# Gold - Silver Ratio Investors' Perspective

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Here's a fresh, in depth look at the important gold-silver ratio indicator with tell-all charts and ideas to help you interpret the ratio and trade the pair. Keep in mind that the majority of investors lose, and that successfully playing

the game in the markets is about doing things that the majority does not. In order to outsmart the majority, we need to look at the gold silver ratio in a unique way.

The gold-silver ratio is one of the first indicators traders look at to comprehend the state of the precious metals market. Indeed, it has been out of favor among modern investors who believe that a simple sinusoidal (smooth repetitive oscillation) movement does not often work.

We believe that the gold silver ratio is not outdated; it's only how we view it that needs to be refreshed. The gold-to-silver ratio is the price of gold divided by the price of silver, in other words, a single ounce of gold is worth so many ounces of silver. (The naturally-occurring ratio of gold to silver in the earth - 17:1) Some traders look at the gold-silver ratio as a way to determine if one commodity is over or undervalued relative to the other. They then may try to short the overvalued commodity and buy the undervalued commodity, with the hope of profiting from the reversion to the mean. Comparing gold prices to those of silver gives us a feel for the price fluctuations between the two metals.

# A different perspective of looking at Gold-Silver correlation

Let's start with a tell-all chart which lets you see the whole structure of the correlation without using the time axis. Please take a minute to understand the chart and the shape of the trend lines.

Each point on the graph represents the combination of the price of silver and gold at a particular date. Looking at this chart



Chart 1: Gold and Silver Prices

instead of standard gold/silver and time axis does not give you a clear idea about the ratio extremities, but it shows a clear view of general tendencies. Looking at a thing from different perspectives usually leads to better decisions, especially investment-related ones. Let's look at broad tendencies,

We have drawn three trend lines to see general tendencies for the scatter plot. A solid exponential fit, a dotted linear fit and a dashed logarithmic fit. All trend lines on the above chart are rising. That means that if we took the first stage of the bull market, the second stage or even the whole bull market, we would see that on average, price of silver increases along with the price of gold.

Not much news, up to this point. What is interesting to note is that in all these time frames this correlation is best described using different trend lines. What is not obvious is that all these trend lines have different shape. First, we will focus on the long-term trend line and what implications it has on the current situation on the metals market (with available data as of August, 2011).

Data for the whole bull market in precious metals (in this case we'll assume that it

started in 2000) is best represented by a linear trend line, so the trend line is rising and the slope is constant. If this trend line is to be taken into account, silver is even currently overvalued to gold and therefore, it might make sense to add to your gold positions by selling silver (if you are inclined to trade this ratio) or making additional purchases of metals by buying gold instead of silver. The recent points are still well above the linear trend line despite a sharp correction in silver prices and a rally in gold. The idea is to figure out whether silver is above the general linear fit or below and accordingly make a call on which metal is overvalued.

This trend line may change its shape in the future as it will be calculated using more price data. The cycle usually goes like this - gold makes the first big move and silver catches up. Then gold moves again and silver catches up again. Silver, just like junior mining companies, tends to 'take its time' before finally starting to move significantly. However, when it finally does move, then it's 'up, up and away.' We saw this in the recent silver rally or in the first few months of 2004, 2006, 2008 and 2011. We have seen this type of performance on very long-term charts that go back to the previous secular bull market in precious metals. Silver's catch up materialized mostly in the final stage of the bull market.

Another factor we notice from our graph is that in the first stage of this bull market, the points follow the logarithmic trendline better than the other two (linear and exponential). What does that mean? In an initial phase of a bull market, silver lags in response to gold fluctuations. Then comes a phase where the relationship is closer to a linear trendline. Finally, we have an exponential fit where silver catches up in a big way (second stage of the bull market). One of the main principles of technical analysis is that history repeats itself, or at the very least, rhymes. So we might infer that the catch-up stage of this bull market is probably over (as of mid-2011) and we may revert back to the gold-leads-the-way stage again where gold rises and silver lags. This is something we have been seeing indeed in the last few points of the graph (most recent data of Aug, 2011). Certainly, the exponential trend line is no longer the best fit. Whether we have moved towards another logarithmic trend line remains to be seen (when more points come across. Is the bull market nearing an end? Not likely, based on fundamental factors, so we may see silver outperform gold again - just like it did in the first half of 2011.

