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"GOLD AND THE STOCK MARKET: 3 ESSAYS ON GOLD INVESTMENTS"

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Abstract

This thesis gives an overview of the history of gold per se, of gold as an investment good and offers some institutional details about gold and other precious metal markets. The goal of this study is to investigate the role of gold as a store of value and hedge against negative market movements in turbulent times. I investigate gold's ability to act as a safe haven during periods of financial stress by employing instrumental variable techniques that allow for time varying conditional covariance. I find broad evidence supporting the view that gold acts as an anchor of stability during market downturns. During periods of high uncertainty and low stock market returns, gold tends to have higher than average excess returns. The effectiveness of gold as a safe haven is enhanced during periods of extreme crises: the largest peaks are observed during the global financial crises of 2007-2009 and, in particular, during the Lehman default (October 2008). A further goal of this thesis is to investigate whether gold provides protection from tail risk. I address the issue of asymmetric precious metal behavior conditioned to stock market performance and provide empirical evidence about the contribution of gold to a portfolio's systematic skewness and kurtosis. I find that gold has positive coskewness with the market portfolio when the market is skewed to the left. Moreover, gold shows low cokurtosis with the market returns during volatile periods. I therefore show that gold is a desirable investment good to risk averse investors, since it tends to decrease the probability of experiencing extreme bad outcomes, and the magnitude of losses in case such events occur. Gold thus bears very important and under-researched characteristics as an asset class per se, which this thesis contributed to address and unveil.

EXECUTIVE SUMMARY

The first chapter of this monograph gives an overview of the history of gold per se, of gold as an investment good and offers some institutional details about gold and other precious metal markets as well as the main determinants of supply and demand to place the following work in the relevant context. The main part of this monograph focuses on the higher moments of gold returns. It investigates the role of gold as a store of value and hedge against negative market movements in turbulent times which are key in understanding the investment demand of gold described in chapter one. Chapter two looks at the conditional covariance to highlight the desirability of gold as a safe haven during times of low stock market returns. Chapter three moves on to the third moment, the skewness of gold and the systematic skewness of gold with the market to allow for a preference for skewness by investors along the lines of Kraus and Litzenberger (1976) as well as Harvey and Siddique (2000) and to investigate the qualities of gold as protection against negative stock market movements. I also mention results for the forth moment in chapter three. The subsequent part summarizes the main findings regarding the higher moment properties of gold in chapters two and three. The subsequent part presents the two main themes around which this empirical study revolves.

I. **GOLD AND STOCK MARKET IN GOOD AND BAD TIMES** In this section, I investigate gold's ability to act as a safe haven during periods of financial stress. I employ instrumental variable techniques that allow for time varying conditional covariance. I find broad evidence supporting the view that gold acts as an anchor of stability during market downturns. During periods of high uncertainty and low stock market returns, gold tends to have higher-than-average excess returns. The effectiveness of gold as a safe haven is enhanced in periods of rare but extreme crises: the largest peaks are observed during the global financial crises of 2007-2009 and, in particular, at the default of Lehman Brothers (October 2008).

II. **A Tale of tails: Higher moments and Precious Metals** In this section, I investigate whether gold provides protection from tail risk. I address the issue of asymmetric behavior of precious metals conditional on stock market performance and provide empirical evidence of the contribution of gold and silver to a portfolio's systematic skewness (coskewness) and kurtosis (cokurtosis). I find that gold, unlike silver, has positive coskewness with the market portfolio when the market is skewed to the left (i.e. during bear markets or market turmoil), which is when investors care most about the performance of their portfolio Moreover, I document that gold shows low cokurtosis with the market return during volatile periods (gold's returns tend to be higher during periods of high uncertainty). I show that gold is desirable to risk adverse investors since it tends to decrease the probability and the magnitude of extreme bad outcomes.

Within each section, I explain the relevant empirical methods and describe the data used in the study. The following part presents the main results of the empirical analysis. A section with robustness checks is provided in order to show the generality of findings. Finally, I conclude each section with discussions on avenues for future research.

CONTENTS

Foreword

My interest in gold began when I was a little girl. My father decided to leave his successful company that specialized in the design and manufacturing of hydraulic and pneumatic equipment, and realized his lifetime dream of becoming a goldsmith. One day, he came home and greeted my mother by saying*: "Women complain that their men never buy them nice jewelry, I bought you an entire jewelry store".*

We were shocked, but, had you known my father, you would have realized he was serious. I was 12 year old and that is, when I started to join my father at world trade shows for dealing with suppliers and clients of his goldsmith business. At age 14,I created my first piece of jewelry. It wasn't a great success. I eventually found myself interested in gold as an investing vehicle and decided to deepen my knowledge of the gold market during my doctoral studies. Not only did the skyrocketing prices of gold over the last decade catch my attention, but they also increased awareness of the broad investment properties of this precious metal to the broader public. While completing my MSc. dissertation, I have spent a visiting period at the London School of Economics. In fact, I spent most of my time harassing people involved in the global gold market, and trying to obtain interesting data for my studies. I was very fascinated with gold, and especially with its self-regulated market system structure. I was so personally convinced of the prospects of gold as a solid performing asset class that I decided to invest in it. I bought ETFs on gold: it was July 2008.

As far back as our knowledge of human history goes, gold has played an enduring and special role as a provider of beauty, as storage of value and a medium of exchange. There is no other metal or natural source whose appeal has been so captivating to people: gold has created empires, and the lack of it has forced empires into ruins. Gold's appeal is a worldwide symbol of power and riches. Once he eventually stepped foot on the American land, Christopher Columbus asked: “Where is the gold?”

Gold is an ultimate storage of value, and the only medium of exchange recognized in the whole world. It does not carry credit risk, and it has a long history as an inflation and hedge against US dollar fluctuations. Over the last decade, as the world economy fell into its worst recession since the 1930s, investors searched for the protection of traditional safe haven assets such as gold. Gold is perceived as the ultimate safe-haven asset, the universal accepted currency that cannot be debased by quantitative easing put in place by the world’s central banks or by fiscal devaluations of national governments.

Why is gold, among so many other important and useful commodities, the most coveted of metals by governments and investors?

According to Prof. Robert Triffin of Yale University: “Nobody could ever have conceived of a more absurd waste of human resources than to dig gold in distant corners of the earth for the sole purpose of transporting it and reburying it immediately afterwards in other deep holes, especially excavated to receive it and heavily guarded to protect it” [1]. Despite the logical kernel of this view, both investors and governments are revaluing the role of gold. Gold is becoming an accepted asset as part of investors’ portfolios, ensuring its importance as a unique safe haven. This offers a competing role for gold among a wide range of very sophisticated financial instruments. If the recent crisis has taught us anything, it is the importance of structuring our portfolios with assets that will help to protect our wealth during extreme bad outcomes which, although very rare, do occur and do so with devastating results. This monograph is primarily intended to investigate whether gold is able to protect against these rare events that can erode the capital of an investor in a substantial way. Such events are typically referred to as *tail risk,* as they produce observed returns that fall into the “tail” of the distribution of returns. The studies of this monograph investigate the properties of precious metals if added

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[1] Robert Triffin, Gold and the Dollar Crisis, Yale University Press, London and Newhaven, 1961.

to a well-diversified portfolio. It describes the defining characteristics of the gold market from an investor's point of view, and it aims at providing an answer to a long-standing question: is gold a "barbarous relic"[2] or whether can "there be no other criterion, no other standard than gold"[3].

[2] John Austin Stevens wrote to the New York Times in October 1873 "gold is a relic of barbarism to be tabooed by all civilized nations". Tennessee merchant John Goss testified before the U.S. Senate in 1894, saying "Gold is a relic of barbarism and should be discarded by all civilized nations as a medium of exchange". The book *Civilized Money* (1985) by Charles M. Howell also states "gold is a relic of barbarism". However, Keynes has been credited with calling the gold standard a "barbarous relic" in 1923.

[3] In a memorable press conference that took place in France at the beginning of 1965, General Charles de Gaulle said: "there can be no other criterion, no other standard than gold. Yes, gold which never changes, which can be shaped into ingots, bars, coins, which has no nationality and which is eternally and universally accepted as the unalterable fiduciary value par excellence".

1. The Gold Market

1.1. Introduction

During the last decade, gold has often been at the center of public attention: the international financial community is increasingly recognizing gold as an asset class, attracting investments and speculation. For the first time, individual investors are drawn to the gold market as a result of increased coverage by the press, television, and the web. Growing interest in gold has been further fueled by a large rise in prices over the last years. Yet, our understanding of gold market characteristics, and of its institutional features, is very limited.

This chapter describes the defining characteristics of the gold market from an investor's point of view. It also analyzes the most salient characteristics of demand and supply, and it offers a review of the main strategies to invest in gold.

The word *gold* comes from the old English word *geolo*, which means yellow. The chemical symbol of gold is *Au,* from the Latin word *aurum,* whose original etymology means *shining dawn*. According to its geological definition, gold is a natural element that occurs in a pure state, it is yellow, durable, and malleable. These basic properties are some of the factors, which have influenced the desire by humans to possess gold.

Although the first appeal of gold was strictly aesthetic, its unique qualities recommended it above all other metals. Gold is indestructible and, unlike silver, it does not tarnish, and it is not easily corroded. Gold is a symbol of power, beauty, and it is the universally and eternally accepted, unalterable fiduciary value *par excellence*[4].

Its malleability made of gold a natural candidate to be used for decoration. Its shining yellow color was associated with gods and immortality since the dawn of humanity. The scarcity of gold ensured its high value as evidence of wealth and power. Eventually, what made gold a worldwide, unique asset was the combination of very peculiar qualities combined with a universal demand. The invention of coins was not a sudden fact in history, but it came as a result of a long development process. Before the first coin was manufactured, other forms of primitive money, such as golden rings or axes, were widespread as means of payment. These primordial means of payment were often made of "electrum", a natural alloy mixing silver and gold. This form of money was usually conceived as a magical symbol of power and worth. It was also often gathered and hoarded as a symbol of magical and divine power.

Around 1000 B.C., the Chinese people manufactured the first coin in the form of knives and spades. As Timothy Green, author of *The Ages of Gold* and many others pointed out in a meeting in London in summer 2012, gold, unlike all paper-based assets, is no one's liability and, hence, its value cannot be eroded by any decline in the creditworthiness of its issuer. This ensures a unique "safe-haven" quality. The importance of this use of gold over the centuries is illustrated by the fact that the famous coins of the past such as the Roman *aureus*, the Roman *solidus* that became the Byzantine *nomisma,* the Islamic *dinar* and the Venetian *ducat*, endured for centuries and were constantly used not just in their original countries, but also internationally. In particular, Roman coins have been heavily used for centuries after the fall of the Roman empire itself. In fact, five gold coins (solidus, dinar, ducat, and the British sovereign that was introduced after the Napoleonic Wars in 1816) dominated the coin market from the first century BC until the last century.

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[4] Ibid

During the 19th century, most of the worldwide nations involved in trade, including America and India, adopted the Gold Standard as the basis of their monetary system. This system was adopted broadly. According to the gold standard, the fact that different nations had different coins of different weights did not matter as long as the coins were made of gold. On a full gold standard, the national currency consisted of a fixed weight of gold and of a specific fineness. Consequently, law fixed the price of gold and countries were completely free to buy or sell gold. The amount of money issued by a country depended on its gold stock: if the stock of gold increased, the quantity of currency could be expanded and vice versa. The international role of gold as money had two different functions. First, the gold standard offered stability of the exchange rates between countries. In addition, it offered a solution to balance of payments adjustment problems. Second, the gold standard provided an effective way to control the growth of domestic money supply. Since a country would not be allowed to issue more money than its gold stock imposed, high inflation or hyperinflation was not possible. The period between the defeat of Napoleon and the outbreak of World War I is probably the greatest age of gold. During those 100 years the world was at peace and commerce flourished, dominated by gold coins. The US golden age, which took place between 1900 and 1932, ended when President F. Roosevelt issued the "Proclamation of National Emergency", on March 5, 1933. In the midst of a terrible crisis, President Roosevelt decided to suspend all banking operations, to end the minting of gold coins, and to prohibit any further transactions of gold coins or gold certificates. Most privately held gold coins or gold bullion were collected at the central level. Limited use of gold was permitted in specific industries, while the private ownership of gold was confined to rare and unusual coins of special value to collectors. Gold coins were demonetized and gold was nationalized and made subject to a government monopoly (the price of gold was set at $35 and kept fix). The gold standard collapsed in 1971, when President R. Nixon decided to close the "gold window" and end the dollar convertibility into gold. Americans were allowed to own gold privately, and the limitations to trade gold were eliminated in 1973. Following a heated public debate, Ronald Reagan created a "gold commission" in 1981, which decided not to go back to the gold standard. More

recently, the US Republican Party proposed to set up a commission to look into re-establishing the gold standard.
In the next sections, I provide the reader with a better understanding of the gold market. I describe specific characteristics of gold demand and supply. I also describe the defining elements of the gold market from an investor's point of view and show the various investing options available to investors. The last part of the chapter summarizes the main reasons why gold deserves a place in every portfolio.

1.2. The Price of Gold: Supply and Demand.

The price of gold is determined twice a day (at 10:30am and 3pm - London Time) each business day on the London Market by the five members of the London Gold Market Fixing Ltd. The main goal of the gold fixing process is to reach a price for settling contracts between members of the London bullion market. The gold fixing also provides a benchmark for pricing gold products and derivatives in the world markets.
After World War I "there was no room in the world […] for so finely balanced a device as the international gold standard of pre-war days"[5]. Since the greatest source of monetary demand for gold was in the United States of America, the value of gold became identified with the value of money to the US.
Mining companies in South Africa were forced to sell their excavation output to the Bank of England. They where therefore forgoing a premium they could have otherwise been secured in New York (the value of the pound sterling was lower than that of the US dollar). At the same time, South African miners were also suffering from an increase in local inflation that caused mining costs to go up.
In order to restore the international dimension of the gold market, the first step was taken by the US, whose administration lifted the embargo on the export of gold in June 1919. On the 25th of July, the Bank of England, the South African government,

[5] William A. Brown, England and the New Gold Standard, 1919 to 1926, P. S. King, London 1929, p.8

and the mining finance houses agreed that all the South African output would have been shipped to the Bank of England, who would also deliver it to the refiners. The Bank of England also had the responsibility to issue export licenses once the gold was sold. Eventually, the sales responsibility was given to the Rothschild family (being both refiners and bank, they would have had the necessary financial resources[6]). Rothschild would sell the gold at the best price, giving the London Market and the Bullion Brokers an opportunity to bid. On the morning of the 12th September 1919, at 11am, the London market had its first "fixing" on the phone by the representative of each broker[7]. The procedure became a daily ceremony, held at 11 am at Rothschild's offices at New Court. During the meeting, the leading participant would suggest an opening price (usually close to the current spot price) and each broker indicated if he intended to take part in the transaction market as a seller, a buyer or with no interest. At the end of the procedure, each broker would state how much gold (in ounces) they wished to buy. If the sellers were able to meet the requirement, the price was "fixed"[8] (on-call auction). Otherwise, the chair was required to knock down the price and restart the process. For the first 85 years until 2004, the five member banks of the Gold Fix would meet face-to-face. Buyers were charged 20 cents per troy ounce as a premium to fund the fixing process (implicit bid-offer spread).

Nowadays, price fixing takes place twice a day in the form of an auction. The five members[9] who take part in the auctions interact by telephone.

Most of the trades in gold (and other precious metals) around the world are carried out on over-the-counter (OTC) markets. London is the largest global center for OTC transactions, followed by New York[10], Zurich, and Tokyo. Turnover in the

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[6] McDonald, History of Johnson Matthey, Vol. II

[7] The five principal gold bullion traders and refiners were: N M Rothschild & Sons, Mocatta & Goldsmid, Pixley & Abell, Samuel Montagu & Co. and Sharps Wilkins.

[8] Timothy Green, The World of Gold, Michael Joseph, London, 1968, p.105

[9] In Apil 2004, N.M. Rothschild decided to pull out of the gold market. The current five members of the Gold Pool are: Bank of Nova Scotia – ScotiaMocatta, Barclays Bank Plc, Deutsche Bank AG, HSBC Bank USA, Societe Generale.

[10] New York's development as a gold trading center began only in January 1975 when US citizens were given the right to hold the metal.

gold market reached 9 trillion dollars in 2012, which was less than the trading volume of stocks, bonds, and currencies, but, nevertheless, this market represents a non-trivial percentage of the US market. Current above ground stocks of gold are estimated to be 173,400 tonnes with a value of approximately $9.9 trillion[11], about one quarter of the market capitalization of $35.7 trillions of the world's ten largest equity exchanges[12]. Thus, at current prices, gold makes non-trivial, portion of the world portfolio.

According to the World Gold Council (WGC)[13], every 4.4 days the LBMA clears an amount equal to the annual gold mine production. However, it is worth mentioning that the Gold Anti-Trust Action Committee claims that clearing data are underestimated. The OTC market operates 24 hours a day, and it has no formal structure. Transactions are mostly made by telephone or through electronic dealing systems. Market operations are guided by the London Bullion Market Association (LBMA). The LBMA does not operate as a stock exchange, but more as a self-regulatory organization whose members are banks, metal producers, suppliers, and brokers. The absence of a clearing house implies that all the risks are born by the participants of the transaction. The Bank of England provides important support for the London bullion market. LMBA members have their own vaults and hold part of their gold holdings at the bank. This simplifies the settlement of trades, which can be executed by transfer of title of accounts without involving the physical movement of gold. According to the Financial Services and Markets Act 2000, the Financial Service Authority (FSA) has the responsibility for the regulation of the participants in the London bullion market. All the UK-based banks and other investment firms are subject to a number of requirements, such as capital adequacy, liquidity and systems and controls.

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[11] Price of $1,780 per troy ounce as of October 1, 2012. Above ground stock at end of 2011 of 171,300 tonnes (Gold Survey 2012, Thomson Reuters GFMS) plus 2,100 tonnes of new production through October 1, 2012 (Gold Survey 2012, Thomson Reuters GFMS and The Economist, October 13, 2012).

[12] As of end of June 2012, "Market highlights for first half-year 2012," World Federation of Exchanges, http://www.worldexchanges.org/files/files/1st%20half%20%202012%20WFE%20market%20highlights%20with%20comments.pdf

[13] The World Gold Council (WGC) was founded in 1987 by the leading gold miners to represent and promote the gold industry. It publishes a quarterly report on supply and demand trends for gold in collaboration with GFMS Ltd. The WGC's website provides a plethora of other information on the gold market, much of it in conjunction with GFMS, and is viewed by analysts as the "official" data.

The demand for gold consists of the combined requirements for industrial, jewelry, and investment purposes. Jewelry is by far the largest component of demand (61% of the total demand), followed by investment demand, which accounts for 27% of the total, and industry demand for the remaining 12%. Since the beginning of the decade, total investment demand has soared from only 4% of overall gold demand in 2000 to a record 45% in 2009. From 2003 to 2007, the increase in gold demand was mainly driven by the launch of new gold-backed products such as gold ETFs and related products. In 2012 the annual global demand measured on a value basis increased to an all time record of US$236 billion. Annual gold demand was 15% higher than in the previous 5 years due to growth in demand from the physical bar segment of investment demand and central bank purchases. India is the largest consumer market. In 2010, the official sector turned net buyer of gold for the first time in 20 years. This is probably due to the decreasing attractiveness of the other assets (e.g., sovereign bonds). In 2012, the increase in central bank net purchases was concentrated among central banks of emerging markets[14]. Gold is used in a number of industrial applications and for decorative purposes. Research over the last decade has uncovered a number of possible new practical uses for gold as a catalyst in fuel and cells, chemical processing, nanotechnology, and controlling pollution.

The annual supply of gold, which interacts with demand to determine the price of gold, is a combination of three sources: sales from new mine production, the mobilization of central bank reserves, and from existing stocks of bullion and fabricated gold (scraps). Gold is mined in every country with the exception of Antarctica, where mining is forbidden. The dominant producer of gold until most of the 20th century was South Africa. China is currently the world's largest producer of gold, followed by Australia and South Africa.

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[14] One factor driving the demand for gold has been that gold has been relatively under owned by emerging-market central banks – while advanced economies held, as of end-2012, on average 22% of their reserves in gold, emerging-market central banks held on average less than 4% (International Financial Statistics).

During the last decade, the demand for gold has exceeded the amount of gold mined. Since all gold ever mined still exists, the shortfall has been made up from scrap and at times disinvestment from private and public investment holdings.

