Gold Betas

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Abstract

On the basis of daily returns, gold exhibits no sensitivity to the market factor, SMB, HML, and UMD during the period 1978-2006. It works as a hedge (i.e. has a negative beta) against the average stock during periods of rising inflation and against short-term losers during periods of rising inflation, bear markets, and economic expansions. However, it fails as a hedge (i.e. has positive beta) against the average stock during recessions, against small stocks during periods of falling inflation, bear markets and recessions, and against growth stocks during periods of falling inflation.

Keywords: gold; beta; Fama-French model; momentum
JEL Classification: E31, E32, G11, G12

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I. Introduction

Extant studies report that gold either exhibits zero or negative correlation with the return on stocks, i.e., it is either a zero or negative beta asset and hence is a good hedge against stocks (for recent work see McCown and Zimmerman, 2006 and Baur and Lucey, 2006). None of the extant studies, however, examine the risk dimensions of gold in the context of the Fama-French model (1993, 1996). We fill this gap. Furthermore, we investigate whether the risk dimensions change during the cycles associated with inflation, monetary policy, stock prices, and economic growth.

Fama and French FF (1992) review and update evidence indicating that the CAPM betas do not fully capture the cross-sectional differences in stock returns. They find that in a horse race of various variables that add to the explanation of expected stock returns provided by betas – size and book-to-market equity ratio (BtM) turn out to be the winners. FF (1993) therefore advance a model consisting of not only the market factor but two additional portfolios (return on Small stocks Minus the return on Big stocks SMB; and return on High BtM stocks Minus the return on Low BtM stocks HML) designed to proxy factors related to size and BtM ratio of firms. FF (1993) document that this model captures much of the common variation in stock returns and so their central message is that pervasive risk in stocks is multi-dimensional. Some studies (details are in the next section) even report that the FF factors proxy for state variables of hedging concern to investors in the sense of Merton's (1973) multi-period Inter-temporal CAPM

(the CAPM by contrast is a single period model). It is therefore important to understand how gold loads on the FF factors.

Jegadeesh and Titman (1993) document that short-term winners and losers continue to be so in the short term, i.e., exhibit momentum. FF (1996) report that their three factor model fails to explain the momentum effect. Like Carhart (1997) we therefore add one more factor mimicking portfolio (UMD; Up Minus Down - the difference between the return on winner and loser stocks) to the FF model in our analysis. Gold is known to have a relationship with inflation and so is likely to be affected by term-structure variables (default and horizon premiums). However, since FF (1993) show that the market factor carries information about the common variation in stock returns related to term structure variables we do not separately include these variables in our analysis (we of course do control for the impact of inflation in our analysis).

Investors obviously would never want the worth of their investments to decline, but this desire would be especially strong during bad times (recessions, rising inflation, rising interest rates, etc.) when their livelihood income (in real terms) is likely to take a hit. Small stocks and distressed stocks (high BtM) are likely to be particularly vulnerable during and/or in anticipation of bad times (see Fama and French 1995, and Opler and Titman, 1994). Investors would therefore prefer gold to work as a hedge i.e. have a negative beta against not just the average stock (market portfolio) but also against small and high BtM stocks (against SMB and HML) during bad times. The work by Moskowitz and Grinblatt (1999) indicates that the momentum effect arises mainly from shorting losers which tend to be small illiquid stocks. Such stocks too would be

particularly vulnerable during bad times and so again investors would prefer gold to have negative beta against short-term losers (i.e. load positively on UMD) during bad times.

We examine the above issues using daily returns on gold and FF factors during 1978-2006. To take into account important cycles in our sample, we identify periods of rising and falling inflation, restrictive and expansive monetary policy, bull and bear markets, and economic expansions and recessions. The main findings are as follows,

1. During the entire period (1978-2006), the average weekly and monthly buy-hold return on gold are positive, but daily return and daily excess return (return in excess of T-bill rate) are not different from zero. Furthermore, excess gold returns do not load on any of the four factors (Rm-RF, SMB, HML, and UMD) and in this sense over a long haul it works as a true zero-beta asset.

2. Gold does best during periods of rising inflation. The average daily, weekly, and monthly buy-hold return as well as the daily excess return on gold is positive when inflation is rising. Furthermore, during periods of rising inflation, gold loads negatively on the market factor and positively on UMD, i.e., works as a hedge against the average stock and short-term losers (small illiquid stocks). In periods of falling inflation it loads positively on SMB and negatively on HML i.e. fails as a hedge against small stocks but works as a protection against distressed (low BtM) stocks.

3. During the sample period, the Fed usually follows a restrictive monetary policy when inflation is rising and so the findings pertaining to monetary regimes mirror those for inflationary regimes.

4. During bull markets gold does not load on any of the four factors. During bear markets gold loads positively on SMB and UMD i.e. it fails to work as a hedge against small stocks but provides protection against short-term losers.

5. During economic expansions gold loads negatively on the market factor and positively on UMD i.e. works as a hedge against the average stock and against illiquid stocks. During recessions, however, it fails as a hedge against the average stock and small stocks.

Thus, in the context of stocks, gold works as a zero-beta asset if the investment horizon is long. It works as a hedge against the average stock during periods of rising inflation but fails during recessions and it usually works as a hedge against short-term losers but not against small stocks.

The study proceeds as follows. In the next section we review the literature about the FF model relevant for developing an understanding about using gold as a hedge against stocks. Section three provides details about the data. Empirical findings are in section four. We wrap up with our conclusions in section five.

