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Short-run and Long-run Determinants of the Price of Gold

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Executive summary

In 1833 the price of gold was $20.65 per ounce, about $415 in 2005 terms, while in 2005 the actual price of gold was $445 – a very small change in the real price of gold over a period of one hundred and seventy two years. Despite this apparent constancy in real terms over the long run, it is also true that, outside of periods when the gold price was fixed through various iterations of the gold standard, it has fluctuated significantly in the shorter term, sometimes for years at a time. Can these two apparently contradictory realities be reconciled? And can one be sure that the long run positive relationship between gold and inflation has persisted beyond the era of Bretton Woods? Indeed, is there any credence to the claim that gold can be used as a long-run hedge against inflation? The results reported in this paper provide some answers to these questions that are so central to the gold market and its many participants around the world.

We also address the inflation hedging properties of gold in the currencies of the major gold-consuming countries outside of the USA, taking into account both the domestic exchange rate relative to the dollar and domestic consumer price index movements. Real gold prices denominated in the home currency of investors outside of the USA also deviate in the short-run from their home country inflation hedge price and there is also a long-run tendency for gold prices to revert to the long-run hedge price. The major gold consuming countries outside of the USA, that is, India, China, Turkey, Saudi Arabia and Indonesia were rational to purchase gold in that it proved more than adequate as an inflation hedge. For these countries the actual USA dollar gold price between 1976 and 2005 far exceeded the dollar gold price required to provide an inflation hedge after taking account of exchange rates between the US dollar and the home country and the home country consumer price index movements.

Study framework

To answer the questions set out above, we develop a theoretical framework based on the simple economics of "supply and demand" that is consistent with the view that gold is an inflation hedge in the long-run, yet at the same time allows the price of gold to fluctuate considerably in the short run. In this model, the total supply of gold is a function of the price of gold, the gold lease rate, convenience yield, and the default risk premium. The short-run demand for gold is modelled as a function of the price of gold, the US dollar/world exchange rate, the gold lease rate, gold's beta, US inflation, US inflation volatility, credit risk and political uncertainty.

In theory, short-run fluctuations in the gold price are expected to be caused by political and financial turmoil as well as changes in exchange rates, real interest rates and the beta for gold.

We use cointegration techniques to analyse data from January 1976 to August 2005 to test the hypothesis that short-run movements in the gold price are indeed related to these factors, while the long-run price of gold moves with the general price level (consumer price index) to act as a hedge against inflation. The estimation model

hypothesises that the price of gold is determined by general price levels in the US and internationally, US and world inflation, US and world inflation volatility, world income, the US-world exchange rate, the gold lease rate, alternative investment opportunities, credit risk and time-specific uncertainty caused by political and/or financial risk.

Main findings

Three main findings emerge with respect to the analysis of the long-run determinants of the price of gold. First, there is a long-term relationship between the price of gold and the US price level. Second, the US price level and the price of gold move together in a statistically significant long-run relationship supporting the view that a one percent increase in the general US price level leads to a one percent increase in the price of gold. This evidence substantiates the belief that gold is a long-term hedge against inflation. Third, in the wake of a shock that causes a deviation from this long-term relationship, there is a slow reversion back towards it. The estimate of the error correction term is − 0.019, which implies that each month's error is about 2 per cent smaller than the previous month. In effect, this means that, in the aftermath of a shock, it typically takes around five years to eliminate two-thirds of the deviation from the long-term relationship between the price of gold and the US price level.

Short-run relationships between the following explanatory variables and changes in the gold price were found to be statistically significant. There was a positive relationship between gold price movements and changes in US inflation, US inflation volatility and credit risk. We found a negative relationship between changes in the gold price and changes in the US dollar trade-weighted exchange rate and the gold lease rate. The significant negative parameter on the "error correction mechanism" reflects the slow return of the gold price to its long-run relationship. These findings are in accordance with the theoretical framework put forward. However, on the basis of the empirical analysis, there was no significant relationship between changes in the price of gold and changes in world inflation, world inflation volatility, world income, and gold's beta.

These results are consistent with the widely held belief that there is a long-term one-for-one relationship between the price of gold and the general price level in the US. More specifically, a one per cent rise in US inflation raises the long-term price of gold by an estimated one per cent. A one percent increase in the long-term price of gold for a one percent rise in the general US price level lies within the 95 percent confidence interval. However, there are short-run deviations from the long-run relationship between the price of gold caused by short-run changes in the US inflation rate, inflation volatility, credit risk, the US dollar trade-weighted exchange rate and the gold lease rate. There is a slow reversion towards the long-term relationship following a shock that causes a deviation from this long-term relationship. It takes about five years for two-thirds of the long-term relationship between the price of gold and the general price level to be restored following any shock that causes a deviation in this long-term.

A major unresolved issue concerns gold as a long-run inflation hedge for countries other than the US. If the price of gold is quoted in US dollars and gold is an inflation hedge for

the US, holding gold is profitable for investors domiciled in countries whose currencies depreciate against the US dollar more than required to compensate for the difference between the country's and US inflation rate. It is surely no coincidence that the major gold consuming countries appear to be over-represented among countries that profited from holding gold because their currency depreciation against the US dollar exceeded that required to compensate for the inflation rate differences between the two countries. This relationship has not been rigorously examined in our analysis and a deeper investigation is warranted.

Policy implications

Finally, we turn to the policy implications of this analysis for potential investors in gold. One important implication concerns a likely US dollar depreciation required to restore balance to the US current account. There appears to be a consensus that US dollar depreciation is inevitable – the only issue being when it will occur and whether the adjustment path will be smooth or disorderly. Jarrett (2005) lists fourteen estimates of the dollar depreciation that would be needed to restore the imbalance in the US current account deficit. These estimates range between 12 per cent and 90 per cent. If gold is a long-run hedge against inflation, and if it is true that real dollar depreciation against other currencies is inevitable, US wealth holders should profit from holding gold during this period for two reasons.

The first reason is that the dollar depreciation will lower the price of gold to investors outside of the USA, and this will raise their demand for gold and raise the US dollar price of gold. That is in addition to the long-run relationship between the US price level and the price of gold. The second reason is that dollar depreciation will likely to raise US inflation rates, and gold would act as an inflation hedge during this period.

1. Introduction

In December 2005 the price of gold broke through the US$500 per ounce barrier for the first time since 1981. This price increase continued, reaching $548 by mid-January 2006. In April 2001, the price of gold was at a low of $260 (monthly average). Taking this date as a benchmark, the price of gold has effectively doubled in five years. Although this increase has without doubt been impressive, it was preceded by a long decline from an all-time monthly-average peak of $674 in September 1980.

From an economic and financial point of view, movements in the price of gold are both interesting and important. It is often argued that investment in gold is historically associated with fears about rising inflation and/or political risk. However, financial markets do not currently show the classic symptoms associated with such fears. US bond markets reveal long interest rates at a 35-year low below 5 per cent, while annual US inflation is around 3 per cent. The answer to this apparent paradox may lie in the extent to which the USA is in debt. Over the last three years, the cumulative trade deficit exceeded $1.8 trillion, while the current-account deficit reached $2 trillion. Last year the US current-account deficit reached 6.4 percent of GDP. There is good reason to think that this could result in a further major depreciation of the dollar (see box).

Dollar Depreciation

The US current account measures foreign trade including investment flows and foreign aid as well as sales of goods and services. The current account deficit is financed by convincing foreigners to hold more dollars which they invest in US stocks, bonds and US Treasury securities. To date, the USA has succeeded in attracting these investments. However, if foreigners were to reduce their purchases of dollar-denominated investments, the dollar could depreciate sharply in value against other currencies, reducing US stock prices and likely causing interest rates to rise and house prices to fall. This in turn could launch the US economy into a serious economic downturn.

There is a growing consensus amongst economists that depreciation in the international value of the US dollar is likely. The main factor behind this is the large increase in China's foreign currency reserves, which increased by 34 per cent in 2005 to a record high of $818.9 billion. China's dollar reserves have swollen in recent years as the Chinese Central Bank purchased most of the dollars generated by foreign trade and inward investment. China's trade surplus with the rest of world has more than tripled to $102 billion in 2005, up from $32 billion in 2004. Beijing re-valued the Yuan in 2005 for the first time in a decade, allowing it to appreciate slowly against the dollar within a narrow trading band. In early January 2006 it rose to a new strength of 8.06 to the dollar.

A recent OECD report (Jarret, 2005) gives five reasons for expecting the US current account deficit to continue to worsen, which will cause the dollar to weaken. First, imports are nearly half again as large as exports. Therefore the dollar value of the balance will grow unless export growth exceeds import growth by the same fraction. Second, United States growth in imports will exceed its growth of exports if its economy continues to expand faster than its trading partners. Third, the investment income balance is likely to deteriorate over time in view of the spread of returns between those earned by US residents on their investments and the average yield on foreign investments in the United States.

Fourth, the comparatively slow speed of ageing in the United States is expected to have a fairly sharp negative effect on the current account over the next couple of decades. Finally, most policies designed to achieve a substantial improvement in the balance entail second-round effects that tend to offset the initial helpful shock. For example, dollar depreciation raises costs and prices, which decreases competitiveness and eats away at the improvement in the trade balance.

There is debate as to whether the situation can be defused without some sort of abrupt reversal/crisis but whatever the adjustment path it is widely agreed that adjustment will entail some degree of dollar depreciation. The estimated depreciation that may be required ranges from a modest decline to as much as 90 per cent. In this Report we do not enter the debate as to whether the resolution of the current account US deficit will involve a soft or hard landing. It is sufficient for our purpose to emphasise that the adjustment is expected to require a significant degree of dollar depreciation, which will likely have a sizeable impact on prices of a wide range of financial assets, including gold.

The perceived long-term sustainability of the Euro is likewise in doubt. The credibility of the Euro has been damaged by the failure to agree a European Constitution that could provide a formal ownership of the currency. France and Germany have for the last four years breached the growth and stability pact rule that requires government budget deficits to be not more than 3 per cent of GDP. Under these circumstances gold represents a more credible means of preserving wealth compared with the alternative of holding US dollar denominated assets. Unlike paper money, turning on the minting presses cannot increase the supply of gold.

The current uncertainty over the dollar raises the profile of the traditional view that gold provides an effective "hedge" against inflation and other forms of uncertainty. However, the reality is that although gold may be an inflation hedge in the long-run, there is significant evidence of short-run price volatility (Aggarwal, 1992. Figure 1 shows the actual price of gold and the inflation hedge price in the period 1833 to 2005 (annual averages). The inflation hedge price is the dollar price that gold would have to be in order to maintain its 1833 purchasing power as measured by the US consumer price index. In 1833 the price of gold was $20.65 per ounce, about $415 in 2005 dollars, while

in 2005 the actual price of gold was $445 – a very small change in the real price of gold over a period of one hundred and seventy two years. Fitting a trend line indicates that the real price of gold increased on average by only about 0.04 per cent per year in this one hundred and seventy two year period. For the period 1833 to 2005, the price elasticity of gold with respect to the US Consumer Price Index (CPI) is + 0.9, which is not that different to "1". When viewed against this nearly two century time frame, long-run investment in gold appears to be a very effective long-run inflation hedge in the United States. Harmston (1998) has demonstrated that this is also the case in the UK, France, Germany and Japan.

Figure 1: US Dollar Price of Gold Required for Gold to be an Inflation Hedge in the United States, 1835-2005
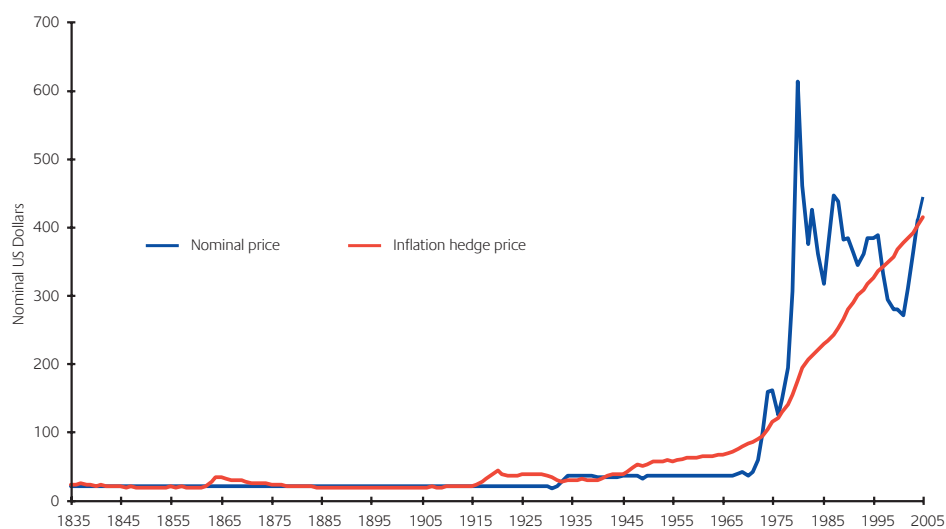

Figure 1 also reveals that over the last few decades, however, gold has not always been a reliable hedge against inflation. It seems to be the case that there is mean reversion towards a long run price of gold that causes the return to holding gold to be sensitive to the choice of the start date. Investors who bought gold in the 1960's or early 1970s when gold was below fair value would have gained relative to inflation, but investors purchasing gold in periods when gold was above fair value would have lost relative to inflation. For example, the nominal price of gold was $384 in January 1982, $283 in December 1999 and $510 in December 2005. The price of gold would need to have risen to $685 by December 1999 and $803 in December 2005 in order to be an effective inflation hedge. In other words, the real wealth of an investor in the USA buying gold in January 1982 and holding it to December 1999 would have fallen to 41 per cent of the value of the initial investment—a loss of 59 per cent in real terms. If the investor held the gold until December 2005 the real wealth of the investor would have fallen to 64 per cent of the initial investment—a loss of 36 per cent in real value. The timing problems would be facilitated if the long run price of gold and the short-run factors that cause deviation from this fair value price could be identified.

It is important to note that exchange rates between the US dollar and currencies of different countries fluctuate over time and inflation rates vary both between countries and over time. This, of course, is important since gold is denominated in US dollars. Therefore Figure 1 does not indicate whether or not gold acts an inflation hedge for countries other than the USA.

Before turning to examining the relationship between the price of gold and inflation in countries other than the USA, it is worth noting that the analysis presented below, which aims to understand the determinants of the price of gold, is heavily influenced by the economist's notion of "supply and demand". Therefore, it makes some sense to consider countries that are important in the production and consumption of gold. Table 1 shows the "top-20" gold producing countries while Table 2 shows the "top-20" gold consuming countries on the basis of end-use gold jewellery sales (Gold Survey 2006, GFMS Ltd.). Institutional investment demand, which can only be partly measured (and is not allocated by country) has also likely been an important influence on the price of gold.

Table 1: Top-20 Gold Producing Countries, 2005

Rank	Country	Production in Tonnes
1	South Africa	296.3
2	Australia	262.9
3	United States	261.7
4	China	224.1
5	Peru	207.8
6	Russia	175.5
7	Indonesia	166.6
8	Canada	118.5
9	Uzbekistan	79.3
10	Papua New Guinea	68.8
11	Ghana	62.8
12	Tanzania	48.9
13	Mali	45.9
14	Brazil	44.9
15	Chile	39.6
16	Philippines	31.6
17	Mexico	30.6
18	Argentina	27.9
19	Colombia	24.8
20	Venezuela	23
	Rest of World	277.8
Source: GFMS Gold Survey 2006, April 2006		

Table 2: Top-20 Gold Consuming Countries, 2005

Rank	Country	Jewellery Consumption (including scrap) tonnes
1	India	587.1
2	United States	349.0
3	China	241.2
4	Turkey	194.9
5	Saudi Arabia	146.2
6	United Arab Emirates	96.0
7	Indonesia	78.0
8	Egypt	75.3
9	Italy	71.0
10	Pakistan	65.1
11	Russia	64.5
12	UK & Ireland	59.4
13	Mexico	42.4
14	Thailand	40.9
15	South Korea	37.6
16	France	35.1
17	Japan	34.0
18	Brazil	33.3
19	Vietnam	26.9
20	Germany	24.6
Source GFMS Gold Survey 2006, April 2006		

Figure 2 shows the propensity for gold to act as an inflation hedge in the United States for the more recent period of 1976 to 2005. As the figure shows, the real price of gold for US investors is almost identical in 2005 compared to 1976. Nevertheless, there are deviations from the long-run hedge price in the shorter term. More specifically, in the period of the late-1970s to early 1990s, the nominal price of gold was above inflation hedge price. However, the opposite was the case from the late-1990s until 2005.

Figure 2: US Dollar Price of Gold Required for Gold to be an Inflation Hedge in the United States, 1976-2005 (Production Rank 3, Consumption Rank 2)

Figure 3 shows the propensity for gold to act as an inflation hedge in the period 1976 to 2005 in the "top-ten" gold producing and consuming countries. Certain countries, such as the United States, China and Indonesia, appear on both lists. Also, because of problems with finding reliable exchange rate and inflation data for Russia and Uzbekistan before the fall of communism, the figures for these two countries are for 1992 to 2005. Also for Uzbekistan because of data restrictions, the exchange rate is expressed in purchasing power parity (PPP) units. A comparison of these figures suggests that there is considerable variation in this relationship. For example, gold appears to be an excellent inflation hedge in China and India, as well as in those countries that have experienced hyperinflation in the period, such as Indonesia and Turkey. The figures also suggest that real gold prices denominated in the home currency of investors outside of the USA also deviate in the short-run from their home country inflation hedge price and there is also a long-run tendency for gold prices to revert to the long-run inflation hedge price.