1.3. How to Invest in Gold.

If we think about the gold market, we would soon realize that it has been one of the most controlled and restricted markets in the world. In 1971, there were many restrictions and limitations applied to gold ownership. Gold was subject to discriminatory taxation and import restrictions; institutions involved in gold trading were subject to special controls; in some countries, the local price of gold was different from the international market price. A substantial deregulation process of gold markets has taken place since 1975, when the US gold market was freed and US citizens could finally invest in gold rather than jewelry. The liberalization of the Indian market took place in 1990, and eventually, the Chinese gold market was deregulated in 2005. Overall, most of regulatory barriers have disappeared: import restrictions have been lifted and discriminatory tax regimes reduced. Investors had few vehicles to be exposed to gold besides investing in gold shares (i.e., gold mining company's shares). The introduction of gold bullion coins, marketed as pure investment coins, traded at the ruling price (plus a small premium to cover making costs), stimulated investment demand providing a useful way for individuals to invest in gold. The Krugerrand was launched in 1967 and the American Eagle, and the Canadian Maple Leaf followed. The second major initiative was developed only recently: gold backed Exchange Traded Funds (ETFs) and Exchange Traded Commodities (ETCs). The latter are regulated financial products designed to provide access to gold to both individual and institutional investors who were either unable, for legal reasons or through restrictions in their mandate, to purchase physical commodities, or who were unwilling to incur the hassle and expense of investing in, and storing, physical products rather than paper instruments. Many of the currently available products are backed by gold bullion held in secure vaults on behalf of investors. This is a major distinction between the purchase of physical gold and other investments that offer an exposure to movements in gold prices. ETFs are intended to offer a means of participating in the gold market without the need of taking physical delivery of gold. The introduction of ETFs has substantially helped to eliminate or, at least, lower the barriers (e.g., access, custody, and transaction costs) that have prevented individuals from investing in gold as an asset class. The credit for the first attempt to provide investors with an exchange-traded product that would allow owning gold bullion goes to Benchmark Asset Management Company Private Ltd in India in 2002. Unfortunately, they did not receive regulatory approval at first and the exchange-traded product was only launched later, in 2007. Graham Tuckwell is the founder and major shareholder of the actual first launched gold exchange traded fund. Gold Bullion Securities (ticker symbol "GOLD") was launched in 2003 at the Australian Securities Exchange. Since the launch of the first physical gold backed ETF, many other commodity ETFs have entered the market and have changed the way gold is seen by investors. According to WGC, ETFs accounted for 7% of all identifiable demand in 2007. While gold coins and bars are common ways of owning gold, there are a number of other methods that allow investors to either buy gold or gain exposure to gold price movements.

- Derivatives

  Gold forwards, futures and options trade in several exchanges around the world and OTC.

  Gold futures are binding commitments to make or take a delivery of a specified quantity and purity of gold, on a specific date and at an agreed price. Gold futures are primarily traded in the CME Globex (result from a merger between the New York Mercantile Exchange and the Chicago Mercantile Exchange), the Chicago Board of Trade (part of CME), the Tokyo Commodity Exchange, the National Stock Exchange of India, and the Dubai Mercantile Exchange. Gold forwards are very similar to gold futures, except that they offer the investor a non-standardized contract.

  Gold options offer the holder the right, but no the obligation, to buy or sell a specified amount of gold, at a predetermined price, by an agreed date.

These instruments can give the holder substantial leverage because the initial margin is only a small fraction of the price of the underlying asset. While this can yield significant trading profits, it can also be very risky since face the risk of total loss.

- Gold Accounts

  This represents the most secure way to invest in physical gold. Gold is stored in a vault owned and managed by a recognized bullion dealer or depository. Investors pay a premium for storage and insurance. The dealer and the depository cannot trade or lease gold unless otherwise instructed by the owner of the account. There are alternative options for investors wishing to open gold accounts: allocated account investors have bars and/or coins numbered and identified by hallmark, weight and fineness; unallocated account investors do not have specific bars allotted to them (they could take delivery of their gold within two business days).

  As a general rule, bullion banks deal with institutional investors, private banks and other market participants willing to trade large quantities of gold (at least 1000 ounces, with a value of approximately $1.7 billion at the current price of gold). However, there are Gold Pool Accounts that offer the possibility to invest in as little as one ounce.

- Gold Accumulation Plans (GAPs)

  These instruments offer the opportunity to engage in a saving plan that consists of putting aside a fixed amount of money every month that buys gold every trading day in that month. These plans are not subject to the premium normally charged on small bars or coins. Also, at any time during the contract or when the account is closed, the holder can decide to take delivery of the gold in the form of bars or coins or sell the gold and get cash.

- Gold Certificates

  Gold certificates are another way to own gold without the hassle of the physical delivery. Usually a bank holds the gold on behalf of the client. In this way the customer saves money on custody and insurance and is also able to sell the gold very easily. Historically, gold certificates were part of the gold standard and the U.S. Treasury issued the fist gold certificates during the civil war until 1933.

- Structured Product

  Gold-linked bonds and structured notes allow investors to have exposure to gold price fluctuations, a yield, and a principal protection at the same time.

- Gold oriented funds

  A number of "collective investment vehicles" that specialize in the shares of gold mining companies and operate worldwide have developed over the last years. These funds are regulated financial products and pursue different strategies.

- Gold mining stocks

  Investing in mining stocks is probably the most direct way to gain exposure to gold price movements. However, there are significant differences between investing in gold mining stocks and direct investment in gold bullion. The success of this type of investment depends on the future earnings, the growth of the company and the capital structure just to mention a few additional determinants. Most mining companies tend to be more volatile than the gold price itself.

1.4. Gold as an Investment

According to Prof. Roy Jastram, gold's appeal stems from two basic needs: the human need for security and the desire of adornment.

Prof. Roy Jastram constructed an historical index series of the gold price and an historical index of prices for U.K. and the U.S. from 1560 to 1976. By comparing the two, Jastram was able to compute an index of the real value of gold or "operational wealth"[15] of gold. Jastram's seminal work represents the first statistical proof of gold's hedging qualities. Jastram describes this phenomenon as the "retrieval phenomenon"[16]: commodity prices tend to return to the same price in terms of ounces of gold, for instance, the prices of manufactured goods don't behave in the same way because they reflect rising labor costs. Jastram's most famous example mentions a loaf of bread: he shows that a brick of bread costs very much the same in terms of gold in 1960 as it did in 1560. His findings confirm that gold can function as an effective long-term hedge not only against inflation but also as a short-term hedge against deflation because its purchasing power appreciated more rapidly than anything else during such period.

Gold's investment qualities have intrigued many economists and scholars and several arguments have been advanced for owning gold. There are very few academics researchers and scholars who study the gold market, and findings so far are inconclusive[17]. The following gives an overview of the main findings in the academic literature:

- Gold as an inflation hedge

  Gold's inflation hedging qualities strictly depend on the presence of a long-term relationship between the price of gold and inflation. This implies that the price of gold should move in parallel with the inflation rate. The purchasing power of gold over time has intrigued many economists since Jastram's seminal work was published in 1977. However, studies have shown that the price of gold does not act as an effective inflation hedge since the 70s. Harmston (1998) follows up Jastram's work and finds that some goods tend to command a constant price when denominated in ounces of gold. However, Taylor (1998) finds that gold has actually acted as an inflation hedge on a small number of occasions. McCown et al (2007) confirm these mixed results, since they argue that gold acts as a hedge against stock losses

[15] Jastram, R.W. The Golden Constant: The English and American Experience, 1560-1976, Wiley, New York, 1977

[16] Ibid

[17] Brian Lucey, What do academics think they know about gold? - May 2011

and expected inflation in the long run but not constantly and only during periods of very high inflation (e.g., seventies). However, these results are somewhat contested, or at least qualified by following studies. For example, according to Blose (2010), there is no impact of unexpected change in inflation on gold returns, contrary to bond yields. Overall, it seems that gold acts as inflation hedge in a more effective way in the long run and it does not seem to be a good hedge of unexpected inflation in the short run. The motivation of this “intermittency” between gold and inflation can be probably due to the fact that while the price of gold can quickly react to incorporate news and events that might effect the inflation rate, the goods and services included in the Consumer Price Index basket might adjust more slowly. Moreover, it is important to take into account that gold market went through substantial structural changes since the ending of the Bretton Woods system in 1971, when gold transited from being the basis of the monetary system to a “normal” commodity.

- Gold as a currency hedge

  Investors have long regarded gold as a good protection against depreciation in a currency’s value. Technically, gold is only a perfect inflationary hedge when its dollar price rises at the same rate as the domestic index. This is why gold is also seen as a dollar hedge. Jensen at al. (2002) show that commodities, and especially precious metals, yield higher returns during phases of restrictive monetary policy in the US. They link this result to the fact that commodity prices tend to rise with inflation, while interest rates are hiked up precisely in time of inflation. According to their findings, including gold in a portfolio does not unconditionally improve the performance of the portfolio, but an active portfolio management can offer superior performance, when conditioning on the monetary stance. Capie et al. (2005) emphasize the role of US dollar exchange rate. They find a negative correlation with the gold price using weekly data over the period 1971-2004.

More recently, Marzo and Zagaglia (2010) investigate whether the recent turmoil in financial markets has affected the relation between gold prices and the US dollar. By applying the bivariate structural GARCH models and testing for changes of co-dependence, they show that gold prices generate stable comovements with the dollar, even during the recent phases of market turmoil. They also focus on the structural features of volatility transmission in the gold market. Their findings show that exogenous volatility shocks tend to generate reactions of gold prices that are more stable than those of the US dollar.

- Gold diversification properties

  Most of the literature focuses on the diversification properties of gold when added to a portfolio. Jaffe (1989) finds that gold is a hedge against both stocks and inflation: including gold in financial portfolio can reduce the variance, while slightly improving returns. However, according to Johnson and Soenen (1997), gold is an attractive investment in terms of diversification only in specific periods, for example in 1978-1983, whereas it yielded negative returns in 1984-1995. Baur and Lucey (2010) and Baur and McDermott (2010) take into account the two potential functions of gold as a hedge or a safe haven. They run a regression, explaining the returns of gold by those of stocks, in which they add interaction terms. These interaction terms are meant to capture the specific co-movements between the assets under "times of stress in financial markets". Baur and Lucey (2010) run this regression on daily data, for three countries: the US, the UK and Germany. They find that gold is a hedge for stocks. It is also a safe haven, but only in the very short run. On average, investors earn a positive return on gold on the day of extreme negative stock returns, but the day after, gold returns become negative. Moreover, two weeks after the shock, the cumulated returns on gold are negative on average. Baur and McDermott (2010) extend the analysis of Baur and Lucey (2010) in a number of ways. They use different data frequencies: daily, weekly and monthly and introduce simultaneously a range of lower quintiles of stock returns. They extend the number of stock markets studied from three to thirteen, including emerging markets. Baur and McDermott (2010) also explore the role of currency movements in the safe haven property of gold. They obtain different results depending on the crisis periods and the countries considered. Gold is shown to be a safe haven during periods of high volatility on the stock market, but not during extreme return uncertainty. They also document that gold has been a strong safe haven against losses on European and US stocks during the crisis of October 2008. Hillier et al (2006) investigate the role of precious metals in financial markets. They show that gold, platinum and silver have some hedging potential, particularly during periods of abnormal volatility. Moreover, financial portfolios that contain precious metals perform significantly better than those that contains only financial assets.

A range of studies has explored the nature and the efficiency of the gold market in the US. Tschoegl (1980), Solt and Swanson (1981), and Aggarwal and Soenen (1988) generally conclude in favor of market efficiency. More specifically, they show that distributional anomalies are not large enough to represent exploitable trading opportunities. Moreover, looking at the effect of gold prices on the value of gold mining firms, McDonald and Solnik (1977) as well as Blose and Shieh (1995) examined several aspects of the interdependencies.

McDonald and Solnik (1977), develop a model They investigate the theoretical gold elasticity of a gold mining stocks and predict that the elasticity should exceed one. Blose and Shieh (1995) show that the value of a gold mining company is a function of the return on gold, production costs, the level of gold reserves, and the proportion of the assets unrelated to gold price risk. Their model demonstrates that if a company's primary business is gold mining, the gold price elasticity of the company's stock will be greater than one. Tufano (1998) develops a valuation model for gold mining firms. As predicted from the above valuation models, gold firm exposures are significantly negatively related to the firm's hedging and diversification activities and to market conditions (i.e., gold prices and gold return volatilities), and are positively related to firm leverage (i.e., percentage of output hedged and hedged price). Davidson et al. (2003) investigate whether movements in the gold price affect companies in other industries. Specifically, asset-pricing tests reject the null hypothesis that the market and the gold factor exposure of the world's industries are jointly equal to 0.

Some studies have carried out an econometric analysis of the distributional properties of gold prices. Booth et al. (1982) found that over the period 1969-1980, gold price returns reveal persistent dependence over the long term and that cycles of unequal duration occur. Frank and Stengos (1989) look at gold and silver prices over ten years and show that a degree of non-linear dependence exists. Chan and Mountain (1988) explored the pricing relationship between gold and silver. By employing time series models to test causality between metals, they show a "feedback causal" relationship between the two.

Finally, Tufano (1996) investigates the risk management practices followed in the North American gold mining industry (data for 48 firms over 3 years). More specifically, he found that the factors underlying gold industry risk management practices are wealth maximization and managerial risk aversion.

Gold plays several roles within an investor's portfolio, as the next chapters of this monograph will demonstrate. Gold has a low correlation with many asset classes, which makes it a prime candidate as a diversifier. Gold is also typically seen as a store of value, and especially as a hedge for both inflation and currency debasement. The role of gold as a safe haven appears many times in the literature. Although there is not a formal definition of what makes an asset a safe haven, one would expect gold to have a value, which does not fluctuate during times of stress. Also, a safe haven should be liquid and investors should believe that they will always be able to buy and sell it without impacting its price. My studies investigate the specific role of gold in protecting an investor's wealth against rare and extreme negative events. Such events are typically referred to as *tail risk,* since they produce observed returns that fall into the "tail" of the distribution of returns. The goal of this monograph is to investigate the effectiveness of gold as a safe haven by estimating the conditional covariance between gold and the market. I further investigate gold's investment characteristics when added to a well-diversified portfolio by looking at coskewness (and cokurtosis).

2. Gold and Stock Market in Good and Bad Times

2.1. Introduction

The goal of this chapter is to investigate the effectiveness of gold as a safe haven by estimating the *conditional covariance* between gold and the stock market. The hypothesis that gold acts as a safe haven (or a hedge[1]) for financial markets has the conditional implication that its covariance with market returns should be negative (or decrease) during times of stress or extreme negative stock market returns. I show that gold increases in value in response to negative shocks in the stock market and other risky asset classes. Gold returns increase in times of chaos, war or financial crises. These findings support the view that gold acts as a safe haven and a hedge during periods of stress.

Unlike any other asset, essayed gold is a homogeneous asset class, fungible, and indestructible[2]. Its supply is perfectly elastic given that the above-ground inventory is large compared to demand, homogeneous, and liquid[3]. Most of the gold bought can be easily liquidated 24 hours a day, in large denominations and at a narrow spread. For most other investments, including stocks of the world's largest companies, this is not the case. This is true for both investments forms of gold and jewelry. Notably, in Asia and the Middle East, jewelry of high carat[4] is treasured as a basic form of investment. In addition, in such societies, jewelry is the only financial assets women are entitled to own. In the last years, central banks (mainly, emerging market central banks) kept expanding reserves to diversify from the dollar (Capie et al., 2005; Tully and Lucey, 2007; Sjaastad,

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1 Baur and Lucey (2010) offer a clear definition (and distinction) of a safe haven (uncorrelated with stocks and bonds in a market crash) and a hedge (uncorrelated with stocks and bonds on average).

2 As Pindar wrote nearly 2500 years ago, "Gold is the child of Zeus, neither moth nor rust devoureth it".

3 Above-ground inventory is usually held in a way that could readily come to the market

4 Such jewelry of high carat (22-24 carats) is traded by weight and sold at the current gold price plus a moderate mark-up to allow for dealing and making costs. It is also fairly common for jewelry to be bought or part-bought by the trading in another piece of equivalent weight; the traded-in piece will either be resold by the jeweler or melted down to create a new piece.

2008; Marzo and Zagaglia, 2010) and guard against a potential increase in inflation (Adrangi et al., 2003; Worthington and Pahlavani, 2007; Blose, 2010). As reported by Thompson Reuters GFMS, investment has represented the strongest source of growth in gold demand (currently 19% of total gold demand). Consequently, gold still plays an important role in investors' portfolios regardless its long gone role as a reserve currency.

During periods of economic and financial turmoil, one would expect that risk adverse investors rebalance their portfolios, divesting risky asset classes and investing in a relatively safe asset resulting in risky assets prices to collapse while safer asset prices surge. Conventional wisdom is that gold plays a distinctive role by acting as a safe haven and diversifier (Baur and Lucey (2010), Baur and McDermott (2010)). Indeed, the ability of gold to offer positive returns has been widely witnessed during the recent global financial crisis.

Despite the recent price rally, gold has not been overly popular during the 80s and 90s. In the early 80s, the price of gold reached a record high of over $800 but for almost the whole 20 years that followed the price of gold was at an impasse. In September 2001 the price of gold was as low as $257 per ounce and in December 2005 gold broke the $500 barrier for the first time since 1982. Since then, gold continues to rise in value and has been as high as $1784 on October 5th, 2012.

Historically, investing in gold has been motivated by fears of inflation and political instability. However, both in the United States and Europe, inflation levels had been low for an extended time; signs of increasing inflation started to appear. As discussed in Levin and Wright (2006) and Cochrane (2011), the US debt is a possible cause of future inflation[5]. In fact, in 2005, the U.S debt dangerously rose to 6.4% of GDP and the deficit was financed by foreign investments.

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[5] As foreign investments in dollar-denominated investments decline, the dollar could see a (sharp) decline in value. This would lead to a decline in the stock prices and a rise in interest rates and a fall in real estates prices. As a consequence, it could launch the US economy into a *downturn*.

Moreover, during the credit crunch and especially at the time of the Lehman default gold has experienced new highs. When fears of global depression became a real concern and when other traditional diversifiers were disappointing (e.g. in Europe bond yields of prime borrowers have fallen to very low levels), investors' search for a safe haven culminated in an extraordinary demand for gold (as stated above, investment has been the strongest source of growth of gold demand)

The idea I want to test in this paper is that if gold acts as a global store of value and a safe haven, it must move inversely to any risky financial asset class. In this way it can provide a hedge in the case such assets are loosing value. Flight to gold will happen when stock market prices drop.

The recent world crisis has been characterized by crashing real estate and stock markets. In Europe the default risk of several countries has dramatically increased resulting in a sovereign debt crisis. In an effort to address banks and governments' refinancing problems and to circumvent a binding zero lower bound for nominal interest rates, central banks started to pursue unconventional monetary policy with large asset buying programs inflating the balance sheet of many central banks and at the same time, increasing inflation expectations. In such a bad state of the economy, a safe haven is expected to deliver positive returns while risky assets are expected to lose value. As the economy recovers, the demand for gold should decrease and its price decline as a result.

The framework I use to investigate gold's ability to act as a safe haven (or a hedge) is in the spirit of the conditional covariance approach of Duffee (2005). Duffee employs the instrumental variable method pioneered by Campbell (1987) and Harvey (1989) to estimate the conditional covariance between U.S consumption growth and U.S stock returns. By estimating this model that allows for time varying conditional covariance between gold and the stock returns, I document the effectiveness of gold as a safe haven during times of "stress": the conditional covariance between gold and the stock market decreases during times of market turmoil. Almost all the crises periods which I identify with this methodology, are included in Bloom's (2009) research on uncertainty shocks. Two interesting facts emerge from the findings of these analyses: gold behaves both as a safe haven (its covariance with the market decreases or become increasingly negative during periods of financial crisis) and a safe harbor (the conditional covariance between gold and market excess returns decreases or becomes negative in correspondence to political uncertainty shocks). During periods of high uncertainty, gold's higher than average excess returns tend to be paired with lower than average values of market's excess returns. The effectiveness of gold as a safe haven is enhanced during periods of exceptional but severe crises: the largest peaks are observed during the global financial crises of 2007-2009 and, in particular, during the Lehman default (October 2008).

The chapter proceeds as follows. In Section I, I discuss related literature. Section II lays out the estimation methodology. In Section III, I show and discuss the empirical results. In Section IV, I conclude.

2.2. Literature Review

Scholars have emphasized a number of reasons why gold deserves a place in every portfolio. Lucey (2011) provides a recent in-depth survey of academic findings on gold. Researchers have mainly focused on gold's role as a diversifier. Jaffe (1989) is among the first scholars to show the diversification gains obtained when gold is included into a broader portfolio. In later research, Hillier et al (2006) contrast gold to other precious metals (i.e., silver and platinum) and conclude that gold is the most efficient diversifier. In a similar fashion, other studies highlight gold's ability against eroding effects of inflation. In an earlier study, Sherman (1983), among others[6], shows gold's attractiveness as an investment during periods of high inflation as the price rises in times of increasing inflation. In a more recent study, Bruno and Chincarini (2010) suggest that allocation to

[6] Kaufman and Winters (1989), Chua (1990), Johnson and Soenen (1997), and Davidson et al (2003).

gold (together with oil and bonds) minimizes downside risk with respect to inflation and insures positive real returns.

In addition, gold is treasured for its ability to hedge against dollar debasement. Capie et al., (2005), Tully and Lucey (2007), Sjaastad (2008), and Zagaglia and Marzo(2012) focus on the role of gold as a dollar hedge. The general evidence is that the price of gold depends on the U.S dollar: when the dollar declines, the dollar denominated price of gold rises. However, this phenomenon comes at the cost of increased short-run volatility and is quite unstable over time. There is also some evidence that gold serves as a store of value against other major currencies rather than the US dollar (Sjaastad and Scacciavillani, 1996).

Motivated by the current gold price boom and the increasingly important role of gold as a safe haven and a hedge, Baur and Lucey (2010) and Baur and McDermott (2010) have recently examined gold's hedge and safe haven properties. They detect important linkages between gold, equity, and bonds.

This chapter is also related to the literature investigating the volatility of gold. Tulley and Lucey (2007) and Batten and Lucey (2010) focus on some of the features of gold market volatility: the former estimate an asymmetric power Garch (AP-GARCH) model but find not statistically significant results, while the latter investigates volatility in the gold futures market. Baur (2011) studies the volatility of gold and shows that there is an inverted asymmetric reaction[7] to positive and negative shocks. They propose a possible explanation for this effect: investor use gold's positive price as a proxy for future adverse conditions or uncertainty regarding risky asset markets. The focus of this chapter is, however, different from the gold volatility related literature. These studies analyze some features of the volatility of gold (which is a measure of the quantity of the risk) but do not focus on the "directional change" of the risk itself. In this chapter, I focus on the *conditional covariance*, instead of focusing on the unconditional one. If gold co-varies in

[7] A large body of research has focused on equity markets volatility asymmetry to negative and positive shocks. Black, 1976; Christie, 1982; Campbell and Hentschel, 1992 examine the volatility in equity markets and its asymmetric behavior to positive and negative shocks. They find an asymmetry in the reaction to shocks: they observe larger increase in volatility in response to negative shocks than to positive shocks. Among the potential explanations are firms' leverage and a volatility induced by feedback affect.

the same direction as the market in time of financial distress and political uncertainty, the effectiveness of gold as a safe haven (or hedge) is compromised. It is thus essential to analyze the extent to which gold and market excess returns vary together (co-vary) as a function of conditioning variables able to predict risk premia.