II. Relevant Literature

Prior studies that examine whether gold works as a hedge against stocks use the CAPM and/or the APT as the underlying asset pricing model in their analysis (see e.g. Bauer and Lucey, 2006, for the CAPM version and McCown and Zimmerman, 2006, for the CAPM and APT versions). Both the CAPM and APT, however, are static one-period models. On the other hand, Merton's Inter-temporal Capital Asset Pricing Model ICAPM explicitly takes into account the multi-period nature of investment horizons. The ICAPM takes the view that investors face multiple sources of uncertainties over their

lifetime (their income, investment opportunity set, prices of goods, etc.) and they choose assets that allow them to hedge against these uncertainties. According to this model, factors that describe the evolution of the investment opportunity set and are of hedging concern to investors are priced in equilibrium.

FF (1993, 1994, and 1995) admittedly take an aggressive view that empirical results support the contention that their three-factor model is an equilibrium pricing model consistent with Merton's ICAPM. This three-factor model, advanced over a decade ago, has received extensive attention in academic research and so we do not cover this model but instead refer interested readers to FF (1996). This model has successfully withstood criticisms from a number of different fronts (see Cochrane 1999 and Davis 2001 for a review). More importantly, the FF model has garnered reasonable empirical support indicating that the two factor mimicking portfolios SMB and HML are related to macroeconomic variables consistent with Merton's ICAPM (see e.g. Liew and Vassalou, 2002; Lettau and Ludvigson, 2001; Vassalou, 2003; Breenan, Wang, and Xia, 2004; Petkova, 2006; and Guo, Savickas, Wang, and Yang, 2006). Therefore, examination of gold as hedge against stock in the context of the FF model provides a different and perhaps more insightful perspective relative to studies that use CAPM and/or APT as the underlying model.

FF (1995) document that high BtM ratio firms experience persistent low earnings and so do small firms (controlling for BtM). Cochrane (199) argues that such firms (high BtM, small cap) would be particularly vulnerable during and/or in anticipation of bad times (periods of low economic growth, credit crunch, flight to safety, etc.). He suggests that since the typical stockholder is likely to be the proprietor of small privately held

business (as per Heaton and Lucas, 1997), the vulnerability of his/her livelihood income would be synchronous in time with the vulnerability of small caps and high BtM firms. This suggests that the typical investor would prefer gold to work as a hedge not only against stocks in general but especially against small stocks and high BtM firms during bad times. Empirical findings in FF (1993) indicate that small (big) firms load positively (negatively) on SMB and high (low) BtM firms load positively (negatively) on HML. This suggests that if gold loads negatively on SMB then it would be a hedge against small stocks but not against big stocks and if it loads negatively on HML then it would serve as a hedge against high BtM (distressed/value) stocks but not against low BtM (growth) stocks. Furthermore, if such negative loadings occur during bad times then that would naturally count even more to the typical investor.

Stocks exhibit momentum i.e. short-term winners and losers continue their path in the short-term (see Jegadeesh 1990, and Jegadeesh and Titman, 1993). Although the FF model captures most of the empirical short comings of the CAPM (size effect, BtM effect, January effect, long-term return reversals, etc.), it fails to account for the momentum effect in stock returns (see FF 1996). At least since Carhart (1997), researchers therefore sometimes add one more portfolio to the FF model for mimicking the momentum effect in stock returns (difference between the return on winners and losers). Moskowitz and Grinblatt (1999) report that gains from the momentum strategy arise primarily from taking the short position in loser stocks which tend to be small and illiquid in nature. This suggests the possibility that the momentum effect may be related to the inability of investors to quickly load or unload certain stocks. As this may be a factor of interest to investors in choosing gold as a potential hedge against stocks, we

keep the momentum factor in the FF model. As short-term losers (small illiquid stocks) are expected to load negatively on UMD, gold is expected to load positively on UMD for it to be a hedge against such stocks.

III. Data

The study covers the twenty nine year period 1978 – 2006. Since our intention is to examine whether gold works as a hedge against risks that are common in stocks under various business cycle regimes, we start by identifying business cycle phases. Specifically, we identify bull and bear markets (as indicative of phases in leading indicators), economic expansions and recessions (representing phases in co-incident indicators) and inflation and monetary policy regimes (as indicative of phases in lagging indicators). We try to be as precise as possible about the dates of peaks and troughs in business cycle variables. We use daily returns on gold and FF factors so that we avoid contamination between business cycle regimes (monthly/annual returns at the cusp often overlap opposite regimes).

Table 1 provides the dates associated with changes in the direction of inflation, monetary policy, stock prices, and economic growth during 1978 – 2006. Panel A provides specific dates representing shifts in the direction of inflation. For this, in accordance with the methodology followed by the Federal Reserve Bank (St. Louise), we first compute the moving average level of CPI (U) for each month t during the sample period 1978-2006 by using the CPI (U) for month t through t-11. We then compute the annual rate of inflation for each month t as the percentage difference between the average levels of CPI (U) for month t and t-11. A period of rising inflation is taken to be the

period starting with the month subsequent to the month of a local trough in the annual inflation rate up to and including the month of the next local peak. A similar process is used for identifying periods of declining inflation rates. The study period exhibits roughly forty-sixty split in the length of time during which inflation is rising vs. falling.

