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**Working Paper**

## Gold in the investment portfolio

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**Frankfurt School – Working Paper**

**No. 87**

**Gold in the Investment Portfolio**

by Nadeshda Demidova-Menzel, Thomas Heidorn



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## Abstract

The paper examines the key drivers of gold investment. Since 2000 the gold price has risen drastically, making gold an interesting add-on to a portfolio. As gold futures have negative roll returns, gold pool accounts are characterized by high credit risk and physical possession of gold means high transaction costs, Xetra-Gold might be the most efficient way to enter the market. Xetra-Gold is a product created by the Deutsche Börse in 2007, which is handled like a security but can be exchanged into physical gold any time. In the portfolio context gold has had a positive impact on Euro and USD portfolios between 2000 and 2006 due to considerable returns and low correlation to other assets. However, this has not been true for almost all other periods, the correlation was always low but the returns of gold were almost zero, overriding the positive diversification effect.

Key words: investing in gold, gold in the portfolio, correlation of gold, returns of gold, Xetra-Gold

JEL classification: G11, G15, G24.

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## 1 Introduction

During the last years the gold price has risen significantly. As 15 European central banks decided to limit their gold sales in 2004 for the next 5 years, this might be a significant change for the behaviour of the gold price. At the same time, low returns of many asset classes force portfolio managers to look for new investment policies. Gold started to be an interesting add-on to a portfolio. Early in 2007 a new investment vehicle was created. With Xetra – Gold set by the Deutsche Börse gold can now be handled as a normal security, leading to considerable advantages compared to investments in physical gold or gold futures.

The paper outlines the main drivers of the gold price, taking a look on short and long term effects. Correlation with interest rates and inflation are discussed from the USD angle but also from the Euro point of view. Understanding the basic pricing elements we can sum up the specific attributes of gold.

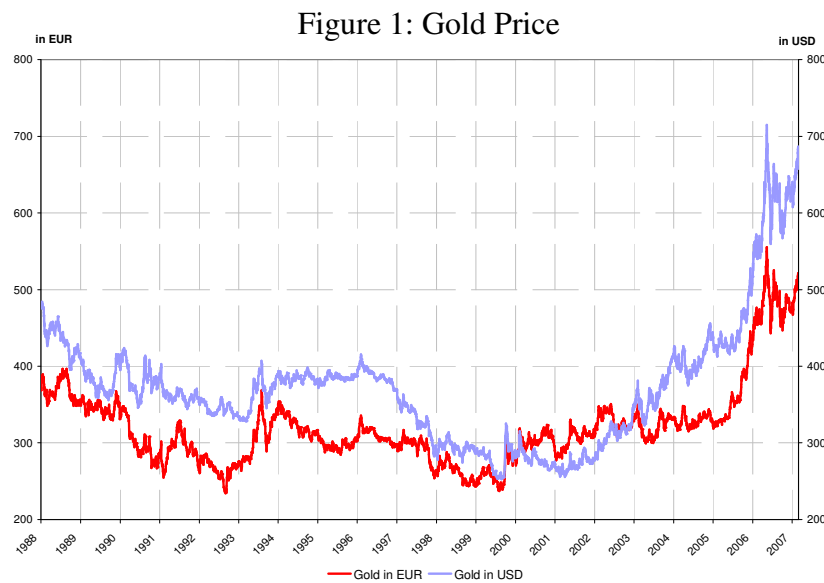
In the next chapter the possible investment forms in gold are analyzed. We start with physical gold, look at gold pool accounts and carefully examine gold futures. Xetra – Gold is then compared to these classic alternatives. The chapter concludes with the investment in gold mining companies instead.

Building on these elements, the contribution of gold in the portfolio context is examined. We look at distinct time periods, as gold has behaved very differently during the last decades. Also, there are substantial differences between the Euro zone and the USD environment.

At the end the major findings are summed up.

## 2 Price Driving Factors in the Gold Market

Similar to every other market, the price determining mechanism in the gold market is driven by supply and demand. To be exact, the *real* supply and demand should be considered in the analysis without taking into account the Central Banks gold sales and purchases as well as the supply component in the form of old gold scrap which are a kind of “recycling” of the above-ground stocks. Especially the overcompensation of the supply deficit through sales of the Central Banks was the reason why the gold price has been tending downwards for many years till 2000 despite of demand excess for a long period of time in the global gold market.



However, on September 27<sup>th</sup> 2004, 15 European Central Banks agreed to limit their annual sales to 500 tonnes and their total gold sales to 2500 tonnes over the next 5 years. This limitation and the fact that the persistent low gold price had already forced a number of mining companies to close their gold mines because of insufficient profitability, caused a shortage of the gold supply (cf. Figures 1 and 2).

Figure 2: Gold Price since September 27<sup>th</sup> 2004



As the gold price began to rise the mining companies were not able to balance the supply deficit immediately because of the time lag between the gold exploration and production. Besides that, the real supply from gold mining is limited by the available under-ground resources. They are estimated with approx. 100,000 tonnes while only half of these resources can be mined at reasonable costs. Increasing energy and transportation prices make gold mining extremely expensive. Additionally, more severe environmental regulations cause an increase in exploration and mining costs.

Political uncertainty in many gold mining countries (in Africa, Latin America, Asia) and unclear owners' rights in Russia<sup>1</sup> are further risk factors which cause shocks in the gold market in the form of sudden supply reduction and contribute to an increase of the gold price volatility.

At the same time, on the *demand side* an increasing popularity of gold can be observed. There are two components of the gold demand: the "use demand" (jewellery, industry) and the "asset demand" (investments). On the one side, gold is a "real" commodity used for consumption and production ("use demand"). On the other side, gold is considered to be a financial or reserve asset ("asset demand"). About 15% of the annual gold production is held by investors in physical form<sup>2</sup> and provides a natural hedge against the currency weakness because of negative correlation to the USD.<sup>3</sup>

The "use" demand for gold is a negative function of the price of gold (price elasticity) and a positive function of the income (income elasticity). Therefore, the demand for jewellery is affected by the price (volatility) and positively influenced by an increase of the available income. The best example is the continuous growth of wealth in Asian countries in which gold jewellery has traditionally been very popular: India and China. The demand of the jewellery sector counted for 71% in 2005. This number shows an increase by 12% in comparison to 2004. India counted for 22% of the global gold jewellery demand in 2005, an annual increase of 17%. India is thought to hold close to 15,000 tonnes or 10% of the world's entire above-ground gold stocks. China's demand also showed an upwards trend: the country's gold trading volume (together with net retail investment in form of coins and bars) increased by 36% in 2005.<sup>4</sup>

The "asset" demand is based on a number of factors including real interest rate, dollar exchange rate expectations, inflationary expectations, "fear" because of political turmoil, the returns on other assets and the lack of correlation with other assets. Gold investment is considered to be a means for the reduction of portfolio volatility because the events that cause a collapse of stock prices also tend to raise the price of gold.

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<sup>1</sup> In Russia only minor ownership in mining companies is allowed. This regulation is a clear disadvantage of gold mining stocks.

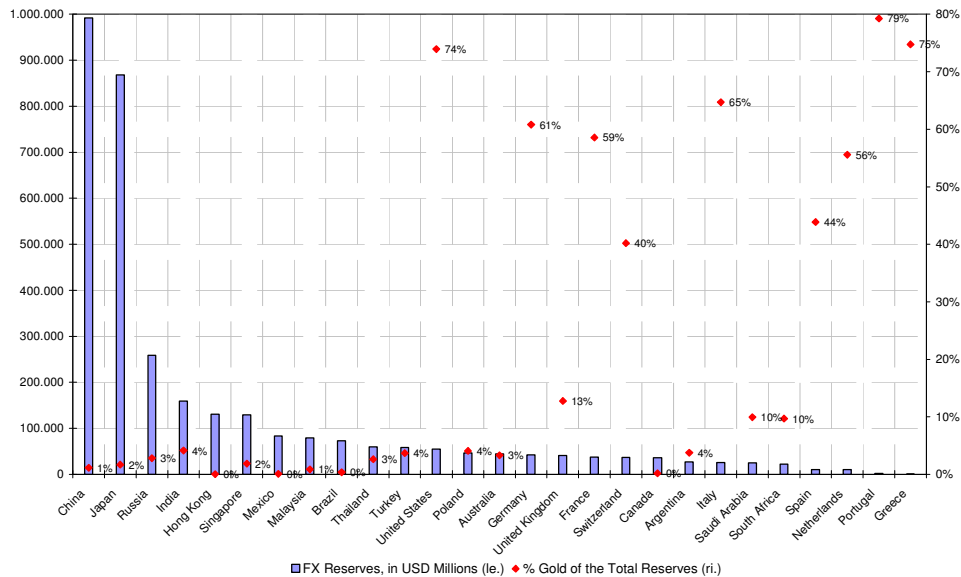
<sup>2</sup> According to the statistics of the World Gold Council, the World Official Gold Holdings of Central banks amount to 30,988.3 tonne as of December 2005; approximately 26% are held by the Federal Reserve Bank

<sup>3</sup> Cf. Kavalis, N. (2006): pp. 3ff.

<sup>4</sup> [www.gold.org/value](http://www.gold.org/value)

Besides those factors one should not disregard the potential of surging gold prices through purchases of physical gold by the Central Banks of the countries with high foreign exchange reserves for the purpose of diversification: e.g. China, Japan, Russia, India, etc. (cf. Figure 3).

Figure 3: Foreign Exchange and Gold Reserve (Q3 2006)



These countries hold less than 5% of their total reserves in gold. As a comparison, the international average is about 10.5% at current market prices. In the EU this quote is over 40% and the USA holds around 70% of its reserves in gold.

To consider the gold price development in much more detail it is important to differentiate between *short-run* and *long-run determinants* of the gold price. The *long-run* price of gold is expected to rise according to the inflation and act as an *inflation hedge* essentially because the long-run price of gold is related to the marginal cost of gold extraction. Assuming a close relationship of production cost and inflation, the price of gold will rise with the increase of production costs and therefore with the inflation. However this effect is not as substantial as the theory proposes and not true for Europe. In the *short-run* the gold price is very volatile. It is determined by supply and demand, and fluctuates considerably around this so called *inflation hedge price*.<sup>5</sup> These short-run movements of the gold price occur in response to factors that alter the supply and/or demand for gold.

<sup>5</sup> Cf. Levin, E.J., Wright, R.E. (2006): pp. 23ff.; the *inflation hedge price* is the mean reversion price.



## 2.1 Short-Run Price Determinants

Such factors that influence the *short-run supply of gold* are the current and lagged gold price, the gold lease rate in the previous and current period (physical interest rate and proxy for real interest rate), convenience yield and default risk, and the previous period quantity of leased gold to be repaid at the previous gold lease rate. The *short-run demand for gold* is described as a function of the price of gold, the available income per capita, the USD/world exchange rate, the gold lease rate, gold's beta, US inflation, credit risk and political uncertainty.

### 2.1.1 Short-Run Gold Supply

The *higher current gold price* motivates gold producers to supply the gold consumers either by extracting gold from their mines or by leasing gold from central bank gold reserves. As there usually is a substantial time lag before mines react to a price change and begin with the gold extraction, there exists a positive relation between the quantity of gold supplied from extraction and the gold price in an earlier period (*lagged gold price*).

The level of the *gold lease rate* determines the amount of gold leased. If the gold lease rate is lower than the marginal extraction costs, the gold producer will decide to satisfy the short-run gold demand by leasing gold from a central bank. At the same time the producer is aware of the repayment commitment in the following period. Hence, the quantity of gold supplied from extraction is negatively related to the amount of leased gold in the previous period which has to be repaid to the central bank in the current period, and therefore negatively related to the gold lease rate in the previous period.

The *gold lease rate* represents physical interest rate and is used as a proxy for real interest rate in the analysis. The term gold lease rate is linked to the terms *convenience yield* and *default risk premium*. *Default risk premium* is a measure of financial credit risk and depends on the credit quality of the borrower. Credit default risk is also associated with financial shocks and structural changes in the international economy. It is assumed that during periods of financial turmoil the demand for gold (and therefore the gold price) is higher. Hence, this premium varies and also includes an extra-charge in periods of political uncertainty. *Convenience yield* is the benefit associated with physically holding gold. Central banks lease out gold at a physical interest rate (gold lease rate) which is in equilibrium equal to the convenience yield plus default risk. Adjusting their gold lending exactly to the point where the physical rate of interest is equal to the convenience yield plus default risk, central banks determine the amount of gold supplied. That is an explanation why central banks reduce the quantity of gold leased to the industry in periods of political or financial turmoil which causes a rise in default risk or a rise in convenience yield, and therefore an increase in the gold lease rate.

## 2.1.2 Short-Run Gold Demand

The *short-run “use” demand* for gold is a negative function of the price of gold and a positive function of the available income per capita. In Figure 4 the worldwide Gross Domestic Product (GDP) per capita<sup>6</sup> is used as a proxy for the income variable.

Figure 4: Gold Price and World GDP per Capita in USD

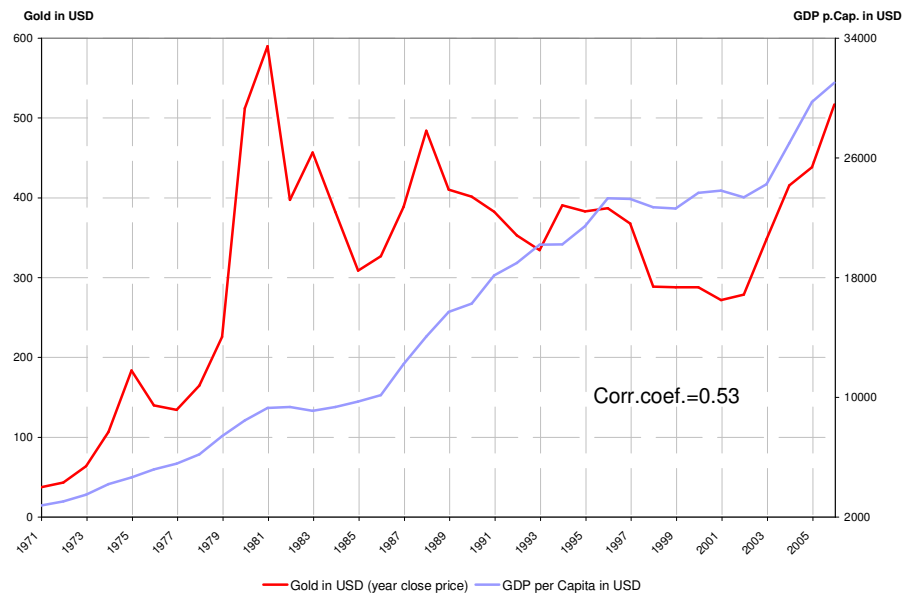
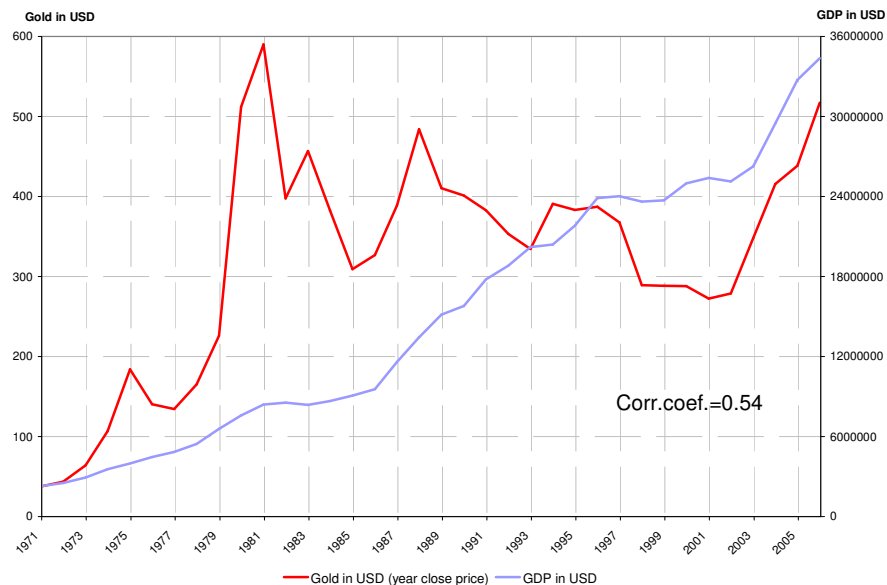


Figure 5 plots the total world income (GDP)<sup>7</sup> which also follows an upwards trend.