2.3. Methodology

2.3.1 Intuition: Gold Predictability and the Stock Market

Investors care about their portfolio's performance during period of market distress and they seek for safe havens in financial markets (i.e., flight to quality). Return predictability is of considerable interest to investors who can develop market timing portfolio strategies that exploit predictability to enhance profits during particular states of the world, that is, in times of market stress or turmoil, if indeed such predictability is present.

Researchers have looked for forecasting variables: any variable that forecasts asset returns or macroeconomic variables (i.e., good and bad times) is a candidate. Empirical evidence[8] has shown that returns are predictable by financial ratios, such as the price-dividend or price-earning ratio.

Time variation in price-dividend ratios is intimately linked to time variation in expected returns and in expected dividend growth rates. A high price-dividend ratio (Campbell and Shiller (1988)) has to predict low future returns, high dividend growth or prices raising even further, a rational bubble. This is a direct implication of the Campbell and Shiller (1988a) approximation.

[8] At the beginning, this finding has been interpreted as evidence against efficient markets. 20 years later, predictability in expected returns is not more considered as an evidence of market inefficiency. Nowadays literature takes returns predictability as given and investigates how it affects asset allocation decisions.

The log-linear approximation looks like the following

$$r_{t+1} \approx \rho\, p_{t+1} + (1-\rho)\, d_{t+1} - p_t + k \,,$$

where

$r_{t+1} = \log((P_{t+1} + D_{t+1}) / P_t)$

$p_t = \log(P_t)$

$d_t = \log(D_t)$

ρ is a parameter slightly less than 1 and k is a constant. P_t is the stock price at the end of the period t while D_t is the dividend paid during period t.

This equation contains no theory but is rather an accounting identity, which holds ex-post but also ex-ante. Empirically, 100% of the variation in the price-dividend ratio comes from time variation in expected returns (Cochrane (2008)). In particular, high price-dividend ratios forecast high future market returns. The empirical evidence favoring predictability, as measured by the R^2 statistic, tends to be stronger at longer horizons due to the persistence in the forecasting variable (Campbell and Shiller (1988b); Fama and French (1998)).

I investigate long-horizon return predictability in the context of the following long horizon regression (Cochrane, 2005) framework:

$$\sum_{i=1}^{H} r_{t+1}^{e} = \alpha_H + \beta_H (D_t / P_t) + e_{t+1}^{H} \tag{1}$$

I start from H-period gold returns, where H = [1, 4, 8, 12, 24] in months. I sum log excess gold returns (r^e) and use the log dividend price log (D_t / P_t) ratio.

For each sample length and return horizon I present results (Table 1) for four conventional covariance estimators: "OLS", the standard OLS covariance estimator, "Newey-West" which uses a Bartlett kernel to downweight higher order autocorrelation and to ensure positive definiteness of the spectral density matrix, the "Hansen-Hodrick" which is the heteroscedasticity-consistent version of Hansen and Hodrick (1980), and "Hodrick" which is the Hodrick's (1992) estimator that produces heteroscedasticity-consistent standard errors.

Results in Table 1 show that gold is negatively forecasted by the dividend-price ratio at long horizon. During bad times when stock prices are low, a high dividend-price ratio forecasts low future gold returns but high future stock market returns. During good times, on the contrary, a low dividend-price ratio forecast low future stocks returns, periods of downturns but high returns on gold. This means that in bad times, stock and gold markets are negatively correlated. This is what one would expect from a reliable safe haven during times of stress: gold should do well during periods of negative stock market returns. The hypothesis that gold acts as a key safe haven for financial markets, especially during periods of extreme negative shocks, has the conditional implication that its returns should increase (or, its value should be, at least, stable) when other risky assets weaken or lose value.

Long-horizon return regressions potentially suffer from two econometric problems: the bias in the usual OLS slope estimate that arises when the predictor variable is persistent and its innovations are strongly correlated with returns and the presence of strong autocorrelation due to overlapping observations. A number of studies have addressed the specific issue of overlapping observations. Hansen and Hodrick (1980), Newey and West (1987), and Hodrick (1992) offer sophisticated techniques to mitigate these concerns.

The truncated-kernel Heteroscedasticity and Autocorrelation Consistent (HAC) covariance matrix, introduced by Newey and West (1987) is widely used by economists[9] to "correct" the standard errors of OLS time series coefficient for serial correlation. The covariance estimator presented by Hodrick (1992) imposes that the regressors need to be past returns and returns need not be conditionally homoscedastic. This is a method specific to multiple step predictability regressions as it uses the one-step regression residuals to compute the covariance matrix for multiple step regressions, and computes them under the null of no predictability. Consequently, this is an alternative method for calculating predictability test statistics. This estimator produces heteroscedasticity-consistent standard errors. Hodrick (1992) instead of summing the error terms into the future to obtain an estimate of the standard errors, sums the error terms into the past. Scholars show that the performance of Hodrick's (1992) standard errors is far superior to Newey and West's (1987) or to the robust GMM generalization of Hansen and Hodrick's (1980) standard errors typically used in the literature.

In my predictability evidence I consider all the conventional methodologies and the predictability is confirmed even when the most conservative Hodrick's (1992) standard errors are employed.

2.3.2. The Econometric Approach for the Conditional Covariance Estimation

To determine whether gold acts as a safe haven during periods of market distress or turmoil I rely on Duffee's (2005) approach. He investigates the conditional covariance between consumption and US stock market. The underlying reasoning of Duffee's methodology is that we cannot observe either the true innovations to market and gold returns or the entire set of conditioning information available to investors. We can, instead, use forecasting regressions to construct fitted residuals as proxies for the true innovations. The product of the resulting fitted residuals is then projected on a set of instruments (see Campbell (1987) and Harvey (1989)).

[9] Greene (2003: 201) reports that its use is now "standard in the econometrics literature."

As a first step, expected excess gold and market returns can be written as the sum of the one-period-ahead expectations and innovations

$$r_{t+1} = E_t[r_{t+1}] + \varepsilon^r_{t+1} \tag{2}$$

$$g_{t+1} = E_t[g_{t+1}] + \varepsilon^g_{t+1} \tag{3}$$

The forecasting regressions for returns on the market and on gold can be written as

$$r_{t+1} = \alpha_r Y^r_t + e^r_t \tag{4}$$

$$g_{t+1} = \alpha_g Y^g_t + e^g_t \tag{5}$$

where α_r and α_g are the parameters vectors; Y^r and Y^g are the vectors of predictive variables and are realized in period t or earlier. This is the first-step regression needed to extract the expectation at time t, that is, the predictable element in equations (2) and (3).

The product of the fitted residuals is the covariance between gold and the US stock market and can be expressed as

$$Cov_t(r_{t+1}, g_{t+1}) = E_t\left\lfloor \varepsilon^r_{t+1}\ \varepsilon^g_{t+1} \right\rfloor \tag{6}$$

The first stage regression projects the ex post covariance estimate on a set of instruments, Z_t, to obtain an estimate of the time t conditional covariance.

$$\hat{C}ov^*(r_{t+1}, g_{t+1}) = \alpha_z Z_t + \eta_{t+1} \tag{7}$$

$$\hat{C}ov(r_{t+1}, g_{t+1}) = \alpha_z Z_t \tag{8}$$

where the asterisk indicates an ex post estimate. Equation (8) is the conditional time t covariance estimate of unobservable conditional covariance in equation (6). Equation (7) is estimated with OLS.

2.3.3. Data Description and Instrumental Variables.

For the empirical analysis, I use monthly and daily Fixing prices in U.S. dollars on a month and day-average[10] from January 1968 to June 2011. I also use monthly and daily U.S. equity returns from the CRSP NYSE, AMEX, and Nasdaq files (from CRSP). As a proxy of the market portfolio I use the CRSP value weighted index. As proxy of the risk free rate, I use the one-month Treasury bill rate. All data are analyzed from the perspective of a US investor, and are expressed in U.S. dollar. The analysis focuses on the period January 1968 to June 2012.

[10] The price of gold is fixed twice, on a daily basis, in London, by the five members of the London gold pool (the members of the London Bullion Market Association (LBMA)). The fixes start at 10.30am and 3.00 pm London time. The London Fixings are internationally published benchmarks for precious metals prices. It is the price at which the world's largest size gold (silver) purchases and sales are accomplished on any given day. London gold (and silver) fix prices can be found on LBMA's website (http://www.lbma.org.uk/pages/index.cfm)

My choice of predictive variables follows a well-know literature based on Campbell and Shiller's (1988) seminal work.

As predictors in (Y_t^r, Y_t^g) I use the dividend-price ratio and I include one lag of gold excess returns to account for possible serial correlation.

To summarize, the vectors of predictive variables are

$$Y_t^r = [1, dp_t, r_t] \qquad\qquad Y_t^g = [1, g_t]$$

The aim of this chapter is to show that the conditional covariance of gold with the market decreases in times of market distress or turmoil, when expected risk premia increase. Consequently, in the second stage, I include as instruments (the Z_t) variables that have been shown to be good proxies for time varying risk premia during market downturns.
The first instrument considered is the price-dividend ratio. Cochrane (2008) shows that changes in the price-dividend ratio are due to time varying risk premia. Same reasoning applies to the lagged variance of gold and stock returns as well as lags of stock and gold returns since large movements are associated with increases in the variance and risk premia (Sarno et al. (2011)). Following Duffee (2005), I include lagged ex post covariance estimates to take into account fluctuations in volatility. As shown by Pyndick and Rotemberg (1988), gold prices are affected by unobserved forecasts of economic variables. Consequently, I include lagged changes in the unemployment rate, CPI,

industrial production and the volatility index of Bloom (2009) as explanatory variables of the conditional covariance. For similar reasons, I include change in oil prices (as suggested in Baffes (2007), Cheng et al., (2009), and Zhang and Wei (2010)).

The set of instrumental variables in the second stage regression can be summarized as follow:

$$Z_t = [1, dp_t, r_t, g_t, \mathrm{var}_t^r, \mathrm{var}_t^g, Cov_t, \Delta Oil_t, \Delta CPI_t, \Delta up_t, \Delta ur_t, \Delta vol_t]$$

I extend the analyses by employing a (more conservative) subset of instruments

$$Z_t = [1, r_t, g_t, \mathrm{var}_t^r, \mathrm{var}_t^g, Cov_t, \Delta CPI_t]$$

Following Duffee, I compute ex post covariances and variances using demeaned excess stock and gold returns. In this way, Duffee obtains ex-post covariance estimates that are similar to the traditional ones but do not depend on parameter estimates from the first-stage regressions.

$$\mathrm{var}_t^r = \sum_{i=0}^{1}(r_{t-1} - \bar{r})^2; \qquad \mathrm{var}_t^g = \sum_{i=0}^{1}(g_{t-1} - \bar{g})^2;$$

$$Cov_t = \sum_{i=0}^{2}(r_{t-1} - \bar{r})(g_{t-1} - \bar{g}),$$

where $\overline{g}$ and $\overline{r}$ are, respectively, the market and gold excess return averages.

2.4. Empirical Results

The conditional covariance between market and gold excess returns shows a pattern that is consistent with the safe haven (and tail protect) argument. Gold's returns are inversely related to the market excess returns in times of stress. This relation holds also during period of political instability or global uncertainty. This is exactly what makes an asset a safe haven asset: gold is a "safe" from losses in financial markets and it behaves as a safe harbor in times of uncertainty. Figure 1 shows the conditional covariance between daily market and gold excess returns using a rolling window approach. The covariance is for most of the period (December 1986-December 2012) negative or around zero with few interesting exceptions. The covariance decreases towards large negative values during the 1987 Crash and the Black Monday (October 1987). As the shock fades, the covariance slowly returns to values closer to zero (still negative). Interestingly, the covariance becomes increasingly negative during the 1990-92 Recession. Once again, the covariance moves back to values around the zero (also during the 1995-1996 Government Shutdown[11]). Gold's price reaction to the 9/11 terroristic attacks (September 2001) confirms gold's perception as a safe "harbor" during periods of extreme uncertainty and fear. During this period the price of gold increased as investors rebalanced their portfolios and sold what they believed were riskier assets. The covariance stays negative also during the WorldCom and Enron bankruptcies (July-September 2002). In the following period, investors kept investing in gold. This time, the covariance with the

[11] From November 14 through November 19, 1995 and from December 16, 1995 to January 6, 1996 the U.S. government was shut down as a result of a budgetary impasse between Congress and the White House.

market increased towards (small but) positive values during market upturns (instead of going back to slightly negative values). As predicted, gold's ability to protect against losses in financial markets is confirmed during the Credit Crunch (August 2007 – March 2009), with the largest negative covariance values observed during the sadly famous Lehman Default (October 2008). Starting from March 2009, as the market recovers, the relation between the market and gold becomes positive: even though the stock market was stabilizing, the demand and hence the price for gold continued to rise as investors feared further turmoil ahead, explaining the positive covariance in this period As a consequence of the European sovereign debt crisis, the US stock market started to decrease again, in September 2011, resulting again in a negative covariance between gold and the market. The most likely explanation for these results is that investors are continuously looking for a stable asset in unstable times. Particularly, the recent world financial crisis together with the current European sovereign debt crisis has caused an increasing demand for gold and, thus, the corresponding price surge.

In the next section, I estimate the conditional covariance between gold and the market following the methodology of Duffee (2009).

While the database covers the period 1968-2011, in the benchmark econometric estimation, I consider the period starting from 1981 in order to eliminate possible concerns about the breakdown of the Bretton Woods regime (December 1972 – March 1973). In 1971, the Federal Reserve in New York closed its "gold window", ending the gold exchange standard. By 1973, most of the major countries had adopted a floating exchange rate system and in 1975, American citizens were again permitted to own gold after 42 years[12]. I start the sample in 1981 to also avoid taking into account the 1980 Gold Bubble[13].

[12] The Comex 1 kilo contract was launched and the US Treasury began five years of gold sales.

[13] The London Fixing experiments its first record at $850 on January 21st 1980. This presented the end of an inflationary decade of oil prices shocks, the freezing of Iran's assets and the Soviet invasion of Afghanistan, which sent investor into gold. At the end of this period, the price of gold plummeted down and remained steady, around $300-400 range, for several years.

Table 2 contains the results from the first stage regressions (Regressions 4 and 5). Figure 2 plots the ex-post estimate of the covariance $Cov^*(r_{t+1}, g_{t+1})$ obtained as the product of the residuals of these regressions. The graph confirms, to some extent, the pattern discussed above. Table 3 contains the results of the Second Stage regression. The covariance predictability is robust to the choice of most of the instruments. However, the inclusion of volatility and changes in oil prices and industrial production does not help to predict the conditional covariance.

Figure 3 plots the conditional covariance estimated using the full set of instruments while Figure 4 plots the conditional covariance using the subset of instruments (see section C). The covariance shows a fair degree of time variation and peaks in times of crises or political uncertainty. The most dramatic event in the sample seems to be the Credit Crunch followed by the Lehman default (2007-2009; October 2008). Gold reconfirms its safe haven ability during the 1987 Crash, followed by the 9/11 attacks in September 2001 and the WorldCom/Enron bankruptcies (July-September 2002). Large decreases in the conditional covariance also occur during the Latam defaults and the Latin American debt crisis (early 80s), the 1990-92 Recession (already discussed above), during the LTMC collapse and the Russian default (August-September 1998)[14].

However, there is a data point that needs further attention. In October 1999 the conditional covariance registers a large spike. This is probably due to a gold market specific event: the Washington Agreement of Gold (a.k.a. the Central Gold Agreement) set a five-year term on limited gold sales by central banks to stabilize the market[15].

The above results provide strong evidence that gold acts as a safe haven and a hedge during periods of stress. Moreover, gold is not only risk insurance for portfolios but also a

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14 All the episodes of crises considered here, with the exception of the political episodes, match those identified by Bloom's (2009) list.

15 In August 1999, the price of gold fell to an all-time low at $251.70 on concerns about the central banks reducing gold bullion reserves while at the same tile companies were selling gold in forward markets to protect against falling prices. Also, the Euro was introduced, with the European Central Bank holding 15% of its reserves in gold. The Bank of England announced the sale of half of the UK's gold stock.

harbor in periods of high political (not only financial) uncertainty. In particular, these results (see Figure 4) are robust to focusing to my restricted set of predictive variables.

2.5. Conclusions

In this chapter, I show that gold acts as a store of value during periods of financial crisis. Moreover, my findings support the view that investors consider gold as an important safe haven when a global flight to quality takes place. Gold returns increase in times of chaos, war or financial crises. It would be incorrect to assume that gold's ability to be safe from financial losses and at the same time not expect gold's price to trend downwards in the future. Gold prices can be highly volatile. In late 2011, after reaching record levels, the price of gold fell nearly 20% in one week.

Table 1. EXCESS RETURNS/DIVICEND-PRICE RATIO PREDICTIVE REGRESSIONS

$$\sum_{i=1}^{H} r_{t+1}^{e} = \alpha_H + \beta_H (D_t / P_t) + e_{t+1}^{H}$$

The regressor is the monthly gold log excess return for different horizons (shown in the first column). The regressand is the lagged log monthly dividend-price ratio level. All regressions are run with a constant. The second column shows the OLS estimate of beta. For each sample length and return horizon I present results for the four conventional covariance estimators: “OLS”, the standard OLS covariance estimator, “Newey-West” which uses the Newey-West HAC estimator for long-run covariance, the “Hansen-Hodrick” which is the heteroscedasticity-consistent version of Hansen and Hodrick (1980), and “Hodrick” which is the Hodrick’s (1982) estimator that produces heteroscedasticity-consistent standard errors. The last column shows the coefficient of determination, R^2. The regressions are for the period January 1979- March 2010.

Horizon (In months)	Excess Gold Returns					
	β	OLS	Newey-West	Hansen-Hodrick	Hodrick	R^2
1	-0.0048	(0.0060)	(0.0078)	(0.0076)	(0.0076)	0.0018
4	-0.0180	(0.0121)	(0.0284)	(0.0329)	(0.0301)	0.0064
8	-0.0410	(0.0184)	(0.0572)	(0.0687)	(0.0577)	0.0143
12	-0.0791	(0.0229)	(0.0762)	(0.0873)	(0.0790)	0.0343
24	-0.2402	(0.0286)	(0.1001)	(0.1088)	(0.1319)	0.1784

Table 2. FIRST STAGE REGRESSIONS: MARKET RETURNS AND GOLD RETURNS

First column shows the regression results of the one month market return on a constant, the logarithm of the dividend-price ratio, and the lagged excess market return (see equation 4). The second column shows the regression results of the one month lagged excess gold return on a constant and the lagged excess gold return (see equation 5). The explanatory variables are lagged one month. The regressions are for the period January 1979- March 2010. The estimates are OLS and the standard errors reported in parenthesis.

	Market	**Gold**
α	-0.0647 (0.56)	0.0684 (0.25)
dp_t	0.1919 (0.17)	
r_{t-1}	0.1054 (0.05)	
g_{t-1}		0.2089 (0.05)

Table 3. SECOND STAGE REGRESSIONS: MARKET RETURNS AND GOLD RETURNS

This table shows the point estimates from the Second Stage regression (Equation 7). The cross product of residuals from the First Stage regression for market and gold excess returns is regressed on the sell of instruments. Two sets of instruments are considered. “All Instruments” includes: a constant, the dividend-price ratio, the excess market return (one month lag), the gold excess return (one month lag), the lagged one month variances for market and gold excess returns, the lagged one and two-month lagged ex-post covariances of gold and market excess returns, the change in the unemployment rate, the change in the oil price, the change in the industrial production, the change in the Consumer Price Index, and the volatility index. “Ex-Instruments” includes: a constant, the excess market return (one month lag), the gold excess return (one month lag), the lagged one month variances for market and gold excess returns, the lagged one and two-month lagged ex-post covariances of gold and market excess returns. The period of estimation is December 1979 – March 2010. The estimates are OLS and the standard errors reported in parenthesis.

	ALL INSTRUMENTS	EX-INSTRUMENTS
INSTRUMENTS	α_z	α_z
α	-5.1507	-4.1571
	(4.40)	(2.13)
dp_t	-0.3325	
	(1.53)	
r_{t-1}	-0.4935	-0.5987
	(0.40)	(0.39)
g_{t-1}	-0.9892	-1.0366
	(0.38)	(0.38)
Cov_{t-1}	0.1048	0.1081
	(0.04)	(0.04)
Cov_{t-2}	-0.0004	-0.0052
	(0.04)	(0.04)
var_{t-1}^{r}	0.3733	0.3913
	(0.28)	(0.26)
var_{t-1}^{g}	0.5817	0.6228
	(0.24)	(0.24)
Δur_t	-96.78	116.02
	(50.0)	(44.4)
Δoil_t	2.4532	
	(4.97)	
Δip_t	24.2886	
	(197)	
ΔCPI_t	129.93	
	(80.1)	
Vol_t	0.0939	
	(0.16)	

Figure 1. DAILY COVARIANCE BETWEEN GOLD AND MARKET EXCESS RETURNS

The historical daily rolling covariance of gold holdings to the U.S. market portfolio's return distribution is shown. The rolling period consists of 250 days. Period of estimation: January 1986 - June 2012.

