Available online at www.sciencedirect.com
SCIENCE DIRECT®

Int. Fin. Markets, Inst. and Money 15 (2005) 343–352

Journal of INTERNATIONAL FINANCIAL MARKETS, INSTITUTIONS & MONEY

www.elsevier.com/locate/intfin

Gold as a hedge against the dollar

Forrest Capie [a,*], Terence C. Mills [b,1], Geoffrey Wood [a,2]

[a] *Cass Business School, City University, 106 Bunhill Row, London EC1Y 8TZ, UK*
[b] *Loughborough University, Department of Economics, Loughborough, Leics LE11 3TU, UK*

Received 24 March 2004; accepted 20 July 2004
Available online 28 June 2005

Abstract

The extent to which gold has acted as an exchange rate hedge is assessed using weekly data for the last thirty years on the gold price and sterling–dollar and yen–dollar exchange rates. A negative, typically inelastic, relationship is indeed found between gold and these exchange rates, but the strength of this relationship has shifted over time. Thus, although gold has served as a hedge against fluctuations in the foreign exchange value of the dollar, it has only done so to a degree that seems highly dependent on unpredictable political attitudes and events.

JEL classification: C22; F31; F33

Keywords: Gold; Exchange rates; Hedge; GARCH

1. Introduction

Charles de Gaulle once said, “There can be no other criterion, no other standard than gold. Yes, gold which never changes, which can be shaped into ingots, bars, coins, which has no nationality and which is externally and universally accepted as the unalterable fiduciary value par excellence”. With these famous words, prompted and perhaps written by his

* Corresponding author. Tel.: +44 20 7040 8730; fax: +44 20 7040 8881.
E-mail addresses: f.h.capie@city.ac.uk (F. Capie), t.c.mills@lboro.ac.uk (T.C. Mills), g.e.wood@city.ac.uk (G. Wood).
[1] Tel.: +44 1509 22703; fax: +44 1509 223910.
[2] Tel.: +44 7040 8740; fax: +44 7040 8881.

1042-4431/$ – see front matter
doi:10.1016/j.intfin.2004.07.002

adviser Jaques Rueff, de Gaulle summarised both a long-held view of gold and many of the reasons for that view being held. It is durable, divisible, and, for many years over a large part of the world, was indeed the ultimate standard of value. Not only that, it was a standard which held steady its purchasing power in terms of goods over a very long period of years (although there were short-term, occasionally quite substantial, fluctuations).

Looking at the entire period for which data on the gold price are available is, however, highly likely to be misleading. For there was part way through that data period a very substantial regime change. For many years gold was, if not money, the basis of the monetary system; then that ceased, and it became a commodity like any other. It is useful to explain briefly why gold was inevitably a good hedge when it was the basis of the monetary system, as understanding that is crucial to our choice of data period; and then to consider why gold may have remained a hedge even when these circumstances changed.

Having gold as money, or as the basis of the monetary system, meant linking a currency to gold at a fixed price. The behaviour of prices was thus taken outside the control of government and central banks, and depended on the gold supply relative to the demand for it. In such a situation an automatic stabilising mechanism was in place. Suppose that for some reason the price of goods rose relative to gold; this fall in the relative price of gold reduced incentives to produce gold, and also diverted some of the existing stock to non-monetary uses such as jewellery. Conversely, if the price of goods fell there was a rise in the relative price of gold, and thus a stimulus to its production. Hence, a considerable degree of price stability in terms of gold was to be expected. This built-in stabilising mechanism has been described in detail by several authors (see, for example, Mill, 1871; Barro, 1979; Rockoff, 1984). Crucial to this mechanism was gold being the basis of the monetary system. When gold no longer had that role, the *automatic* stabilising mechanism, working from changes in the relative gold price, through changes in gold output and use, to changes in the money supply, was no longer in place.

That does not mean that gold could no longer be a good store of value or protection against exchange rate change. But whether it is or not depends on different forces. It depends on whether, when currencies weaken, people switch to gold; and on when currencies strengthen, they become more confident about the value of currencies, and switch from gold. Even though gold no longer has any role in the monetary system of any major country, such behaviour could still be sensible. For, as de Gaulle pointed out, gold has no nationality and is not controlled by governments.