Figure 5: Gold Price and World GDP in USD

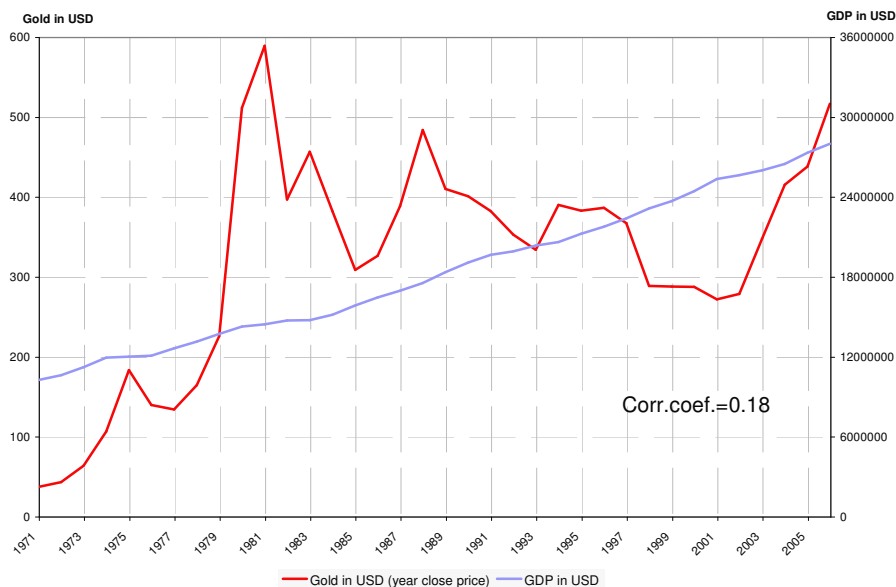


<sup>6</sup> Data source: OECD

<sup>7</sup> Data source: OECD

Figures 4 and 5 show that an increase of the world income (and consequently of the income per capita) might also have an effect on the long-run price of gold by increasing demand for jewellery and for gold as an investment. This statement is supported by a correlation coefficient of over 50%. However, it is difficult to interpret this relationship exactly because the income and the gold price both rose over time with the general price level, and it is necessary to separate these two effects. In Figure 6 the world GDP under assumption of constant prices and constant exchange rates is used. This leads to a very small correlation between the world income and the price of gold. Therefore it is not clear whether rising income leads to higher gold prices.

Figure 6: Gold Price and World GDP in USD (constant prices, constant exchange rates)

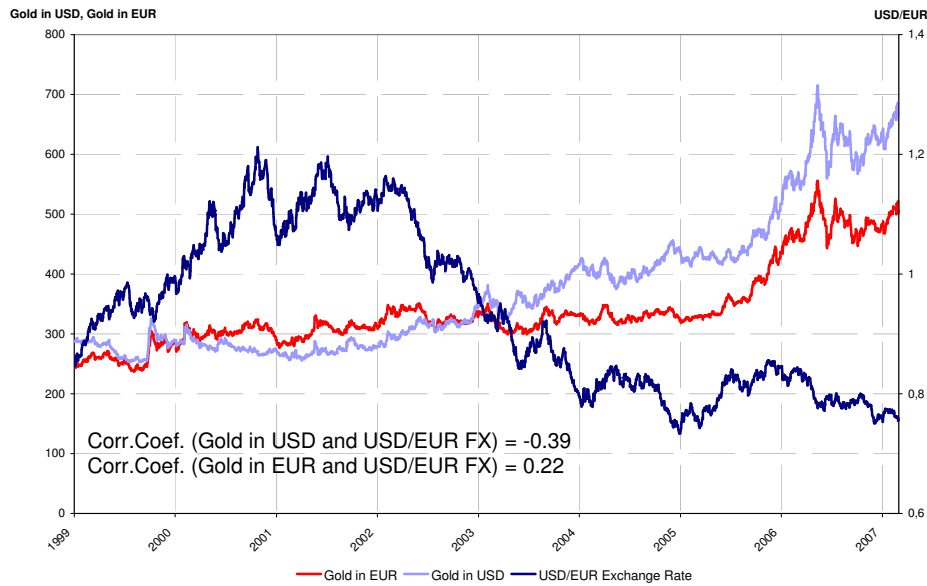


The *short-term “asset demand”* is based on a number of factors including dollar exchange rate expectations, inflationary expectations, the gold lease rate, the returns on other assets and the lack of correlation with other assets.

Figures 7-11 show the individual relationships between the nominal price of gold (denominated in USD) with each of the explanatory variables.

Figure 7 shows a clear negative relationship between the gold price and the *US-dollar-Euro exchange rate*. A rise in the price of USD makes gold more expensive for investors outside of the dollar area, and this will reduce the demand for gold and this in turn lowers the price of gold.

Figure 7: Gold Price and USD/EUR Exchange Rate



There are two important conclusions concerning Figure 7. If the US dollar weakens, the price of gold denominated in USD will rise. At the same time the price of gold denominated in Euro will fall, i.e. gold denominated in Euro will get cheaper which would boost the demand for gold, and therefore will cause an upwards trend of the gold price development.

In Figure 8 the *US inflation rate* was calculated on a 12 month-basis and then graphically shifted 12 months into the past. Especially in the years 1973/74, 1978/79 a positive relation between the shifted US inflation rate and gold price is obvious.

Figure 8: Gold Price and US Inflation Rate

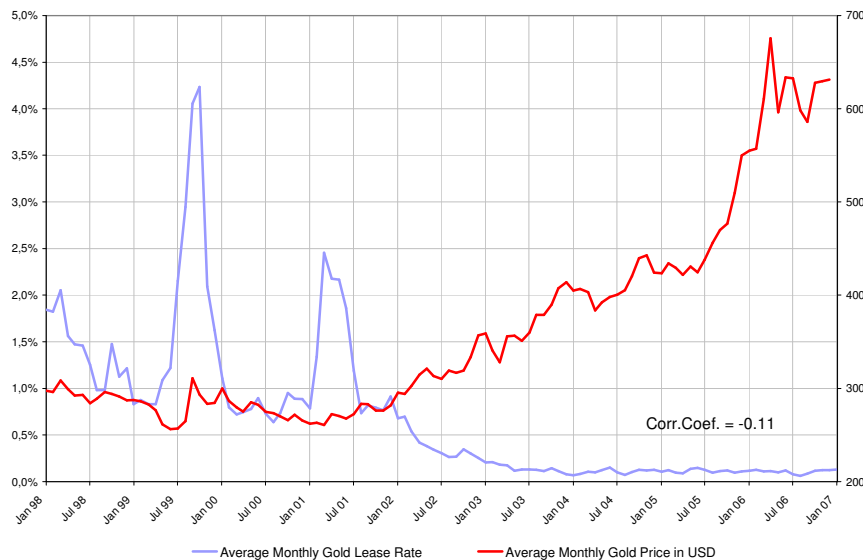


Figure 9 represents the relationship between the gold price and *gold lease rate*. It is calculated by subtracting the three-month gold forward rate from the three-month LIBOR dollar interest rate.<sup>8</sup>

As already mentioned, the gold lease rate is used as an empirical proxy for the *real interest* because in the market equilibrium there is an arbitrage relationship that drives the *physical interest rate* (the gold lease rate) into equality with the real interest rate. Theoretically, in equilibrium, a mine is indifferent between extracting gold now and selling the mined gold now, *or* leasing gold now, selling the leased gold now, investing the proceeds of the sale in a bond, selling the bond in one year and using the proceeds including interest to pay for extracting the gold plus the physical interest rate. If the costs of extraction rises at the general rate of inflation, the gold lease rate is equal to the real interest rate.

Thus it is assumed that the asset demand for gold will fluctuate in response to changes in the real interest rate, and there is an assumption that the gold price moves inversely with interest rates (cf. Figure 9). The real interest rate represents the opportunity cost of holding gold in the form of forgone yield (real interest rate) instead of holding an alternative interest bearing asset. In case of low gold lease rate the investors would prefer gold instead of low interest bearing assets and the rising “asset demand” would drive the gold price upwards.

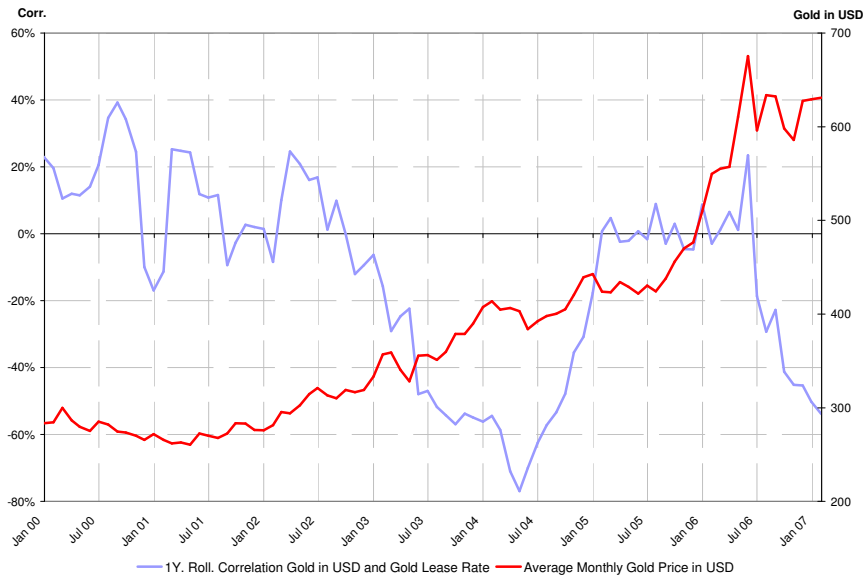
Figure 9: Gold Price and Gold Lease Rate



Hence, the real price of gold moves in the opposite direction from the lease rate, but there are time periods in which this relationship is not that obvious and the correlation coefficient lies in the positive area (cf. Figure 10).

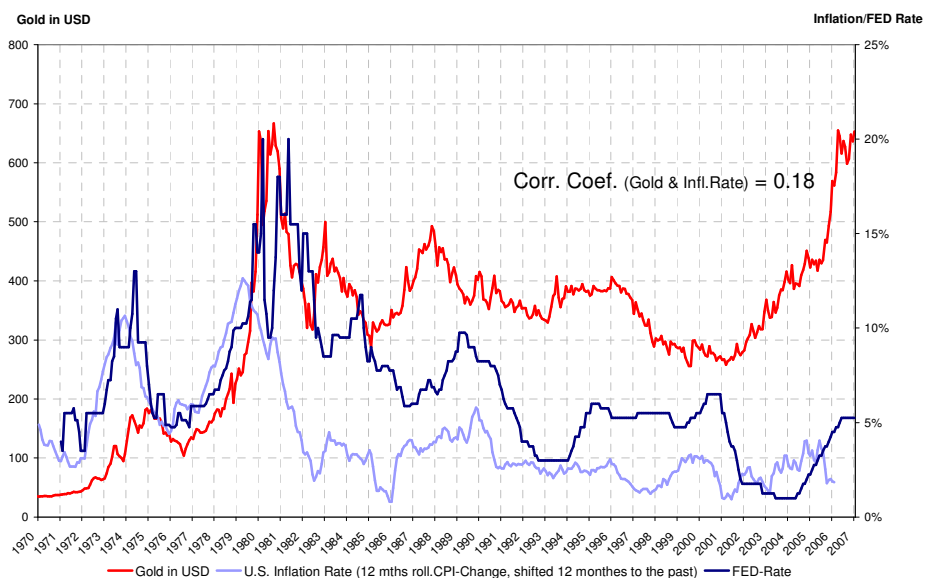
<sup>8</sup> Gold was not leased every day in the early years, therefore gold prices and lease rates averaged over the month for the entire sample period.

Figure 10: Rolling Correlation between Gold Price and Gold Lease Rate



Moreover it is to be considered that if for example, the rising interest rates reflect a concern over inflation or over the US dollar exchange rate, gold prices and interest rates move in line (both rise). The relationship between interest rates and the gold price depends on a clear distinction between real and nominal interest rates and the precise cause of the rise in interest rates. In case the nominal interest rate (FED-Rate) increases slower than the inflation rate (which causes a negative real interest rate), an increase in the gold price can be observed (cf. Figure 11).

Figure 11: Inflation, FED-Rate and Gold Price

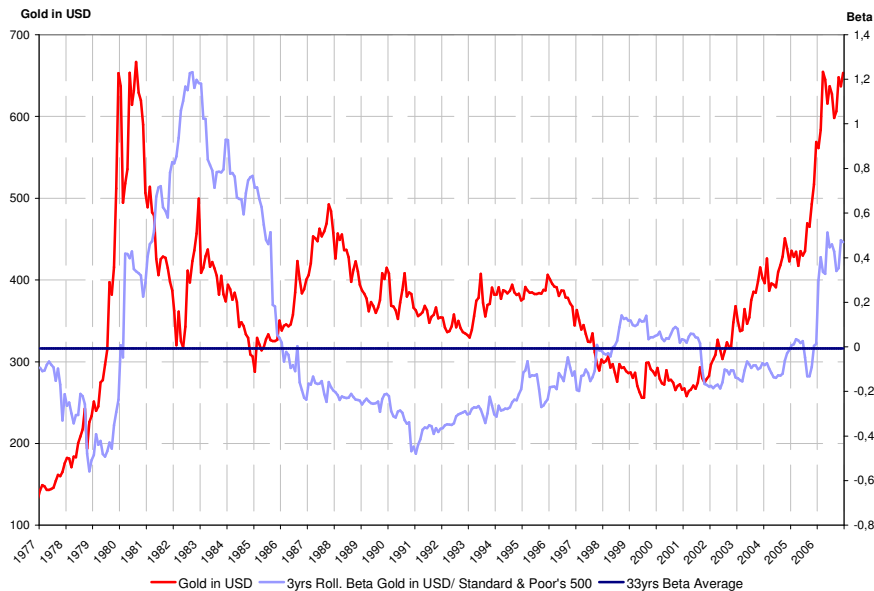


The correlation to other assets, especially to the stock market, is represented by gold's beta. Gold's beta influences the investors' demand for gold in accordance with gold's ability to reduce portfolio volatility. The effectiveness of gold in reducing portfolio risk is inversely related to *beta* which measures the extent to which the price of gold moves in the opposite direction of the stock market. In other words, beta is equivalent to the correlation coefficient:

$$\beta_{Gold} = \frac{\rho_{Gold, EquityMarket} \cdot \sigma_{Gold}}{\sigma_{EquityMarket}}$$

It is believed that gold has a low beta in relationship to the stock market. In Figure 12 beta was calculated by regressing the monthly gold return on the monthly return of the Standard & Poor's 500 (Total Return) Index, based on information from the previous 36 months.