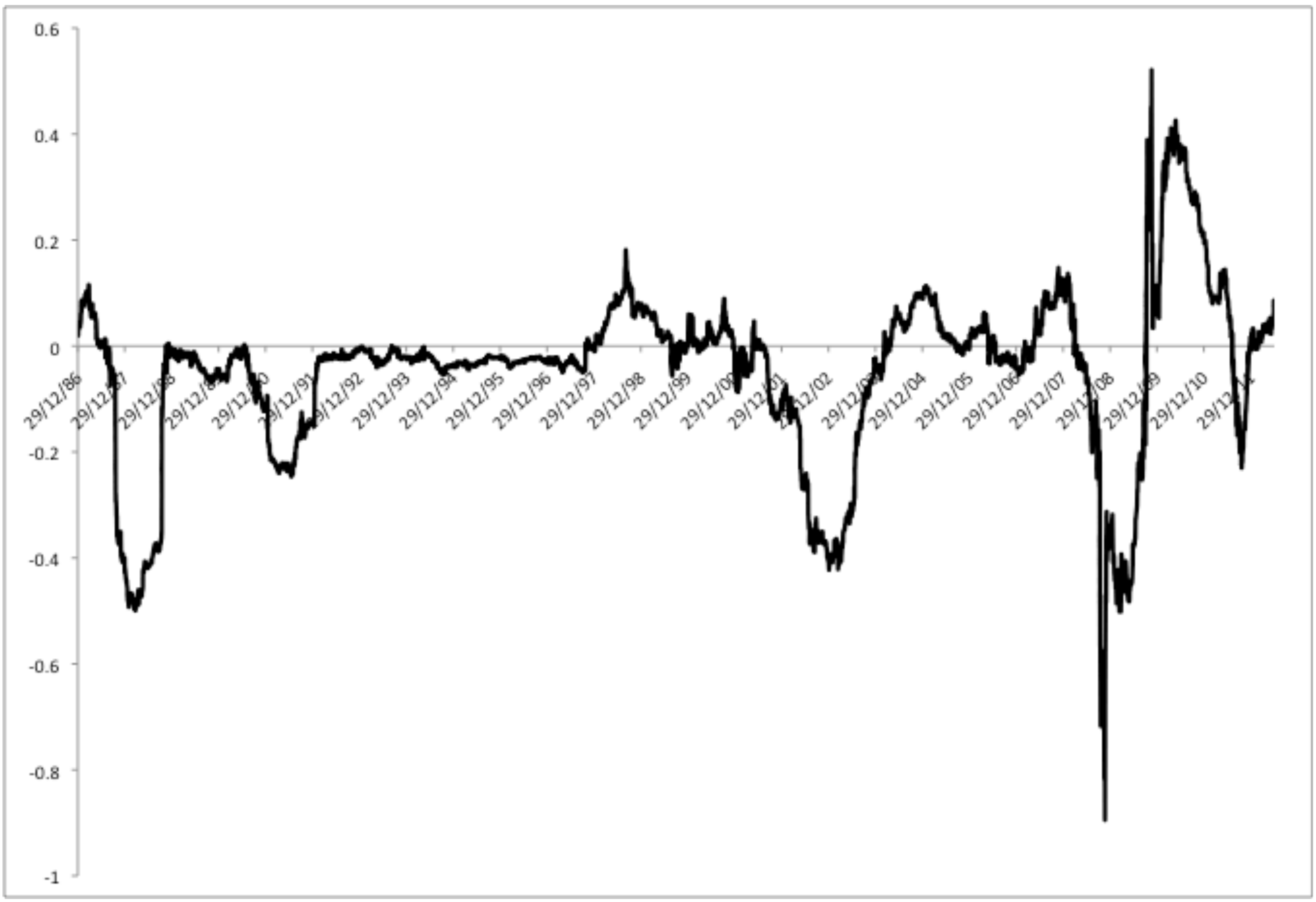


Figure 1a. DAILY COVARIANCE BETWEEN GOLD AND MARKET EXCESS RETURNS

The historical daily rolling covariance of gold holdings to the U.S. market portfolio's return distribution is shown. The rolling period consists of 250 days. Period of estimation: January 2000 - June 2012.

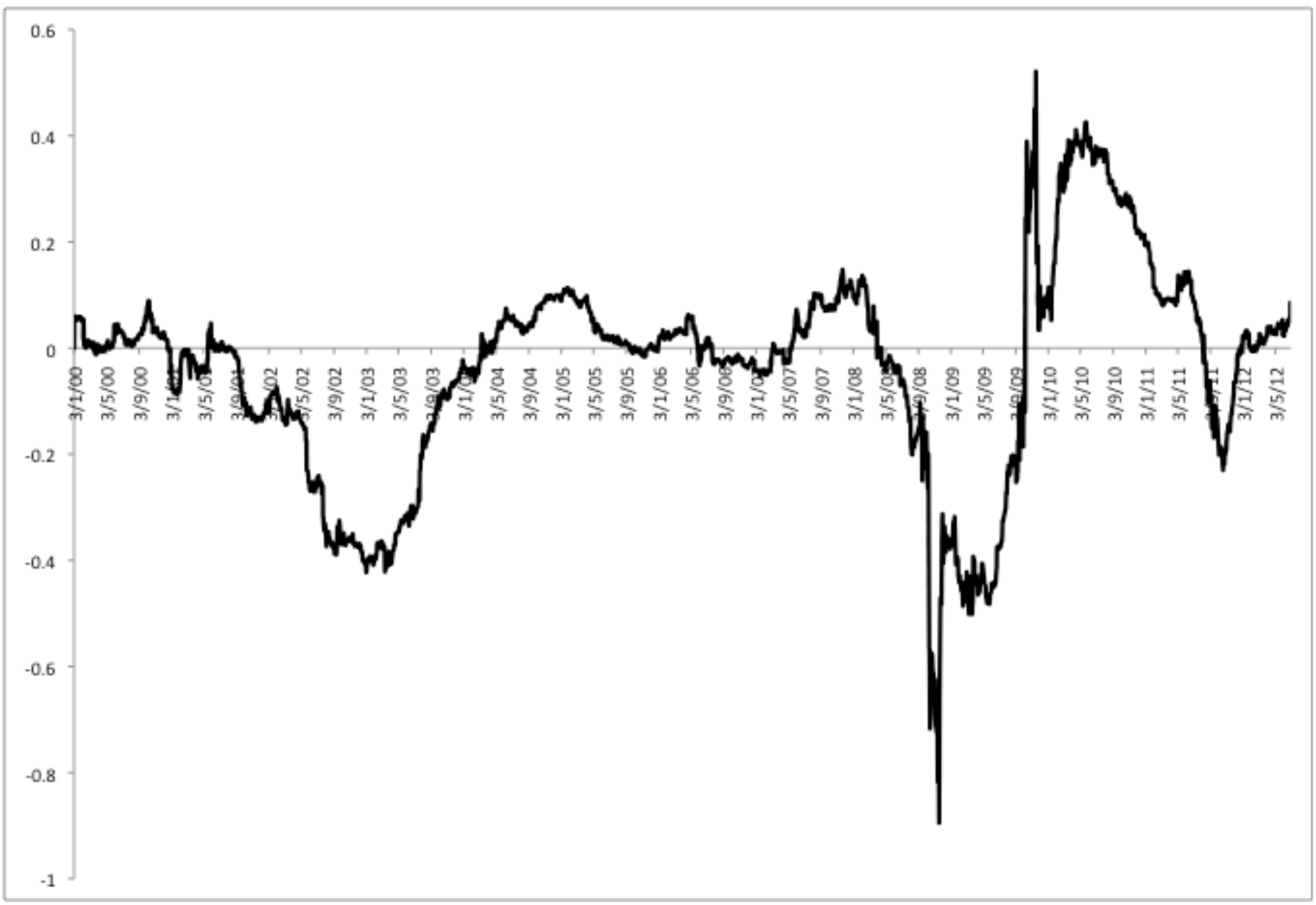


Figure 2. EX POST COVARIANCE $Cov_t^*(r_{t+1}, g_{t+1})$

The ex post covariance is the given by the product of the residuals obtained from the First Stage regression.

$$Cov_t^*(r_{t+1}, g_{t+1}) = \varepsilon_{t+1}^r \ \varepsilon_{t+1}^g$$

Where ε_{t+1}^r and ε_{t+1}^g represent the residual from the Equations 4 and 5. The ex post covariance is monthly (June 1981 – March 2010). The estimates are obtained by OLS.

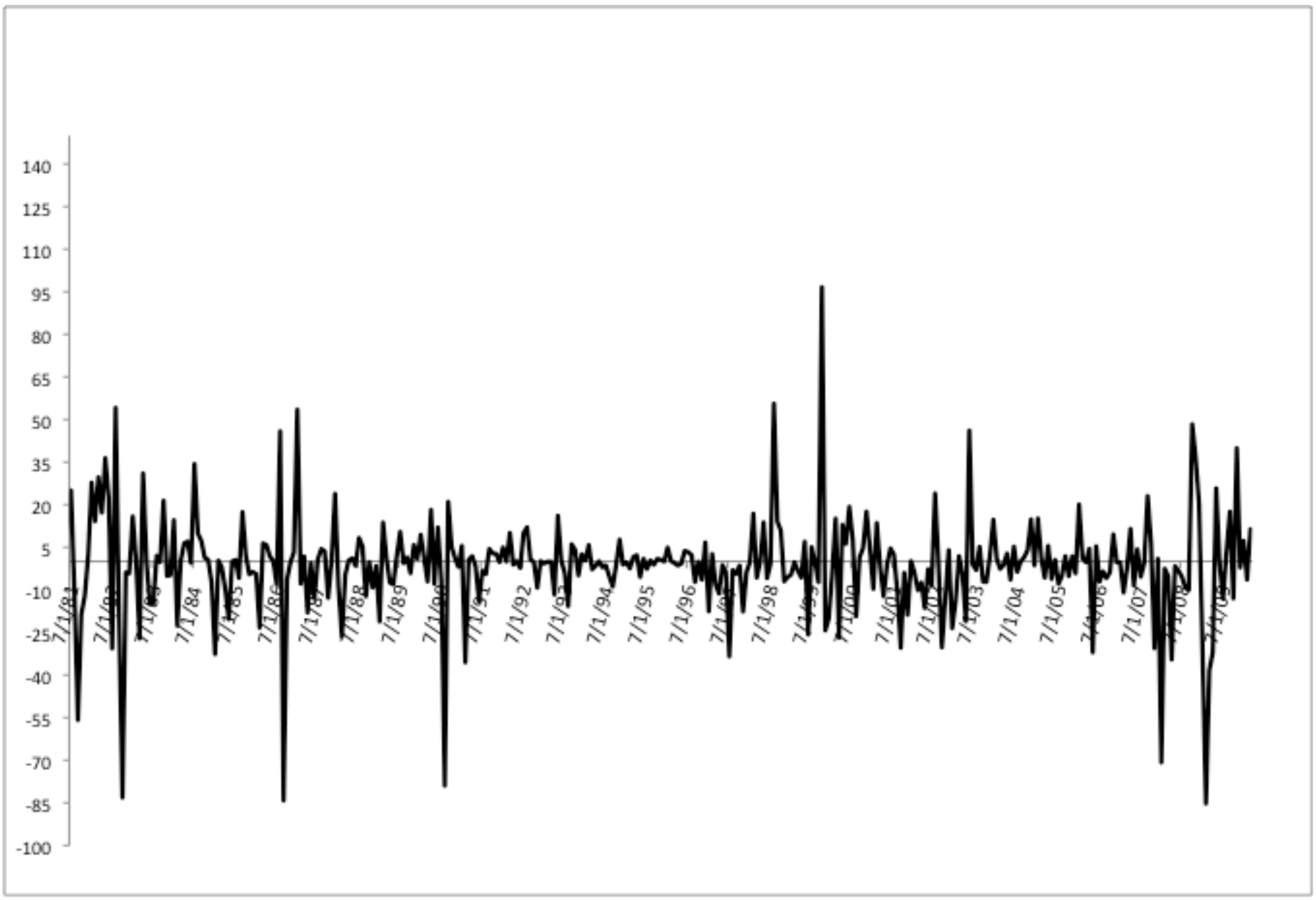


Figure 3. CONDITIONAL COVARIANCE $Cov_t(r_{t+1}, g_{t+1})$: All Instruments

The conditional covariance is the fitted value of the second stage regression (7)

$$Cov^*(r_{t+1}, g_{t+1}) = \alpha_z Z_t + \eta_{t+1}$$

The first stage regression projects the ex post estimates (obtained from the first stage regression) on a set of instruments (Z_t) to produce a conditional covariance estimate. The set of instrumental variables can be summarized as follow:

$$Z_t = [1, dp_t, r_t, g_t, \text{var}_t^r, \text{var}_t^g, Cov_t, \Delta Oil_t, \Delta CPI_t, \Delta up_t, \Delta ur_t, \Delta vol_t]$$

A detailed description can be found in Section C.

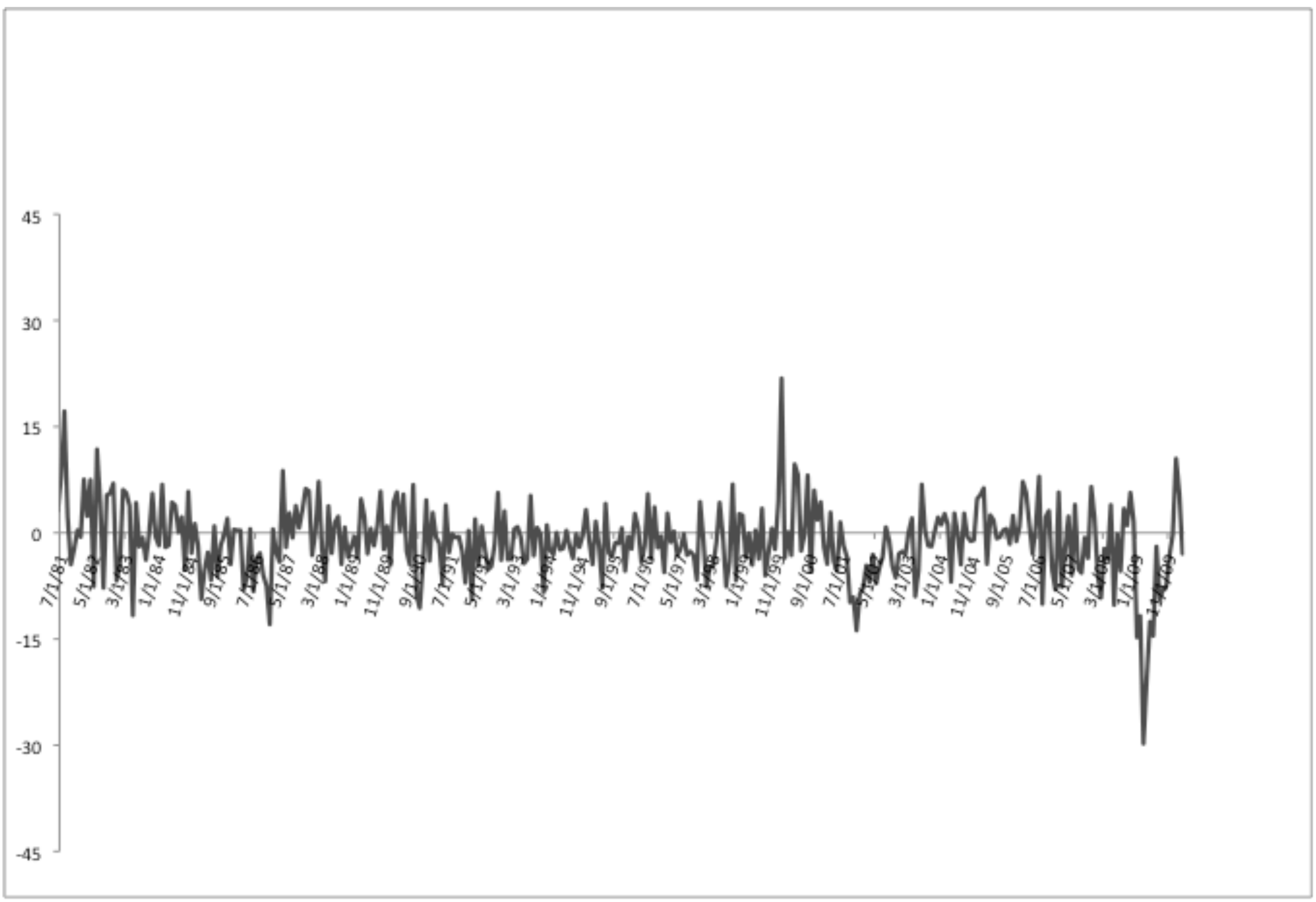


Figure 4. CONDITIONAL COVARIANCE $Cov_t(r_{t+1}, g_{t+1})$: Ex-Instruments

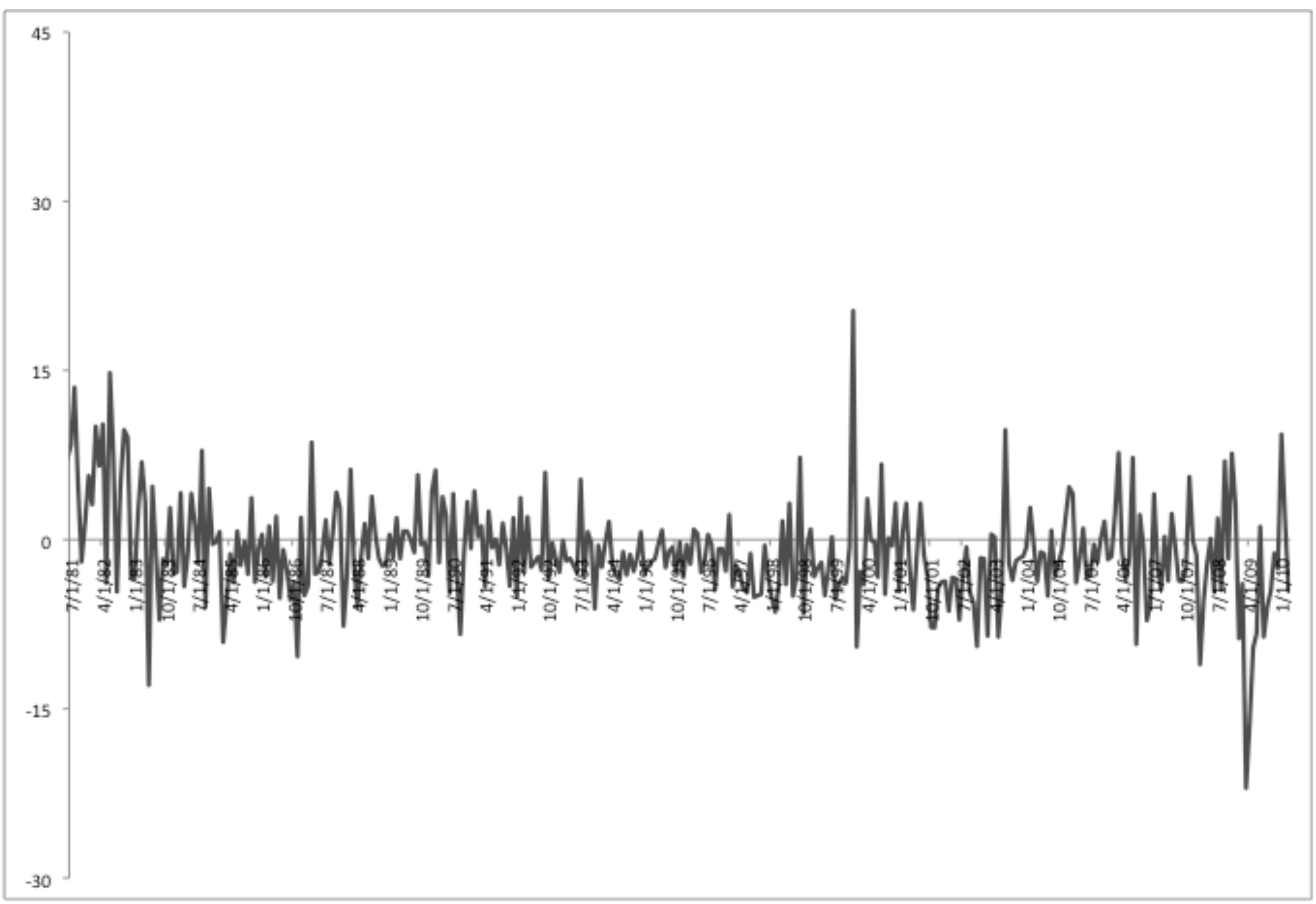
The conditional covariance is the fitted value of the second stage regression (7)

$$Cov^*(r_{t+1}, g_{t+1}) = \alpha_z Z_t + \eta_{t+1}$$

The first stage regression projects the ex post estimates (obtained from the first stage regression) on a set of instruments (Z_t) to produce a conditional covariance estimate. The set of instrumental variables can be summarized as follow:

$$Z_t = [1, r_t, g_t, \mathrm{var}_t^r, \mathrm{var}_t^g, Cov_t, \Delta CPI_t]$$

A detailed description can be found in Section C.



3. Tale of Tails: Precious Metals and Higher Co-moments

3.1. Introduction

Gold is the oldest financial asset. Throughout history, gold has served as both currency and a store of value. Gold has been valued for its beauty and used as jewelry for thousands of years. In 1091 B.C. squares of gold, about the size of a postage stamp, become a form of money in China. In 560 B.C. in Lydia, now a region of Turkey, the first coin was minted. During the first century B.C., the Romans struck the first gold “aureus”, a coin that continued to circulate for almost 400 years. The Bank of England was the first central bank to have gold reserves. In 1717, Sir Isaac Newton, as master of the Royal Mint, fixed the price of gold at about 3.17 pounds per troy ounce, essentially putting Britain on a gold standard until 1931. The US adopted the gold standard through passage of the Gold Standard Act in 1900. In 1944, the Bretton Woods agreement pegged the U.S. dollar to gold and other currencies to the dollar. The dollar is set to maintain a conversion rate of 35 dollars to one ounce of gold. In 1968 this system collapsed and the market price of gold became free to fluctuate.