### How to Play the Gold-Silver Ratio

So far, we have discussed typical goldsilver ratio fluctuations to open up investment opportunities based on the phase of the precious metals market. To make investments/trades irrespective of market conditions, we have pair trading. By taking up two legs (one long and the other short), a pair enables the investor to limit losses and gain from a number of scenarios in comparison to a standalone position that can gain only in case of only one favorable fluctuation. In a sense, a pair trade is market neutral. However, a ratio also can be played by other means which come with further limits on profits and losses. If one can predict which way the ratio is going to move, one can also realign the portfolio churning investments towards the outperformer. Most importantly, it must be understood that pair trading is not a long-term investment vehicle. Investors are advised to implement a small part of their capital as speculative capital to benefit from short term/medium term relative price swings. Pair trading is a trading strategy more than an investment option.

The main requirement of ratio play is to identify two related instruments that have a high correlation in day-to-day prices. When the <u>correlation</u> between the instruments weakens, (one instrument moves up while the other moves down) the pair trade would involve shorting the outperforming asset and to going long the underperforming one. This is a bet on the spread between the two instruments that are eventually expected to converge. Realignment would involve redirecting partial investments from the underperformer towards the outperformer, while still staying long on both. This is a play on the relative price swing; as the underperformer picks up relative to the outperformer, profits can be made irrespective of individual leg fluctuations.

Divergence between a pair can be due to temporary demand/supply changes, bulky buy/sell orders for one leg of the pair, significant news about one of the instruments, and so on. The underlying principle of mean reversion is that since the instruments are fundamentally linked, the normal relationship will resume once any temporary effect is subdued.

Any ratio correction can happen in three ways. Both legs move up and one outperforms the other, or both move down (where realigning works better). Only in the event that both legs move in different directions does a pair trade work better. But, risks are higher in case of an unfavorable outcome. We will observe how

Both legs expected to gain

the illustration below favors realignment in most cases. Also, in our subsequent essays, we will establish why both gold and silver are expected to grow with one outperforming the other and make the case for portfolio realignment rather than pair trade.

One of the pillars of making trades based on a ratio (such as gold-silver) is the philosophy of mean reversion. Mean reversion is more of a certainty in the case of pairs because opposing forces of two correlated instruments tend to force the ratio to revert to its historical average values. Imagine two strong magnets. Move the two magnets apart, and there is a strong tendency of the two to drift back together once the external force weakens. Sometimes the external force is strong enough to drift them sufficiently apart to a degree that the magnetic field is no longer effective, or the strength altered. We will analyze methods to detect regime changes further on in our analysis.

### Pair Trading vs. Portfolio Re-alignment - Example

Expectation indicates predicted movement on which bet is taken.

Both legs expected to decline			aggressive with higher potential gains and losses. Also, a pair trade has more exposure to the market because of the extra leverage from the short positions and involves greater costs due to margin requirements and costs of borrowing							
	Realigned portfolio			Pair Trade			Normal portfolio			
Investment	Gold 60 \$	Silver 40 \$		Gold long 200\$	Silver Short 100\$		Gold 50 \$	Silver 50 \$		
Favorable outcome	Gold declines 10%; Silver declines 12%									
Profits (\$)	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total	
	-6	-4.8	-10.8	-20	12	-8	-5	-6	-11	
Worst case	Gold declines 10%; Silver declines 8%									
Profits (\$)	-6	-3.2	-9.2	-20	8	-12	-5	-4	-9	

A realigned portfolio gains more while even in the case of a downside the losses are limited. In contrast, a pair trade is more aggressive with higher potential gains and losses.

	Realigned portfolio			Pair Trade			Normal portfolio		
Investment	Gold 60 \$	Silver 40 \$		Gold long 200\$	Silver Short 100\$		Gold 50 \$	Silver 50 \$	
Favorable outcome	Gold gains 10%; Silver gains 8%								
Profits (\$)	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total
	6	3.2	9.2	20	-8	12	5	4	9
Worst case	Gold gains 10%; Silver gains 12%								
Profits (\$)	6	4.8	10.8	20	-12	8	5	6	11

One leg expected to gain

The risk of a pair trade is most evident in this case. Losses and Gains are multiple times that of a realigned portfolio.