Figure 3(a): South African Rand Price of Gold Required for Gold to be an Inflation Hedge in South Africa, 1976-2005 (Production Rank 1)
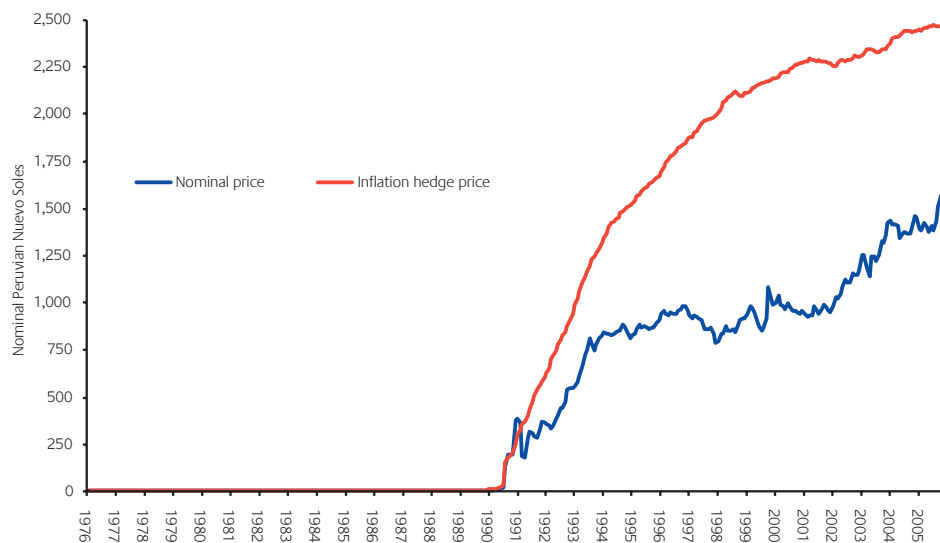

Figure 3(b): Australian Dollar Price of Gold Required for Gold to be an Inflation Hedge in Australia, 1976-2005 (Production Rank 2)
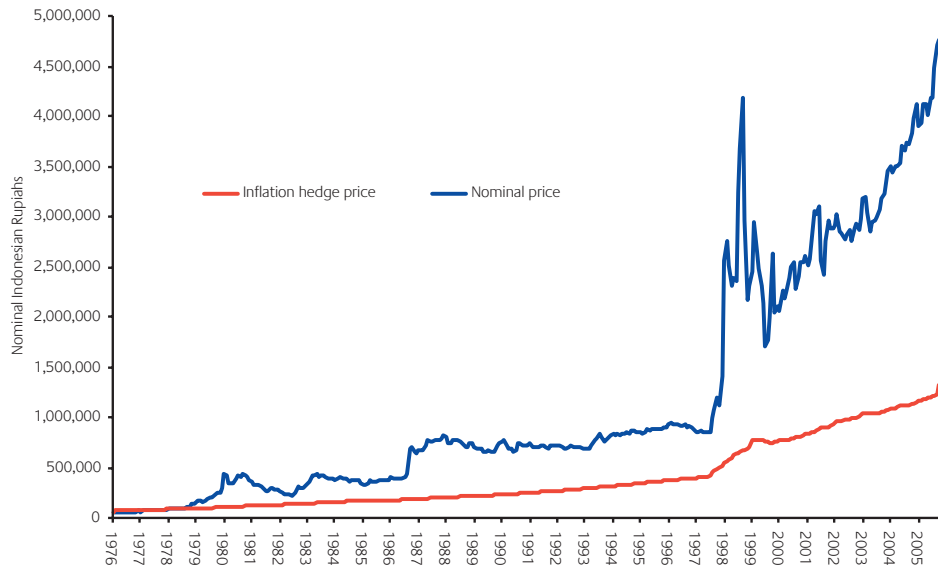
Figure 3(c): Chinese Yuan Price of Gold Required for Gold to be an Inflation Hedge in China, 1976-2005 (Production Rank 4, Consumption Rank 3)
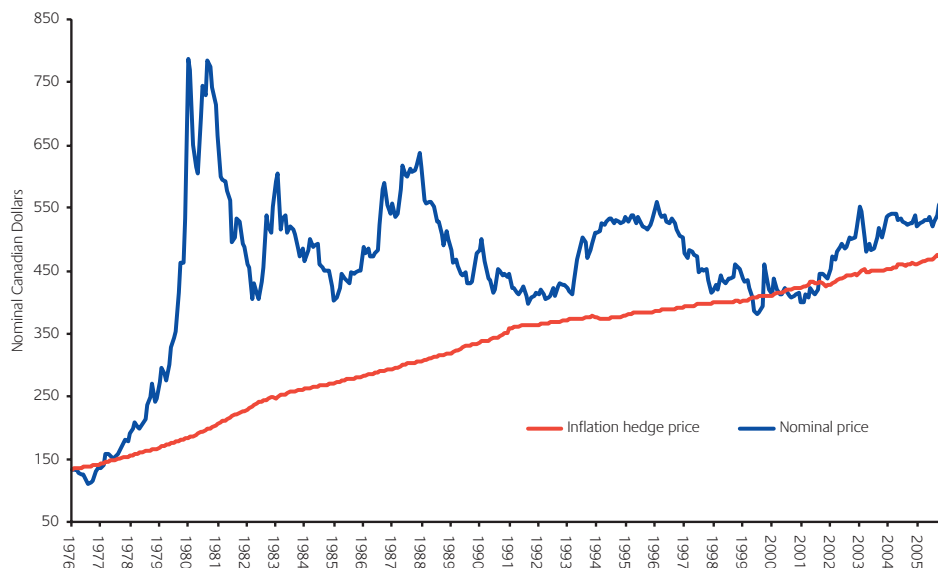

Figure 3(d): Peuvian Nuevo Sole Price of Gold Required for Gold to be an Inflation Hedge in Peru, 1976-2005 (Production Rank 5)
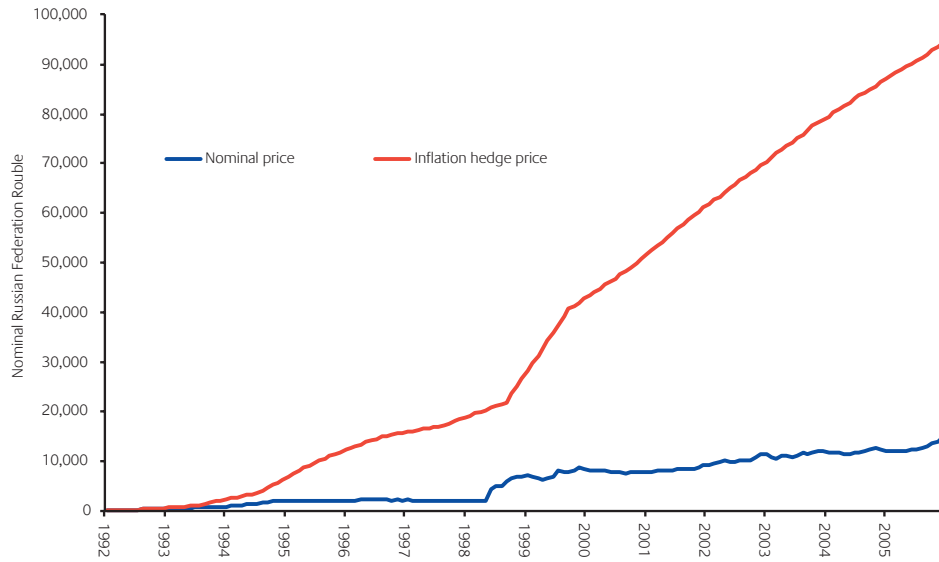
Figure 3(e): Indonesian Rupiah Price of Gold Required for Gold to be an Inflation Hedge in Indonesia, 1976-2005 (Production Rank 6, Consumption Rank 7)
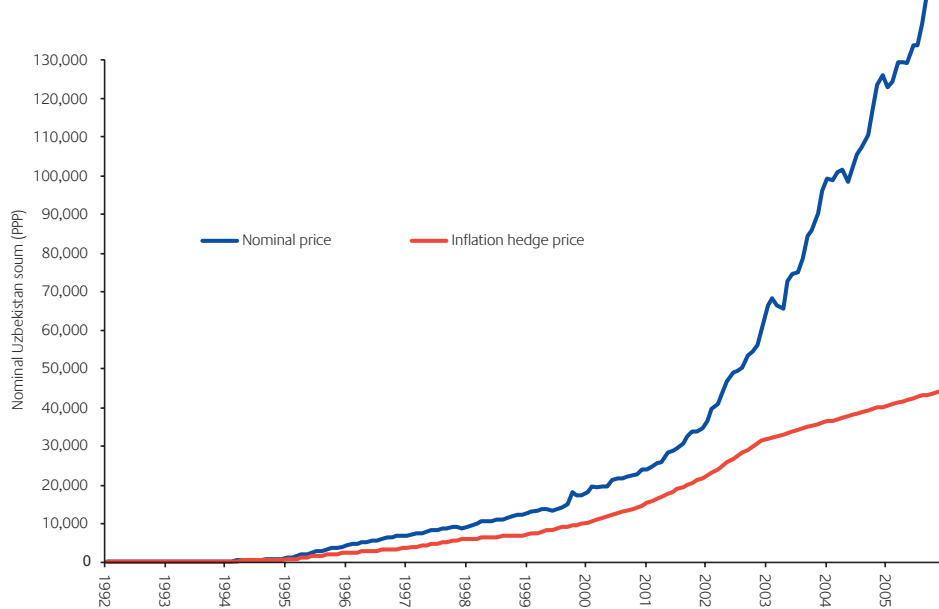

Figure 3(f): Canadian Dollar Price of Gold Required for Gold to be an Inflation Hedge in Canada, 1976-2005 (Production Rank 7)

Figure 3(g): Russian Rouble Price of Gold Required for Gold to be an Inflation Hedge in Russia, 1992-2005 (Production Rank 8)

Figure 3(h): Uzbekistan Soum Price of Gold Required for Gold to be an Inflation Hedge in Uzbekistan, 1992-2005 (Production Rank 9)

Figure 3(i): Papua New Guinea Kiva Price of Gold Required for Gold to be an Inflation Hedge in Papua New Guinea, 1976-2005 (Production Rank 10)
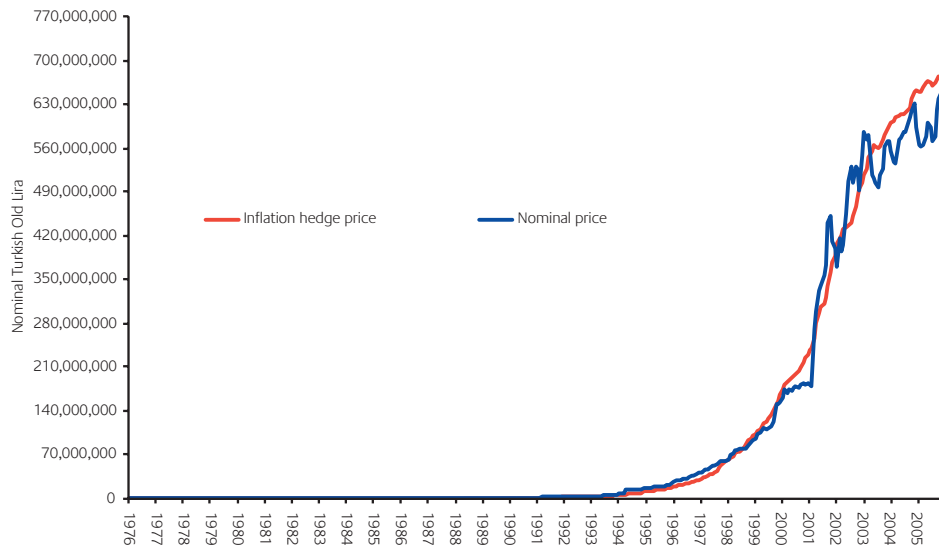

Figure 3(j): Indian Rupee Price of Gold Required for Gold to be an Inflation Hedge in India, 1976-2005 (Consumption Rank 1)

Figure 3(k): Turkish Lira Price of Gold Required for Gold to be an Inflation Hedge in Turkey, 1976-2005 (Consumption Rank 4)

Figure 3(l): Saudi Riyal Price of Gold Required for Gold to be an Inflation Hedge in Saudi Arabia 1976-2005 (Consumption Rank 5)

Short-run and Long-run Determinants of the Price of Gold
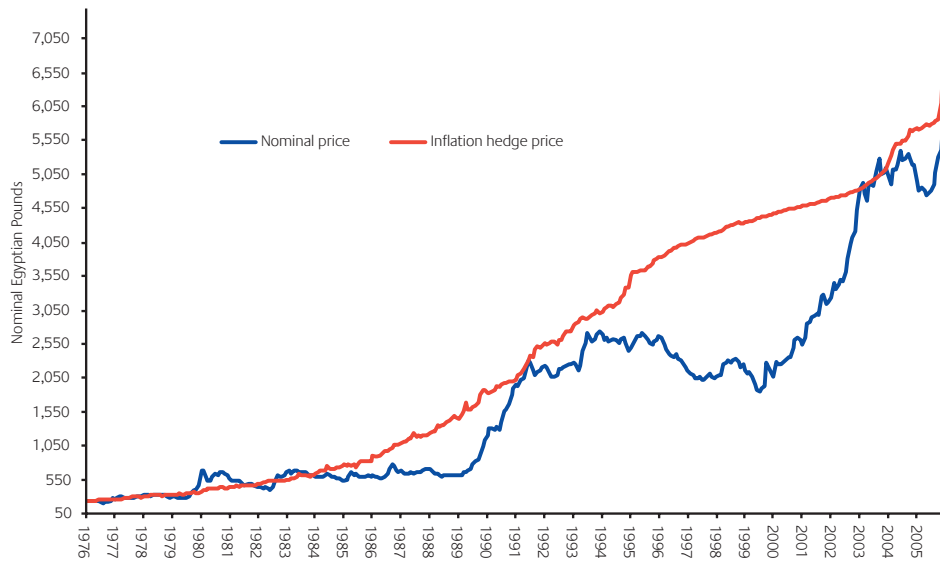
Figure 3(m): United Arab Emirates Dirham Price of Gold Required for Gold to be an Inflation Hedge in UAE, 1976-2005

Figure 3(n): Italian Lira Price of Gold Required for Gold to be an Inflation Hedge in Italy, 1976-2005 (Consumption Rank 8)

Figure 3(o): Egyptian Pound Price of Gold Required for Gold to be an Inflation Hedge in Egypt 1976-2005 (Consumption Rank 9)

Figure 3(p): Pounds Sterling Price of Gold Required for Gold to be an Inflation Hedge in the United Kingdom, 1976-2005 (Consumption Rank 10)

Figure 4 shows home country inflation hedge gold prices between 1976 and 2005 expressed in dollar prices for ten countries. This figure clearly shows that the major gold consuming countries outside of the USA, that is, India, China, Turkey, Saudi Arabia and Indonesia were rational to purchase gold. For these countries the actual US dollar gold price far exceeded the dollar gold price required to provide an inflation hedge after taking account of exchange rates between the US dollar and the home country and the home country consumer price index movements. If the price of gold is quoted in US dollars and gold is an inflation hedge for the USA, holding gold is profitable for investors domiciled in countries whose currencies depreciate against the US dollar by more than what is needed to compensate for the difference between the country's and US inflation rate.

Whether investors in any particular country gain or lose by holding gold depends on the start date when gold is purchased and the length of the holding period. More specifically, it is far more likely to be profitable to invest in gold when the nominal price of gold is below its inflation hedge price. Conversely, it more likely to be unprofitable to invest in gold when the nominal gold price is above its inflation hedge price. In both cases the US dollar price at 1976 is expressed in the local currency at 1976. This local currency gold price is uplifted by the local price index for each time period to ensure that gold is a local hedge against inflation, and this local currency inflation hedge price is then converted back to US dollars at the exchange rate ruling at that time period.

Figure 4: Dollar Price of Gold Required for Gold to be an Inflation Hedge in Ten Countries, 1976-2005
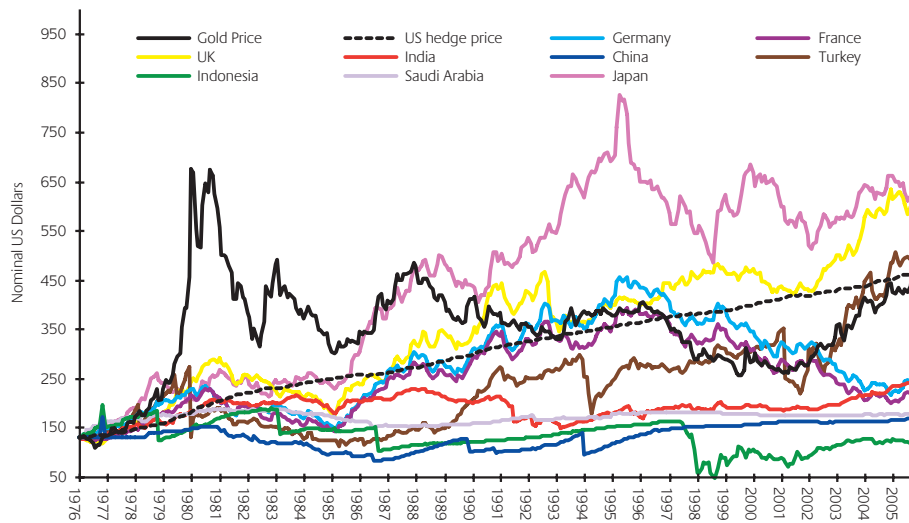

Figure 4 provides prima facie evidence that justifies the countries that were the most active purchasers of gold. Gold out-performed the inflation hedge benchmark in these countries because their currencies depreciated faster than their inflation rate gap with the US inflation. For example, Indian consumer prices in 2006 are ten times higher than

in 1976 while US consumer prices in 2006 are four times higher than in 1976. Rupees per US dollar rose from 9 to 45, five times more than 1976. Consequently gold greatly outperformed the inflation hedge price for an Indian investor while gold acted as an inflation hedge for a US investor between 1976 and 2005.

An Indian investor buying and holding dollars instead of gold would have enjoyed the same gains plus the additional interest that dollar-denominated assets would have earned, and without facing the risk that gold might not be an inflation hedge. (The investor would, of course, have lost the utility from wearing jewellery, if gold was bought in that form as was more often the case, and the other cultural benefits of gold.) Thus it might seem that holding real interest-bearing dollar-denominated assets would be preferable to holding gold, provided that gold is a US inflation hedge and there is no expectation of real dollar depreciation against the rupee. However, the earlier discussion suggests that real US dollar depreciation is inevitable. Under these circumstances it is preferable for the Indian investor to hold gold rather than US dollar-denominated assets provided that gold acts as an US inflation hedge.

The main purpose of this report is to examine empirically the short-run and long-run determinants of the price of gold. The proposition that gold is a long-run inflation hedge is explored while incorporating a number of systematic economic factors that cause the price of gold to temporarily deviate from its long-run price. We examine the hypothesis that the long-run price of gold rises one for one with the general price level within a theoretical framework that reconciles the observed short-run volatility of the gold price with it also being a long-run inflation hedge. A large number of issues such as exchange controls and capital controls that affect the price of gold by impeding the smooth operation of markets are not included in our analysis. The purpose of our exercise is to find a parsimonious economic model that explains most of the price behaviour, in which the outliers and deviation from the fitted values will always have interesting but unique stories to tell.

The remainder of this report is organised as follows. Section (2) presents a theoretical framework, based in the simple economics of "supply and demand", that is consistent with the view that gold is an inflation hedge in the long-run, yet at the same time, the price of gold can fluctuate considerably in the short-run. Section (3) is a time-series statistical analysis aimed at testing some of the key hypotheses generated by this theoretical framework. Conclusions and recommendations follow in Section (4).

2. Determinants of the Price of Gold

Assuming that the short-run price of gold is determined by supply and demand, it will fluctuate on a period-by-period basis in response to variables that alter the supply and/or demand for gold. We start by discussing factors that influence the short-run supply of gold. Central banks have been willing to lease gold since the early 1980's (see O'Callaghan 1991). Gold producers (i.e. mines) can implicitly supply their customers by leasing gold from central bank gold reserves, through a bullion bank intermediary, as well as extracting it from their mines. The quantity of gold supplied from extraction in any period is positively related to the gold price in an earlier period because there may be a substantial time lag before mines react to a price change. The quantity of gold supplied from extraction is also negatively related to the amount of extracted gold that is diverted to repay central banks for the gold leased in the previous period incremented by a physical interest rate in those cases where the central bank opts for interest to be repaid in gold. Therefore the total supply of gold to the market in each period from extraction is positively related to the lagged gold price, negatively related to the amount of gold leased in the previous period and negatively related to the gold lease rate in the previous period.

Central banks forgo convenience yield, which is the benefit associated with actually physically holding gold for one period on the gold they have leased out in return for the gold lease rate. The amount of gold supplied by central banks for leasing is determined by central bank lenders adjusting their gold reserves to the point where the physical rate of interest they receive is equal to the convenience yield forgone to the central banks from holding gold plus a default risk. In equilibrium, the lease rate is equal to the convenience yield plus default risk. Therefore a fall in the physical interest rate, a rise in default risk or a rise in convenience yield caused by political or financial turmoil would reduce the quantity of gold leased to the industry from central banks in that period. However, the repayment of gold leased in the previous period also impacts on the current period supply. The total supply of gold in any given period fluctuates in response to the current price, gold lease rate, convenience yield and default risk, and also the previous period quantity of leased gold to be repaid at the previous physical interest rate (when appropriate). The previous period quantity of leased gold to be repaid depends on the previous period convenience yield and default risk. Therefore the total supply of gold depends on the current price of gold and the current and lagged values of the physical interest rate, the convenience yield, and the default risk premium.

There are two components to the short-run demand for gold. The first category consists of the "use" demand for jewellery, medals, electrical components etc. The "use" demand for gold is a negative function of the price of gold. The demand for jewellery is also affected by price volatility but the impact of this variable may be too short-term to affect this analysis. The second category is the "asset" demand for gold as an investment. This demand is based on a number of factors including dollar exchange rate expectations, inflationary expectations, "fear", the returns on other assets and the lack of correlation with other assets. There has been considerable debate surrounding the assertion that gold reduces portfolio volatility because the types of events that cause stock prices to

collapse also tend to raise the price of gold. That is, there is disagreement about the claim that gold has a "negative beta" because the returns to holding gold have the opposite sign to the returns on a market portfolio (beta is equivalent to the correlation of returns). We include this motivation to hold gold since the theoretical justification is unaffected by the debate. The debate about the beta of gold is an empirical issue and the relationship has been demonstrated to hold over some time periods.

The effectiveness of gold in reducing portfolio risk is inversely related to beta which measures the extent to which the price of gold moves in the opposite direction from the stock market. Generally the empirical evidence shows that on average there is no correlation (see Lawrence, 2003; O'Connell, 2005; Pulvermacher, 2005a, b). However, the correlation between the returns on holding gold and the returns on the stock market become negative for short periods when the stock markets under-perform very badly. If the beta for gold rises for a period of time, the portfolio demand for gold will fall during that period. Therefore the demand for gold as an investment is negatively related to the current beta and positively related to the lagged values of beta.

