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Two gold return puzzles

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Abstract

Since the dismantling of the Bretton Woods system, gold has delivered average return comparable to the average return delivered by the aggregate US stock market. This suggests that none of the growth and technological improvement gains accrued to the financiers. In the context of modern asset pricing models, say the CAPM model or the Fama-French three factor model, gold is a risk free asset, as it has no covariation with the risk factors. The large average gold return is a Jensen's alpha not explained by covariation with what modern asset pricing models consider risk factors, i.e., the market, the growth, and the small firms risk factors.

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1. Introduction

Gold is an important store of value, which is extremely convenient for retail investors. One possibility is to buy physical gold and to store it. Alternatively, as of this writing, we can purchase any number of ounces of gold through a retail investor account at 1% margin (roughly speaking, if one deposits 1,000 USD in the account one can purchase gold for the value of 100,000 USD), and at fixed bid/ask spread of 0.60 USD per troy ounce of gold. Taking long positions in gold (buying gold) is just as easy as taking short positions (selling gold you do not own).

Conversely, the celebrated broadly diversified US stock market cannot be traded without an intermediary, say a mutual fund or an exchange traded fund. These intermediaries impose substantial transaction costs, and the retail investors need to play by their rules. Investing into broad based US stock index entails double corporate governance problem. The retail investor has to trust the management of the particular company, as creating value is one thing, passing over this value to the shareholders is yet another.[2] Next the investor has to trust the financial intermediary, as high individual company returns do not necessarily translate into high mutual fund, or exchange traded fund returns. In contrast the corporate governance demands on gold trading are very minimal—all that is needed is that the retail trading system has its margin requirements in order.

The return on the broadly diversified US stock market is well documented in any textbook on corporate finance, asset pricing or investments. In contrast the return on gold is poorly documented and poorly understood. In this paper we fill this gap and document the basic facts regarding gold returns. How much has gold returned on average, does this average return look reasonable, and what is the variation around this average since it has been traded free of governmental regulation? Can this gold return be explained by modern asset pricing models, or does it pose a puzzle? These are the issues we address in this paper.

Two puzzles emerge from our analysis. The first puzzle is that gold returns and stock market returns have very similar means and standard deviations, and their distributions look very similar. In theory investing in broadly diversified stock index is a great idea, because the investor shares in (and finances) the growth and development in the country. As humans learn how to do things better, technology and efficiency improvements and the welfare gains they deliver, should spread over the different parties involved—the government, the management, the scientists, the engineers, the rest of the labor force, and the financiers.

In practice, apparently none of the growth and development welfare gains have accrued to the financiers. A paranoid investor who simply bought gold bars and hid them, would have done just as well as an enlightened investor who invested in the growth and development that stock prices reflect. This puzzle is of interest to any economist, including economists studying growth and development, and how these accrue to different segments of the population. Piketty and Saez (2003) document that "the working rich have replaced the rentiers at the top of the income distribution," and more generally that most of the income growth since the seventies has accrued only to the very top of the income distribution, say top 1 percentile and above. (This scientific research has been accompanied by populist reaction, the occupy Wall Street movement, and the avalanche of accompanied by various pictures complaints on Facebook that one is the 99%.) Here we document that since the seventies most of the income growth has accrued to labor, and not to capital providers. In fact, if gold returns measure what capital providers would obtain should they completely withhold capital from the production sector and if stock returns measure what financing the production sector delivers, capital providers just broke even.

[2]Having thousands of articles written on CEO compensation, we are not still quite agreed whether a CEO collecting hundreds of millions of dollars in compensation is a sign of an "efficient labor market," an indication that the CEO has been paid the competitive wage for the value he/she generated, or it is shareholders' expropriation.

The second puzzle is of more limited interest but still important within the field of finance. Contemporary asset pricing models such as the Capital Asset Pricing Model, the Fama-French three factor model, and the Fama-French-Jegadeesh-Titman-Carhart four factor model, cannot explain gold returns. Most of the gold return is Jensen's alpha, i.e., abnormal return which is not explained by covariation of gold returns with the risk factors.

The paper proceeds as follows. In the next section we describe shortly the development and current state of the empirical asset pricing models. Then we describe our data. The Results sections contain our findings. In the last section we conclude.

