns can trigger a 0.55% increase in the AGI returns. In contrast, when US bonds increases by 1%, the returns on AGI decreases by 0.07%. Since linear regression can be thought of as a one-way causal relationship of X explanatory variable to dependent Y, I can easily recognise that bondholders can use the world's art market as a hedge to their portfolio. On the other hand, since cointegration implies inefficiency, art investors can easily replicate the gold index movement to track when to sell/buy art collections for higher expected profit. However, this only works when investors have inside information – that is assuming no one else knows and no one else can beat him/her in buying/selling artworks. I found no cointegrating relationship of gold on AGI. That is, the OLS result in ***Table V*** is misleading, as these two variables do not cointegrate.

For the ECM of AGI on gold: DX(-1) is positive and highly significant with p-value < 5%, indicating that in the short-term, a 1% return of gold from last quarter can lead to a positive change of 0.33% on AGI. DY(-1) is negative and statistically insignificant, bearing a zero average autocorrelation in AGI returns. The $e(-1)$ coefficient is negative and marginally significant, indicating that if the difference between the returns of the AGI and gold is positive in one period, the price of AGI will fall by 0.14% in the next period to restore equilibrium. Predicting the direction of the AGI benefits arbitrageurs as they can easily beat the expectation of an art market downturn by buying art this period and immediately selling next period. There is a trap on this argument – investing in art should be viewed as a long-term investment.

For the $e(-1)$ of AGI on US bonds: the coefficient is not statistically significant; therefore, I can conclude that the dependent variables do not adjust to disequilibrium.

5.8.1.2 Summary of Results for Non-Risky Assets

(Please refer to Table VI). Gold plays a major role in the global art arena. Likewise, the same cointegrating results are observed for the bonds market. It should be noted that when reverse cointegration is performed, that is, putting the art market as an independent variable, I could not accept the alternative hypothesis of cointegrating variables. This is because the size of the art market is very small compared to larger gold and bonds markets.

Table VI: SUMMARY OF RESULTS FOR NON-RISKY ASSETS

Regression Equation	*Y = α + βX*		*X = α + βY*	
	cointegration	*ε(-1)*	*cointegration*	*ε(-1)*
AGI on Gold	yes	marginal	no	NA
AGI on US bonds	yes	insignificant	NA	NA

Legend:
marginal means, it is difficult to reject insignificance of the variable
insignificant means, explanatory variable has no influence on the dependent variable
NA means non-stationary variables; hence cannot proceed to cointegration and ECM tests

In terms of ECM, the return of the art market in the next quarter is highly predictable using gold but not bonds. I observed that a positive rise in gold depress the returns of the global art. While a rise in bonds do not affect the art market.

It should be noted that gold and art share similar intrinsic characteristics of rarity and of beauty. Rarity in art is mostly observed from deceased artists, where supply is very limited and demand is high. The slow adjustment, $e(-1)$ = -0.14%, of the global art to equilibrium can be attributed to the limited supply of art. If I define gold as a monetary instrument, then whenever I spend monies for art, the art market rises until it hits the equilibrium. Moreover, the negative ECM relationship from last quarter to next quarter between art and gold is due to the short-term investing horizon; otherwise, in the long-term, AGI and gold should trend together with β = 0.55%.

5.8.2 Cointegration and ECM Test Results for Risky Asset

Table VII: COINTEGRATION AND ECM TEST RESULTS FOR RISKY ASSETS

Regression Equation ✪		*Coefficient*	*t-stat*	*p-value*
AGI on Oil & Gas	α	2.0874	10.5197	0.0000
	β	0.3656	10.9120	0.0000
Oil & Gas on AGI	α	-2.0255	-1.7589	0.0826
	β	1.8408	6.3993	0.0000

ECM ✜		*Coefficient*	*t-stat*	*p-value*
AGI on Oil & Gas	intercept	-0.0062	-0.6257	0.5335
	ε(-1)	-0.2254	-2.6832	0.0090
	DY(-1)	-0.0986	-1.0593	0.2930
	DX(-1)	0.0015	0.0317	0.9748
Oil & Gas on AGI	intercept	0.0111	0.5782	0.5649
	ε(-1)	-0.1364	-1.4144	0.1616
	DY(-1)	-0.0100	-0.1072	0.9149
	DX(-1)	0.6223	1.9392	0.0564

Legend:

✪ *Regression equations:* $Y = \alpha + \beta X$ *and* $X = \alpha + \beta Y$

✜ *ECM equation:* $D(X) = \alpha + \lambda\varepsilon(-1) + \omega_1 DX(-1) + \omega_2 DY(-1) + \mu$

5.8.2.1 The Art Market Perspective for Risky Asset

Oil & gas has significant explanatory power given that the past few decades, many companies and individuals made money from trading in the oil & gas business. A case in point: when newly-minted oil billionaires from Russia bought the most expensive artworks sold in London in 2007. A 1% increase in the return of silver influences AGI by 0.45% quarterly while oil & gas only influences the world's art by 0.37%.