Figure 12: Gold Price and Correlations to the Stock Market



Generally, the empirical evidence shows that on average there is no correlation (very low gold's beta near to zero in Figure 12).<sup>9</sup> If, however, the beta for gold rises for a period of time, the portfolio demand for gold will fall during that period. A negative beta makes gold attractive for investors to hold in a portfolio because a negative beta results in gold reducing the portfolio volatility. Therefore the demand for gold as an investment is negatively related to the beta. That was not the case in 2006 however, because the demand for gold was mainly driven by professional investors like hedge-funds.

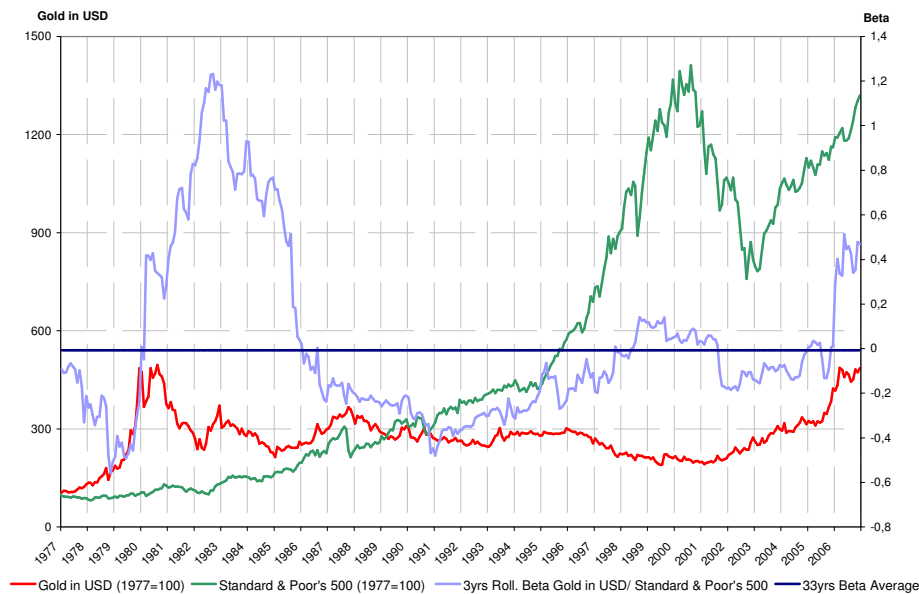
Figure 12 indicates a positive relationship between gold's beta and the price of gold between 1980 and 1986 as well as in 2006, and a negative relationship for most of the remaining peri-

<sup>9</sup> Cf. Lawrence, C. (2003); O'Connell, R. (2005); Pulvermacher, K. (2005b)

ods. Whatever the reason, the ambiguity and empirical instability of this relationship suggests that investors would need perfect foresight in deciding for an exposure to gold only during periods when it has a negative beta to the stock market.

The correlation between the returns on holding gold and the returns on the stock market also became negative for periods when the stock markets under-performed very badly. This relationship is very obvious in the years 2001/2002 in Figure 13.

Figure 13: Gold and Stock Market Performance, Gold Price Correlations to the Stock Market



Having discussing the short-term price determinants, the long-term influence variables are the subject of the following section.

## 2.2 Long-Run Price Determinants

While short-run fluctuations in the gold price are expected to be caused by political and financial turmoil as well as by changes in inflation and exchange rates, real interest rates and the beta for gold, there are also a number of macro economical factors which play a crucial role for the development of the gold price in the long-run.

Fear of inflation plays an essential role in an increase in investors' interest as physical gold has always been considered as a hedge against currency weakness. A rising interest of investors, using gold as a hedge against the US dollar weakness, were driving gold prices up in 2006. Being a *real asset*, gold has maintained its value in terms of the real purchasing power in the long run.

The long-run price of gold is expected to move with the general price level (consumer price index) to act as a hedge against inflation, essentially because the long-run price of gold is re-



lated to the marginal costs of extraction which rise at the rate of inflation. This conclusion is not affected if gold producers supply their customers by leasing from central banks as well as by extracting gold from mines. Since this leased gold has to be repaid it only affects supply in the short term. Profit maximising behaviour by gold producers ensures that the cost of gold from leasing is equal to the cost of gold from extraction. The general price level in the USA and in the world (represented by the OECD countries excluding countries with a high inflation) are used as explanatory variables in order to test the hypothesis that the price of gold moves with the general price level so that gold can be considered as a long-run hedge against inflation. The results of the empirical analysis are presented graphically in Figure 14 for the US price index and in Figure 15 for the world price index.

Figure 14: Gold Price and U.S. CPI



Figure 15: Gold Price and OECD CPI

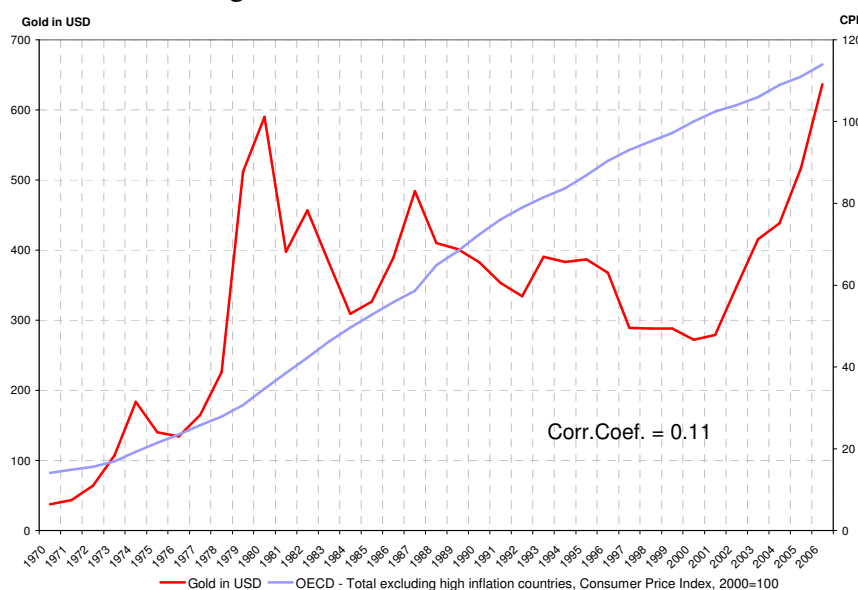
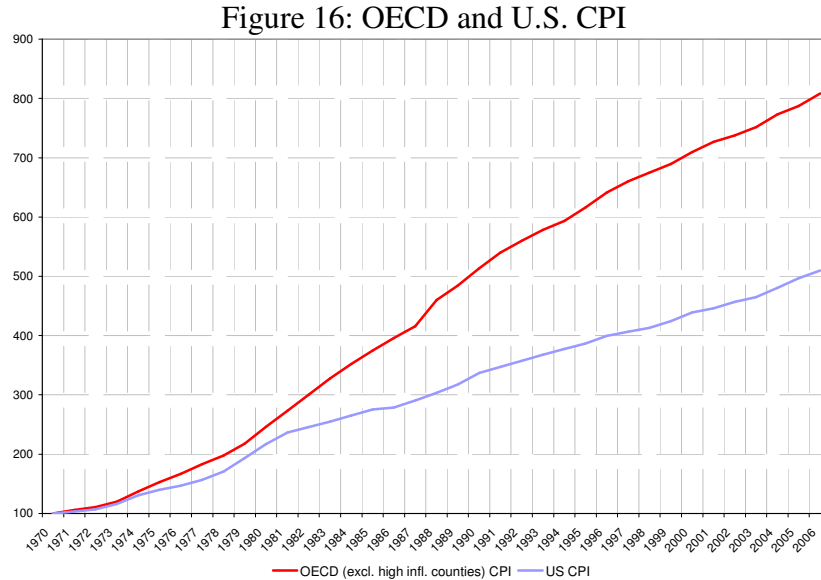
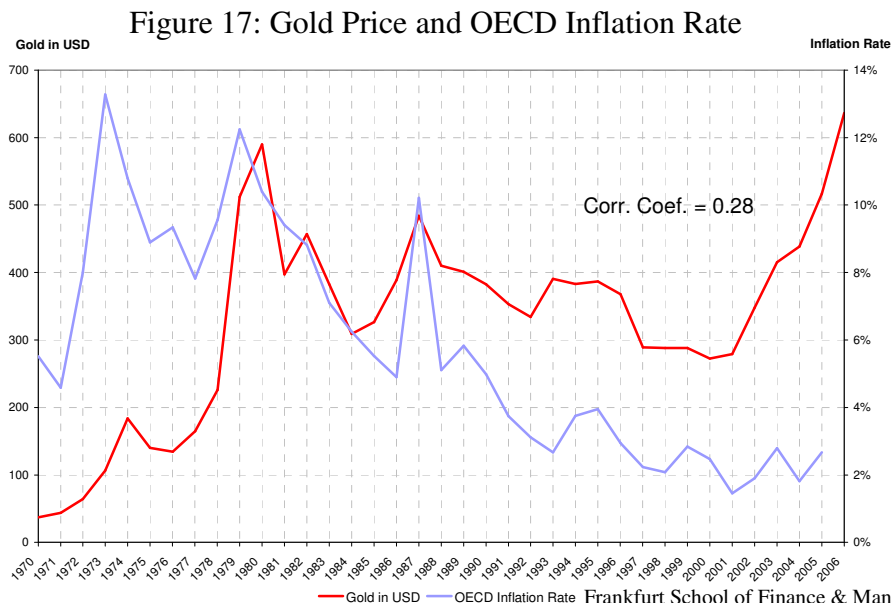


Figure 16 puts both indexes together starting from a common base of 100 in 1970. While both variables follow an upwards trend, the trajectory of the world price index is much steeper than the US price index.



The trends shown in these figures are consistent with the view of a likely long-run relationship between the price of gold and the general price level, and that gold can be a long-run hedge against inflation. However, there are significant deviations between movements in the price of gold and the general price level in the short-run. It is clear that gold is not a short-run hedge against inflation. Transforming the Consumer Price Index in inflation rates, a link between the price of gold and inflation can be seen in Figure 8 for the US inflation and in Figure 17 for the world inflation. Including the US and world inflation rates in the analysis suggests that the price of gold is higher during periods of high inflation because the demand for gold as an inflation hedge rises during such periods. This is clear for the periods 1972-1974, 1978-1980 and 1986-1987. However, this relationship does not appear to hold between 2002 and 2005.



In the Euro zone, however, there is absolutely no relationship between the price of gold denominated in EUR and the CPI or rather the inflation rate (cf. Figure 18 and 19). In Figure 18 a convergence of the gold price to the so called *inflation hedge price* (cf. section 2) can be observed in 2007. This picture is identical to Figure 14 and 15 which means that the current gold price is very close to the long-run inflation hedge price.

Figure 18: Gold Price in EUR and Euro zone CPI

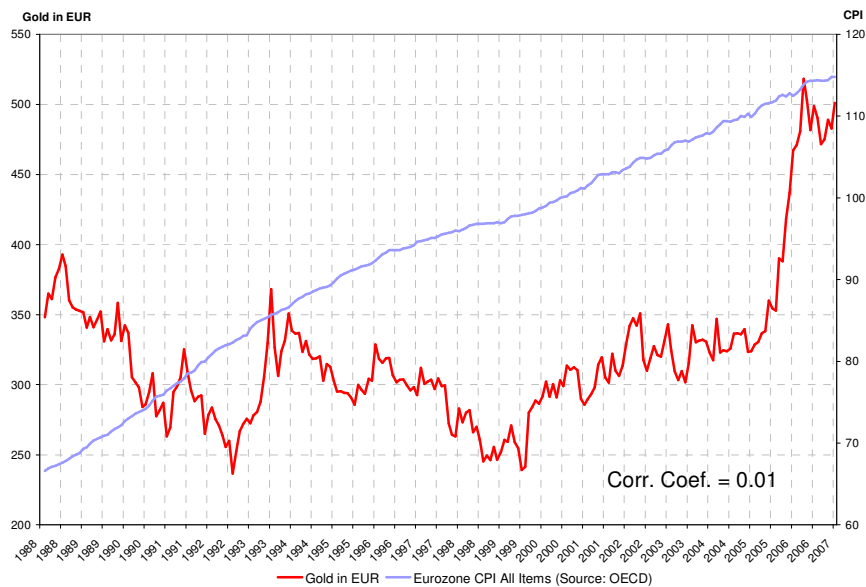
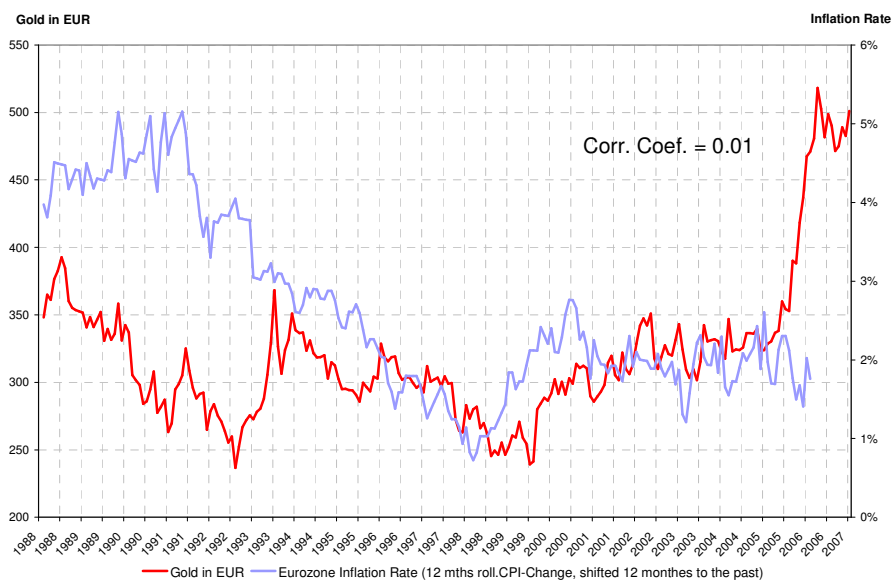


Figure 19: Gold Price in EUR and Euro zone Inflation



For countries other than the US, whether gold can be considered as a long-run inflation hedge depends on the country's currency strength against the US dollar. It is important to note that exchange rates between the US dollar and currencies of different countries fluctuate over time

and inflation rates vary both between countries and over time. This, of course, is important since gold is denominated in US dollars. If the price of gold is quoted in US dollars and gold can be considered as an inflation hedge for the US, holding gold is profitable for investors domiciled in countries whose currencies depreciate against the US dollar more than the required to compensate for the difference between the country's and US inflation rate. It is surely no coincidence that the major gold consuming countries appear to be over-represented amongst those who have profited from holding gold because their currency depreciation against the US dollar exceeded what was required to compensate for the inflation rate differences between the two countries. As the Euro appreciates against the US dollar, this favourable investment effect currently does not exist in the Euro zone.

There is a growing consensus amongst economists that depreciation in the international value of the US dollar is likely. The main reason is the growing US current account deficit. Over the last three years, the cumulative trade deficit has exceeded 1.8 trillion US dollar, while the current account deficit has reached 2 trillion US dollar. In 2005, the US current account deficit reached 6.4% of GDP. There is reason to believe that this could result in a further major depreciation of the dollar. Under these circumstances it is preferable for the foreign investor to hold gold rather than US dollar-denominated assets, provided that gold acts as an inflation hedge in the US because gold represents a more credible means of preserving wealth compared with the alternative of holding US dollar denominated assets.

Another reason behind the US dollar depreciation potential is the large increase in China's foreign currency reserves, which has increased by 34% in 2005 to a record high of 818.9 billion US dollar. China's dollar reserves have swollen in recent years as the Chinese Central Bank purchased most of the dollars generated by foreign trade and inward investment. The Yuan was revaluated in 2005 for the first time in a decade, allowing it to appreciate slowly against the dollar within a narrow trading band. Further currency revaluation steps are not excluded.