2. Theoretical Background

The Capital Asset Pricing Model (CAPM) developed by Tobin (1958), Treynor (1961, 1962), Sharpe (1964), Lintner (1965), and Mossin (1966) is widely used by practitioners and commonly taught to students of finance. The CAPM model explains the cross section of asset returns by the following linear equation

$$E(R_i - Rf) = \beta_i * E(Mkt - Rf), \qquad \beta_i \equiv Cov(R_i, Mkt)/Var(Mkt), \tag{1}$$

where R_i is the return on any asset i, Rf is the return on the risk free asset, and Mkt is the return on the value weighted market portfolio.

Initial empirical evidence, e.g., Black, Jensen, and Scholes (1972), and Fama and MacBeth (1973) among many others, supported the major predictions of the CAPM that the empirical proxy used for the market portfolio is mean-variance efficient. More recent work culminating with Fama and French (1992, 1993) has challenged the CAPM and has suggested that a three factor model, including high minus low book to market and small minus big size portfolio returns on the top of aggregate market return, does a better job at explaining the cross section of stock returns (Fama and French 1995, 1996).

$$E(R_i - Rf) = \beta_i * E(Mkt - Rf) + \chi_i * E(HML) + \varsigma_i * E(SMB). \tag{2}$$

There is evidence suggesting that these three factors are indeed risk factors (Petkova, 2006 and Petkova and Zhang, 2005). Further work by Jegadeesh and Titman (1993), and Carhart (1997) suggests adding a momentum factor to obtain four factor asset pricing model

$$E(R_i - Rf) = \beta_i * E(Mkt - Rf) + \chi_i * E(HML) + \varsigma_i * E(SMB) + \mu_i * E(MOM) \tag{3}$$

where $\beta_i, \chi_i, \varsigma_i, \mu_i$ are now the partial regression coefficients from a multiple regression of R_i on the factors.

The current consensus in finance is that such portfolio-based asset pricing models, i.e., where the average return on a given asset on the left hand side is explained by risk factors which themselves are returns on portfolio spreads (say, market minus risk free rate, high book to market minus low book to market, small firms minus big firms), are the best empirically performing models (Cochrane, 2005; Cochrane, 2011).[3] There is no agreement as to whether momentum is a risk factor or not (Fama and French, 2004; Cochrane, 2005; Cochrane, 2011). Portfolios formed on managerial characteristics such as chief executive officer's gender (Wolfers, 2006;

[3]E.g., Cochrane (2005, footnote 6 and the surrounding discussion) writes "the 'mimicking portfolio' theorem states that if we have the perfect model of the marginal utility of wealth, then a portfolio formed by its regression on to asset returns will work just as well. And this 'mimicking portfolio' will have better-measured and more frequent data, so it will work better in sample and in practice."

Kolev, 2012) and chief executive officer's golf playing skills (Kolev and Hogarth, 2010) show that, first, it makes a big difference whether one uses as a benchmark model the CAPM or the Fama-French three factor model, second, it does not make much difference whether one uses Fama-French three factor model or Fama-French-Jegadeesh-Titman-Carhart four factor model. We find in this paper that none of the multi-factor models explains gold return, that is, as far as mispricing (Jensen's alpha) of gold returns is concerned, there is no difference between the CAPM, the three factor model, and the four factor model.

3. Data

We download the Fama-French factors at weekly frequency, and the momentum factor at daily frequency, from the website of Kenneth R. French.[4] Data on price of gold in London (London Bullion Market Association's afternoon fixing, in USD per 1 ounce of fine gold) at daily frequency are downloaded from the website of Deutsche Bundesbank.[5]

We transform all the data to weekly frequency, following the definition of a week of Kenneth R. French. First we make sure that gold price is not missing for every date denoting end of week in Kenneth R. French's data, i.e., this is a date for which the weekly factor return is not missing. In the sample we use in our analysis there are 42 dates where gold price is missing, but weekly factor return is not missing. (These are dates at the end of December where there is mismatch in working days between the US and the UK.) In these cases we replace the missing gold price with the latest previous gold price that is not missing. To ensure gold price is never missing when factor return is not missing we need to go maximum three days back, and when we go three days back this always happens for Friday's factor return. So in these worse mismatch between trading days cases, we have to replace the missing Friday gold price with the most recent previous non missing gold price which appears on Tuesday.

Once we have non missing gold price for each end of week day having non missing factor return, we calculate the gold return as the price this end of week day, minus price last end of week day divided by the price last end of week day. To transform the momentum factor to weekly frequency we form the product of daily gross returns for the current week.

On 15 August 1971, President Nixon unilaterally dismantled the Bretton Woods system, and made the dollar inconvertible to gold directly, except on the open market.[6] We restrict our analysis to the sample in which the first week ends on the 3 September 1971, and the last week ends on the 25 January 2013, for a total of 2161 weekly observations.

