

Facts and Fantasies about Gold

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January 5th, 2014

Abstract

Many explanations have been given for the decline of the price of gold in 2013. Many more explanations about movements in the price of gold have been given over the last couple of years. In this report we check the most common of these explanations for their empirical validity. It turns out that most of these explanations (particularly those frequently heard in the media) are not based on facts but belong in the realm of fiction. And with fiction we do not even mean science fiction because any kind of scientific enquiry into these explanations would disguise them as false. It turns out that the price of gold is essentially influenced by inflation expectations and to a lesser degree real interest rates and the marginal costs of production. But even these factors are hard or nigh impossible to predict so that investors have to come up with scenarios about the future development of these factors. In our view at least throughout 2014 inflation expectations and real interest rates should continue to be dominated by central bank actions in the United States and other countries. Thus, in the short-term – but not necessarily in the long-term – these institutions will decide about the fate of gold.

JEL classification:

Keywords: Gold, inflation, US dollar, forecasts

After 12 consecutive years of positive performance gold will post its first year of losses in 2013. And what a year it was! Particularly in the second quarter of 2013 gold was on a roller coaster ride. In April, gold lost 13.7% within two days after unprecedented amounts of futures had been sold short triggering several stop loss limits that caused a cascade (or shall we say avalanche) of gold selling. During May and June expectations of a Fed tapering led to rising real interest rates and falling inflation expectations that caused another sell-off. All in all, gold prices declined by 23.8% in the second quarter alone and many investors got so sick of the ride that they abandoned gold altogether.

Much has been said about the reasons for the weak performance of gold this year, but it seems to us that a lot of these “reasons” cannot hold up to scrutiny. In fact most arguments about the recent gold weakness that we have seen seem to belong firmly in the camp of fantasy and wishful thinking and have no empirical validity whatsoever. Thus, we think it is time to separate fact from fiction in gold markets and analyze, which indicators that are frequently used by analysts and pundits work and which don’t. In the following sections we will go through each indicator in turn describing the theory behind it, describing the group of investors and pundits that typically use this indicator as a basis of their investment decisions and recommendations and assess its quality based on empirical facts. It turns out – maybe not surprisingly to many of our readers – that most indicators referred to in the media are not validated by the actual data while the ones that work are typically not referred to in the media because they are quite boring and don’t make a good story. But while storytelling is part of the entertainment value that media reports bring, serious investors should rely on indicators that are truly reliable.

In the following sections we will first look at classic indicators of gold performance like inflation or real interest rates. Then we turn our attention to gold as a crisis hedge and the relationship between gold and the US Dollar as well as production costs and the price of gold. Finally we will touch on some indicators like ETF holdings that have been used frequently to explain this year’s decline in prices before conclude with a short analysis of the ability of professional gold analysts to forecast the price of gold.

Gold as an inflation hedge and store of value

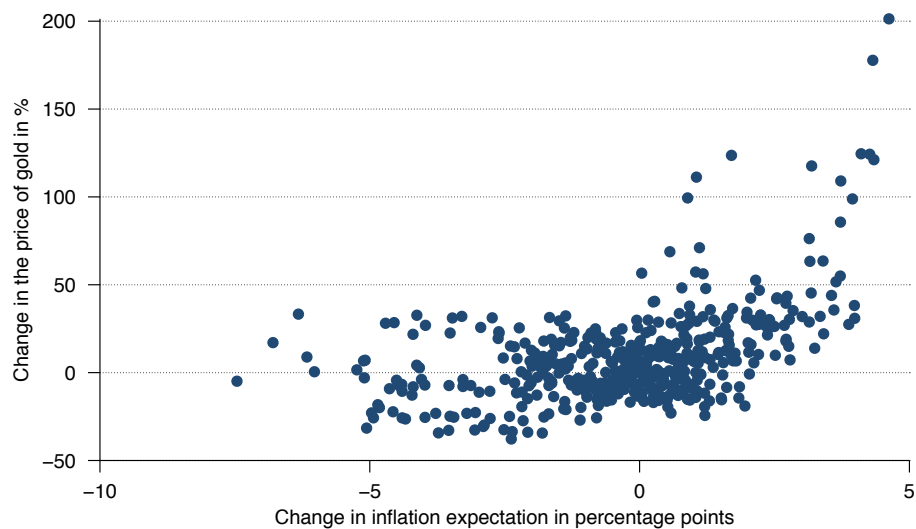
Theory: Gold is one of the oldest stores of value in human history and has protected investors against surprise inflation for many thousands of years. Thus, gold is the oldest inflation hedge in the world and should continue to protect against inflation in the future.

Fan base: Long-term investors seeking protection against inflation, economists, hard money advocates and doomsday prophets.