Throughout history, gold has served as a safe haven and hedge against inflation and currency debasement. The Roman aureus was originally valued at 25 silver denarii. A little over three centuries later, in 301 A.D., the denarii contained little silver and the aureus was valued at 833 1/3rd denarii; by 324 A.D., the exchange rate was 1 aureus to 4,350 denarii[1]. In addition to providing protection against currency inflation, gold may add value to portfolios through the low correlation of its returns with those of stocks and bonds returns combined with the positive skewness[2] of its returns.

In this paper, I examine the investment characteristics of gold, when added to a well-diversified portfolio of equities. I calculate the unconditional coskewness of gold with the market portfolio for daily and monthly data. I also calculate coskewness conditional on positive and negative market returns and for periods of high and low uncertainty as inferred from implied volatilities. I find that gold has positive coskewness with the market

1 Green, Timothy. 2007. The Ages of Gold. London, UK. GFMS Ltd

2 Lucey, Poti et all, 2006

portfolio during bear markets or market turmoil. Moreover, gold's returns tend to be higher during periods of high uncertainty. I show that gold is desirable to risk adverse investors since it tends to decrease the probability and the magnitude of extreme bad outcomes.

The remainder of this paper is organized as follows: In Section I, I give a brief overview of the main findings in the literature on gold and precious metals. In Section II, I describe the coskewness measures and models, before I present the data and the empirical models in Section III. In section IV, I present the empirical results. In Section V, I offer some concluding remarks.

3.2. The Gold Market.

Current above ground stocks of gold are estimate to be 173,400 tonnes with a value of approximately $9.9 trillion,[3] about one quarter of the market capitalization of $35.7 trillions of the world's ten largest equity exchanges.[4] Thus, at current prices, gold makes up a small, but non-trivial, portion of the world portfolio.

Unlike most other commodities, the majority of the gold ever produced still exists. Central banks and multinational organizations (such as the IMF) currently hold about 17% of the global above-ground stocks of gold as a reserve asset (29,000 tons dispersed across approximately 110 organizations) and industrial demand is low relative to new supply. Gold is an industrial metal as well however, industrial use is small relative to supply. In 2011, industrial demand, including dentistry, was 453 tonnes, far less than new production of 2,818 tonnes. Since 2003, investment has represented the strongest source of growth in demand and it currently accounts for approximately the 19% of gold demand. Furthermore, in many countries, high carat jewelry is viewed as an investment

3 Price of $1,780 per troy ounce as of October 1, 2012. Above ground stock at end of 2011 of 171,300 tonnes (Gold Survey 2012, Thomson Reuters GFMS) plus 2,100 tonnes of new production through October 1, 2012 (Gold Survey 2012, Thomson Reuters GFMS and The Economist, October 13, 2012).

4 As of end of June 2012, "Market highlights for first half-year 2012," World Federation of Exchanges, http://www.world-exchanges.org/files/files/1st%20half%20%202012%20WFE%20market%20highlights%20with%20comments.pdf

that can be easily liquidated. In 2011, 1973 tonnes of new gold jewelry were fabricated, while 1661 tonnes of old gold scrap were reclaimed at refineries.[5]

Between 1933 and November 1973, U.S. citizens were not allowed to possess gold except as jewelry. After 1973, U.S. investor could buy and sell gold coins and bars, however, it is likely that many were not comfortable doing so. The introduction of gold exchange trade funds (ETFs) in 2003 represented a technology shift for retail investors in gold who could now buy and sell gold as they do with common stocks and other ETFs. ETFs gold holdings have grown to 2,461 tonnes or, approximately, U.S. $140 Billions[6]. In addition to retail investors, institutional investors, including large hedge funds, use ETFs to invest in gold[7]. On the whole, although the literature has documented the role and the impact that gold has had on financial markets, investors, and the modern firm, the results are mixed and there are very few studies on the specific distributional properties of gold and their contribution to a portfolio's return distribution.

Perhaps the area in which most of the literature focuses on is the role of gold as a tool of diversification. Jaffe (1989) finds that by including gold in financial portfolios a well-diversified investor can reduce their variance, while slightly improving returns. Gold can then act as a hedge against both stocks and inflation. Other academic researchers such as Sherman (1982) and Chua (1990) have focused on the role and weighting that gold has in a portfolio. It appears that by holding between 6% and 25% of gold in equity portfolios results in lower risk and higher returns. Lucey, Poti et al (2006) examine portfolio choices when the investor is concerned about downside protection and find an optimal weight of between 6% and 25% that depends on the period and the typology of assets included (focusing mainly on equity). This result might be partially explained by Johnson and Soenen's (1997) findings. According to their research, gold is an attractive investment in terms of diversification only in specific periods, for example in 1978-1983, whereas it yielded negative returns in 1984-1995. More recently, Hillier et al (2006) investigate the role of precious metals in financial markets. They show that gold, platinum

5 Gold Survey 2012, Thomson Reuters GFMS

6 Ibid.

7 "Paulson boosts holdings of gold ETF", Financial Times, August 15, 2012.

and silver have some hedging potentials. They show that financial portfolios that contain precious metals perform significantly better than those that contain only financial assets, particularly during periods of abnormal volatility. Baur and McDermott (2010) take this previous work one step further by extending it to more countries. They obtain different results depending on the crisis periods and the countries considered: gold is also proven to have been a strong safe haven against losses on European and US stocks during the crisis of October 2008. They find that gold acts as a hedge for stocks and as a safe haven only in the very short run. Interestingly gold is shown to be a safe haven during periods of high volatility on the stock market, but not during extreme returns uncertainty.

Many academic researchers[8] have focused their attention on gold's role as an inflation and a dollar hedge. For example, McCown et al (2007) confirm gold's role as a hedge against stocks and expected inflation during the seventies, when inflation was especially high. However, Blose (2010) does not find any impact of the unexpected change in inflation on gold returns, contrary to bond yields.

The precious metal's dollar hedge function is another subject of research. For example, Capie et al. (2005) emphasize the role of gold as a hedge against dollar depreciation. They find that the US dollar exchange rate is negatively related to the gold price on weekly data over the period 1971-2004. In addition, Jensen et al. (2002) show that commodities, and especially precious metals, yield higher returns during phases of restrictive monetary policy in the US. According to them, including commodities in a portfolio does not necessarily improve its performance, but an active management of these assets can do so, when taking into account the monetary stance.

A range of studies has also explored the nature and the efficiency of the gold market in the US. Tschoegl (1980), Solt and Swanson (1981), and Aggarwal and Soenen (1988) generally conclude in favor of market efficiency. Interestingly, more recent studies by Lucey and Tully (2007), Aggarwal and Lucey (2007), and Lucey (2010) find that the gold market is not efficient and a number of behavioral anomalies could be certainly

8 Fortune (1997), Moore (1990), Taylor (1998), and Wang, Lee et al (2010), just to cite a few contributions on the hedging potential effect of gold against inflation.

exploited. Tully and Lucey (2007) and Khalifa, Miao et al (2011) document that shocks to the gold market take a long time to disappear.

McDonald and Solnik (1977) and Blose and Shieh (1995) examine the effect of gold prices on the valuation of gold mining firms. McDonald and Solnik (1977) develop a model predicting that the elasticity of one. Blose and Shieh (1995) show that the value of a gold mining company is a function of the return on gold, production costs, the level of gold reserves, and the proportion of the assets unrelated to gold price risk. Their model demonstrates that if a company's primary business is gold mining, the gold price elasticity of the company's stock will be greater than one. Tufano (1998) develops a valuation model that posits several determinants of gold factor exposures in gold mining firms. Gold firm exposures are significantly negatively related to the firm's hedging and diversification activities and to market conditions (i.e., gold prices and gold return volatility), and are positively related to firm leverage (percentage of output hedged and hedge price). Davidson et al. (2003) investigate whether movements in the gold price affect companies in other industries. Specifically, asset-pricing tests reject the null hypothesis that the market and the gold factor exposure of the world's industries are jointly equal to 0, confirming gold's important role in today's economy.

Another strand of literature looks at the distributional properties of gold prices. Booth et al. (1982) found that over the period 1969-1980, gold price returns reveal persistent dependence over the long term and that cycles of unequal duration occur. Frank and Stengos (1989) look at gold and silver prices over ten years and show that a degree of non-linear dependence exists. Chan and Mountain (1988) explored the pricing relationship between gold and silver. By employing a time series model to test causality between metals, they show a "feedback causal" relationship between the two.

Overall there is a rich and growing body of research on the gold market but the results are mixed and need further investigation. The purpose of this paper is to contribute to a greater understanding of the economic and financial aspect of the gold market.

3.3. Asset pricing; the Role of Coskewness and Cokurtosis.

There is ample empirical evidence that the returns of many financial assets are not normally, or log-normally, distributed and this is generally attributed to skewness and excess kurtosis (Richardson and Smith, 1993). Skewness characterizes the degree of asymmetry of a distribution around the mean. Positive skewness indicates a distribution with an asymmetric tail extending toward more positive values while negative skewness indicates a distribution with an asymmetric tail extending toward more negative values. The kurtosis of a probability distribution characterizes the relative "peakness" or "flatness" (i.e., the extent to which the distribution tends to have large frequencies around the center or in the tails) of the distribution compared to the normal one. Consequently, the mean and the variance of returns alone are insufficient to completely characterize the return distribution.

The importance of including higher moments in the asset-pricing framework can be read from the shape of the return distribution. Positively skewed distributions tend to offer small probabilities of windfall gains while limiting large downside losses. The excess kurtosis reflects either large frequency around the center (low probabilities of moderate loss) or in the tails of distribution (small probabilities of large losses). Consequently, investors with decreasing marginal utility of wealth and non-increasing absolute risk aversion favor payoffs exhibiting positive skewness and dislike kurtosis (Kraus and Litzenberger (1976); Harvey and Siddique, (2000); Dittmar, (2002)). This behavior is also described in Kimball (1990) and termed "prudence".

Furthermore, investors seem to place more importance on the probability of losses than gains. Kahneman and Tversky's (1979) Prospect Theory as well as Gul's (1991) Disappointment-Aversion Framework show that there is an asymmetrically higher impact on utility by losses in comparison to gains. This implies that investors are even more averse to negative skewness. The empirical evidence suggests that investor should and do care about higher moments.

Kraus and Litzenberger's (1976) seminal work was the first to offer a theoretical development of the CAPM with the skewness, documenting the importance of considering higher moments of returns. In line with their work, a growing literature emphasizes the role of higher moments in asset pricing. Dittmar (2002), Harvey and Siddique (2000), and Smith (2007) focus on the impact of higher moments in U.S. stock market. Hung et al (2002) analyze the UK market while Ajili's (2004) research examines whether coskewness or cokurtosis risk factors are priced in the French stock market. Chung et al. (2006) show that, since returns are not normal, higher-order co-moments matter to risk-averse investors.

Kraus and Litzenberger (1976) and Chung et al. (2006) show that systematic skewness (coskewness) and systematic kurtosis[9] (cokurtosis) matter for the portfolio of a well-diversified investor rather than total skewness and total kurtosis. In equilibrium, investors are not compensated for diversifiable risk (Rubinstein (1973)).

The intuition behind coskewness and cokurtosis is the same as the traditional beta: what counts is the systematic (undiversifiable) part of skewness (called coskewness) and kurtosis (called cokurtosis). While covariance represents the contribution of the security to the variance of a well-diversified portfolio, coskewness and cokurtosis represent the contribution of the security to respectively the skewness and the kurtosis of a well-diversified portfolio. Hence, a well-diversified investor should care about an asset's coskewness and an asset's cokurtosis with the market portfolio.

The desirable feature of higher co-moments is that these measures allow focusing on investors preferences over particular features of the underlying security return distribution.

Adding an asset with negative coskewness to a portfolio reduces its total skewness and, therefore, the investor requires a higher expected return. On the other hand, investors would be willing to pay a premium (accept lower returns) for assets that have positive coskewness with the market portfolio (Siddique and Harvey (2000)). Kurtosis

9 Systematic skewness and systematic kurtosis are also called coskewness and cokurtosis. (Christie-David and Chaudry, 2001).

could be either risk reducing or risk enhancing depending on the trade-off between the fatness at the center and tail of the return distribution. Theoretical suggestions (Fang and Lai (1997)) lead us to conclude that in general investors dislike variance and kurtosis and therefore will need to be compensated for the additional risk added by an asset that shows positive cokurtosis with the market portfolio.

In the following section, the coskewness and cokurtosis measures and estimators used in the empirical study are described and discussed

3.3.1. Coskewness measures

To analyze the coskewness and cokurtosis of gold with the market I employ both the methodologies pioneered by Harvey and Siddique (2000) (hereafter HS) and by Kraus and Litzenberger (1976) (hereafter KL). To derive the higher moment asset-pricing model, Harvey and Siddique (2000) use a linear model of the stochastic discount factor (SDF). In Kraus and Litzenberger (1976), a more classic approach is used with a specification of the preference functions over a range of moments solving the resulting higher moment asset-pricing model. In Kraus and Litzenberger (1976) and Harvey and Siddique (2000) the utility is approximated using a third order polynomial (to account for skewness). Dittmar (2002) uses a fourth-order polynomial (to also account for kurtosis).

Coskewness and Cokurtosis between gold and silver excess returns and the market portfolio are calculated considering four different ways.

The first set of measures refers to the traditional measures of coskewness and cokurtosis derived following KL's approach.

Coskewness and Cokurtosis are defined as follows:

$$\gamma_i = \frac{E\left(\left(R_{it} - \overline{R_i}\right)\left(R_{Mt} - \overline{R_M}\right)^2\right)}{E\left(\left(R_{Mt} - \overline{R_M}\right)^3\right)} = \frac{\sum_{t=1}^{T}\left(\left(R_{it} - \overline{R_i}\right)\left(R_{Mt} - \overline{R_M}\right)^2\right)}{\sum_{t=1}^{T}\left(\left(R_{Mt} - \overline{R_M}\right)^3\right)} \tag{1}$$

$$\delta_i = \frac{E\left(\left(R_{it} - \overline{R_i}\right)\left(R_{Mt} - \overline{R_M}\right)^3\right)}{E\left(\left(R_{Mt} - \overline{R_M}\right)^4\right)} = \frac{\sum_{t=1}^{T}\left(\left(R_{it} - \overline{R_i}\right)\left(R_{Mt} - \overline{R_M}\right)^3\right)}{\sum_{t=1}^{T}\left(\left(R_{Mt} - \overline{R_M}\right)^4\right)} \tag{2}$$

γ_i represents the ratio of the coskewness of that security's return and market's return to the market's skewness. While, δ_i is defined as the ratio of the cokurtosis of that security's return and market's return to the market's skewness. These two measures can be interpreted in the same way as covariance is interpreted: the coskewness (the numerator of gamma) represents the security's marginal contribution to the skewness of the market portfolio and the cokurtosis (numerator of delta) represents the security's marginal contribution to the cokurtosis of the market portfolio. Investors are compensated by the expected excess returns for bearing relative risk measured by gamma and delta.

These traditional measures of coskewness and cokurtosis (equations (1) and (2)) have not been largely used in empirical studies. Recently, studies use standardized measures of coskewness and cokurtosis as in Harvey and Siddique (2000) and Ajili (2004). Standardized measures of higher co-moments tend to work better, with less excessive observations and smaller variances.

Standardized coskewness and cokurtosis measures (Siddique and Harvey (2000) and Ajili (2004)) are calculated as follows:

$$\beta_{SKD_i} = \frac{E[\varepsilon_{i,t+1}\varepsilon^2_{M,t+1}]}{\sqrt{E[\varepsilon^2_{i,t+1}]}E[\varepsilon^2_{M,t+1}]} \tag{3}$$

$$\beta_{KOD_i} = \frac{E[\varepsilon^2_{i,t+1}\varepsilon^2_{M,t+1}]}{E[\varepsilon^2_{i,t+1}]E[\varepsilon^2_{M,t+1}]}$$

(4)

where $\varepsilon_{i,t+1} = r_{i,t+1} - \alpha_i - \beta_i(r_{M,t+1})$ is the residual from a regression of the excess return on the contemporaneous market excess return (from one factor market model) and ε_M is the mean deviation for the market excess return. As Harvey and Siddique (2000) point out, this measure of standardized coskewness (cokurtosis) has an important advantage: it is constructed by residuals, so it is by construction independent of the market excess returns and similar to the traditional CAPM beta (p.1276).

β_{SKD_i} represents a direct measure of coskewness and is interpreted as a proxy of the tendency for an asset to follow the asymmetry of the market. A negative measure means that the security is adding negative coskewness to a market portfolio and should hence have higher returns (i.e., a positive risk premium). Intuitively, adding an asset characterized by positive coskewness with the market portfolio (positive coskewness) increases the skewness of the portfolio. In this case, such an asset is valuable and the investor will be willing to give up part of the returns to benefit from a less negatively skewed return distribution of the broader portfolio. Consequently, the effect of market coskewness might be state dependent and time varying.

β_{KOD_i} represents a direct measure of cokurtosis. Intuitively, an increase in kurtosis increases the probability of extreme outcomes and consequently risk. The marginal utility of kurtosis is expected to be negative and, hence, a positive relation is expected between expected returns and market cokurtosis risk.

Following Harvey and Siddique (2000) and in line with a number of recent asset pricing models (Fama and French (1993)), coskewness-mimicking and cokurtosis-mimicking portfolios are constructed. The returns on the factor replicating portfolios are—supposedly—the additional return that investors gave to coskewness risk in a particular month.

Another measure of coskewness and cokurtosis is derived from regressing the asset returns on the square of the market return and on the cube of the market returns.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{1,i}(R_{M,t} - R_{f,t}) + \beta_{2,i}(R_{M,t} - R_{f,t})^2 + \beta_{3,i}(R_{M,t} - R_{f,t})^3 \tag{5}$$

In this case the return generation process is a cubic model that establishes a nonlinear relationship between the return of the risky asset and the stock index representative of the market (Christie-David and Chaudry (2001)). The coefficient $\beta_{2,i}$ in equation (5) is a measure of coskewness while the coefficient $\beta_{3,i}$ is a measure of cokurtosis.

3.4. Data and Empirical Investigation.

3.4.1.Data

For this empirical analysis, I use monthly and daily spot prices for gold from December 1978 to June 2012[10]. I also use the gold and silver Fixing prices in U.S. dollars on a month and day-average[11] from January 1968 to June 2011. I also use monthly and daily U.S. equity returns from CRSP NYSE/AMEX and Nasdaq files (from CRSP). As a proxy of the market portfolio I use the NYSE/AMEX and Nasdaq value weighted index. As proxy of the risk free rate, I use the one-month Treasury bill rate. The Fama and French's (1993) risk factors SMB and HML, size and book to market factors,[12] are used as additional risk factors. The Chicago Board of Exchange VXO stock market volatility measure is used as a measure of uncertainty (Bloom (2009)). I use the monthly VOX available on Bloom's site from monthly estimations starting from January 1979[13], while daily estimations start in January 1986[14]. All data are analyzed from the perspective of a US investor, and are expressed in U.S. dollar. The analysis focuses on the period January 1968 to June 2012.

10 Comex spot gold prices. Data was kindly provided by WGC http://www.gold.org/

11 The price of gold is fixed twice daily in London by the five members of the London gold pool, all members of the London Bullion Market Association (LBMA). The fixes start at 10.30am and 3.00 pm London time. The London Fixings are internationally published benchmarks for precious metals prices. It is the price at which the world's largest size gold (silver) purchases and sales are accomplished on any given day. London gold (and silver) fix prices can be found on the site of the LBMA (http://www.lbma.org.uk/pages/index.cfm

12 Data are downloaded from the Fama and French Data Library (http://mba.tuck.dartmouth.edu/pages/faculty//ken.french/data_library.html)

13 Data available at http://www.stanford.edu/~nbloom/index_files/Pages315.htm

14 Data available at http://www.cboe.com/micro/vix/historical.aspx

3.4.2. Empirical Investigation.

At this stage, I document the historical coskewness and cokurtosis of gold and US stock market and test whether these higher co-moments affect returns of gold.

I calculate the unconditional coskewness of gold with the market portfolio for daily and monthly data. I also calculate coskewness conditional on positive and negative market returns and for periods of high and low uncertainty as inferred from implied volatilities.

Following the methodology of HS (2000), I use monthly and daily excess returns on gold $r_{au,t}$ and estimate the market model for gold

$$r_{au,t} = \alpha_{au} + \beta_{au} r_{m,t} + \varepsilon_{au,t} \tag{6}$$

extracting residuals $\varepsilon_{au,t}$ that are by definition orthogonal to the excess market returns $r_{m,t}$. Therefore, the residuals are purified from the systematic risk as this is measured by covariance of gold returns with the market returns. However they still incorporate the exposure to coskewness and cokurtosis risks. Therefore I can get the measure of the standardized coskewness and cokurtosis of gold returns with the market returns.

These are given by:

$$\beta_{SKD}^{au} = \frac{E[\varepsilon_{au,t}\varepsilon_{m,t}^2]}{\sqrt{E[\varepsilon_{au,t}^2]}E[\varepsilon_{m,t}^2]} \tag{7}$$

$$\beta_{KOD}^{au} = \frac{E[\varepsilon_{au,t}^2\varepsilon_{m,t}^2]}{E[\varepsilon_{au,t}^2]E[\varepsilon_{m,t}^2]} \tag{8}$$

where $\varepsilon_{au,t}$ are the residuals previously extracted from the market model (equation (6)) for gold excess returns at time t and $\varepsilon_{m,t}$ is the deviation of the excess market return at time t from the average excess market return in the examined period.

