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Gold investment as an inflationary hedge: Cointegration evidence with allowance for endogenous structural breaks

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This note tests for the presence of a stable long-run relationship between the price of gold and inflation in the United States from 1945 to 2006 and from 1973 to 2006. Since both the gold market and the inflationary regime have been subject to structural change over time, a novel unit root testing procedure is employed which allows for the timing of significant breaks to be estimated, rather than assumed exogenous. After taking these breaks into account, a modified cointegration approach provides strong evidence of a cointegrating relationship between gold and inflation in the post-war period and since the early 1970s. The results lend support to the widely held view that direct and indirect gold investment can serve as an effective inflationary hedge.

I. Introduction

Investors have increasingly sought to add gold, both directly and indirectly, to their strategic asset allocations. A range of benefits are thought to accrue, including gold's diversification benefits and its potential role as a hedge against inflation, political unrest and currency risk, along with other investment-related dimensions of the valuable commodity [see, amongst others, Koutsoyiannis (1983), Jaffe (1989) Chua et al. (1990), Dooley et al. (1995), Mahdavi and Zhou (1997), Faff and Chan (1998), Adrangi et al. (2000), Coutts and Sheikh (2002), Smith (2002), Liu and Chou (2003), Capie et al. (2005) and Lucey and Tully (2006a; 2006b)].

The view that gold provides an effective inflation hedge is the focus of this note. Conventional wisdom is that because commodities are physical assets, they are the best way to hedge against rising prices. However, unlike most commodities, gold is durable, relatively transportable, universally acceptable and easily authenticated. Tantalising evidence for gold as an inflationary hedge already exists. For example, by breaking through US\$562 per oz. in January 2006, the average monthly increase in the US gold price from 1875-2006 (0.2024 percent) exceeded the average monthly increase in the US consumer price index (0.2022 percent) over the same period.

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A novel cointegration approach is used to assess the long-run inflation hedging properties of gold while taking into account the structural changes to the gold market and inflationary regimes. The paper itself is divided into four main areas. Section II presents the data employed in the analysis. Sections III and IV explain the empirical methodology and present the results. The paper ends with some brief concluding remarks in Section V.

II. Data

The data used are monthly observations of the price of gold, in US dollars per troy ounce, and the US inflation rate. All data are from Global Financial Data (2006). The computational analysis is undertaken with respect to two overlapping sub-samples: from January 1945 to February 2006 (734 observations) and from January 1973 to February 2006 (398 observations). The former corresponds to the formation and eventual breakdown of Bretton-Woods, while the latter coincides with more flexible gold prices.

II. Unit root tests with endogenous structural breaks

Structural change occurs in many time series. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, the results may be biased towards the erroneous non-rejection of the non-stationarity hypothesis (Perron, 1989, 1997; Leybourne and Newbold, 2003).

Zivot and Andrews (1992) propose a testing procedure where the timing of the break is estimated, rather than assumed exogenous. The null hypothesis is that the variable under investigation contains a unit-root with a drift that excludes any structural break, while the alternative hypothesis is that the series is a trend stationary process with a one-time break occurring at an unknown point in time.

In this methodology, T_b (the time of break) is chosen to minimize the one-sided t -statistic of $\alpha=1$. The Zivot and Andrews (1992) model endogenizes a single structural break in a series (such as y_t) as follows:

$$H_0: \quad y_t = \mu + y_{t-1} + e_t \quad (1)$$

$$H_1: \quad y_t = \hat{\mu} + \hat{\theta} DU_t(\hat{T}_b) + \hat{\beta} t + \hat{\gamma} DT_t(\hat{T}_b) + \hat{\alpha} y_{t-1} + \sum_{j=1}^k \hat{c}_j \Delta y_{t-j} + \hat{e}_t \quad (2)$$

As shown, this model accommodates the possibility of a change in the intercept as well as a broken trend. DU_t is a sustained dummy variable capturing a shift in the intercept, and DT_t is another dummy variable representing a break in the trend occurring at time T_b where $DU_t=1$ if $t > T_b$, and zero otherwise and DT_t is equal to $(t-T_b)$ if $(t > T_b)$ and zero otherwise. The null hypothesis is rejected if the α coefficient is statistically significant.

Table 1 summarizes the test results. T_b is endogenously determined by running the model sequentially allowing for T_b to be any year within a 15 percent trimming region. The optimal lag length is determined on the basis of the Schwartz-Bayesian Criterion. Using this procedure, the time of the structural changes for each of the variables is detected based on the most significant t ratio for $\hat{\alpha}$, that is $t_{\hat{\alpha}}$ and the results are presented in Table 1. The most significant structural breaks for gold occur in January 1973 and December 1978, while those for inflation are in February 1973 and January 1979. These correspond to the 1973 and 1979 oil crises.