Thus economical facts show that real US dollar depreciation against other currencies is inevitable. Therefore, provided that gold is a long-run hedge against inflation, US wealth holders should profit from holding gold during this period for two reasons. The first is that the dollar depreciation will lower the price of gold to investors outside of the USA, and this will raise their demand for gold and raise the US dollar price of gold. That is in addition to the long-run relationship between the US price level and the price of gold. The second reason is that a dollar depreciation will likely lead to raised US inflation rates, and gold would act as an inflation hedge during this period.

The current uncertainty over the US dollar results in an emphasis of the traditional view that gold provides an effective but not perfect "hedge" against inflation and other forms of uncertainty. However, the reality is also that although gold may be an inflation hedge in the long-run, there is significant evidence of a short-run price volatility.

A reverse option has to be mentioned because some researchers consider that gold is an inflation predictor rather than the price consumer index or the bond market. That means the cau-

salinity is exchanged, i.e. not the inflation influences the gold price, but from the development of the gold price it is possible to predict the inflation.<sup>10</sup>

As a conclusion the following Figures 20 and 21 are presented.

Figure 20: Gold Price in USD and 10 Years US Treasuries

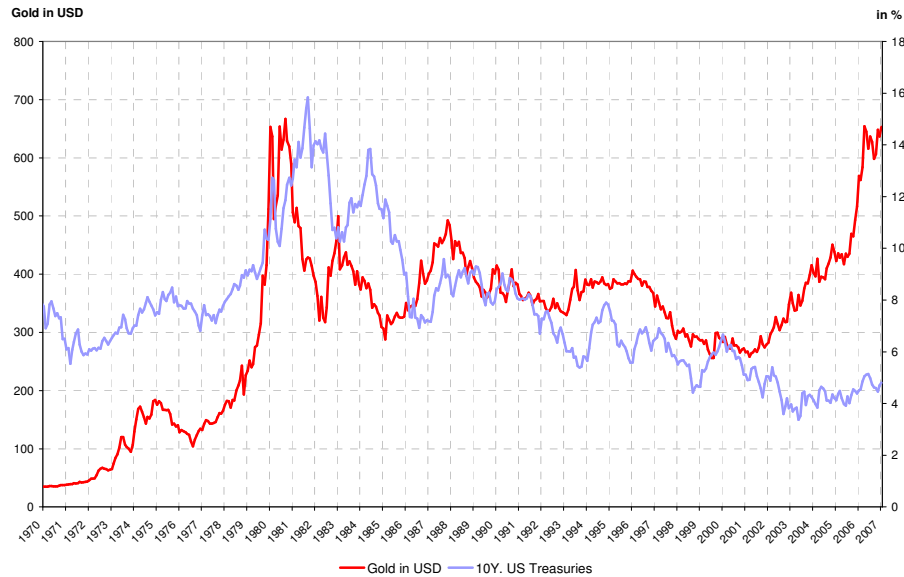
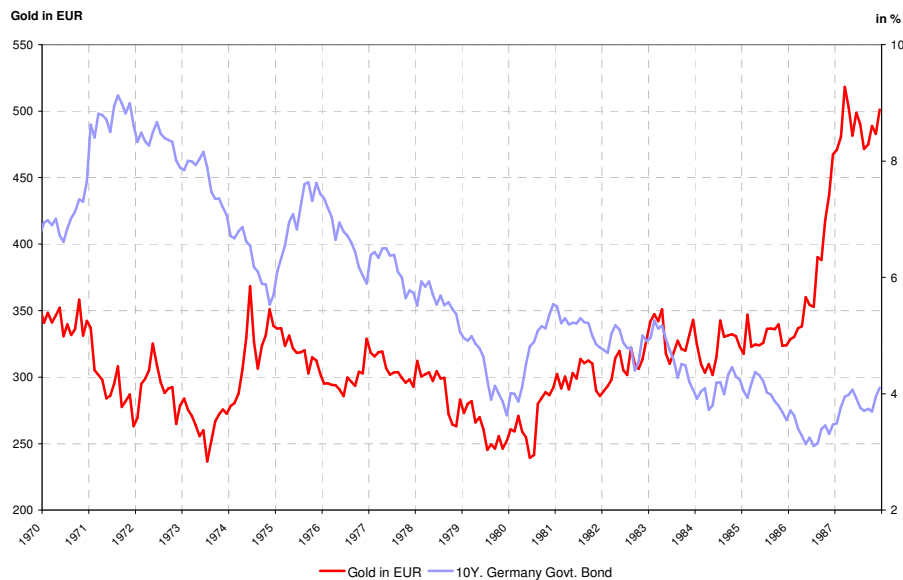


Figure 21: Gold Price in Euro and 10 Years Germany Government Bonds



<sup>10</sup> Cf. Ranson, D. (2005)

In Figures 20 and 21 the bond markets present a deflationary picture, the gold market an inflationary one. For any investment decisions it is necessary to discuss which of these two predictors of the economical state is more influential.

### 3 Specific Attributes of Gold

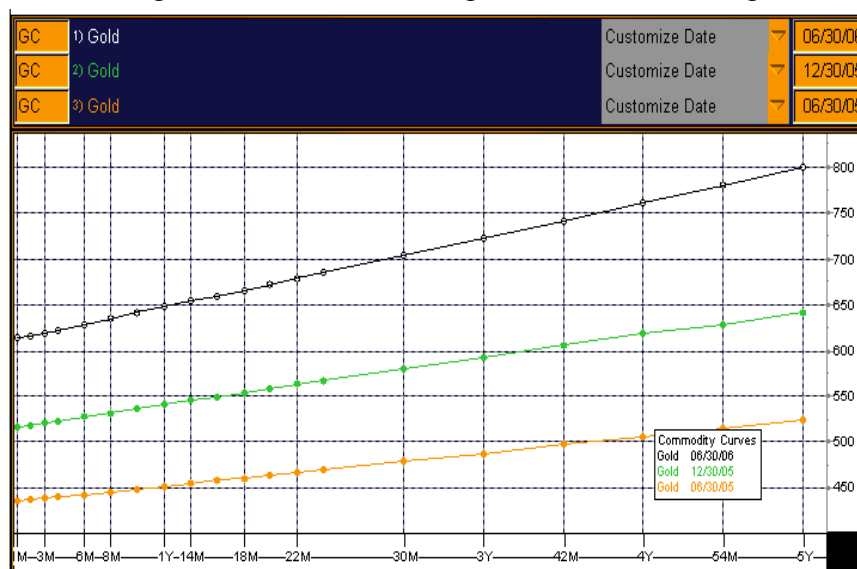
Gold possesses three distinct attributes which make it unique in the “commodities universe”:

- Gold is fungible.
- Gold is indestructible and storable.
- Gold is characterised by massive above-ground stocks which are enormous relative to the supply flow.<sup>11</sup> This last attribute means that a sudden increase in gold demand can be quickly and easily met through sales of existing holdings of gold jewellery, increasing the amount of gold recovered from scrap. It can also be met through the mechanism of the gold leasing market.

Gold’s potential to be highly liquid and to have a high price elasticity is seen as its critical difference from other commodities.

Another crucial characteristic of the gold market is the fact that it is always in contango.<sup>12</sup> An explanation for the constant contango situation in the gold market which is presented graphically in Figure 22, is derived from the Theory of Storage and Convenience Yield.

Figure 22: Gold in Contango, Source: Bloomberg



<sup>11</sup> Currently the above-ground gold stocks amount to 150,000 tonnes; the supply contribution from the gold production amounted to around 2,500 tonnes in 2005; the total supply (with the sales of the Central Banks, scrap recycling, short-positions) amounted to approx. 3,700 tonnes in 2005.

<sup>12</sup> Contango is the market situation in which spot prices are below the forward prices. Contango is the opposite of backwardation where spot prices are higher than forward prices.

The storability of gold and its enormous above-ground-stocks can explain why the gold markets are always in contango, and why the future price of gold is always higher than its spot price:

*Forward price = spot price + interest costs (=gold lease rate) + storage/insurance costs.*

The existence of storage acts as a dampener on price volatility because it is able to balance supply and demand, but causes additional costs. The convenience yield presents the benefit from owning physical gold because it allows e.g. to avoid production disruptions or simply to give the investor a secure feeling. As already mentioned in Section 2.1.1 the convenience yield is included in the gold lease rate together with the credit risk premium.

## 4 Investments in Gold

There are a number of ways to invest in gold:

- Investment in physical gold: jewellery, bars or bullion coins
- Buying Gold Pool Account
- Buying investment futures
- Buying Gold Backed Securities (e.g. Xetra-Gold).
- Investing in Gold Mining Companies

All these possibilities have their pros and cons.

### 4.1 Investment in Physical Gold

The ownership of gold jewellery has the substantial disadvantage that acquisition costs are extremely high because jewellery is often marked up by 300 per cent or more in the retail shops. All jewellery pieces are different and their values are subjective. The real value of jewellery is in the gemstones, the design and the craftsmanship. These greatly outrank the value of the gold.

The advantage of physically owning the metal in form of bullion coins or small bars is the liquid market for buying and selling them. That means it is comparatively easy to find buyers or sellers. Coins and small bars can be an appropriate gold investment method for sums from 100 to 10,000 US dollar, especially for people whose view is long term and for whom physical possession is the main objective. The disadvantage is the significant difference between the buying and the selling price (7% or more). Moreover, there are considerable storage costs. The overall costs for dealing, delivery, storage and insurance can add up to a 10-15% range.

Trading with big bars (400 troy ounces, about 12 kilogram) is reserved for professional market participants (companies and institutions). The bars are serial numbered, and usually do not leave the security of industrial strength vaults. They are competitively priced but inaccessible to the private investor because the access to competitive and simultaneous market pricing is restricted to those with financial sector data feeds. Moreover, the smallest trade size for most professionals exceeds US dollar 500,000.

## 4.2 Buying Gold Pool Accounts

Gold pool accounts allow the customer to buy a gold liability from the account provider. Effectively the customer pays cash and the supplier treats him as a creditor for bullion which may or may not have been actually bought. Pool accounts are synonymous with unallocated gold. The advantages of gold accounts are their easy accessibility and relatively low dealing costs because there is usually no commission and the spreads are fairly tight at about 1%. The disadvantages of gold accounts lie in their non-quantifiable credit risks because unallocated gold grants very substantial unsecured credit to the account provider and places the bullion 'owner' at material credit risk. The owner is benefiting from a promise, and unlike the bank's promise to repay there is no assurance underlying the promise that the provider is competent to operate in much the same way as a bank.

## 4.3 Investing in Gold Futures

**Gold futures** are exchange-traded standardized contracts that oblige the buyer, to buy a definite quantity of gold at a future delivery date to a price fixed beforehand. The future buyer assumes that the price of gold increases at due date. The contracts are usually settled in cash, without delivery of physical gold. Gold futures are traded on the Commodity Exchange (COMEX) of the NYMEX and the Londoner Bullion Market (LBMA).

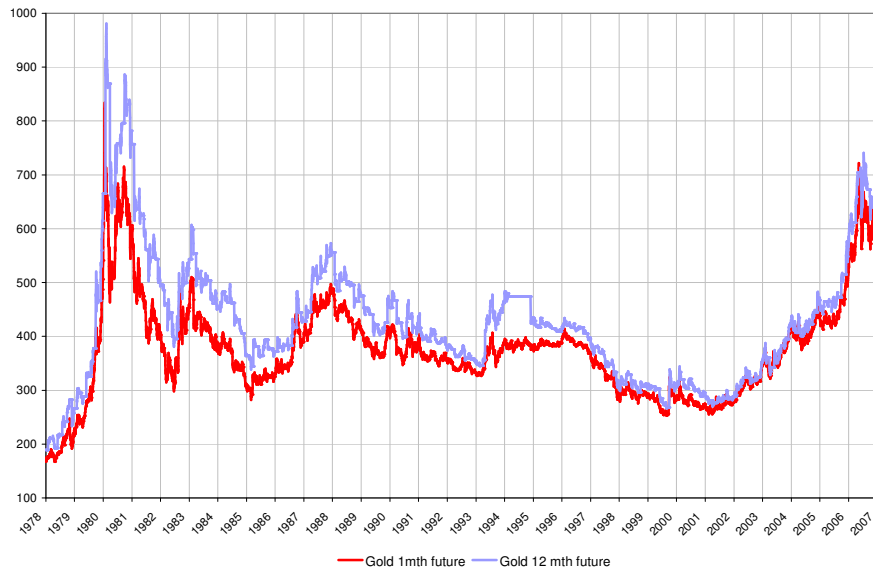
The advantage of such gold investment is the possibility to bet on rising (long position) as well as falling (short position) gold prices depending on the investor's market expectation, without the **inconvenience of taking delivery of the underlying physical gold**. The market is deep and liquid, and it is quite easy to track the true value of the futures contract by following the exchange price.

Trading gold futures eliminates the costs of settlement and significantly reduces the costs of storage. Buying gold futures implies small transaction costs (initial and maintenance margin). An initial margin with 2% of the future value has to be paid upfront, and any profit or loss will be adjusted on the down-payment and paid back to the investor net. In case of significant movements in the gold price which could lead to losses, the additional margin (variation margin) is however required. Therefore, the disadvantage is the high risk because of the high short-term volatility of the gold prices.



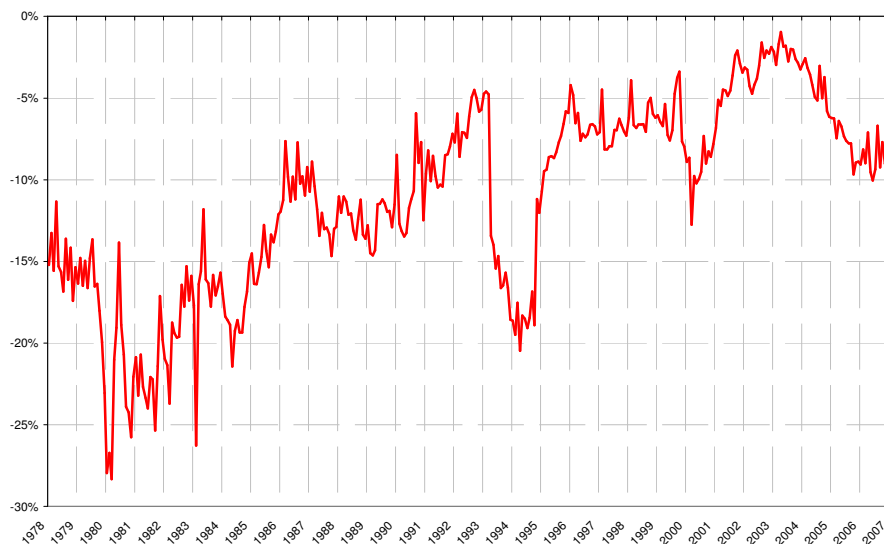
Also, taking into consideration that gold is always in contango, investing in gold futures would produce negative rolling returns because a future contract for 12 months costs more than a nearby future contract for 1 month (cf. Section 3). In Figure 23 the development of gold future prices with a delivery date of 1 and 12 months is presented. It can be seen that the long-term future contract costs more than a short-term future contract.

Figure 23: Gold future contracts



As gold is always in contango a long investment in gold provides no positive rolling yield, unlike other commodities in backwardation as it is presented in Figure 24.