Holding gold precludes earning interest on holding an alternative interest bearing asset.

The real interest rate forgone is the cost of holding gold. Therefore the asset demand for gold will fluctuate in response to changes in the real interest rate as well as gold's beta. There have been occasions when the gold price has moved in line with interest rates, although the norm is for the price to move inversely with interest rates. For example, gold prices and interest rates both rise if the rising interest rates reflect concern over inflation or over the US dollar. The relationship between interest rates and the gold price depends on a clear distinction between real and nominal interest rates and the precise cause of the rise in interest rates.

The market price of gold is determined where supply is equal to demand. However, as explained above, the supply and demand for gold and therefore the equilibrium short-run gold price will fluctuate in response to changes, *inter alia*, in the gold lease rate, convenience yield, default risk, the beta for gold and the real interest rate. There is an arbitrage relationship (see Levin, Abhyankar and Ghosh, 1994) that drives the physical interest rate (the gold lease rate) into equality with the real interest rate. Theoretically, in equilibrium, a mine is indifferent between extracting gold now and selling the mined gold now, and leasing gold now, selling the leased gold now, investing the proceeds of the sale in a bond, selling the bond in one year and using the proceeds including interest to pay for extracting the gold plus the physical interest rate. If the cost of extraction rises at the general rate of inflation, the gold lease rate is equal to the real interest rate.

The gold lease rate, therefore, can be used as an empirical proxy for the real interest rate in the empirical analysis of the short-run gold price. The theoretical analysis of the short-run gold price implies that there will be fluctuations in the gold price caused by political and financial turmoil as well as changes in real interest rates and the beta for gold that will cause divergences from the long-run inflation hedge price.

The long-run price of gold is expected to rise in line with inflation and act as an inflation

hedge essentially because the long-run price of gold is related to the marginal cost of extraction and if the cost of production rises at the rate of inflation, the price of gold will rise at the same rate. This conclusion is not affected if gold producers implicitly supply their customers by leasing from central banks as well as by extracting gold from mines. Since this gold has to be repaid it only affects supply in the short term. Profit maximising behaviour by gold producers ensures that the cost of gold from leasing is equal to the cost of gold from extraction. If this was not the case then the cost of gold from one source would not be equal to the cost of gold from the other source. In this situation, profit could be increased by sourcing a higher proportion from the less costly source.

The long-run price of gold will be equal to the marginal cost of gold extraction if the market is competitive or proportional to the marginal cost of gold extraction if gold producers have market power. In either case the long-run price of gold will rise at the general rate of inflation. The theoretical basis that enables the gold lease rate to be used as a proxy for world real interest rates in the empirical analysis requires that the marginal cost of extraction rises at the general rate of inflation over the sample period. It is of course possible that technical progress may negate this assumption over longer time periods.

There are a large number of studies that have attempted to statistically model the determinants of the price of gold. Basically these studies follow three main approaches. The first approach models variation in the price of gold in terms of variation in main macroeconomic variables (e.g. Ariovich, 1983; Dooley, Isard and Taylor, 1995; Kaufmann and Winters, 1989; Sherman, 1982, 1983, 1986; Sjaastad and Scacciallani, 1996). The second approach focuses on speculation and the rationality of gold price movements (Baker and Van Tassel, 1985; Chua, Sick and Woodward, 1990; Diba and Grossman, 1984; Koutsoyiannis, 1983; Pindyck, 1993). The third approach examines gold as a hedge against inflation with particular emphasis on short-run and long-run relationships (Chappell and Dowd, 1997; Ghosh et al, 2004; Kolluri, 1981; Laurent, 1994; Mahdavi and Zhou, 1997; Moore, 1990; Ranson, 2005a, b). The analysis in our paper extends the third approach by including political and financial risk variables into the econometric analysis.

3. Empirical Analysis

The analysis above shows that the long-run price of gold will rise at the general rate of inflation as long as extraction costs rise with inflation. At the same time the short-run price of gold may fluctuate in response to political and financial shocks that cause convenience yield and default risk to alter, as well as changes in real interest rates and the beta for gold. Taken together, the theory reconciles the widely held belief that gold represents a hedge against inflation with clear evidence of short-run movements in gold prices that are not related to inflation. In this section cointegration techniques are used to test the hypothesis that short-run movements in the gold price are related to these factors, while the long-run price of gold moves with the general price level to act as a hedge against inflation.

3.1 Model

A simple empirical model based on the supply and demand explanation of movements in the price of gold presented in Section 2 can be written as:

$$Pg = f(P_{USA}, \pi_{USA}, V(\pi)_{USA}, P_{WORLD}, \pi_{WORLD}, V(\pi)_{WORLD}, Y_{WORLD}, ER, Rg, \beta g, CRDP, Risk, \theta)$$

where:

Pg is the nominal price of gold measured in nominal $US per ounce;

P_{USA} is the consumer price index in the USA;

π_{USA} is the rate of change in the US retail price index;

$V(\pi)_{USA}$ is the volatility of US inflation measured as the standard deviation divided by the mean of the last 12 months;

P_{WORLD} is the IMF "World" price index;

π_{WORLD} is the rate of change in the World price index;

$V(\pi)_{WORLD}$ is the volatility of World inflation measured as the standard deviation divided by the mean of the last 12 months;

Y_{WORLD} is world income;

ER is the "Nominal Major Currencies Dollar Index", which is a trade weighted exchange rate of the dollar to the rest of the World;

Rg is the gold lease rate;

βg is "Gold's Beta" which is return on gold regressed on the return on the Standard and Poor 500 index.

$CRDP$ is the credit risk default premium;

$Risk$ is an index of political risk; and

θ is a set of dummy variables aimed at capturing unmeasured determinants of the price of gold.

In a nutshell, the model hypothesises that the price of gold is determined by the US and world price levels, US and world inflation, US and world inflation volatility, world income, the US-world exchange rate, the gold lease rate, alternative investment opportunities, credit risk and time-specific uncertainty caused by political and/or financial risk. The data used in the modelling are monthly observations covering the period January 1976 to August 2005. It is worth noting (as is discussed below) that the political risk index is only available from January 1984 onwards, which has consequences for the way in which the price of gold is modelled. Each of the variables are defined further below. Data sources are given in the Appendix.

3.2 Description of Variables

The price of gold (Pg) is the monthly average spot dollar price per ounce. The general price level in the USA (P_{USA}) and the world (P_{WORLD}) are included as explanatory variables in order to test the hypothesis that the price of gold moves with the general price level so that gold can be considered as a long-run haven against inflation. The world index (non-adjusted IMF World Consumer Price Index) is included because there is no single measure of the general price level that applies to all investors. The inclusion of this should control for the fact that we do not know to what extent the price of gold is determined by investors inside and outside of the USA. Consequently, two measures of the general price level are used in the empirical analysis. The US price index measures the general price index for investors living in the USA, while the world price index measures the general price level for investors outside of the USA.

US and world inflation rates (π_{USA} and π_{WORLD}) and inflation volatilities, [$V(\pi)_{USA}$ and $V(\pi)_{WORLD}$] are included as variables that influence the price of gold because it is hypothesised that the demand for gold as an inflation hedge will rise during periods of high inflation and high inflation volatility. Volatility is measured as the coefficient of variation for inflation over the previous 12 months.

World income (Y_{WORLD}) is included as a control in order to avoid bias in the estimated long-run relationship between the general price level and the price of gold because it is possible that long-run increases in the level of world income might affect the long-run price of gold via increased demand for jewellery and for gold as an investment.

The US-world exchange rate (ER) is included as an explanatory variable to control for movements in the price of gold denominated in US dollars caused by exchange rate movements that are not associated with changes in the relative price levels between the USA and the rest of the world. The spot dollar/world currencies exchange rate controls for gold dollar price movements attributable to gold market activity outside of the dollar area caused by exchange-rate-determined changes in the non-dollar gold price. The exchange rate used is the "nominal major currencies dollar index".

The gold lease rate (Rg) influences the demand for gold because, being a proxy for the world real rate of interest (see Levin, Abhyankar and Ghosh, 1994), it provides a measure of the opportunity cost of holding gold. It is calculated by subtracting the three-month

gold forward rate from three-month LIBOR dollar interest rate. Gold was not leased every day during the early years. Therefore to avoid the problem of stale prices we use price and rates averaged over the month for the entire sample period. It is important to note that gold leasing only commenced in 1982. Therefore, in the modelling (which begins in 1976), the impact of gold leasing on the price of gold before 1982 is constrained to be zero.

Golds's Beta (βg) influences the portfolio demand for gold in accordance with gold's ability to reduce portfolio volatility. It was calculated by regressing the monthly gold return on the monthly *"Standard and Poor500 Index"* (dividends reinvested) return, based on information from the previous 36 months.

Credit risk default premium (*CRDP*) is included because the demand for gold is expected to be higher during periods of financial turmoil. Default risk is associated with financial shocks and structural changes in the international economy. For example, a financial shock occurred following the collapse of Drexel Burnham Lambert in 1990 with large outstanding gold liabilities to central banks. Another possible example would be the collapse of LTCM in 1998. The credit risk default premium is a measure of financial credit risk. It is calculated as the yield gap between *"Moody's Seasoned Aaa Corporate Bond Yield"* and *"Moody's Seasoned Baa Corporate Bond Yield"* expressed as proportion.

Political risk (Risk) is measured by an index of global political risk constructed by the *"International Country Risk Guide"* It is a monthly indicator of political risk and uncertainty for 143 countries. However, it is only available after January 1984. Each value is the aggregated score over 12 components of political risk that include government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability and bureaucracy quality. Each component is assigned a maximum numerical value of "risk points", with a higher number of points indicating a lower risk for that component. After this has been done for each of the 12 components, they aggregated to form a composite index of political risk.

3.3. Statistical Methods

The statistical methods used to identify the key determinants of the price of gold are "cointegration regression techniques". This method can be used to isolate the factors that are correlated with movements of a variable in both the short-run and long-run. For example, what causes the variables to fluctuate in the short-run around a long-run trend? In this sense, the method is well suited to modelling movements in the price of gold. The results of this analysis are discussed below in a qualitative manner. Since the method is complicated, all the technical details relating to the "nuts and bolts" of the analysis are laid out in the Appendix.

The fact that the political risk index is only available for 1984 onwards complicates the analysis further. In an attempt to deal with this, a set of models were estimated over the complete 1976-2005 time period that do not include the risk variable. In these models, a

set of ad hoc period-specific dummy variables were included in order to control for residual spikes not "explained" by the included explanatory variables. It is our view that that these spikes are caused by political risk generated by events such as the fall of the Berlin Wall, the Falklands War, the invasion of Kuwait by Iraq, the invasion of Iraq by the USA, etc. The model is then re-estimated over the shorter 1984-2005 period, including the measure of political risk. Although this strategy is less than ideal, there is little else that can be done, since we were not successful at locating a suitable measure of political risk for the earlier period. However, before turning to discussing the results, it is useful to first examine trends in each of these variables.

3.4 Trends in Explanatory Variables

In this section we start by examining the bivariate relationships between the market price of gold and each of the explanatory variables. However, it is important to note that this descriptive analysis may reveal spurious trends and correlations. The subsequent multivariate analysis holds other factors constant while examining the effect of each variable on the price of gold. Figures 5-17 shows the individual relationships between the nominal price of gold (denominated in US dollars) with each of the explanatory variables. Figure 5 is for US price index (P_{USA}), while Figure 6 is for the world price index (P_{WORLD}). Figure 7 puts both indexes together starting from a common base of 100 in 1968. While both variables trend upwards, the trajectory of the world price index is much steeper than the US price index. The trends shown in these figures are consistent with the view of a likely long-run relationship between the price of gold and the general price level, and that gold is a long-run hedge against inflation. However, there are significant deviations between movements in the price of gold and the general price level in the short-run. It is clear that gold is not a short-run hedge against inflation.
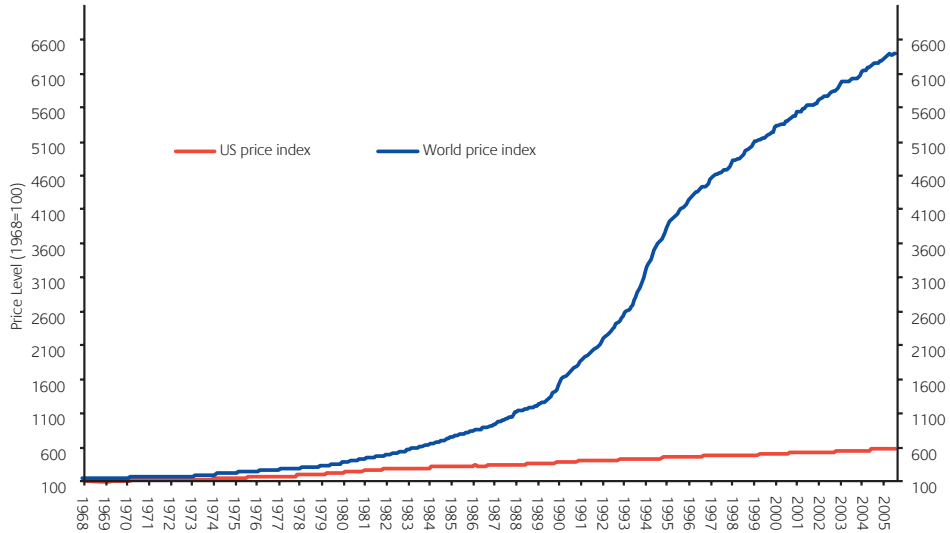
Figure 5: Price of Gold and US Consumer Price Index 1968-2005

Figure 6: Price of Gold and World Consumer Price Index 1968-2005

Figure 7: US and World Consumer Price Indices 1968-2005


Figures 8 and 9 plot US inflation (π_{USA}) and world inflation (π_{WORLD}), respectively. Both suggest that the price of gold is higher during periods of high inflation. This is clear for the periods 1972-1974, 1978-1982 and 1997-1998. However, this relationship does not appear to hold between 1986-1989 and 2002-2005. Figure 10 is US inflation volatility $[V(\pi)_{USA}]$ and Figure 11 is world inflation volatility $[V(\pi)_{WORLD}]$. Once again there appears

to be a relationship between the price of gold and inflation volatility in the periods 1973-1975, 1980-1982, and around 1987. However, in other periods, this relationship is not clearly visible.
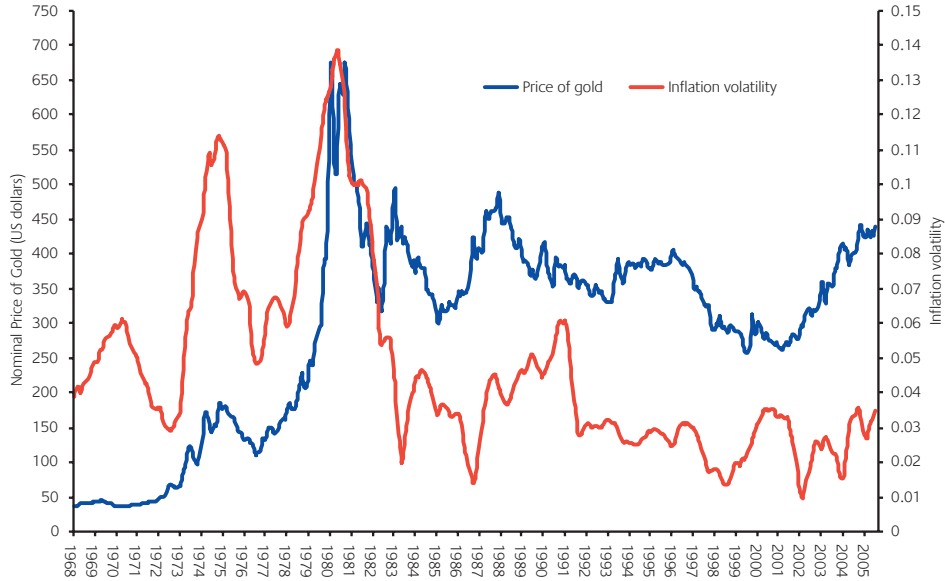
Figure 8: Price of Gold and US Inflation 1968-2005

Figure 9: Price of Gold and World Inflation 1968-2005
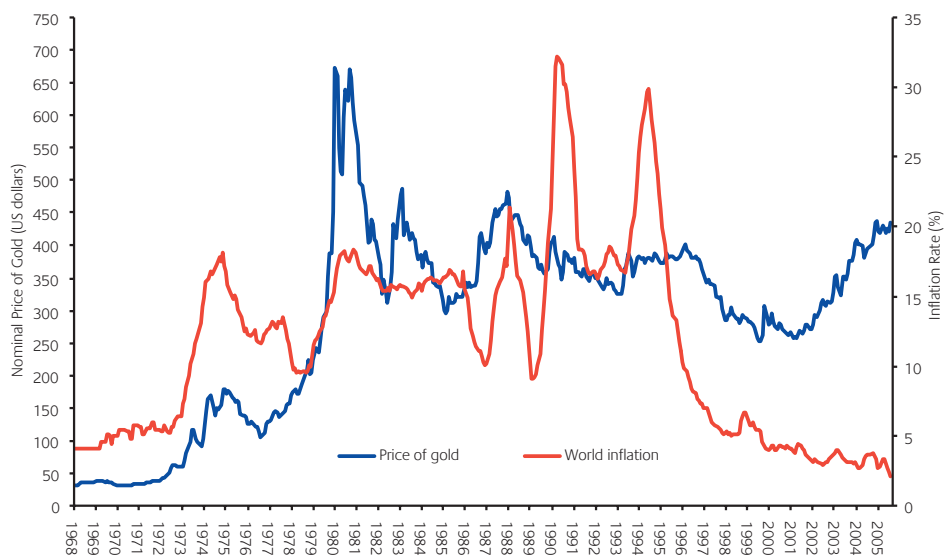
Figure 10: Price of Gold and US Inflation Volatility 1968-2005

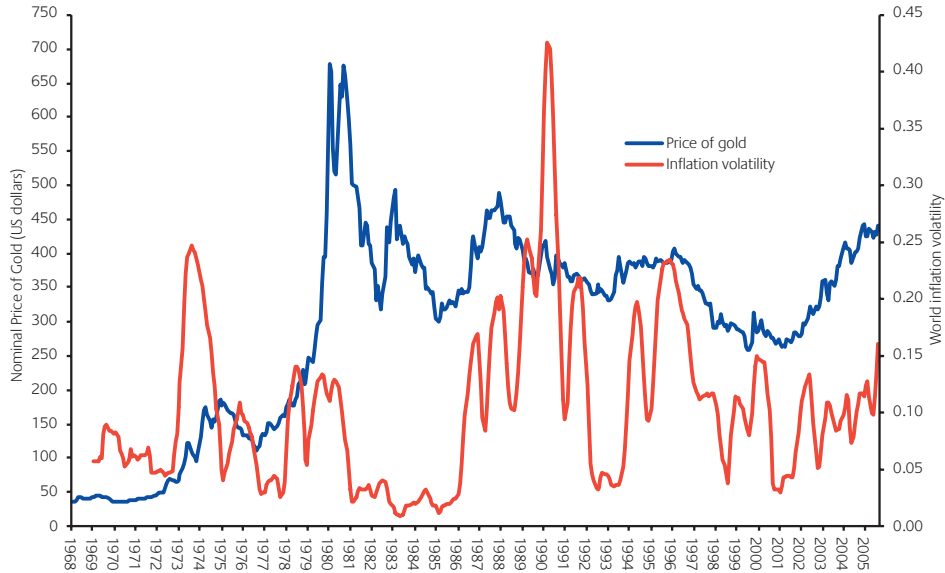**Figure 11: Price of Gold and World Inflation Volatility 1968-2005**

Figure 12 plots world income (Y_{WORLD}), which trended upwards in this period. However, it is difficult to interpret this relationship because income and the price level both rose over time, and it is necessary to examine this in a multivariate analysis in order to disentangle these two effects. Figure 13 shows a clear negative relationship between the gold price

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and the US dollar-world exchange rate (*ER*). This is in accord with prior expectations. This index is a weighted average of the foreign exchange value of the US dollar against a subset of the broad index currencies that circulate widely outside the country of issue. A rise in the price of dollars makes gold more expensive for investors outside of the dollar area, and this will depress the demand for gold and this in turn lowers the price of gold. This is clearly seen in Figure 13, and is in agreement with Capie *et al* (1990).

