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The Golden Dilemma

Claude B. Erb, CFA, and Campbell R. Harvey

Although gold has been around for thousands of years, its role in diversified portfolios is not well understood. The authors critically examined such popular stories as “gold is an inflation hedge.” Investors face the following dilemma: The real price of gold is historically very high and may revert to the mean, but if prominent emerging markets increase their gold holdings, the real price of gold may rise even further from today’s elevated levels.

The global equity and fixed-income markets have a combined market value of about \$90 trillion.¹ Institutional and individual investors own most of the outstanding supply of stocks and bonds. At current prices, the world’s stock of gold is worth about \$9 trillion. Yet, investors own only about 20%, or less than \$2 trillion, of the outstanding supply of gold. A move by institutional and individual investors to “market-weight” gold holdings would require them to offer current gold owners a price sufficiently attractive to incentivize them to part with their gold, probably sending both nominal and real prices of gold much higher. Should investors target a gold “market weight”? Could they achieve a gold market weight even if they wanted to?

The goal of our study was to better understand how we should treat gold in asset allocation. We started by examining a number of popular stories that are used to justify some allocation to gold, such as inflation hedging, currency hedging, and

disaster protection. We then examined basic supply-and-demand factors. Remarkably, the new supply of gold that comes to the market each year has not increased substantially over the past decade even though the nominal price of gold has risen fivefold. We also looked at the distribution of gold ownership in both developed and emerging market countries and estimated the impact on gold demand if key emerging market countries were to follow the same patterns of central bank gold ownership as in important developed countries.

Gold has had an amazing recent run. From December 1999 to March 2012, the U.S. dollar price of gold rose more than 15.4% a year, the U.S. Consumer Price Index (CPI) increased by 2.5% a year, and U.S. stock and bond markets registered annual gains of 1.5% and 6.4%, respectively. Indeed, Saad (2012) noted a recent Gallup poll that found that some 30% of respondents considered gold the best long-term investment, making it a more popular investment than real estate, stocks, and bonds.

Although some might use historical returns to estimate long-run forward-looking expected returns, an expected long-run real rate of return on gold of about 13% a year (15.4% nominal minus an assumed 2.5% annual inflation) is implausible. Yet, it is essential to have some sense of gold’s expected return for purposes of asset allocation. Current views are sharply divergent. On one side is Warren Buffett (2012), who has compared the current value of gold with three famous bubbles—the tulip bubble, the dot-com bubble, and the recent housing bust:

What motivates most gold purchasers is their belief that the ranks of the fearful will grow. During the past decade, that belief has proved correct. Beyond that, the rising price has on its own generated additional buying enthusiasm, attracting purchasers who see the rise as validating

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Authors’ Note: Campbell R. Harvey is associated with the Man Group, plc, as its investment strategy adviser. Some of the Man Group’s investment funds trade gold as part of diversified commodity portfolios. Professor Harvey does not offer to the Man Group any advice on gold investment, and the Man Group was not involved in providing financial or other support for this independent research. Claude B. Erb is unaffiliated and also has no conflict of interest.

an investment thesis. As “bandwagon” investors join any party, they create their own truth—for a while. (p. 18)

On the other side is Ray Dalio, who argued in a *Barron's* interview (see Ward 2011) that U.S. Treasury bills are no longer a safe asset and that there will be an ugly contest to depreciate the three main currencies (dollar, yen, and euro) as countries print money to pay off debt:

Gold is a very underowned asset, even though gold has become much more popular. If you ask any central bank, any sovereign wealth fund, any individual what percentage of their portfolio is in gold in relationship to financial assets, you'll find it to be a very small percentage. It's an imprudently small percentage, particularly at a time when we're losing a currency regime.

It is not surprising that there is so much disagreement about gold's future. This disagreement reflects the fact that at least six different arguments for owning gold have been advanced:²

- Gold provides an inflation hedge.
- Gold serves as a currency hedge.
- Gold is an attractive alternative to assets with low real returns.
- Gold is a safe haven in times of stress.
- Gold should be held because we are returning to a *de facto* world gold standard.
- Gold is “underowned.”