Fact or fantasy? Fact (with a capital F)

Empirical assessment: Gold as a store of value has a history that goes back thousands of years. The real price of gold has been remarkably stable over most of these times indicating that gold provided an inflation hedge at least for most of the time. However, there have been prolonged episodes that can last decades when the real value of gold declines. The last of these episodes happened after the gold crash in 1982 when the price of gold declined in real terms until 1999. Since then however, the real price of gold has risen dramatically. But holding gold as an inflation hedge should work not only over time periods like decades. In order to provide a meaningful investment proposition there should be a reliable relationship between changes in the price of gold and changes or levels of inflation expectations. Our analysis indicates that this might indeed be the case. Fig. 1 shows the change in inflation expectation in percentage points together with the change in the price of gold over rolling 12-month periods. We used monthly data since January 1970 for both the price of gold as well as inflation expectations. Inflation expectations have been approximated by the average annual inflation rate over the previous five years, a reasonable proxy for inflation expectations derived from inflation-linked securities that are only available for the last fifteen years or so.

Fig. 1: Change in inflation expectations and change in the price of gold



Source: Thomson Financial Datastream, Wellershoff & Partners

The relationship between the change in inflation expectations and the change in the price of gold is clearly non-linear. However, the intuition behind the theory seems to hold. Rising gold prices tend to coincide with periods of rising inflation expectations. This relationship becomes particularly strong when inflation expectations rise strongly (i.e. more than about 2 percentage points within 12 months). On the other hand declining inflation expectations tend

to coincide with a drop in the price of gold. In order to test the power of gold as an inflation hedge in practice we have performed a χ^2 -test on the hypothesis that the price of gold rises when inflation expectations increase and vice versa. The χ^2 -test may not be familiar to our readers but it is the simplest way to test a hypothesis for statistical significance without assuming any specific relationship between the change in the price of gold and the change in inflation expectations. Thus, the test is especially suited for non-linear relationships like the one we observe here.

Table 1 below counts the number of incidences when rising (falling) inflation expectations coincided with rising (falling) prices of gold during the last 40 years. Incidents where the postulated relationship holds are marked in white. Incidents when the relationship between gold and inflation was violated are marked in grey.

Table 1: Relationship between change in inflation expectations and the price of gold

	Inflation expectations rise	Inflation expectations fall
Gold price rises	163	108
Gold price falls	71	125

Source: Wellershoff & Partners

The resulting χ^2 -statistics is 26.04 which is highly statistically significant. In other words over the last forty years there has been a reliable relationship between changes in inflation expectations and changes in the price of gold. We have also tested the relationship between the level of inflation expectations at the beginning of each month and the subsequent twelve-month change in the price of gold. Again we found a significant result that showed that high expected inflation (meaning inflation expectations of 4% or more) is typically followed by rising prices in gold during the subsequent year. Both relationships prove robust not only when tested since 1970 but also over the last ten or the last five years since the end of the financial crisis.

Overall then, we conclude that there is a reliable relationship between the price of gold and inflation expectations. While gold does not seem to protect investors against surprise inflation, changes in inflation expectations are reflected in the price of gold. Given the drop in inflation expectations during 2013 it is thus no surprise that the price of gold declined as well. According to our analysis that is exactly what should have happened.

The main problem in applying this rule, however, is that inflation and inflation expectations are very hard to predict. While it seems reasonable to assume that inflation expectations should rise in coming years due to the mounting inflation pressures of a recovering global economy and the rapid rise in monetary aggregates in most Western industrial nations it is impossible to predict when and by how much inflation expectations will rise. Declining inflation expectations in 2013 were probably a surprise to most investors and economists and should keep us humble in the assessment of our abilities to predict inflation.

Gold and real interest rates

Theory: Gold competes with fixed income investments for investor liquidity. If real interest rates rise or are high, the opportunity costs of gold relative to fixed income investments rises and the demand for gold drops.

Fan base: Except for a small group of economists surprisingly few people.

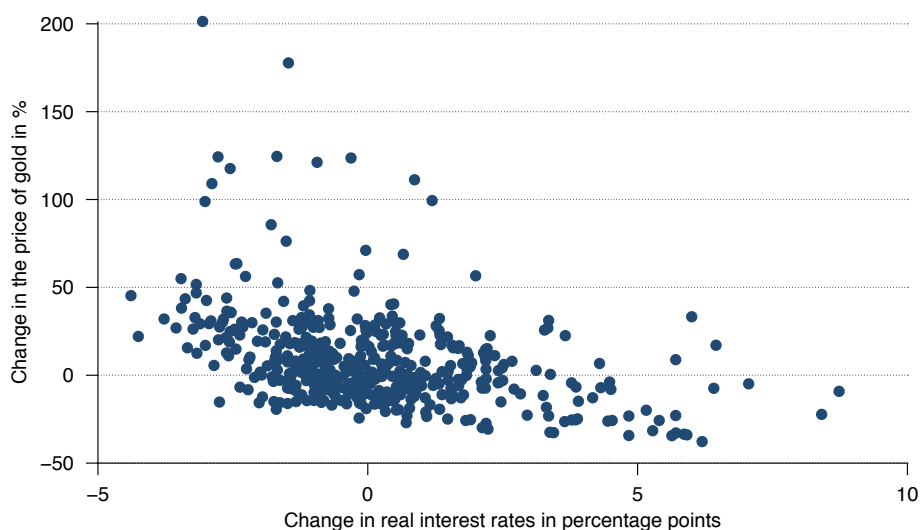
Fact or fantasy? Fact – even though it might be just correlation not causation