	Realigned portfolio			Pair Trade			Normal portfolio		
Investment	Gold 60 \$	Silver 40 \$		Gold long 200\$	Silver Short 100\$		Gold 50 \$	Silver 50 \$	
Favorable outcome	Gold gains 1%; Silver declines 1%								
Profits (\$)	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total	Gold leg	Silver leg	Total
	0.6	-0.4	0.2	2	1	3	0.5	-0.5	0
Worst case	Gold declines 1%; Silver gains 1%								
Profits (\$)	-0.6	0.4	-0.2	-2	-1	-3	-0.5	0.5	0

Table 1: Simulation: Gold to Outperform Silver by 2%

Investment is considered in three forms. A normal portfolio which does not act upon expectation, in this case, say a 50-50 allotment. A realigned portfolio which is slightly skewed based on the prediction (in this case we have a 60-40 allotment just as an example). A pair trade with the proceeds of the short leg going into extra long positions

The budget for all three forms of investments is fixed at \$100.

Favorable outcome is defined as the case when the prediction is true.

Worst case is a potential opposite outcome from the prediction.

### Gold and Silver ETFs

There has been an extraordinary expansion of gold ETFs (Exchange Traded Funds) in the gold market. This has led many investors to consider ETFs as an alternative investment vehicle. Some analysts even attribute the current bull market to the growing purchase of gold by ETF funds. The choice between gold futures or ETFs must be considered since each has its own set of pros and cons. However, since ETFs are so much easier to use for most investors, we'll use this asset class in the following part of this essay. Please keep in mind that we do not advocate using ETFs as a proxy for long-term investments. However, when it comes to trading, ETFs are easy to buy and sell and are extremely liquid. When playing with ratios it is of utmost importance that the instruments are easy to transact. Also, because both legs of a pair have similar tracking error, the impact of tracking error is nullified and ease of operation takes precedence.

We observed several measures of representative tracking error viewpoints on the SPDR Gold ETF closing prices and spot gold. First, we observed something that is already known- a high correlation of 0.9995 (practically 1) between the GLD ETF and spot gold data. However, we investigated a few other characteristics that provide a real description of the ETF's tracking ability. The ratio of the prices between ETF and spot should ideally be a the ETF touches 2.1 when measured only those days when the spot made a change of over 3%. This highlights how the ETF does well in tracking spot gold with 'exceptions on exceptional days' only.

The bottom line is - ETFs track the spot price efficiently enough to be considered for frequent portfolio churning. Its ease of handling characteristics make it ideal for algorithmic trading as well, whereas futures trading are more complicated. Again, this is not true for long-term investors (because ETFs track poorly in the event of big moves). Again, we would like to emphasize that ETFs are not the ideal proxy for long-term investments. The final stages of the current bull market in precious metals might witness exceptional days where only part of gains is realized if ETFs are chosen as an investment ve-



Chart 2: Spot Gold to SPDR Gold ETF Ratio

straight horizontal line (or minimum deviation) if the tracking if perfect. We observed what we expected – mostly horizontal line with little fluctuations that are only significant when magnified sufficiently.

We also observed that the ratio of standard deviation (of EFT-spot ratio) to its mean is 1.11%. This number should serve as a good measure of how much is the average tracking error of ETFs over gold spot. On closer scrutiny it was seen that the bigger deviations were on those days where the spot made a big move and the ETF lagged in replicating the same movement. Standard deviation of absolute changes in ETF-spot gold ratio since 2004 is 0.87. The standard deviation of hicle. Physical positions are definitely less risky.

### Silver's Correlation with Gold Makes It Ideal for Mean Reversion

The Silver gold long term correlation is visibly high. The overall correlation since 2000 is close to 0.95. An individual breakup of correlation numbers across years (since 2000) shows that barring 2001-02, the correlation is strong, enabling possibilities of mean reversion of the ratio. Unlike popular perception, correlation is extremely path dependent rather than a measure of overall movements. For instance, gold and silver prices may both be moving in the same direction but still have a lower correlation if the path is different (the shorter the term we take into account, the bigger the difference may be).