The debate about the prospects for gold resembles the parable of the six blind men and the elephant (see Saxe 1872). Different perspectives and different models lead to different insights. Depending on which rationale or combination of rationales one embraces, gold is either very expensive or attractive. The debate about the value of gold is also an example of a Keynesian “beauty contest,” which suggests that the price of gold is not determined by what you think gold is worth—what matters is what others think gold is worth (see Keynes 1936).³

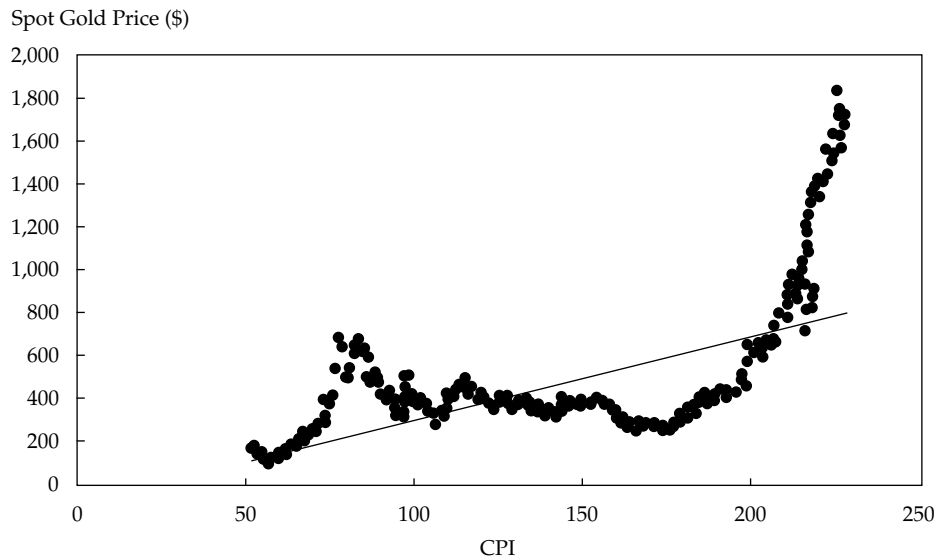
Although the value of all the gold ever mined is arguably about \$9 trillion,⁴ only a small amount of gold actually trades in financial markets. The investment demand for gold is characterized by positive price elasticity, which is one way of referring to momentum investing. As a result, even though historical measures of “value” may suggest that gold is very expensive, it is possible that the actions of a relatively small number of marginal momentum buyers of gold could drive both the real and the nominal price much higher (especially if the marginal buyers are not focused on “valuation”).

Gold as an Inflation Hedge

Probably one of the most widely held beliefs about gold is that it is an inflation hedge. Jastram (1978) pointed out that historically gold has been a poor inflation hedge in the short run, though it has been a good inflation hedge in the long run. For Jastram, the short run was the next few years and the long run was perhaps a century. Jastram used the phrase “the golden constant” to communicate his belief that the real price of gold maintains its purchasing power over long periods and that gold's long-run average real return has been zero. Harmston (1998) built on Jastram's research, finding that in the long run, some goods, such as bread, seem to command a constant price when denominated in ounces of gold.⁵ “Gold as an inflation hedge” means that if, for instance, inflation rises by 10% a year for 100 years, the price of gold should also rise by roughly 10% a year over the same period. The “gold-as-an-inflation-hedge” argument says that inflation is a fundamental driver of the price of gold.⁶

It is worth asking for whom gold might be an inflation hedge—that is, even if gold provides potential inflation-hedging ability, it might not be accessible to investors. For example, in the United States, private ownership of gold was outlawed by President Franklin Roosevelt in early 1933 with the signing of Executive Order 6102. Private ownership of gold in the United States was restored when Public Law 93-373 went into effect on 31 December 1974. If different countries have different laws regarding the ownership of gold, then investors in different countries face different realities with regard to the legal inflation-hedging ability of gold. In addition, when an investment is outlawed in a country, it is questionable whether investors in that country can observe “market prices” for the outlawed investment. As a result, exploring the various arguments for investing in gold requires selecting, and being constrained by, both a country perspective and a legal perspective. It is also desirable—and important—that if one invests in a legal inflation hedge, the position remain a legal hedge until at least a fraction of a second after the position is sold.⁷ For the purposes of our study, the United States was a convenient country perspective and our focus was largely on the period in which it has been legal to own gold in the United States. This approach does not suggest that the “U.S. perspective” is the only perspective or that investors should consider only legal investments. Rather, it is a starting point.