Empirical assessment: In testing this theory one has to be mindful of the relationship between real interest rates, inflation expectations and nominal interest rates. Real interest rates should in the long run be correlated with real GDP growth – at least in theory. However, real interest rates plus inflation expectations sum up to nominal interest rates. Thus, real rates might not only change because of a change in economic growth expectations but also due to a change in inflation expectations when nominal interest rates remain stable. Particularly during the era of financial repression 1940 to 1980 and again since the end of the financial crisis 2009 central banks in the United States and other countries have been trying to actively influence long-term nominal interest rates and keep them at artificially low levels to stimulate economic activity. Thus, real rates might fall not because the economic outlook deteriorates but because inflation expectations rise while nominal interest rates are kept stable.

Thus, when we look at Fig. 2 the observable relationship should not be over-interpreted.

There is a clear statistically significant relationship between changes in real interest rates and changes in the price of gold over the last 40 years. If real interest rates decline this decline is reflected by increasing prices of gold and vice versa. We tested this relationship also for shorter time periods like the last ten or the last five years and found that it is stable over time and still holds in the post-crisis market we live in. Again the relationship is non-linear and skewed, meaning that declining real interest rates typically coincide with bigger rallies in the price of gold than rising real rates and a decline in the price of gold.

Fig. 2: Change in real interest rates and change in the price of gold



Source: Thomson Financial Datastream, Wellershoff & Partners

Similarly we looked at the relationship between the level of real interest rates and subsequent 12-month changes in the price of gold and found again a statistically significant relationship between the two that remained stable over the last years. A high level of real interest rates is typically followed by negative changes in the price of gold while negative or low levels of real interest rates are typically followed by a rally in gold.

However, in practice we cannot know what caused real interest rates to change. It might be that real interest rates directly influence the price of gold, but it might also be that both the price of gold and real interest rates are influenced by a common factor like changes in inflation expectations or fears of tail events and crisis. In this case the correlation seen in Fig. 2 would not imply causation.

The reaction of real interest rates in May and June 2013 when the Fed announced it might start reducing its current bond purchasing program can explain to a large part the decline in the price of gold during this time period. When the Fed announced its plans to “taper”, inflation expectations fell while nominal interest rates rose. This rational reaction of markets due to lower inflation pressure (because the Fed balance sheet would grow more slowly in the future) and less demand for treasury notes and bonds (because the Fed is currently one of the biggest buyers of Treasuries) led to sharp increases in real interest rates and a corresponding negative impact on the price of gold.

Gold as a crisis hedge

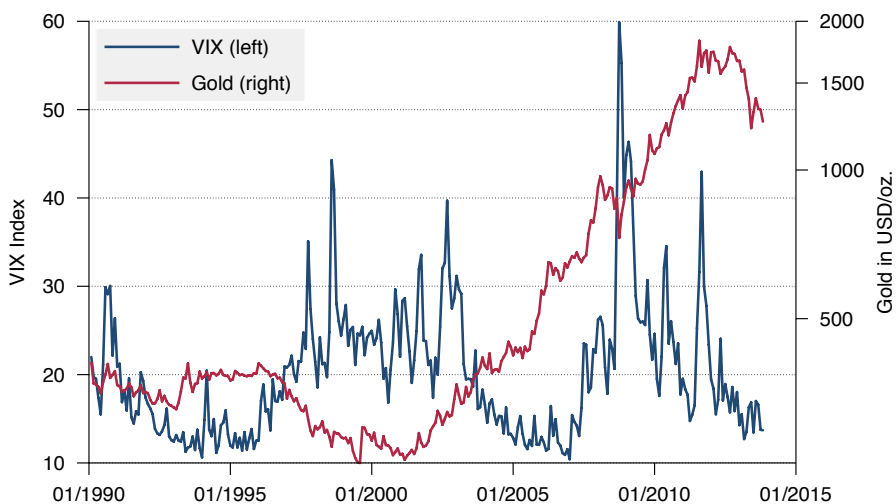
Theory: In times of economic or political crisis investors flee into safe haven assets like gold.

Fan base: Long-term investors looking for a hedge against political uncertainty, investors who have experienced war and crisis themselves as well as doomsday prophets.