Figure 24: Negative Roll Return of Long Investment in Gold



Therefore, the reasonable way of investing in gold is selling future contracts in order to capture the positive roll yield, provided it is possible to buy an equivalent contract back before

the available contract expires. But it is important to mention that this way of investing in gold is not accessible to private investors with small investment amounts. Especially the future selling in order to lock in the positive roll return from the gold investment in contango is next to impossible because it requires a seller to borrow gold for delivery. For retail investors because of their credit risk there is no institution willing to lend gold for this purpose.

#### 4.4 Buying Gold Backed Securities and Xetra – Gold

Gold backed securities are a relatively new innovation but currently represent more than 10 billion US dollar globally. They aim to combine the benefits of physical gold coins/bars with the liquidity and infrastructure of the traditional securities market.

Gold backed securities are close to owning bars. They are quoted on securities markets which are accessible with low dealing spreads for relatively small investments. The custody function is undertaken by a professional vault which is much safer than any form of private storage. The transaction costs are not higher than with other stock market investments.

This innovation is created to encourage private gold ownership with a high degree of security and low costs. By design, this form of securitised gold investment is expected to track the gold price almost perfectly. These securities are all regulated financial products and 100% backed by physical gold held mainly in allocated form.

One alternative is to invest in the gold-backed tracker funds, also known as Exchange Traded Funds (ETFs). Tracker funds follow the underlying gold price, and charge low fees because they do not require active fund management.<sup>13</sup>

Gold certificates offer investors a method of holding gold without taking physical delivery. Issued by individual banks they confirm an individual's ownership while the bank holds the metal on the client's behalf. The client saves on storage and personal security issues, and gains liquidity.

An alternative is to invest in a new product of the **Deutsche Börse: Xetra-Gold**. This is a security backed by physical gold. Even though the product has no maturity, the investor can exchange it into physical gold at any time. Xetra-Gold is constructed as a zero bond perpetual. Each security can be exchanged into one gram of gold. The smallest dealable size is one gram of gold; on the other hand 1/1000 of a gram can be delivered. Issuer is the Deutsche Börse Commodities GmbH (DBCo). The gold is stored by the Clearstream Banking AG (CBF). Generally Xetra-Gold is created by delivering gold, which is then generally stored by the CBF. Deutsche Bank is market maker and also lead manager of the issues. The investor can ask his bank to exchange Xetra-Gold for physical gold at any time, which is delivered to the custodian of the investor. If the investor is not allowed to hold physical gold, the gold can also be sold and the proceeds are then paid to him.

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<sup>13</sup> Gold ETFs are an initiative of the World Gold Council, the industry body for gold miners, to boost demand for gold – which is heavily dependent on jewellery.

Xetra-Gold offers substantial advantages in comparison to other forms of gold investment. The storage cost is minimized and the transaction costs are similar to any other security. Also the counterparty risk is small as the gold is backing the issued security at a one to one ratio. Therefore it incurs lower costs compared to physical gold but does not carry the credit risk of gold pool accounts. Compared to a long position in the gold future Xetra-Gold eliminates the negative roll returns. As the gold market has always been in contango, the buying price is above the spot price, thus there is a systematic loss involved in a gold future investment. Xetra-Gold creates a very efficient way of investing in the gold spot market.

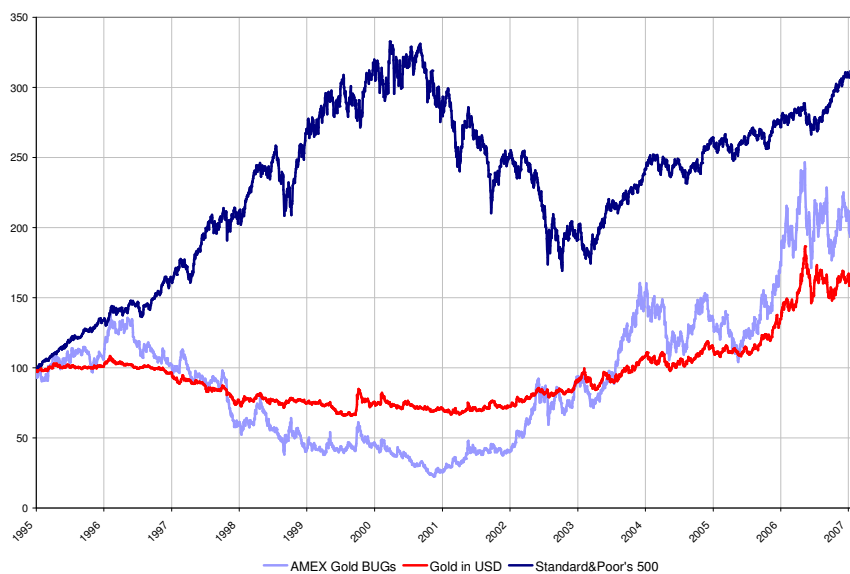
## 4.5 Investing in Gold Mining Companies

Investing directly in companies in the area of gold exploration and production (e.g. equity or debt ownership) is not the same as investing in physical gold. The financial state of the company often depends only indirectly on the gold price development. Many more factors might have an influence on the company's earnings than just the gold price, such as management decisions, interest rates, wage rates, unforeseen development of exploration costs etc.<sup>14</sup>

It is also well known that many gold mining firms hedge their exposure to gold price fluctuations. In case the company takes on hedging activity against the gold price downturn, there is absolutely no way of tracking of the gold price development.

In Figure 25 the development of the share prices of gold mining companies (represented by the AMEX Gold BUGs Index) and actual gold prices is presented. AMEX Gold BUGs Index represents "Blue Chip" companies of the gold mining sector that do not hedge their gold production beyond 1 ½ years. Additionally the stock market index Standard & Poor's 500 is added to the picture.

Figure 25: Gold and Stocks Markets

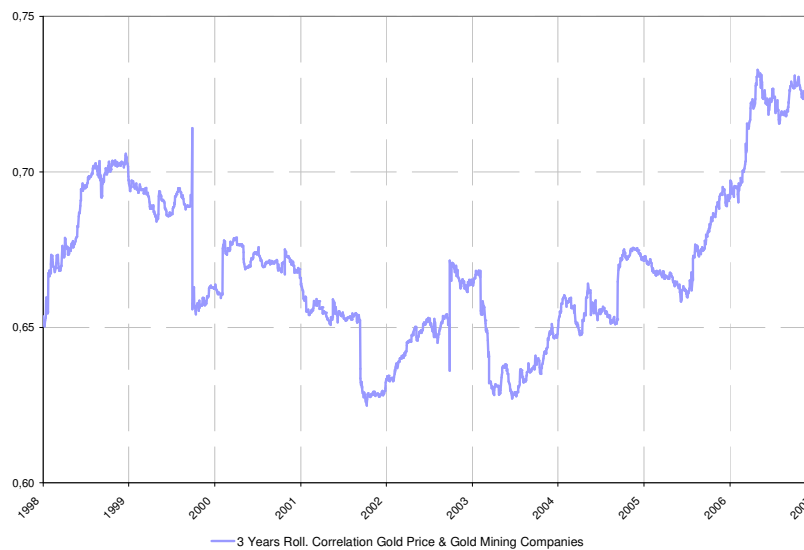


<sup>14</sup> Cf. Gorton, G./Rouwenhorst, K.G. (2004); Pulvermacher, K. (2005a)

Figure 25 shows that the gold mines stocks co-move with the gold markets, but the gold price development is not always completely reproduced by the stock prices. Recently, the value of gold mining shares was even more sensitive to the price of gold than the value of a gold bar, i.e. the gearing effect was much higher.

In Figure 26 the strength of the relationship between physical gold and gold mines stocks is presented, exhibiting the rolling correlation between daily changes in the share prices of gold mining companies (AMEX Gold BUGs Index) and actual gold prices. Between the gold price and the gold mining companies price development there is a relatively low correlation of only 67% from 1995<sup>15</sup> to February 2007.

Figure 26: Gold and Gold Mining Stocks Markets (AMEX), rolling Correlation

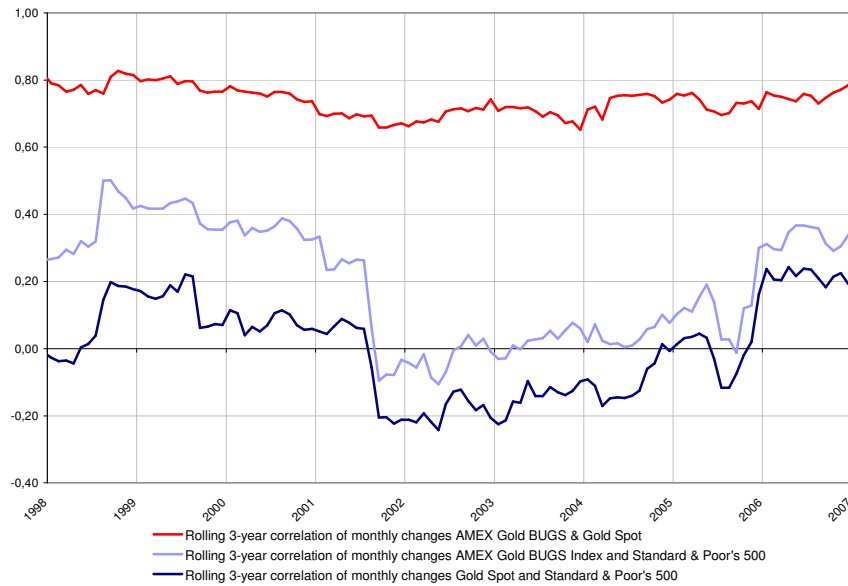


However, compared to other commodities and commodity-related companies, gold shows a far stronger correlation to gold mining companies.<sup>16</sup> Another confirmation of that phenomenon is presented in Figure 27 with the rolling correlation of gold and gold mining companies based on their monthly price changes. In Figure 27 the correlation between the share prices of the gold sector companies and the broader US equity market is also shown.

<sup>15</sup> The AMEX Gold BUGs Index exists since 16.12.1994.

<sup>16</sup> The relationship between US commodity-related companies (represented by the Morgan Stanley Commodity Related Index) and the overall equity market is far stronger than the relationship between commodity-related companies and actual commodity prices. The correlation between commodity-related companies and the rest of the equity market is consistently higher than with the underlying commodities themselves. Consequently, having exposure to commodity-related companies is not the same as having commodity investments. Commodity-related stocks are a weak substitute for their underlying commodity.

Figure 27: Rolling Correlations of the Gold Spot Price, Gold Mines Stocks and S&amp;P 500



It is clear that the relationship between gold mining companies and actual gold prices with approximately 75% is far stronger than the relationship between gold mining companies and the overall equity market with about 16%. Consequently, having exposure in gold mining companies is nearly the same as having gold investments.

A disadvantage has to be mentioned: Gold shares investment is potentially risky because most gold mining equities tend to be more volatile than the gold price. The appreciation potential of a gold mining company share depends on market expectations of the future price of gold, the costs of mining, the likelihood of additional gold discoveries and several other factors. For an expected return of 6.14% calculated with available data of the AMEX index between 1995 and 2006, the volatility of 37.90% should be taken into account. For gold the expected return, calculated on this base, was 4.41% and its volatility was 13.29%. While the gold mining equities are subject to the same risk factors that influence the prices of most other equities there are additional risks that are specific to the mining business generally and to individual mining companies specifically.

## 5 Gold as a Portfolio Constituent

Gold has good diversification properties in a portfolio because the price of gold behaves in a completely different way than the prices of stocks or bonds, therefore it is worth examining a gold contribution to the overall portfolio return under the constraint of a given maximal risk.

### 5.1 Performance

First of all, possible returns from a gold investment should be considered. A distinction between expected returns in US dollar and in Euro is necessary. In Tables 1 and 2 the calculation results are presented. It is obvious that the return expectation in terms of Euro is different from US dollar-returns. Gains in US dollar often turn around to losses in Euro. If for example the price of gold denominated in US dollar gets higher, but the US dollar gets weaker against the Euro at the same time, the price of gold denominated in Euro does not change at the same rate as the gold price in US dollar. A graphical presentation of the development of the gold price over time is presented in the Appendix.

Table 1: Gold Returns in Euro

Compound Annual Return in EUR					
to the end of the year	1 year	3 years	5 years	10 years	15 years
1987					
1988	-4,31%				
1989	-15,70%				
1990	-3,41%	-7,98%			
1991	-7,74%	-9,10%			
1992	4,04%	-5,93%	-5,64%		
1993	27,32%	6,91%	-0,10%		
1994	-10,91%	5,68%	-1,14%		
1995	-3,12%	3,19%	1,07%		
1996	-1,55%	-5,28%	2,39%		
1997	-11,79%	-5,60%	-0,93%	-3,32%	
1998	-6,32%	-6,65%	-6,83%	-3,52%	
1999	16,25%	-1,33%	-1,73%	-1,44%	
2000	1,18%	3,29%	-0,88%	0,09%	
2001	8,13%	8,34%	1,00%	1,69%	
2002	5,75%	4,98%	4,73%	1,86%	-0,71%
2003	0,81%	4,50%	6,06%	-0,59%	-0,43%
2004	-2,18%	1,07%	2,46%	0,34%	-0,16%
2005	35,08%	9,66%	8,56%	3,73%	2,84%
2006	10,49%	13,44%	4,29%	4,94%	4,08%

Table 2: Gold Returns in US Dollar

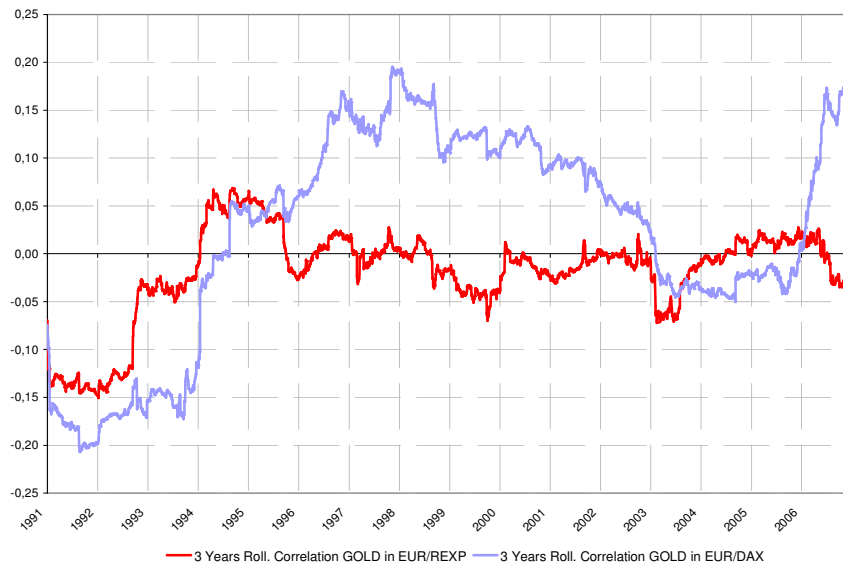
Compound Annual Return in USD					
to the end of the year	1 year	3 years	5 years	10 years	15 years
1987					
1988	-15,26%				
1989	-9,84%				
1990	3,49%	-7,53%			
1991	-7,75%	-4,87%			
1992	-5,28%	-5,88%	-7,13%		
1993	16,80%	0,68%	-0,97%		
1994	-1,92%	2,76%	-0,92%		
1995	1,02%	4,99%	0,22%		
1996	-5,01%	-2,00%	0,81%		
1997	-21,39%	-8,97%	-2,88%	-5,03%	
1998	-0,28%	-9,36%	-5,90%	-3,47%	
1999	-0,09%	-7,82%	-5,55%	-3,26%	
2000	-5,47%	-1,98%	-6,80%	-3,35%	
2001	2,46%	-1,09%	-5,37%	-2,33%	
2002	24,77%	6,52%	3,78%	0,40%	-2,18%
2003	21,72%	15,13%	7,58%	0,62%	0,08%
2004	5,54%	16,27%	8,77%	1,36%	0,59%
2005	17,92%	14,10%	13,69%	2,94%	2,02%
2006	23,15%	15,29%	10,37%	5,64%	4,01%

## 5.2 Empirical Results

### 5.2.1 Euro zone / Germany

Figure 28 exhibits the 3 years rolling correlation between monthly changes in the actual gold prices denominated in Euro and the stock as well bonds markets.