Figure 1 illustrates one literal version of the gold-as-an-inflation-hedge argument. Our initial “legal” sample starts in 1975 because that is when U.S. citizens were once again able to own and trade

Figure 1. Gold as an Inflation Hedge, January 1975–March 2012

Source: Bloomberg.

gold. The “market price” of gold became readily visible with the launch of gold futures trading (for most of the history of the United States, the price of gold was fixed by the government).⁸ Figure 1 shows the month-end value of the nearby gold futures contract versus the monthly reading for the CPI over January 1975–March 2012. The regression line⁹ shows that on average, the higher the level of the CPI, the higher the price of gold. This line roughly graphs the implied price of gold—if gold were driven by the CPI. In Figure 1, however, the price of gold swings widely around the CPI. The inflation-derived price of gold and the actual price of gold have rarely been equal. Given the most recent value for the CPI, this version of the gold-as-an-inflation-hedge argument suggests that the price of gold should currently be around \$780 an ounce.

Another way to assess how effective gold has been as an inflation hedge is to examine the historical fluctuations in the real (inflation-adjusted) price of gold. If gold were a perfect short-term inflation hedge—in the sense of Jastram’s (1978) metaphor of a long-run, zero-real-return “golden constant”—the real price of gold would be a constant and exhibit no real price variability.¹⁰ Alternatively, if the real price of gold fluctuates—perhaps behaving like a valuation measure, such as a stock market price-to-earnings ratio—gold may be an imperfect short-term inflation hedge.

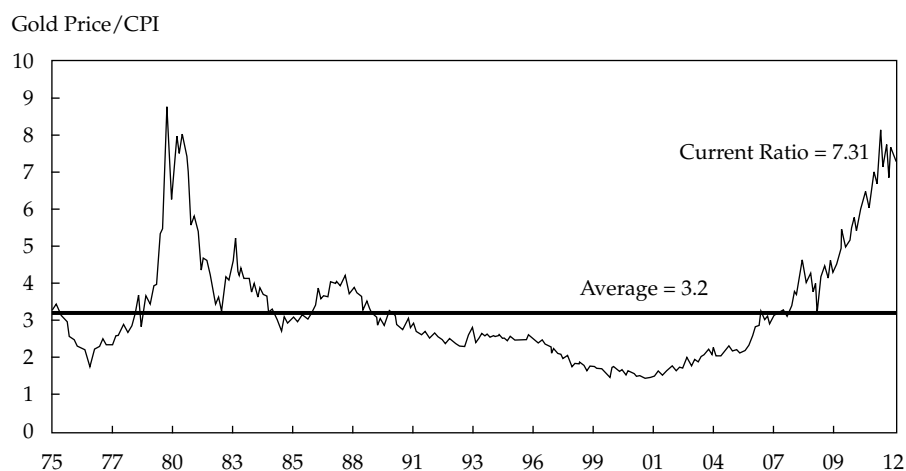
Figure 2 shows one way to think about fluctuations in the real price of gold from a U.S. perspective (later in the article, we will consider an international perspective; see also Erb and Harvey 2012a). In January 1975, the month-end nominal price of the nearby gold futures contract was \$175

an ounce. The month-end January 1975 index value of the CPI was 52.1.¹¹ The ratio of the nominal price of gold to the CPI (one way to calculate the “real price of gold”) was 3.36. Since the inception of gold futures trading, this real price ratio has averaged about 3.2, reaching a low of 1.46 in March 2001 and a high of 8.73 in January 1980. Under this measure, the month-end March 2012 real price of gold was 7.3. Since the start of gold futures trading, the only other time the real price of gold has been roughly as high as it is today was in 1980. Following the high in 1980, the real price of gold, as well as the nominal price of gold, fell significantly.

Figure 2 shows that the real price of gold has been quite volatile. In fact, the volatility of the real price of gold has basically been the same as the volatility of the nominal price of gold, and the real price of gold tends to mean-revert over a period of about 10 years. The variability of the real price of gold suggests that gold has been a poor short-term inflation hedge.

