Review of the sale of part of the UK gold reserves

HM Treasury
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1. EXECUTIVE SUMMARY

1.1 On 7th May 1999 the Government announced a restructuring of the UK's reserve holdings to achieve a better balance in the portfolio by increasing the proportion held in currencies. Since then a total of approximately 395 tonnes of gold has been sold at 17 auctions, run by the Bank of England on the Treasury's behalf. Revenue from the auctions, totalling around $3.5 billion, has been reinvested in interest-bearing foreign currency assets and retained within the reserves.

1.2 The motivation for the restructuring was one of risk reduction. With nearly 50 per cent of the net foreign currency reserves invested in gold, the exposure to a single asset was too great. Historically the volatility of returns on gold has tended to be high relative to the volatility of returns on the fixed income assets held in the reserves portfolio. However, the returns on gold have also tended to be uncorrelated with those on fixed income assets, and even negatively correlated for some time periods. Thus, gold can play an important role in a minimum risk portfolio. However, it is not unique in this role and other assets, such as inflation index-linked bonds, can be usefully employed to diversify portfolios. Optimal portfolio analysis showed that total risk on the net reserves portfolio could be reduced if the proportion of gold in the portfolio was reduced to around 20%. The first auction took place on 6th July 1999 and the programme concluded with the 17th auction on 5th March 2002.

1.3 Part way through the auction programme the National Audit Office undertook a review of the gold sales programme. The report, published in January 2001, concluded that: "in designing and implementing the sales programme so far the Treasury has met successfully its objective to sell in a transparent and fair manner while achieving value for money. The prices achieved at each of the nine auctions have been competitive and well in line with the prices achieved in similar gold sales by overseas central banks. The Treasury's agent, the Bank of England, has worked hard to keep the gold market well informed and to secure a technically successful sales programme".[1]

1.4 The report formed the basis of the Public Accounts Committee (PAC) hearing which took place in February 2001. The PAC report concluded that: "The Treasury are being rigorous in their approach to achieving a reduction in the riskiness of the portfolio in that they are carrying out the sales within a framework of risk assessment and management".[2]

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[1] See The National Audit Office Report 'The Sale of Part of the UK Gold Reserves', HC86, session 2000-2001: page 10.

[2] Public Accounts Committee, Seventh Report, "Sale of part of the UK gold reserves", Session 2001-2002, paragraph 4.

1.5 As stated above, the motivation behind the restructuring was to reduce risk. As a result of better diversifying the net reserves, the sales programme has resulted in a one-off and permanent reduction in value-at-risk of around 30 per cent.

2. INTRODUCTION

2.1 The total amount of gold ever mined is estimated to be 142,600 tonnes[3] and the above-ground stock is believed to have increased by nearly 40% since 1980. Gold mining production in 2000 was estimated to total 2,573 tonnes, up from 2,162 tonnes in 1991.

2.2 Central bank and government holdings of gold are believed to be around 33,000 tonnes or 23% of all the gold that has ever been mined, but recently a number of governments and central banks (including the UK government) have decided to reduce their gold holdings and are doing this in a controlled way over a period of several years. The UK has sold a total of 395 tonnes at 17 auctions over the course of three financial years, the Swiss are in the process of selling around 1300 tonnes, the Dutch have sold around 800 tonnes and Belgium has sold around 1000 tonnes. The UK's sales have reduced its holding from around 700 tonnes to around 300 tonnes. The World Gold Council estimates that official sector sales totalled 12 per cent of total supply in 2000[4].

2.3 Whilst the nominal price of gold rose nine-fold between 1970 and 2002 (see Figure 1), growth rates have varied greatly over different sub-periods. The greatest rise took place during the 1970s and early 1980s' inflationary period when the price rose from $35 per ounce in 1970 to a brief spike of $850 in January 1980. However, at the start of this period the official price was artificially depressed as a result of the Bretton Woods agreement. Consequently, using the official price in 1970 exaggerates the rate of the underlying rise. Since 1980 the price has fallen back, at one point dropping more than $200 per ounce over a period of only five trading days, and more recently (since late 1997) has been trading in a relatively tight $250–330 range. In real terms the price of gold rose about 13-fold during the 1970s and early 1980s (again this figure should be treated with some caution because of the impact of the Bretton Woods agreement) but since then has fallen back and has now returned to its mid-1970s level. The real price of gold is currently around 2_ times higher than it was at the start of 1970.

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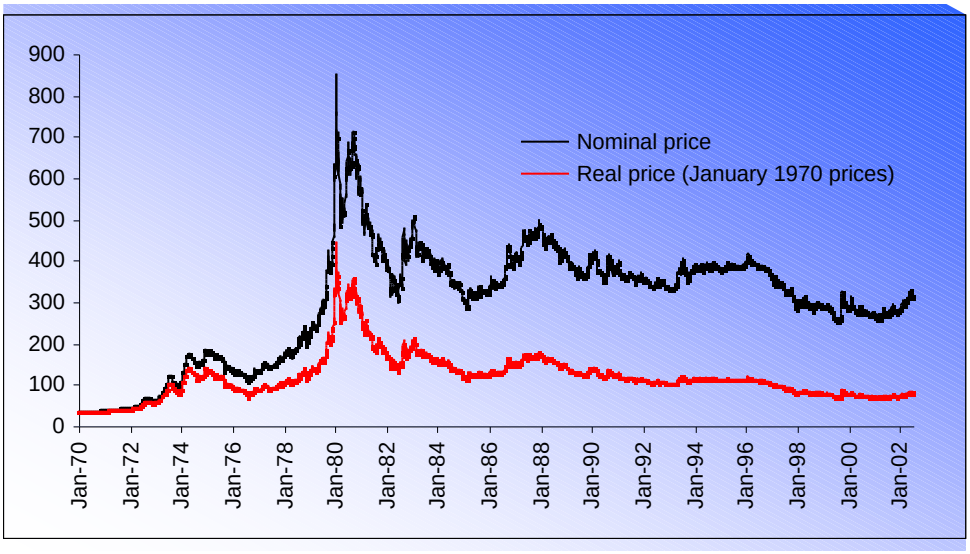
[3] Data from Gold Fields Mineral Services.
[4] World Gold Council, "Gold – the ultimate currency", ***Euromoney***, April 2002.

Figure 1: Real and nominal gold price ($ per ounce)



Source: Bloomberg

3. THE PURPOSE OF FOREIGN CURRENCY RESERVE HOLDINGS

3.1 The main reasons governments and central banks hold foreign currency reserves include as a formal backing for the domestic currency, as a tool for exchange rate or monetary policy, for servicing foreign currency liabilities and debt obligations, as a source of funds to pay for government expenditure overseas, as a defence against emergencies or disaster, and as an investment fund[5]. The purposes that a country holds reserves for will largely dictate the way they are managed and the assets they are invested in.

3.2 The United Kingdom's official holdings of international reserves consist of gold, foreign currency assets, International Monetary Fund (IMF) Special Drawing Rights and the UK's reserve tranche position at the IMF. In contrast to a number of other countries, the government, as opposed to the central bank, owns the UK's official reserves with the Treasury being responsible for policy on official reserves management. The Bank of England, as the Treasury's agent, manages the UK's foreign currency reserves. As specified under the Exchange Equalisation Act 1979[6], the UK holds foreign currency reserves to provide it with the means to undertake exchange rate intervention, to make payments abroad and for certain purposes arising from the UK's membership of the IMF.

[5] For more detail on the reasons for holding foreign currency reserves see, "Foreign Exchange Reserves Management", Nugée J., Handbooks in Central Banking number 19, Centre for Central Banking Studies, Bank of England.

[6] The Exchange Equalisation Account is the account that holds the majority of the UK's official holdings of international reserves.

3.3 To ensure that these objectives can be met, the UK's reserves managers, in common with reserves managers of other countries, follow an investment strategy which puts special emphasis on liquidity and capital preservation. It is within this framework that the role for gold in a foreign exchange portfolio is considered.

3.4 Gold has traditionally formed part of a country's foreign exchange reserves. As noted in the Bank of England Handbook on Foreign Exchange Reserves Management[5], "the traditional reasons for holding gold have included:

- the war-chest argument – gold is seen as the ultimate asset to hold in an emergency and in the past has often appreciated in value in times of financial instability or uncertainty;
- the ultimate store of value, inflation hedge and medium of exchange. Gold has traditionally kept its value against inflation and has always been accepted as a medium of exchange between countries;
- no default risk – gold is 'nobody's liability' and so cannot be frozen, repudiated or defaulted on;
- gold's historical role in the international monetary system as the ultimate backing for domestic paper money."[7]

3.5 On the other hand, gold is expensive to store and keep secure, and it can be inconvenient to trade if transactions involve a change of storage location. However, a case can be made for preserving a role for gold in a country's reserves management strategy on the basis of, amongst other things, risk management. Historically, the correlation between the return on gold and the return on other assets commonly held in foreign exchange portfolios has been low (and over some periods even negative). As such, gold can play an important role in diversifying a country's reserves portfolio. However, it should be noted that gold is not unique in this respect and other assets with similar properties could be considered for diversification purposes.