**Figure 12: Price of Gold and World Per-capita Income 1968-2005**

Figure 13: Price of Gold and US Trade-weighted Dollar Exchange Rate Index 1968-2005

Figure 14 is for gold lease rate (Rg). Theory suggests that the gold price should be higher when the gold lease rate is low, which is analogous to the relationship between inflation indexed bond prices and real market interest rates (see Basta *et al*., 1996; Kinney, 1999). This certainly appears to be the case from 2000 onwards. However, the relation is not so clear for the other years. There are nevertheless some indications of the hypothesised negative relationship between the lease rate and the real gold price. For example, the real price of gold moved in the opposite direction from the lease rate in 1982, 1989, 1990, 1993 as well as 2000 onwards. It is interesting to note that lease rate has large spikes in periods when central banks required very much higher physical interest rates on their gold loans. These spikes would have been caused by sudden rises in the real interest rate, convenience yield, or default risk.

Figure 14: Price of Gold and Gold Lease Rate 1982-2005
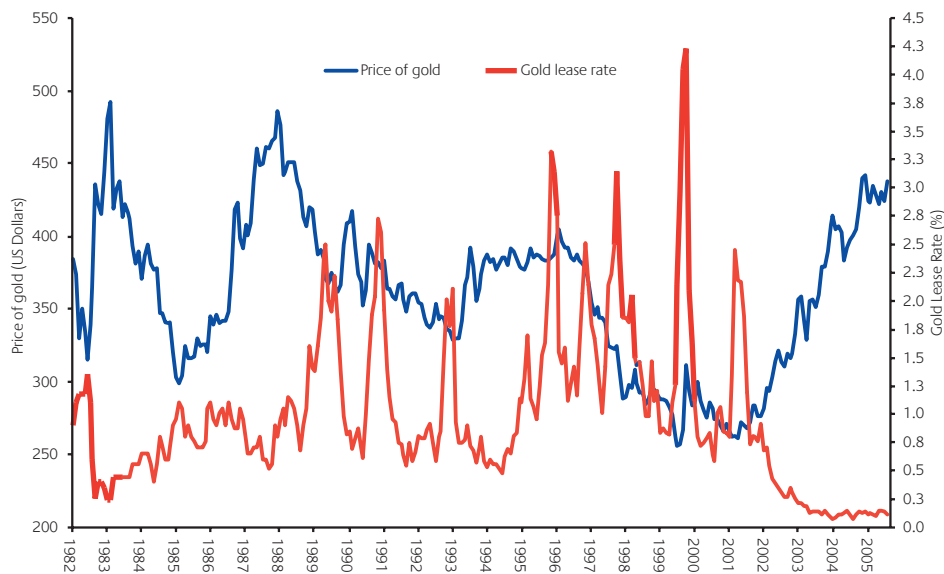
There should be a negative relationship between the price of gold and the gold's beta (βg). A negative beta makes gold attractive for investors to hold in a portfolio because a negative beta makes gold reduce portfolio volatility. Figure 15 indicates a positive relationship between gold's beta and the price of gold between 1978 and 1986, and a negative relationship for most of the remaining periods. The ambiguous relationship between the price of gold and gold's beta may be accounted for by the theoretical expectation that the sign of the relationship between gold and its beta should reverse for lagged values of beta. Whatever the reason, the ambiguity of this relationship suggests that investors would need perfect foresight were they to seek exposure to gold only during periods when it has a negative beta.

Figure 15: Price of Gold and Gold's Beta 1968-2005

Figure 16 plots the credit risk default premium (*CRDP*). Theory suggests that the price of gold should be lower during periods of low credit risk when central banks are more willing to lease gold. There is some indication of this relationship during the 1990s. However, the multivariate analysis is needed to establish the relationship holding other factor constant because credit risk is likely associated with other explanatory variables such as the real interest rate.

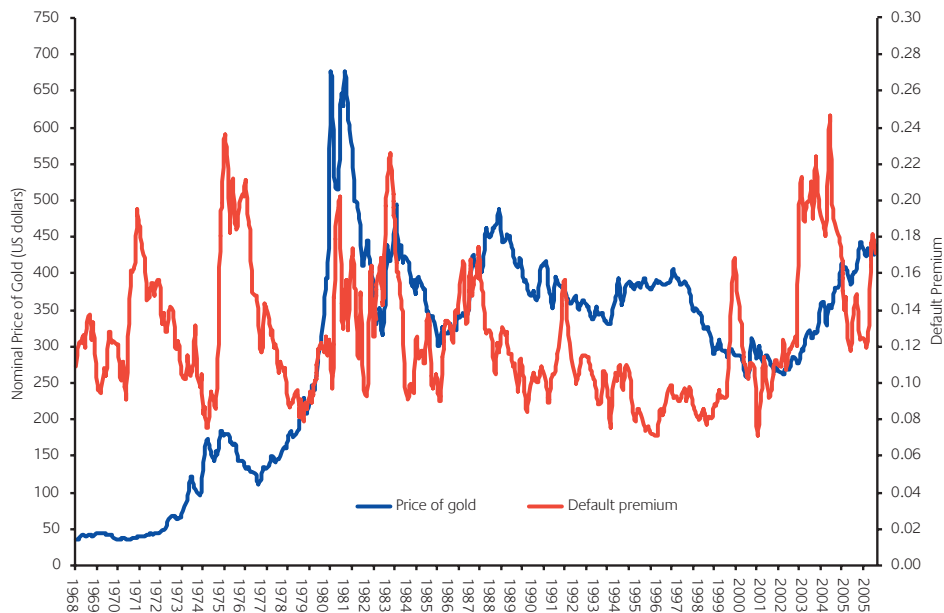**Figure 16: Price of Gold and Credit Risk Default Premium 1968-2005**

Figure 17 is the plot for the political risk index (*Risk*). The price of gold should be positively related to political risk. A higher score on the political risk index indicates lower political risk. Therefore we expect to see a negative relationship between the gold price and the political risk index. There is evidence of this relationship in the late 1980s and in the period 1996-2005.

Figure 17: Price of Gold and the Political Risk Index (1984-2005)
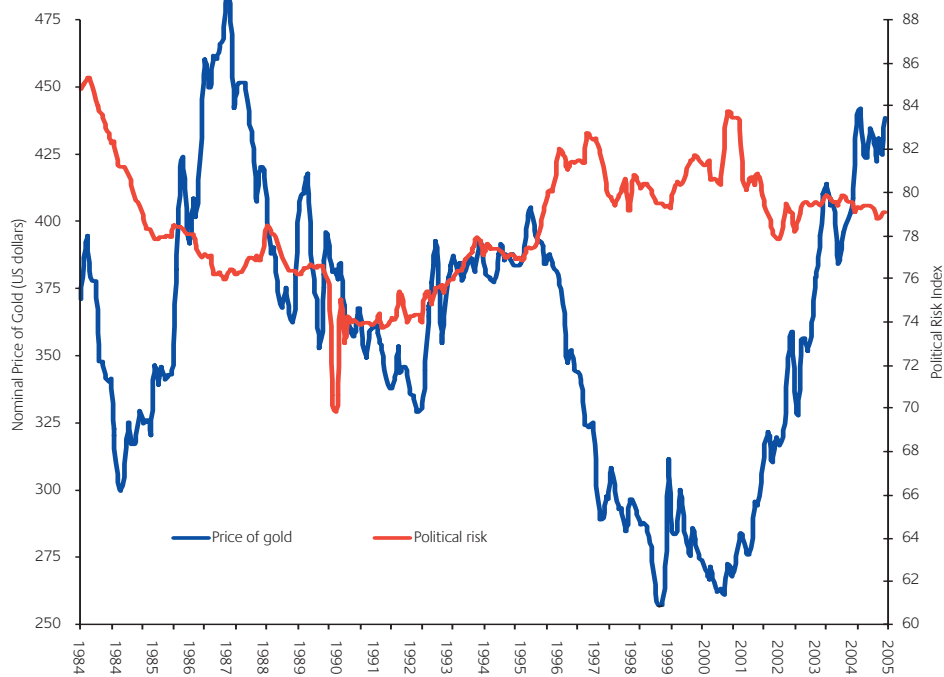
3.5 Main Findings

3.5.1. Long-term Relationships

The long-term price refers to the equilibrium price of gold in relation to the general price level after all shocks to the gold price caused by the other short-run variables have been washed out. The theoretical section presented in Section 2 suggests that there should be a long-run one-to-one relationship between the nominal price of gold and the general price level. That is, the nominal price of gold and the general price level should move together if gold is an effective hedge against inflation. We started by examining the relationships between the price of gold (Pg) and both the US (P_{USA}) and world price levels (P_{WORLD}). A series of statistical tests confirm that the long-run price of gold moves with only the US price level. The world price level does not appear to contribute anything more to the relationship between the price of gold and the US price level. The analysis proceeds with only relationship between the gold price and the general price level in the USA.

Three main findings emerge with respect to the analysis of the long-run determinants of the price of gold. First, there is a long-term relationship between the price of gold and the US price level. Second, the long-run parameter of unity lies within the 95 per cent confidence interval. This implies that the US price level and the price of gold move together in the long-run. That is, a one percent increases in the general US price level leads to a long-term one percent increase in the price of gold. The evidence provides support for the belief that gold is a long-term hedge against inflation. Third, there is a slow reversion towards the long-term relationship following a shock that causes a deviation from this long-term relationship. The estimate of the error correction term is -0.019, which implies that each month's error is about 2 per cent smaller than the previous month. Numerically, it takes five years to eliminate about two-thirds of the deviation from the long-term relationship between the price of gold and the US price level caused by a shock.

3.5.2 Short-term Relationships

The analysis of the determinants of the price of gold in the short-term analysis suggests that several factors are important. This analysis essentially explores the short-run dynamics that cause short-run deviations from the long-run relationship. The theory presented in Section 2 suggests a number of factors that might influence the short-run price of gold.

US and world inflation (π_{USA} and π_{WORLD}) and US and world inflation volatility [$V(\pi)_{USA}$ and $V(\pi)_{WORLD}$] should raise the price of gold because high values for these variables increase the need for an inflation hedge, which would likely increase the demand for gold and this would in turn raise the price of gold. Rising world income (Y_{WORLD}) should increase the demand for gold jewellery that would raise the gold price. A fall in the dollar/world exchange rate (ER) should raise the price of gold because a US dollar depreciation would make gold cheaper for investors outside of the dollar area that would increase the demand for gold and raise the US dollar price of gold.

A rise in the real interest rate (Rg), proxied by the gold lease rate, would depress the demand for gold and lower the price of gold because higher real interest rates represent higher forgone interest payments on holding government securities instead of gold. A rise in credit risk ($CRDP$) should increase the price of gold because the demand for gold is expected to be higher during periods of financial turmoil. This would also apply to central banks who would be prepared to lease less gold at any given lease rate as the convenience yield from holding gold rises. The demand for gold to reduce portfolio volatility would be high during periods when the beta for gold is negative (βg) and this would cause a negative relationship between changes in beta and changes in the gold price. We also expect that the demand for gold and the price of gold should rise during periods of political risk, uncertainty and turmoil ($Risk$).

A series of models were estimated with data covering the period 1976 to 2005. These models did not include the political risk index because no data was available for this variable prior to 1984. The results confirm a significant short-run relationship between

the movements in the following variables and movements in the price of gold. The empirical analysis found statistically significant positive relationships between changes in the price of gold with changes in US inflation (π_{USA}), US inflation volatility [$V(\pi)_{USA}$] and credit risk ($CRDP$). The empirical analysis found statistically significant negative relationships between changes in the price of gold with changes in the US dollar trade-weighted exchange rate (ER) and the gold lease rate (Rg). The significant negative parameter on the "error correction mechanism" reflects the slow return of the gold price to its long-run relationship. These findings are in accordance with the theory. However, the empirical analysis did not find any significant relationship between changes in the price of gold and changes in world inflation (π_{WORLD}), world inflation volatility [$V(\pi)_{WORLD}$], world income (Y_{WORLD}), and gold's beta (βg).

The model also included a number of ad hoc time dummies. Inclusion of these dummies was based on statistical criteria. Ten dummies were statistically significant and large in magnitude. They are shown in Table 3. These time dummies tend to cluster in the late1970s/early 1980's period, and therefore likely capture the high uncertainty in this period following the OPEC oil price shock of 1979.

Table 3: Statistically Significant Period Dummies from Short-run Model of the Price of Gold

Year	Month
1976	November
1978	November
1979	September
1979	December
1980	January
1980	March
1980	June
1981	July
1982	March
1982	April
1982	May
1982	September
1983	March
1986	September
1999	October

We also examined news reports in the month before during and after for the six largest time dummies. The conclusions of this search are twofold. First, it is possible to identify a major crisis somewhere in the world in most months. Therefore attributing a rise in the gold price to a particular crisis in that month is a classic case of the fallacy "post hoc, ergo propter hoc". For example, the gold price spike of December 1979 may be due to the Soviet invasion of Afghanistan. It seems more likely that the spikes that occurred in September 1979, December 1979, and January 1980 were more likely to be associated with rising panic as Iranian oil shipments were halted following the January 1979 Iranian Revolution. We should recall that Saudi light oil prices increased nearly five times from $2 to $9.6 from 1973 to 1974, then oil prices doubled from $13 to $26 in 1979, and reached $37 by 1981. Meantime US annual inflation rose from 8.5 per cent in September 1978 to 11.8 per cent in August 1979 to 14.6 per cent in March 1980. The 1982 oil spike may be due to Middle East turbulence or it might be associated with the death of Leonid Brezhnev.

The October 1999 price spike is explained by the first *Central Bank Gold Agreement* (CBGA). In the late 1990s a number of high-profile central bank sales started to spook the market and raised fears of a possible tidal wave of selling, particularly from European central banks who had large gold holdings acquired during the Bretton Woods period. Matters came to a head in 1999 with possible major Swiss and IMF sales, together with the UK announcement that it was to sell over half of its holdings. The CBGA was an attempt by 15 European central banks to restore orderly markets by limiting sales to 2000 tonnes over the following five years and an agreement that combined leasing from the signatories would not exceed its current level. This agreement was unexpected and the fears of a shortage of leased gold created a price spike.

The parameters of the model suggest that supply and demand factors do affect the price of gold in the short-run, but the fact that the model needs to include ten ad hoc time dummies is problematic. One hypothesis, discussed in Section 2, is that political risk and uncertainty dramatically affect the short-run price of gold and the time dummies are picking up these effects. In order to explore this further, models were estimated over the shorter period 1984-2005, which allows for the inclusion of the political risk index (*Risk*). As mentioned above, this measure is a weighted index for 143 countries. When this variable was included in the model, it was found to be statistically significant but with the "wrong" sign—higher levels of political risk are associated with lower gold price levels.

It is important to recognise that this index weighted by each country's income, it is dominated by those countries that have the largest economies. In addition, it is our view that much uncertainty is generated by uncertainty with respect to the price of oil. In order to explore this further, the index was constructed for the "Top-10" oil producing nations (*RiskOil-10*): Saudi Arabia, USA, Russia, Iran, Mexico, Venezuela, China, Norway, UK and Iraq. Again, because this index is a weighted measure, it is dominated by the USA. Therefore, we also constructed the index leaving the USA out (*Risk0il-10 minus USA*). In the models that includes these measures, both were statistically significant with a negative sign, providing evidence that higher level of political risk are associated with a higher price of gold in the short-run.

It is important to note that statistical significance does not necessarily mean that the relationship is quantitatively important. In order to illustrate the magnitude of these effects the estimates were used to decompose the short-run increase in the price occurring in the period 2001 to 2005. More specifically, the price of gold increased from a "low" of $260 in April, 2001 to $438 in August 2005. That is, the price of gold increased by about 70 per cent in this period.

The contribution that each explanatory variable made to the change in the price of gold between April 2001 and August 2005 can be approximated by using the estimated equation to conduct a dynamic simulation of the price of gold. The dynamic nature of the simulation implies that the predictions of the price of gold at time "t" are fed back into the simulation via lagged values. Initially the simulation is run forward with all the explanatory variables taking their actual values through to August 2005. In this way conditional predictions for the price of gold are derived. This series defines the "full simulated effect". Next the values of the explanatory variables are returned to their March 2001 values and the simulation is reworked with the actual time path for one variable at a time incorporated, each time the proportion of the full simulated effect achieved is noted.

It is important to note that estimated equation predicts an increase in the price of gold from $258 in April 2001 to $395 in August 2005, which is smaller than the actual increase. That is, the estimated equation predicts about 75 per cent of the actual increase over this period. Therefore, the remaining 25 per cent is explained by other factors not included in the model. The results of the decomposition are shown in Table 4. As the table suggests, most of the "explained" change is associated with changes in the US price level, followed by changes in the exchange rate and US inflation volatility. Changes in the gold lease rate and changes in credit risk default premium were not of great importance. Note that the model used in this decomposition is based on data from the 1976-2005 period, so it is not possible with this specification to comment on the contribution that changes in political risk make. This finding is not in entirely in agreement with the view of many gold market analysts that the strength/weakness of the dollar was the key determining factor of the price during that period.

**Table 4: Decomposition of 2001 to 2005 Increase in the Price of Gold**

Factor	Percentage share of total explained price change	Percentage share of total price change
Changes in the US price level	48.9	36.2
Changes in the exchange rate	24.8	18.4
Changes in US inflation volatility	13.9	10.3
Changes in the gold lease rate	3.6	2.7
Changes in credit risk default premium	2.2	1.6
Unexplained	–	26.0

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Figures 18 to 23 show the impulse response functions for the five factors included in the decomposition. These functions trace out the response of the price of gold to a hypothetical exogenous "shock" in each of the explanatory variables. These functions use the estimated equation to describe how the price of gold will respond to a given increase in an explanatory variable. They take into account both the initial impact of the change, and the timing of this impact, and the way that this effect dissipates over time as captured by the dynamic structure of the model and through the lagged dependent variable in particular. The impulse response functions are for a positive shock (i.e. increase) of 10 per cent. They confirm the findings of the decomposition by illustrating the importance of changes in the inflation and the exchange rate in the explanation of short-run movements in the price of gold.