I noted before that the long run multiplier of AGI on oil & gas is 0.37%. ***Table VII*** summarises the short run properties of AGI on oil & gas. Last quarter's returns of oil & gas have no statistical influence on the return of AGI this quarter. Its $e(-1)$ coefficient, however, is negative and statistically significant, which implies that AGI falls by 0.23% in the next period. Silver on the other hand reacts slower to an equilibrium error, AGI falls by 0.17% in the next quarter.

5.8.2.2 Summary of Results for Risky Asset

(Please refer to Table VIII). In summary, the return on the price of oil & gas has cointegrating impact to the return of the global art market. This connection makes sense because wealth derived from oil & gas triggers surplus in monies, enabling art collectors to buy more. In terms of ECM or short-term forecasting, the return of the global art market in the next quarter is highly predictable using oil & gas. I observed that a positive rise in oil & gas depresses the returns of the global art market. My disequlibrium estimate, $e(-1)$ is -0.23% for oil & gas. This quarter, I suggest a strong buy for artworks and potentially sell them next quarter – this is partly due to the observation of a potential rise in the returns of art.

Table VIII: SUMMARY OF RESULTS FOR RISKY ASSET

Regression Equation	*Y = α + βX*		*X = α + βY*	
	cointegration	*ε(-1)*	*cointegration*	*ε(-1)*
AGI on Oil & Gas	yes	yes	yes	insignificant

Legend:
marginal means, it is difficult to reject insignificance of the variable
insignificant means, explanatory variable has no influence on the dependent variable
NA means non-stationary variables; hence cannot proceed to cointegration and ECM tests

5.8.3 Cointegration and ECM Test Results for an Economic Factor

Table IX: COINTEGRATION AND ECM TEST RESULTS FOR AN ECONOMIC FACTOR

Regression Equation ✪		*Coefficient*	*t-stat*	*p-value*
AGI on USA GDP*	α	-2.8674	-0.8695	0.3873
	β	0.7535	2.1246	0.0369
USA GDP on AGI	α	7.9611	16.1865	0.0000
	β	0.3183	2.6025	0.0111

ECM ✜		*Coefficient*	*t-stat*	*p-value*
AGI on USA GDP*	intercept	-0.0226	-2.0131	0.0478
	ε(-1)	-0.1082	-1.7736	0.0804
	DY(-1)	-0.2048	-2.9499	0.0043
	DX(-1)	2.7464	1.7309	0.0877
USA GDP on AGI	intercept	0.0037	2.3953	0.0192
	ε(-1)	-0.0047	-1.2769	0.2057
	DY(-1)	0.4573	2.6493	0.0099
	DX(-1)	0.0074	0.8048	0.4236

Legend:

✪ *Regression equations: $Y = \alpha + \beta X$ and $X = \alpha + \beta Y$*

✜ *ECM equation: $D(Y) = \alpha + \lambda\varepsilon(-1) + \omega_1 DY(-1) + \omega_2 DX(-1) + \mu$*

* *USA GDP is used as proxy for the world's GDP*

5.8.3.1 The Art Market Perspective for an Economic Factor

(Please refer to Table IX). GDP is suited to use as measurement for economic activities. A 1% change in the USA GDP induces AGI to increase by 0.75%. This is very close to 1. This makes sense because a healthy economy means better productivity, high wages, and improved financial strength. I can relate this factor to the purchase of artworks – better economy may mean more excess monies to buy items people have been withholding to buy for a while.

Looking at the ECM results of AGI on USA GPD, GDP is marginally significant with p-value = 0.08. A 1% GDP increase from last quarter can decrease the AGI by -0.11%. In the short-term, I recommend a strong buy this period and immediately sell in the next period. In the long-term, however, the direction of AGI positively co-trends with the US GDP with β = 0.75%.

Market conditions are determinants of price changes in the stock market. The same is true in the art market. Regulations (e.g. Droite de Suite), increase in the number of wealthy individuals, geography, supply, demand, and market shocks are other examples of market conditions not covered on this research.