We take the thirty three percent of months with the highest annual inflation rates to comprise the months of high prevailing inflation rate (the inflation rates are between 4.1% and 13.5%, roughly corresponding to the period 1978-1983 and 1989-1991). Thirty three percent of months with the lowest inflation rate are taken to comprise the months of low prevailing inflation rate (the inflation rates are between 1.6 and 2.8%, roughly corresponding to the period 1994-2004). The middle portion in this sort is taken to be months in which the prevailing inflation rate is moderate (between 2.8% and 4.1%, roughly corresponding to the period 1984-1994 and parts of 2005 and 2006). This data is not in the table but is used in some of the analysis in the study.

Panel B displays the dates we identify as those associated with changes in the Fed's monetary policy. Two or more consecutive increases (decreases) in the discount rate subsequent to a previous decrease (increase) are taken as an indication that Federal Reserve Bank is pursuing a restrictive (expansive) monetary policy. Continuation of changes in the discount rate in the same direction is taken as continuation of the existing policy by the Fed. The period from the date of the first increase in the discount rate (in a series of at least two increases) till the date prior to the first decrease (in a series of at least two decreases) is taken to be a restrictive policy period. A similar approach is used for identifying expansive monetary policy periods. In our sample period, the Fed generally follows a restrictive monetary policy during periods of rising inflation and so

the sample, like in the case of inflation regimes, exhibits a forty-sixty split between periods of restrictive vs. expansive monetary policy.

Panel C of Table 1 provides specific dates we identify as the beginning of bull and bear markets. We follow the often used convention in the financial press that an increase in the S&P500 Index of 40% or more is a bull run whereas a decline of 20% or more represents a bear market. We make one exceptions – the S&P 500 fell by 19.3% between July18, 1998 and August 31, 1998. This is taken as a bear phase even though it is slightly less than the definition for a bear market. The date after the trough and up to and including the date of the subsequent peak is taken as a bull phase. A reverse approach is taken to identify the bear phases. The sample period exhibits a roughly eighty-twenty split between periods of bull vs. bear markets.

The National Bureau of Economic Research (on the basis of changes in real GDP, real income, employment, industrial production, and wholesale-retail shares) decides the dates for business cycle peaks and troughs. The period starting with the month following the peak month and ending with the subsequent trough month is taken as a recession. A similar approach is used for identifying periods of economic expansions. These dates are in Panel D of Table 1. The study period exhibits roughly ninety-ten split between periods constituting economic expansions vs. recessions.

IV. Findings

Table 2 displays the mean daily return, daily excess return (return in excess of the one month T-bill rate), weekly return, and monthly returns on gold (these are all buy-hold returns). The mean weekly and monthly returns on gold are positive for the full sample

period and even if the sample is sliced according to phases of different economic cycles. The exceptions are periods of declining inflation and recessions (during periods of declining inflation the monthly buy-hold return is significantly negative). By contrast, if inflation is rising, then the mean daily return, daily excess return, weekly return and monthly return are all significantly positive. The findings in panel B indicate that this is true irrespective of whether the prevailing rate of inflation is high or low. In other words, the return on gold is associated with the direction of inflation rather than the prevailing level of inflation. Thus, consistent with conventional wisdom, gold does well during periods of rising inflation and in this sense is a hedge against inflation.

One other thing to note in Table 2 is that the volatility of the return on gold generally increases during periods of rising inflation (restrictive monetary policy), bear markets, and recessions. This suggests that when investors are more likely to look at gold to provide respite from declining stock returns they are likely to encounter more uncertainty about the return on gold.

Panel C of Table 2 displays the mean daily returns on the factor mimicking portfolios used in the augmented FF model. For the full sample period, the average daily market excess return, HML and UMD are positive (SMB is positive but not significant), i.e., the risk premiums are on average positive even on a daily basis. Splitting the data according to economic cycles indicates that the average stock performs relatively poorly during bear markets and although statistical significance is lacking this is true even during recessions and periods of restrictive monetary policy in terms of economic significance.

Differences in SMB are not statistically significant across business cycle regimes, but economic significance suggests that small stocks perform poorly (relative to big stocks) when the Fed is tightening money supply and during bear markets. By contrast, small stocks do well (relatively to big stocks) during periods of rising inflation (perhaps representing accelerated economic growth). HML and hence high BtM stocks (distressed stocks or value stocks), surprisingly do well during bear markets (relative to bull markets) – perhaps their stock prices are already beaten down and so they decline by less during bear markets. Though statistical significance is lacking, economic significance suggests that rising inflation, restrictive monetary policy or recessions are not good for distressed stocks (i.e. they do not fare well relative to growth stocks).

As discussed previously, extant evidence indicates that the momentum effect arises because of taking a short position in small illiquid stocks, i.e., perhaps from the inability of investors to quickly load or unload certain stocks. Such a effect is therefore likely to be present irrespective of any economic cycles and is likely to be severe during bad times (recessions, bear markets, etc.). Consistent with this view, we find the momentum effect is more pronounced (i.e. short-term losers suffer more relative to winners) during bear markets, recessions, and periods of restrictive monetary policy.

In a nut-shell, investors would benefit from hedging properties of gold if their stock holdings represent a well diversified index fund or a value fund (distressed stocks) or if their holdings consist of short-term losers (small illiquid stocks). If their holdings represent if their holdings have a tilt towards distressed stocks (value funds stocks) it has a tilt towards well diversified but is tilted towards their stock holdings bear markets, recessions, and restrictive monetary policy are not good for investors if their stock

portfolios represent index funds or if their portfolios have a tilt towards distressed (value stocks) or short-term losers (small-illiquid stocks) qiuid , distressed or value funds, and small illiquid stocks. stocks, (or value funds), e above findings indicate that investors could benefit from protection against average stocks, small stocks, and short-term losers especially during bear markets. They would also benefit from protection against average stocks, distressed stocks, and short-term losers during recessions and restrictive monetary policy.