The lower correlation between gold and silver during the last recession (here: meaning a plunge in the general stock market) can be attributed to the higher volatility of silver when compared to gold. The last recession impacted industry and in turn, the demand for silver, which has industrial uses. Typically, during stock market crashes, investments are redirected to safe havens such as gold and silver - however, silver remains more volatile during such periods when compared to gold. As a result, both the periods of 2008-09 and the early 2000s (the Dot com crash), a lower correlation is observed. 2011 also witnessed an abnormal surge in silver prices in relation to gold which had started to stagnate. This was followed by two other events that altered the goldsilver correlation considerably. First, a correction in silver prices and then another

Chart 3: Anual Gold Silver Correlation



Chart 4: Gold Silver Ratio and Changing Correlation

temporary. We took a 3-month (approx. 65 trading days) rolling correlation measure to gauge the current relationship between gold and silver across the last ten years. We chose this period of time because calculations of a much shorter term correlation are often not indicative and change greatly with the addition of one point more. Similarly, too long a period does not reflect current conditions efficiently. Therefore, a quarter of rolling correlation is an ideal balance between the two extremes.

The above graph has 3 important implications.

- First, there is no long-term impact of the waxing and waning correlation on the ratio. The correlation between rolling correlation and the ratio is marginally negative -0.12 – a number that points to little, or no, relationship in the long term.
- Second, for short-term trades, the effect of some sort of a short-term rolling period correlation should indicate the mean reverting properties of the ratio. Investors should also look at the correlation before betting on mean reversion (if the correlation dips, the

SILVER-GOLD CORRELATION

2011 <sup>1</sup>	0.70
2010	0.92
2009	0.69
2008	0.90
2007	0.72
2006	0.85
2005	0.90
2004	0.75
2003	0.88
2002	0.37
2001	-0.03
2000	0.83

period of soaring gold prices (as a fresh bout of concern about the world economy began to cripple markets)! Consequently, correlation numbers in 2011 thus far has been lower than usual.

Our analysis showed that **the ratio is not impacted directly by a change in correlation**, the mean reversion properties are retained even in the event that correlation numbers are lower. This is because, as seen earlier, the long-term correlation is intact and any drop in correlation is only chances of mean reversion in the short term is lower).

Third, the rolling period correlation could also point to regime changes where the ratio has attained a new equilibrium and reverting to the old mean in the medium term is not in the cards.

Remember the keys to ratio play:

- Detecting regime changes,
- Identifying the investment time horizon,
- Looking into correlation to determine possible peaking and 'trough'ing
- Choosing wisely between pair trading or portfolio realigning.

### Mean Reversion

It must be noted that this essay is a simplistic approach to pair study. Real life strategies could be more complex. Also, mean reversion is not a winning proposition all the time. With proper stop losses, however, it works out well on the winning side over a number of trades. Pair trading gives investors benefits in that positions are hedged and market exposure is lower than when trading single positions. Also, when one realigns portfolios (i.e. using pair trading signals to work in the long term), the question of losses is obsolete - the attempt is to increase returns of the precious metals portfolio and it has been observed that acting on information from the ratio will increase returns significantly (as compared to not acting on it at all).

## Does the Gold-Silver Ratio Really Revert to Its Mean?

A long-term gold-silver ratio chart shows a wide range of 40 to 85. So do gold and silver really revert to their mean? Here the investor has to be aware of the notion of a moving average measure of the mean and use it, rather than a fixed one. A moving average takes recent history into account. That is, while a 10 year simple average may not be relevant today, a moving average puts emphasis on current market conditions and provides a more tradable average number. Also, the investor must be aware of the phenomenon of regime changes. Regime changes arise from fundamental changes in the components of the ratio (we will see various regimes in a separate study in our next article). However, a visual inspection of the ratio over the past ten years shows visible signs of a sinusoidal move. A long term moving average trend line emphasizes how the ratio oscillates between peaks and troughs.

The ratio, when broken down into smaller subsets of time, also shows the same character of mean reversion. This is



Chart 5: Sinusoidal movement in Gold Silver Ratio



Chart 6: Gold Silver Ratio - 2006

somewhat analogous to fractal theory – a fractal is a "fragmented geometric shape that can be divided into parts, each of which is an approximate copy of the whole (self-similarity)". When we break the 10year chart into smaller domains of a year (or even smaller intervals), we still observe mean reversion. We have provided a sample chart for the year 2006. **The property** of mean reversion is observed over any time domain – traders have to define their own frequency of trade and analyze the ratio accordingly.