Figure 28: Rolling Correlations Gold and Bond/Equity Market (Euro zone)



We see the low correlation especially with the REXP but also with the DAX. In Table 3 the performance measures of gold, stocks and bonds investments for various periods are summarized.

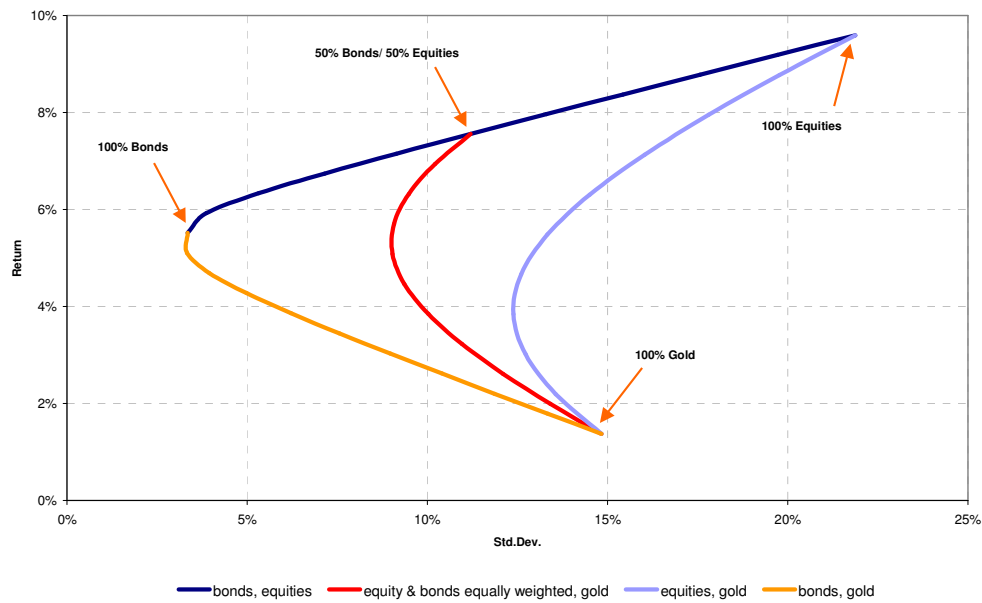
Table 3: Returns, Correlation and Volatility in the Gold, Bond and Equity Market (Euro zone)

<b>1988-2006</b>					
	<b>Gold in EUR</b>	<b>Gold in USD</b>	<b>REX</b>	<b>DAX</b>	<b>EuroStoxx 50</b>
<b>Gold in EUR</b>	1,00	0,67	-0,02	0,02	0,13
<b>REX</b>			1,00	0,08	-0,01
<b>DAX</b>				1,00	0,45
<b>EuroStoxx 50</b>					1,00
<b>Compound Annual Return</b>	1,43%	1,45%	5,88%	10,44%	14,09%
<b>Annual...</b>					
<b>...Performance (Average Return)</b>	1,37%	1,39%	5,52%	9,59%	12,74%
<b>...Volatility</b>	14,83%	13,80%	3,35%	21,87%	30,11%
<b>1990-1999</b>					
	<b>Gold in EUR</b>	<b>Gold in USD</b>	<b>REX</b>	<b>DAX</b>	<b>EuroStoxx 50</b>
<b>Gold in EUR</b>	1,00	0,57	-0,02	0,00	0,14
<b>REX</b>			1,00	0,25	0,06
<b>DAX</b>				1,00	0,27
<b>EuroStoxx 50</b>					1,00
<b>Compound Annual Return</b>	-1,44%	-3,26%	7,62%	14,54%	31,36%
<b>Annual...</b>					
<b>...Performance (Average Return)</b>	-1,40%	-3,20%	7,09%	13,11%	26,33%
<b>...Volatility</b>	14,86%	12,22%	3,11%	19,40%	36,20%
<b>2000-2006</b>					
	<b>Gold in EUR</b>	<b>Gold in USD</b>	<b>REX</b>	<b>DAX</b>	<b>EuroStoxx 50</b>
<b>Gold in EUR</b>	1,00	0,80	-0,01	0,04	0,07
<b>REX</b>			1,00	-0,16	-0,18
<b>DAX</b>				1,00	0,91
<b>EuroStoxx 50</b>					1,00
<b>Compound Annual Return</b>	7,91%	11,95%	5,24%	-0,33%	-0,35%
<b>Annual...</b>					
<b>...Performance (Average Return)</b>	7,21%	10,95%	4,90%	-0,74%	-0,49%
<b>...Volatility</b>	14,93%	16,14%	3,00%	25,43%	23,31%



Figures 29-31 show the effect of adding gold to the investment portfolio over various periods of time. Figure 29 presents the overall period of time from 1988 till 2006. Here it can be seen that there is no reasonable risk-adjusted performance contribution of gold to the total portfolio.

Figure 29: Euro zone (1988-2006)



The period 1990-1999 (cf. Figure 30) is characterised by extraordinary returns in the equity market where a gold investment would be an unprofitable solution.

Figure 30: Euro zone (1990-1999)

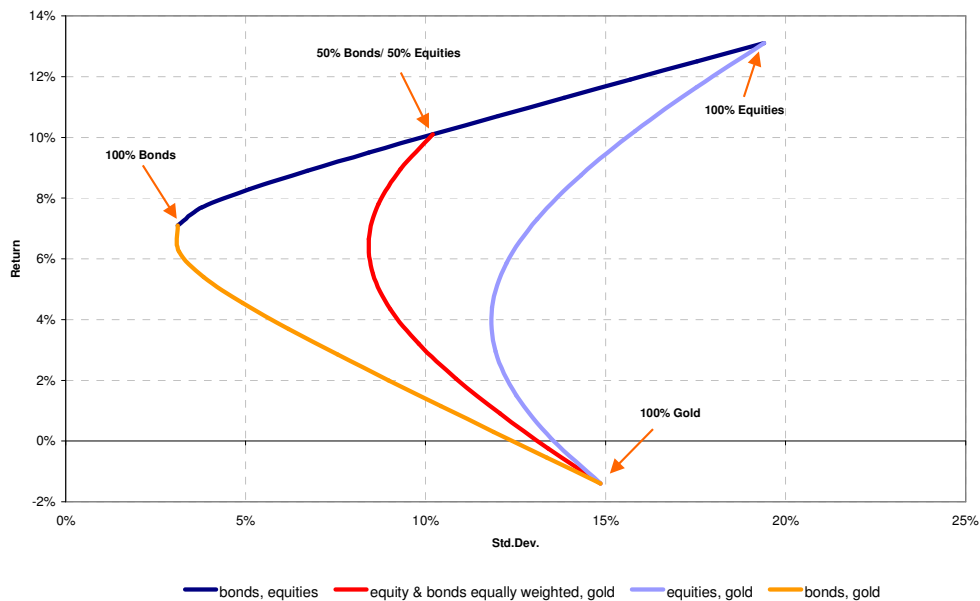
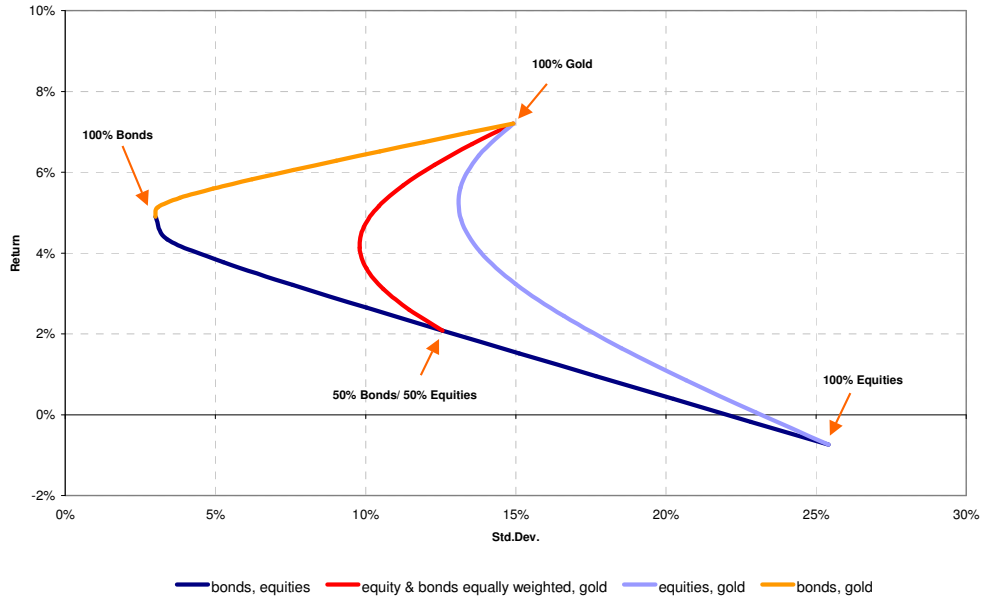


Figure 31 emphasizes the risk reducing ability of gold by shifting the efficient line to the left in the area of the lower volatility in the years 2000-2006. During the last six years gold was an interesting element in the portfolio, differing sharply from most other periods. This depended on comparatively high returns in gold and low performance of equity.

Figure 31: Euro zone (2000-2006)



## 5.2.2 USA

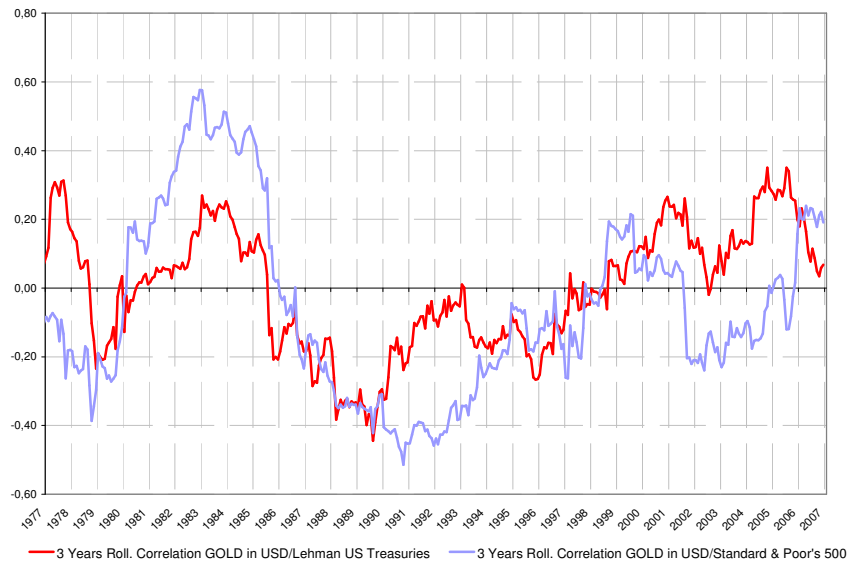
In Table 4 the performance measures of gold, stocks and bonds investments for various periods are summarized.

Table 4: Returns, Correlation and Volatility in the Gold, Bond and Equity Market (USA)

1974-2006			
	Gold in USD	Lehman US Treasury	Standard&Poor's 500
Gold in USD	1,00	0,00	-0,01
Lehman US Treasury		1,00	0,18
Standard&Poor's 500			1,00
Compound Annual Return	5,56%	8,34%	8,45%
Annual...			
...Performance (Average Return)	7,33%	8,19%	9,31%
...Volatility	19,79%	5,48%	15,27%
1974-1979			
	Gold in USD	Lehman US Treasury	Standard&Poor's 500
Gold in USD	1,00	0,01	-0,11
Lehman US Treasury		1,00	0,32
Standard&Poor's 500			1,00
Compound Annual Return	25,80%	6,05%	1,87%
Annual...			
...Performance (Average Return)	29,96%	6,08%	3,09%
...Volatility	27,32%	3,85%	16,98%
1980-1989			
	Gold in USD	Lehman US Treasury	Standard&Poor's 500
Gold in USD	1,00	0,01	0,17
Lehman US Treasury		1,00	0,25
Standard&Poor's 500			1,00
Compound Annual Return	-4,75%	12,35%	11,96%
Annual...			
...Performance (Average Return)	0,14%	11,81%	13,28%
...Volatility	22,95%	7,40%	16,38%
1990-1999			
	Gold in USD	Lehman US Treasury	Standard&Poor's 500
Gold in USD	1,00	-0,04	-0,13
Lehman US Treasury		1,00	0,35
Standard&Poor's 500			1,00
Compound Annual Return	-3,59%	7,60%	16,14%
Annual...			
...Performance (Average Return)	-2,58%	7,29%	15,23%
...Volatility	12,24%	4,27%	13,42%
2000-2006			
	Gold in USD	Lehman US Treasury	Standard&Poor's 500
Gold in USD	1,00	0,09	-0,01
Lehman US Treasury		1,00	-0,34
Standard&Poor's 500			1,00
Compound Annual Return	12,25%	6,12%	0,24%
Annual...			
...Performance (Average Return)	12,35%	6,11%	0,51%
...Volatility	14,07%	4,81%	14,28%

Furthermore, Figure 32 exhibits the 3 years rolling correlation between monthly changes in the actual gold prices denominated in US dollar and the stock as well bonds markets.

Figure 32: Rolling Correlations Gold and Bond/Equity Market (USA)



Figures 33-37 show the effect of adding gold to the investment portfolio. Because of broader available data the overall period could be subdivided into 4 sub-periods. Figure 33 shows that gold did not have a positive impact on a portfolio risk-adjusted performance during the time period of 1974 to 2006.