IV. Cointegration analysis with endogenous structural breaks

Saikkonen and Lütkepohl (2000a; 200b; 2000c) propose a cointegration test that allows for possible shifts in the mean of the data-generating process. They argue that "...structural breaks can distort standard inference procedures substantially and, hence, it is necessary to make appropriate adjustment if structural shifts are known to have occurred or are suspected". According to Saikkonen and Lütkepohl (2000b) and Lütkepohl and Wolters (2003), an observed n -dimensional time series $y_t = (y_{1t}, \dots, y_{nt})$, y_t is the vector of observed variables ($t=1, \dots, T$) which are generated by the following process:

$$y_t = \mu_0 + \mu_1 t + \delta_0 DT_{0t} + \delta_1 DU_{1t} + x_t \quad (3)$$

where DT_{0t} and DU_{1t} are the respective impulse and shift dummies which account for the existence of structural breaks, DT_{0t} is equal to one when $t=T_0$ and zero otherwise and the step (shift) dummy (DU_{1t}) is equal to one when ($t>T_1$), and zero otherwise. The parameters μ_0 , μ_1 , δ_0 and δ_1 are associated with the deterministic terms.

A maximum likelihood approach is used for testing and determining the long-run relationship between gold and inflation. The timing of the most significant structural breaks has been determined earlier. We consider three cases: a dummy with an intercept included; a dummy with trend and intercept included; and finally, a dummy with a statistically independent trend (orthogonal) to the cointegration relation.

The three null hypotheses of no long-run relationship between gold and inflation are tested and the results presented in Table 2. Critical values are provided for the 90, 95 and 99 percent levels of significance. The empirical results indicate that the null hypothesis of no cointegration ($r=0$) is rejected at the 1 percent level of significance for both sample periods and the three cases considered: intercept, intercept and trend and trend orthogonal to the cointegration relation. In sum, there is abundant evidence of a stable long-run relationship between the price of gold and inflation in both the post-war and post-1970s period as long as allowance is made for significant

structural changes in the US gold market and US inflationary regimes in 1972/73 and 1978/79. Put differently, since the long-run price of gold and inflation move together, investment in gold can serve as an inflationary hedge.

V. Concluding remarks

The inflation hedging quality of gold depends on the presence of a stable long-term relationship between the price of gold and the rate of inflation. Because of structural change in both the gold market and consumer prices, this analysis uses a test procedure to endogenously determine the most significant structural breaks impacting upon this relationship. The results suggest the breaks correspond to the gold market moving to purely open market operations and the acceleration of inflation in the 1970s. A modified cointegration method incorporating these breaks indicates a strong cointegrating relationship exists between gold and inflation suggesting that gold is a useful inflation hedge in the post-war and post-1970s period.

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Table 1. Zivot-Andrews test results with break in intercept and trend

$$\Delta y_t = \mu + \beta t + \theta DU_{1t} + \gamma DT_{1t} + \alpha y_{t-1} + \sum_{i=1}^k c_i \Delta y_{t-i} + \varepsilon_t$$

Period	Variable	Break	K	$t_{\hat{\alpha}}$
1945:1-2006:2	Gold	1972:01	1	-4.541
	Inflation	1973:02	4	-3.324
1973:1-2006:2	Gold	1978:12	1	-4.321
	Inflation	1979:01	4	-6.486

Notes: Critical values at 1, 5 and 10 percent levels are -5.57, -5.08 and -4.82, respectively.

Table 2. Saikkonen and Lutkepohl cointegration test results

r_0	Intercept included (C)					Intercept and trend included (C/T)					Trend orthogonal to cointegration relation (C/O)				
	LR	p-value	90%	95%	99%	LR	p-value	90%	95%	99%	LR	p-value	90%	95%	99%
0	54.82	0.00	10.47	12.26	16.10	39.31	0.00	13.88	15.76	19.71	24.84	0.00	8.18	9.84	13.47
1	1.88	0.20	2.98	4.13	6.93	1.06	0.77	5.47	6.79	9.73	–	–	–	–	–
0	67.17	0.00	10.47	12.26	16.10	57.96	0.00	13.88	15.76	19.71	44.11	0.00	8.18	9.84	13.48
1	0.00	0.98	2.98	4.13	6.93	5.98	0.07	5.47	6.79	9.73	–	–	–	–	–