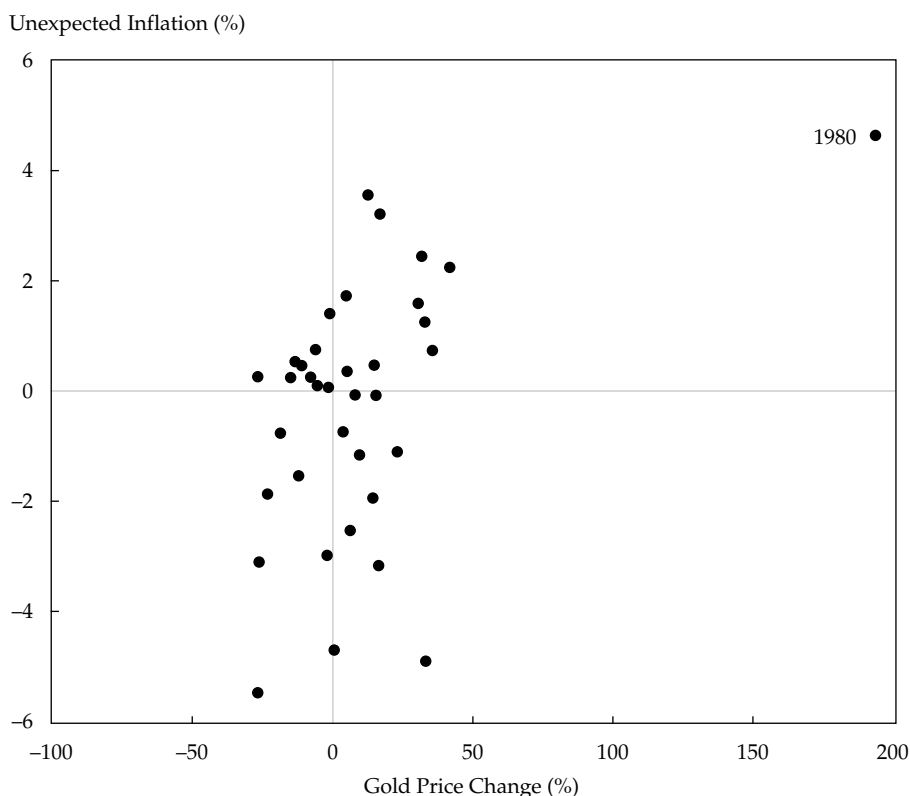
There are at least two ways to think about inflation: the rate of inflation that investors expect and the rate of inflation that comes as a surprise to investors. An asset that hedges both expected and unexpected inflation would probably appeal to a broad number of investors. If an investor possessed perfect foresight, there would be no unexpected inflation. As a result, one of the easiest ways to test whether an asset is a good hedge of unexpected inflation is to ask whether it hedges perfect foresight of future inflation changes. **Figure 3** depicts the inability of gold to hedge against unexpected inflation (measured by the actual year-to-year change in the annual inflation rate over

Figure 2. The Real Price of Gold since the Advent of U.S. Futures Trading, 1975–2012



Source: Bloomberg.

Figure 3. Gold Price Change and Unexpected Inflation, 1975–2011



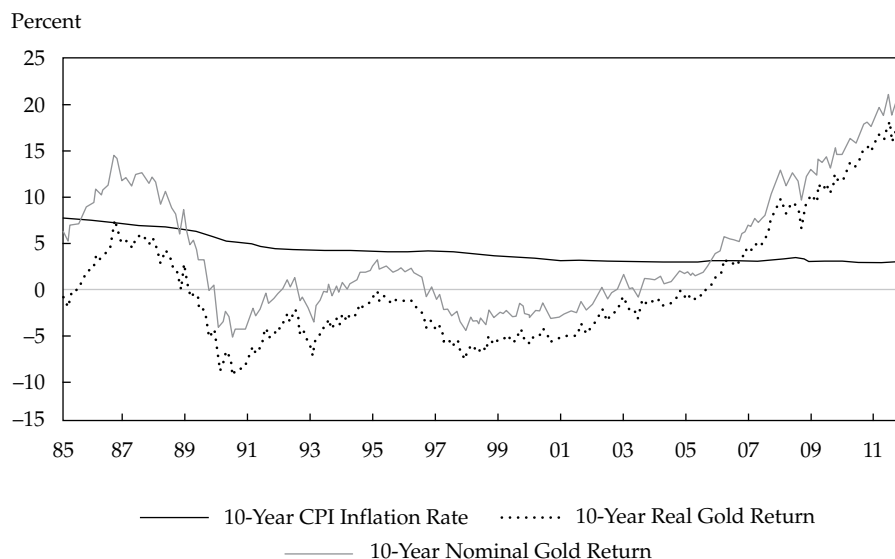
Source: Bloomberg.