4. Results for the full sample since the fall of the Bretton Woods system

Table 1 displays the summary statistics for the full sample since the dismantling of the Bretton Woods system, the data run weekly from the week that ends on the 3 September 1971 to the week that ends on the 25 January 2013, for a total of 2161 weekly observations. Table 1 also displays the summary statistics for the risk free rate, excess returns of gold and stock market over the risk free rate, and the small minus big, high minus low, and momentun risk factors.

[4] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[5] http://www.bundesbank.de/Navigation/EN/Statistics/statistics.html. Detailed source description for the series reads as follows "General: 1 ounce of fine gold = 31.1034768 g. First quoted on 1 April 1968. Sources: April 1968 - March 1974: Financial Times (FT); April 1974 - December 1980: Samuel Montagu & Co. Ltd.; January 1981 - December 1998: FT; January 1999 - present: The London Bullion Market Association."

[6] http://en.wikipedia.org/wiki/Bretton_Woods_system

In this period of economic prosperity in the US, we observe that gold and the aggregate stock market have delivered quite similar returns. Their means and standard deviations are hardly distinguishable, however the whole distributions of gold and aggregate stock market returns are different at the middle and at the extreme of the right tails.[7] Weekly aggregate stock returns are slightly left skewed, i.e., the mean is lower than the median. Weekly gold returns are slightly right skewed, i.e., the mean is larger than the median. Also the 90th percentile of gold returns and the maximum are substantially larger than the respective points in the aggregate stock market distribution.

Table 1: Summary Statistics, full sample since the fall of the Bretton Woods system. The data is weekly, expressed in percents. The annualized means, i.e., the respective means in the table multiplied by 52, are as follows: Gold Return 10.87%; Stock Market Return 11.04%; RiskFree Rate (Rf) 5.57%.

	mean	sd	min	p10	p25	p50	p75	p90	max
Gold Return	0.209	2.768	-20.000	-2.535	-1.091	0.120	1.408	3.035	34.029
Stock Market Return	0.212	2.312	-17.980	-2.423	-1.065	0.365	1.532	2.625	13.587
RiskFree Rate (Rf)	0.107	0.067	-0.001	0.007	0.065	0.105	0.145	0.189	0.336
Gold - Rf	0.102	2.771	-20.199	-2.647	-1.207	0.023	1.318	2.942	33.830
Market - Rf	0.105	2.313	-18.000	-2.510	-1.180	0.260	1.420	2.540	13.460
High - Low	0.089	1.253	-7.000	-1.260	-0.570	0.060	0.710	1.460	9.790
Small - Big	0.025	1.217	-9.370	-1.340	-0.670	0.040	0.730	1.410	6.440
Momentum	0.158	1.932	-15.749	-1.798	-0.563	0.240	1.053	2.063	12.497
Observations	2161								

Table 2 displays the regression results from fitting linear multi-factor models to gold returns. Parameters point estimates are accompanied by robust standard errors displayed in parentheses below the point estimates. The first four columns fit the CAPM model eq. (1) to four spreads: column (1) the excess return of gold over the risk free rate, column (2) the small minus big (size) risk factor, column (3) the high minus low (value/growh) risk factor, and column (4) the momentum factor. The Constant is the Jensen's alpha, which has to be zero if the linear factor model explains the returns of the dependent variables, which here are the mentioned spreads.

We see in Table 2 that the high unconditional return on gold is not explained by the CAPM—gold has no covariation with the market factor, i.e., the CAPM β is close to zero and insignificant. Therefore the high unconditional return that gold delivers is Jensen's alpha. We also see that for this sample the size factor does not pose a problem for the CAPM model, which is also obvious from Table 1—the unconditional return on the size factor is negligible to start with. The Jensen's alpha (i.e., the constant in these regressions) for the excess return of gold over the risk free rate is the same order of magnitude as the high minus low risk factor, and smaller than the Jensen's alpha of the momentum factor.

In columns (5) and (6) we verify that the three factor Fama-French model eq. (2) and the four factor Fama-French-Jegadeesh-Titman-Carhart model eq. (3) do not explain gold returns either. Gold returns exhibit some covariation with the size and momentum factors, yet the Jensen's alphas remain large, 5.25% per annum in colum (5) and 4.36% per annum in column (6). (The annualized values of Jensen's alphas are just the respective constant in the regression table multiplied by 52, that is assuming that there are 52 weeks in the year.)

[7] Formal Kolmogorov-Smirnov test rejects the null hypothesis of equality of distributions.