4. REASONS FOR, AND AIMS OF, THE UK GOLD SALES PROGRAMME

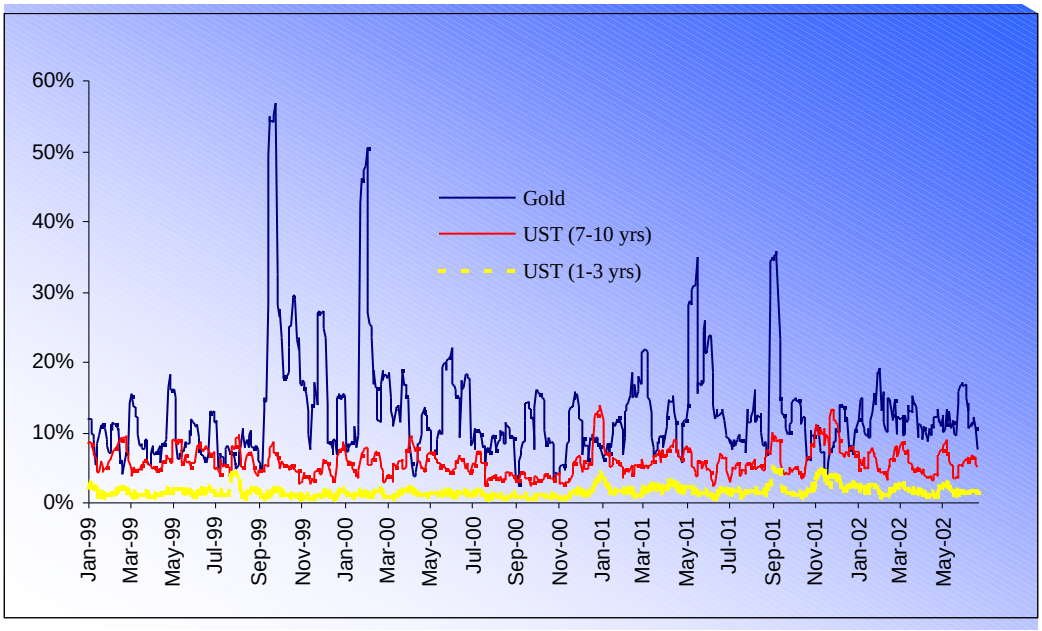
4.1 In early 1999, the UK's foreign currency net reserves stood at around $13 billion. Of this, gold accounted for just under $6.5 billion or 50 per cent. Analysis of past volatilities of returns on the assets held in the net reserves and the correlations between the returns on different asset classes suggested that market

[7] 'Foreign Exchange Reserves Management', Nugée J., Handbooks in Central Banking number 19, Centre for Central Banking Studies, Bank of England, page 15.

risk on the net reserves could be reduced if the level of gold holding was decreased to between 0 and 20%, depending on the sample period used.

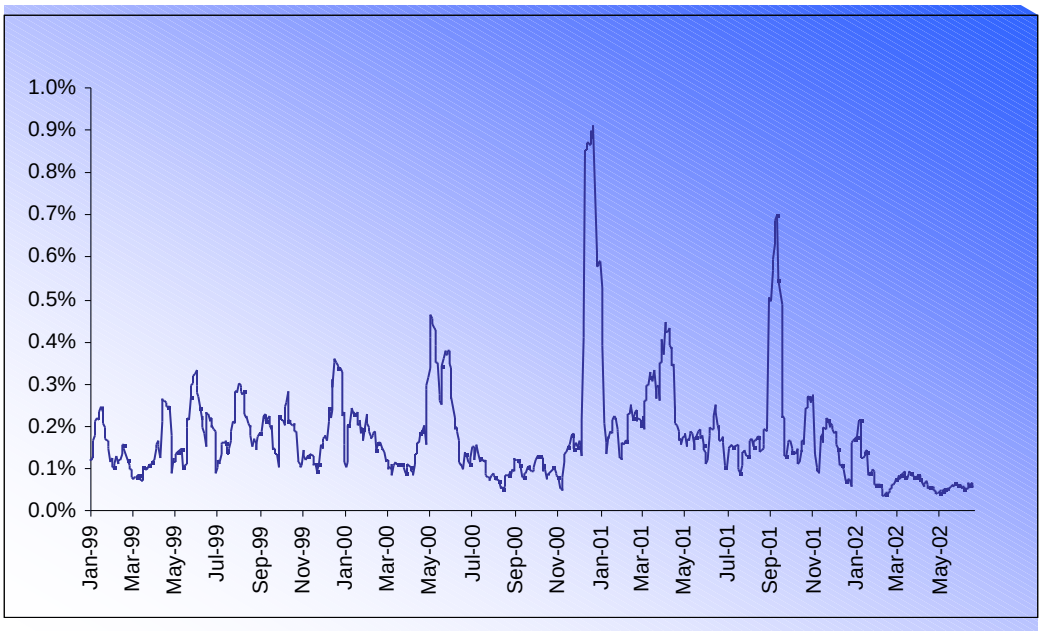
4.2 The benefit of risk reduction through diversification can be seen from figures calculated using the Value at Risk (VaR) measure (for more details see the section on risk reduction, page 14). Reducing the proportion of the net reserves invested in gold from 50% to 20% reduces the VaR by around 30%. This is primarily because the return on gold is more volatile than the return on US, euro-area and Japanese government bonds or short-term government assets. As can be seen from Figure 2 and Figure 3, over the last three years the annualised price volatility of gold has been significantly higher than that for US government securities. The average annualised 10-day price volatility for gold was 12.7% compared to 5.6% for 7-10 year US government bonds, 1.5% for 1-3 year US government bonds and only 0.2% for 90-day US Treasury bills.

Figure 2: Annualised price volatility for gold, 7-10 year US Treasury bonds and 1-3 year US Treasury bonds



Source: HM Treasury/Bloomberg

Figure 3: Annualised price volatility for 90-day US Treasury bills



Source: HM Treasury/Bloomberg

4.3 However, riskier assets can play an important role in low risk portfolios if the returns are less than perfectly positively correlated with the returns on other assets in the portfolio. By combining assets with less than perfectly correlated returns, total risk on a portfolio can be reduced without sacrificing expected portfolio return. The correlation between gold and the fixed income assets typically held in a reserves portfolio has tended to be relatively low and over certain periods has even been negatively correlated. As an example, Table 1 reports the correlation between the return on gold and the return on certain US government assets over the last three years.

Table 1: Correlation between daily returns on gold and on US government securities (Jan 1999-July 2002)

	US Treasury bills	US Treasuries (1-3 yrs)	US Treasuries (7-10 yrs)
Gold	-0.02	0.05	0.02

4.4 Analysis of the risks and returns on the assets held in the UK's net foreign currency reserves showed that reducing the share of gold in the portfolio could reduce expected total portfolio risk. For these risk reduction reasons a decision was taken to reduce the amount of gold held in the UK's reserves and in May 1999 the Government announced that it planned to reduce its gold holdings to

around 300 tonnes from the 715 tonnes held at the time and that the reduction would be achieved via a series of auctions. The decision did not involve taking a view on gold prices, but it did assume that the future volatility of returns on gold and other assets would be broadly the same as they had been in the past. The announcement is reproduced in Box 1.

Box 1: Treasury press release announcing the gold sales programme

7 May 1999

RESTRUCTURING UK RESERVE HOLDINGS

The Treasury today announced a restructuring of the UK's reserve holdings to achieve a better balance in the portfolio by increasing the proportion held in currency. This will involve a programme of auctions of gold from the Exchange Equalisation Account, which holds the UK's official reserves of foreign currency and gold, with the proceeds being invested instead in foreign currency assets and retained in the reserves.

The Treasury intends to sell 125 tonnes of gold, 3 per cent of the total reserves, during 1999-2000, with the Bank of England conducting five auctions on the Treasury's behalf. Auctions will be held every other month starting in July.

$6.5bn of the UK's reserves is held in gold (715 tonnes). Over the medium term the Treasury is planning to reduce its gold holdings to around 300 tonnes. Detailed plans for auctions in 2000-01 and later years will be announced nearer the time, but arrangements are likely to be similar to those announced today.

4.5 The Government's objectives for the sale programme were to sell gold in a transparent manner, over the medium term, fairly and with a view to obtaining value for money for the taxpayer. A variety of different sales methods were considered against these objectives, including sales through the Fix (see Box 2 for more details on the London Gold Fix), bilateral sales and a number of different types of auction. The preferred sales method was the uniform price auction format (see section 6 below for a more detailed discussion) and the first auction was held on 6th July 1999.

Box 2

The London Gold Fix

The London Gold Fix is a long-established system that enables buyers and sellers of gold around the world to trade twice daily with one another. The Fix takes place at 10.30 and 15.00 London time each day. It is run by five Fix members from different trading houses who, from a dedicated Fixing room at NM Rothschild, relay bids from their own organisation along with the numerous traders they represent (at a commission). Each session begins with the chairman suggesting an opening price, to which each member indicates if they are a seller or buyer at that price. The price is then moved up or down until quantities are traded at a common 'clearing' price. The Fix was first established in 1919 and earned an international reputation as a competitive market place for trading gold. It provides a daily 'benchmark' for gold prices.

5. THE SALES PROGRAMME AND DEVELOPMENTS OVER THE COURSE OF THE PROGRAMME

5.1 The sales programme spanned three financial years. During this time a total of approximately 395 tonnes of gold was sold at 17 auctions run by the Bank of England on the Treasury's behalf. The revenue from these auctions, totalling around $3.5 billion, was reinvested in interest-bearing assets denominated in dollars, euro and yen, and retained in the reserves. The currency split of the assets purchased was broadly 40 per cent dollars, 40 per cent euros and 20 per cent yen, thus matching the currency benchmark already in place for the net reserves. Details of the 17 auctions are set out in the table at Annex A. The following discusses the structure of the auctions held and a number of developments that occurred over the course of the programme.

Auction structure and reserve price

5.2 The arrangements and terms and conditions for the gold auctions to take place during each financial year were published by the Bank in an Information Memorandum prior to the start of each financial year.

5.3 Those eligible to bid included members of the London Bullion Market Association (both market makers and ordinary members), and central banks and other international monetary institutions holding gold accounts at the Bank of England. Bids had to be received by the Bank of England, either by authenticated SWIFT message or in paper form, by no later than 11.30am London time on the auction date.

5.4 There were no limits on the total amount of gold that a bidder could bid for, nor the total number of bids a single bidder could submit except that a maximum of five bids could be submitted in the 10 minutes before the auction closed. In addition, once submitted bids could not be withdrawn or cancelled.