I also calculate coskewness and cokurtosis conditional on positive and negative market. In this case I use the following market models:

$$r_{au,t}^{+} = \alpha_{au}^{+} + \beta_{au}^{+}(r_{m,t} \mid r_{m,t} = r_{mkt>0}) + \varepsilon_{au,t}^{+} \qquad (9)$$

$$r_{au,t}^{-} = \alpha_{au}^{-} + \beta_{au}^{-}(r_{m,t} \mid r_{m,t} = r_{mkt<0}) + \varepsilon_{au,t}^{-} \qquad (10)$$

where $\varepsilon_{au,t}^{+}$ are the residuals extracted from the market model conditional on positive market returns and $\varepsilon_{au,t}^{-}$ are the residuals extracted from the market model conditional on negative market returns. β_{au}^{+} and β_{au}^{-} can be interpreted as upside and downside betas (Bawa and Lindberg (1977); Lettau, Maggiori, and Weber (2011)). Therefore I can get measures of coskewness and cokurtosis conditional on market returns by using the residuals extracted from conditional market models defined in equation (9) and (10).

In the same fashion, I calculate coskewness and cokurtosis conditional on periods of high and low uncertainty as inferred from implied volatilities. The Chicago Board of Exchange VXO stock market volatility measure is used as a proxy of uncertainty (Bloom (2009)). High periods of volatility occur when the VXO index is greater than its mean and, consequently, low periods occur in correspondence of days (or months) in which the VXO index is lower than its mean.

In this case I use the following market models:

$$r_{au,t}^{high} = \alpha_{au}^{high} + \beta_{au}^{high}(r_{m,t} \mid VXO > \overline{VXO}) + \varepsilon_{au,t}^{high} \qquad (11)$$

$$r_{au,t}^{low} = \alpha_{au}^{low} + \beta_{au}^{low}(r_{m,t} \mid VXO < \overline{VXO}) + \varepsilon_{au,t}^{low} \quad (12)$$

where VXO is the Chicago Board of Exchange VXO stock market volatility measure and $\overline{VXO}$ is the VXO index mean of the examined period. $\varepsilon_{au,t}^{high}$ are the residuals extracted from the market model conditional on periods of high market volatility and $\varepsilon_{au,t}^{low}$ are the residuals extracted from the market model conditional on periods of low market volatility.

I use the bootstrap method to test the statistical significance of unconditional and conditional coskewness and cokurtosis. In my bootstrap[15] exercise, I first generate 10,000 series of gold residuals, separately for the upstate and downstate, drawing from the empirical state dependent error distribution with replacement. I assume that the market return is observed without error[16].

I also investigate whether coskewness and cokurtosis of gold and silver[17] with the market might be state dependent and time varying. I calculate coskewness and cokurtosis using an estimation period of 60 months. In the first step I regress gold and silver excess returns on the market excess returns as in equation (6), I then use the residuals and calculate the coskewness and cokurtosis for both gold and silver with the market. These estimates are then considered as the coskewess and cokurtosis factors for the last month of the examined period. The estimation period is then rolled forward one month and the process repeated. This provides 574 coefficient estimates for the full period of study for both gold and silver (1972 to 2011) and the shorter period (1980-2011) for gold when spot prices are used.

As stated before, the direct measures of standardized coskewness and cokurtosis (equations (3) and (4)) are similar to the traditional CAPM beta (HS (2000), p.1276).

15 Serial correlation frequently arises when using time series data. I perform the Breusch-Pagan test (assuming no serial correlation – 4 lags): the resultant p-values leads me to not reject the null.

16 In my bootstrap exercise I also generate 10,000 times series of market residuals and I assume that the gold return is observed without error. Significance levels are very similar in both approaches.

17 For this analysis I use both the fixing prices (for gold and silver) and spot prices (for gold).

Moreover, these standardized measures are unit free and analogous to a factor loading. I investigate the interaction between gold and the US stock market by computing the standardized measures of coskewness and cokurtosis for each stock in the NYSE/AMEX and Nasdaq files, using 60 months of data. These stocks are then sorted on coskewness and two value weighted porfolios are formed: a positive coskewness portfolios, S^{+}, from the 30 percent of stocks with the highest coskewness and a negative coskewness portfolio, S^{-}, from the 30 percent of stocks with the lowest coskewness. The return on $S^{-} - S^{+}$ in the 61st month is used as a coskewness replicating portfolio (i.e., a proxy for systematic coskewness). Another coskewness mimicking portfolio is computed by using the return on $S^{-} - R_f$ in the 61st month (post-ranking). Similarly, I calculate the direct measures of cokurtosis (equations (2) and (4)) for all NYSE/AMEX and Nasdaq stocks using 60 months of data. I then rank the stocks based on their past coskurtosis and form a negative cokurtosis portfolio, K^{-}, from the 30 percent of stocks with the lowest cokurtosis and a positive cokurtosis portfolio, K^{+}, from the 30 percent of stocks with the highest cokurtosis. The return on $K^{+} - K^{-}$ in the 61st month is used as a cokurtosis replicating porfolio (i.e., a proxy for systematic cokurtosis). Another cokurtosis mimicking portfolio is computed by using the return on $K^{+} - R_f$ in the 61st month (post-ranking).

I proceed in the same way and compute the traditional measures of coskewness and cokurtosis (as detailed in equations (1) and (2)). I then obtain another set of value weighted portfolios: a positive coskewness portfolios, γ^{+} from the 30 percent of stocks with the highest co-skewness and a negative coskewness portfolio, γ^{-}, from the 30 percent of stocks with the lowest coskewness. The return on $\gamma^{-} - \gamma^{+}$ in the 61st month is used as a coskewness replicating porfolio (i.e., a proxy for systematic coskewness). Another coskewness mimicking portfolio is computed by using the return on $\gamma^{-} - R_f$ in the 61st month (post-ranking). Similarly I calculate the traditional measures of cokurtosis (equation (2)) for all NYSE/AMEX stocks using 60 months of data. I then rank the stocks based on their past cokurtosis and form a negative cokurtosis portfolio, δ^{-}, from the 30 percent of stocks with the lowest cokurtosis, a positive cokurtosis portfolio, δ^{+}, from the 30 percent of stocks with the highest cokurtosis. The return on $\delta^{+} - \delta^{-}$ in the 61st month is used as a cokurtosis replicating porfolio (i.e., a proxy for systematic cokurtosis). Another cokurtosis mimicking portfolio is computed by using the return on $\delta^{+} - R_f$ in the 61st month (post-ranking). In order to disentangle the effects of coskewness and cokurtosis factors on gold returns, from other risk factors, the standard CAPM and the Fama and French three-factor model (Fama and French (1993)) are used.

Additional to the monthly excess market returns, I add the monthly excess returns of the four hedge portfolios[18].

The traditional CAPM with the co-moments of order three and four, expressed by the mimicking portfolios detailed above, is as follows:

$$r_{au,t} = \alpha_{au} + \beta_{au} r_{m,t} + \beta_{au}^{csk} CSK_t + \beta_{au}^{ck} CK_t + \varepsilon_{au,t} \tag{13}$$

where r_m is the excess return on the market and $r_{au,t}$ is the excess return on gold.

The three-factor porfolios of Fama and French (i.e., market porfolio, HML, and SMB) are considered together with the monthly excess returns on the hedge portfolios.

$$r_{au,t} = \alpha_{au} + \beta_{au}^{mkt} r_{m,t} + \beta_{au}^{smb} SMB_t + \beta_{au}^{hml} HML_t + \beta_{au}^{csk} CSK_t + \beta_{au}^{ck} CK_t + \varepsilon_{au,t}$$

(14)

18 The first hedge portfolios is given by the spread between the returns on the S^{-} (proxy for the negative coskewness portfolio derived from the 30 percent of stocks with the lowest coskewness) and S^{+} (proxy for a positive coskewness portfolio derived from the 30 percent of stocks with the highest coskewness). I call this $CSK^{S^{-}-S^{+}}$ while $CSK^{S^{-}-R_f}$ represents the excess return on the S^{-} portfolio. The spread between the returns on the K^{+} (proxy for a positive cokurtosis portfolio derived from the 30 percent of stocks with the highest cokurtosis) and K^{-} (proxy for the negative cokurtosis portfolio derived from the 30 percent of stocks with the lowest cokurtosis) is $CK^{K^{+}-K^{-}}$ and the excess returns on the excess return on the K^{+} portfolio is called $CK^{K^{+}-R_f}$ These four portfolios are the HS hedge portfolios. In the same way, four hedge portfolios are also calculated following Kraus and Litzenberger (1976): $CSK^{(\gamma^{-}-\gamma^{+})}$, $CSK^{(\gamma^{-}-R_f)}$, $CSK^{(\delta^{+}-\delta^{-})}$, and $CSK^{(\delta^{+}-R_f)}$.

where $r_{au,t}$ is the excess return on gold. For the explanatory variables r_m is the excess return on the market, SMB_t represents the difference between the return on the small-sized stock and the return on the large-sized stocks, and captures the market-wide systematic size risk premium. HML_t represents the difference between return on high book-to-market stocks and returns on low book-to-market stocks, which captures the market wide systematic book-to-market risk premium. β_i is the systematic risk, β^{csk} indicates the factor loading on systematic skewness (traditional coskewness) of the asset, and β^{ck} indicates the factor loading on systematic kurtosis (traditional cokurtosis).

3.5. Empirical Results

Figure 1-2 plot the historical rolling standardized unconditional coskewness of gold and silver[19] holdings to the US market portfolio's return distribution. Periods of financial distress and crisis are highlighted. I also plot in Figure 3 the US Stock Market Index Volatility as computed in Bloom (2009). Bloom uses the Chicago Board of Exchange VXO stock market volatility measure as a measure of uncertainty. He backdates the index using realized volatility and selects events with characteristics that are supposed to generate notable high levels of economic uncertainty (i.e., stock market volatility more than 1.65 standard deviations above the Hodrick-Prescott detrented mean of the stock market volatility series). This measure of uncertainty shows two important advantages: first it represents an exogenous variable not prone to data mining and, second, it economically indicates times of high market uncertainty during which investors seek a safe haven in which to invest their wealth during stock market turmoil. The rolling coskewness of gold and silver has a substantial degree of time variation and spikes in time of crises. It clearly emerges from Figure 1, that gold is positively contributing in terms of coskewness to the market portfolio in turbulent times. Most of the events shown in Figure 1 and 2 are taken from Bloom (2009). However, a few episodes are added to the list of crises to account for well-known historical events. Interestingly, gold realized high levels of coskewness during the 1990-92 Recession. The early 90s crisis was the largest recession since that of the early 80s. Gold also positively reacts to the 1995-1996 Government Shutdown[20]. One data point that needs further attention is the Sri Lankan and Israeli suicide bombings that happened between February and March 1996. These two attacks killed almost 140 people and attracted mass media from all over the world. This event does not appear in Bloom's (2009) list and does not configure as a major financial event thus, it should not affect financial market. However, gold's price reaction is strong and confirms that because of its long and important story in human affairs, may be

19 I analyze both gold and silver returns to be able to provide a comparative analysis of both metals' roles of gold and silver in the financial markets. Silver is included to allow a comparison of the investment properties of gold, traditionally seen as a "safe haven" with those of a precious metal used primarily for industrial applications and, hence, traded as a traditional commodity. Average annual demand for silver is dominated by industrial requirements (approximately 60 percent) and jewelry (close to 30 percent). Silver demand for investment purposes is much smaller than the one for gold.

20 From November 14 through November 19, 1995 and from December 16, 1995 to January 6, 1996 the U.S. government was shut down as a result of a budgetary impasse between Congress and the White House.

particularly subject to the effects of psychological behavior such as those lead by fear or loathing.

Figure 2 plots historical rolling standardized unconditional coskewness of silver with the US market portfolio's return distribution. Silver is included in these analyses to allow a comparison of the investment properties of gold, traditionally seen as a "safe haven", with those of a precious metal used principally for industrial applications and, hence, traded as a traditional commodity. Average annual demand for silver is dominated by industrial requirements (approximately 60 percent) and jewelry (close to 30 percent). Silver demand for investment purposes is much smaller than the one for gold. Figure 2 shows that silver coskewness with the market is, for most of the period considered, negative and only becomes positive during "obvious" episodes (included in Bloom's (2009) list). However, among the crises that are emphasized in the graph, we ignore the Silver Thursday event that occurred on March, 27th 1980 in the silver commodity market following the cornering of the precious metal market by the Hunt Brothers. A steep fall in silver prices led to panic on commodity and futures exchange.

Table 1 reports regression estimates for unconditional and conditional beta and alpha for both daily and monthly data. Unconditional and conditional standardized coskewness and cokurtosis measures (equations (7) and (8)) are also reported. The unconditional beta (equation (6)) is negative and statistical significant when the market is up and during periods of high volatility while in the remaining cases, i.e., low market periods and periods of low volatility as well as the whole period, betas are not statistical significant. However, the estimated daily betas are very small suggesting that gold virtually bears not market risk. Table 1 also reports unconditional and conditional coskewness and cokurtosis (equations (7) and (8)). Coskewness and cokurtosis conditional on market returns being negative show that gold provides some protection against tail risk. Specifically, conditional coskewness of gold with the market is positive and significant during market downturns and, at the same time, conditional cokurtosis decreases from 5.37 during market upturns to 3.45 during market downturns, and from to 3.028 during periods of high volatility to 1.32 during calm times. Monthly regression estimates are overall statistically insignificant with the exception of cokurtosis coefficients. Cokurtosis of gold with the market is generally smaller than the one obtained in the analyses based on daily data. To further investigate the statistical robustness of my results (following Siddique and Harvey (2000, p.1276, footnote 9)), I also compute coskewness as the coefficient obtained from regressing gold excess return on the square of the market return, if the market return and the square market return are orthogonalized (i.e., their correlation coefficient is zero). In Table 2, coskewness and cokurtosis still show the same sign and statistical significance. Results so far indicate that investing in gold could eliminate or reduce the probability of obtaining undesirable extreme values (in the left tail of the distribution), especially during periods of market downturns.

Table 3 contains results for the quadratic and cubic models. Coskewness signs and magnitudes are as expected: coskewness is positive during market downturns and cokurtosis magnitudes tend to decrease as returns on the market decrease and volatility increases.

Table 4 reports the ordinary least square (OLS) estimates for the standard CAPM that includes the monthly excess returns on the hedge portfolios (equation (13)) using both HS (2000) and KL's (1976) approaches. The hedge portfolios should be associated with high-expected returns. The returns on the factor replicating portfolios are—supposedly—the additional return that investors gave to coskewness in a particular month. If gold covaries with the returns on the coskewness factor replicating portfolios, the coskewness of gold must be priced. Why? First, because gold is coskewed with the market; second, the return on the factor-replicating portfolio is an estimate of how much additional return negatively co-skewed stocks received in a month. This is a return; it is a measure of the "price" of co-skewness. If the coskewness of gold is not priced, then gold returns should not co-vary with the returns on the coskewness replicating portfolios.

The coefficient on the hedge portfolio can, in fact, be interpreted as factor loadings on the SMB portfolio in the Fama and French model. Both coskewness and cokurtosis factor loadings are significant in 5 out of the 12 models estimated. These results are interesting because, while coskewness factor loadings are positive[21], the cokurtosis factor loadings are negative. These results turn out to be important because gold confirms its attractiveness as an investment for risk adverse investors for it is able to reduce the overall kurtosis when added to a broader portfolio. Moreover, I consider an alternative CAPM model that takes into account the positive and negative coskewness and cokurtosis portfolios ((both HS and KL's measures - see Section III for more details). The results, shown in Table 5, are intriguing. Factor loadings on γ^{+} and S^{+} (i.e., the positive market coskewness portfolios) are positive and statistically significant while the factor loadings on γ^{-} and S^{-} (i.e., the negative market coskewness portfolio) are negative and significant. At the same time, factor loadings on δ^{+} and K^{+} are negative while factor loadings on δ^{-} and K^{-} are positive, and all statistically significant. To gain intuition for these findings, note that assets that have positive coskewness with the market portfolio are desirable to risk averse investors since they tend to have higher expected returns when the market is skewed to the left (i.e., during bear markets or market turmoil). Similarly, low cokurtosis with the market returns means that the asset's expected returns tend to be higher during volatile periods. I show that gold is desirable to risk adverse investors since it tends to decrease the probability and magnitude of extreme bad outcomes.

Moreover, coskewness and cokurtosis are still able to "explain" a significant part of gold's investment characteristics even when Fama and French's risk factors (SMB and HML) are added to the asset-pricing model (equation (14)). Results are shown in Table 5 and 6.

In parallel analyses, I estimate the same models using gold and silver fixing prices.

Even though most of the coefficients for silver are found not statistically significant, the findings for these estimates are consistent with the predictions with some exceptions. Gold and, to some extend silver, show an interesting behavior when a cokurtosis term is included into the traditional CAPM model directly (Table 8)The coefficient of the

21 I would have expected a negative factor loading for the coskewness hedge portfolios

cokurtosis term, β^{ck}, is significantly different from zero and positive when the coskewness term considered in the linear regression is either δ^{+} or K^{+}. Moreover, β^{ck} becomes negative and significantly different from zero when the cokurtosis term is added, δ^{-} or K^{-}. These results are extremely interesting and suggest that gold is indeed an asset that would decrease the total kurtosis of the market portfolio's distribution. On the other hand, silver seems to be positively adding skewness to the portfolio when the market is positively skewed. Hence, it seems that increased coskewness with market should be regarded as more valuable if the return distribution of the market is positively skewed. When the market shows high level of negative coskewness, silver factor loading is positive and significant. However, the coefficient term is overall insignificant with inconclusive sign. The economic magnitude of coskewness factor loading for silver is not trivial but the statistical evidence does not indicate that these factor loadings are significantly different from zero at conventional levels of significance. Overall, the results support the hypothesis in favor of gold and, to some extent, against silver. To sum up in testing the validity of these models, the returns on the factor replicating portfolios are taken under consideration. I conduct a second set of regression models in which, this time, I include hedge portfolio terms into the traditional CAPM model (equation (13)) and into the Fama and French three-factor model (equation (14)) directly. Hedge portfolios are derived from both the standardized and traditional measures of coskewness and cokurtosis. To allow an easy comparison of HS (2000) and KL's (1976) factor replicating portfolios, regression estimates for the extended traditional CAPM are reported in Tables 10-13. Some of the results estimates as silver are omitted for they are insignificant and signs are inconclusive. These results are surprisingly challenging to interpret: I find, positive and significant factor loadings for the silver coskewness with the market. On the other hand, the cokurtosis factor loadings are overall significant but positive. So far, silver does not appear to share with gold the same investing appeal as a hedge or a safe haven. It would have been more satisfying if one measure of coskewness and/or cokurtosis appeared to be priced in all situations.

3.6. Conclusions

The analysis conducted in this chapter help to understand the behavior of precious metals over long periods and support the idea that the allocation in gold can decrease or eliminate the probability of obtaining undesirable extreme values. Specifically, allocations to gold and, to some extent, silver reduce the probability of extreme negative outcome. Gold provides an "indemnity" against extreme bad movements during market downturns and periods of high uncertainty. These findings are

The recent financial crisis has reminded us that extreme bad outcomes, although very rare, do occur and can do so with devastating results. We have witnessed the failure and bailout of large financial corporations, the spillover of the financial crisis to the production economy, and the resulting drop in economic activity. Academics, regulators, and investors are now converging to a view that the probabilities and magnitudes of extreme negative outcomes cannot be downplayed or ignored

Most investors prefer assets with greater probabilities of large gains than equivalent large losses, that is, distributions skewed to the right (or positively skewed) and with low kurtosis. A well-diversified investor will focus on the skewness of her portfolio rather than the skewness of the assets in her portfolio. She will value assets more highly when they are positively coskewed with her portfolio because this will result in an increase in the portfolio's skewness.

However, gold's hedge capabilities don't come without a price tag. During periods of market upturns, gold shows a small negative coskewness with the market. Intuitively, this is what one would expect from a safe haven commodity, which is in particular high demand in times of market turmoil. In a time where there is increasing concern regarding capital preservation, gold is shown to be a key portfolio constituent. My findings support the view that gold acts as a "safe haven" in times of crisis and high uncertainty, when flights to quality towards assets of last resort takes place.

FIGURE 1.

STANDARDIZED UNCONDITIONAL COSKEWNESS OF GOLD WITH THE MARKET

The historical rolling standardized unconditional coskewness of gold holdings to the US market portfolio's return distribution is shown. Periods of financial distress and crisis are highlighted.