Please take a look below to see how the

mean reversion worked in a smaller time frame in 2006.

Clearly, two above featured charts are very similar (fractal nature of the markets) and the gold:silver ratio moves above and below its averages in both cases.

Can the situation change, so that betting on the ratio will not play out exactly as expected? Yes, however there is a way to deal with that.

#### Detecting Regime Changes

Detecting regime changes is critical 5



Chart 7: Regime Changes

to pair traders or even long term investors taking cues from the ratio. Regime changes are critical because it helps to reset any existing model (in terms of trading signals). Because the pair is analyzed on the basis of averages, it is imperative to know if any **changes in fundamentals** alter the average numbers. Observe the below graph to understand when a regime change can be detected numerically (for illustration). In this graph, rolling correlation is measured over a one year time period. Divergence is the absolute difference between the ratio and a six month moving average.

One of the most important indicators highlighting a possible regime change is a relative high correlation combined with a wide divergence between a long-term and short-term moving average. A wide divergence shows that there has been a recent tendency of the ratio to move wide apart from the earlier averages. However, a high correlation implies that despite the changing ratio numbers, the relationship between gold and silver is still intact. This means that the current change in ratio numbers is likely to stay intact - a weakening relation evident from lower correlation could imply a likely reversion of the ratio.

Our graph uses a 6-month moving average as a long-term measure while a 10day average is used as a short-term measure. This is not a thumb rule – indicators are chosen keeping the investment horizon in mind (and extensive back-testing for the quant-advanced Investors). We observe at least three points on the graph where the criteria of high correlation and high divergence are met. It is also perhaps interesting to note how the ratio falls into a new steady state following such a regime change. Regime changes are not only graphically or quantitatively detected. One should be on the lookout for fundamental reasons why the ratio should change. For example - setting a silver standard where silver would be used as money, while gold would not be used. In this hypothetical case the demand for silver would soar while the demand for gold would stay at the same level, and thus the gold:silver ratio would decline and most likely not reverse soon after that, as the factor that caused the ratio would not be purely emotional - it would be fundamental and sustainable.

# Silver – Gold Pair Trading: Vital Parameters

Because a pair trade is based on the property of mean reversion, the most important parameter in a pair analysis is **the average itself**. A moving average is most commonly used because it retains more recent information than long-term historic averages. Exponentially moving average (less popular than the simple moving average) measures can also be setup wherein old historic values continue to impact today's

PAIR TRADE SIMULATION (SAMPLE STRATEGY)								
Entry Date	Exit Date	Days	Bet on Ratio Direction	P/L				
12/20/2001	2/8/2002	50	Down	L				
1/16/2002	1/24/2003	373	Up	Ρ				
7/9/2003	3/24/2004	259	Down	Ρ				
7/14/2003	1/20/2004	190	Up	L				
7/23/2003	3/22/2004	243	Down	Ρ				
8/13/2003	3/12/2004	212	Down	Ρ				
12/8/2004	3/22/2006	469	Up	L				
2/10/2005	4/11/2006	425	Down	Ρ				
3/23/2005	4/18/2006	391	Down	Ρ				
3/14/2007	8/21/2007	160	Down	L				
5/3/2007	8/26/2008	481	Up	Ρ				
5/5/2009	11/8/2010	552	Down	Ρ				
7/6/2009	11/3/2010	485	Down	Ρ				
7/9/2009	8/13/2009	35	Up	L				
7/14/2009	11/3/2010	477	Down	Р				

Tabelle 2: Pair trade simulation (sample strategy)

average (with emphasis on older data decaying exponentially), while new data is also weighed in. The time period of the moving average taken will depend on the investment horizon or the trading frequency at which the individual investor aims. For long-term Investors, a 1 year moving average (or an exponential one with more weight on historical data) would be used, while a short-term Trader would possibly look at a 10-day average (or an exponential one with significantly more weight on recent data).