5.8.3.2 Summary of Results using an Economic Factor

(Please refer to Table X). Most economists use data derived from the GDP as good measurement of the economy's health. Individuals and corporations are induced to buy pieces of art when the economy is stronger. Generally, the art market is highly predictable when GDP is used as indicator for the direction of the return of art prices. The short-term direction of the art market is also highly predictable. Given positive GDP, the art market is negative, which induces it to rise in the next quarter. This event triggers buy-now-and-sell-immediately-after behaviour, in order to obtain short-term profitability.

Table X: SUMMARY OF RESULTS FOR AN ECONOMIC FACTOR

Regression Equation	*$Y = \alpha + \beta X$*		*$X = \alpha + \beta Y$*	
	cointegration	*ε(-1)*	*cointegration*	*ε(-1)*
AGI on USA GDP	yes	marginal	yes	insignificant

Legend:
marginal means, it is difficult to reject insignificance of the variable
insignificant means, explanatory variable has no influence on the dependent variable
NA means non-stationary variables; hence cannot proceed to cointegration and ECM tests

CHAPTER 6

CONCLUSION

I aim to understand art prices and returns from a market efficiency point of view and I seek to understand whether the art market exhibits predictability, randomness, or just pure chance. Proponents against market efficiency may be correct with their previous assumptions given that art is not homogeneous, taste- and location-independent, and does not have sophisticated information feeding market participants.

Using Artprice™ Global Index (AGI), I tested the weak-form efficiency random walk using ADF and found that most of the time-series data are non-stationary; hence, they all possess randomness. However, the ADF test has a low power in predicting randomness and the end result is the difficulty of rejecting a false random walk. I proceeded and tested the art data using cointegration and the ECM by comparing them to non-risky and risky assets as well as economic factors. The results are conflicting.

I can predict the direction of art using gold as benchmark for the world's art market. Bonds are not useful predictors for art market in the short-term. Oil & gas is a good predictor of the general art market. The GDP is the best economic predictors for the world's art market.

The implications of the efficient market hypothesis in the art market are mixed. Art can be used as hedge when bundled with bonds. Portfolio diversification seems to be less favourable for the art market. The way to profit is to look at the returns of oil & gas, assuming other people do not possess this information. Note that the market reacts fast - looking at historical data will not serve investors well. My study contradicted the academic belief of market efficiency in favour of practitioners. Subjected to scrutiny, my mixed results do not suggest fully abandoning the notion of efficiency in the art market.

According to Dwyer and Wallace (1992, p.318), “there is no general equivalence between market inefficiency and cointegration or, for that matter, a lack of cointegration.”

Perhaps the only way to measure market efficiency is through the behaviours of investors and not through prices and returns alone. There are the inherent psychological factors in art collections such as receiving pleasure from artworks, a non-monetary dividend in art investment. Proponents of market efficiency may contend that when irrational and rational art investors are put together in the market, the market suddenly becomes efficient. However, with the cointegration and ECM results, non-random walk believers such Haugen (1995), Lo, and MacKinlay (1988) may be content sitting on their laurels until the next batch of scholars disprove their notions of inefficiency in the art market.

Further Study

To fully understand the art market, other types of artworks should also be studied apart from the traditional paintings, prints, and sculptures. Availability of data is always a challenge in studying the art market and its effect in people’s lives. My dataset from Artprice^{TM} suffers from its limited scope as it only tracks auction-related art prices from around the world. Auction prices are a narrow representation of the art market.

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APPENDIX

Appendix I: RSR Method

Following Erdős (2010) method of estimating RSR, Artprice[TM] follows a similar estimate:[11]

$$r_i = \ln\left(\frac{P_{i,s}}{P_{i,b}}\right) = \sum_{t=b_i+1}^{s_i} r_{i,t} = \sum_{t=b_i+1}^{s_i} \mu_t + \sum_{t=b_i+1}^{s_i} \varepsilon_{i,t}$$

Where:

r_i = is the log return of an artwork i accumulated between the time of purchase b_i and the time of sale s_i.

$P_{i,s}$ and $P_{i,b}$ = are the sales and purchase price of the artwork i.

μ_t = is the average return of the market at time t.

$\varepsilon_{i,t}$ = is the error term of the regression.