In determining the extent to which gold acts as an exchange rate hedge, it is, therefore, well worth exploring the past, to see how well gold protected against currency fluctuations. That, in itself, is of interest, and it may also be of interest in the future. Section 2 explains the historical background to the extent necessary to justify our choice of data period. This sets the scene for the detailed econometric modelling, using data from the last thirty years, which is reported in Section 3. Conclusions are drawn in Section 4.

2. Gold as an exchange rate hedge

For a long part of the recorded past, gold was a hedge because it was the basis of the monetary system. In the nineteenth century, the gold standard was the monetary system that predominated in the developed world. There were areas using silver, and the sterling standard (of course linked, albeit indirectly, to gold) held sway in much of the British Empire. But gold was the standard to which most countries aspired. Countries joined the gold standard in part, at least, because “it was a badge of honour and decency”, to quote Joseph Schumpeter’s words on the reasons behind Austria’s decision to link her currency to gold.

The thirty years following the outbreak of the First World War saw the gradual crumbling of the gold standard in the face of unrelenting political, social, and economic forces. Some countries held on until 1936, but Britain, the standard’s predominant member before 1914, had left it in 1931 and the United States followed in 1933. In the newly designed international monetary system that followed the end of the Second World War there remained a vestige of gold, at least in principle. Although the system actually turned out to be in effect a dollar standard, the US dollar was still expressed in terms of a fixed gold price (US$ 35.00 per oz).

These arrangements came under strain in the late 1960s, and there was some limited movement in the gold price in the 1950s and 1960s. The price began to move around significantly towards the end of the 1960s, when there began to be anticipations of breakdown in the system. The Bretton Woods system collapsed completely with President Nixon’s closing of the gold window in 1971. Some talk of an official role for gold lingered on, but it soon became pretty clear that there was to be no official role for gold in the future.

Accordingly, it seems appropriate for our statistical work to start in 1971, for only since then can we explore the behaviour of gold as a hedge uninfluenced by expectations of future official actions on gold. For our purpose in this study, then, history starts in 1971.

What is meant by saying that gold was a hedge against the US dollar in this period? It could be a hedge in two senses. The first is a hedge against changes in the *internal* or domestic purchasing power of the dollar. The second is a hedge against changes in the *external* purchasing power of the dollar. If gold were a perfect internal hedge, its dollar (i.e., nominal) price would rise at the same rate and time as a domestic US price index. If it were a perfect external hedge, its dollar (i.e., nominal) price would rise at exactly the same rate and time as the number of units of foreign currency per dollar fell. The focus of the paper is the latter, with the aim of assessing to what extent gold was an external dollar hedge.

Before setting out our approach and our results, it is useful to consider why any firm (or individual) might be interested in using gold as a hedge. There is after all a wide range of ways to hedge against exchange risk. An early examination of these can be found in Carse et al. (1980); a recent study of hedging dollar risk using derivatives is Allayannis and Ofek (2001). With such choice available, why might gold be of interest? The answer is two fold. First, a range of products have developed which mean that one can in effect buy gold without actually taking possession of the physical commodity. Second, all the available techniques provide what can be termed a “special hedge”. Protection is given lest one currency fluctuated against some other specific currency. Gold, in contrast, is incapable of protecting against fluctuations of currencies in general. Whether it did so in practice is, of course, a different matter. That is the subject of the remainder of this paper.

3. The data and econometric modelling

The data series used are weekly observations on the price of gold, quoted in US dollars per troy ounce, and the sterling–dollar and yen–dollar exchange rates. The gold price is the Friday London 3:00 p.m. fix, or the nearest observation to that. The "gold fix" takes place twice daily in the offices of NM Rothschild in London. The five members of the fix meet at 10:30 a.m. and 3:00 p.m., London time, and begin the fix with a 'trying' price. The fixing members' representatives relay the price to their dealing rooms and these are in contact with as many dealers as are interested (or who have interested clients). These market members then declare how much gold they are prepared to buy or sell at that price. The dealers, who are in contact with their clients, may change their order or add to it or cancel it at any time. The position declared by the dealers is the net position outstanding among all their clients. (If one is buying 2 tonnes and another is selling 1 tonne, then he declares himself a buyer of 1 tonne). If more gold is required than is offered, then the price will be adjusted upwards (and vice versa) until equilibrium is reached. At this point the price is fixed. On very rare occasions the price will be fixed when there is disequilibrium, at the discretion of the chairman of the fix. The fix is in this way entirely open and any market user may participate through his bank. The Zurich and New York markets follow London; it is the dominant market, and price change would be initiated elsewhere only if news came in while London was closed.