5.5 All auctions were conducted on a single, or uniform, price basis with valid bids being ranked in descending order of price. Allotments were made in multiples of 400 ounces[8] to bidders whose bids were at, or above, the lowest price which the Bank of England decided should be accepted. Applicants whose bids were accepted were allotted in full at the lowest accepted price.

[8] There are around 32,150 ounces per tonne.

5.6 However, if the total bids at the lowest accepted price exceeded the amount of gold remaining to be allotted after all the higher bids had been satisfied then bids at the lowest accepted price were scaled back.

5.7 The Bank of England reserved the right, at its discretion, not to allot all of the gold offered for sale. In the event, this right was not exercised, but if it had been, the Bank reserved the right to re-offer the surplus gold at a subsequent auction. The level at which bids would be rejected - the reserve price[9] - was set by the Treasury prior to each auction. In setting the reserve price the aim was to balance value for money considerations at the auction with the need to not deter bidding at future auctions by rejecting bids at too small a discount to the prevailing market price. No bids were rejected for being too low at any of the 17 auctions.

The European central bank agreement

5.8 Shortly after the second auction (September 1999) it was announced that 15 European central banks (including the Bank of England on the UK Government's behalf) had signed an agreement limiting the amount and pace of official gold sales by the signatories over the five-year period from September 1999 to September 2004 (see Box 3). The amount to be sold was limited to 2000 tonnes over the five years with a maximum of approximately 400 tonnes to be sold in each 12-month period beginning in September. Gold lending and the use of gold futures and options were also capped at the September 1999 level.

[9] In common with gilt auctions, the reserve price was not published. Under certain circumstances, a published reserve price might have acted as a target for bidders seeking to exercise market power and drive the allotment price down.

Box 3: European central bank agreement

Joint statement on gold

26 September 1999

European Central Bank
Oesterreichische Nationalbank
Banque Nationale de Belgique
Suomen Pankki
Banque de France
Deutsche Bundesbank
Central Bank of Ireland
Banca d´Italia
Banque centrale du Luxembourg
De Nederlandsche Bank
Banco de Portugal
Banco de España
Sveriges Riksbank
Schweizerische Nationalbank
Bank of England

In the interest of clarifying their intentions with respect to their gold holdings, the undersigned institutions make the following statement:

1. Gold will remain an important element of global monetary reserves.
2. The undersigned institutions will not enter the market as sellers, with the exception of already decided sales.
3. The gold sales already decided will be achieved through a concerted programme of sales over the next five years. Annual sales will not exceed approximately 400 tonnes and total sales over this period will not exceed 2,000 tonnes.
4. The signatories to this agreement have agreed not to expand their gold leasings and their use of gold futures and options over this period.
5. This agreement will be reviewed after five years.

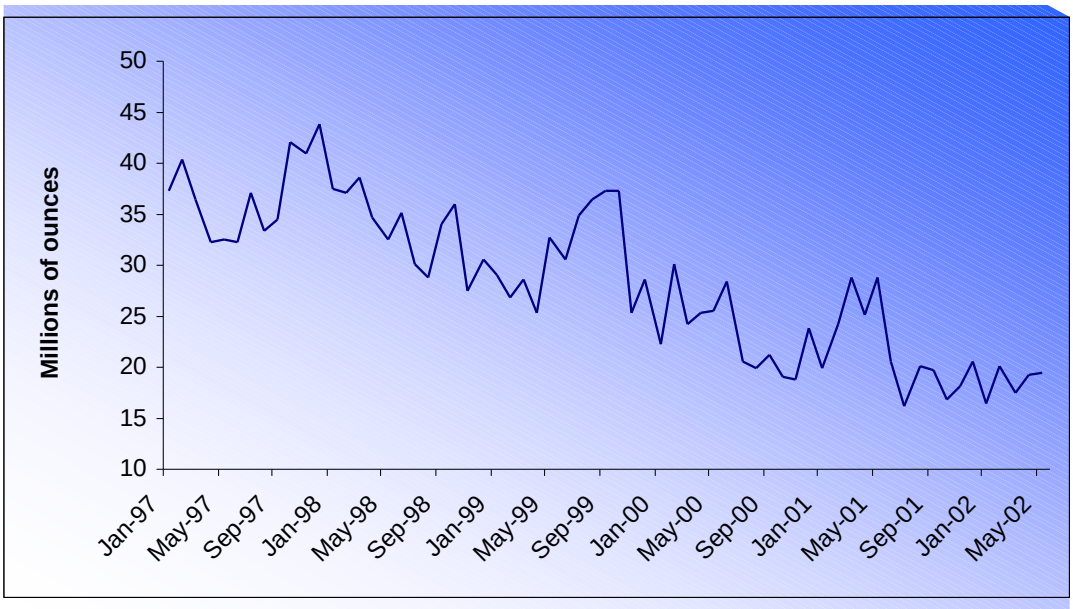
Changes to the sales programme format

5.9 A number of changes to the auction programme were made during the course of the programme. These reflected the changing structure of the gold market and came after recommendations made by the NAO in their report (see below).

5.10 At the start of the programme, auction dates were announced two auctions (approximately four months) in advance. However, it was felt that this amount of advance notice added little in terms of transparency and predictability but risked causing operational difficulties, and so notice of auction dates was reduced to one auction (approximately two months) in advance in September 2000.

5.11 A more significant change to the programme came about prior to the start of the 2001/02 auction programme. For the auctions held in 1999/00 and 2000/01, around 25 tonnes was made available for sale at each auction. This figure was subsequently reduced to 20 tonnes for the six auctions held during 2001/02 because of increasing evidence that changes in the structure of the gold market meant that 25 tonnes may have become too much for the market to absorb at a single auction. This decision was taken following the annual review of the gold sales programme by the Treasury and the Bank of England, towards the end of 2000/01. This review took into account, amongst other things, the views of market participants and evidence of a reduction in turnover in the market such as the London Bullion Market Association (LBMA) clearing data (see Figure 4 below) and Comex open interest data. Neither of these data series is a perfect indicator of market liquidity but taken together they provide strong evidence of a steady decline in turnover over the last four years. Part of the explanation of this decline may be the merger of a number of companies that had been significant players in the market. Additionally, during this period another large market participant, Credit Suisse First Boston, withdrew from the gold market.

Figure 4: London Bullion Market Association clearing volume (daily averages, millions of ounces)



Source: London Bullion Market Association

National Audit Office inquiry and Public Accounts Committee hearing

5.12 Not long after the start of the sales programme, the National Audit Office (NAO) announced that they were to undertake a study of the sales programme. The NAO stated that they had chosen to undertake the study for the following reasons. "First of all, total proceeds that will be retained within the reserves could well exceed £2.3 billion. Secondly, the programme is likely to continue for a further 14 months, if the current rate of sales is continued, after the publication of the report, over which time the Treasury will need to draw lessons from earlier sales to ensure the success of the programme. Thirdly, the Government's announcement on 7 May 1999 that it was to sell some of the UK's gold reserves has attracted a lot of media and Parliamentary attention and one of the aims of this examination has been to respond to the interest expressed and to present the material gathered in an impartial light."[10] It considered whether the sales undertaken had achieved good prices, whether the Treasury had met the Government's sale objective and whether there were any ways in which future sales might be improved.

5.13 The NAO undertook analysis of sale prices, benchmarking them against market prices and the prices achieved by other countries. They commissioned work by auction and gold market experts, and they sent a questionnaire to members of the London Bullion Market Association.

5.14 The NAO report, published in January 2001, concluded that: "In designing and implementing the sales programme so far the Treasury has met successfully its objective to sell in a transparent and fair manner while achieving value for money. The prices achieved at each of the nine auctions have been competitive and well in line with the prices achieved in similar gold sales by overseas central banks. The Treasury's agent, the Bank of England, has worked hard to keep the gold market well informed and to secure a technically successful sales programme that has been applauded by almost all of the gold market participants interviewed and surveyed for this examination."[11] The report went on to state that "As the programme progresses, the Treasury will continue to review developments. In this context the National Audit Office considers that the Treasury should include in its review the advantages and disadvantages of adapting the existing sales methodology, for example by changes to the auction design or even to using the London Gold Fix as an alternative or additional means of selling gold"[11].

5.15 The report formed the basis of the Public Accounts Committee (PAC) hearing, which took place in February 2001. At the hearing the PAC took evidence from Gus O'Donnell (the then Managing Director, Macroeconomic

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[10] See The National Audit Office report 'The sale of part of the UK gold reserves', HC 86, session 2000-2001: p14.
[11] See The National Audit Office report 'The sale of part of the UK gold reserves', HC 86, session 2000-2001: p20.

Policy and International Finance, HM Treasury and Accounting Officer for the Exchange Equalisation Account), Ian Plenderleith (the then Executive Director for Financial Market Operations, Bank of England) and Paul Mills (Head of Debt and Reserves Management, HM Treasury).

5.16 The PAC published their report in December 2001. The full text of the PAC's conclusions and HM Treasury's response is attached as Annex C.

6. ANALYSIS OF THE PROGRAMME

Risk reduction

6.1 The motivation behind selling part of the UK's gold reserves was to reduce portfolio risk. At around 50% of the net reserves prior to the announcement in May 1999, it was considered that the net reserves were overexposed to a single asset. As a result of the programme to better diversify the net reserves, this figure had fallen to around 22% following the completion of the programme. This represents a one-off and permanent reduction in market risk of around 30 per cent.

6.2 Diversification of a portfolio is beneficial because, except in exceptional circumstances, the risk of a portfolio is not simply the weighted average of the riskiness of the assets in the portfolio. By investing in assets that have returns that are not perfectly correlated with each other the risk of a portfolio can be reduced. The exact proportion of a portfolio that needs to be invested in each asset in order to minimise market risk depends on the volatilities and correlations of assets within the portfolio. By reducing the proportion invested in gold and increasing the proportion invested in interest-bearing foreign currency assets the expected risk on the portfolio was reduced.