Figure 18: Impulse Response Function 10 per cent Increase in US Inflation
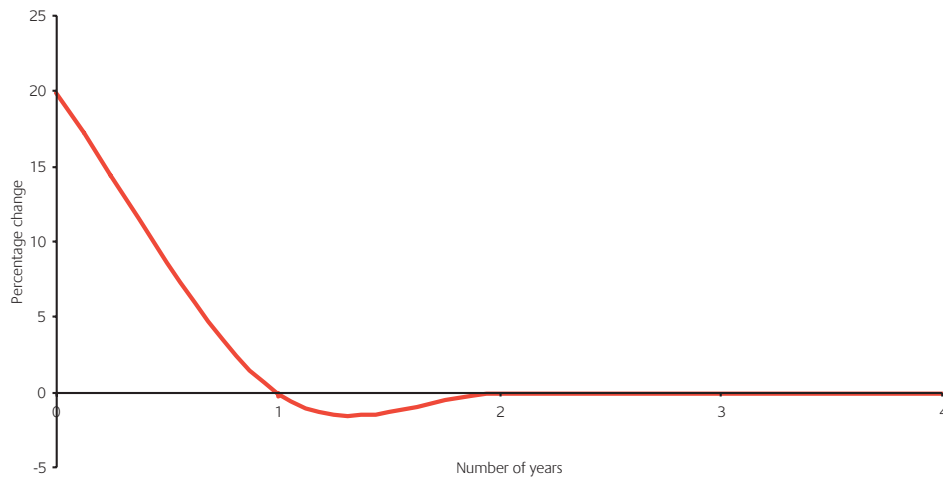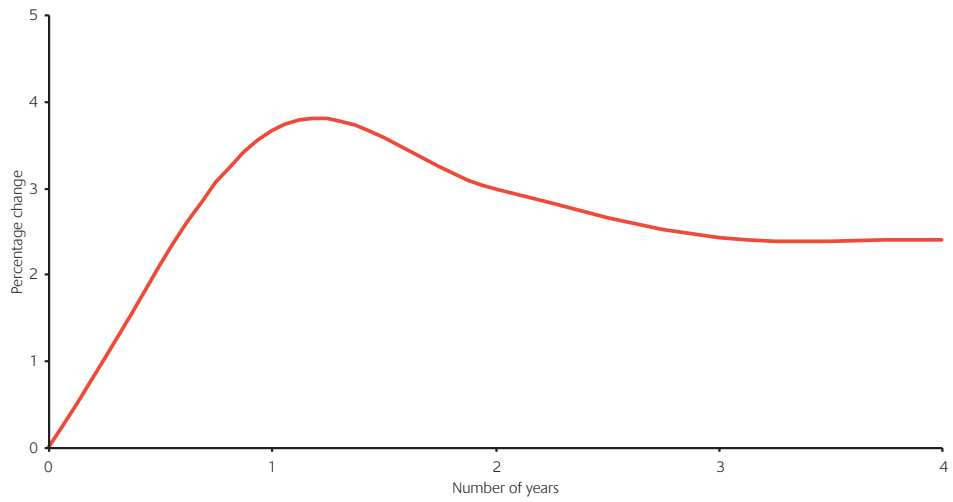

Figure 19: Impulse Response Function 10 per cent Increase in the Exchange Rate
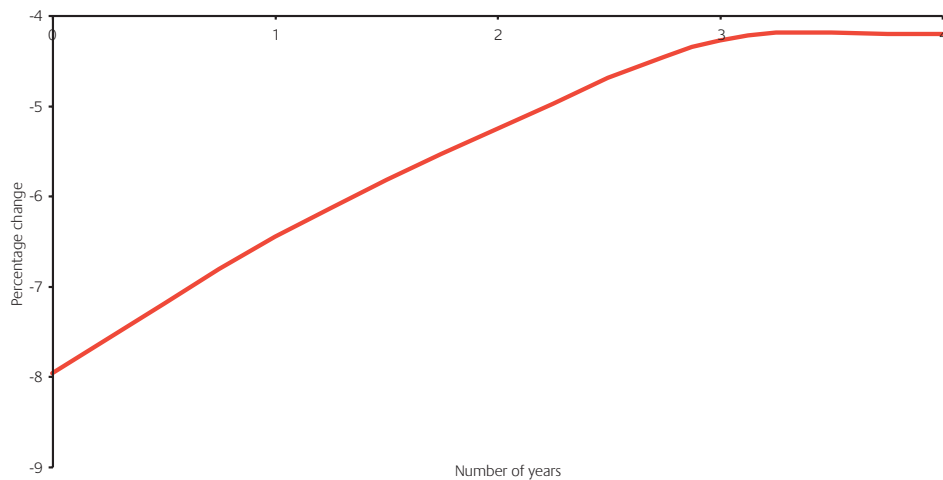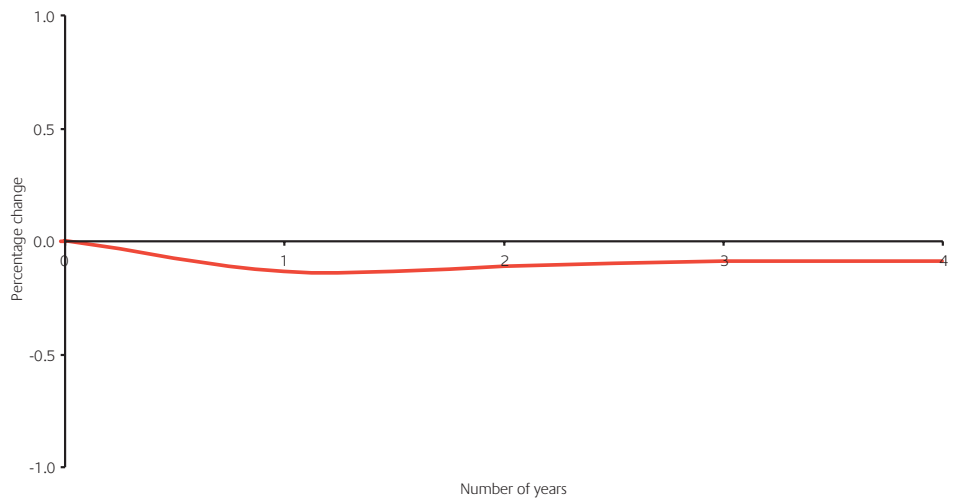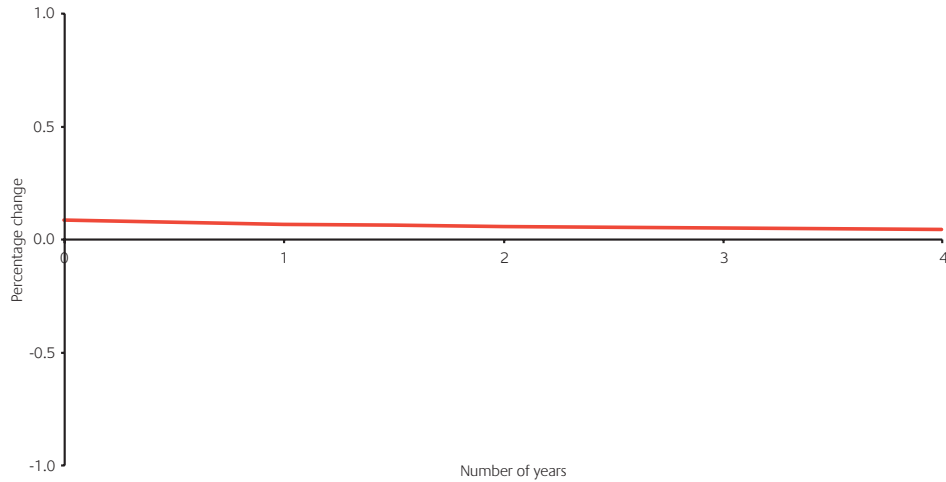
Figure 20: Impulse Response Function 10 per cent Increase in the Credit Risk Default Premimum

Figure 21: Impulse Response Function 10 per cent Increase in the Gold Lease Rate

Figure 22: Impulse Response Function 10 per cent Increase in US Inflation Volatility

Finally, Figure 23 shows the impulse response function for political risk. This figure is for a 10 per cent increase in political risk (i.e. a higher level of risk). The function is shown for the index based on the "Top-10" oil producing nations (*RiskOil-10*) and for the "Top-10" minus the USA. The time path for the two indices is very similar. This finding suggests that political risk associated with oil-producing countries is an important determinant of the short-run changes in the price of gold.

Figure 23: Impulse Response Function 10 per cent Increase in Political Risk
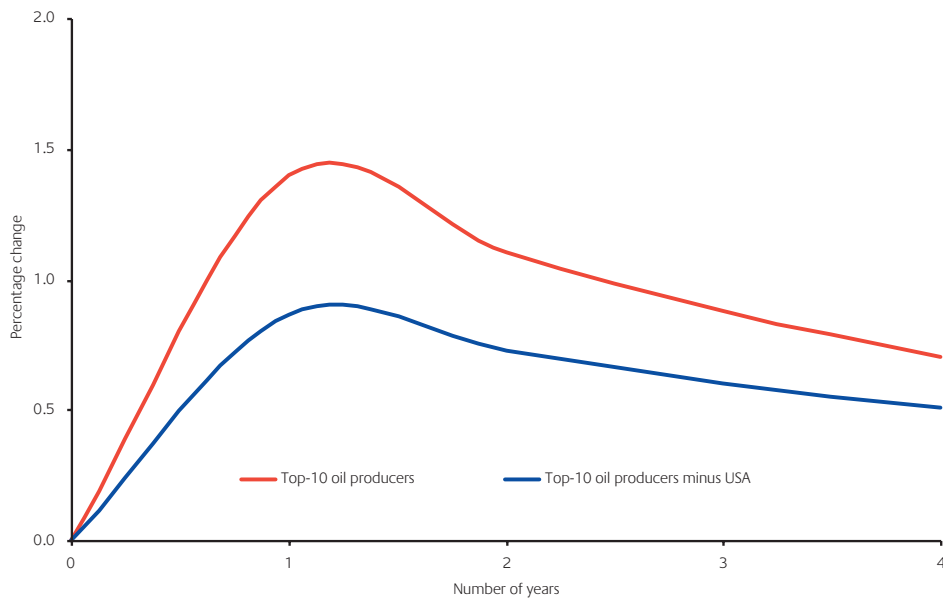
4. Conclusions

The results of the empirical analysis are consistent with the widely held belief that there is a long-term one-for-one relationship between the price of gold and the general price level in the USA. More specifically, a one per cent rise in US inflation raises the long-term price of gold by an estimated one per cent. A one percent increase in the long-term price of gold for a one percent rise in the general US price level lies within the 95 percent confidence interval. However, there are short-run deviations from the long-run relationship between the price of gold caused by short-run changes in the US inflation rate, inflation volatility, credit risk, the US dollar trade-weighted exchange rate and the gold lease rate. There is a slow reversion towards the long-term relationship following a shock that causes a deviation from this long-term relationship. It takes about five years for the long-term relationship between the price of gold and the general price level to be restored following any shock that causes a deviation in this long-term relationship.

Two major issues remain unresolved. The first concerns gold as a long-run inflation hedge for countries other than the USA. If the price of gold is quoted in US dollars and gold is an inflation hedge for the USA, holding gold is profitable for investors domiciled in countries whose currencies depreciate against the US dollar more than required to compensate for the difference between the country's and US inflation rate. It is surely no coincidence that the major gold consuming countries (see Table 2) appear to be over-represented among countries that profited from holding gold because their currency depreciation against the US dollar exceeded that required to compensate for the inflation rate differences between the two countries. This relationship has not been rigorously examined in our analysis and a deeper investigation is warranted.

Second, the time dummies remain unexplained. The rationale for this study was to improve the reliability of an earlier finding (Ghosh et al, 2004) that the hypothesis that gold is a long-run hedge against inflation could not be rejected at the 10 confidence level. This study improved the confidence level to 5 per cent by extending the sampling period and adding in additional explanatory variables including US and world inflation volatility, credit risk and political risk. However, the time dummies remain. We believe that the political risk indexes used in the analysis could be improved in two ways. The remaining spikes in the gold price may be explained by using the sub-components of the political risk index and/or using a sub-set of oil-producing countries instead of the aggregate political risk index.

Finally we turn to the policy implications of this analysis for potential investors in gold. One important implication concerns a likely US dollar depreciation required to restore balance to the US current account. There appears to be a consensus that US dollar depreciation is inevitable − the only issue being when it will occur and whether the adjustment path will be smooth or disorderly. Jarrett (2005) lists fourteen estimates of the dollar depreciation that would be needed to restore the imbalance in the US current account deficit. These estimates range between 12 per cent and 90 per cent. If gold is a long-run hedge against inflation, and if it is true that real dollar depreciation

against other currencies is inevitable, US wealth holders should profit from holding gold during this period for two reasons.

The first reason is that the dollar depreciation will lower the price of gold to investors outside of the USA, and this will raise their demand for gold and raise the US dollar price of gold. That is in addition to the long-run relationship between the US price level and the price of gold. The second reason is that dollar depreciation would be likely to raise US inflation rates, and gold would act as an inflation hedge during this period. In this context it is important to note that *US Treasury Inflation Protected Securities* would not provide protection against inflation because the inflation uplift on the principal is taxable. Basta et al (1996) and Kinney (1999) show that annual inflation in excess of 5 percent may cause the tax on the inflation uplift to exceed the coupon payment so that investors could receive net negative interest payments in return for lending the inflation proof principal to the government.

Technical Appendix

Statistical Modelling of the Price of Gold

This Appendix outlines the statistical methods that were used to identify the key determinants of the price of gold. The results of this analysis are discussed in a more qualitative fashion in Section (3). This appendix is concerned with the technical details. The method that is used is based on co-integration regression techniques that attempt to identify the factors that determine the price of gold in both the short-run and long-run. For an excellent introduction to these methods see Hall (1986), Hendry (1986) and Muscatelli and Hurn (1992); The model hypothesises that the price of gold is determined by the US and World price levels, US and World inflation; US and World inflation volatility, world income, the US-World exchange rate, the gold lease rate, gold's beta, credit risk and time-specific uncertainty caused by political and financial risk. The main sources of the data are given in Table A1.

Table A1: Data Sources

Variable	Mnemonic	Source	Link
Price of gold	P_g	KITCO Bullion Dealers	www.kitco.com
US price index	P_{USA}	USA Department of Labour Statistics	www.stats.bls.gov
World price index	P_{WORLD}	Datastream	www.datastream.com
World income	Y_{WORLD}	Datastream and OECD	www.oecd.org
Exchange rate	ER	USA Federal Reserve Board	www.federalreserve.gov
Gold lease rate	Rg	Mitsui Global Precious Metals	www.mitsui-gold.com
Gold's beta	βg	Economic Time Series Page	www.economagic.com
Credit risk default premium	$CRDF$	Economic Time Series Page	www.economagic.com
Political risk	$Risk$	PRS Group	www.prsgroup.com
Note: Inflation (π_{USA} and π_{WORLD}) and inflation volatility [$V(\pi)_{USA}$ and $V(\pi)_{WORLD}$] are transformations of P_{USA} and P_{WORLD}.			

Long-run Relationships

The theoretical arguments presented in Section 3 suggests that if there is a long-run relationship between the nominal price of gold and the general price level (i.e. if gold is an effective long-run inflation hedge), the (nominal) price of gold and the price level should "move together". That is, the variables should be cointegrated. However, which price level should gold be a hedge against? This is not an easy question to answer *a priori* so formal cointegration tests were carried out exploring the relationships between lnP_g and lnP_{USA} and lnP_{WORLD}. The specific methods used are those developed by Johansen (1988, 1991).

Granger's representation theorem (see Engle and Granger, 1987) proved that if two or more variables are cointegrated there must exist at least one valid error correction mechanism (ECM) for the data. The ECM describes the short-run adjustment process of the cointegrated variables after a movement away from the long-run relationship. Since a key hypothesis of this paper is that there should be a long-run relationship between the general price level and the (nominal) price of gold then a meaningful ECM is of the form:

$$ecm_{t-1} = \gamma(\alpha lnPg_{t-1} - \beta lnP_{USAt-1} - \rho lnP_{WORLDt-1}) \tag{A1}$$

where $lnPg_t$, $lnPusa_t$ and $lnPw_t$ are cointegrated variables and γ, the speed of adjustment parameter, lies between 0 and -1. Equation ($A1$) implies the existence of a cointegrating vector of the following form:

$$\alpha lnPg_t = m + \beta ln_{PUSAt} + \rho lnP_{WORLDt} + \omega_t \tag{A2}$$

where ω_t is a white noise process and m represents possible non-stochastic elements of the vector (such as a constant or time-trend). If the appropriate measure of the general price level is a linear combination of lnP_{USA} and lnP_{WORLD} we would expect to find the restrictions $\alpha = -1$ and $\beta + \rho = 1$ hold.

In carrying out the Johansen procedure we began with an unrestricted VAR of order 6. On the basis of the adjusted likelihood ratio test, reduction from the VAR of order 7 to a VAR of order 6 cannot be rejected. The choice of order 6 lags is also supported by Akaike's information criterion, which is maximized at 6 lags. The likelihood ratio tests indicate that further reduction is rejected at the 10 per cent level of significance, although it is supported by Schwarz Bayesian information criterion. Serial correlation tests carried out on the individual equations of the VAR do not reject the null hypothesis of no serial correlation against the alternative of up to 12th order serial correlation, using the 5 per cent significance level. So we conclude that this VAR provides the basis for testing for cointegration. We allow for an unrestricted constant in the cointegrating VAR, that is we allow for a drift term in the dynamic specification as well as a constant in the long-run relationship.

The Johansen procedure then produces two test statistics: (1) a likelihood ratio test statistic based on the maximum eigenvalue of the stochastic matrix of the VAR and (2) a likelihood ratio test statistic based on the trace of the same matrix. In practice although Johansen's Trace and Maximal Eigenvalue tests indicate that a single cointegrating vector exists among the three price level variables. We easily reject the null hypothesis of no cointegration but are unable to reject the null of one or fewer cointegrating vectors on both tests. However, having established the existence of a cointegrating vector the next step is to estimate α, β and ρ. This is achieved by normalising one of the coefficients (in this case we set $\alpha = 1$). The remaining "just identified" parameter estimates suggest that both β and ρ are non-zero but a likelihood ratio test of the restrictions is rejected. One possible explanation for this rejection is the high correlation that exists between lnP_{USA} and lnP_{WORLD} (r = 0.997). The strong relationship between these two variables suggests it may be legitimate to remove one or other of the price level terms from our cointegrating vector and the *ECM*.

Table A2 presents the diagnostic test results for the two variable VAR involving $lnPg$ and lnP_{USA}. Again we can conclude that a VAR of order 6 is the preferred benchmark for the tests for cointegration. Johansen's methodology also requires that the VAR residuals are normally distributed. The null of normality is rejected for the residuals in the $lnPg$ equation, but cannot be rejected for lnP_{USA}.

Table A2: Test Statistics and Choice Criteria for Selecting the Order of the VAR – Variant 1

Order	LL	AIC	SBC	Adjusted LR test
7	2036.4	2006.4	1948.2	–
6	2034.9	2008.9	1958.5	Chi Sq(4)= 2.9 [0.60]
5	2030.5	2008.5	1965.9	Chi Sq(4)= 8.8 [0.08]
4	2018.8	2000.8	1965.9	Chi Sq(4)= 22.7 [0.00]
Single equation diagnostic tests				
Serial Correlation				
$lnPg$	F(12, 331) = 1.46 [0.14]			
$lnPUSA$	F(12, 331) = 1.74 [0.06]			
Normality				
$lnPg$	Chi Sq(2) = 1550.6 [0.00]			
$lnPUSA$	Chi Sq(2) = 2.2006 [0.33]			

A plot of the residuals from the $lnPg$ equation reveals a number of large outliers. Introducing a number of dummies as conditioning variables in the VAR can overcome this problem. With the dummies included normality of the residuals cannot be rejected and the full set of test results are provided in Table A3. The results indicate that the AIC is now indifferent to the 6 or 5 lags VAR, while SBC prefers 3. The adjusted LR test suggests 5. We therefore continued the cointegration testing using the VAR order 5.

Table A3: Test Statistics and Choice Criteria for Selecting the Order of the VAR– Variant 2

Order	LL	AIC	SBC	Adjusted LR test
6	2172.5	2116.5	2008.0	–
5	2168.5	2116.5	2015.8	Chi Sq(4)= 7.3 [0.12]
4	2157.1	2109.1	2016.1	Chi Sq(4)= 21.1 [0.00]
3	2150.7	2106.7	2021.4	Chi Sq(4)= 12.1 [0.02]
Single equation diagnostic tests				
Serial Correlation				
$lnPg$	F(12, 318) = 1.6[0.09]			
$lnPUSA$	F(12, 318) = 1.9[0.04]			
Normality				
$lnPg$	Chi Sq(2) = 1.6[0.46]			
$lnPUSA$	Chi Sq(2) = 2.7[0.25]			

Table A4 presents the tests for cointegration in the 5 lag VAR, first without dummies, since the inclusion of dummies invalidates the standard critical values. Both the maximal eigenvalue and trace tests are consistent with the presence of a single CIV. The same tests based on the VAR that includes the conditioning variables are reported in Table A5.

Table A4: Cointegration Tests for VAR with Unrestricted Intercepts

Maximal Eigenvalue Test			
Null	Alternative	Statistic	95% Critical Value
r=0	r=1	29.9	14.9
r<=1	r=2	7.44	8.1
Trace Test			
Null	Alternative	Statistic	95% Critical Value
r=0	r>= 1	37.4	17.9
r<=1	r = 2	7.4	8.1

Table A5: Cointegration Tests for VAR with Unrestricted Intercepts and Dummy Variables

List of eigenvalues in descending order: .080575 .020693			
Maximal Eigenvalue Test			
Nul	Alternative	Statistic	95% Critical Value
r=0	r=1	24.8	14.9
r<=1	r=2	9.9	8.2
Trace Test			
Null	Alternative	Statistic	95% Critical Value
r=0	>= 1	34.7	17.9
r<=1	r = 2	9.8	8.1

Based on the standard critical values it would appear that the null hypothesis of at most one cointegrating vector is rejected. This suggests that there are two cointegrating vectors in the set of variables (i.e. the VAR has full rank and both price series are trend stationary). However, given the presence of the dummy variables, the appropriate critical values should in fact be adjusted upward. It is not feasible to quote appropriate critical values without conducting Monte Carlo simulations so we simply note that an unknown upward revision is appropriate and that both sets of test results are likely to remain consistent with at most one cointegrating vector.

Moving on, the just identified Johansen vectors normalized on lnP_G are:

$lnP_G = constant + 2.0133\ lnP_{USA}$ for the undummied VAR and

$lnP_G = constant + 2.3566\ lnP_{USA}$ for the dummied VAR.