The sterling–dollar and yen–dollar exchange rates were taken as those observed closest to the gold price. These rates were chosen as they are from the two most important foreign exchange markets that were in operation for the complete sample period, which is from 8 January 1971 to 20 February 2004, a total of 1728 observations.

Fig. 1 shows the weekly gold price series, which is seen to range from about $37 at the beginning of 1971 to a maximum of $835 on 18 January 1980, with the price being around $400 during January and February 2004. The gold price increased rapidly between 1971 and the end of 1974 and from September 1976 to January 1980, before declining to around $300 by mid-1982. Since that time it has traded within a range of approximately $250–$500. Detailed statistical analysis of the series may be found in Mills (2004a).

The two exchange rate series are also shown in Fig. 1. The behaviour of the yen has been that of a general appreciation, but with long interruptions for depreciation (i.e., dollar appreciation) during the first half of the 1980s. Sterling, although it too depreciated dramatically during the first half of the 1980s, has since held relatively stable, particularly in the last ten years after its exit from the ERM in September 1992, although it had again begun to appreciate during the last couple of months of the sample period.

Given the large range of fluctuations in each of the series, logarithms were used throughout the analysis. In fact, analysis was conducted on the first difference of the logarithm of the gold price, which we denote Δg_t, and the first differences of the logarithms of the two exchange rates, which we generically denote Δx_t.[1]

[1] Nonstationary time series of the type being analysed here typically contain time varying means and variances, e.g. trends of some form and changing volatility. When analysing an individual time series, such nonstationary can often be eliminated by taking differences. It was found that first differences were all that was required to eliminate nonstationarity for all three series under investigation, i.e., each series x_t was transformed to $\Delta x_t = x_t - x_{t\text{-}1}$.

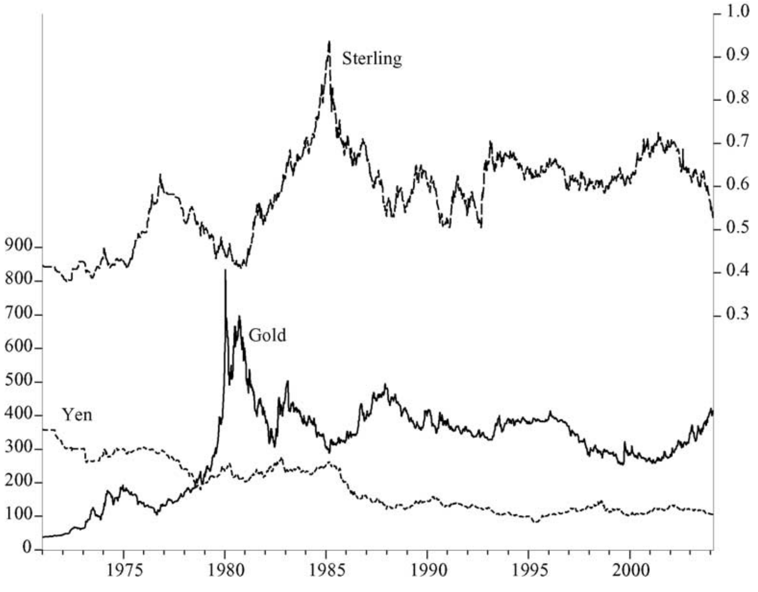

Fig. 1. Gold price in dollars (Gold), sterling–dollar exchange rate (sterling), yen–dollar exchange rate (yen); end week, 8 January 1971–20 February 2004.