6.3 Risk can be measured in a number of different ways but a popular and intuitive method is Value at Risk (VaR). This measures the aggregate market risk on a portfolio for a given holding period and confidence interval (see Annex B for more details). It is an estimate of the maximum potential change in the value of a portfolio given the historic pattern of movements in financial markets. For example, "99% of the time losses will not exceed $10 million over a two week period".

6.4 As an example of the impact of the gold sales programme on risk, the VaR on a $14 billion portfolio with 50% held in gold and the remainder split 40% dollar assets, 40% euro assets and 20% yen assets would be around $499 million (based on a two week holding period and 99 per cent confidence interval). However, if the portfolio is better diversified so that only 20% is held in gold and

the remainder is held 40%, 40% and 20% in dollar, euro and yen assets respectively the VaR falls by around 30 per cent to $352 million[12].

6.5 Reserves are held to allow governments to intervene in the currency markets in times of crisis and to maintain payments abroad when currency markets are closed to them. In the majority of scenarios that can be envisaged it would be possible to liquidate interest-bearing foreign currency assets to meet the objectives of reserves. However, under some conditions it is likely that gold could become more liquid than high quality government bonds. Thus gold can be seen as insurance against these worst-case scenarios. How much gold a government would need for what are likely to be relatively infrequent events (and it is likely to be a substantial amount), and whether the increased portfolio risk that would arise from holding the required amount of gold makes it worthwhile, is a matter of judgement.

6.6 In short, the decision to reduce the UK's gold holding was not motivated by taking a view on the future price of gold. Rather it was a long-term restructuring of the foreign currency reserves portfolio aimed at reducing the risk that resulted from over-exposure to a single asset.

Portfolio value

6.7 The process of selling gold, reinvesting the proceeds in interest-bearing assets and retaining them in the reserves changes the nature of the reserves portfolio, including its risk characteristics. It is, of course, possible to compare the return made on the portfolio following the sales programme with that which would have occurred had the sales not taken place. However this is not a like-for-like comparison. When comparing portfolios, other things being equal, a rational, risk averse investor would prefer a portfolio with a higher expected return but lower risk relative to another portfolio. However, whether a portfolio with a higher (lower) expected return and higher (lower) expected risk is preferred depends on the investor's risk preferences.

6.8 When analysing the value of the actual reserves portfolio and the counterfactual portfolio if gold had not been sold, it is also important to remember that this is a medium- to long-term restructuring programme. It does not make sense to put too much weight on the variation in values on any given day – it is the return variance over the medium- to long-term, having taken into account the difference in risk, that is important.

6.9 The value of the portfolio, had the sales not taken place, is the marked-to-market value of the 395 tonnes of gold that have been sold, with the holding being built up at the same rate as the gold was sold at auction (e.g. 25 tonnes in July 1999, a further 25 tonnes in September 1999 and so on) until the counterfactual portfolio contained 395 tonnes by March 2002. As at 28th July

[12] Figures as at February 2002.

2002, at the then current market prices, this portfolio equated to $3.9 billion. The annualised average return on the counterfactual portfolio at that time was approximately 5_% p.a. There are no interest receipts to be included in the calculation because, under the European central bank agreement on gold, the size of the UK Government's gold lending programme is capped and the gold that has been sold could not have otherwise been lent.

6.10 The portfolio that has arisen following the sales can be modelled by assuming that the proceeds of each auction are reinvested in interest-bearing foreign currency assets (e.g. US T-bills and Treasuries, euro government bills, euro government bonds and Japanese financing bills) in the proportions 40% dollars, 40% euros and 20% yen. This reinvestment of auction proceeds took place shortly after each auction in line with the wider investment policy for the net reserves. The value of this portfolio includes the interest accrued on the assets plus the exchange rate gain or loss on non-dollar assets. As at 28th July 2002, the marked-to-market value of this portfolio was also approximately $3.9 billion making the annualised average return on this portfolio also around 5_% p.a. However, as a result of the volatility in the prices of the assets held the difference in the values of the two portfolios can alter significantly from day to day. Over recent weeks the additional interest return on the portfolio actually held in the reserves has averaged around $1.75 million per week.

Sale method

6.11 Prior to taking the decision to sell gold, analysis was undertaken to ascertain the most appropriate method for selling gold. As stated earlier, the Government's objectives were to reduce its holdings of gold to around 300 tonnes by selling in a transparent manner, over the medium term, fairly and with a view to obtaining value for money for the taxpayer.

6.12 The main variables considered when determining the format of the sales programme were whether sales should take place overtly or covertly and what method should be used to sell the gold (e.g. sales through the London Fix, bilateral sales or auctions).

6.13 ***Covert versus overt sales:*** Analysis at the time recognised that covert sales might in principle reduce the immediate negative impact on the price of gold of any sales thereby improving the return to the reserves. However, this risked subsequent rumours causing unnecessary uncertainty over the UK's intentions, with consequently greater price impact – a fact noted by Professor Binmore in his evidence to the NAO[14]. Separately, soon after the gold sales programme had been announced, the maximum lag with which changes in the reserves portfolio become public was reduced from five months to one month because of a change in IMF statistical guidelines. Thus, the window within which covert sales could have been undertaken would in any case have been relatively short.

6.14 The Swiss also signalled their intention to sell part of their gold reserves well in advance and it is possible that other countries may have done likewise if the IMF's guidelines on the publication of reserves data, which came into force in early 2000, had been in place at the time they sold.

6.15 In addition to realising that there were potential problems with covert sales, the Government believed that overt sales could be positively beneficial in that predictability and transparency can increase the revenue from sales. The reasons for this include the belief that transparency reduces the risk premium priced in by the market, the fact that the authorities are unable to outguess the market on its processing of information, that predictability should increase participation and that increasing competition in capital markets means that issuers cannot rely on captive investors (transparency and predictability can give a seller a competitive edge in the market). These issues are outlined in more detail in Box 4. They are the main reasons why the UK Government switched its method of sale of government bonds from a mainly short-term flexible approach to one based largely on pre-announced auctions in the mid-1990s and the reasons why it was decided to also sell gold in an overt and transparent manner with sales being pre-announced.

6.16 ***The method for selling gold:*** The methods for selling gold considered included selling on a spot basis into the market, bilateral off-market sales and a number of different types of auctions. Concerns over off-market sales revolved around whether a buyer could be found for the volume of gold the Government was looking to sell. Additionally, off-market sales clearly did not meet the Government's objective of transparency and fairness. Although spot market sales (and specifically sales through the Fix) could be pre-announced and would therefore enjoy a degree of transparency, they do not score well on fairness because only a limited number of banks participate directly in the Fix – there are five fixing seats, and seats can be vacant at times. Others can purchase and sell gold through the Fix but only through the participants. Additionally, although a seller through the Fix could unilaterally choose to make their sales transparent by publishing details, broadly speaking the Fix is less transparent. For example, information on the overall level of turnover in the Fix is not publicly available.

6.17 In contrast to off-market and spot sales, auctions met the Government's objectives well. They are completely transparent in that a policy announcement could be made signalling to the market and other central banks the scale and timing of sales to be undertaken. Significant post-auction information can be published including the amount sold, the clearing price and the cover ratio. Auctions could also be conducted on a regular basis, to a timetable published in advance and in a way similar to the issuance of government debt. They were also fair in that all LBMA members, other central banks and certain international monetary institutions holding accounts at the Bank of England were able to participate directly.

Box 4: Transparency and predictability

During the mid-1990s, the UK government switched its method of sale of government bonds from a mainly short-term flexible approach to one based largely on auctions. The auction programme is pre-announced well in advance in the annual Debt and Reserves Management Report and updates are published quarterly by the Debt Management Office and when the fiscal forecast is changed at the time of the Budget and Pre-Budget Report. The move to a transparent approach to selling government bonds was driven by the following factors:

- **The authorities are unable to outguess the market on its processing of information.** Numerous studies have found that financial markets are generally 'efficient' in their processing of information. This means that, unless one can trade on private information, one should not expect systematically to outperform the market's expectations. Hence, once the decision to sell a certain bond or commodity is taken, retaining discretion over timing should not mean that expected receipts at the outset of the process are higher.

- **Participation should increase with predictability.** Participation from market-makers and investors should be greater if the seller gives adequate notice. This allows market-makers to pre-sell the issue and investors to plan their strategies ahead of the sale. The sale itself also generates liquidity as traders can be more confident of filling short positions in the auction. Gilt auctions are announced on a quarterly calendar.

- **Increasing competition for global capital means that issuers cannot rely on captive investors.** With global bond markets becoming ever more open, issuers need to compete actively for investor interest to reduce the yields paid. An element in the competitive armoury of repeated issuers is to be as predictable and transparent as is practicable to ensure investors are confident that they will not be surprised by a supply shock after participating in an auction. Together these factors mean that there is an a priori case that the revenue from auctions will be increased through a predictable and transparent sales process. To believe that revenue would be systematically increased through retaining significant discretion, one must believe that the value of private information that the authorities would trade on would exceed the risk premium that would thereby be priced into investors' valuations.

6.18 ***Why use uniform rather than multiple price auctions?*** Of the types of auction that could have theoretically been used, only multiple and uniform price auctions were given serious consideration. Given that financial markets are most accustomed to these types of auction, it would have increased operational risk to attempt to sell gold using a method that the market was not familiar with, such as

a Vickrey auction.[13] Professor Ken Binmore states[14] that an auctioneer "…would be unwise to be too innovative in designing his auction – especially when adequate entry to the auction is an issue – because he would then face the risk of frightening off bidders who feel that they may get burned by participating in an unfamiliar process. In an auction with untried rules, who knows how the other bidders may behave? Such strategic uncertainty can be as damaging as more conventional sources of uncertainty".