Fact or fantasy? Fantasy

Empirical assessment: No matter which time we live in, gold has been touted as the ultimate crisis hedge for decades. One would expect that in times when political or economic uncertainty is rising, equity markets should drop while gold prices should rise. Unfortunately, this is only half fact. While equity prices drop during a crisis, gold prices tend to remain stable or rise slightly. This alone might qualify gold as a crisis hedge for some investors but in the strict meaning of the term “hedge” it is not. What we would expect is a rising price of gold whenever fear in the market rises. Fig. 3 shows the VIX Volatility index as a typical gauge of investor fear in equity markets together with the price of gold. It is obvious that there is no long-term correlation between gold and the VIX. Similarly we have tested the correlation between gold and the VIX over shorter time frames like days, weeks or months as well and found correlations close to zero. Even if we restrict our sample to the 10% of time with the highest readings of the VIX fear index we still get only very small correlations between the VIX and gold. Overall then, we have to conclude that gold as a crisis hedge only works in so far, as gold prices tend to be uncorrelated to equity prices and as a result tend to remain stable when equity markets drop.

Fig. 3: VIX and the price of gold since 1990



Source: Thomson Financial Datastream, Wellershoff & Partners

Gold and the US Dollar

Theory: A weaker dollar should lead to increased demand for hard currencies like gold.

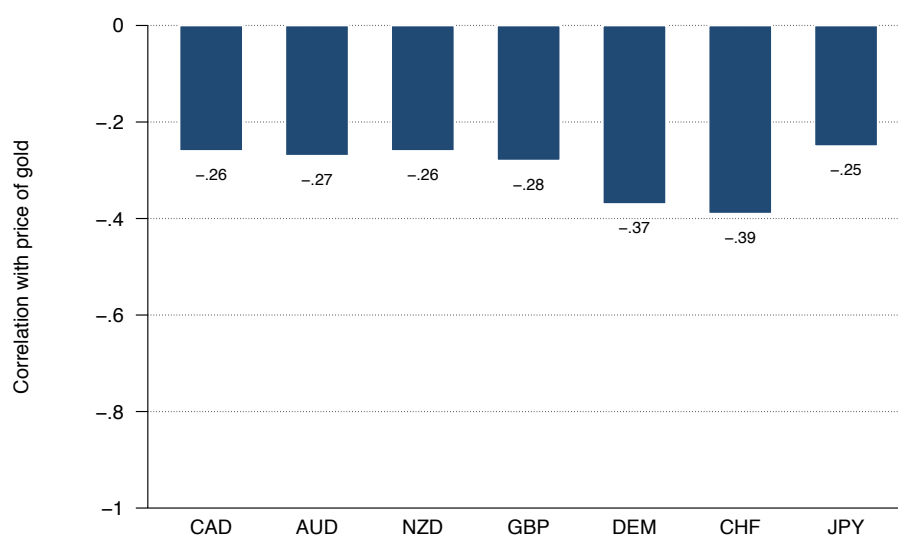
Fan base: Hard money advocates

Fact or fantasy? More fantasy than fact

Empirical assessment: It is often argued that gold provides a hedge against currency debasement. If inflation in the United States is higher than in Switzerland for example, the US Dollar should over time depreciate against the Swiss Franc. The price of gold since it is denominated in US Dollars should at least partially hedge against this currency depreciation since through its inflation hedging properties. Similarly if the US Dollar is devalued against other currencies through other forms of debasement (e.g. currency reform or change of a fixed exchange rate) gold as safe haven asset should partially protect against this debasement as well. Unfortunately, the empirical evidence for this theory is rather weak. If gold were effectively a protection against a devaluation or debasement of the US Dollar the price of gold expressed in a safe haven currency like the Swiss Franc should be much less volatile than the price of gold expressed in US Dollars. But the annualized volatility of gold expressed in Swiss Francs between 1970 and 2013 is 20.2% compared to 21.2% when the price of gold is expressed in US Dollars.

The theory is further weakened when one looks at correlations between the changes in the price of gold and changes in exchange rates for different currencies vs. the US Dollar in Fig. 4. While there is a negative correlation between the price of gold and exchange rate movement for all the currencies shown here, the correlation is rather small. Changes in exchange rates can typically explain less than 10% of the variation in the price of gold. Investors should thus refrain from using currency movements as explanation for changes in the price of gold let alone as a basis for their investment decisions.

Fig. 4: Correlation between exchange rates and the price of gold (1975-2012)



Source: Erb and Harvey (2013), Wellershoff & Partners

Gold and production costs

Theory: Economic theory states that the price of gold should at least be as high as the marginal costs of production of gold. Otherwise production will be curtailed and the resulting supply shortage leads to rising prices.

Fan base: Economists and gold bears

Fact or fantasy? Fact, as long as one uses the right argument... and even then it is unreliable.