Table 1
Estimated cross-correlations between Δx and Δg

	$r_{\Delta x,\Delta g}(k)$								
	$k=-4$	$k=-3$	$k=-2$	$k=-1$	$k=0$	$k=1$	$k=2$	$k=3$	$k=4$
Sterling	−0.02	−0.05	0.02	−0.01	−0.24	−0.02	−0.03	0.01	−0.06
Yen	−0.02	0.00	−0.05	−0.03	−0.16	−0.01	−0.06	0.01	−0.07

$r_{\Delta x,\Delta g}(k)$ is the correlation between Δx_{t+k} and Δg_t. Thus, negative values of k correspond to Δx 'leading' Δg. The standard error attached to these cross-correlations is of the order of 0.025, so (absolute) values of 0.05 and above are statistically significant at the 5% level.

Table 1 reports the cross-correlations between Δg_t and Δx_t for up to four lags. Of obvious importance are the highly significant negative contemporaneous correlations, of around −0.2, between the change in the gold price and the changes in the two exchange rates, thus providing statistical confirmation of the hedging properties of gold. However, there is little evidence of significant cross-correlations between Δg_t and Δx_t, thus suggesting that any dynamic relationship, if it exists at all, will be very short-lived.

The need for first differencing was formally tested via the application of unit root tests. When relating one nonstationary series to another, however, it is possible that differencing may not be required for statistical analysis to be undertaken. This is the situation when the two series are *cointegrated*, which informally means that the series contain common trend components that a linear combination of the two annihilates. Prior testing found that the logarithm of the gold price was not cointegrated with either of the exchange rates, thus necessitating the use of first differences in the fitted relationships. See, for example, Hamilton (1994) and Mills (1999) for detailed discussion of all these concepts.

Since we are particularly interested in the response of the gold price to changes in exchange rates, we consider autoregressive distributed lag models of the form

$$\Delta g_t = \alpha_0 + \alpha_1 \Delta g_{t-1} + \beta_0 \Delta x_t + \beta_1 \Delta x_{t-1} + \varepsilon_t \tag{1}$$

Thus the current change in (the logarithm of) the gold price is assumed to depend linearly on the current and past change in (the logarithm of) the exchange rate and the past change in the gold price itself. In both cases, the residuals from OLS estimation of this model showed strong evidence of time varying conditional error variances, thus rendering statistical inference problematic. As is now conventional, such conditional variances were then modelled as ARCH processes. A variety of such processes were entertained: the conventional GARCH process, the threshold GARCH process, and the exponential GARCH process (EGARCH), with innovations, ε_t, assumed to be distributed as either Gaussian, Student's *t*, or generalised exponential. The combination of process and innovation distribution that produced the maximum likelihood value was selected. See Mills (1999, chapter 4) for example, for discussion of the various models entertained here.

Very similar models were selected for both exchange rates (Δs_t and Δy_t are used below to denote the log-changes in sterling and the yen, respectively). On defining the conditional error variance as $E(\varepsilon_t^2 \,|\Delta g_{t-1}, \Delta x_{t-1}, \ldots) = \sigma_t^2$, the following models were arrived at (the notation $\varepsilon_t \sim t(v)$ denotes that the innovations, ε_t, are distributed as Student's *t* with *v* degrees of freedom):

Sterling equation

$$\Delta g_t = -\underset{(0.027)}{0.314}\,\Delta s_t + \underset{(0.023)}{0.049}\,\Delta g_{t-1} + \varepsilon_t$$

$$\log(\sigma_t^2) = -\underset{(0.081)}{0.443} + \underset{(0.148)}{0.465}\,\log(\sigma_{t-1}^2) + \underset{(0.147)}{0.508}\,\log(\sigma_{t-2}^2) + \underset{(0.047)}{0.331}\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \underset{(0.025)}{0.064}\,\frac{\varepsilon_{t-1}}{\sigma_{t-1}},\ \varepsilon \sim t(v), \quad v = 4.3$$