6.19 In a multiple price auction, all the successful bidders pay the price they bid whereas in a uniform price auction all the successful bidders pay the same price (with the clearing price being set by the lowest accepted bid). At first glance it might seem obvious that the multiple price format should raise more revenue and this would be true if bidders were to enter the same demand schedule irrespective of the auction type. But in practice bidders adjust their bidding strategies to the type of auction format the seller has chosen. Bidders have an incentive to "shade" their bids downwards and the incentive is greater in a multiple price auction, i.e. because in a multiple price auction a bidder knows that, if successful, they are going to have to pay their bid there are strong incentives to lower the bid providing that in so doing, they remain reasonably confident of being successful. In contrast, under the uniform price format, bidders have stronger incentives to bid their true valuation as the price paid is set by the marginal bidder. The empirical evidence on whether a seller should prefer one auction format over the other on the basis of expected revenue is mixed, with some studies favouring uniform price formats and others favouring multiple price formats[15].

6.20 As noted by Binmore and Swierzbinski, auction formats also differ in terms of "strategic uncertainty"[16]. Choosing an auction format (such as uniform price) that does not require bidders to process significant amounts of information can reduce strategic uncertainty, thus encouraging greater participation. In a uniform auction, bidders need only ensure that that part of their demand curve that will influence the clearing price is correct. In contrast, in a multiple price format bidders need to get their entire demand curve correct. Similarly, participation may be wider for a uniform price format auction in the sense that a small player who wants to ensure the purchase of a small quantity of gold may be encouraged to enter the auction with a high bid (thus increasing the probability that their bid is successful), safe in the knowledge that they will pay the clearing price and not

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[13] In a Vickrey auction, each bidder pays for each unit the price that another bidder would have been willing to pay if that bidder had the opportunity to add that unit to his allocation.

[14] The National Audit Office report "The sale of part of the UK gold reserves", HC 86, session 2000-2001: Appendix 3, p40.

[15] For a summary and discussion of the empirical evidence see 'Treasury Auctions: Uniform or Discriminatory?', Binmore, Ken; Swierzbinski, Joe, Review of Economic Design, 5(4), December 2000, pages 387-410.

[16] 'Treasury Auctions: Uniform or Discriminatory?', Binmore, Ken, Swierzbinski, Joe, Review of Economic Design, 5(4), December 2000, pages 387-410.

necessarily the price they bid.[17] Uniform price auctions can also offer participants an element of insurance against suffering the 'winner's curse'[18], thus encouraging greater participation. This is because bidders pay the clearing price and not their own bid (unless their bid was a price setting bid).

6.21 The US Treasury found that the introduction of a uniform price format to 2- and 5-year note auctions resulted in a statistically significant reduction in the award concentration to its top primary dealers. In addition, their results show that the spread between the average auction prices and prices in the when-issued (WI) market were significantly different from zero in multiple price auctions, but were not in uniform price auctions. On this measure, expected revenue under the uniform-price technique was found to be marginally greater than under the multiple price technique.[19]

6.22 Strategic uncertainty could conceivably also impact on revenue if the uncertainty led to bids being shaded excessively, for example as a result of an overly complex auction format or one lacking in transparency. However, it was predominantly because a uniform price auction format was more likely to encourage participation that it was selected.

6.23 However, there are potential disadvantages with a uniform price auction format. For instance, Klemperer[20] comments that uniform price auctions are more vulnerable to collusion, particularly "tacit" collusion, than multiple price auctions. Collusion is harder in a multiple price auction and less rewarding as each of the winners pay their actual bid. Conversely, a uniform price structure encourages marginal bidders with limited information to enter the auction, thereby maximising participation and reducing the likelihood of collusion.

6.24 Klemperer also notes that where there are a large number of bidders for whom auction entry is easy, such as in the sale of government securities or gold, auction design probably does not matter for either price or efficiency. Given the large number of competitive bidders participating in the UK gold auctions, the choice between multiple and uniform price auction formats was probably not of critical importance.

Price achieved

6.25 In order to evaluate the prices achieved over the course of the auction programme, they were benchmarked against London Fix prices. However, as

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[17] Admittedly, with a multiple price auction the same result can be achieved by allowing non-competitive bids (i.e. bids from small players who agree to pay the average price).

[18] The 'winner's curse' refers to the regret bidders experience, for example in multiple price auctions, when they realise after the event that they could have entered a lower bid and still been successful (i.e. they could have paid a lower price for the object).

[19] 'Uniform-Price Auctions: Evaluation of the Treasury Experience', Department of the Treasury (October 1995).

[20] 'What Really Matters in Auction Design', Paul Klemperer, (2001), mimeo.

was recognised by the NAO, although the London Fix is the best available benchmark, it is far from perfect.[21] This is because the Gold Fix price is set to balance demand and supply in that mechanism. If an additional 395 tonnes of gold had been sold through the mechanism, even if spread evenly over the period, and demand at the Gold Fix had been unchanged, this extra supply would have been likely to lead to lower Gold Fix prices than were actually observed. Of course, it is possible that all the demand that occurred at auctions might have appeared in the Fix but this is by no means certain.

6.26 Three sets of benchmarks have been used. These are:

Weighted average Fix price on the day of the auction[22];

Average daily Fix price over the period starting with the first auction on 6 July 1999 and ending with the final auction on 5th March 2002; and

Average daily Fix price over the 34-month period beginning the day after the announcement of the sales programme. This is used because if the Fix had been used sales could have potentially started the day after the announcement.

6.27 For the second and third benchmarks a variant has also been calculated, as the NAO did in their report, excluding prices during October 1999. This adjusts for the extreme volatility in prices that arose as a result of the European central banks' agreement.

6.28 The weighted average price achieved at the 17 auctions compared favourably with the weighted average Fix on the days of the auctions. The weighted average price achieved over the course of the auction programme was $274.92 per ounce. This compares with the weighted average Fix price on the days of the auctions of $274.17 per ounce, a difference 75 cents or +0.3%. At the time the NAO report was published, following the ninth auction, the variance was +0.1%.

6.29 The average auction price was 0.5% lower than the average daily Fix over the auction period but this figure falls to only 0.1% lower when the extremely volatile period during October 1999 following the announcement of the Washington Agreement is excluded. The benchmark comparisons in the NAO report following the ninth auction were –1.6% and –0.9% respectively. When discussing the benchmark comparisons they had published, the NAO noted that the differences in prices were not statistically significant.

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[21] See the NAO report on "The sale of part of the UK gold reserves", pp 17-19.

[22] The weighting adjusts for the fact that approximately 25 tonnes was sold at each of the first 11 auctions and 20 tonnes at each of the remaining 6 auctions.

6.30 Of course, if the Treasury had decided to sell through the Fix, these sales could have started immediately following the announcement. Therefore, the third set of comparisons looks at the price that might have been achieved had sales taken place over a 34-month period starting from the 10th May 1999. The weighted average auction price was 0.4% below the average daily Fix price over this period. If the volatile October 1999 period is excluded this differential rounds to 0.0%. The differences between the auction price and these benchmarks as published in the NAO report were –1.1% and –0.4% respectively. These differences were also not significantly different from zero.

Table 2: Benchmark calculations[23]

$ per ounce / *variance from benchmark*	*After completion of programme*	*At time of NAO report*
Weighted average auction price	274.92	275.01
Weighted average Fix on auction dates	274.17 / +0.3%	275.91 / +0.1%[24]
Average daily Fix over auction period	276.42 / -0.5%	278.46 / -1.6%[24]
Excluding October 1999	275.31 / -0.1%	276.58 / -0.9%[24]
34 months from announcement of programme	275.91 / -0.4%	278.08 / -1.1%[25]
Excluding October 1999	274.85 / +0.0%	276.18 / -0.4%[25]

6.31 The comparison of the prices achieved at the 17 auctions and the benchmarks suggest that the prices achieved were competitive and in line with what might have been expected had an alternative route been chosen for the sale of the gold. However, as stated above it should be remembered that whilst being the best benchmark available, the Fix is by no means a perfect benchmark because it is possible that if the UK had sold gold through the Fix, the Fix price could have been lower as a result.

Price movements prior to and following the auctions

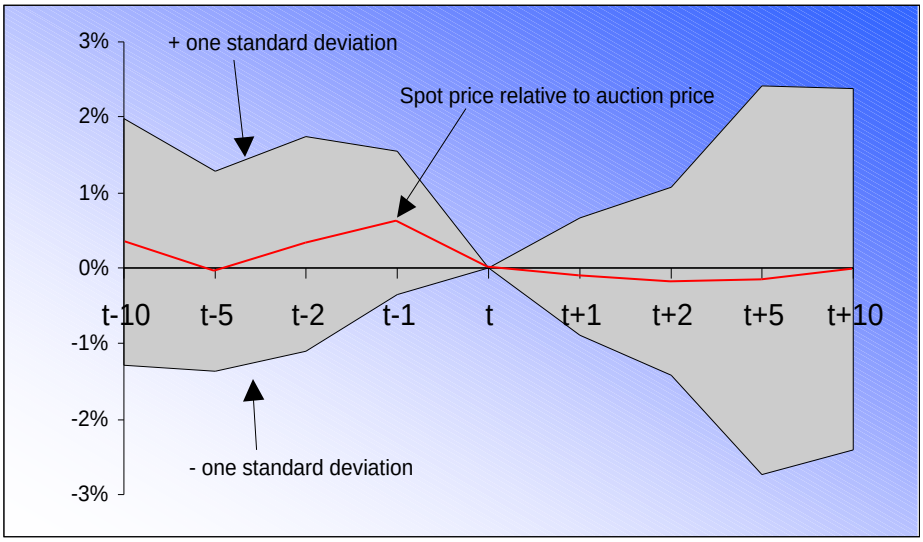
6.32 The issue of price movements prior to, and following, the auctions was raised at the PAC hearing[26]. The question was whether there had been any