1975–2011). There is effectively no correlation here. Any observed positive relationship is driven by a single year, 1980.

What about the ability of gold to hedge, or keep pace with, longer-term inflation?

Figure 4 shows rolling monthly observations of trailing 10-year rates of inflation, as well as both

nominal and real gold returns. There has been substantial variation in trailing nominal 10-year annualized gold returns: from as low as -6% a year to as high as 20% . There has also been significant variation in real gold returns. In contrast, over the same period, the lowest and highest inflation rates were 2.3% and 7.3% a year—a range of only 5 percentage points.

Figure 4. Long-Term Inflation Hedging and Gold Returns, 1985–2012

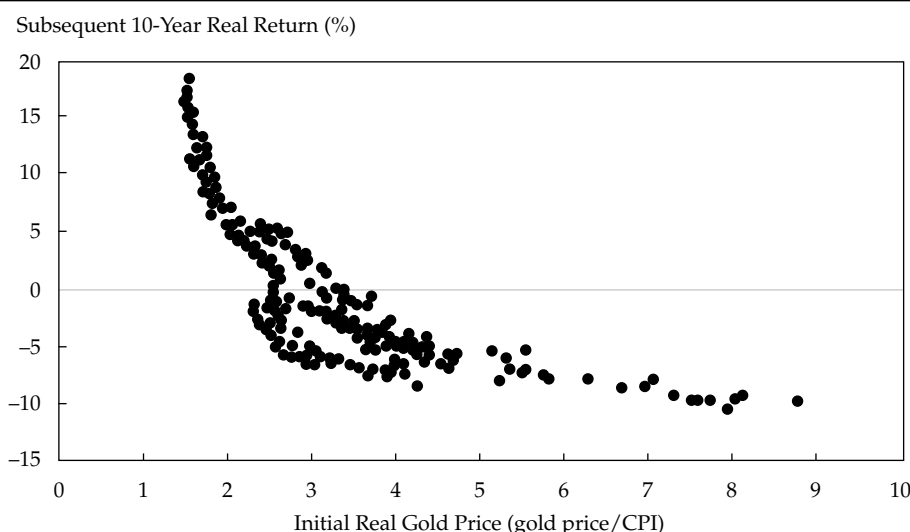
Source: Bloomberg.

From Figure 4 we can make at least four observations. First, perfect knowledge of the future rate of inflation did not translate into an accurate forecast of future nominal or real gold price returns (inflation did not predict gold returns). Second, knowing future nominal and real gold returns provided no real insight into the course of future inflation (gold returns did not predict inflation). Third, variation in the real price of gold accounted for most of the variation in the nominal price of gold. Finally, given that the trailing 10-year real gold return was negative from 1988 to 2005, it is obvious that gold might have failed to live up to investor expectations as an effective long-term inflation hedge.

By definition, the nominal return of gold is the sum of the inflation rate and the real gold price return. Of course, the rate of inflation varies from country to country. In Figure 4, the average rate of inflation in the United States was about 4% a year, driving a wedge between nominal and real gold returns. What if the average rate of inflation in some other country had been 50% a year rather than 4%? In a “golden constant” sense, the average nominal return on gold would have been higher. However, there is no obvious reason why the real gold return would have changed. In fact, as we illustrated in an earlier study (Erb and Harvey 2012a), when the real price of gold is high or low in one country, it is generally high or low in other countries. As a result, the nominal return of gold (within a country) will consist of a local, country-specific inflation effect and what appears to be a global real price effect. Figure 4 suggests that the real price of gold can vary a lot. Gold may not be a very effective long-term inflation hedge when the long term is defined as 10 years.