Figure 33: USA (1974-2006)

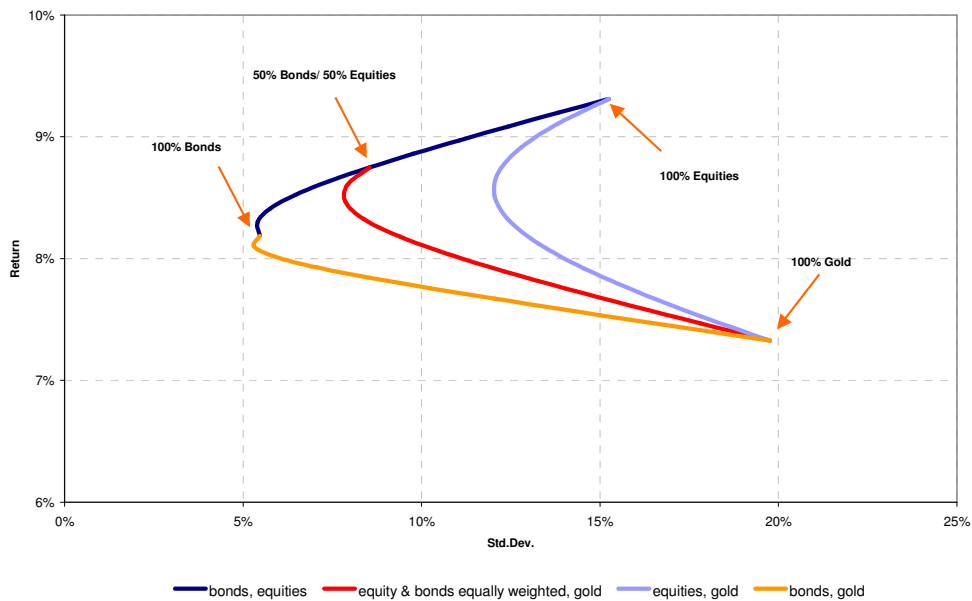
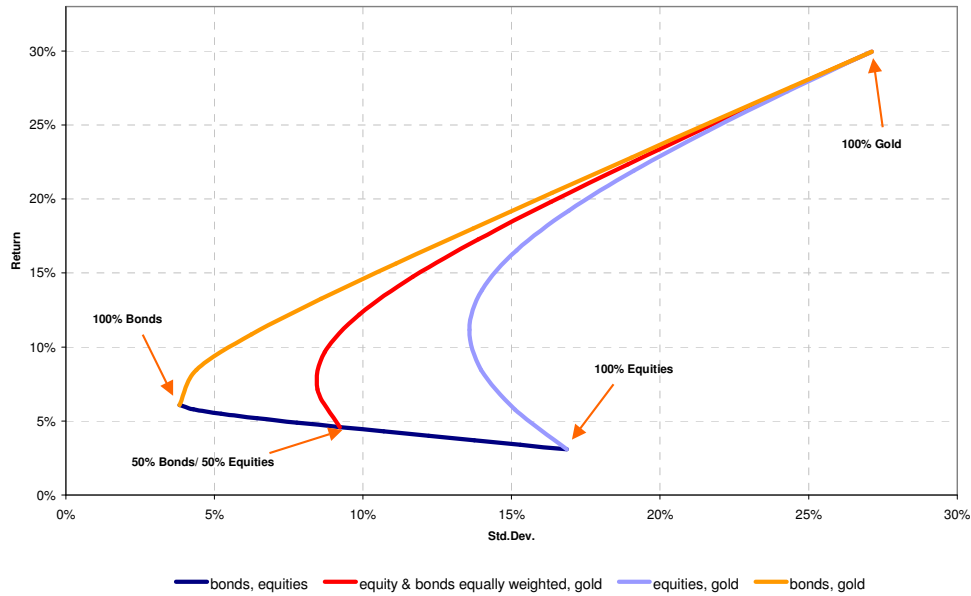


Figure 34 shows that in the time periods with high inflation gold improved the investment results of the total portfolio.

Figure 34: USA (1974-1979)



But Figures 35 and 36 for the years 1980-1989 and 1990-1999 in which equity investments provided extraordinary returns show an absolutely contrary picture.

Figure 35: USA (1980-1989)

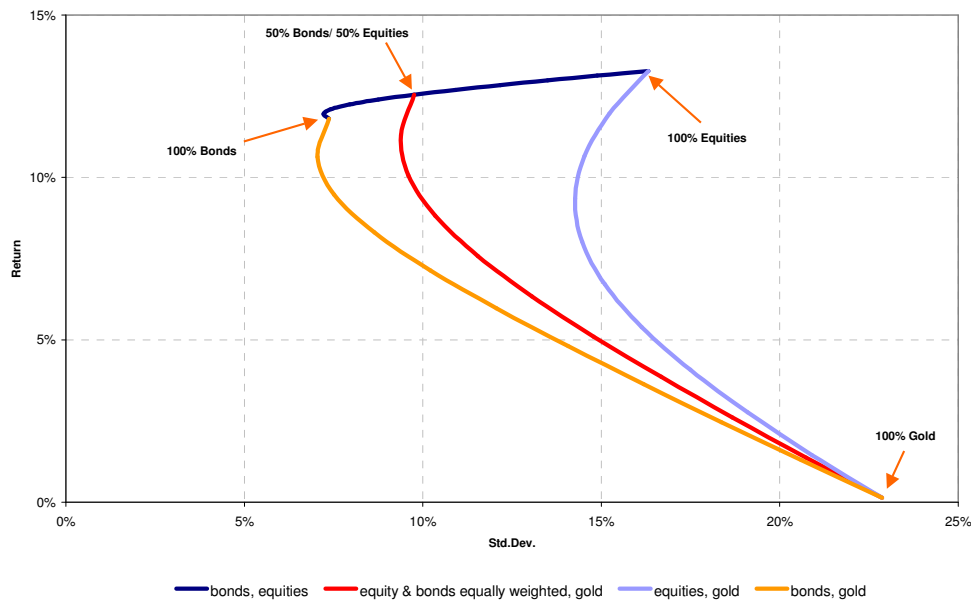


Figure 36: USA (1990-1999)

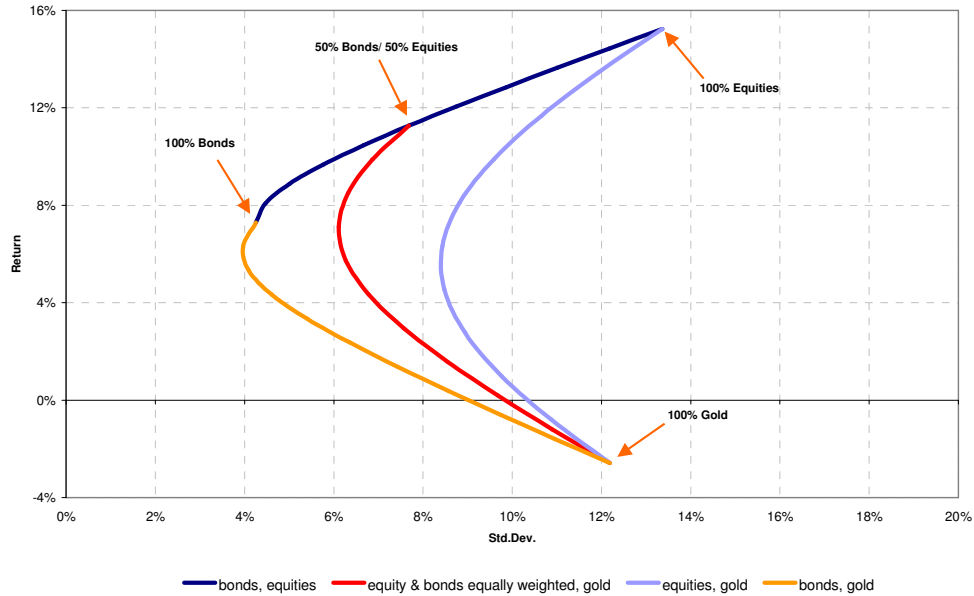
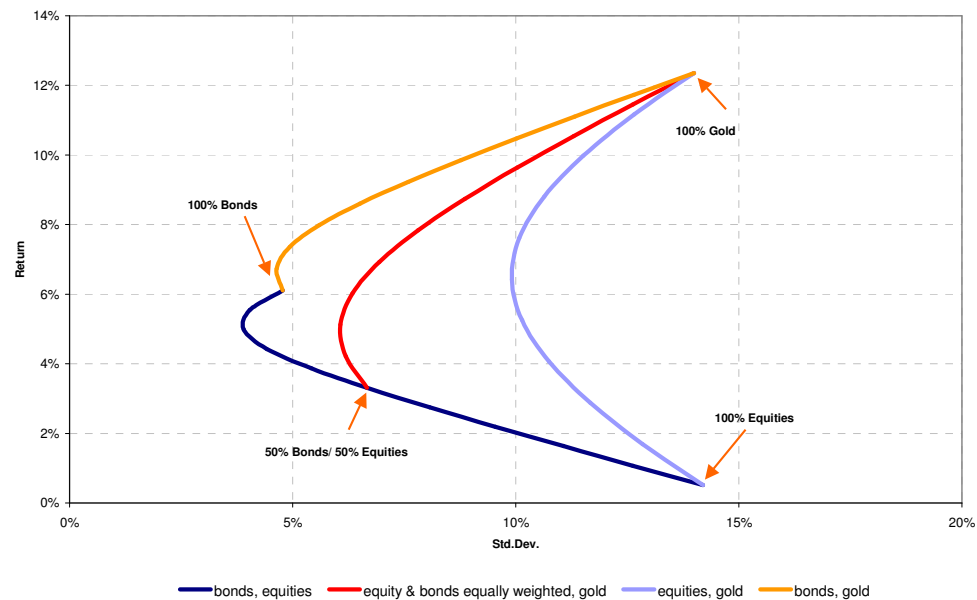


Figure 37 emphasizes the risk reducing ability of gold by shifting the efficient line to the left in the area of the lower volatility in the years 2000-2006. Therefore gold was an interesting asset during the last six years.

Figure 37: USA (2000-2006)



### 5.2.3 World

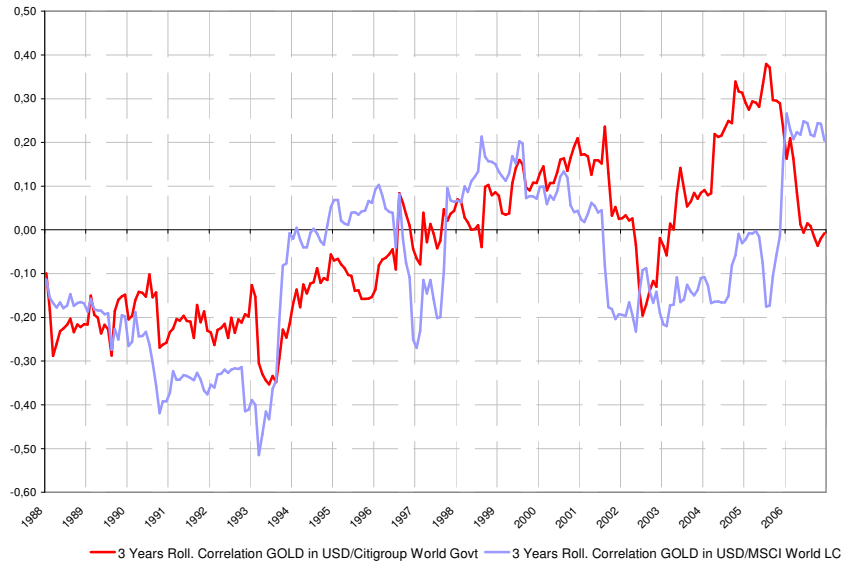
In Table 5 the performance measures of gold, stocks and bonds investments for various periods are summarized.

Table 5: Returns, Correlation and Volatility in the Gold, Bond and Equity Market (World)

<b>1985-2006</b>			
	<b>Gold in USD</b>	<b>Citigroup World Govt</b>	<b>MSCI World LC</b>
Gold in USD	1,00	-0,06	-0,09
Citigroup World Govt		1,00	0,08
MSCI World LC			1,00
Compound Annual Return	3,38%	7,42%	7,89%
Annual...			
...Performance (Average Return)	3,33%	7,18%	7,62%
...Volatility	13,34%	3,51%	14,09%
<b>1985-1989</b>			
	<b>Gold in USD</b>	<b>Citigroup World Govt</b>	<b>MSCI World LC</b>
Gold in USD	1,00	-0,07	-0,16
Citigroup World Govt		1,00	0,10
MSCI World LC			1,00
Compound Annual Return	6,88%	9,87%	17,19%
Annual...			
...Performance (Average Return)	5,47%	9,28%	16,44%
...Volatility	14,53%	4,53%	15,00%
<b>1990-1999</b>			
	<b>Gold in USD</b>	<b>Citigroup World Govt</b>	<b>MSCI World LC</b>
Gold in USD	1,00	-0,06	-0,10
Citigroup World Govt		1,00	0,28
MSCI World LC			1,00
Compound Annual Return	-3,59%	8,52%	9,78%
Annual...			
...Performance (Average Return)	-3,32%	8,01%	8,80%
...Volatility	12,11%	3,35%	13,81%
<b>2000-2006</b>			
	<b>Gold in USD</b>	<b>Citigroup World Govt</b>	<b>MSCI World LC</b>
Gold in USD	1,00	0,02	0,01
Citigroup World Govt		1,00	-0,40
MSCI World LC			1,00
Compound Annual Return	12,25%	4,64%	0,42%
Annual...			
...Performance (Average Return)	11,33%	4,52%	-0,27%
...Volatility	13,88%	2,73%	13,62%

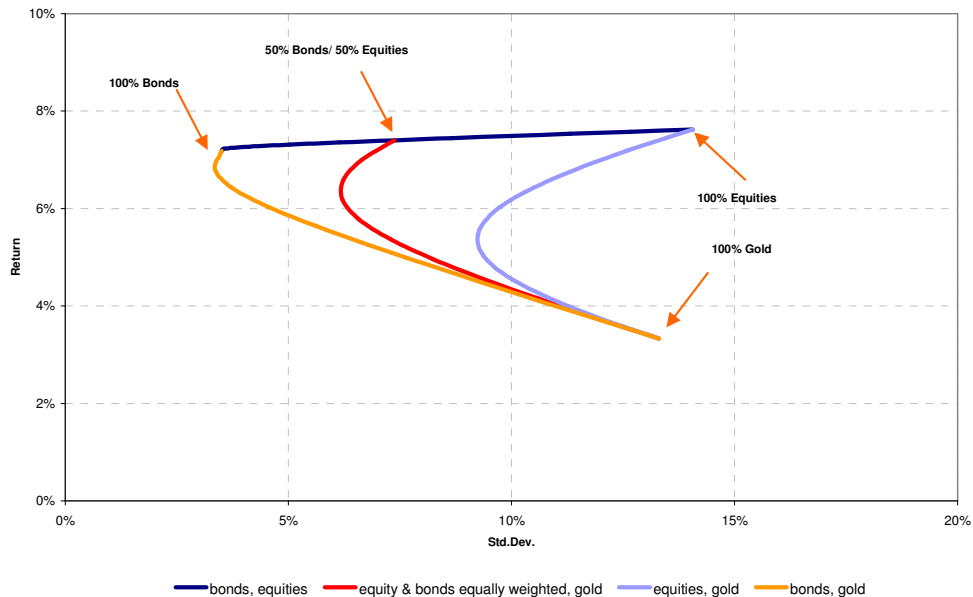
Furthermore, Figure 38 exhibits the 3 years rolling correlation between monthly changes in the actual gold prices denominated in US dollar and the stock as well bonds markets.

Figure 38: Rolling Correlations Gold and Bond/Equity Market (World)



Figures 39-42 show the effect of adding gold to the investment portfolio. Figure 39 presents the overall period of time from 1985 till 2006. Here it can be seen that there is no reasonable risk-adjusted performance contribution of gold to the total portfolio.

Figure 39: World (1985-2006)





The same picture arose in the following years (cf. Figure 40 and 41).