Table 3 provides the findings about how gold loads on the Market (in the CAPM sense) and on the four factors in the augmented FF model. For the full sample period, gold does not load on the market portfolio or any of the factors in the FF model. In this sense, it has a zero market beta, zero size beta (does not load on SMB), zero distress beta (does not load on HML), and zero momentum beta (does not load on UMD). Simply put, over a long investment horizon it does not contribute any risk to diversified stock portfolios even if it is not an index fund. This finding is important because what it says is that, as long as the investment horizon is reasonably long, even if gold is added to a style fund (value, growth, small cap, big-cap, contra fund, etc.) and not necessarily an index fund it does not add risk to the portfolio.

If the investment horizon is reasonably long then one could expect the rising and ebbing of waves in economic cycles to even out and as long as this happens then gold works as a zero beta asset, i.e. does not add or reduce the risks that are common in stocks. This, however, does not rule out the possibility that gold may have completely different risk characteristics when the wave in a given business cycle variable is rising or ebbing. This aspect would be particularly relevant for investors with short investment horizons

because they are likely to catch uneven lengths of a business cycle wave. We therefore split the sample according to sustained up and down phases in business cycle variables and then investigate how gold loads on the factors in the augmented FF model.

The findings in Table 3 show that if inflation is rising then gold has a negative market beta, zero size beta, zero distress beta, and a positive momentum beta. In other words, if inflation is rising then gold works as a hedge against the average stock and short term losers without affecting the size and distress dimensions. Recall from Table 2 that the return on gold is most attractive when inflation is rising and also recall from panel C that rising inflation is bad for distressed stocks and short-term winners. Thus, during periods of rising inflation, not only is the return on gold attractive but also it provides protection against the decline in average stocks and short-term losers. This is of course the benefit of using hindsight and as it would be difficult to forecast periods of rising inflation with foresight the findings cannot be taken to suggest any inefficiencies in the gold market. In periods of falling inflation, it loads negatively on HML but positively on SMB. This indicates that, in periods of falling inflation, gold provides protection against stocks subject to distress risk but not small stocks. Thus, an investor working for a small company or with substantial investment in small stocks would be ill advised to use gold as a hedge during periods of falling inflation.

The Federal Reserve Bank, at least during the study period, has usually taken a restrictive monetary stance during periods of rising inflation. It is therefore not surprising that the findings from splitting the sample according to the monetary policy (restrictive vs. expansive) are for the most part very similar for those from splitting the sample according to the direction of inflation. During periods of restrictive monetary policy, like

in the periods of rising inflation, gold loads negatively on the market factor and positively on UMD indicating that it works as a hedge against typical stocks and short-term losers. In periods of expansive monetary policy, like in the periods of falling inflation, gold loads negatively on HML (the significance is weak) and does not load positively on any of the other factors (recall that it loads positively on SMB during periods of falling inflation). Taken together, the findings in Tables 3 and 4 suggest that whether gold works or fails as a hedge against stocks (or sub-groups of stocks) depends on what is happening to the direction of inflation and not on the Fed's policy about it.

In Table 5 we explore whether gold works as a hedge against stocks during bull and bear markets. By definition the average stock performs well during bull markets and so this is not the period where investors would want gold to work as a hedge against stocks. Conversely, the average stock performs poorly during bear markets and so this is where investors would want gold to work as a hedge against stocks. Also recall from Table 2 that during bear markets investors would benefit if gold works as a hedge against small stocks, growth stocks, and short-term losers. The findings in Table 5 indicate that during bull markets gold does not load at all on any of the four factors in the FF model, i.e., it does not work as a hedge against stocks. During bear markets gold loads positively on UMD, i.e., works as a hedge against short-term losers, but it also loads positively on SMB, i.e., instead of working as a cushion for small stocks it would add to the impact of the fall in small stock prices. Thus, if an investor works for a small company or if the investor holds a portfolio tilted towards small stocks then gold would not be a good hedge against potential decline in income during bear markets. If the study period is any indication, bull markets last much longer than bear markets (recall from Table 2 that on

average bull markets last four times as long as bear markets) and gold is neutral during the bull markets and it works as a hedge against short-term losers during bear markets.

Finally, in Table 6 we examine how gold works as a hedge against stocks during business expansions and contractions. During expansions gold loads negatively on the market factors and positively on UMD i.e. it works as a hedge against the average stock and against short-term losers. During recessions, however, it loads positively on the market factor and SMB and also on UMD. Thus, although it provides some protection against short-term losers, it adds to the market risk and size risk of the portfolio. Thus, if an investor works for a typical company or a small company or holds an index fund or a fund tilted towards small stocks then gold would not work as a hedge for such investor during recessions.

One thing that consistently comes through in Tables 3 through 6 is that the adjusted r-squares in all the regressions, for the full sample and split samples, improve substantially if we use the FF model instead of the CAPM. The r-square values are, however, very low (less than one percent in most cases) indicating that price of gold is primarily subject to pull from factors unrelated to those that are common in stock prices. This suggests that an avenue for future research would be to explore whether factors common in bonds have a bigger impact on gold and whether gold works as a long-term or short-term bond.