Table 2: Regression results, full sample since the fall of the Bretton Woods system. The data is weekly, expressed in percents. The annualized Jensen's Alphas for Gold - Rf (unconditional mean 5.3%), i.e., the constant multiplied by 52, are as follows: from the CAPM model, column (1), 5.25%; from the four factor model, column (6), 4.36%.

	(1)	(2)	(3)	(4)	(5)	(6)
	Gold - Rf	High - Low	Small - Big	Momentum	Gold - Rf	Gold - Rf
Market - Rf	0.009	-0.161**	0.012	-0.113**	0.004	0.017
	(0.034)	(0.026)	(0.020)	(0.041)	(0.037)	(0.037)
High - Low					-0.023	0.008
					(0.061)	(0.064)
Small - Big					0.156**	0.156**
					(0.056)	(0.056)
Momentum						0.074*
						(0.039)
Constant	0.101*	0.106**	0.023	0.170**	0.100*	0.084
	(0.060)	(0.026)	(0.026)	(0.042)	(0.060)	(0.060)
Observations	2161	2161	2161	2161	2161	2161

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$

5. Results for the sample since the start of quantitative easing

In the Introduction we argued that gold is a robust asset, that has minimal requirements regarding public and corporate governance. That is, even if the whole economy sinks and stocks and public debt deliver dismal returns, gold would still preserve value for the investor. It is instructive to consider and compare gold and aggregate stock returns since the Great Recession and quantitative easing started in the US. Figure 1 shows time series plot of the US monetary base. With hindsight, it is clear when the recent period of easy money started in the US. Up to 3rd of September, 2008, US monetary base grows at small and stable rate. Then there is a clear break, and a steep increase in the monetary base starts.

In this section we consider the results for the sub-sample starting in the week of 3rd of September, 2008, to the week that ends on the 25 January 2013, for a total of 230 weekly observations.

Table 3 displays the summary statistics for the quantitative easing sub-sample. Here gold delivers twice as large mean return than the aggregate stock market, for *smaller* standard deviation. Note also that all the spreads deliver dismal returns over this sub-sample. Only the stock market over the risk free rate comes close to the gold over the risk free rate spread, and the former is half of the latter.

Table 4 displays regression results for multi-factor models over the quantitative easing sub-sample. Parameters point estimates are accompanied by robust standard errors displayed in parentheses below the point estimates. None of the factor models explains the return of the gold over the risk free rate spread, most of the large unconditional return remains unexplained Jensen's alpha. The annualized unconditional mean for the spread of gold return over the risk free rate is 17.95%. The annualized Jensen's alphas are column (1) 17.03% from the CAPM model, and column (6), 14.76% from the four factor model.

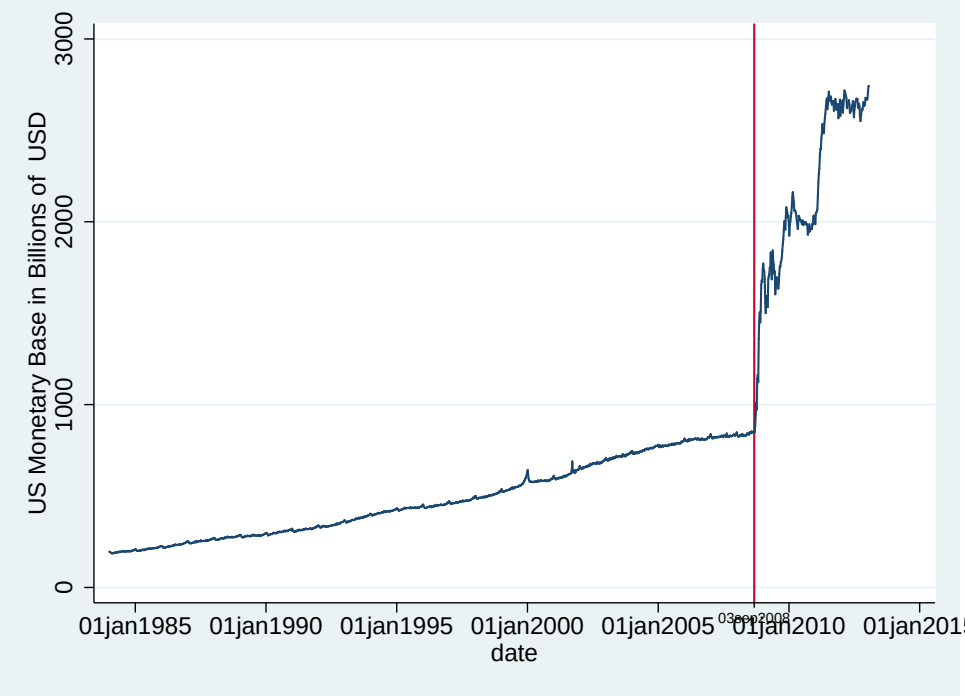

Figure 1: The start of quantitative easing in the US. A break in the growth of the US monetary base is visible in the week of 3rd of September, 2008.