Figure 40: World (1985-1989)

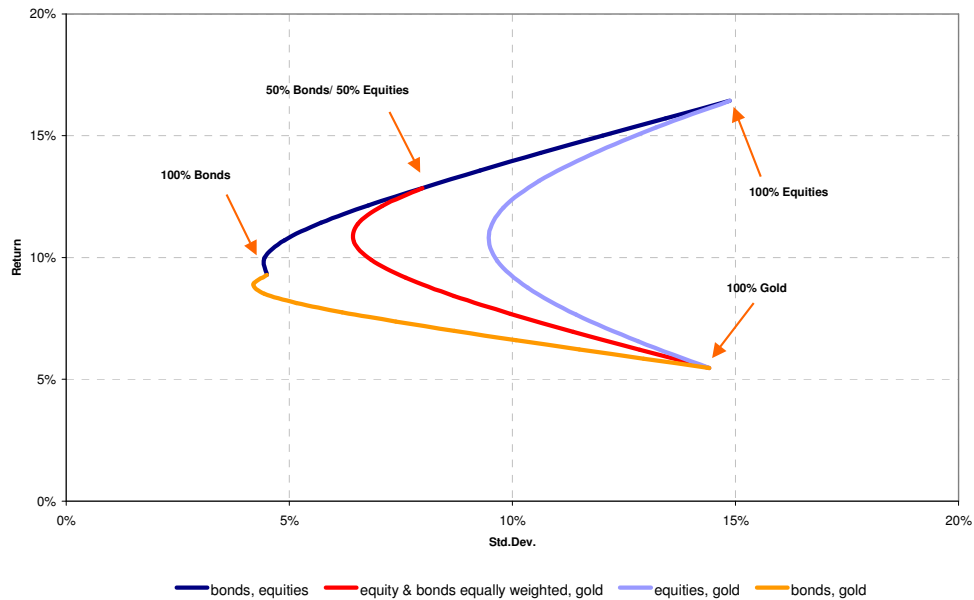
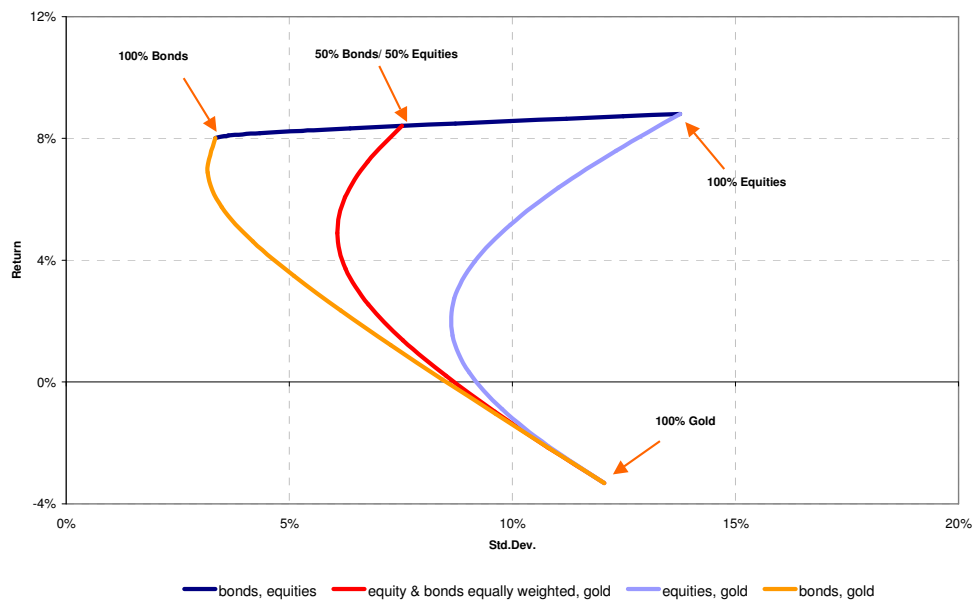
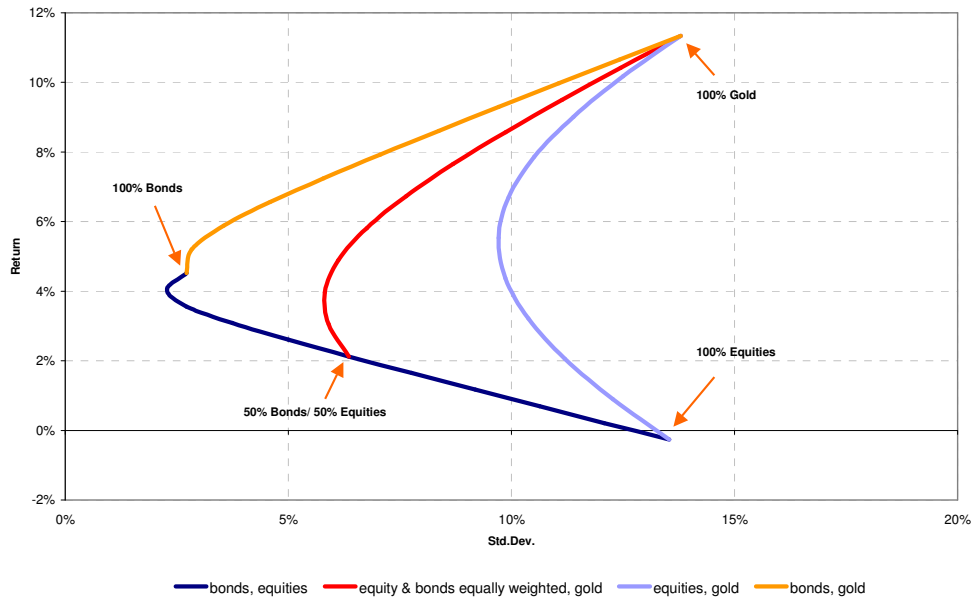


Figure 41: World (1990-1999)



But Figure 42 emphasizes that the risk-reducing ability of gold by shifting the efficient line to the left in the area of the lower volatility in the years 2000-2006 is also true in a worldwide investment framework.

Figure 42: World (2000-2006)

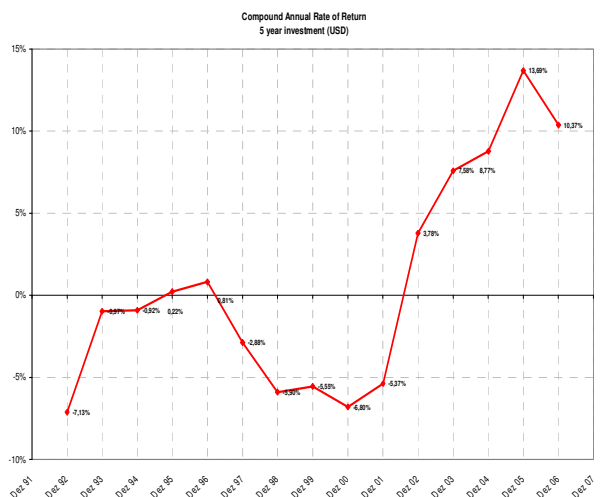
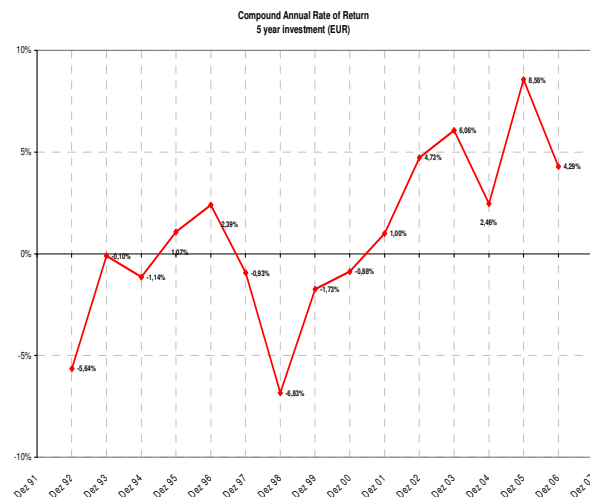
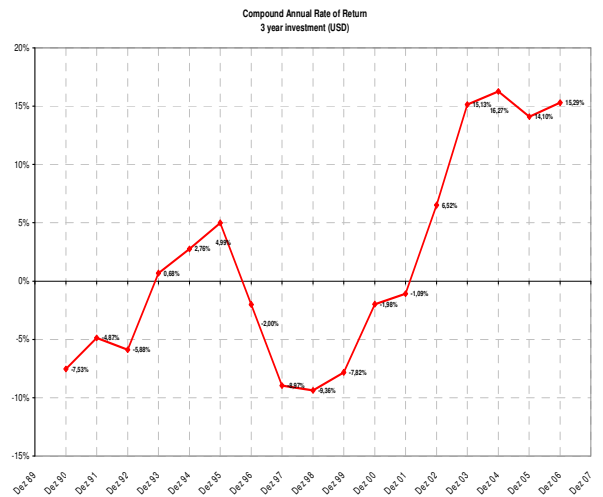
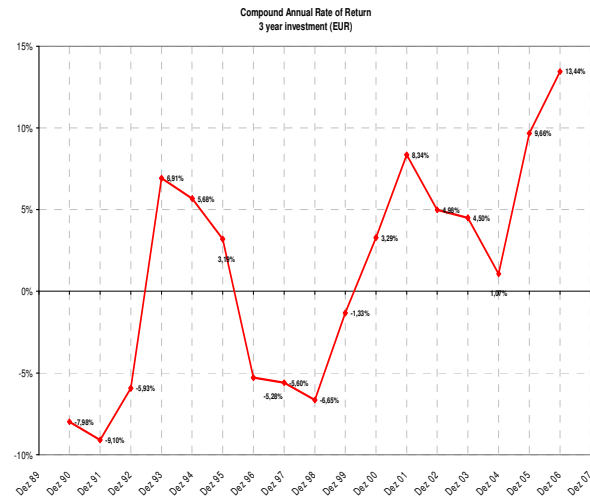
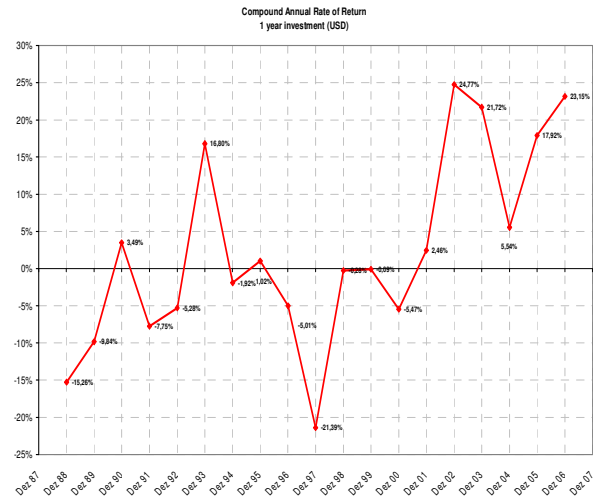
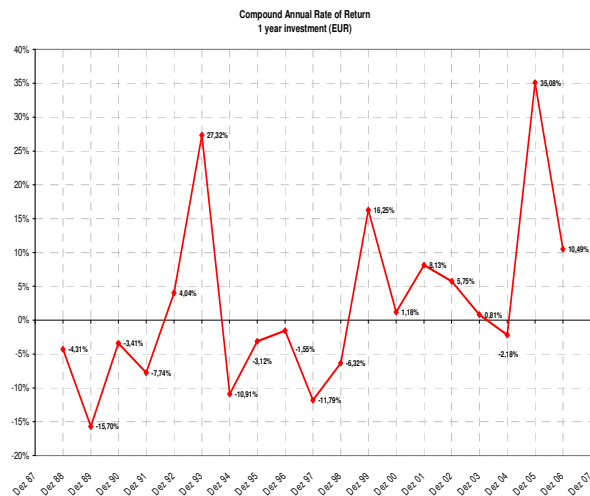


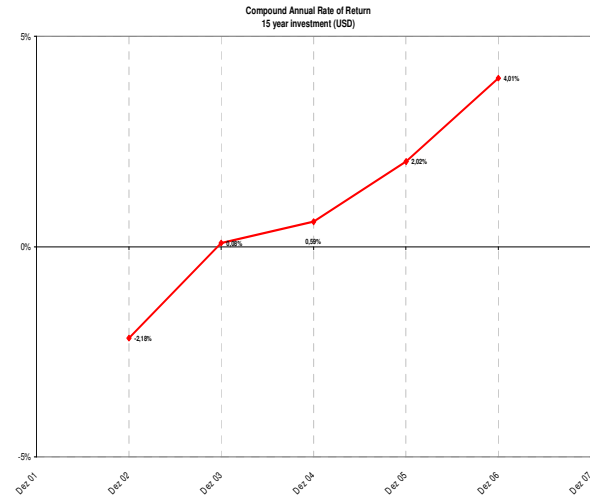
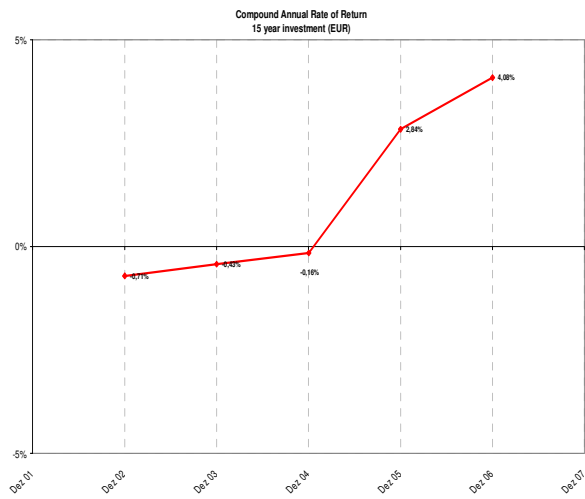
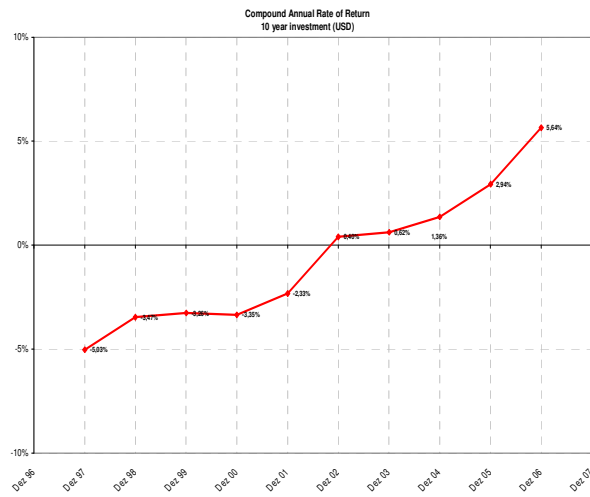
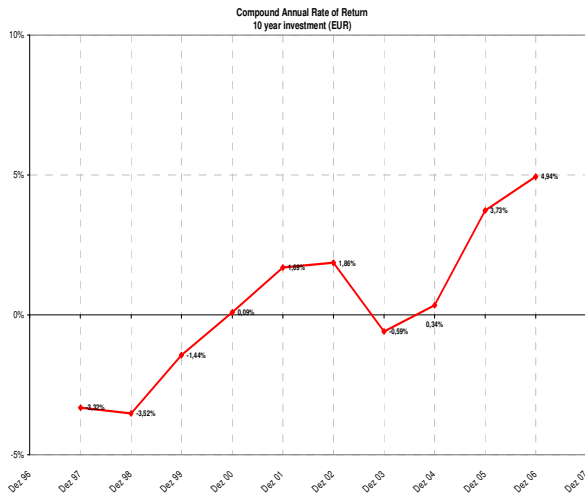
## 6 Conclusion

The development of the gold price changed after central banks had decided to limit their gold sales. Since that time supply and demand is less dependent on central bank gold selling policy and is characterised by a supply shortage, leading to a substantial rise in the gold price. With an annual Euro-performance of almost 8% between 2000 and 2006 gold became an interesting asset. The correlation to other assets was always low, but a total return below 1,5% between 1988 and 2006 meant no positive impact on the portfolio. Therefore investing in gold depends on the development of how central banks will deal with their gold reserves in the future. If they continue their policy of the last years, the positive effect on the gold price by higher demand, especially from India and China, might lead to a further positive movement.

Xetra-Gold was created by the Deutsche Börse in 2007 offering a new dimension for investing in gold in the form of a security. Investing in physical gold leads to high transaction costs. Using gold pool accounts inflicts substantial credit risk. Gold futures have negative roll returns; therefore a long term position in gold is not well supported. Compared to that, Xetra-Gold offers a cost-effective solution to all disadvantages of the above-mentioned ways of investing in gold. Xetra-Gold minimizes the transaction costs, has almost no credit risk and no problem with negative roll returns. Handling gold as a security can considerably improve the investment efficiency.

## Appendix: Performance





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