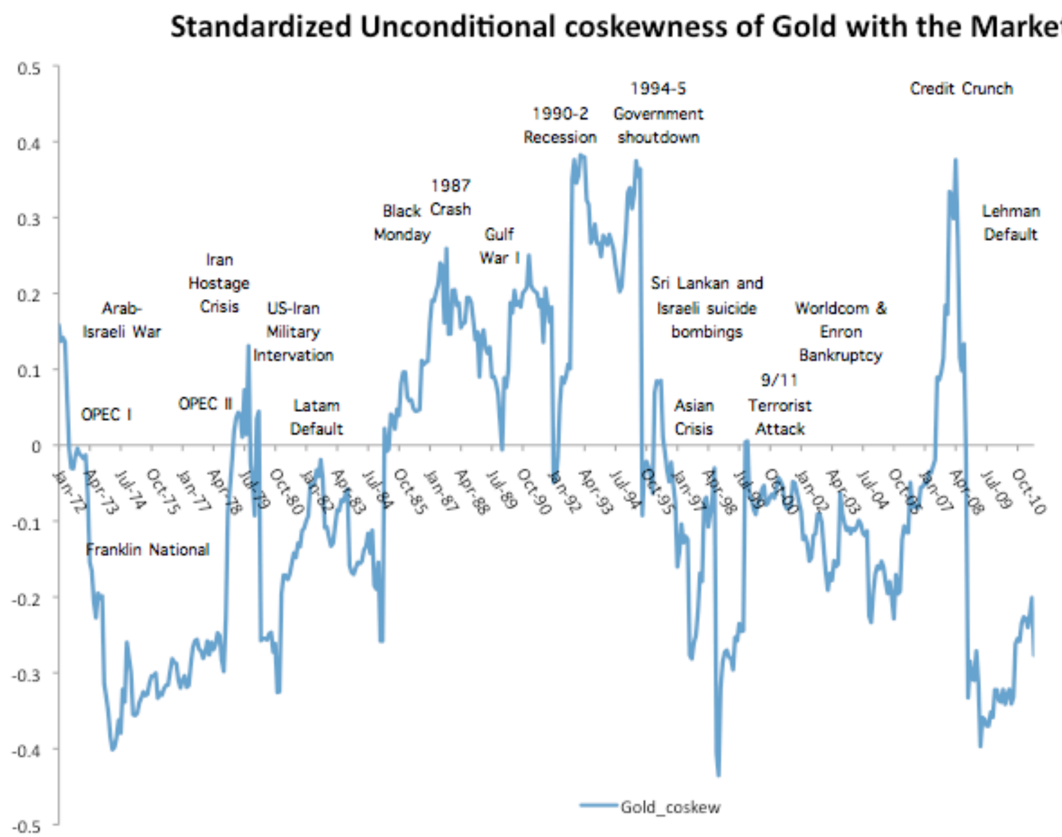


FIGURE 2

STANDARD UNCONDITIONAL COSKEWNESS OF SILVER WITH THE MARKET

The historical monthly rolling standardized unconditional coskewness of silver holdings to the U.S. market portfolio's return distribution is shown. Periods of financial distress and crises are highlighted. Period of estimation 1972-2012.

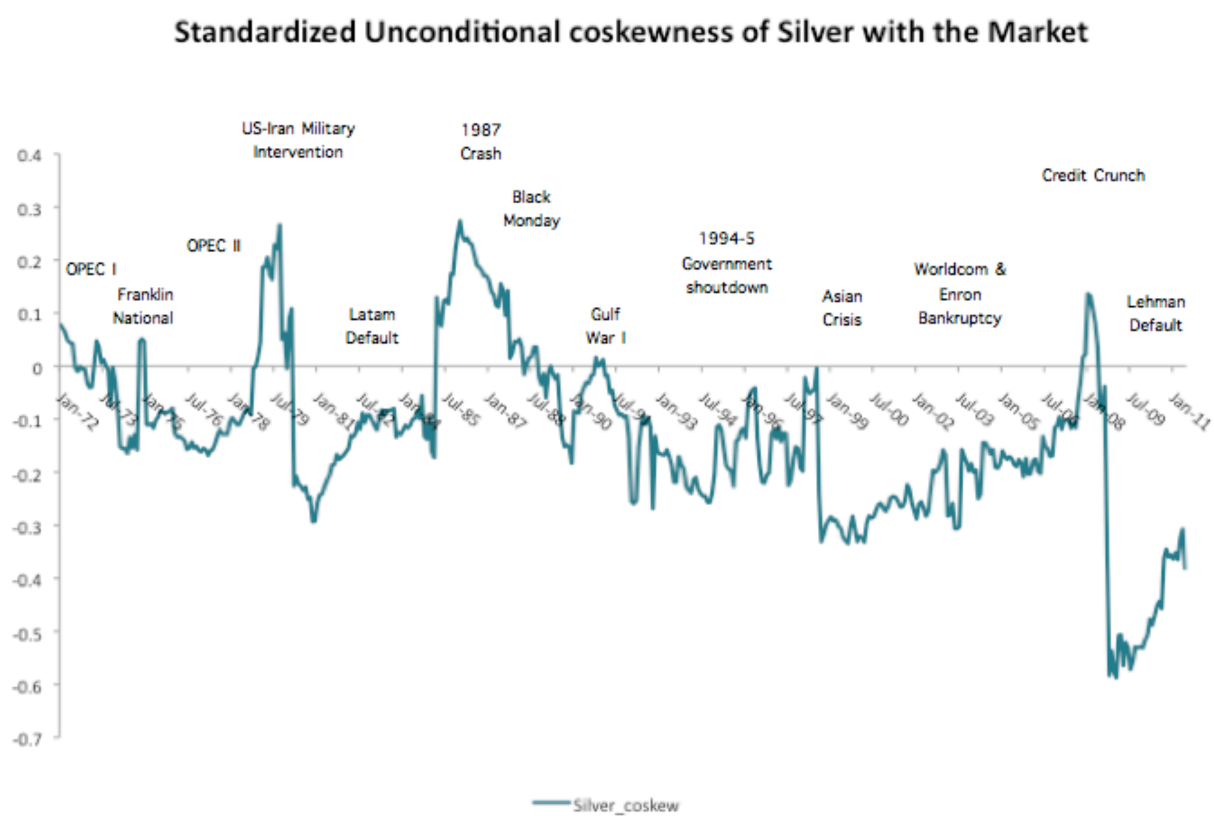


FIGURE 3.

STANDARDIZED UNCONDITIONAL COSKEWNESS OF GOLD vs BLOOM'S (2009) MARKET VOLATILITY

The historical monthly rolling standardized unconditional coskewness of gold holdings to the US market portfolio's return distribution is plotted against monthly U.S. stock market volatility.

Notes: Chicago Board of Options Exchange VXO index of percentage implied volatility, on a hypothetical at the money S&P100 option 30 days to expiration, from 1986 onward. Pre-1986 the VXO index is unavailable, so actual monthly returns volatilities are calculated as the monthly standard deviation of the daily S&P500 index normalized to the same mean and variance as the VXO index when they overlap from 1986 onward. Actual and VXO are correlated at 0.874 over this period.

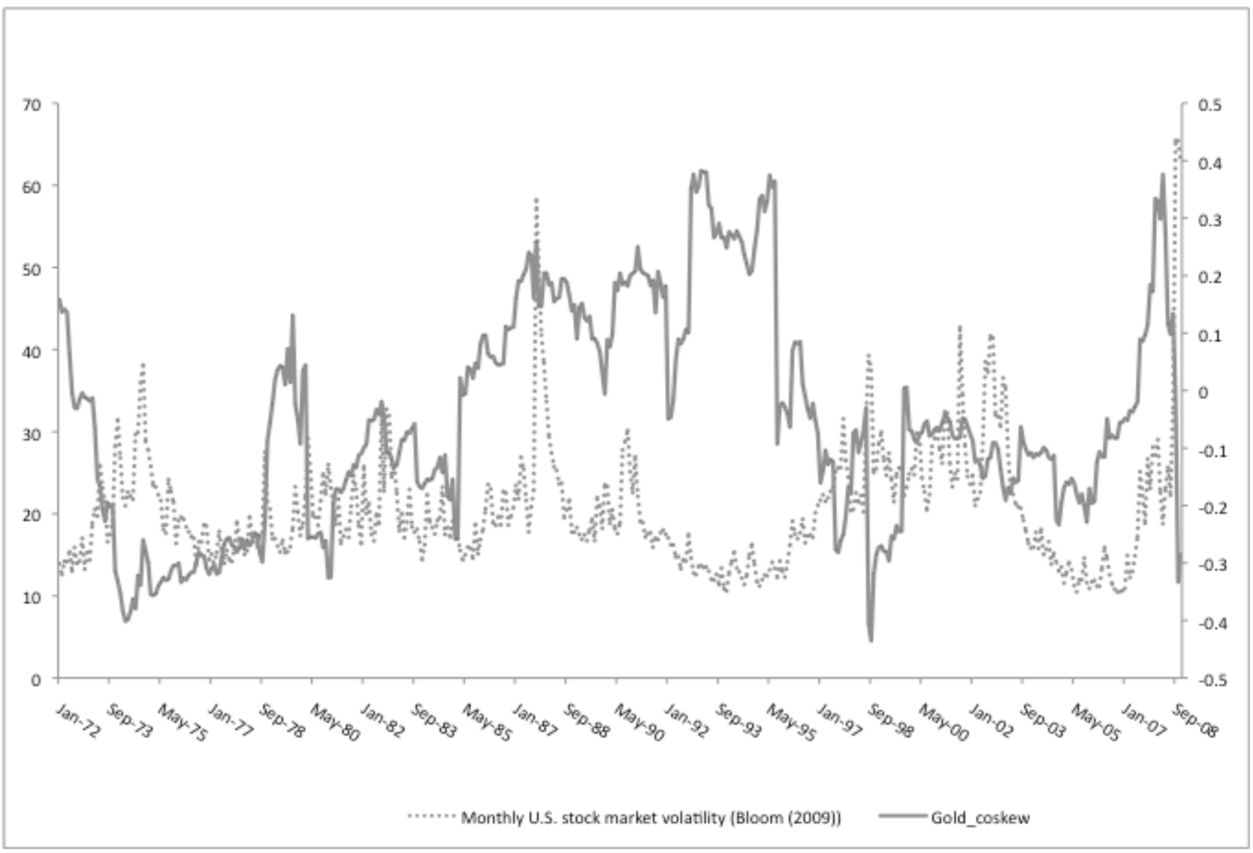


TABLE 1: REGRESSION ESTIMATES FOR CONDITIONAL BETA, COSKEWNESS, AND COKURTOSIS

In this table, I calculate the standardized unconditional coskewness (as detailed in equation (7)) and standardized unconditional cokurtosis (equation (8)) of gold with the market portfolio for daily and monthly data. I also calculate standardized coskewness, and cokurtosis conditional on positive and negative market returns and for periods of high and low uncertainty as inferred from implied volatilities. Specifically, positive market returns are used as a proxy of the bull market and negative returns as a proxy of the bear market. The Chicago Board of Exchange VXO stock market volatility measure is used as a proxy of uncertainty (Bloom (2009)). High periods of volatility occur when the VXO index is greater than its mean and, consequently, low periods occur in correspondence of days (or months) in which the VXO index is lower than its mean. Period of estimation 1979-2012 (monthly) and 1986-2012 (daily).To perform the statistical significance levels of the standardized unconditional and conditional measures of coskewness and cokurtosis, a bootstrap resampling approach with 10,000 simulations is applied.

Daily 1986-2012	UNCONDITIONAL	MKT>0	MKT<0	HIGH VOL	LOW VOL
α_{au}	0.0119	0.0374	-0.00724	0.00866	0.00913
	(0.0122)	(0.0221)	(0.0241)	(0.0218)	(0.0140)
β_{au}	-0.0302**	-0.0491*	-0.0373	-0.0413**	0.0167
	(0.0106)	(0.0205)	(0.0193)	(0.0137)	(0.0210)
β_{SKD}^{au}	-0.0106	-0.2201**	0.1877*	-0.0276	0.0519
β_{KOD}^{au}	3.5226***	5.3696***	3.4530***	3.0275***	1.3218
N	6675	3660	3008	2829	3846
R-sq	0.0011	0.0013	0.0009	0.0029	0

Monthly 1979-2012	UNCONDITIONAL	MKT>0	MKT<0	HIGH VOL	LOW VOL
α_{au}	0.1508	-0.0253	0.4353	0.1478	0.1129
	(0.2789)	(0.5637)	(0.7127)	(0.4452)	(0.3728)
β_{au}	0.1043	0.1361	0.1464	0.0915	0.1419
	(0.0599)	(0.1334)	(0.1348)	(0.0735)	(0.1154)
β_{SKD}^{au}	-0.0426	0.0943	-0.2315	-0.0401	-0.0853
β_{KOD}^{au}	1.6559*	1.2033	2.2116*	1.6670*	1.0016
N	402	251	151	172	230
R-sq	0.0050	0.0002	0.0012	0.0032	0.0022

Standard errors in parentheses   * p<0.05   ** p<0.01   *** p<0.001

TABLE 2: REGRESSION ESTIMATES FOR FACTOR LOADINGS IN THE QUADRATIC MODEL WITH MARKET RETURNS AND SQUARED RETURN ORTHOGONALIZED

The standardized coskewness meaures is unit free and similar to a factor loading. As stated by Siddique and Harvey (2000, p.1276, footnote 9) their standardized coskwness measure (equation (3)) is related to the coefficient obtained from regressing gold excess return on the square of the market return, if the market return and the square market return are orthogonalized (i.e. their correlation coefficient is zero). The following regression is run using daily data (1986-2012).

$$R_{au,t} = \alpha_{au} + \beta_{1,au}^{orth}(R_{m,t}^{orth}) + \beta_{2,au}^{orth}(R_{m,t}^{orth})^2 + \varepsilon_{au}$$

	UNCONDITIONAL	MKT>0	MKT<0	HIGH VOL	LOW VOL
α_{au}	0.0111	-0.0437	0.0301	0.00881	0.0378
	(0.0122)	(0.0307)	(0.0307)	(0.0220)	(0.0211)
$\beta_{1,au}^{orth}$	-0.0285**	0.0736	0.00428	-0.0392**	-0.00866
	(0.0099)	(0.0381)	(0.0264)	(0.0129)	(0.0241)
$\beta_{2,au}^{orth}$	-0.00209	-0.116***	0.0383*	-0.00535	0.142
	(0.0099)	(0.0317)	(0.0185)	(0.0119)	(0.0796)
N	6675	3660	3008	2829	3846
R_{adj}^2	0.001	0.005	0.002	0.003	0.000

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

TABLE 3: REGRESSION ESTIMATES FOR FACTOR LOADINGS IN THE QUADRATIC AND THE CUBIC MODELS

	UNCONDITIONAL			MKT>0			MKT<0			HIGH VOL			LOW VOL		
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
$\beta_{1,au}$	-0.00858 (0.0116)	-0.0305** (0.0107)	-0.0115 (0.0116)	-0.139* (0.0606)	0.0595 (0.0361)	0.0184 (0.0250)	-0.0453 (0.0503)	0.0106 (0.0301)	-0.0108 (0.0223)	-0.0157 (0.0153)	-0.0423** (0.0138)	-0.0202 (0.0153)	-0.00306 (0.03)	0.0133 (0.021)	0.000694 (0.0299)
$\beta_{2,au}$	-0.00697** (0.0026)	-0.000462 (0.0022)		0.0697** (0.0244)	-0.0256*** (0.0070)		-0.0114 (0.0149)	0.00846* (0.0041)		-0.00780* (0.0031)	-0.00118 (0.0026)		0.0315 (0.0176)	0.0314 (0.0176)	
$\beta_{3,au}$	-0.00107*** (0.0002)		-0.000750*** (0.0002)	-0.00835*** (0.0021)		-0.00274*** (0.0005)	-0.0011 (0.0008)		-0.00052* (0.0002)	-0.00106*** (0.0002)		-0.000697** (0.0002)	0.00877 (0.0114)		0.00857 (0.0114)
α_{au}	0.0197 (0.0126)	0.0126 (0.0126)	0.0107 (0.0122)	0.051 (0.0298)	-0.0111 (0.0257)	-0.00145 (0.0235)	-0.003 (0.0312)	0.0184 (0.0271)	0.011 (0.0253)	0.0278 (0.0231)	0.0116 (0.0228)	0.00848 (0.0218)	-0.00383 (0.0161)	-0.0046 (0.0161)	0.00994 (0.0141)
N	6675	6675	6675	3660	3660	3660	3008	3008	3008	2829	2829	2829	3846	3846	3846
R-sq	0.005	0.001	0.004	0.01	0.005	0.007	0.003	0.003	0.003	0.009	0.003	0.007	0.001	0.001	0

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

In this table coefficients on the square and cubic terms are reported according to the following model:

$$R_{au,t} = \alpha_{au} + \beta_{1,au}(R_{m,t}) + \beta_{2,au}(R_{m,t})^2 + \beta_{3,au}(R_{m,t})^3 + \varepsilon_{au} \quad (1)$$

R_{au} and R_{au} are respectively the daily excess returns on the market and on gold. The return generation process is a cubic model that establishes a nonlinear relationship between the return of the risky asset and the stock index representative of the market. The coefficient $\beta_{2,au}$ in equation (5) is a measure of coskewness while the coefficient $\beta_{3,au}$ is a measure of cokurtosis. The model is run both unconditionally and conditional on positive and negative market returns and for periods of high and low uncertainty as inferred from implied volatilities. Specifically, positive market returns are used as a proxy of the bull market and negative returns as a proxy of the bear market. The Chicago Board of Exchange VXO stock market volatility measure is used as a proxy of uncertainty (Bloom

TABLE 4: **TIME SERIES ESTIMATION RESULTS FOR GOLD: A COMPARISON OF HS (2000) and KL (1976) HEDGE PORTFOLIOS**

This table summarizes estimation results for the traditional CAPM with the co-moments of order three and four are expressed by the mimicking portfolios.

$$r_{au,t} = \alpha_{au} + \beta_{au} r_{m,t} + \beta_{au}^{csk} CSK_t + \beta_{au}^{ck} CK_t + \varepsilon_{au,t}$$

where r_m is the monthly excess return on the market and $r_{au,t}$ is the monthly excess return on gold. Additional to the monthly excess market returns, I add to the standard CAPM, as explanatory variables, the monthly excess returns of the four hedge portfolios. All of the 4 hedge portfolios are based on both the Harvey and Siddique (2000) direct standardized measures of coskewness and cokurtosis and the traditional ones proposed by Kraus and Litzenberger (1976). Results for silver are not reported because insignificant and with inconclusive signs. Period 1979-2012.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
α_{au}	0.00147	0.00135	0.00134	0.00163	0.00103	0.0019	0.000206	0.000205	0.00142	0.00148	-0.000119	-0.0000742
	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)
$\beta_{au}^{(R_m-R_f)}$	0.0615	-0.0632	0.102	-0.0526	0.108	-0.63	0.112	-0.377*	0.0598	0.261	0.0714	-0.0276
	(0.0758)	(0.1400)	(0.0847)	(0.1940)	(0.0848)	(0.3460)	(0.0602)	(0.1760)	(0.0627)	(0.2210)	(0.0618)	(0.2320)
$\beta_{au}^{(\gamma^- - \gamma^+)}$	-0.0433				-0.179							
	(0.0776)				(0.1350)							
$\beta_{au}^{(\gamma^- - R_f)}$		0.193				0.400*						
		(0.1620)				(0.1990)						
$\beta_{au}^{(\delta^+ - \delta^-)}$			-0.0187		-0.162							
			(0.0758)		(0.1320)							
$\beta_{au}^{(\delta^+ - R_f)}$				0.0963		0.279						
				(0.1271)		(0.1560)						
$\beta_{au}^{(S^- - S^+)}$							0.344**				0.440***	
							(0.1161)				(0.1210)	
$\beta_{au}^{(S^- - R_f)}$								0.492**				0.683***
								(0.1750)				(0.1930)
$\beta_{au}^{(K^+ - K^-)}$									-0.217		-0.379**	
									(0.1410)		(0.1460)	
$\beta_{au}^{(K^+ - R_f)}$										-0.185		-0.564*
										(0.226)		(0.2470)
N	390	390	390	390	390	390	390	390	390	390	390	390
R-sq	0.006	0.009	0.006	0.007	0.01	0.017	0.028	0.025	0.011	0.007	0.044	0.038

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

TABLE 5: TIME SERIES ESTIMATION RESULTS FOR GOLD: A COMPARISON OF HS (2000) AND KL'S (1976) MEASURES OF COSKEWNESS AND COKURTOSIS

Time series regressions of monthly gold excess returns on the market, coskewness, and cokurtosis factors. Period 1979-2012.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
α_{au}	0.00087 (0.003)	0.000781 (0.003)	0.000571 (0.003)	0.0013 (0.003)	0.00057 (0.003)	0.000599 (0.003)	0.00421 (0.003)	-0.00128 (0.003)	0.0000478 (0.003)	0.00287 (0.003)	0.000258 (0.003)	0.00229 (0.003)
$\beta_{au}^{(R_m-R_f)}$	-0.00187 (0.137)	-0.17 (0.182)	-0.00456 (0.114)	0.0111 (0.194)	-0.00475 (0.137)	-0.0618 (0.197)	0.931*** (0.269)	-0.282 (0.173)	-0.22 (0.276)	0.375 (0.214)	0.122 (0.225)	0.526 (0.343)
γ^-	0.115 (0.158)				0.000637 (0.245)							
γ^+		0.188 (0.126)				0.451* (0.222)						
δ^-			0.138 (0.146)		0.138 (0.227)							
δ^+				0.0525 (0.128)		-0.323 (0.224)						
S^-							-0.833** (0.259)					-0.938*** (0.264)
S^+								0.392* (0.172)			0.636** (0.192)	
K^-									0.29 (0.253)			0.482 (0.255)
K^+										-0.307 (0.220)	-0.677** (0.244)	
N	390	390	390	390	390	390	390	390	390	390	390	390
R-sq	0.007	0.011	0.008	0.006	0.008	0.016	0.031	0.018	0.009	0.01	0.038	0.04

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

TABLE 6: FAMA AND FRENCH 3-FACTOR MODEL REGRESSION RESULTS FOR GOLD: COSKEWNSS AND COKURTOSIS HEDGE PORTFOLIOS

The three-factor porfolios of Fama and French (market porfolio, HML, and SMB) are considered together with the monthly excess returns on the hedge portfolios.