Table 3: Summary Statistics, sample since the quantitative easing started. The data is weekly, expressed in percents. The annualized means, i.e., the respective means in the table multiplied by 52, are as follows: Gold Return 18.11%; Stock Market Return 9.25%; RiskFree Rate (Rf) .16%.

	mean	sd	min	p10	p25	p50	p75	p90	max
Gold Return	0.348	3.108	-12.882	-3.098	-1.480	0.462	2.206	3.611	15.828
Stock Market Return	0.178	3.383	-17.980	-4.005	-1.458	0.272	1.764	3.712	12.617
RiskFree Rate (Rf)	0.003	0.006	-0.001	0.000	0.001	0.002	0.003	0.004	0.038
Gold - Rf	0.345	3.108	-12.902	-3.098	-1.481	0.461	2.203	3.607	15.790
Market - Rf	0.175	3.384	-18.000	-4.015	-1.460	0.270	1.760	3.710	12.610
High - Low	-0.003	1.703	-7.000	-1.590	-0.840	-0.050	0.730	1.820	7.600
Small - Big	0.050	1.254	-3.470	-1.540	-0.690	0.080	0.800	1.585	3.660
Momentum	-0.169	3.157	-15.749	-3.414	-1.367	0.077	1.243	2.587	12.497
Observations	230								

6. Conclusion

We document that in the long run, since the dismantling of the Bretton Woods system, gold has returned just as much as the aggregate stock market. The means of both gold and aggregate stock returns and their standard deviations are hardly distinguishable. We argue that this poses two puzzles. One puzzle emerges in the context of modern multi-factor asset pricing models. Gold returns have no covariation with the market return, so most of the unconditional mean return of gold is Jensen's alpha in the context of the CAPM model. Adding more factors in Fama-French-Jegadeesh-Titman-Carhart four factor model does not reverse this conclusion—most of the mean return of gold is still unexplained by the four factors.

The second puzzle is present even if we do not take seriously modern multi-factor asset pricing

Table 4: Regression results, sample since the quantitative easing started. The data is weekly, expressed in percents. The annualized Jensen's Alphas for Gold - Rf (unconditional mean 17.95%), i.e., the constant multiplied by 52, are as follows: from the CAPM model, column (1), 17.03%; from the four factor model, column (6), 14.76%.

	(1)	(2)	(3)	(4)	(5)	(6)
	Gold - Rf	High - Low	Small - Big	Momentum	Gold - Rf	Gold - Rf
Market - Rf	0.101	0.278**	0.107**	-0.465**	0.073	0.041
	(0.082)	(0.056)	(0.040)	(0.133)	(0.131)	(0.134)
High - Low					-0.124	-0.248
					(0.184)	(0.211)
Small - Big					0.580	0.616
					(0.378)	(0.378)
Momentum						-0.135
						(0.116)
Constant	0.328*	-0.051	0.031	-0.088	0.303*	0.284*
	(0.168)	(0.100)	(0.064)	(0.191)	(0.173)	(0.168)
Observations	230	230	230	230	230	230

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$

models. An investor in the aggregate stock market takes on many risks, which are not quantifiable by a simple measure of risk, such as the standard deviation measured over a sample during which no major trouble took place. To obtain a return on investment in the aggregate stock market there are at least two conditions that need to be satisfied to some extent. First, the corporate governance in the country under study has to be in order, so that individual firms return anything to their stockholders. Second, financial intermediaries have to be present and orderly operating, as it is unrealistic and prohibitively expensive in terms of transaction costs, for an individual retail investor to invest in the aggregate stock market. (This might involve buying of thousands of stocks.)[8]

To illustrate that in turbulent economy gold strongly dominates the stock market we consider the sub-sample since the quantitative easing started in the US. During this sub-sample gold has returned twice as much as the stock market on average for *lower* standard deviation.

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[8]One might argue that in case of war or any other major disaster, it is still possible to preserve value through holding of well-hidden physical gold. In such case obtaining return on stocks would be impossible.

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