[23] Consistent with the approach in the NAO report, benchmark calculations use the PM Fix. The NAO noted that, "the afternoon Gold Fix price is most often used when prices are referred to as, although volume information is not available, volumes traded are considered by the market to be greater than in the morning". See the National Audit Office report "The sale of part of the UK gold reserves", p18.
[24] NAO figures covered first nine auctions from 6th July 1999 to 7th November 2000.
[25] NAO figures covered 18-month period from announcement of programme on 10th May 1999.
[26] Public Accounts Committee, Seventh Report, "Sale of part of the UK gold reserves", Session 2001-2002.

systematic movements in price around the time of the auctions which could have suggested that firms were collectively 'shorting' the auctions (i.e. driving down the market price in the hope of purchasing gold 'cheaply' at the auction). Analysis shows that there were no such systematic price movements, but it might not have been surprising if there had been evidence of a slight fall in price just prior to each auction. This sort of price movement is often observed in the run up to bond auctions with the asset being sold at a slight discount to the market price. In effect, the discount constitutes the successful bidder's fee for distributing the asset. In fact, the gold price fell[27] into the auction in 8 of the 17 auctions and it rose out of the auction in only 5 of the 17 auctions, including the September 1999 auction when the price rose due to the announcement of the Washington Agreement. In percentage terms on average the market price of gold ranged from –0.1% below the price achieved in the auction five days prior to the auction, to 0.5% above the auction price the day prior to the auction. The average market price prevailing two to five days after each auction was 0.1-0.2% below the auction price once the September 1999 auction is stripped out.

6.33 It is not apparent from the data that the market was systematically depressing the price of gold in the run up to the auctions, as would have been expected if the market had been 'shorting' the auction in the hope of purchasing gold back cheaply. Nor is there any evidence that the price of gold systematically rose following the auctions.

Figure 5: Average gold spot price relative to the auction price in the days prior to and following the auctions



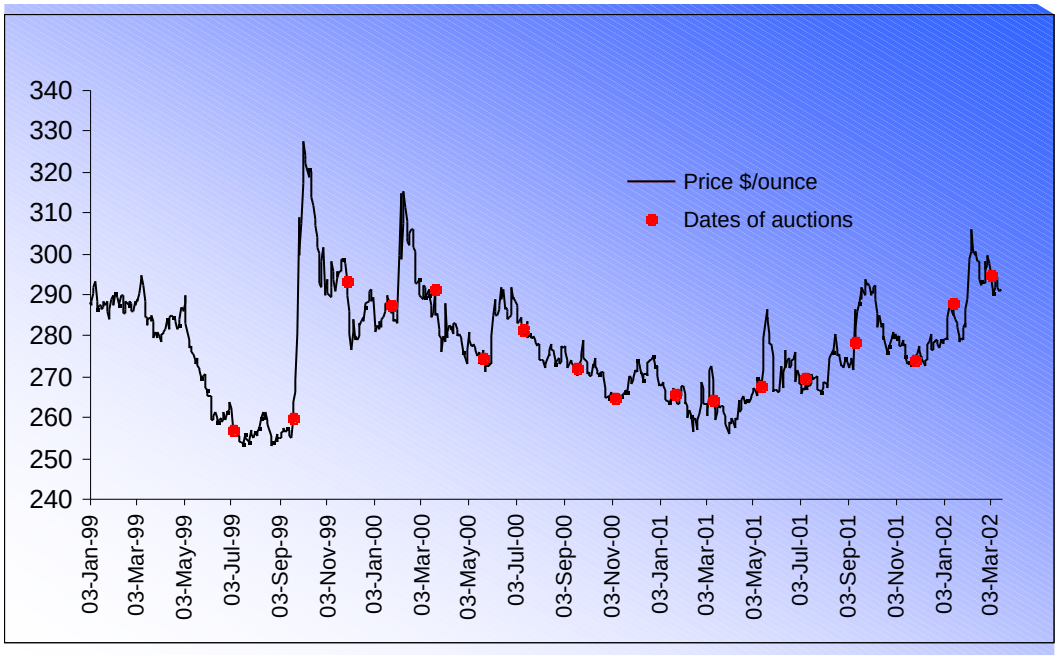
Source: HM Treasury/Bloomberg

[27] For the purpose of this analysis, the gold price was deemed to have fallen into the auction if it was higher than the auction price on any two of 1) the day prior to the auction, 2) two days prior to the auction and 3) five days prior to the auction. The same approach was taken for assessing whether prices rose out of the auction.

Price movements over the course of the auction programme

6.34 Figure 6 plots the gold price over the period from the first auction in July 1999 to the final auction in March 2002. The average PM Fix over the programme was $276.42 per ounce. The highest price was $325.50 per ounce and the lowest was $252.80 per ounce. The key price movement during the programme was the spike in prices just after the second auction following the announcement of the Washington Agreement when the price rose from around $260 per ounce to around $330 per ounce over the course of around two weeks. The overriding trend over the six-month period following October 1999 was one of a general decline in the price with lows of just under $260 per ounce being reached in March 2001. The notable exception to this was the sharp rise in price in late February 2000 when the price once again rallied to around $315 per ounce. Since March 2001, the trend has once again been of price rises with the price reaching $305 per ounce in February 2002.

Figure 6: Gold price ($ per ounce)

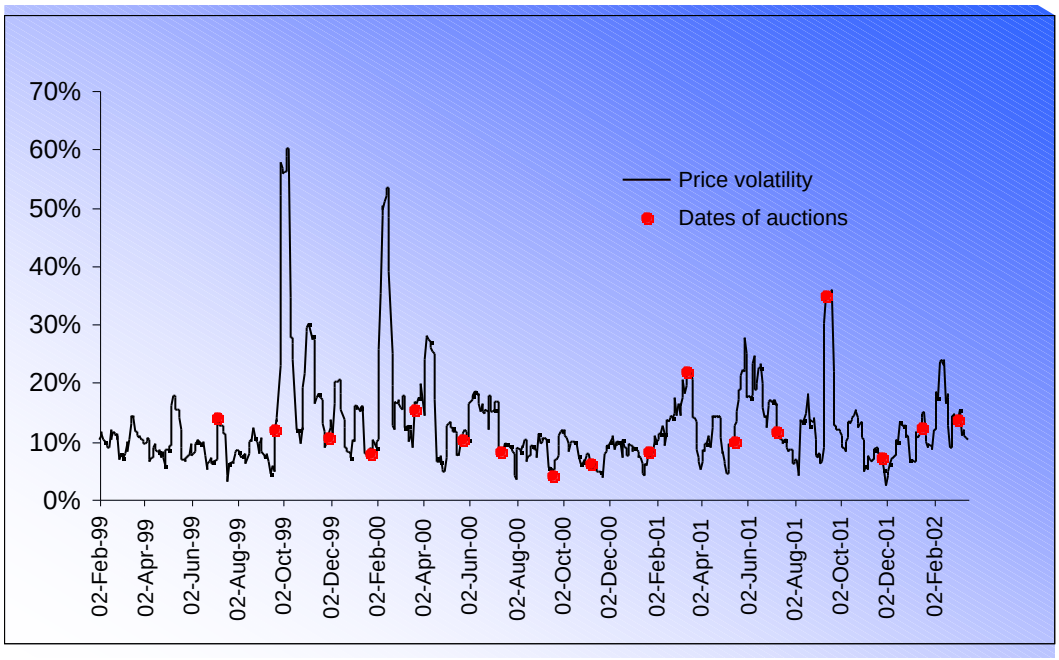


Source: HM Treasury/Bloomberg

Price volatility over the course of the auction programme

6.35 Figure 7 plots the 10-day gold price volatility[28] over the course of the auction programme. Average price volatility over the entire programme was 13.3%. However, volatility rose to 60 per cent following the announcement of the European central bank's agreement on gold in September 1999 and rose sharply in February 2000 (due to developments at Ashanti mines) and September 2001 (due to the terrorist attacks in the US).

Figure 7: 10-day gold price volatility



Source: HM Treasury/Bloomberg

7. CONCLUSIONS

7.1 The UK government's sales programme has clearly demonstrated that auctions provide a transparent and fair method for selling gold and similar types of asset. The programme was transparent in that it was pre-announced with sales taking place according to a clear timetable and information on each auction was published shortly after bidding closed. All members of the LBMA, other central banks and certain international monetary institutions with accounts at the Bank of England were able to participate in the auctions making it demonstrably fair. It is also clear from the analysis contained in this report and that undertaken

[28] Price volatility is the annualised standard deviation of the daily price change over a given period (in this case the last 10 trading days).

by the National Audit Office that the auction programme scored well on value for money grounds.

7.2 Auctions of 20-25 tonnes of gold every other month helped create liquidity within the gold market and by the end of the programme a number of participants were quoted as saying that the programme was seen as useful and natural.

7.3 The smooth running of the programme was largely down to the work undertaken by the Bank of England. Their close contacts with market participants and the effort taken to ensure the market was kept well-informed resulted in an auction process that bidders understood and worked efficiently.

7.4 The annual reviews of the programme undertaken by the Treasury and the Bank of England allowed information to be gathered, the views of the market to be taken and changes to the programme to be made. On this aspect, the PAC report concludes "We also endorse the Treasury's decision to consult market participants as part of their series of reviews of the on-going sales process, because it is important in such programmes for departments to develop as close an understanding as possible of market sentiment and the concerns of other interested parties".[29]

7.5 The successful implementation of the programme was recognised by the National Audit Office when they concluded that: "In designing and implementing the sales programme so far the Treasury has met successfully its objective to sell in a transparent and fair manner while achieving value for money. The prices achieved at each of the nine auctions have been competitive and well in line with the prices achieved in similar gold sales by overseas central banks. The Treasury's agent, the Bank of England, has worked hard to keep the gold market well informed and to secure a technically successful sales programme that has been applauded by almost all the gold market participants interviewed and surveyed for this examination"[30].