$$r_{au,t} = \alpha_{au} + \beta_{au}^{mkt} r_{m,t} + \beta_{au}^{smb} SMB_t + \beta_{au}^{hml} HML_t + \beta_{au}^{csk} CSK_t + \beta_{au}^{ck} CK_t + \varepsilon_{au,t}$$

where $r_{au,t}$ is excess return on gold. For the explanatory variables r_m is the excess return on the market, SMB_t represents the difference between the return on the small-sized stock and the return on the large-sized stocks. HML_t represents the difference between return on the high book-to-market stocks and return on the low book-to-market stocks. CSK_t and CK_t represent the hedge portfolios calculated as described in the previous section. β_{au}^{mkt} is the systematic risk, β_{au}^{csk} indicates the factor loading on coskewness of the asset, and β_{au}^{ck} indicates the factor loading on cokurtosis.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
α_{au}	0.00131 (0.003)	0.00138 (0.003)	0.00102 (0.003)	0.00132 (0.003)	0.000805 (0.003)	0.00168 (0.003)	0.00042 (0.003)	0.000351 (0.001)	0.00108 (0.002)	0.00128 (0.003)	-0.00001 (0.003)	-0.00003 (0.003)
β_{au}^{mkt}	0.0668 (0.077)	-0.217 (0.161)	0.134 (0.086)	0.0609 (0.213)	0.141 (0.086)	0.0539 (0.350)	-0.0671 (0.064)	-0.558** (0.197)	0.0528 (0.065)	0.126 (0.297)	0.0559 (0.064)	-0.26 (0.312)
β_{au}^{smb}	0.15 (0.189)	0.2 (0.144)	0.19 (0.156)	0.131 (0.149)	0.122 (0.138)	0.0941 (0.118)	-0.102 (0.097)	-0.104 (0.103)	-0.104 (0.102)	-0.0934 (0.093)	-0.0963 (0.098)	-0.0952 (0.097)
β_{au}^{hml}	-0.0169 (0.099)	-0.0635 (0.101)	-0.0658 (0.105)	-0.014 (0.103)	-0.091 (0.107)	-0.0414 (0.103)	-0.121 (0.102)	-0.139 (0.103)	0.0442 (0.109)	0.00038 (0.117)	-0.0407 (0.11)	-0.0722 (0.117)
$\beta_{au}^{(\gamma^- - \gamma^+)}$	0.0136 (0.087)				-0.185 (0.137)							
$\beta_{au}^{(\gamma^- - R_f)}$		0.332 (0.176)				0.432* (0.201)						
$\beta_{au}^{(\delta^+ - \delta^-)}$			-0.121 (0.0928)		-0.274 (0.147)							
$\beta_{au}^{(\delta^+ - R_f)}$				-0.00037 (0.150)		0.175 (0.170)						
$\beta_{au}^{(S^- - S^+)}$							0.400** (0.122)				0.443*** (0.124)	
$\beta_{au}^{(S^- - R_f)}$								0.623** (0.188)				0.693*** (0.196)
$\beta_{au}^{(K^+ - K^-)}$									-0.195 (0.166)		-0.308 (0.166)	
$\beta_{au}^{(K^+ - R_f)}$										-0.0649 (0.288)		-0.365 (0.297)
R-sq	0.012	0.021	0.016	0.012	0.021	0.024	0.039	0.039	0.016	0.012	0.047	0.043

Standard errors in parentheses * p<0.05 ** p<0.01 *** p<0.001

TABLE 7: FAMA AND FRENCH 3-FACTOR MODEL REGRESSION RESULTS FOR GOLD: A COMPARISON OF HS (2000) AND KL'S (1976) MEASURES OF COSKEWNESS AND COKURTOSIS

Fama and French three-factor model (Fama and French (1993)): Time series regressions of monthly gold excess returns on the market, HML, SMB, coskewness, and cokurtosis factors. Period 1979-2012.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
α_{au}	0.000324	0.000908	-0.000457	0.00149	-0.000455	0.00105	0.00442	-0.00171	0.0000572	0.00233	-0.000268	0.00259
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_{au}^{mkt}	-0.137	-0.0992	-0.189	0.139	-0.188	0.0676	0.901**	-0.443*	-0.2	0.325	0.00399	0.544
	(0.157)	(0.194)	(0.143)	(0.212)	(0.161)	(0.215)	(0.273)	(0.194)	(0.278)	(0.287)	(0.301)	(0.350)
β_{au}^{smb}	0.177	0.108	0.211*	0.159	0.211*	0.126	0.104	0.151	0.139	0.119	0.1	0.0915
	(0.097)	(0.103)	(0.100)	(0.102)	(0.100)	(0.103)	(0.094)	(0.094)	(0.095)	(0.098)	(0.097)	(0.094)
β_{au}^{hml}	-0.0496	-0.00552	-0.0877	-0.0261	-0.0877	-0.0746	-0.0692	-0.117	0.00526	0.0448	-0.0154	-0.0423
	(0.101)	(0.098)	(0.104)	(0.102)	(0.104)	(0.105)	(0.098)	(0.104)	(0.099)	(0.116)	(0.116)	(0.099)
γ^-	0.236				-0.00468							
	(0.171)				(0.244)							
γ^+		0.122				0.45						
		(0.14)				(0.230)						
δ^-			0.335		0.338							
			(0.171)		(0.244)							
δ^+				-0.0581		-0.437						
				(0.149)		(0.244)						
S^-							-0.835**					-0.920***
							(0.264)					(0.268)
S^+								0.509**			0.631**	
								(0.185)			(0.195)	
K^-									0.25			0.425
									(0.260)			(0.261)
K^+										-0.264	-0.566	
										(0.279)	(0.291)	
N	390	390	390	390	390	390	390	390	390	390	390	390
R-sq	0.017	0.014	0.022	0.012	0.022	0.022	0.037	0.031	0.014	0.014	0.04	0.044

Standard errors in parentheses * $p<0.05$ ** $p<0.01$ *** $p<0.001$

TABLE 8. TIME SERIES ESTIMATION RESULTS FOR GOLD: A COMPARISON OF HS (2000) AND HL (1976) MEASURES OF COSKEWNESS AND COKURTOSIS

Time series regressions of gold excess returns on the market, coskewness, and cokurtosis factors. Period 1975-2011.

Note I: T-stats are in round brackets - * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Model Id.	α	β to $\left(R_M - R_f\right)$	β to γ^-	β to γ^+	β to δ^-	β to δ^+	β to S^-	β to S^+	β to K^+	β to K^-	R^2_{adj}
I	-0.0001 (-0.01)	-0.1660 (-1.10)					0.2218 (1.51)				0.0025
II	0.00150 (0.59)	0. 0662 (0.27)						-0.0187 (0.937)			-0.0027
III	0.0024 (0.92)	0. 2362 (0.223)							-0.1995 (-1.01)		-0.0004
IV	-0.0014 (0.579)	-0.6179** (-2.73)								0.6252** (3.02)	0.0178
V	-0.0011 (-0.42)	-0. 5108 (0.094)						-0.1240 (-0.53)		0.6415** (3.06)	0.0162
VI	0.0009 (0.36)	0.0961 (0.47)					0.3699* (2.24)		-0.4280* (-1.96)		0.0088
VII	0.00034 (0.14)	-0.1353 (0.276)	0. 2243 (1.63)								0.0034
VIII	0.0009 (0.41)	-0.1451 (-0.98)		0.1452 (1.39)							0.0017
IX	0.00116 (0.48)	-0.1554 (-0.98)				0.1435 (0.178)					0.0015
X	0.00078 (0.31)	-0.0255 (-0.25)			0.1065 (0.82)						-0.0012
XI	-0.0009 (-0.33)	-0.4457* (-1.96)		0.2419* (2.04)	0.2512 (1.70)						0.0610
XII	-0.0014 (-0.55)	-0.7837** (-2.85)	0.4506** (2.79)			0.3281** (2.63)					0.0168

TABLE 9. TIME SERIES ESTIMATION RESULTS FOR SILVER: A COMPARISON OF HS(2000) AND KL(1976) MEASURES OF COSKEWNESS AND COKURTOSIS

Time series regressions of silver excess returns on the market, coskewness, and cokurtosis factors. Period 1975-2011.

Note I: T-stats in square brackets. - * p<0.05 ** p<0.01 *** p<0.001

Model Id.	α	β to $(R_M - R_f)$	β to γ^-	β to γ^+	β to δ^-	β to δ^+	β to S^-	β to S^+	β to K^+	β to K^-	R^2_{adj}
I	0.0040	-0.0598					0.3901				0.0288
	[0.91]	[-0.23]					[1.56]				
II	0.0055	-0.0290						0.3441			0.0251
	[1.28]	[-0.07]						[0.86]			
III	0.0077	0.5336							0.2302		0.0244
	[1.75]	[1.62]							[0.081]		
IV	0.0021	-0.74048*								0.9926**	0.0408
	[0.47]	[1.96]								[2.81]	
V	0.0016	-0.9002						0.1851		0.9684**	0.0391
	[0.35]	[-1.74]						[0.46]		[2.71]	
VI	0.0054	0.3073					0.5974*		-0.5993		0.0322
	[1.20]	[0.89]					[2.12]		[-1.59]		
VII	0.0051	0.0655	0.3072								0.0272
	[1.20]	[0.31]	[1.31]								
VIII	0.0057	-0.1451		0.2988*							0.0297
	[1.38]	[-0.98]		[1.98]							
IX	0.0061	-0.0769				0.2777					0.0287
	[1.47]	[-0.28]				[1.54]					
X	0. 0061	0.2568			0.0862						0.0237
	[1.40]	[1.46]			[0.39]						
XI	0.0031	0.4925		0.4314*	0.3441						0.0317
	[0.69]	[-1.26]		[2.14]	[1.37]						
XII	0.0021	-1.0465*	0.6953**			0.5627**					0.0406
	[0.48]	[-2.23]	[2.53]			[2.65]					

TABLE 10. TIME SERIES ESTIMATION RESULTS FOR GOLD: A COMPARISON OF HS (2000) AND KL (1976) HEDGE PORTFOLIOS

Time series regressions of gold excess returns on the market and on the hedge portfolios built as described in section III. All of the 4 hedge portfolios are based on both the Harvey and Siddique (2000) direct measures of coskewness and cokurtosis and the traditional ones proposed by Kraus and Litzenberger (1976). Results for silver are not reported because insignificant and with inconclusive signs. Period 1975-2011.

Model Id.	α	β to $(R_M - R_f)$	β to $(S^- - S^+)$	β to $(S^- - R_f)$	β to $(K^+ - K^-)$	β to $(K^+ - R_f)$	β to $(\gamma^- - \gamma^+)$	β to $(\gamma^- - R_f)$	β to $(\delta^+ - \delta^-)$	β to $(\delta^+ - R_f)$	R^2_{adj}
I	0.0011	0.0518	0.1083								-0.0001
	[0.44]	[-0.98]	[1.07]								
II	0.0014	0.0128			-0.2930**						0.0104
	[0.60]	[0.24]			[-2.58]						
III	0. 00080	-0.23019		0.2877*							0.0058
	[0.33]	[-1.50]		[1.96]							
IV	0.0015	0.1429				-0.10059					-0.002
	[0.60]	[0.72]				[-0.50]					
V	0.0015	0.0440					-0.00683				-0.002
	[0.60]	[0.70]					[-0.10]				
VI	0.0019	-0.1961								0.17194	0.0033
	[0.77]	[-1.24]								[1.63]	
VII	0.0013	-0.1891						0.2895*			0.0069
	[0.55]	[-1.49]						[2.05]			
VIII	0.0016	0.0276							0.0273		-0.002
	[0.64]	[0.39]							[0.42]		

Note I: T-stats in square brackets. - * p<0.05 ** p<0.01 *** p<0.001

TABLE 11. FAMA AND FRENCH REGRESSION RESULTS FOR SILVER: KL COSKEWNSS AND COKURTOSIS HEDGE PORTFOLIOS

Fama and French three-factor model (Fama and French (1993)): a coskewness and/or cokurtosis hedge portfolio is included.

$$r_{ag,t} = \alpha_{ag} + \beta_{ag}^{mkt} r_{m,t} + \beta_{ag}^{smb} SMB_t + \beta_{ag}^{hml} HML_t + \beta_{ag}^{csk} CSK_t + \beta_{ag}^{ck} CK_t + \varepsilon_{ag,t}$$

where $CSK^{(\gamma^- - \gamma^+)}$, $CSK^{(\gamma^- - R_f)}$, $CSK^{(\delta^+ - \delta^-)}$, and $CSK^{(\delta^+ - R_f)}$ are the hedge portfolios computed using the standardized measures by HS(2000). High factor loadings should be associated with high-expected returns. Period 1975-2011.

Model Id.	α	β_{ag}^{mkt}	β^{smb}	β^{hml}	β to $CSK^{(\gamma^- - \gamma^+)}$	β to $CSK^{(\gamma^- - R_f)}$	β to $CSK^{(\delta^+ - \delta^-)}$	β to $CSK^{(\delta^+ - R_f)}$	R^2_{adj}
I	0.0011 [0.44]	0.0239 [0.43]	0. 0959 [1.19]	-0.0611 [-0.69]	0.1349 [1.26]				0.0006
II	0.0011 [0.45]	0.0127 [0.23]	0. 0531 [0.64]	0. 0478 [0.53]			-0.2960* [-2.12]		0.0228
III	0.0009 [0.37]	-0.3390* [-1.99]	0.0972 [1.21]	-0.0979 [-1.10]		0.3627* [2.27]			0.0087
IV	0.0014 [0.55]	0. 0165 [0.07]	0.1019 [1.23]	-0.0259 [-0.27]				0.0085 [0.04]	-0.003
V	0.0007 [0.29]	0. 0095 [0.17]	0.0397 [0.47]	0.0084 [0.09]	0.1783 [1.65]		-0.3353* [-2.37]		0.0112
VI	0.0007 [0.30]	0.1879 [-0.71]	0.0822 [0.99]	-0.0669 [-0.68]		0.4039* [2.38]		-0.1921 [-0.75]	0.0077

Note I: T-stats in square brackets. - * p<0.05 ** p<0.01 *** p<0.001

TABLE 12. FAMA AND FRENCH REGRESSIONS RESULTS FOR GOLD: KL COSKEWNESS AND COKURTOSIS HEDGE PORTFOLIOS

Fama and French three-factor model (Fama and French (1993)): a coskewness and/or cokurtosis hedge portfolio is included.

$$r_{au,t} = \alpha_{au} + \beta_{au}^{mkt} r_{m,t} + \beta_{au}^{smb} SMB_t + \beta_{au}^{hml} HML_t + \beta_{au}^{csk} CSK_t + \beta_{au}^{ck} CK_t + \varepsilon_{au,t}$$

where $CSK^{(\gamma^- - \gamma^+)}$, $CSK^{(\gamma^- - R_f)}$, $CSK^{(\delta^+ - \delta^-)}$, and $CSK^{(\delta^+ - R_f)}$ are the hedge portfolios computed using the standardized measures by HS(2000). High factor loadings should be associated with high-expected returns. Period 1975-2011.

Model Id.	α	β_{ag}^{mkt}	β^{smb}	β^{hml}	β to $CSK^{(\gamma^- - \gamma^+)}$	β to $CSK^{(\gamma^- - R_f)}$	β to $CSK^{(\delta^+ - \delta^-)}$	β to $CSK^{(\delta^+ - R_f)}$	R^2_{adj}
I	0.00131 [0.53]	0.0393 [0.62]	0.1149 [1.35]	-0.0350 [0.685]	0.0365 [0.50]				-0.002
II	0.0013 [0.52]	0.0389 [0.54]	0.1116 [1.28]	-0.0363 [-0.39]			0.0247 [-0.31]		-0.002
III	0.00145 [0.60]	-0.3267* [-2.27]	0.1379 [1.70]	-0.0985 [-1.13]		0.4045** [2.65]			0.0130
IV	0.0016 [0.65]	-0.1616 [-0.94]	0.0638 [0.73]	0.0098 [0.11]				0.14120 (0.254) [1.14]	0.0000
V	0.0022 [0.90]	-1.0106*** [-3.49]	0.0582 [0.68]	-0.0483 [-0.55]		0.6213*** [3.63]		0.3746** [2.72]	0.0274

Note I: T-stats in square brackets. - * p<0.05 ** p<0.01 *** p<0.001

TABLE 13. FAMA AND FRENCH REGRESSION RESULTS FOR SILVER: HS COSKEWNSS AND COKURTOSIS HEDGE PORTFOLIOS

Fama and French three-factor model (Fama and French (1993)): a coskewness and/or cokurtosis hedge portfolio is included.

$$r_{ag,t} = \alpha_{ag} + \beta_{ag}^{mkt} r_{m,t} + \beta_{ag}^{smb} SMB_t + \beta_{ag}^{hml} HML_t + \beta_{ag}^{csk} CSK_t + \beta_{ag}^{ck} CK_t + \varepsilon_{ag,t}$$

where $CSK^{(S^- - S^+)}$, $CSK^{(S^- - R_f)}$, $CK^{(K^+ - K^-)}$, and $CSK^{(K^+ - R_f)}$ are the hedge portfolios computed using the standardized measures by HS(2000).

Model Id.	α	β^{mkt}	β^{smb}	β^{hml}	β to $CSK^{(S^- - S^+)}$	β to $CSK^{(S^- - R_f)}$	β to $CSK^{(K^+ - K^-)}$	β to $CSK^{(K^+ - K^-)}$	R^2_{adj}
I	0.0057 [1.36]	0.2754** [2.88]	0.0754 [0.53]	0.1532 [1.00]			0.4887* [-2.06]		0.0312
II	0.0054 [1.30]	-0.2699 [-0.93]	0.1486 [1.09]	-0.0802 [-0.53]		0.5636* [2.07]			0.0313
III	0.0053 [1.26]	0.2720** [2.84]	0.0609 [0.43]	0.1110 [0.70]	0.1911 [1.04]		-0.5309* [-2.20]		0.0314
IV	0.0051 [1.22]	-0.0208 [-0.05]	0.1238 [0.88]	-0.0291 [-0.17]		0.6315* [2.19]		-0.3167 [-0.72]	0.0302

Note I: T-stats in square brackets. - * p<0.05 ** p<0.01 *** p<0.001

4. CONCLUSIONS

I started this monograph with the promise to help the reader better understand whether gold deserves a place in her portfolio. The analyses conducted in the chapters of this thesis support the view that gold acts indeed as an anchor of stability during market downturns. During periods of high uncertainty and low stock market returns, gold tends to have higher-than-average excess returns. The effectiveness of gold as a safe haven is enhanced during periods of rare but extreme crises: the largest peaks have been observed during the global financial crises of 2007-2009 and, in particular, in the occasion of the default of Lehman Brothers (October 2008). This thesis' findings help to understand the behavior of precious metals over the long run, and to support the idea that allocating some investment funds to gold may reduce the probability of experiencing undesirable extreme outcomes. This thesis shows that the same is true for investing in silver, although to a lower extent.. Gold provides an insurance against extreme bad movements of sotck returns during downturns and /or periods of high uncertainty. In order to investigate whether gold provides protection from tail risk, I addressed the issue of asymmetric precious metal behavior conditional on stock market performance. More specifically, I provided empirical evidence on the contribution of gold and silver to a portfolio's systematic skewness (coskewness) and kurtosis (cokurtosis). My analysis shows that gold, unlike silver, has positive coskewness with the market portfolio when the market is skewed to the left (i.e., during bear markets or market turmoil). Moreover, gold has low cokurtosis with market returns during volatile periods (i.e., gold's returns tend to be higher during periods of high uncertainty). I show that gold is desirable to risk averse investors because it tends to decrease the probability and incidence of extreme bad outcomes. A question is still left to be answered, which is why, despite the wide range of sophisticated financial instruments, which are available to investors nowadays, and especially throughout the turbulences of the twenty-first century, does gold still display the same appealing properties. The recent financial crisis has reminded us that extreme bad outcomes, although very rare, do occur and can do so with devastating effects. We have witnessed the failure and bailout of large financial corporations, the spillover of the financial crisis to the production economy, and the resulting drop in economic activity. Academics, regulators, and investors are now converging to a view that the probabilities and magnitudes of extreme negative outcomes cannot be ignored.

Most investors prefer assets with greater probabilities of large gains than equivalent large losses, that is, distributions skewed to the right (or positively skewed) and with low kurtosis. A well-diversified investor will focus on the skewness of her portfolio rather than the skewness of the assets in her portfolio. She will value assets more when they are positively coskewed with her portfolio because this will result in an increase in the portfolio's skewness. My results support the important role played by gold as an asset class. Gold does not only help to manage risk more efficiently by protecting against unforeseen extreme negative events, it also acts as a currency and inflation hedge. It serves as a portfolio diversifier since it tends to be uncorrelated with stocks. Gold's role extends beyond providing insurance in extremely negative circumstances. There is a great deal of disagreement about the future of gold. On the one hand, Warren Buffett compares the current value of gold to one of the past infamous bubbles, "Tulips of all things, briefly became a favorite of such buyers in the 17th century" [1]; on the other hand, Dalio shares his concerns about the global economy. He thinks that Treasury Bills cannot be seen as safe assets. According to Dalio[2], gold is the only potential safe haven left to protect an investor from currency debasement and expansionary monetary policies. Consequently, gold should be part of every investor's portfolio.

However, gold's hedge capabilities do not come without a price tag. During periods of market upturns, gold shows a small negative coskewness with the market. Intuitively, such behavior should be expected from a safe haven commodity, which is demanded highly in times of market turmoil. In a time when there is increasing

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[1] Buffett, Warren. 2012. "2011 Berkshire Hathaway Shareholder Letter."

[2] Interview with Maria Bartiromo at the Council on Foreign Relations - September 2012. Raymond Dalio, Bridgewater Associates founder and CIO. In 2012, Dalio was named one of the *Time* magazine's most influential people in the world.

concern regarding capital preservation, gold is shown to be a key portfolio constituent. My findings support the view that gold acts as a “safe haven” in times of crisis and high uncertainty, when flight to quality towards assets of last resort is expected to be observed.

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