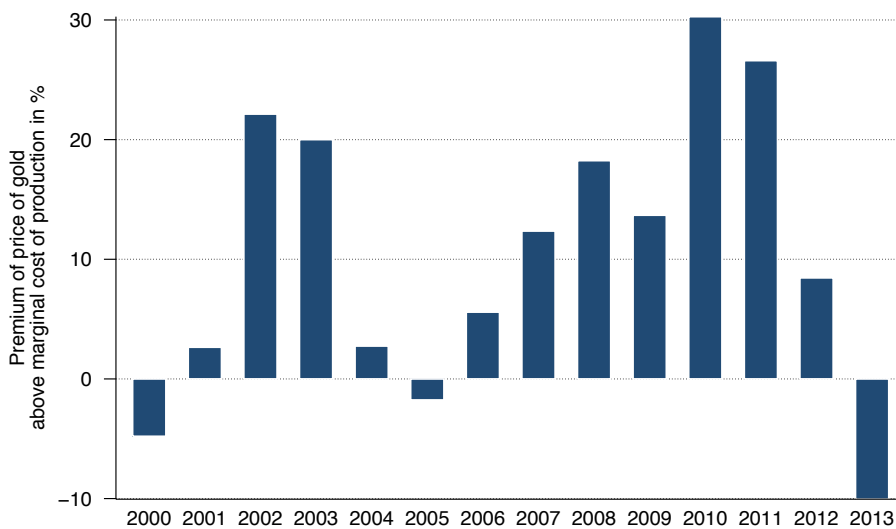
Empirical assessment: While there is an intuitive logic behind this argument it is often used in the wrong way. Many investors and analysts compare the average production cost of an ounce of gold and conclude that since the average price of gold is significantly above the average price of gold, gold is overvalued. The flaw in this argument is that the average cost of production of an ounce of gold is not what should determine the price of gold. It is the marginal cost of production (i.e. the cost of production of the last ounce of gold sold in the market) that puts a floor under the price of gold. If the price of gold drops below this marginal cost of production for a sufficiently long time, some loss making production facilities will close and gold supply will decline. The result should be either a rising price of gold until these production facilities can operate profitably again or inefficient production is replaced with more cost efficient methods.

Research by Scotiabank GBM shows indeed that after 1974 when the gold price was allowed to float relative to the US Dollar until about 2000 the price of gold was indeed at least as high as the sustainable cost of production. But even then there were prolonged periods (e.g. from 1977 to 1983 and again from 1987 to 1991) when the price of gold was significantly higher

than the marginal cost of production. Fig. 5 shows the premium of the average price of gold and the marginal cost of production since 2000. It is obvious that during the last 13 years the marginal cost of production has acted as a floor for the price of gold that was touched at the beginning of the new millennium and then again around 2004 and 2005. All the other years, until 2013 show a significant premium of the price of gold relative to the marginal cost of production. This year's decline in the price of gold more than eliminated this premium. Today the price of gold is about 10% below the marginal cost of production indicating that some mines probably are producing at a loss at the moment. If gold prices remain at current levels for some time a decline in global gold production seems likely in the coming years.

Overall then, this theory does have merits if it is applied properly. In practice the use of this theory is limited because in many instances, the price of gold remains significantly above the marginal cost of production for several years in a row and it is impossible to predict, when – or if – the price of gold reverts back to the marginal cost of production.

Fig. 5: Premium of average price of gold relative to marginal cost of production



Source: Thomson Financial Datastream, Earth Resource Investment Group, Wellershoff & Partners

Gold and central bank demand

Theory: Central banks are amongst the biggest investors in gold. If they buy or sell gold out of their vaults, this should impact the gold price.

Fan base: Constantly changing.

Fact or fantasy? Fantasy

Empirical assessment: If there are organizations in the world that own enough gold to influence the price with their purchases and sales it is the central banks of this world. In particular the big Western central banks of the United States (official reserves of 8'133.5 tons or about twice the annual global demand for gold), Germany (3'390.6 t), Italy (2'451.8 t), France (2'435.4 t) or Switzerland (1'040.1 t) together with the IMF could move the market. However, these major central banks together with the IMF and some smaller central banks have entered into three consecutive Central Bank Gold Agreements since 1999 to coordinate and limit their sales of gold. Under these agreements central banks have sold up to 500 tons of gold per year during the early phase of the most recent bull market in gold from 1999 till 2005. Recently gold sales have declined and Western central banks still do not purchase new holdings in gold. This continues a long tradition of net sales by the official sector that started with the secular bear market of the 1980s. Between 1980 and 1999 central bank gold holdings around the world declined by 10%. Thus, at least when it comes to western central banks there does not seem to be any relationship between central bank sales and the price of gold since central banks have been selling gold both during the secular bear and the secular bull markets of the last 30 years.