Conclusions

Prior research on gold indicates that it is a zero beta asset but that in some periods it actually has a negative beta and hence works as a hedge against stocks. These studies, however, use the one-period static CAPM or APT as the underlying model in their investigation. Our study instead uses the Fama French three-factor model which has received strong empirical support as being consistent with Merton's multi-period ICAPM. In the ICAPM sense, this study therefore provides direct evidence on how gold loads on factors that may be of hedging concern to investors. The Fama French model does not account for the momentum effect in stocks and so we also incorporate this factor as well in the FF Model.

For the period 1978 – 2006, the average daily excess return on gold is zero and it does not load on any of the four factors in the FF model, i.e., it has a zero market beta, zero size beta, zero distress beta, and a zero momentum beta. This finding suggests that if the investment horizon is sufficiently long then if gold is added to an index fund or even a style fund (contrarian, value, small cap, growth, etc.) then it does not add to the non-diversifiable risk of the fund.

Investors would be interested in knowing how gold performs as a hedge against stocks during periods in which their real livelihood income could be at risk, e.g., periods of rising inflation, falling stock prices, and recession. During periods of rising inflation – gold shines. It provides attractive return as an investment (average weekly and monthly excess returns are positive). Furthermore, it works as a hedge against the average stock (i.e., the market) and against short-term losers. During bear markets, gold fails to work as a hedge against small stocks – instead of loading negatively it loads positively on small stocks. Therefore, during bear markets gold is not suitable for investors working in

small growth companies or with investments in growth funds and/or small cap funds. During recessions, gold loads positively on the market and small stocks. In other words, it would not be suitable for being included with an index fund or a small cap fund. One redeeming aspect during recessions is that gold loads positively on UMD i.e. works as a hedge against short-term losers. Thus, gold shines as a hedge against stocks during periods of rising inflation but looses its luster during recessions. It generally works as a hedge against short-term losers but fails against small stocks.

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Table 1
Regimes shifts in inflation, monetary policy, stock prices and business cycles: 1978-2006

Rising and declining inflation regimes are identified on the basis of changes in annual inflation rates. Expansive (restrictive) monetary policy regimes are inferred on the basis of whether the Fed decreases (increases) interest rates twice in a row. Stock market phases are computed on the basis of changes in S&P 500 index. Business Cycle phases are as identified by the NBER.

Panel A — Annual Inflation

Rising		Falling	
Starting with	Ending with	Starting with	Ending with
	up to October 1980	November 1980	February 1987
March 1987	May 1991	June 1991	December 1998
January 1999	February 2001	March 2001	October 2002
November 2002	August 2006	September 2006	Past December 2006

Panel B — Monetary Policy

Expansive		Restrictive	
Starting with	Ending with	Starting with	Ending with
		8/30/1977	5/28/1980
5/29/1980	9/25/1980	9/26/1980	11/1/1981
11/2/1981	9/3/1987	9/4/1987	12/17/1990
12/18/1990	5/16/1994	5/17/1994	1/30/1996
1/31/1996	5/23/1999	5/24/1999	1/2/2001
1/3/2001	6/29/2004	6/30/2004	past December 2006

Panel C — Stock Market Phases

Bull			Bear		
Starting with	Ending with	Change (%)	Starting with	Ending with	Change (%)
3/7/1978	11/28/1980	140.52	11/29/1980	8/12/1982	-27.11
8/13/1982	8/25/1987	228.81	8/26/1987	12/4/1987	-33.51
12/5/1987	7/16/1990	64.77	7/17/1990	10/11/1990	-19.92
10/12/1990	7/17/1998	301.66	7/18/1998	8/31/1998	-19.34
9/1/1998	3/24/2000	59.56	3/25/2000	10/9/2002	-49.15
10/1/02002	past 12/2006				

Panel D — Business Cycle

Expansion		Recession	
Starting with	Ending with	Starting with	Ending with
	January 1980	February 1980	July 1980
August 1980	July 1981	August 1981	November 1982
December 1982	July 1990	August 1990	March 1991
April 1991	March 2001	April 2001	November 2001
December 2001	past December 2006		

Table 2
Return on gold during various economic cycles, 1978-2006

Rising and declining inflation regimes are identified on the basis of changes in annual inflation rates. Expansive (restrictive) monetary policy regimes are inferred on the basis of whether the Fed decreases (increases) interest rates twice in a row. Stock market phases are computed on the basis of changes in S&P 500 index. Business Cycle phases are as identified by the NBER. Daily, weekly, and monthly gold returns are on a buy-hold basis and excess returns are computed relative to the returns on a 30-day T-bill.