Once this normalizing restriction is imposed (see Table A6), we are able to obtain a standard error for the parameter on lnP_{USA}. This allows us to generate a confidence interval for the long-run parameter attached to lnP_{USA}. A long run parameter of unity is clearly within this confidence interval. Theoretically a parameter of 1 on lnP_{USA} implies long run price homogeneity, i.e that lnP_G and lnP_{USA} move together in the long run.

Table A6: Maximum Likelihood Estimates of the Exactly Identified Cointegrating Relationship (Standard errors in parentheses)

Vector 1		
lnP_G	-1	(imposed)
lnP_{USA}	2.36	(1.01)
Note: Cointegration with unrestricted intercepts and no trends in the VAR		

Imposing long-run homogeneity in the Vector Error Correction Model, indicates that the long run cointegrating relationship feeds through significantly into the error correction equation for ΔlnP_G, with a t_{ECM} of 2.96. It also feeds through into the error correction equation for ΔlnP_{USA}, with a t_{ECM} of -3.08, although with a much slower speed of adjustment.

Short-run Relationships

In order to explore the short-run dynamics of the model, an equation of the following general form is estimated over the period 1976(1) to 2005(8):

$$\Delta lnPg_t = \alpha + aA(L)\Delta lnPg_{t-1} + bB(L)\pi_{USAt} + cC(L)\Delta V(\pi)_{USAt}$$

$$+ dD(L)\Delta \pi_{WORLDt} + eE(L)\Delta V(\pi)_{WORLDt} + fF(L)\Delta lnY_t$$

$$+ gG(L)\Delta lnER_t + hH(L)\Delta Rg_t + iI(L)\Delta \beta g_t + jJ(L)\Delta CR_t$$

$$+ \Sigma_k \theta_k t_k + \gamma ecm_{t-1} + u_t \qquad (A3)$$

where: "α" is a constant; $A(L), B(L), …, J(L)$ are finite order lag polynomials; "a", "b", …, "j" are vectors of the parameters associated with these lag polynomials; θ_k is an empirically determined set of "k" period specific (t_k) dummy variables; "u" is a random error term; "ecm_{t-1}" is the error correction mechanism constructed from the results of the cointegration tests presented above. In the estimation it is assumed that there is a cointegrating relationship between $lnPg$ and lnP_{USA} and a unitary cointegrating vector:

$$ecm_{t-1} = lnPg_{t-1} - lnP_{USAt-1} \qquad (A4)$$

The lag length "L" was set to six. An initial unrestricted VAR was tested to see how many lags were required to enable the residuals to pass various diagnostic tests, including serial correlation, functional form, normality, ARCH and heteroskedasticity. The Akaike Information Criterion suggested one to two lags (Akaike, 1992) while the Schwarz Bayesian Criterion and LR tests suggested longer lag lengths from six to twelve lags (Schwarz, 1978). Six lags were chosen as a compromise between parsimony and stationarity for the cointegration test and this was carried over to the short run model. It is also important to note that a linear time trend is not included. In earlier models we included a time trend and it was not statistically significant so it was excluded. This finding is common in models of first differences.

Formal unit root tests (not reported here) suggest that lnP_G, lnP_{WORLD}, lnY, $lnER$, R_g, β_g and CR are $I(1)$ variables i.e. they are stationary upon first differencing based on standard Dickey-Fuller (1979, 1981) tests. It is also worth mentioning that the political

risk variable, *Risk*, used in the analysis reported below is also *I(1)*. In addition (and not surprisingly) $V(\pi)_{USA}$ and $V(\pi)_{WORLD}$ are *I(0)* variables. However, the tests suggest that lnP_{USA} is *I(2)* − it must be differenced twice to be stationary. This is problematic since, in a strict sense, it excludes the possibility of a cointegrating relationship between lnP_G and lnP_{USA}. However, it must be remembered that unit root tests have low power and are adversely affected by outliers. Furthermore the analysis of the long-run above, which follows the influential Johansen framework, suggests that lnP_{USA} is *I(1)*. Therefore we include *lnPUSA* in first differences along with the other variables. Models that "mix" variables in different levels of differencing often fail residual tests badly, most notably tests for serial correlation. Furthermore, such models are typically difficult to interpret in terms of the hypothesis suggested by the underlying theory. However, the "liberal" approach adopted here is widespread in the applied cointegration literature.

We then estimated the model <u>without</u> including any period specific dummies. We carried out a number of tests in order to evaluate the suitability of this specification. These tests included: 1) a Lagrange multiplier test of residual correlation (see Godfrey 1978a, 1978b); 2) the Ramsey (1969) RESET test of functional form misspecification, using the square of the fitted values; 3) the Bera and Jarque's (1981) normality test of the residuals; and 4) a Langrange Multiplier test of heteroskedasticity based on the regression of squared residuals on squared fitted values (see Pesaran and Pesaran 1997). This empirical model did not perform well on these tests with the null hypotheses of normality, homoskedasticity and no functional form misspecification being solidly rejected.

A careful examination of a plot of the residuals from this model suggested a number of clear outliers that were likely responsible for the failure of these tests. We then included a number of time-specific dummy variables in the model in order to "dummy out" the effect of these outliers. The inclusion of these dummies resulted in a well-specified model that passes the above tests (test statistics given below). In order to make the model more parsimonious, we reduced the number of right-hand side variables by eliminating variables with statistically insignificant parameters. This was accomplished by testing for zero restrictions using a Wald (1949) test. This process was continued until the following "final" model was arrived at:

$$\Delta lnPg_t = \begin{array}{c} 0.006 + 0.128\Delta lnPg_{t-1} - 0.127\Delta lnPg_{t-2} \\ [1.2] \qquad [3.6] \qquad\qquad [3.2] \end{array}$$

$$+ 1.99\pi_{USA\,t} + 0.008\Delta V(\pi)_{USAt}$$
$$[3.0] \qquad\qquad [1.6]$$

$$-0.796\Delta lnER_t - 0.016\Delta Rg_{t-3} + 0.436\Delta CR_{t-3}$$
$$[8.3] \qquad\quad [2.8] \qquad\qquad [3.4]$$

$$-0.017ecm_{t-1} + time\ dummies \qquad\qquad\qquad (A5)$$
$$[3.0]$$

The absolute value of each parameter's associated t-statistic is shown in parentheses.

The R^2 value of this model is 64 per cent, suggesting a good fit for a model in first differences. The Lagrange multiplier test for serial correlation suggests no significant

serial correlation is present: $\chi^2(12) = 24.4$ with a *p-value = 0.98* (the correlogram of the residuals is also indicative of a white noise process). The Ramsay RESET test for functional form suggests that the model is not misspecified: $\chi^2(1) = 0.7$ with a *p-value = 0.41*. The Bera-Jarque test for normality indicates that the residuals are normally distributed: $\chi^2(2) = 4.7$ with a *p-value = 0.095*. The test based on the regression of squared residuals on squared fitted values indicates that no significant heteroskedasticity is present: $\chi^2(1) = 2.2$ with a *p-value = 0.14*. Based on these tests serial correlation, non-normality, heteroskedasiticity and functional form misspecification are not problems based on the 5 per cent threshold level.

The model also included a set of ad hoc time dummies. In total, there were a total of 10 time dummies included in the specification, and all are statistically significant. As the table suggests, the time dummies tend to cluster in the late-1970s/early-1980s period, and may be capturing the considerable uncertainty in this period relating to future oil prices (i.e. the OPEC-driven oil price shock of 1979). Nevertheless, the inclusion of these dummies is important from a statistical point of view. When the model is estimated without them, most of the test statistics (discussed above) fail. These residuals are shown in Table A7.

Table A7: Statistically Significant Residuals from Short-run Model of the Price of Gold

Year	Month	Sign	Residual	t-value
1976	November	Positive	0.121	4.1
1978	November	Negative	-0.094	-3.1
1979	September	Positive	0.154	5.1
1979	December	Positive	0.138	4.5
1980	January	Positive	0.351	11.4
1980	March	Negative	-0.119	-3.5
1980	June	Positive	0.117	3.9
1981	July	Negative	-0.105	-3.5
1982	March	Negative	-0.114	-3.8
1982	April	Positive	0.109	3.5
1982	May	Negative	-0.099	-3.2
1982	September	Positive	0.203	6.6
1983	March	Negative	-0.124	-4.1
1986	September	Positive	0.092	3.1
1999	October	Positive	0.150	5.0

Before exploring these time shocks further, it is worth noting the parameter estimates are consistent with the main hypotheses regarding the determinants of short-run

movements in the price of gold. These finding are discussed in detail in Section 3, so will not be elaborated on here. In brief:

(1) $\Delta lnPg$ is statistically significant at lags of one and three months. with positive and negative signs respectively.

(2) π_{USA} is statistically significant at a lag of one month with a positive sign.

(3) $\Delta V(\pi)_{USA}$ is statistically significant at a lag of one month with a positive sign.

(4) $\Delta lnER$ is statistically significant at a lag of one month with a negative sign.

(5) ΔRg is statistically significant at a lag of three months with a negative sign.

(6) $\Delta CRDP$ is statistically significant at a lag of one month with a positive sign.

(7) ecm, the error correction mechanism, is statistically significant with a negative sign

Although the parameters of the model suggest that supply and demand factors affect the price of gold in the short-run, the fact that the model needs to include a large number of *ad hoc* time dummies is problematic. In an ideal world, we would have variables that precisely measure what the underlying factors are that are causing these period effects. One hypothesis, discussed in Section 2, is that price of gold in the short-run is affected quite dramatically by political risk and uncertainty.

In order to explore this further, we estimate a series of models that include measures of what can be termed "political risk". This variable is only available for 1984 to 2005. This is clearly not ideal, but the problem is that such measures are a relatively new invention and we were unsuccessful at finding any monthly measure of this type available before 1980. In order to explore the potential importance of political risk, Equation (A1) was estimated across the shorter time period.

Table A8 shows the parameters of the political risk variable from this analysis. In the specification that includes the index based on 143 countries, the effect is statistically significant at the 10 per cent level but the sign is opposite to what is expected. However, when the index only includes the "Top 10" oil producers, the variable is statistically significant at the 5 per cent level (on a one-tail test) with the expected negative sign at a lag of four months. When the "Top10" index excludes the USA, the sign remains negative but the effect is weaker but is also statistically significant at the 5 per cent level (on a one-tail test). This analysis provides evidence that it is the political risk and uncertainty associated with oil producing countries that puts upward pressure on the price of gold in the short-run.

Table A8: Political Risk and Uncertainty Estimates

Specification	Countries Included in Risk Index	Lag Length	Parameter	t-statistic
1	*All 143 countries*	0	*0.0078*	1.8
2	*Top-10 oil producers*	4	*-0.0027*	2.6
3	*Top-10 oil producers minus USA*	4	*-0.0016*	1.9
Note: Time period is 1985(6)-2005(8). Other explanatory variables included but parameters not shown				

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References

Aggarwal, R., 1992, "Gold Markets". In: P. Newman, M. Milgate and J. Eatwell, (eds.), The *New Palgrave Dictionary of Money and Finance* (Volume 2), Basingstoke, Macmillan, pp. 257-258.

Akaike, H., 1974, A New Look at Statistical Model Identification, *IEEE Transactions on Automatic Control*, ac-19, pp. 716-23.

Ariovich, G., 1983, The Impact of Political Tension on the Price of Gold, *Journal for Studies in Economics and Econometrics*, vol. 16, pp. 17-37

Basta, K. M., Islam, I., Kan, W., Lucas, G., Quek, T. and Sowanick, T.J., 1996, *Understanding Treasury Inflation Protected Securities (TIPS): A Fundamental and Analytical Framework,* London, Merrill Lynch Global Fixed Income Research

Bera, A.K. and Jarque, C.M., 1981, *An Efficient Large Sample Test for Normality of Observations and Regression Residuals*, Working Papers in Economics no. 40, Canberra, Australian National University

Baker, S. A., and van Tassel, R.C., 1985, Forecasting the Price of Gold: A Fundamentalist Approach, *Atlantic Economic Journal*, vol. 13, pp. 43-51

Capie, F, T.C. Mills and G. Wood, *Gold as a Hedge against the US Dollar*, London, World Gold Council

Chappell, D. and Dowd, K., 1997, A Simple Model of the Gold Standard, *Journal of Money, Credit and Banking*, vol. 29, pp. 94-105

Chua, J., Sick, G. and Woodword, R., 1990, Diversifying with Gold Stocks, *Financial Analysts Journal*, vol. 46, pp. 76-79

Diba, B. and Grossman, H., 1984, *Rational Bubbles in the Price of Gold*, NBER Working Paper: 1300. Cambridge, MA, National Bureau of Economic Research

Dickey, D.A. and Fuller, W.A., 1979, Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, vol. 74, pp. 427-431

Dickey, D.A. and Fuller, W.A., 1981, Likelihood Ratio Tests for Autoregressive Time Series with a Unit Root, *Econometrica*, vol. 50, pp. 1057-1072

Dooley, M.P., Isard, P. and Taylor, M.P., 1995, Exchange Rates, Country-specific Shocks and Gold, *Applied Financial Economics*, vol. 5, pp. 121-129

Engle, R.F. and Granger, C.W.J., 1987, Cointegration and Error-Correction: Representation, Estimation and Testing, *Econometrica*, vol. 55, pp. 251-276.

Ghosh, D.P., E.J. Levin, P. Macmillan and R.E. Wright and, 2004, Gold as an Inflation Hedge?, *Studies in Economics and Finance*, vol. 22, no. 1, pp. 1-25

Godfrey, L., 1978a, Testing against General Autoreggressive and Moving Average Error Models when the Regressors include Lagged Dependent Variables, *Econometrica*, vol. 46, pp. 1293-1301

Godfrey, L., 1978b, Testing for Higher Order Serial Correlation in Regression Equations when Regressors include Lagged Dependent Variables, *Econometrica*, vol. 46, pp. 1303-1310

Hall, S.G., 1986, An Application of the Engle-Granger Two Step Estimation Procedure to United Kingdom Aggregate Wage Data, *Oxford Bulletin of Economics and Statistics*, vol. 48, pp. 229-240

Harmston, S., 1998, *Gold as a Store of Value*, London, World Gold Council

Hendry, D.F., 1986, Econometric Modelling with Cointegrated Variables: An Overview, *Oxford Bulletin of Economics and Statistics*, vol. 46, pp. 201-212

Jarrett, P., 2005, *Coping with the Inevitable Adjustment in the US Current Account*, Economics Department Working Paper no. 467, OECD, Paris

Johansen, S., 1988, Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control,* vol. 12, pp. 231-54

Johansen, S., 1991, Estimation and Hypothesis Testing of Cointegration in Gaussian Vector Autoreggression Models, *Economometrica*, vol. 59, pp. 1551-80

Kinney, C.F., 1999, "The Individual Investor and Inflation-Indexed Bonds: Tax Issues and Retirement Planning". In: J. Brynjolfsson and F.J. Fabozza, (eds.), *Handbook of Inflation Indexed Bonds*, F.J. Fabozzi and Associates, New Hope, Penn

Kaufmann, T. and Winters, R., 1989, The Price of Gold: A Simple Model, *Resources Policy*, vol. 19, pp. 309-318

Koutsoyiannis, A., 1983 A Short-Run Pricing Model for a Speculative Asset, Tested with Data from the Gold Bullion Market, *Applied Economics*, vol. 15, pp. 563-581

Kolluri, B.R., 1981, Gold as a Hedge against Inflation: An Empirical Investigation, *Quarterly Review of Economics and Business*, vol. 21, pp. 13-24

Laurent, R.D., 1994, Is There a Role for Gold in Monetary Policy?, *Economic Perspectives* (Federal Reserve Bank of Chicago), vol. XVIII: pp. 2-14

Lawrence, C., 2003, *Why is Gold Different from Other Assets?* An Empirical Investigation, London, World Gold Council

Levin, E.J, A. Abhyankar, A., and D. Ghosh, 1994, Does the Gold Market Reveal Real Interest Rates?, *Manchester School* (supplement), vol. 62, pp. 93-103

Mahdavi, S. and S. Zhou, 1997, Gold and Commodity Prices as Leading Indicators of Inflation: Tests of Long-Run Relationship and Predictive Performance, *Journal of Economics and Business*, vol. 49, pp. 475-489

Moore, G., 1990, Gold Prices and a Leading Index of Inflation, *Challenge*, vol 33, pp. 52-56

Muscatelli, V.A. and S. Hurn, 1992, Cointegration and Dynamic Time Series Models, *Journal of Economic Surveys*, vol. 6, pp. 1-43

O'Callaghan, G., 1991, *The Structure and Operation of the World Gold Market*, IMF Working Paper no. 91-120. Washington, International Monetary Fund

O'Connell, R., 2005, *What Sets the Precious Metals Apart from Other Commodities?*, London, World Gold Council

Paulos, G.J., 2001, *The Long Wave Gold Cycle*, London, Gold-Eagle

Pesaran, M. H. and B. Pesaran, B., 1997, *Working with Microfit 4.0: Interactive Econometric Analysis*, Oxford, Oxford University Press

Pindyck, R.S., 1993, The Present Value Model of Rational Commodity Pricing, *Economic Journal*, vol. 103, pp. 511-530

Pulvermacher, K, 2005a, *Commodity Returns and the Economic Cycle*, London, World Gold Council

Pulvermacher, K, 2005b, *Investing in Commodities: A Risky Business?*, London, World Gold Council

Ramsey, J.B., 1969, Tests for Specification Errors in Classical Linear Last Squares Regression Analysis, *Journal of the Royal Statistical Society*, B, pp. 350-71

Ranson, D., 2005a, *Why Gold, Not Oil, Is the Superior Predictor of Inflation*, London, World Gold Council

Ranson, D., 2005b, *Inflation Protection: Why Gold Works Better Than "Linkers"*, London, World Gold Council

Sjaastad, L.A. and F. Scacciallani, 1996, The Price of Gold and the Exchange Rate, *Journal of Money and Finance*, vol. 15, pp. 879-897

Sherman, E., 1986, *Gold Investment: Theory and Application*, New York, Prentice Hall

Sherman, E.J, 1983, A Gold Pricing Model, *Journal of Portfolio Management*, vol. 9, pp. 68-70

Sherman, E. J., 1982, New Gold Model Explains Variations, *Commodity Journal*, vol. 17, pp. 16-20

UBS, Various Years, *Precious Metals Outlook* , London, Union Bank of Switzerland

Schwarz, G., 1978, Estimating the Dimension of a Model, *Annals of Statistics*, vol. 6, pp. 461-464

Wald, A., 1943, A Note on the Consistency of the Maximum Likelihood Estimator, *Annals of Mathematical Statistics*, vol. 20, pp. 595-601

World Gold Council, 1995, *The Value of Gold to Society*, London, World Gold Council

World Gold Council, 2005, *Annual Review 2004*, London, World Gold Council

World Gold Council, 1992, *European Guide to Gold Investment*, London, World Gold Council

List of Authors Publications

Eric J. Levin and Robert E. Wright

Chapters

1. Levin, E.J. and R.E. Wright, (2001), "An Optimal Internet Location Strategy for Markets with Different Tax Rates". In: T. Wichmann, (ed.), *Economics and the Internet*, Berlin, BERLECON, pp. 5-9

Journal Publications

1. Levin, E.J. and R.E. Wright (2006) "Downward Sloping Demand Curves for Stock?", *Studies in Economics and Finance*, vol.23, pp. 51-74.
2. Levin, E.J. and R.E. Wright (2004) "Regional Taxation and Retailing: The Economic Geography of the Internet", *International Review of Retail Distribution and Consumer Research*, vol.14, pp. 337-356.
3. Levin, E.J., Y. Ma and R.E. Wright (2004) "Profit Maximization in a Multi-product Firm with Impatient Customers", *Journal of the Operational Research Society*, vol.55, pp. 211-219.
4. Levin, E.J. and R.E. Wright (2004) "Estimating the Profit Markup Component of the Bid-ask Spread: Evidence from the London Stock Exchange", *Quarterly Review of Economics and Finance*, vol. 44, pp. 1-19.
5. Levin, E.J. with Ghosh, D., MacMillan, P. and R.E Wright (2004) "Gold as an Inflation Hedge?", *Studies in Economics and Finance*, vol. 22, pp.1-25.
6. Levin, E.J. and R.E. Wright (2003) "The Effect of Inter-regional Tax Differentials on Internet Sellers in Markets with Different Tax Rates", *The Business Economist*, vol. 34, pp. 42-47.
7. Levin, E.J. and R.E. Wright (2002) "Estimating the Price Elasticity of Demand in the London Stock Market", *European Journal of Finance*, vol. 8, pp. 222-237.
8. Levin E.J. and R.E. Wright (2001) "Unemployment Insurance, Moral Hazard and Economic Growth", *International Advances in Economic Research*, vol. 7, pp. 373-484.
9. Levin, E.J. and R.E. Wright (2001) "Tax Clientele Effects in the Term Structure of UK Interest Rates?", *Journal of Business Finance and Accounting*, vol. 28, pp.303-325.
10. Levin, E.J. and R.E. Wright (2000) "The Gilt-equity Yield Ratio – A Useful Indicator?", *The Business Economist*, vol. 31, pp. 7-11.
11. Levin, E.J. and R.E Wright (1999) "Explaining the Intra-day Variation in the Bid-ask Spread in Competitive Dealership Markets – A Research Note", *Journal of Financial Markets*, vol. 2, pp. 179-191.
12. Levin, E.J. and R.E. Wright (1999) "Why Does the Bid-ask Spread Vary Over the Day?", *Applied Economics Letters*, vol. 6, pp. 563-567.
13. Levin, E.J. and R. E. Wright (1998) "Relative Excess Returns", *Journal of Business Finance and Accounting*, vol. 25, pp. 869-892.
14. Levin, E.J. and R.E. Wright (1998) "How Large is the Tax Clientele Bias in the Term Structure of UK Interest Rates ?", *Applied Economics Letters*, vol. 5, pp. 429-432.
15. Levin , E.J. and R. E. Wright (1998) "The Information Content of the Gilt-equity Yield Ratio", *The Manchester School*, vol. 66, pp. 73-85.
16. Levin, E.J. and R.E. Wright (1997) "Speculation in the Housing Market?", *Urban Studies*, vol. 34, pp. 1419-1437.
17. Bell, D., E. J. Levin, and R.E. Wright (1997) "Indexed Bonds, Expected Inflation and Tax Clientele Bias", *National Tax Journal*, vol. 50, pp. 315-320.
18. Levin, E.J. and R.E. Wright (1997) "The Impact of Speculation on House Prices in The United Kingdom", *Economic Modelling*, vol. 14, pp. 567-585.
19. Levin, E.J. and R.E. Wright (1996) "Unemployment Insurance and Moral Hazard", *Review of Policy Issues*, vol. 2, pp. 63-72.
20. Levin, E.J. and R.E. Wright (1996) "The Gilts Market as an 'On-line Window' on Expected Inflation", *Applied Economics*, vol. 28, pp. 909-918.