Theoretically central bank purchases by emerging market central banks in China, Brazil, Russia or other countries might change this picture, since these central banks have started to accumulate gold during the last ten years. Especially the Chinese central bank with its large Dollar reserves could accumulate meaningful amounts of gold. However, so far the impact could not be noticed in gold markets. This might largely be due to the limited scope of gold purchases by emerging market central banks so far. Net purchases of central banks account for about 10% of global demand and have been rather stable during the last three years when the price of gold first rose to almost 2'000 US Dollar per ounce and then fell below 1'200 US Dollars again.

Gold and ETF holdings

Theory: Investment demand for gold is focused largely on physical gold ETF. If investors demand for gold declines, the resulting reduction in ETF holdings leads to selling pressure in gold markets and should trigger price declines. Alternatively, increased demand by ETF investors should support gold prices.

Fan base: Pretty much every investment bank in the world and a wide range of investors chasing past returns.

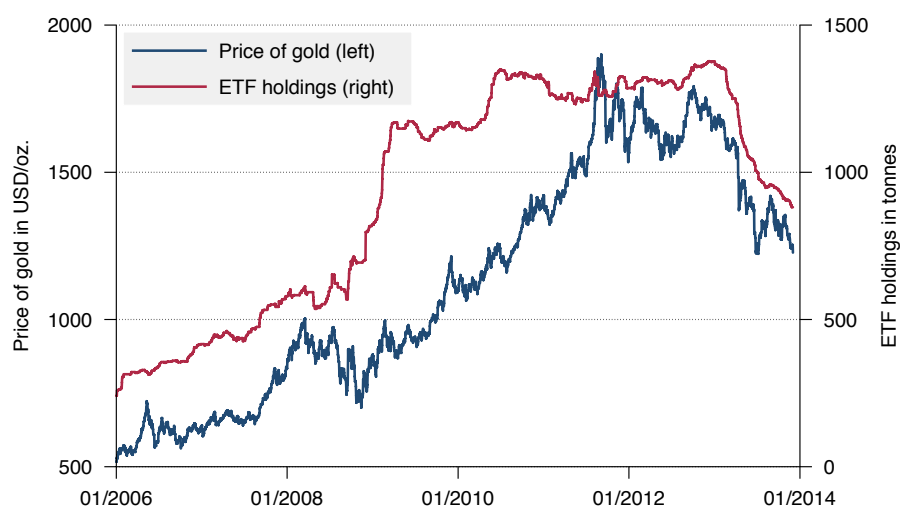
Fact or fantasy? Fantasy

Empirical assessment: Particularly during the last 12 months this theory has gained a lot of traction with research analysts at banks and with many investors. They typically point to a

simultaneous decline in ETF holdings and the price of gold during much of 2013. But a closer inspection shows that this argument is flawed on many different levels.

First of all, while investment demand by physical gold ETFs and similar investment vehicles is very volatile, the demand over the last five years was just about 5% of total demand. More than 80% of global demand stems from the demand for gold bars and coins and jewelry. It would be quite surprising if such a small part of the total demand could lead to price swings in the magnitude of 20% or more. In Fig. 6 we have adopted a wider view of the link between ETF holdings and the price of gold. The figure shows the price of gold together with the holdings of the two largest physical gold ETFs in the world (the SPDR Gold Trust and the ZKB Physical Gold ETF). There are other similar products available by now but the amount of gold they hold is much smaller than any of the two ETFs we track and their holdings are typically highly correlated with the holdings of the two big ETFs. Visual inspection of the chart alone shows that the current co-movement of ETF holdings and the price of gold exists only since the end of 2012. Before this time there has been practically no correlation between ETF holdings and the price of gold. We have calculated the correlation between ETF holdings and the price of gold on investment horizons of one day up to one year and found a correlation of just 0.2 to 0.4.

Fig. 6: Price of gold and ETF holdings since 2006

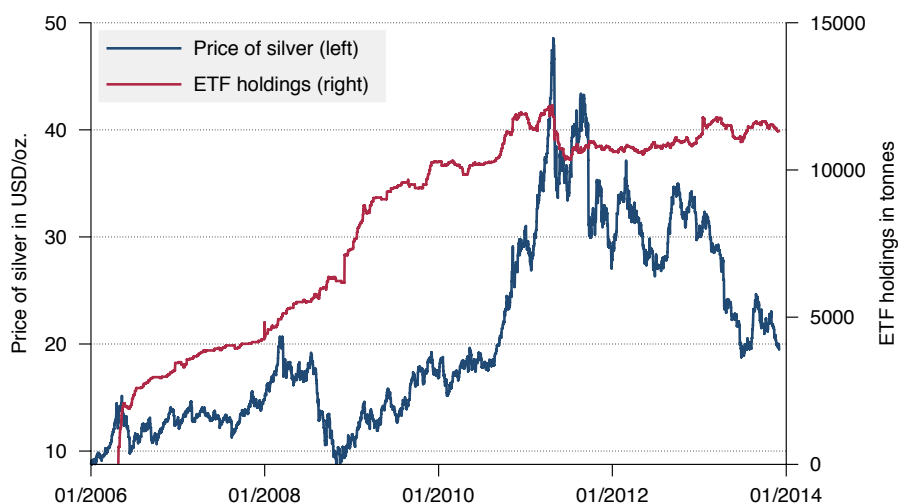


Source: Bloomberg, Wellershoff & Partners

It is possible that the recent co-movement of gold ETF holdings and the price of gold may just be spurious correlation. When one looks at the development of ETF holdings in physical silver ETFs it becomes more evident that this might indeed be the case. In Fig. 7 we show the