Panel A	Mean (Standard Deviation) of Return on Gold (%)			
	Daily Return	Weekly Return	Monthly Return	Daily Excess Return
Full Period (1978-2006)	0.02 (1.31) [n=7284]	0.10$ (2.45) [n=7207]	0.51$ (5.83) [n=7165]	0.002 (1.31) [n=7211]
Rising Inflation	0.071$ (1.45) [n=3038]	0.27$ (2.75) [n=3008]	1.41$ (7.01) [n=2986]	0.048$ (1.45) [n=3004]
Falling Inflation	-0.005 a, x (1.21) [n=4246]	-0.03 a, x (2.20) [n=4199]	-0.14 a, x, $ (4.71) p [n=4179]	-0.03 a, x (1.20) [n=4207]
Expansive Fed Policy	0.01 (1.19) [n=4103]	0.06$ (2.20) [n=4058]	0.26$ (4.81) [n=4053]	-0.006 (1.19) [n=4068]
Restrictive Fed Policy	0.04 (1.45) [n=3181]	0.15 a, x, $ (2.74) [n=3149]	0.83 a, x, $ (6.92) p [n=3112]	0.014 a, x, $ (1.46) p [n=4056]
Bull Market	0.03 (1.11) [n=5767]	0.11$ (2.10) [n=5715]	0.53$ (4.95) [n=5691]	0.005 (1.11) [n=5713]
Bear Market	0.03 (1.89) p [n=1517]	0.07 (3.49) p [n=1492]	0.44$ (8.41) p [n=1474]	-0.007 (1.89) p [n=1498]
Economic Expansion	0.03 (1.16) [n=6489]	0.10$ (2.21) [n=6420]	0.53$ (5.42) [n=6377]	0.005 (1.17) [n=6424]
Economic Recession	0.03 (2.17) p [n=795]	0.05 (3.89) p [n=787]	0.38 (8.43) p [n=788]	-0.01 (2.17) p [n=787]

[n=Sample Size]

$ = different from zero at the 5% level
a = means are different for comparable categories at the 5% level (parametric test)
x = means are different for comparable categories at the 5% level (Wilcoxon non-parametric test)
p = standard deviations are different for comparable categories at the 5% level (f test)

Panel B: Mean (Standard Deviation) of Return on Gold (%)

	Daily Return	Weekly Return	Monthly Return	Daily Excess Return
Level of Inflation = Low				
Rising Inflation	0.044 [$]	0.181 [$]	0.895 [$]	0.031
	(1.01)	(2.05)	(5.10)	(1.01)
	[n=1507]	[n=1491]	[n=1485]	[n=1474]
Falling Inflation	-0.007 [a, x]	-0.012 [a, x]	-0.067 [a, x]	-0.025 [a, x]
	(0.754) [p]	(0.431) [p]	(2.79) [p]	(0.740) [p]
	[n=1765]	[n=1744]	[n=1727]	[n=1732]
Level of Inflation = High				
Rising Inflation	0.217 [$]	0.848 [$]	4.404 [$]	0.184 [$]
	(2.40)	(4.48)	(11.34)	(2.40)
	[n=711]	[n=700]	[n=684]	[n=710]
Falling Inflation	-0.042 [a, x]	-0.212 [a, x]	-0.986 [$, a, x]	-0.085 [a, x]
	(2.03)	(3.69)	(8.02)	(2.03)
	[n=789]	[n=780]	[n=778]	[n=1474]

[n=Sample Size]

$ = different from zero at the 5% level
a = means are different for comparable categories at the 5% level (parametric test)
x = means are different for comparable categories at the 5% level (Wilcoxon non-parametric test)
p = standard deviations are different for comparable categories at the 5% level (f test)

Panel C Mean (Standard Deviation) of daily Fama-French factors (%)

	Rm – Rf	SMB	HML	UMD
Full Period (1978-2006)	0.030[$] (0.95) [n=7283]	0.004 (0.55) [n=7256]	0.019[$] (0.49) [n=7231]	0.038[$] (0.64) [n=7256]
Rising Inflation	0.029 (1.03) [n=3037]	0.016 (0.63) [n=3036]	0.012 (0.53) [n=3006]	0.030[$] (0.72) [n=3031]
Falling Inflation	0.031 (0.88) [n=4246]	-0.004 (0.48) [n=4230]	0.025 (0.47) [n=4225]	0.048[$] (0.58) [n=4225]
Expansive Fed Policy	0.044[$] (0.93) [n=4107]	0.009 (0.51) [n=4095]	0.022[$] (0.49) [n=4087]	0.030[$] (0.66) [n=4093]
Restrictive Fed Policy	0.012 (0.96) [n=3176]	-0.002 (0.60) [n=3161]	0.016[$] (0.50) [n=3144]	0.051[$] (0.62) [n=3163]
Bull Market	0.070[$] (0.81) [n=5759]	0.006 (0.50) [n=5743]	0.003 (0.40) [n=5713]	0.029[$] (0.51) [n=5739]
Bear Market	-0.120[$, a, x] (1.34)[p] [n=1524]	0.002 (0.71)[p] [n=1513]	0.079[$, a, x] (0.75)[p] [n=1518]	0.073[$, a, x] (1.00)[p] [n=1517]
Economic Expansion	0.033[$] (0.93) [n=6491]	0.004[$] (0.54) [n=6471]	0.020[$] (0.49) [n=6442]	0.038[$] (0.61) [n=6468]
Economic Recession	0.008 (1.10) [n=792]	0.007 (0.58) [n=785]	0.010 (0.58) [n=789]	0.044 (0.86) [n=788]

[n=Sample Size]

$ = different from zero at the 5% level
a = means are different for comparable categories at the 5% level (parametric test)
x = means are different for comparable categories at the 5% level (Wilcoxon non-parametric test)
p = standard deviations are different for comparable categories at the 5% level (f test)

Table 3
Gold betas during periods of rising and falling inflation, 1978-2006

Daily return on gold is regressed against daily return on the market (S&P 500) for periods of rising and falling inflation rates during 1978-2006. For the Fama-French model, daily excess return on gold (return on gold minus return on a 30-day T-bill) is regressed against excess market return (Rm – Rf), SMB, HML, and UMD. Dummy variables are used to control for different phases of the stock market (Bull=1, Bear=0), business cycle (expansion=1, recession=0), and monetary policy (expansive=1, restrictive=0).