Yen equation

$$\Delta g_t = -\underset{(0.024)}{0.214}\,\Delta y_t + \underset{(0.024)}{0.041}\,\Delta g_{t-1} + \varepsilon_t$$

$$\log(\sigma_t^2) = -\underset{(0.080)}{0.412} + \underset{(0.191)}{0.633}\,\log(\sigma_{t-1}^2) + \underset{(0.188)}{0.342}\,\log(\sigma_{t-2}^2) + \underset{(0.050)}{0.310}\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \underset{(0.024)}{0.074}\,\frac{\varepsilon_{t-1}}{\sigma_{t-1}},\ \varepsilon \sim t(v), \quad v = 4.4$$

α_0 and β_1 were found to be insignificant in the 'mean' Eq. (1) in both cases. Neither finding is surprising, as a non-zero constant would imply either a generally upward or downward drifting process for the levels of the gold price, g_t, which we know not to be the case from Fig. 1, whilst mis-specifying the dynamics of the conditional error variance process (i.e., by ignoring its time varying nature) will often manifest itself in a mean process that contains spurious dynamics. In both cases the estimate of β_0 is negative, confirming that gold is indeed a hedge against exchange rate changes. Since β_0 is the short-run elasticity, gold is thus inelastic in

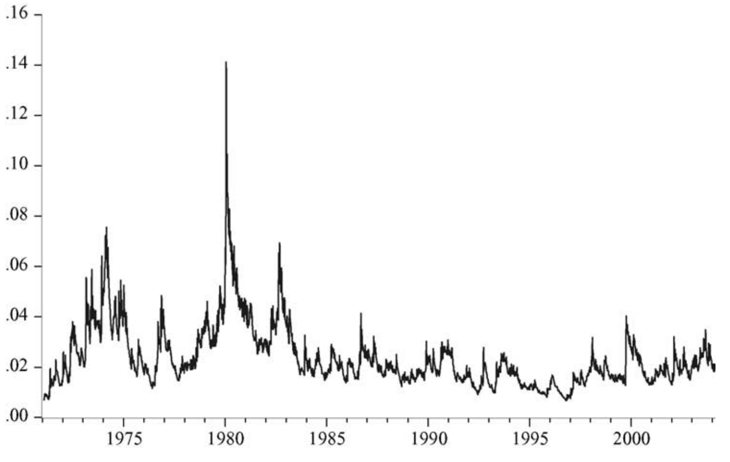

Fig. 2. Conditional error standard deviation from the sterling equation.

the short-run with respect to both exchange rates. It is also inelastic in the long-run, for these elasticities are $-0.214/(1-0.041)=-0.223$ and $-0.223/(1-0.049)=-0.330$ for sterling and the yen, respectively. The long-run response is reached extremely swiftly, in well under a week, and is very similar to the short-run elasticity, a consequence of the small estimate of α_1.

The conditional error variance equation was found to be best modelled as an EGARCH(1,2) process with Student's *t*-distributed innovations. The presence of both the lagged standardised error $\varepsilon_{t-1}/\sigma_{t-1}$ and its absolute value implies that innovations have asymmetric effects, but because the coefficients on both terms are positive, an $\varepsilon_{t-1}>0$ ('good' news: an unanticipated increase in the price of gold) will have a greater impact on the conditional error variance, and hence the volatility of gold, than an $\varepsilon_{t-1}<0$ ('bad' news: an unanticipated fall in price). The coefficients on the lagged conditional variances in the equation sum to 0.97, so that shocks are extremely persistent, as can be seen from the plot of the estimated value of σ_t (the conditional error standard deviation) from the sterling equation shown in Fig. 2 (the analogous plot from the yen equation is almost identical). Volatility is high throughout the 1970s and particularly so during the early months of 1980. It stabilised from the mid-1980s onwards, but the autumn of 1999 saw an upsurge in volatility that gradually dissipated during the first quarter of 2000. The degrees of freedom associated with the Student's *t*-distribution is of the order of 4, which makes the error distribution highly fat-tailed, a feature of gold price data that is analysed in some detail in Mills (2004a).

Given the very different behaviour of the gold price pre- and post-1982 and the different exchange rate regimes that were in operation between 1971 and 2002, scatterplots of the logarithms of the gold price against both of the exchange rates were investigated. Fig. 3 shows the scatterplot between gold and sterling, and the points are seen to fall into four distinct 'strata', identified by different plotting symbols. (Mills, 2004b, provides further analysis of this feature of the data). These strata delineate four non-overlapping periods.