price of silver together with the holdings of the biggest physical silver ETFs since 2006. The correlation between changes in the price of silver and changes in ETF holdings are almost exactly zero no matter which time horizon we investigated. The biggest paradox, however, is that while silver has declined more than gold in 2013, holdings of silver ETFs have increased! It is extremely hard to explain why declining ETF holdings in gold should have driven prices lower but rising ETF holdings in silver could not prevent an even steeper drop in silver prices.

Fig. 7: Price of silver and ETF holdings since 2006

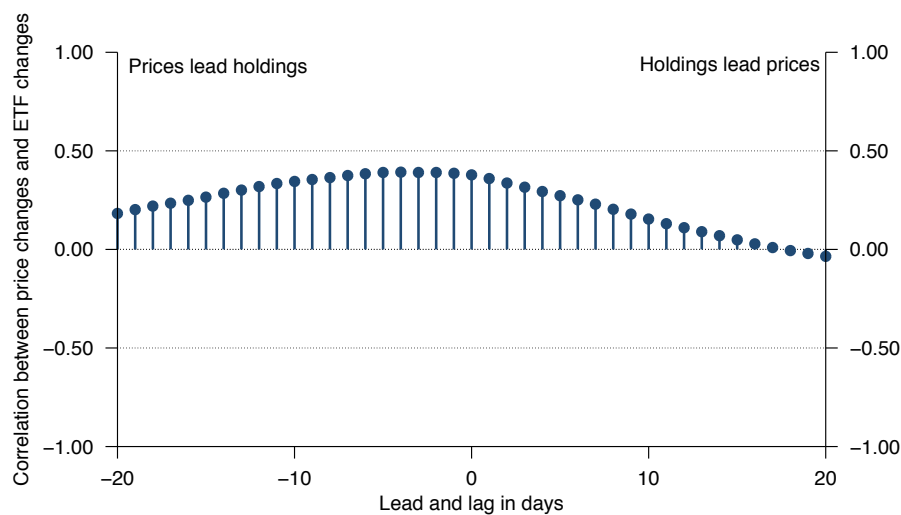


Source: Bloomberg, Wellershoff & Partners

One possible argument could be that physical gold ETFs are just a bigger share of total gold demand than silver ETFs of total silver demand. In this case the developments in silver ETFs would just not be significant enough to materially impact silver prices. In order to directly test the theory that changes in ETF holdings impacted the price of gold in 2013 we have calculated cross-correlations between changes in the price of gold and changes in gold ETF holdings for the calendar year 2013 when the co-movement was strongest. Fig. 8 shows the cross-correlogram for different leads and lags of changes in the price of gold and changes in ETF holdings. It is clear, that changes in ETF holdings typically lag changes in the price of gold by about 1 to 10 days. On the other hand the correlation between changes in ETF holdings and subsequent changes in the price of gold does disappears rather quickly. Put simply, what happens is not that ETF investors sell their gold and this leads to a lower price of gold. What happens is that the price of gold drops and in the subsequent 5 to 10 trading days investors start selling their ETF holdings. This is the classic pattern that we know from equity markets when trend following investors and panicked investors sell their holdings at the worst possible time just after a market collapse.

Our assessment of this theory of ETF holdings influencing the price of gold is that it is clearly straight out of fantasyland and so full of holes that even a Swiss cheese would start to blush.

Fig. 8: Cross-correlogramm of changes in the price of gold and changes in ETF holdings



Source: Wellershoff & Partners

Gold forecasts by experts

Theory: Due to their experience and analytic skills analysts of investment banks and asset management firms should be able to forecast gold prices more accurately than the average investor.

Fan base: Bankers and all their clients gullible enough to believe everything they say