Panel A	Market Model					
	1978-2006		Rising Inflation		Falling Inflation	
Intercept	0.0002	0.0004	0.0007	-0.0000	-0.0001	-0.0001
	(1.73)	(0.44)	(2.81) [a]	(-0.02)	(-0.37)	(-0.20)
Rm	-0.0199	-0.0201	-0.0734	-0.0714	0.0325	0.0296
(S&P500)	(-0.95)	(-0.96)	(-2.85) [a]	(-2.48) [a]	(1.15)	(1.04)
Bull		-0.0001		-0.0009		0.0007
Market =1		(-0.18)		(-1.00)		(1.17)
Economic		-0.0000		0.0015		-0.0008
Expansion=1		(0.04)		(1.54)		(-0.89)
Expansive Fed		-0.0003		0.0003		0.0001
Policy = 1		(-0.84)		(0.53)		(1.11)
Adj. R^2 (%)	0.01	0.00	0.24 [a]	0.20 [b]	0.03	0.02
Sample Size	7201	7201	3001	3001	4199	4199

Panel B	Augmented Fama-French Model					
	1978-2006		Rising Inflation		Falling Inflation	
Intercept	0.0001	0.0000	0.0005	-0.0002	-0.0002	-0.0004
	(0.99)	(0.03)	(1.72) [c]	(-0.06)	(-1.22)	(-0.52)
Rm – Rf	-0.0347	-0.0347	-0.0999	-0.1004	0.0156	0.0111
	(-1.06)	(-1.20)	(-2.33) [a]	(-2.42) [a]	(0.50)	(0.33)
SMB	0.0437	0.0438	0.0021	0.0002	0.0934	0.0894
	(1.03)	(1.11)	(0.04)	(0.00)	(2.10) [b]	(1.90) [c]
HML	-0.0616	-0.0613	0.0107	0.0048	-0.1063	-0.1086
	(-1.34)	(-1.34)	(0.16)	(0.06)	(-1.97) [b]	(-1.72) [c]
UMD	0.0354	0.0353	0.1398	0.1405	0.0014	0.0024
	(1.23)	(1.06)	(3.15) [a]	(3.30) [a]	(0.04)	(0.85)
Bull		0.0001		-0.0009		0.0007
Market = 1		(0.09)		(-1.02)		(1.09)
Economic		0.0001		0.0014		-0.0068
Expansion = 1		(0.10)		(0.45)		(0.77)
Expansive Fed		-0.0001		0.0006		0.0003
Policy = 1		(-0.38)		(1.09)		(0.46)
Adjusted R^2	0.09 [b]	0.05	0.54 [a]	0.53 [a]	0.25 [a]	0.24 [b]
Sample Size	6964	6964	2906	2906	4057	4057

(t-statistic using White's 1980 correction); a, b, and c represent significance at 1%, 5%, and 10% levels
Significance for R^2 is based on F-Statistic

Table 4
Gold betas during periods of expansive and restrictive monetary policies, 1978-2006

Daily return on gold is regressed against daily return on the stock market (S&P 500) for periods representing expansive or restrictive monetary policy pursued by the Fed. For the Fama-French model, daily excess return on gold is regressed against excess market return (Rm – Rf), SMB, HML, and UMD. Dummy variables are used to control for different phases of the stock market (Bull=1, Bear=0), business cycle (expansion=1, recession=0), and inflation trend (rising=1, falling=0).

Panel A	Market Model			
	Expansive		Restrictive	
Intercept	0.0001	0.0003	0.0004	-0.0007
	(0.74)	(0.40)	(1.65)	(-0.42)
Rm	0.0169	0.0160	-0.0632	-0.0639
(S&P500)	(0.84)	(0.63)	(-2.35) [a]	(-1.90) [c]
Bull		0.0001		0.0001
Market = 1		(0.16)		(0.12)
Economic		-0.0005		0.0005
Expansion = 1		(-0.49)		(0.22)
Rising		0.0009		0.0007
Inflation = 1		(1.97) [b]		(1.32)
Adj. R^2 (%)	0.00	0.01	0.14 [b]	0.13 [c]
Sample Size	4049	4049	3151	3151

Panel B	Augmented Fama-French Model			
	Expansive		Restrictive	
Intercept	0.0000	0.0000	0.0000	-0.0009
	(0.06)	(0.03)	(0.17)	(-0.62)
Rm – Rf	-0.0059	-0.0071	-0.1134	-0.1153
	(-0.21)	(-0.25)	(-2.37) [a]	(-2.35) [a]
SMB	0.0342	0.0306	0.0226	0.0193
	(0.83)	(0.75)	(0.32)	(0.27)
HML	-0.0831	-0.0828	0.0066	0.0052
	(-1.79) [c]	(-1.58)	(0.07)	(0.06)
UMD	-0.0023	-0.0001	0.1935	0.1941
	(-0.07)	(-0.00)	(3.25) [a]	(3.23) [a]
Bull		0.0001		0.0001
Market = 1		(0.10)		(0.06)
Economic		-0.0003		0.00032
Expansion = 1		(-0.28)		(0.18)
Rising		0.0009		0.0008
Inflation = 1		(1.94) [c]		(1.40)
Adjusted R^2	0.03	0.04	0.61 [a]	0.60 [a]
Sample Size	3916	3916	3047	3047

(t-statistic using White's 1980 correction); a, b, and c represent significance at 1%, 5%, and 10% levels
Significance for R^2 is based on F-Statistic

Table 5
Gold betas during bull and bear markets, 1978-2006

Daily return on gold is regressed against daily return on the stock market (S&P 500) for bull and bear markets during 1978-2006. For the Fama-French model, daily excess return on gold (return on gold minus return on a 30-day T-bill) is regressed against excess market return (Rm – Rf), SMB, HML, and UMD. Dummy variables are used to control for different phases of the stock market (Bull=1, Bear=0), business cycle (expansion=1, recession=0), and monetary policy (expansive=1, restrictive=0).