The other important parameter of interest in pair trading is the **entry and exit signals**. Generally, these points are where the moving average measure intersects the actual ratio (or a short term moving average that closely follows the actual ratio). Some traders enter when the actual ratio is a certain degree above the mean (i.e. wide divergence), and exit at the mean when it reverts. Other traders favor entry at the mean and exit when it is diverged sufficiently from the mean again. This is subject to well-tested strategies and there is no single rule that wins.

Correlation is the third parameter we examine since the entire philosophy of mean reversion is based on the expectation that the pair reverts to means due to the high correlation between the two legs. We have said earlier that when the ratio changes away from the mean drastically without a drop in correlation, it signifies a strength in the new move (hence a new regime). Similarly, a low correlation when the ratio diverges well away from the mean is favorable for mean reversion. Therefore, divergence away from the mean is not the only indicator at which investors should be looking. Correlation also needs to be monitored.

We add one more parameter of interest in pair trading - volatility. A higher volatility when the ratio moves away from the average is indicative of an unsteady movement and therefore a signal for the ratio to mean revert and vice versa. Generally, with a good choice of moving average/divergence/correlation, volatility is already accounted for. That is, a wide and sudden fluctuation alone leads to a good divergence (a gradual one will be reflected in the long-term moving average as well) - something that will inevitably lead to higher volatility. A weakening correlation is indicative of volatile moves in the prices of gold and silver. However, it is still a good practice to follow volatility moves of the ratio as well to consider entry and exit points for trades.

We must also have good choices of stop losses (in case of unexpected moves) and gain realizations (exit) to have a robust pair trading system.

We tested a random strategy (in terms of entry exit points) keeping in mind the above parameters. Our strategy looked for any crossing of rolling correlation with the ratio (i.e. any point wherein the moving average crosses the ratio triggers a trade signal). Namely, there were 2 cases:

- The ratio is above the moving average. It then crosses the moving average and moves below it. We enter at this point (based on the expectation that the momentum will continue before it mean reverts again) expecting the ratio to go down further. Therefore, we short gold and go long silver.
- The ratio is below the moving average. It then crosses the moving average and moves above it. We enter at this point (based on the expectation that the momentum will continue before it mean reverts again) expecting the ratio to go up further. Therefore, we go long gold and short silver.

In short, if the ratio crosses its moving average to the upside (moving above it) then we buy gold and short silver.

Because we wanted to have a lower frequency trading horizon, we took a 1-year moving average measure. We also checked for volatility (1–year standard deviation of the ratio should be over 3) and correlation (one year moving correlation is less than 0.85). Profits for the trades would be taken at 25% while the stop loss is 10%.

We observed that out of the 15 trades, 10 trades ended in profits (i.e. a 10\*25=250% profit overall compared to 5\*10=50% losses). The average holding period was 390 calendar days, and the true average return of each trade was about 12% if the whole capital was re-invested each time. By "true return" we mean that one would have **increased his/her capital approximately 5.5 times**, which is the same outcome if one would increase his/her capital by 12% 15 times in a row (taking compounding into account).

Given that losses could be minimized and profits enhanced when using more sophisticated measures of volatility, correlation and moving averages (and also stop loss, profit realization), it is almost established that our stand on **pair trading works** (at least it did in the past ten years of historical data).

As emphasized in our earlier essay, Investors with a long-term fundamental take on the precious metals market should not be primarily interested in pair trades. However, they may still take signals from the ratio and adjust exposure to gold and silver according to expectations and maximize portfolio returns. We strongly suggest that Precious Metals Investors and Traders set aside only a small portion of their capital for speculative positions - including pair trades. The biggest emphasis should be on building a long-term precious metals portfolio. However, please note that Investors can treat the entry and exit signals as indicators to realign their portfolio and improve returns even for the long run.

We hope that this essay will contribute to your investment successes in the coming years. Please feel free to rate and comment on this report on <u>our website</u>. If you're interested in reading our other reports, we invite you to visit our <u>Reports</u> section.

A smart investor needs to be aware of possible landmark changes in gold-silver dynamics and how he can act on any changing regime. If we didn't do so already, we invite you to join our free mailing list today. You will also get 7 days of free access to our Premium Service (Premium Updates + unique Charts and Tools).



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