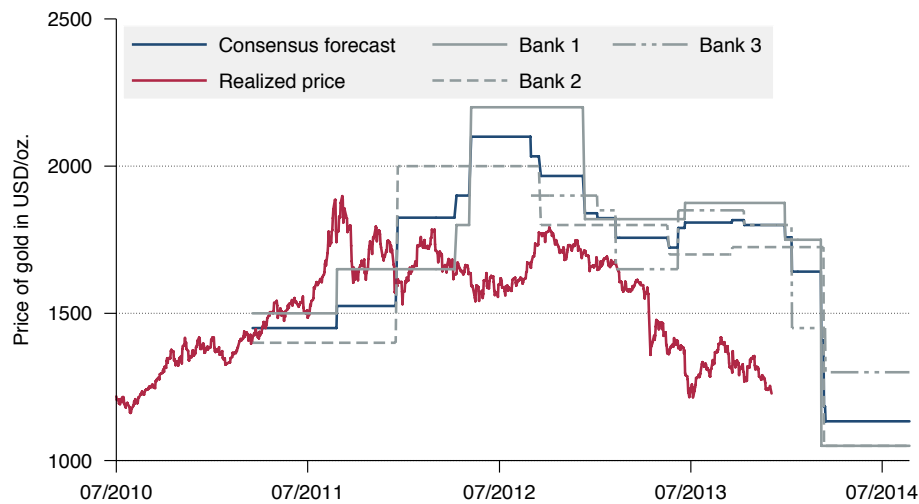
Fact or fantasy? The equivalent of a unicorn in gold markets.

Empirical assessment: This theory is quite easy to test, yet very few investors ever go through the hassle needed to do this. In Fig. 9 we have collected the 12-month price forecasts of three major global banks for gold and compared it with the realized price of gold at the time the forecast should have materialized. Due to our lack of access to different investment bank research we could only calculate the accuracy of the forecasts for these three major banks during the last couple of years. However the results are indicative of a bigger trend as we will explain below.

The figure shows clearly that neither the 12-month price forecasts of the three banks nor the consensus (average?) forecast of the three had anything to do with reality. None of the banks foresaw the peak in gold prices in the middle of 2011. In fact these banks remained bullish on gold until several months or even quarters after it had reached the peak. Also, none of the

banks had target prices below 1'700 USD/oz. before the gold sell-off in spring 2013. Target prices were only adjusted after the sell-off.

Fig. 9: 12-month price forecasts for the price of gold and realized price at the end of the forecast



Source: Wellershoff & Partners

A closer analysis of the actual forecasts given shows that target prices typically are more closely related to the actual price of gold at the time the forecasts are made than to the price of gold at the target date of the forecast. In Table 2 we show the relative deviation of the forecast price from the realized price and the price at the time the forecast was made for the three banks and the consensus forecast. We also show the relative error of a naïve forecast that always assumes the price of gold in one year will be exactly the same as the price of gold today.

Table 2: Relative forecast error (RMSE) for gold target prices

	Relative error with price of gold at time of forecast	Relative error with price of gold at target date of forecast
Bank 1	19.3%	25.7%
Bank 2	15.7%	22.8%
Bank 3	10.5%	27.9%
Consensus	15.5%	22.5%
Naïve forecast		18.5%

Source: Wellershoff & Partners

Several things are important to notice in the table. First of all, for each of the banks the relative error of the forecast with the realized price of gold at the target date of the forecast is bigger than the forecast error of the consensus forecast. Thus, the consensus forecast was on average more accurate than each individual forecast. This shows that there is value in aggregating different opinions about markets. However, even the consensus forecast was much worse than the naïve forecast of no price change over the next 12 months. In other words investors would have fared better ignoring these forecasts in their investment decisions altogether!

Of course our sample is small both in terms of analyzed banks and time frame but this should not mean that our results are not representative of the overall trend. Markus Spiwoks and his colleagues have shown in their work that the forecasts of financial analysts for interest rates, exchange rates and stock markets are highly unreliable. They have tested forecasts of more than 20 banks over a long time frame. In total they have analyzed more than 160'000 predictions by professional analysts and found that 98.5% of forecasts are more closely related to current market conditions at the time of the forecast than the actual realized market condition. Even worse, they found in almost every case that the consensus forecast was better than individual forecasts but worse than the naïve forecast.

In summary then we can safely conclude that analyst forecasts are not reliable at all. While there might be a reliable forecaster out there somewhere the chances of finding him or her are as slim as finding a unicorn in the Amazon rain forest.

Conclusion

Gold is the subject of a lot of stories these days, but unfortunately most of them (like the connection between ETF sales and declining prices of gold or central bank purchases and rising prices of gold) cannot be empirically validated. It turns out that the only reliable indicators for the price of gold seem to be changes in inflation expectations and real interest rates. That of course doesn't make for a compelling story and even if it did, investors would get tired of hearing the same thing over and over again. But that's the way it is, unfortunately.

In the current environment this means, that gold prices should continue to react strongly to the actions of central banks. If the current ultra-expansive monetary policies remain in place inflation pressures continue to rise and inflation expectations may eventually start to rise as well. At the same time real interest rates might remain artificially suppressed for longer leading to further support for the price of gold. If on the other hand central banks start to normalize monetary policy and/or manage to keep inflation expectations under control, then

gold prices should decline significantly due to low or even falling inflation expectations and rising real interest rates.

At this point in time it is impossible to say which of these two scenarios will materialize, but it seems clear that at least in 2014 the price of gold will remain in the hands of the central banks in the United States and other countries.

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