7.6 Above all, the programme successfully delivered a one-off and permanent reduction in risk on the net reserves as a result of the better diversification achieved. The value at risk on the UK's net reserves has fallen by around 30 per cent as a result of the restructuring.

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[29] Public Accounts Committee, Seventh Report, "Sale of part of the UK gold reserves", Session 2001-2002, paragraph 48.
[30] See the National Audit Office report, "The sale of part of the UK gold reserves", p10.

Annex A: Auction Results

Date	Amount Allotted (ounces)	Allotment Price ($/ounce)	Approximate Revenue ($ million)	Cover	AM Fix ($/ounce)	PM Fix ($/ounce)
6th July 1999	804,000	261.20	210	5.2	261.30	257.60
21st September 1999	804,000	255.75	206	8.0	255.20	258.85
29th November 1999	804,000	293.50	236	2.1	293.10	292.25
25th January 2001	804,400	289.50	233	4.3	288.70	288.00
21st March 2000	804,400	285.25	230	3.0	286.15	285.15
23rd May 2000	803,600	275.25	221	2.7	275.15	274.05
12th July 2000	804,000	279.75	225	1.3	282.85	279.95
19th September 2000	804,400	270.60	218	2.6	272.00	271.85
7th November 2000	804,000	264.30	213	3.3	264.10	265.50
23rd January 2001	805,600	268.00	216	4.8	267.10	266.10
14th March 2001	804,800	266.00	214	2.2	267.45	263.85
15th May 2001	644,400	268.00	173	3.7	268.05	266.60
11th July 2001	643,600	267.25	172	4.1	266.55	267.55
12th September 2001	644,400	280.00	180	4.3	279.50	279.00
27th November 2001	644,400	273.50	176	2.6	273.65	273.30
16th January 2002	643,600	283.50	182	1.4	287.95	284.60
5th March 2002	644,400	296.50	191	3.7	296.60	297.80
Weighted averages		274.92		3.5	275.38	274.17
Total	12,712,000		3496			

ANNEX B: VALUE AT RISK (VAR)

Introduction

At the recent PAC hearing on the sale of part of the UK gold reserves, the PAC Chairman, David Davis, asked for a note on value at risk. The following describes the value at risk concept and provides a worked example for two different levels of gold holding within the UK net reserves.

Value-at-Risk: the Concept

Linsmeier and Pearson (1996) describe the concept of value-at-risk as, "Value at risk is a single, summary statistical measure of possible portfolio losses. Specifically, value at risk is a measure of losses due to 'normal' market movements. Losses greater than the value at risk are suffered only with a specified small probability. Subject to the simplifying assumptions used in its calculation, value at risk aggregates all of the risks in a portfolio into a single number suitable for use in the boardroom, reporting to regulators, or disclosure in an annual report. Once one crosses the hurdle into using a statistical measure, the concept of value at risk is straightforward to understand. It is simply a way to describe the magnitude of the likely losses on the portfolio".

Kevin Dowd in his book "Beyond value at risk" states that, "in its most literal sense, VaR refers to a particular amount of money, the maximum amount we are likely to lose over some period, at some specific confidence level".

In other words, since risk reflects uncertain outcomes, it can usefully be described in terms of probabilities. Value-at-risk uses this approach – it is an estimate, with a given confidence level (i.e. some statistical probability of changes in price), of the loss that might be expected in a portfolio if positions are held over some set time horizon. It answers the question "how much can I lose with x% probability over a given time horizon".

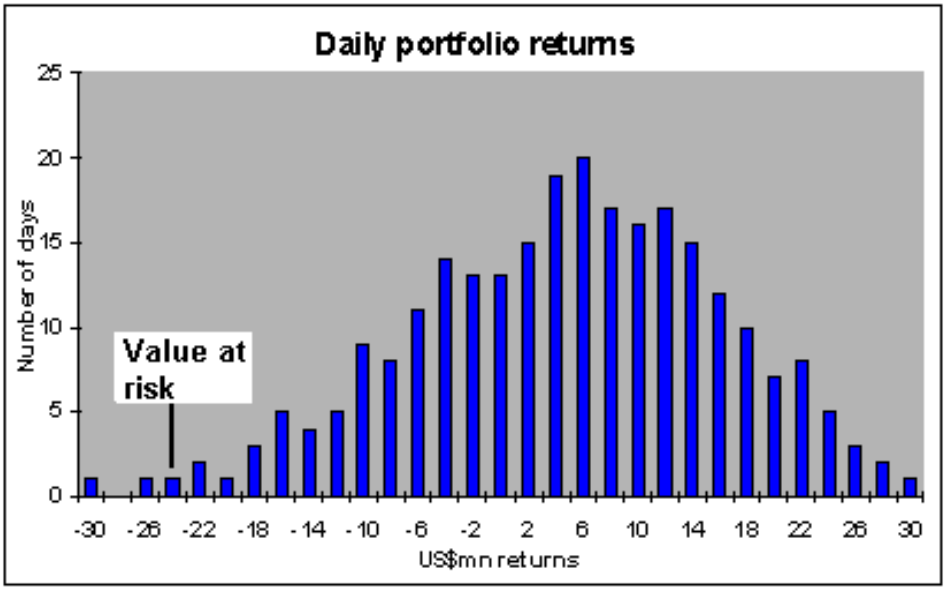
Value at risk methodology – a hypothetical example

There are three methods of calculating value at risk:

1) Numerical value at risk – whereby the historical movements of the portfolio as a whole are used to calculate the value at risk,
2) Parametric value at risk – whereby the relationships (variance and covariances) between the assets held in the portfolio are estimated and the value at risk is calculated using this information, and
3) Monte-Carlo simulation – whereby the value at risk is derived by simulating the relationships between the assets held in the portfolio.

The numerical method is the more intuitive of the three approaches. The following outlines how the value at risk might be calculated for a hypothetical portfolio using the numerical example. We then go on to describe, using the Parametric approach (the method most commonly used in the financial markets), how the value at risk would be calculated for the net reserves.

Figure 1



Daily returns on a portfolio over time, say a year, are likely to be distributed broadly in line with those shown in figure 1. There may be a number of occasions when the portfolio made large positive returns and a number of occasions when the portfolio made large negative returns but the majority of observations will tend to lie towards the middle of the distribution, around or just above zero.

Given that we are talking about risk (Value at risk) we are only concerned with losses and, given that we are considering maximum expected losses subject to a high confidence limit, essentially with large losses, i.e. the observations in the left hand tail. From the hypothetical data shown in figure 1 we can see that losses of US$30mn, US$26mn and US$24mn were made on one occasion each.

In determining the value at risk it is first necessary to decide on a cut off point for the confidence interval, for example 99%. If we choose a 99% confidence interval then we are implicitly saying that we would not expect to lose more than the value at risk figure on all but three (1% of trading days) trading days per year.

Value at risk is the ***maximum*** expected loss over a given horizon period at a given level of confidence. In the above example, the maximum expected daily loss, with a 99% confidence interval, is US$24mn.

A Worked Example using the UK net reserves (the parametric approach)

Consider the case of a portfolio worth $14bn where gold makes up 50% of the portfolio (i.e. $7bn) and the remainder is split 40:40:20 into $, € and Yen (i.e. $2.8bn is held in dollars, $2.8bn is held in euro and $1.4bn is held in Yen).

If the portfolio is managed in $, there are three currency risks – the risk arising from movements in the dollar-gold exchange rate, the risk arising from movements in the dollar-euro exchange rate and the risk arising from movements in the dollar-yen exchange rate.

The variance-covariance matrix for a ten day holding period is :-

	Yen	Euro	Gold
Yen	0.053%	0.004%	0.017%
Euro	0.004%	0.042%	0.012%
Gold	0.017%	0.012%	0.054%

(Data on variances and covariances are based on historical movements in asset prices and are published by a number of firms, for instance by JP Morgan as part of its RiskMetrics service.)

The column vector of positions (in $mn) is

$$\begin{pmatrix} 1400 \\ 2800 \\ 7000 \end{pmatrix}$$

and its transpose is

(1400 2800 7000)

For these purposes, we assume that we are interested in a 99% confidence level (which means that _ is 2.33 in a normal distribution). VaR is calculated as:-

VaR = _ √ x' * _ * x

= 2.33 * √ 38790

$$= 2.33 * \sqrt{(1400\ 2800\ 7000) \begin{pmatrix} 0.053\% & 0.004\% & 0.017\% \\ 0.004\% & 0.042\% & 0.012\% \\ 0.017\% & 0.012\% & 0.054\% \end{pmatrix} \begin{pmatrix} 1400 \\ 2800 \\ 7000 \end{pmatrix}}$$

= 2.33 * 197
= 459

So this portfolio's value-at-risk is $459mn, i.e. this is the maximum amount we could expect to lose (with a 99% confidence interval) over the next 10 days[31].