Panel A	Market Model			
	Bull		Bear	
Intercept	0.0003 (2.02) [b]	0.0013 (0.65)	0.0002 (0.48)	-0.0011 (-0.99)
Rm (S&P500)	-0.0313 (-1.25)	-0.0326 (-1.27)	-0.0047 (-0.13)	-0.0055 (-0.15)
Economic Expansion = 1		-0.0012 (-0.63)		0.0002 (0.22)
Expansive Fed Policy = 1		0.0000 (0.15)		0.0009 (0.84)
Rising Inflation = 1		0.0006 (1.84) [c]		0.0020 (1.64)
Adj. R^2 (%)	0.03 [b]	0.07 [c]	0.00	0.00
Sample Size	5704	5704	1496	1496

Panel B	Augmented Fama-French Model			
	Bull		Bear	
Intercept	0.0001 (0.67)	0.0008 (0.49)	0.0000 (0.01)	-0.0012 (-1.00)
Rm – Rf	-0.0472 (-1.54)	-0.0481 (-1.55)	-0.0132 (-0.18)	-0.0.164 (-0.29)
SMB	-0.0349 (-1.02)	-0.0373 (-0.95)	0.1859 (2.55) [a]	0.1806 (2.44) [b]
HML	-0.0321 (-0.65)	-0.0296 (-0.60)	-0.0737 (-0.68)	-0.0784 (-0.74)
UMD	-0.0116 (-0.23)	-0.0096 (-0.30)	0.0904 (1.90) [c]	0.0930 (2.00) [b]
Economic Expansion = 1		-0.0010 (-0.63)		0.0010 (0.08)
Expansive Fed Policy = 1		0.0001 (0.32)		0.0007 (0.68)
Rising Inflation=1		0.0006 (1.94) [c]		0.0020 (1.62)
Adjusted R^2	0.01	0.03	0.64 [a]	0.70 [b]
Sample Size	5508	5508	1455	1455

(t-statistic using White's 1980 correction); a, b, and c represent significance at 1%, 5%, and 10% levels
Significance for R^2 is based on F-Statistic

Table 6
Gold betas during economic expansions and recessions, 1978-2006

Daily return on gold is regressed against daily return on the stock market (S&P 500) for periods comprising economic expansions and recessions. For the Fama-French model, daily excess return on gold (return on gold minus return on a 30-day T-bill) is regressed against excess market return (Rm – Rf), SMB, HML, and UMD. Dummy variables are used to control for different phases of the stock market (Bull=1, Bear=0), business cycle (expansion=1, recession=0), and monetary policy (expansive=1, restrictive=0).

Panel A	Market Model			
	Expansion		Recession	
Intercept	0.0003	-0.0001	0.0001	-0.0004
	(2.04) [b]	(-0.17)	(0.20)	(-0.31)
Rm	-0.0483	-0.0479	0.1424	0.1367
(S&P500)	(-3.06) [a]	(-2.59) [a]	(2.03) [b]	(1.73) [c]
Dummy		-0.0001		0.0007
Bull=1		(-0.17)		(0.43)
Dummy		0.0001		0.0006
Expansive=1		(0.18)		(0.36)
Dummy Rising		0.0009		0.0002
Inflation=1		(2.79) [a]		(0.17)
Adj. R^2 (%)	0.13 [a]	0.22	0.40 [b]	0.05
Sample Size	6414	6414	786	786

Panel B	Augmented Fama-French Model			
	Expansion		Recession	
Intercept	0.0001	-0.0005	-0.0001	-0.0000
	(0.54)	(-0.63)	(-0.16)	(-0.01)
Rm – Rf	-0.0679	-0.0678	0.1898	0.1817
	(-2.55) [a]	(-2.61) [a]	(1.71) [c]	(1.40)
SMB	0.0151	0.0129	0.2659	0.2675
	(0.39)	(0.34)	(1.81) [c]	(1.76) [c]
HML	-0.0529	-0.0524	-0.1898	-0.1889
	(-1.24)	(-1.26)	(-0.92)	(-0.88)
UMD	0.0443	0.0456	0.2028	0.2030
	(1.80) [c]	(1.85) [c]	(1.89) [c]	(1.54)
Dummy		-0.0001		0.0001
Bull=1		(-0.17)		(0.04)
Dummy		0.0004		-0.0002
Expansive=1		(1.19)		(-0.10)
Dummy Rising		0.0010		0.0001
Inflation=1		(2.99) [a]		(0.01)
Adjusted R^2	0.19 [a]	0.28 [b]	0.99 [a]	0.60 [b]
Sample Size	6205	6205	758	758

(t-statistic using White's 1980 correction); a, b, and c represent significance at 1%, 5%, and 10% levels
Significance for R^2 is based on F-Statistic