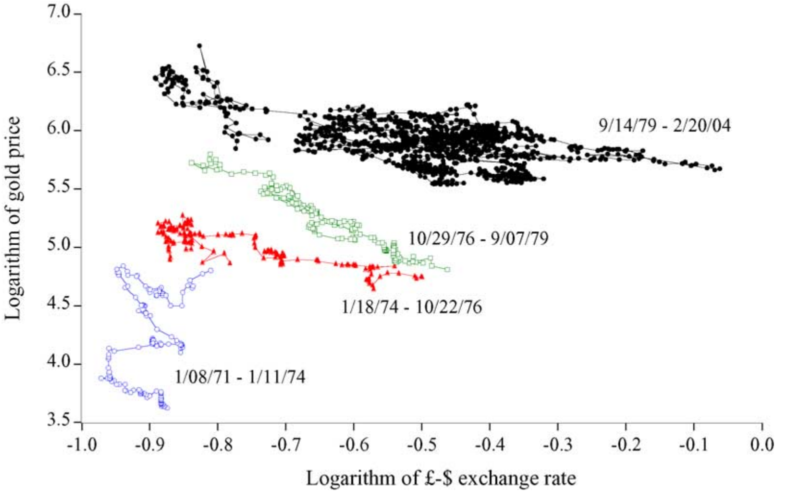

Fig. 3. Scatterplot of gold against sterling, 1971–2004.

The first ends in the second week of January 1974, when the gold price jumped from $122 to $130. The second ends in the third week of October 1976, when gold jumped from $115.5 to $123.15 accompanied by a depreciation in sterling from 0.607 to 0.630 ($1.648–$1.588). The third period ends in early September 1979, when sterling depreciated from 0.444 to 0.461 ($2.250–$2.168). However, this depreciation occurred in the middle of a five-week period when gold soared from $300.55 to $397.25. The yen scatterplot, shown in Fig. 4, has just three strata identified. The first of these has the September 1979 end-point, while the second ends with the Plaza agreement of September 1985.

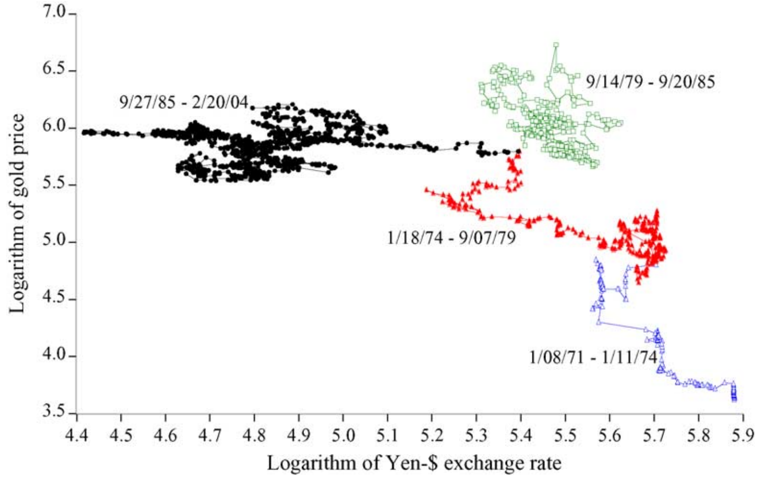

Fig. 4. Scatterplot of gold against the yen, 1971–2004.

Table 2
Sub-period estimates

Sample period	Short-run elasticity	Long-run elasticity	Conditional variance process	Error distribution
(a) Sterling				
1/08/71–2/20/04	−0.314	−0.330	EGARCH(1,2)	*t*(4.3)
1/18/74–10/22/76	−0.216	−0.266	EGARCH(1,1)	*t*(3.9)
10/29/76–9/07/79	−1.319	−1.319	GARCH(1,2)	*N*
9/14/79–2/20/04	−0.302	−0.302	EGARCH(1,2)	*t*(4.8)
(b) Yen				
1/08/71–2/20/04	−0.214	−0.223	EGARCH(1,2)	*t*(4.4)
1/22/71–9/07/79	−0.519	−0.569	EGARCH(1,1)	*G*(1.0)
9/14/79–9/20/85	−0.788	−0.980	EGARCH(1,1)	*G*(1.3)
9/27/85–2/20/04	−0.179	−0.179	EGARCH(1,1)	*t*(5.1)

N denotes Gaussian distribution; $G(v)$ denotes generalised exponential distribution with parameter v; $v < 2$ signifies a fat-tailed distribution.