Consider now a $14bn portfolio where gold makes up 20% of the portfolio (i.e. $2.8bn) with the remainder split 40:40:20 into $, € and Yen (i.e. $ 4.48bn is held in dollars, $4.48bn is held in euro and $2.24bn is held in Yen). The variance-covariance matrix is exactly as before; as is _; the new column vector of positions is:-

$$\begin{pmatrix} 2240 \\ 4480 \\ 2800 \end{pmatrix}$$

and its transpose is:-

$$(2240 \quad 4480 \quad 2800)$$

Value-at-risk is given as before:-

$$VaR = \_ \sqrt{x'} * \_ * x$$

$$= 2.33 \sqrt{(2240\ 4480\ 2800) \begin{pmatrix} 0.053\% & 0.004\% & 0.017\% \\ 0.004\% & 0.042\% & 0.012\% \\ 0.017\% & 0.012\% & 0.054\% \end{pmatrix} \begin{pmatrix} 2240 \\ 4480 \\ 2800 \end{pmatrix}}$$

= 2.33 x √ 21103
= 2.33 x 145
= 338

The value-at-risk of this portfolio is therefore $338mn, some 26% below the value-at-risk for the portfolio with a higher proportion of gold. This is because, as can be seen from the variance-covariance matrix, that a portfolio containing more euro and less gold is less risky because the euro has a lower variance vis-à-vis the dollar and also has a lower covariance, than gold, with the yen. Using different values of _ will alter the absolute figures, but does not affect the relative value at risk of the two portfolios.

[31] The VaR figure, in this example, reflects the maximum amount we could expect to lose over the next ten days. However, variance and covariance matrix is estimated from a long run of data (e.g. one to two years of data).

Calculating value-at-risk

Value-at-risk for a single position is calculated as :-

VaR = sensitivity of position to change in market prices * estimated change in price

or equivalently:-

VaR = amount of position * volatility of instrument
= x _

where x is the position size and volatility (_) is the proportion of the value of the position which may be lost over a given time horizon at the specified confidence level.

When looking at exposure to two or more risks – e.g. the risk in a portfolio of two assets, say gold and euros – as explained in paragraph 2.27 of the NAO report, risk measures must take account of the likely joint movements (or 'correlations') in the asset prices as well as the risks in the individual instruments. This can be written as:-

$$VaR = \sqrt{(VaR_1^{\ 2} + VaR_2^{\ 2} + 2\ \_{12}\ VaR_1\ VaR_2)}$$

where VaR_1 is the value-at-risk arising from the first risk factor, VaR_2 is the value-at-risk arising from the second risk factor and $\_{12}$ is the correlation between movements in the two risk factors. Given the definition of VaR above, this can be written as:-

$$= \sqrt{(x_1^2\ \_1^2 + x_2^2\ \_2^2 + 2\ \_{12}\ x_1\ \_1\ x_2\ \_2)}$$

where $\_1$ and $\_2$ are the confidence level volatilities for the two risk factors (equivalently $\_1^2$ and $\_2^2$ are the confidence level variances) and $\_{12}$ is the correlation between movements in the two risk factors.

Since the covariance of two positions - $\_{1,2}$ - is given by:-

$$\_{1,2} = \_1 * \_2 * \_{12}$$

and since the confidence level variance, $\_1^2$, can be written as $(\_\ \_1)^2$ – i.e. $\_^2\ \_1^2$ - where _ is the confidence level and $\_1^2$ is the historical variance, the above can be rewritten as:-

$$= \_ \sqrt{(x_1^2 \_1^2 + x_2^2 \_2^2 + 2\ x_1\ x_2 \_ 12)}$$

This can be presented in matrix form:-

$$= \alpha \sqrt{\quad} \begin{pmatrix} x_1 & x_2 \end{pmatrix} \begin{pmatrix} \sigma_1^2 & \sigma_{1,2} \\ \sigma_{1,2} & \sigma_2^2 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

In shorthand this is:-

$$VaR = \_ \sqrt{(x' * \_ * x)}$$

where _ is the confidence level, x represents the vector of position size, x' is its transpose (i.e. changes a matrix consisting of a column into a matrix consisting of a row), and _ is the matrix of historical variances and covariances for the risk factors over the given holding period.

Generalising for more than two risk factors gives:-

$$VaR = \_ * \sqrt{(x' * \_ * x)}$$

where x is the matrix of positions (in $), x' is its transpose, _ is the confidence level and _ is the variance:covariance matrix of returns over the given holding period.

References:

Linsmeier, T.J.; and N.D. Pearson. 1996. Risk Measurement: an introduction to value at risk. Mimeo. University of Illinois at Urbana-Champaign.

Dowd, K. 1998. Beyond value at risk. Wiley.

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ANNEX C: PAC CONCLUSIONS AND RECOMMENDATIONS, AND HM TREASURY RESPONSES

Conclusions

On the basis of a report by the Comptroller and Auditor General on the auctions that had taken place by May 2000, our predecessors examined whether the Treasury and the Bank of England had achieved value for money and whether there was scope to introduce improvements to the future gold sale programme. We draw three main conclusions:

- The Treasury are being rigorous in their approach to achieving a reduction in the riskiness of the portfolio in that they are carrying out the sales within a framework of risk assessment and management.

- As a result of reducing the proportion of gold in the UK's portfolio of reserve assets from 44 per cent to 20 per cent, the Treasury expect to reduce the riskiness of the portfolio by about a quarter. Once the sale programme has been completed, the Treasury should evaluate the outcome to assess how far it has been successful in reducing risk.

- With the bulk of the sales having taken place, there is no evidence of any significant variation in the value of the portfolio. The Treasury is prepared, however, to lose money in order to lower the risk to the portfolio, and on completion of the programme it will be important for the Treasury to evaluate the financial gain or loss to the portfolio as a result of these sales.

Recommendations

On achieving value for money

PAC conclusion (i): In order to secure and maintain the reduction in the riskiness of the reserves portfolio it will be important for the Treasury to continue to monitor the appropriateness of their foreign currency benchmark of 40 per cent in US Dollars, 40 per cent in Euros and 20 per cent in Yen, having regard to the fluctuations in gold prices, exchange rates and interest rates (paragraph 32).

1. The Treasury notes the Committee's observation. The Treasury will continue to monitor the appropriateness of the benchmark. If there were a decision to change the benchmark, the Treasury would publish this once the change had been implemented.

PAC conclusion (ii): The Treasury decided to sell the gold through auctions in quantities and on dates announced in advance, as part of a process that would be seen as transparent, and so would increase value for

money in the long run. There can however be a trade off between transparency and flexibility. For example the Treasury does not announce the reserve price and following the auctions does not disclose information on prices bid; and the Treasury has decided to announce only the date of the next auction and to reduce the amount to be sold in each auction from 25 tonnes to 20 tonnes. In managing such programmes the Treasury should continue to keep these trade offs under review, as its experience develops, in order to maximise the benefits of both transparency and flexibility (paragraph 33).

2. The Treasury accepts the Committee's comment. The Treasury believes that, wherever possible it is advantageous to operate programmes where there is a repeated sales process, such as this programme of gold sales with regard to both transparency and flexibility. The Treasury believes that the structure and openness of the sales programme encouraged maximum participation in the auctions, helping to ensure value for money was achieved. The Treasury will continue its policy of keeping such trade-offs under review.

PAC conclusion (iii): The first two auctions (6 July 1999 and 21 September 1999) were preceded by a sharp fall in the price of gold, following the announcement of the proposed sales. They were followed by an even steeper increase in the price of gold when the European central banks (including the Bank of England) reached agreement (26 September 1999) on the overall size of their gold sales programme for the subsequent 5 years. It would have been preferable if this agreement could have been concluded and announced before the announcement and start of the UK sales programme (paragraph 34).

3. Given the sequence of events it was not possible for the agreement to have been concluded and announced before the announcement and start of the UK sales programme. The UK's announcement, and the subsequent reaction to the gold sales programme, in part, acted as the catalyst for the European central banks' agreement of 26 September 1999. Furthermore, early negotiation, had it been possible, may have resulted in the scope of UK sales being limited.

PAC conclusion (iv): Analysis of the prices achieved in the auctions so far indicates that they are in line with the prices that would have been achieved if the London Gold Fix had been used, although interpretation of the figures entails judgement because of the sample size and the uncertainty over the possible impact of the sales on the London Gold Fix price (paragraph 35).

4. The Treasury agrees.

PAC conclusion (v): The Treasury considers that the outcome of the sales programme in relation to its objectives of reducing the riskiness of the portfolio can only be assessed meaningfully in the medium to long term, because in the meantime temporary fluctuations in asset prices could mask

the benefits of risk reduction. The Treasury is also prepared to face a loss as the price of diversifying the portfolio to reduce the risk. At the end of the gold sales programme a reasonable spread of data will be available on the components and weights of the currency benchmark, including the ability to provide protection against shocks to UK macroeconomic policy objectives and minimising market risks (paragraph 36).

5. The Treasury agrees with the Committee's comments. The Treasury is willing to consider accepting a lower return on the assets held if they are less risky. Other things being equal, the return on riskier assets tends to be higher in order to compensate the holder of the asset for the higher level of risk.

PAC conclusion (vi): We recommend that the Treasury should evaluate the programme at that stage, to determine the extent to which the riskiness of the portfolio has been reduced, and at what price or profit by comparison with not selling the gold, on stated assumptions (paragraph 37).

6. The Treasury accepts the Committee's recommendation and will undertake a review of the programme once the sales haves been completed in order to evaluate, including in risk and return terms, the impact of the sales on the portfolio.

On changes to the sales programme

PAC conclusion (vii): Since the sale programme began, the Treasury have carried out three assessments of the options available to sell gold, consulting market participants in the process. We endorse the Treasury's decision, as a result of these reviews, to sell smaller quantities of gold in each auction (paragraph 47).

7. The Treasury welcomes the Committee's endorsement of its decision to sell smaller quantities of gold at each auction in 2001-02. The decision to reduce the size of individual auctions was made following a periodic review of the sales programme undertaken by the Treasury and the Bank of England, which involved discussions with market participants.

PAC conclusion (viii): We also endorse the Treasury's decision to consult market participants as part of their series of reviews of the on-going sales process, because it is important in such programmes for departments to develop as close an understanding as possible of market sentiment and the concerns of other interested parties (paragraph 48).

8. The Treasury welcomes the Committee's endorsement of its decision to consult market participants as part of a series of reviews of the sales process undertaken with the Bank.