Appendix II: HPR Method

Following Chanel and Gerard-Varet (1996) method of estimating HPR for arts' sold, Artprice[TM] follows a similar estimate on their artist-specific indices:[12]

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[11] In the art market, RSR method or a similar variation was used by Goetzmann and Spiegel (1995) for paintings, Goetzmann and Peng (2002) in real estate, Pesando and Shum (1993) on Picasso prints, and Mei and Moses (2002) for masterpieces.

$$\mathrm{P}_{it} = \sum_{k=1}^{m} \alpha_k \chi_{ki} + \sum_{\tau=0}^{t} \sum_{j=1}^{n} \theta_{j\tau} \omega_{ij\tau} + c(t) + \xi_{it}$$

And

$$c(t) = \sum_{t=0}^{T} \gamma_t z_t$$

Where:

P_{it} = is the log return of an artwork i sold at time t.

χ_{ki} =is a time attribute of an artwork i with $k=1, 2, ..., m$ (e.g. materials of an artwork). It is also a dummy variable taking the value of *zero* and *1*.

$\omega_{ij\tau}$ = is a time varying characteristics of an artwork with $\tau = 0, 1, ..., t$ and $j = 1, 2, ..., n$. It is also a dummy variable taking the value of *zero* and *1*.

ξ_{it} = is the error term of the regression.

$c(t)$ = price effect on a market level.

[0, T] = is the time interval of available observations in *c(t)*.

z_t = is a dummy variable with value of *1* if the artwork is sold and *zero* otherwise in period $t \approx [0,T]$.

---

[12] In the art market, HPR method was used by Higgs and Worthington in the Australian paintings market (Higgs, Worthington 2005), Hodgson and Vorkink for Canadian paintings (Hodgson, Vorkink 2004), Renneboog and Van Houtte for realism paintings (Renneboog, Van Houtte 2002), Collins, Scorcu and Zanola for symbolist paintings (Collins, Scorcu & Zanola 2009), Locatelli-Biey and Zanola for the Italian sculptures market (Locatelli-Biey, Zanola 2002), Agnello and Pierce for American art (Agnello, Pierce 1996), Candela and Scorcu for Italian art (Candela, Scorcu 1997), and Czujack for Picasso paintings.

γ_t = is the parameter we are estimating.

Appendix III: Transforming Data to Logarithm Value

The use of logarithm allows us to interpret results and satisfy the linear assumption of a regression model (Koop 2006). The data shown in ***Figure III*** can be misleading and it can be difficult to compare different indices with varying currencies.