Models of the type (1) were thus fitted to each of the sub-periods identified by this analysis, although in several cases, simpler models were found to be warranted (no model is reported for the first sterling sub-period from 1971 to 1974 as no significant relationship could be found). The elasticity estimates and features of the conditional variance processes and error distributions are reported in Table 2. The complete sample elasticities are effectively weighted averages of the sub-period estimates, and so are close to those from the final sub-period, particularly so for sterling. Responses are always rapid, with short and long-run elasticities typically being very close to each other. In all cases, elasticities are negative and they are inelastic except for the sterling 1976–1979 sub-period. This sub-period is also unusual in that it is the only one for which the conditional variance process has a simple GARCH structure and the error distribution is Gaussian: in all other cases EGARCH processes with fat-tailed distributions are the norm.

4. Conclusions

The conclusions are that gold has been a hedge against the dollar, though the extent to which it was so has varied over the last thirty years. This raises two questions: why has it been a hedge? and why did the extent to which it served as a hedge vary as it did? Gold served as a hedge because it is a homogeneous asset unlike, say, property, and therefore is easily traded in a continuously open market. It acquired the attributes of an asset for a wide variety of reasons, some of which have been discussed in this paper, but underlying all these reasons is that gold cannot be produced by the authorities that produce currencies. This means that those who can increase the supply of money and therefore, from time to time, debase its value cannot by similar means debase the value of gold.

Why has the extent to which gold has served as a dollar hedge varied from time to time? There are at least three important influences on this. First, on some occasions there may have been a firm expectation that the exchange-rate fluctuation was temporary. Such an expectation could well lead the majority of people to ride out the fluctuation rather than rearrange their portfolios. Secondly, on some other occasions, private sector attitudes to gold may have been affected by problems in gold producing countries. Such problems would, of course, affect the expected future supply of gold. Thirdly, official attitudes to gold may vary and the official sector is a significant holder of gold stocks. Examples of such variation, when official sectors sold gold at a time or for a reason that seemed puzzling to the observer, were when the British government sold at a trough in the market and, more recently, when the Greek central bank sold gold so as to diversify into bonds issued by its own government.

The results of this study thus both show that gold has served as a hedge against fluctuation in the foreign exchange value of the dollar, but that it has done so to a degree that seems highly dependent on somewhat unpredictable political attitudes and events. This may suggest that despite the words of de Gaulle quoted at the start of this paper, gold serves as a hedge very much *faute de mieux*.

References

Allayannis, G., Ofek, E., 2001. Exchange rate exposure, hedging, and the use of foreign currency derivatives. Journal of International Money and Finance 20, 273–296.

Barro, R.J., 1979. Money and the price level under the gold standard. Economic Journal 89, 13–33.

Carse, S., Williamson, J.G., Wood, G.E., 1980. Financing Procedures in UK Foreign Trade. Cambridge University Press, Cambridge.

Hamilton, J., 1994. Time Series Analysis. Princeton University Press, Princeton, NJ.

Mill, J.S., 1871. Principles of Political Economy, seventh ed. Longmans Green and Company, London.

Mills, T.C., 1999. The Econometric Modelling of Financial Time Series, second ed. Cambridge University Press, Cambridge.

Mills, T.C., 2004a. Statistical analysis of daily gold price data. Physica A 338, 559–566.

Mills, T.C. 2004b. Exploring the relationship between gold and the dollar, Significance 1, in press.

Rockoff, H., 1984. Some Evidence on the Real Price of Gold, its Costs of Production and Commodity Prices. In: Bordo, M., Schwartz, A. (Eds.), A Retrospective on the Classical Gold Standard, 1821–1931. University of Chicago Press, Chicago.