Other publications

1. Levin, E.J., Y. Ma and R.E. Wright, (2002), *Profit Maximization in a Multi-product Firm with Impatient Customers*, Discussion Paper no. 02/03, Stirling, Department of Economics, University of Stirling.
2. Levin, E.J. and R.E. Wright, (2002), *Regional Taxation and Retailing: The New Economic Geography of the Internet*, Discussion Paper, Stirling, Department of Economics, University of Stirling.
3. Levin, E.J., P. Macmillan, R.E. Wright and D. Ghosh, (2000), *Gold as an Inflation Hedge?*, Discussion Paper no. 21. St. Andrews, Department of Economics, University of St. Andrews.
4. Levin, E.J. and R.E. Wright, (1999), *Estimating the Profit Markup Component of the Bid-ask Spread: Evidence from the London Stock Exchange*, Discussion Paper no. 99/4, Stirling, Department of Economics, University of Stirling.
5. Levin, E.J. and R.E. Wright, (1998), *Estimating the Price Elasticity of Demand in the London Stock Market*, Discussion Paper no. 98/7, Stirling, Department of Economics, University of Stirling.
6. Levin, E.J. and R.E. Wright, (1998), *Tax Clientele Bias in the Term Structure of UK Interest Rates*, Discussion Paper no. 98/3, Stirling, Department of Economics, University of Stirling.

7. Levin, E.J. and R.E. Wright, (1997), *The Information Content of the Gilt-equity Yield Ratio*, Discussion Paper no. 97/3, Stirling, Department of Economics, University of Stirling.

8. Levin, E.J. and R.E. Wright, (1996), *Credibility and Targeting Expected Inflation*, Discussion Paper no. 96/15, Stirling, Department of Economics, University of Stirling.

9. Levin, E.J. and R.E. Wright, (1996), T*he Intra-day Variation in the Bid -ask Spread in Competitive Dealership Markets*, Discussion Paper no. 96/14, Stirling, Department of Economics, University of Stirling.

10. Levin, E.J. and R.E. Wright, (1996), *Predicting Equity Prices*, Discussion Paper no. 96/13. Stirling, Department of Economics, University of Stirling.

11. Levin, E.J. and R.E. Wright, (1996), *Unemployment Insurance and Moral Hazard*. Discussion Paper no. 96/12, Stirling, Department of Economics, University of Stirling

12. Ghosh, D. Levin, E.J. and R.E. Wright, (1996), *Gold as an Inflation Hedge?*, Discussion Paper no. 96/10, Stirling, Department of Economics, University of Stirling

13. Levin, E.J. and R.E. Wright, (1996), *The Gilts Market as an "On-line Window"* on Expected Inflation, Discussion Paper no. 96/7, Stirling, Department of Economics, University of Stirling

14. Levin, E.J. and R.E. Wright, (1996), *Speculation in the Housing Market?*, Discussion Paper no. 96/2, Stirling, Department of Economics, University of Stirling

Eric J. Levin

Journal Publications

1. Bell D. and E. Levin (1998) "What Causes Intra-Week Regularities in Stock Returns? Some Evidence from the U.K.", *Applied Financial Economics*, vol. 8, pp.353-357.

2. Abhyankar, A., D. Ghosh, E.J. Levin and R. Limmack (1997) "Bid-Ask Spreads, Trading Volume and Volatility: Intraday Evidence from the London Stock Exchange", *Journal of Business Finance and Accounting*, vol. 24, pp. 343-362.

3. Levin, E. Abhyankar A. and D. Ghosh (1994) "Does the Gold Market Reveal Real Interest Rates?", *The Manchester School* (supplement), vol. LXII, pp. 93-104.

4. Levin, E. and L.S. Copeland (1993) "Reading the UK Bond Market: Real Interest Rates, Expected Inflation and the Risk Premium", *The Manchester School* (supplement), vol. 61, pp. 13-34.

5. Levin, E. and L.S. Copeland (1992) "Real Interest Rates, Expected Inflation and the Inflation Uncertainty Premium: Evidence from UK Index Linked Bond Prices", *Economic Letters*, vol. 38, pp. 331-334.

6. Levin, E. and T. Moutos (1991) "Unemployment Insurance and Union Bargaining: An   Insider-Outsider Approach", *Journal of Economics*, vol. 53, pp. 271-284.

7. Brown, C.V., Levin, E. Rosa, P. Ruffell, R. and D.T. Ulph, D T (1984) "Tax Evasion and Avoidance on Earned Income", *Fiscal Studies. vol.* 5, pp. 1-22.

8. Brown, C.V., Levin, E. and D.T. Ulph (1976) "Estimates of Labour Hours Supplied by Married Male Workers in Great Britain", *Scottish Journal of Political Economy*, vol. 23, pp. 261-277.

9. Saunders, P G and E. Levin (1976) "Student Income and Expenditure: The Results of a Survey at The University of Stirling", *Oxford Bulletin of Economics and Statistics*, vol. 38, pp. 51-66.

10. Saunders, P.G. and E. Levin (1975) "The Finance of Student Maintenance and the Parental Contribution System 1959 to 1974", *Higher Education Bulletin*, vol. 4.

11. Brown, C.V. and E. Levin (1974) "The Effects of Income Taxation on Overtime: The Results of a National Survey", *Economic Journal*, vol. 84, pp. 833-848.

Robert E. Wright

Edited Books

1. Ermisch, J.F. and R.E. Wright, (2005), Changing Scotland: Evidence from the *British Household Panel Survey,* Bristol, Policy Press

2. Wright, R.E., (2004), *Scotland's Demographic Challenge*, Stirling/Glasgow, Scottish Economic Policy Network

3. Hanley, N., D. Shaw and R.E. Wright, (2003), *The New Economics of Outdoor Recreation,* Cheltenham, Edward Elgar

4. Wright, R.E., (1992), *The CEPHID Modelling Project: Canada's Elderly—Projecting Health, Income and Demography. A First Application*, Montreal, Institute for Research on Public Policy.

Chapters

1. Christie, M., N. Hanley, J. Warren, T. Hyde, K. Murphy and R.E. Wright, (2005), "A Valuation of Biodiversity in the UK using Choice Experiments and Contingent Valuation". In: P. Koundouri and T. Swanson, (eds.), *Handbook of Biodiversity Economics, Cambridge*, Cambridge University Press, in press.

2. Christie, M., N. Hanley, J. Warren, T. Hyde, K. Murphy and R.E. Wright (2005), "Developing Measures for Valuing Changes in Biodiversity". In: D. Pearce, (ed.), *Valuing the Environment in Developed Countries: Case Studies*, Cheltenham, Edward Elgar, in press

3. Hanley, H., R.E. Wright and B. Alvarez-Farizo, (2005), "Estimating the Economic Value of Improvements in River Ecology". In: J. Rolfe and J. Bennett, (eds.), *Transferring Environmental Values for Choice Modeling Approaches*, Cheltenham, Edward Elgar, in press

4. Hanley, N. and R.E. Wright, (2005), "Designing Choice Experiments". In: M. Christie and P. Midmore, (eds.), Choice Experiments: *A New Approach to Environmental Evaluation*, Cheltenham, Edward Elgar, in press

5. Ermisch, J.F. and R.E. Wright, (2005), "Devolution, Policy and Evidence." In: J.F. Ermisch and R.E. Wright (eds.), *Changing Scotland: Evidence from the British Household Panel Survey*, Bristol, Policy Press, pp. 1-12

6. Bourque, L.N., V. Gayle and R.E. Wright, (2005), "The Decline of Religion." In: J.F. Ermisch and R.E. Wright (eds.), Changing *Scotland: Evidence from the British Household Panel Survey*, Bristol, Policy Press, pp. 261-275

7   Gayle, V., G. Jack and R.E. Wright, (2005), "Trends in Absolute Poverty." In: J.F. Ermisch and R.E. Wright (eds.), *Changing Scotland: Evidence from the British Household Panel Survey, Bristol*, Policy Press, pp. 113-122

8. Joshi, H.E. and R.E. Wright, (2005), "Starting Life in Scotland". In: D. Coyle, W. Alexander and B. Ashcroft, (eds.), *New Wealth for Old Nations: Scotland's Economic Prospects, Princeton*, Princeton University Press, pp. 166-185

9. Wright, R.E. (2004), "Scotland's Future Demographic Prospects." In: R.E. Wright (ed.), *Scotland's Demographic Challenge*, Stirling/Glasgow, Scottish Economic Policy Network, Universities of Stirling/Strathclyde, pp. 8-33

10. Hanley, N. and R.E. Wright, (2003), "Valuing Recreational Resources using Choice Experiments: Mountaineering in Scotland". In: N. Hanley, D. Shaw and R.E. Wright, (eds.), *The New Economics of Outdoor Recreation*, Cheltenham, Edward Elgar, pp. 59-73

11. Wright, R.E., (2001), "Economic Demography". In: J. Michie, (ed.), *Reader's Guide to the Social Sciences (Volume 1)*, London, Fitzroy Dearborn, pp. 367-368

12. Hanley, N., I. Simpson, R.E. Wright and others, (1999), "Valuing the Landscape and Wildlife Benefits of Woodlands in an Agricultural Context". In: C. Stewart-Roper and A. Park, (eds.), *The Living Forest: The Non-Market Benefits of Forestry,* London, The Stationary Office, pp. 59-65

13. Milne, R.G. and R.E. Wright, (1998), "Competition in the Supply of Support Services and its Impact on Hospital Costs". In: *Control of Health Complexity*, Proceedings of Applied Econometrics Association, Health Econometrics Section, Lyon, University of Jean-Moulin Lyon 3, pp. 67-70

14. Wright, R.E., (1993), "Age, Wages and Education in the Netherlands: Discussion". In: P. Johnson and K. Zimmermann, (eds.), *Labour Markets in an Ageing Europe*, Cambridge, Cambridge University Press, pp. 211-215

15. Ermisch, J.F. and R.E. Wright, (1991), "Differential Returns to Human Capital in Full-time and Part-time Employment". In: N. Folbre, B. Bergmann, B. Argarwal and M. Floro, (eds.), *Women's Work in the World Economy*, London, Macmillan, pp. 195-212

16. Seward, S.B., K. McDade and R.E. Wright, (1991), "Immigration and Human Resource Development in Canada". In: *Proceedings of the Pacific Economic Cooperation Conference Human Resource Development Workshop*, Singapore, PECC, pp. 123-159

17. Ermisch, J.F., S.P. Jenkins and R.E. Wright, (1990), "Analysis of the Dynamics of Lone Parenthood: Socio-economic Influences on Entry and Exit Rates". In: E. Duskin, (ed.), *Lone Parent Families: The Economic Challenge*, Paris, Organisation of Economic Co-operation and Development, pp. 69-90

18. Wright, R.E., (1988), "Female Employment and Fertility: An Application of the Heckman-Borjas Two-spell Methodology to the Issues of State Dependence and Unobserved Heterogeneity". In: O. Anderson and B. Henriksen, (eds.), *Nordic Seminar on Empirical Life History Analysis and Panel Studies, Copenhagen*, Nordic Statistical Secretariat, pp. 223-236

19. Wright, R.E., J.F. Ermisch, A. Hinde and H.E. Joshi, (1988), "The Third Birth in Great Britain". In: O. Anderson and B. Henriksen, (eds.), *Nordic Seminar on Empirical Life History Analysis and Panel Studies*, Copenhagen, Nordic Statistical Secretariat, pp. 173-184

Journal Publications

1. Bergmann, A, N. Hanley and R.E. Wright, (forthcoming), "Valuing the Attributes of Renewable Energy Investments", *Energy Policy*

2. Christie M. N. Hanley, R.E. Wright and others, (forthcoming), "Valuing the Diversity of Biodiversity", *Ecological Economics*

3. Hanley, N., R.E. Wright and B. Alvarez-Farizo, (2006), "Estimating the Value of Improvements in River Ecology", *Journal of Environmental Management*, vol. 78, pp. 183-193

4. Lisiankova, K. and R.E. Wright, (2005), "Demographic Change and the European Union Labour Market", *National Institute Economic Review*, no. 194, pp. 74-81

5. Chowdhury, M., D. Ghosh and R.E. Wright, (2005), "Micro-credit and Poverty: Evidence from Bangladesh", *Progress in Development Studies*, vol. 5, no. 4 , pp. 1-12

6. Fertig, M. and R.E. Wright, (2005), "School Quality, Educational Attainment and Aggregation Bias", *Economic Letters*, vol. 88, no. 1, pp. 109-114

7. Adamowicz, V., N. Hanley, and R.E. Wright (2005), "Price Vector Effects in Choice Experiments", *Resource and Energy Economics*, vol. 27, pp. 227-234

8. Milne, R.G. and R.E. Wright, (2004), "Competition and Costs: Evidence from Competitive Tendering in the Scottish National Health Service", *Scottish Journal of Political Economy*, vol. 51, no. 1, pp. 1-23

9. Bell, D., G. Jack and R.E. Wright, (2004), "Micro-level Data Sources for Scottish Policy Studies", *Scottish Journal of Political Economy*, vol. 51, no. 1, pp. 143-147

10. Hanley, N., D. Macmillan, I. Patterson and R.E. Wright, (2003), "Economics and the Design of Nature Conservation Policy", *Animal Conservation*, vol. 6, pp. 123-129

11. Hanley, N., M. Ryan and R.E. Wright, (2003), "Estimating the Monetary Value of Health Care", *Health Economics*, vol. 12, no.1, pp. 3-16

12. Wright, R.E., (2002), "The Impact of Population Ageing on the Scottish Labour Market", *Quarterly Economic Commentary*, vol. 27, no. 2, pp. 38-43

13. Hanley, N., G. Koop and R.E. Wright, (2002), "Modelling Recreational Demand Using Choice Experiments: Rock-Climbing in Scotland", *Environmental and Resource Economics*, 22, no. 3, pp. 449-466

14. Wright, R.E., (2002), "Can Scotland Afford to Grow Old?", *Scottish Affairs*, vol. 39, no. 1, pp. 5-18

15. Hanley, N., S. Mourato and R.E. Wright, (2001), "Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?" *Journal of Economic Surveys*, vol. 15, no. 3, pp. 435-462

16. Hanley, N., G. Koop, B. Alvarez-Farizo, R.E. Wright and C. Nevin, (2001), "An Application of Recreation Demand Models to Rock Climbing", *Journal of Agricultural Economics*, vol. 52, no. 1, pp. 36-52

17. Laurie, H.M. and R.E. Wright, (2000), "The Scottish Household Panel Survey", *Scottish Journal of Political Economy*, vol. 47, no. 3, pp. 337-339

18. Milne, R.G. and R.E. Wright, (2000), "Competitive Tendering in the Scottish National Health Service", *Scottish Affairs*, vol. 31, no. 1, pp.133-152

19. Alvarez-Farizo, B., N. Hanley, R.E. Wright and D. Macmillan, (1999), "Estimating the Benefits of Agri-environmental Policy: Econometric Issues in Open-ended Contingent Valuation Studies", *Journal of Environmental Planning and Management*, vol. 42, no. 1, pp. 23-43

20. Hanley, N., R.E. Wright and V. Adamowicz, (1998), "Using Choice Experiments to Value the Environment: Design Issues, Current Experience and Future Prospects", *Environmental and Resource Economics*, vol. 11, no. 3/4, pp. 413-428

21. Hanley, N., D. Macmillan, R.E. Wright and others, (1998), "Contingent Evaluation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland", *Journal of Agricultural Economics*, vol. 49, no. 1, pp. 1-15

22. Palme, M.O. and R.E. Wright, (1998), "Changes in the Rate of Return to Education in Sweden", *Applied Economics*, vol. 30, pp. 1653-1663

23. Milne, R.G. and R.E. Wright, (1997), "The Decline of Fertility in Malta: The Role of Family Planning", *European Journal of Population*, vol. 13, no. 2, pp. 147-167

24. Wright, R.E., (1997),"Marital Status and Infant Mortality", *Canadian Studies in Population*, vol. 24, no. 2, pp. 147-161

25. Wright, R.E., (1997), "A Simple Method for Controlling for Compositional Effects in the Measurement of Poverty", *Applied Economics Letters*, vol. 4, no. 1, pp. 37-39

26. Bell, D. and R.E. Wright, (1996), "The Impact of Minimum Wages on the Wages of the Low Paid: Evidence from the Wage Boards and Councils", *Economic Journal*, vol. 106, no. 436, pp. 650-655

27. Findlay, J. and R.E. Wright, (1996), "Gender, Poverty and the Intra-Household Distribution of Resources", *Review of Income and Wealth*, vol. 42, no. 3, pp. 335-352

28. Wright, R.E., (1996), "Standardized Poverty Measurement", *Journal of Economic Studies*, vol. 23, no. 4, pp. 3-17

29. Ermisch, J.F. and R.E. Wright, (1996), "The Economic Environment and Entry to Single Parenthood in Great Britain", *Applied Economics*, vol. 28, pp. 483-489

30. Ermisch, J.F. and R.E. Wright, (1995), "Lone Parenthood and Employment: Male-Female Differences in Great Britain", *Labour Economics,* vol. 2, no. 3, pp. 299-317

31. Wright, R.E., (1995), "Women and Poverty in Industrialised Countries", *Journal of Income Distribution*, vol. 5, no. 1, pp. 31-46

32. Ermisch, J.F. and R.E. Wright, (1994), "Entry to Lone Parenthood: An Analysis of Marital Dissolution in Great Britain", *Genus*, vol. 50, no. 3/4, pp. 75-95

33. Wright, R.E., (1994), "Household Structure and Poverty", *Genus*, vol. 50, no. 3/4, pp. 133-150

34. Ermisch, J.F. and R.E. Wright, (1994), "On the Interpretation of Sample Selection Effects in Wage Offer Equations", *Applied Economics Letters*, vol. 1, no. 11, pp. 187-189