Mean reversion is a “past is prologue” way of looking at the world. The real price of gold is currently high, and the real price of gold was high in 1980. The high real price of gold in 1980 was followed by a long period of unattractive gold returns. Figure 5 details the historical relationship between the real price of gold and subsequent 10-year real gold price returns since 1975. If Figure 5 depicted a “known known” stable relationship, the current high real price of gold would suggest a future 10-year real price return of about -10% a year. But the relationship is not a known known; it is a “known unknown.”

Whether the real price of gold can forecast future real gold returns is similar to the debate about the ability of stock market price-to-earnings ratios (valuation ratios) to forecast future stock market real returns. For instance, Campbell and Shiller (2001) and Asness (2012) argued emphatically that valuation matters and that high valuation levels are followed by low real returns. DeLong (2012) noted diplomatically that “only fools say . . . that movements in marketwide price-earnings ratios are best interpreted as shifts in rational expectations of future earnings and dividend growth.” However, Ibbotson and Chen (2003) were comfortable with the idea that in an efficient market, high price-to-earnings ratios forecast high future earnings growth rates, and Malkiel (2003) viewed the valuation argument as inconsistent with market efficiency. Investors who observe the behavior of the real price of gold have an opportunity to confirm their pre-existing concepts about how markets operate. The real price of gold may or may not mean-revert over time, but the purchasing power

Figure 5. Mean Reversion of the Real Price of Gold, 1975–2012

Source: Bloomberg.

of gold is driven by changes in the real price of gold. An investment in gold is a bet on the future evolution of the real price of gold, whether or not an investor is aware of the bet.

Importantly, it is dangerous to draw inferences about the future from what is arguably one historical episode.

In 1980, the trailing one-year CPI inflation rate was about 13%. Some called bonds “certificates of confiscation,” believing that the rate of inflation would stay at a stubbornly high level well into the future (see Norris 2010). With the clarity of hindsight, it is possible to see a “Volcker moment” in which the U.S. Federal Reserve turned its back on its dual mandate (maximum employment and price stability) and decided to focus on fighting inflation. The actual gold return of -5% a year over 1980–1990 is the one path traveled by history, but it is only one of the many paths that were possible to imagine from the vantage point of January 1980.

What might inflation be over the next 10 years? By looking at the yields of 10-year nominal Treasury bonds and 10-year inflation-linked Treasury bonds, it is possible to back out an approximate “market-implied” 10-year inflation forecast.¹² Currently, the “breakeven” inflation rate over the next 10 years is about 2% a year. Of course, there is no guarantee that inflation will actually average 2% a year over the next 10 years. If the real price ratio of gold mean-reverts over the coming decade to its historical average of about 3.2, gold’s possible rate of return will average about -6% a year, as shown in **Table 1**.

Received gold lore suggests that gold has been mined since 3600 BC (see World Gold Council 2012a). Tversky and Kahneman (1971, p. 25) warned of the “law of small numbers,” which leads

to “exaggerated confidence in the validity of conclusions based on small samples.” It is possible that the behavior of the price of gold since 1975, a span of only 36 years, is an example of the law of small numbers. A possible, but potentially flawed, way to battle the law of small numbers is to obtain more data.

Figure 6 shows the estimated growth of the U.S. GDP price deflator since 1792, which increases the historical inflation time span from 36 years to 220 years. Of course, Figure 6 does not provide any insight into the cost of things between 3600 BC and 1792. Paul and Lehrman (2007, p. 2) suggested that “from 1792 to 1971 [the United States] had an imperfect money and banking system . . . but during that time the dollar was always related to gold in one way or another.” In a more granular review of historical U.S. currency standards written for members of the U.S. Congress, Elwell (2011, pp. 2–13 *passim*) labeled the bimetallic currency years 1792–1834 “basically silver,” the years 1834–1862 “basically gold,” the years 1862–1879 “fiat paper money,” the years 1879–1933 “a true gold standard,” the years 1934–1973 a “quasi-gold standard,” and the years since 1973 a pure fiat money regime.