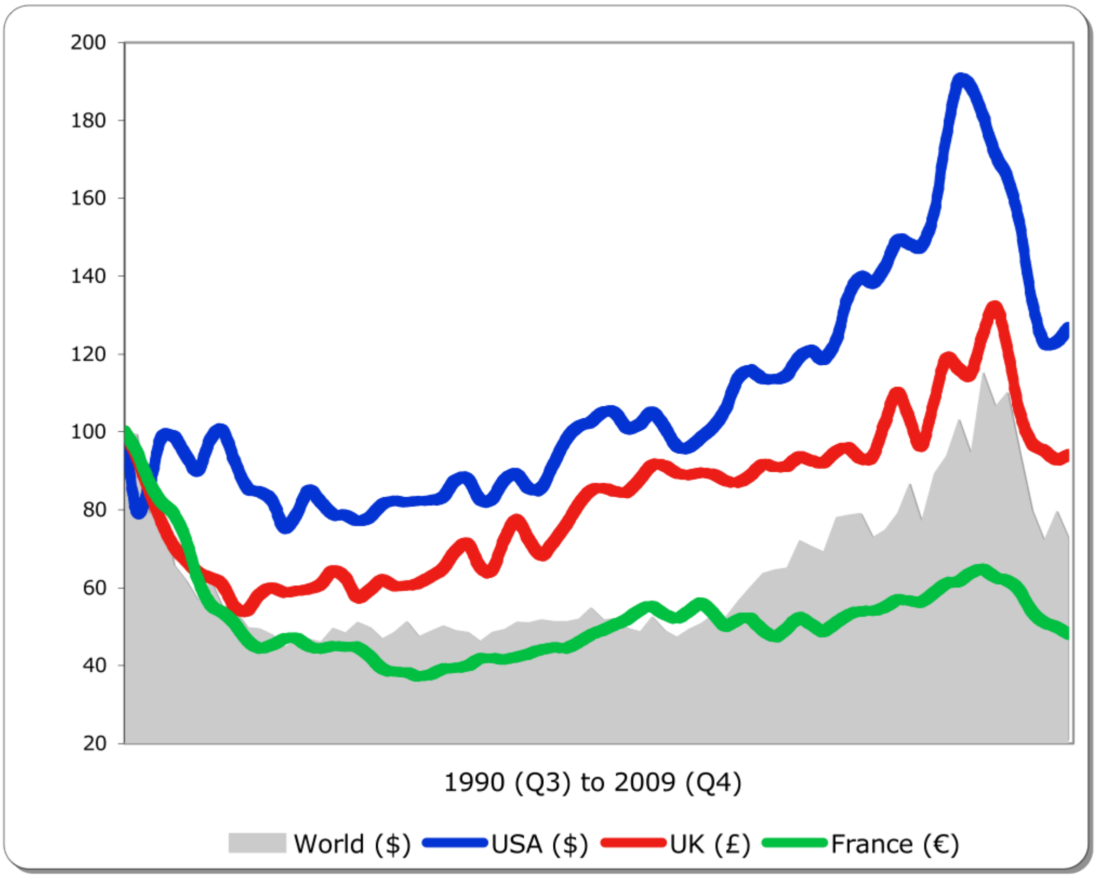

Figure III: Index price in local currency

When prices are transformed into logarithm (***as shown in Figure IV***), foreign exchange issues are eliminated, leaving returns as the sole component for comparisons.

Let Y be the price of the variable. The return of Y at time *t* for the previous period *t*-(*t*-1) is calculated using the formula below:

$$Y_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

Where Y is the return of the index and P is the price of the asset.

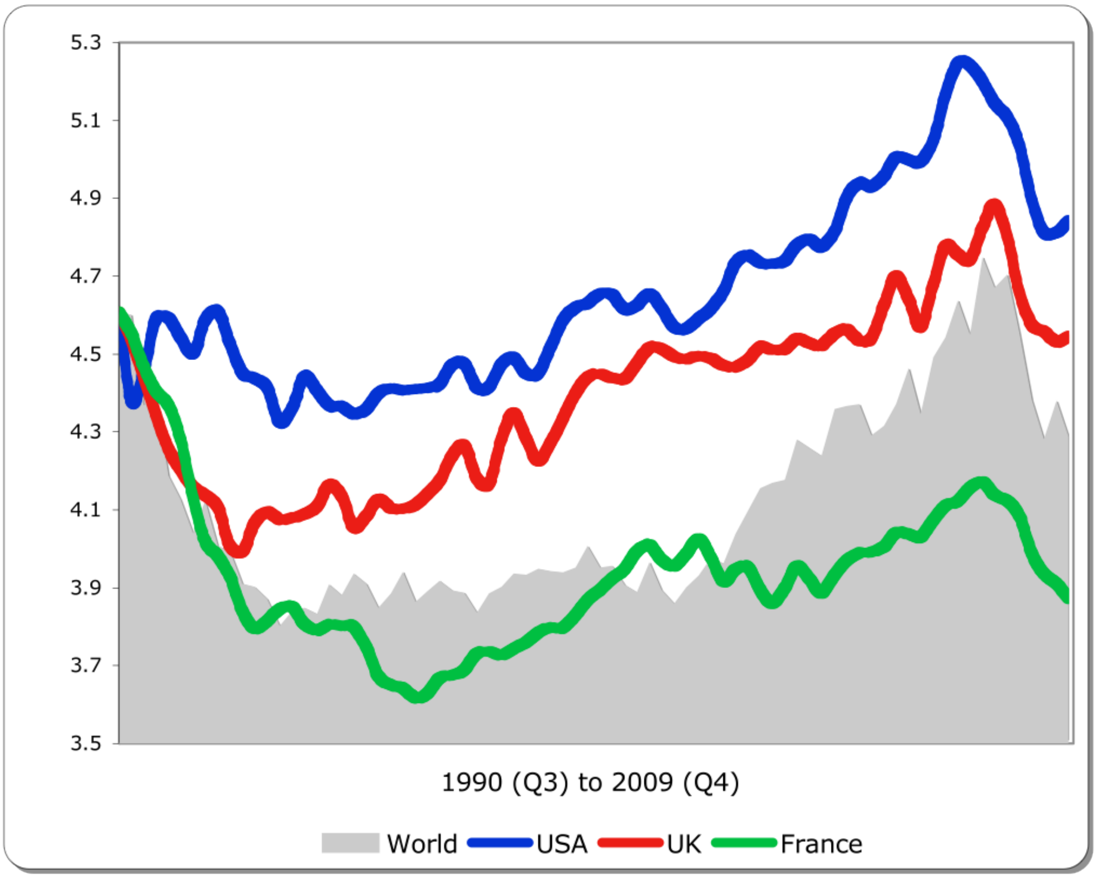

Figure IV: Logarithm of the price index

Looking at the plot in ***Figure IV***, the logarithm transformation made the data appear more linear. Performing regressions on it will produce a higher degree of accuracy.

NOTES