35. Wright, R.E., (1994), "Single Parenthood and Poverty in Great Britain", *Labour*, vol. 8, no. 2, pp. 239-258

36. Hurn, A.S. and R.E. Wright, (1994), "Geology or Economics? Testing Models of Irreversible Investment Using North Sea Oil Data", *Economic Journal*, vol. 104, no. 423, pp. 363-371

37. Milne, R.G. and R.E. Wright, (1994), "Changing Patterns of Contraceptive Use in Malta", *Economic and Social Studies*, vol. 7, pp. 1-7

38. Wright, R.E., (1993), "Using Census Data to Examine Aboriginal Issues: A Methodological Note", *Canadian Journal of Native Studies*, vol. 13, no. 2, pp. 291-307

39. Wright, R.E. and P.S. Maxim, (1993), "Immigration Policy and Immigrant Quality: Empirical Evidence from Canada", *Journal of Population Economics*, vol. 6, no. 4, pp. 335-352

40. Wright, R.E., (1993), "A Feminisation of Poverty in Great Britain? A Clarification", *Review of Income and Wealth*, vol. 39, no. 1, pp. 111-112

41. Ermisch, J.F. and R.E. Wright, (1993), "Wage Offers and Full-time and Part-time Employment by British Women", *Journal of Human Resources*, vol. 28, no. 1, pp. 111-133

42. Palme, M.O. and R.E. Wright, (1992), "Gender Discrimination and Compensating Differentials in Sweden", *Applied Economics*, vol. 24, no. 7, pp. 751-759

43. Wright, R.E., (1992), "A Feminisation of Poverty in Great Britain?", *Review of Income and Wealth*, vol. 38, no. 1, pp. 17-25

44. Wright, R.E. and J.F. Ermisch, (1991), "Gender Discrimination in the British Labour Market: A Reassessment", *Economic Journal*, vol. 101, no. 406, pp. 508-522

45. Ermisch, J.F. and R.E. Wright, (1991), "Employment Dynamics Among British Single Mothers", *Oxford Bulletin of Economics and Statistics*, vol. 53, no. 2, pp. 99-122

46. Ermisch, J.F. and R.E. Wright, (1991), "Welfare Benefits and Lone Parents' Employment in Great Britain", *Journal of Human Resources*, vol. 26, no. 3, pp. 424-456

47. Wright, R.E., (1991), "Cohort Size and Earnings in Great Britain", *Journal of Population Economics*, vol. 4, no. 4, pp. 295-306

48. Ermisch, J.F., H.E. Joshi and R.E. Wright, (1991), "Women's Wages in Great Britain", *International Review of Comparative Public Policy*, vol. 3, pp. 221-240

49. Wright, R.E. and A. Hinde, (1991), "The Dynamics of Full-time and Part-time Female Labour Force Participation in Great Britain", *European Journal of Population*, vol. 7, no. 3, pp. 201-230

50. Ermisch, R.E. and R.E. Wright, (1991), "The Duration of Lone-Parenthood in Great Britain", *European Journal of Population*, vol. 7, no. 2, pp. 129-158

51. Wright, R.E., (1991), "Les Familles Monoparentales et la Pauvrete en France (Single Parenthood and Poverty in France)", *Population*, vol. 46, no. 5, pp. 1265-1267

52. O'Toole, J. and R.E. Wright, (1991), "Parental Education and Child Mortality in Burundi", *Journal of Biosocial Science*, vol. 23, no. 3, pp. 255-262

53. Lorenz, W. and R.E. Wright, (1990), "Die Messung Geschlechtsspezifischer Einkommens- diskriminierung (The Measurement of Gender Discrimination in Wages)", *Wirtschafts Wissenschaftliches Studium*, vol. 11, pp. 573-577

54. Jenkins, S.P., J.F. Ermisch and R.E. Wright, (1990), "Adverse Selection Features of Poverty Amongst Lone Mothers", *Fiscal Studies*, vol. 11, no. 2, pp. 76-90

55. Ermisch, J.F. and R.E. Wright, (1989), "Welfare Benefits and the Duration of Single Parenthood", *National Institute Economic Review*, vol. 130, no. 4, pp. 85-90

56. Wright, R.E., (1989), "The Easterlin Hypothesis and European Fertility Rates", *Population and Development Review*, vol. 15, no. 1, pp. 107-122

57. Wright, R.E., (1989), "The Impact of Fertility on Sexual Union Transitions in Jamaica: An Event History Analysis", *Journal of Marriage and the Family*, vol. 51, no. 2, pp. 353-361

58. Wright, R.E., (1988), "Fertility, Partners and Female Labour Supply in Jamaica", *Genus*, vol. 44, no. 3/4, pp. 205-224

59. Wright, R.E., (1988), "The Impact of Income Redistribution on Fertility in Canada", *Genus*, vol. 44, no. 1/2, pp. 139-156

60. Wright, R.E., J.F. Ermisch, A. Hinde and H.E. Joshi, (1988), "The Third Birth in Great Britain", *Journal of Biosocial Science*, vol. 20, no. 4, pp. 489-496

61. Wright, R.E. and A.K. Madan, (1988), "Union Instability and Fertility in Three Caribbean Societies", *Journal of Biosocial Science*, vol. 20, no. 1, pp. 37-43

62. Wright, R.E. and P.S. Maxim, (1987),"Canadian Fertility Trends: A Further Test of the Easterlin Hypothesis", *Canadian Review of Sociology and Anthropology*, vol. 24, no. 3, pp. 339-357

63. Wolf, L.C. and R.E. Wright, (1987), "Changes in Life Expectancy of Mentally Retarded Persons in Canadian Institutions: A 12-Year Comparison", *Journal of Mental Deficiency Research*, vol. 31, no. 1, pp. 41-59

Other Publications

15. Wright, R.E., (2004), *Demographic Change and the Scottish Labour Market*, Commissioned Report, Economic and Social Research Council, Swindon

16. Wright, R.E., (2004), *Population Ageing and Immigration Policy*, Research Report, Stirling/Glasgow, Scottish Economic Policy Network

17. Bergmann, A., N. Hanley and R.E. Wright, (2004), "*Valuing the Environmental and Employment Impacts of Renewable Energy Investments in Scotland*", Research Report, Stirling/Glasgow, Scottish Economic Policy Network

18. Gibson, H., N. Hanley, R.E. Wright and others, (2004), *An Economic Assessment of the Costs and Benefits of Natura 2000 Sites in Scotland, Final Report*, Edinburgh, Scottish Executive

19. Fertig, M. and R.E. Wright, (2004), *School Quality, Educational Attainment and Aggregation Bias, IZA Discussion Paper no. 994*, Bonn, Institute for the Study of Labour

20. Christie, M., J. Warren, N. Hanley, K Murphy and R.E. Wright, (2004), *Developing Measures for Valuing Changes in Biodiversity: Final Report*, London, DEFRA

21. Wright, R.E., (2004), *Estimating the Willingness-to-pay for NATURA 2000 Sites*, Reading, Jacobs

22. Joshi, H.E. and R.E. Wright, (2004), *Starting Life in Scotland in the New Millennium: Population Replacement and the Reproduction of Disadvantage*, Glasgow, Fraser of Allander Institute, University of Strathclyde

23. Fertig, M. and R.E. Wright, (2003), S*chool Quality, Educational Attainment and Aggregation Bias*, Discussion Paper no. 9, Essen, RWI-Essen

24. Chowdhury, J., D. Ghosh and R.E. Wright, (2002), T*he Impact of Micro-credit on Poverty: Evidence from Bangladesh, Discussion Paper no. 02/01*, Stirling, Department of Economics, University of Stirling

25. Macmillan, D., N. Hanley, R.E. Wright and others, (2001), *The Costs and Benefits of Managing Wild Geese in Scotland, Edinburgh*, Scottish Executive Central Research Unit

26. Macmillan, D., N. Hanley, R.E. Wright and others, (2001), T*he Costs and Benefits of Managing Wild Geese in Scotland (Main Report)*, Edinburgh, Scottish Executive Rural Affairs Department

27. Macmillan, D., R.E. Wright, N. Hanley and L. Philip, (2001), *Willingness to Pay for the Conservation and Management of Wild Geese in Scotland (Technical Report)*, Edinburgh, Scottish Executive Rural Affairs Department

28. Hanley, N., R.E. Wright G. Koop, (2000), *Modelling Recreation Demand using Choice Experiments: Climbing in Scotland*, Discussion Paper in Economics no. 00-11, Glasgow, Department of Economics, University of Glasgow

29. Hanley, N., G. Koop, R.E. Wright and B. Alvarez-Farizo, (1999), *An Application of Recreational Demand Models to Rock-climbing in Scotland,* Discussion Paper no. 99/7, Stirling, Department of Economics, University of Stirling

30. Wright, R.E., (1999), *The Rate of Return to Private Schooling*, Discussion Paper 99/5, Stirling, Department of Economics, University of Stirling and IZA Discussion Paper no. 92. Bonn, Institute for the Study of Labour

31. Milne, R.G. and R.E. Wright, (1999), Competitive Tendering in the Scottish National Health Service: Was it Compulsory and Did It Make a Difference?, Discussion Paper in Economics no. 99-11, Glasgow, Department of Political Economy, University of Glasgow

32. Bell, D.N.F., R.A. Hart and R.E. Wright, (1997), *Double Job Holding in Great Britain,* Discussion Paper no. 97/9, Stirling, Department of Economics, University of Stirling

33. Bell, D.N.F., R.A. Hart and R.E. Wright, (1997), *Multiple Job Holding as a "Hedge" Against Unemployment*, Discussion Paper no. 1626, London, Centre for Economic Policy Research

34. Alvarez-Farizo, B, N. Hanley and R.E. Wright, (1996), *Sample Selection Bias and the Estimation of Bid Curves in Open-ended Contingent Valuation Studies*, Ecological Economics Discussion Paper no. 96/5, Stirling, Environmental Economics Research Group, University of Stirling

35. Milne, R.G. and R.E. Wright, (1996), *The Decline of Fertility in Malta: The Role of Family Planning*, Occasional Paper no. 21, Glasgow, Centre for Development Studies, University of Glasgow

36. Bell, D. and R.E. Wright, (1996), *The Impact of Minimum Wages on the Wages of the Low Paid: Evidence from the Wage Boards and Councils*, Discussion Paper no. 96/5, Stirling, Department of Economics, University of Stirling

37. Wright, R.E., (1994), *Lone Parenthood and Employment, Male-Female Differences in Great Britain (Revised), Discussion Paper*, Glasgow, Applied Population Research Unit, University of Glasgow

38. Wright, R.E., (1994), *Sexual Union Status and Infant Mortality in Jamaica*, Discussion Paper, Glasgow, Applied Population Research Unit, University of Glasgow

39. Wright, R.E., (1994), *Generational Crowding and Occupational Attainment*, Discussion Paper in Economics no. 94-06, Glasgow, Department of Political Economy, University of Glasgow

40. Palme, M.O. and R.E. Wright, (1994), *Changes in the Rate of Return to Education in Sweden* (Revised), Working Paper Series in Economics and Finance no. 6, Stockholm, Stockholm School of Economics

41. Findlay, J. and R.E. Wright, (1994), *Gender, Poverty and the Intra-Household Distribution of Resources* (Revised), Discussion Paper no. 913, London, Centre for Economic Policy Research

42. Wright, R.E., (1994), *The Income, Earnings and Employment of the Aboriginal Population*, Final Report, Montreal, Institute for Research on Public Policy

43. Palme, M.O. and R.E. Wright, (1993), *Changes in the Rate of Return to Education in Sweden*, Discussion Paper in Economics no. 93-12, Glasgow, Department of Political Economy, University of Glasgow

44. Wright, R.E., (1993), *Using Census Data to Examine Aboriginal Issues: A Methodological Note*, Discussion Paper in Economics no. 93-11, Glasgow, Department of Political Economy, University of Glasgow

45. Milne, R.G. and R.E. Wright, (1993), *Contraceptive Use in Malta*, Discussion Paper in Economics no. 93-08, Glasgow, Department of Political Economy, University of Glasgow

46. Findlay, J. and R.E. Wright, (1993), *Gender, Poverty and the Intra-Household Distribution of Resources* (Revised), Discussion Paper in Economics no. 93-07, Glasgow, Department of Political Economy, University of Glasgow

47. Ermisch, J.F. and R.E. Wright, (1993), *The Economic Environment and Entry to Single Parenthood in Great Britain*, Discussion Paper in Economics no. 92-05, Glasgow, Department of Political Economy, University of Glasgow

48. Wright, R.E., (1993), *Women and Poverty in Industrialised Countries*, Luxembourg Income Study Working Paper no. 96, Walferdange, Luxembourg

49. Hurn, A.S. and R.E. Wright, (1993), *Geology or Economics? Testing Models of Irreversible Investment Using North Sea Oil Production Data*, Discussion Paper in Economics no. 93-03, Glasgow, Department of Political Economy, University of Glasgow

50. Wright, R.E., (1993), *Women and Poverty in Industrialised Countries*, Discussion Paper in Economics no. 93-02, Glasgow, Department of Political Economy, University of Glasgow

51. Findlay, J. and R.E. Wright, (1992), *Gender, Poverty and the Intra-Household Distribution of Resources*, Luxembourg Income Study Working Paper no. 83, Center for the Study of Population, Poverty and Policy Studies, Walferdange, Luxembourg

52. Wright, R.E., (1992), "Summary". In: R.E. Wright (ed.), *The CEPHID Modelling Project. Canada's Elderly--Projecting Health, Income and Demography:* A First Application, Montreal, Institute for Research on Public Policy

53. Ermisch, J.F. and R.E. Wright, (1992), *Entry to Lone Parenthood: An Analysis of Marital Dissolution in Great Britain*, Discussion Paper in Economics no. 92-15, Glasgow, Department of Political Economy, University of Glasgow

54. Ermisch, J.F. and R.E. Wright, (1992), *Lone Parenthood and Employment: Male-Female Differences in Great Britain*, Discussion Paper in Economics no. 92-14, Glasgow, Department of Political Economy, University of Glasgow

55. Wright, R.E. and P.S. Maxim, (1992), *Immigration Policy and Immigrant Quality*, Discussion Paper in Economics no. 92-13, Glasgow, Department of Political Economy, University of Glasgow

56. Ermisch, J.F. and R.E. Wright, (1992), *On the Interpretation of Sample Selection Effects in Wage Offer Equations*, Discussion Paper in Economics no. 92-12, Glasgow, Department of Political Economy, University of Glasgow

57 Wright, R.E., (1992), *Single Parenthood and Poverty in Great Britain: What the Data Tells Us*, Discussion Paper in Economics no. 92-11, Glasgow, Department of Political Economy, University of Glasgow

58. Wright, R.E., (1992), *Household Structure and Poverty*, Discussion Paper in Economics no. 92-10, Glasgow, Department of Political Economy, University of Glasgow

59. Wright, R.E., (1992), Household Structure and the Measurement of Poverty, Luxembourg Income Study Working Paper no. 74, Center for the Study of Population, Poverty and Policy Studies, Walferdange, Luxembourg

60. Wright, R.E., (1992), *Changing Household Structure and Poverty in Great Britain,* Discussion Paper no. 92-1, Glasgow, Applied Population Research Unit, University of Glasgow

61. Wright, R.E., (1992), *Standardised Poverty Measurement*, Discussion Paper in Economics no. 92-03, Glasgow, Department of Political Economy, University of Glasgow

62. Palme, M.O. and R.E. Wright, (1992), *Gender Discrimination and Compensating Differentials in Sweden*, Discussion Paper in Economics no. 92-02, Glasgow, Department of Political Economy, University of Glasgow

63. Wright, R.E. and K. McDade, (1992), *Barriers to the Recognition of the Credentials of Immigrants in Canada: An Analysis Using Census Data*, Montreal, Institute for Research on Public Policy

64. Wright, R.E., (1991), *The Income, Earnings and Employment of the Aboriginal Population: An Interim Report,* Ottawa, Institute for Research on Public Policy

65. Wright, R.E., (1991), *Les Familles Monoparentales et la Pauvrete en France*, Luxembourg Income Study Working Paper no. 64, Center for the Study of Population, Poverty and Policy Studies, Walferdange, Luxembourg

66. Ermisch, J.F. and R.E. Wright, (1990), "Welfare Benefits and Lone Parent's Employment", *General Household Survey Newsletter*, no. 8, pp. 24-53

67. Wright, R.E. and J.F. Ermisch, (1990), *Male-Female Wage Differentials in Britain*, Discussion Paper in Economics no. 10, London, Birkbeck College

68. Ermisch, J.F., H.E. Joshi and R.E. Wright, (1990), W*omen's Wages in Great Britain*, Discussion Paper in Economics no. 8, London, Birkbeck College

69. Ermisch, J.F. and R.E. Wright, (1990), *Entry to Lone Parenthood: Analysis of Marital Dissolution*, Discussion Paper in Economics no. 9, London, Birkbeck College

70. Ermisch, J.F. and R.E. Wright, (1989), *Wage Offers and Full-time and Part-time Employment by British Women*, Discussion Paper no. 164, London, National Institute of Economic and Social Research

71. Ermisch, J.F. and R.E. Wright, (1989), *Lone Parenthood and Labour Force Participation in Great Britain: Male-Female Differences*, Discussion Paper in Economics no, 9. London, Birkbeck College

72. Wright, R.E., (1989), *Cohort Size and Earnings in Great Britain*, Discussion Paper in Economics no. 8, London, Birkbeck College

73. Ermisch, J.F. and R.E. Wright, (1989), "Lone Parenthood and Employment: Theoretical Issues and Empirical Evidence". In: M. Hardy, (ed.), *Family Life in Lone Parent Households Conference Papers*, Surrey, Social and Computer Science Research Group, University of Surrey

74. Ermisch, J.F. and R.E. Wright, (1989), *Welfare Benefits and Lone Parent's Employment*, Discussion Paper no. 159, London, National Institute of Economic and Social Research

75. Ermisch, J.F., S.P. Jenkins and R.E. Wright, (1989), *Adverse Selection Aspects of Poverty amongst Lone Mothers*, Discussion Paper in Economics no. 2, London, Birkbeck College

76. Ermisch, J.F. and R.E. Wright, (1989), *The Duration of Lone Parenthood in Great Britain*, Discussion Paper no. 303, London, Centre for Economic Policy Research

77. Ermisch, J.F. and R.E. Wright, (1989), *Employment Dynamics among British Lone Mothers*, Discussion Paper no. 302, London, Centre for Economic Policy Research

78. Ermisch, J.F. and R.E. Wright, (1988), *Differential Returns to Human Capital in Full-time and Part-time Employment: The Case of British Women*, Discussion Paper in Economics no. 14, London, Birkbeck College

79. Wright, R.E. and J.F. Ermisch, (1988), *Gender Discrimination in the British Labour Market: A Reassessment*, Discussion Paper no. 278, London, Centre for Economic Policy Research

80. Wright, R.E. and A. Hinde, (1988), *The Dynamics of Female Labour Force Participation in Great Britain*, Research Paper no. 2, London, Centre for Population Studies, LHTM, University of London

81. Ermisch, J.F. and R.E. Wright, (1988), *Women's Wages in Full- and Part-time Jobs in Great Britain, Discussion Paper no. 234*, London, Centre for Economic Policy Research

82. Ermisch, J.F., S.P. Jenkins and R.E. Wright, (1987), T*he Dynamics of Lone Parenthood in Great Britain,* Papers in Political Economy no. 12, Bath, School of Humanities and Social Sciences, University of Bath

83. Ermisch, J.F., S.P. Jenkins and R.E. Wright, (1987), *Analysis of the Dynamics of Lone Parenthood: Socioeconomic Influences on Entry and Exit Rates, Conference of National Experts Paper no. 5*, Paris, Directorate for Social Affairs, Manpower and Education, OECD

84. Wolf, L.C. and R.E. Wright, (1986), *Life Expectancy of Mentally Retarded Persons in Canadian Institutions: A Twelve-year Comparison*, Toronto, Government of Ontario

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Short-run and Long-run Determinants of the Price of Gold

Notes

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Gold Derivatives: The Market Impact Anthony Neuberger, May 2001

Gold and the International Monetary System in a New Era: Proceedings of Paris Conference, 18 November 1999

The Euro, the Dollar and Gold: Proceedings of Rome Conference, 17 November 2000

The Euro, the Dollar and Gold: Proceedings of Berlin Conference, 16 November 2001

A Touch of Gold: gold mining's importance to lower income countries Jill Leyland, May 2005

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