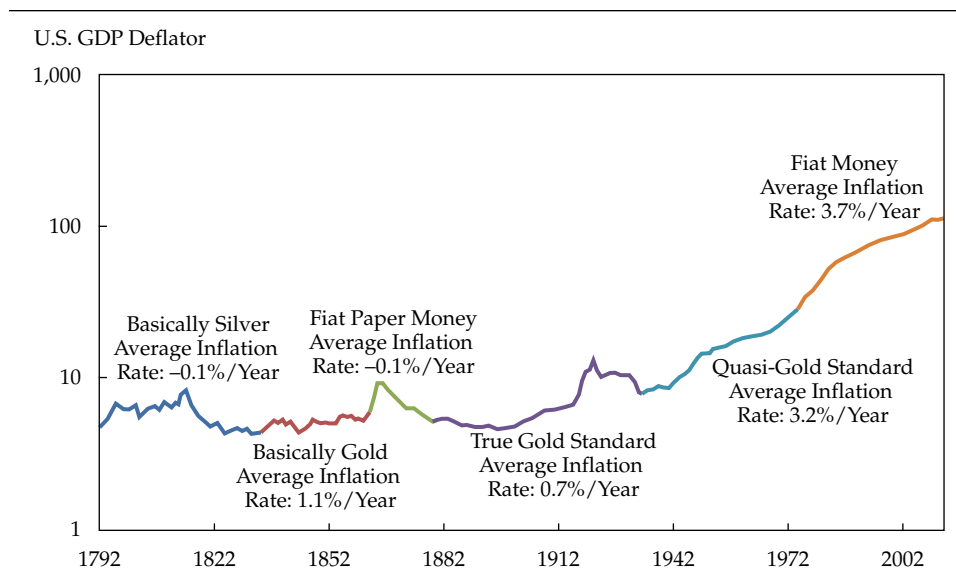
The highest U.S. inflation rate since 1792 occurred under the current fiat money regime. To some, this is proof of the fragility of a fiat money regime; von Mises (1953) believed that fiat money systems were inherently prone to inflationary excesses, especially if social policy focused on full employment rather than price stability.¹³ But the devil is in the details. The fiat money regime of 1862–1879 experienced what seems to be a low rate of inflation, and the quasi-gold standard regime of 1934–1973 had a relatively high inflation rate. Bordo

Table 1. Rates of Return on Gold under Different Inflation Scenarios

Ending Real Price Ratio	Annual Inflation Rate over the Next 10 Years								
	0%	2%	4%	5%	6%	8%	10%	20%	40%
	Return Given Inflation and Ending Valuation								
12.2	5.32%	7.42%	9.53%	10.58%	11.64%	13.74%	15.85%	26.38%	47.44%
11.2	4.42	6.51	8.60	9.64	10.68	12.77	14.86	25.30	46.19
10.2	3.45	5.52	7.59	8.62	9.65	11.72	13.79	24.14	44.83
9.2	2.39	4.43	6.48	7.51	8.53	10.58	12.62	22.86	43.34
8.2	1.21	3.24	5.26	6.28	7.29	9.31	11.34	21.46	41.70
7.2	-0.09	1.90	3.90	4.90	5.90	7.90	9.90	19.89	39.87
6.2	-1.58	0.39	2.36	3.34	4.33	6.30	8.27	18.11	37.79
5.2	-3.29	-1.36	0.58	1.54	2.51	4.44	6.38	16.05	35.39
4.2	-5.34	-3.44	-1.55	-0.60	0.34	2.24	4.13	13.60	32.53
3.2	-7.88	-6.03	-4.19	-3.27	-2.35	-0.51	1.34	10.55	28.97
2.2	-11.26	-9.49	-7.71	-6.83	-5.94	-4.16	-2.39	6.48	24.23
1.2	-16.48	-14.81	-13.14	-12.31	-11.47	-9.80	-8.13	0.22	16.92
0.2	-30.18	-28.79	-27.39	-26.69	-25.99	-24.60	-23.20	-16.22	-2.26

Notes: We assumed an initial gold price of \$1,665 and a March 2012 CPI level of 229. The “Return Given Inflation and Ending Valuation” is an exploration of how the possible 10-year nominal price return for gold varies with (1) the current real price of gold (current gold price/current CPI), (2) the annualized rate of CPI inflation realized over the next 10 years, and (3) the ending (10 years in the future) real price of gold (nominal gold price/CPI). For instance, if inflation over the next 10 years is 2% per year, then the ending level of the CPI will be 279.15 (= 229 × 1.02¹⁰). If one assumes that the ratio of the price of gold to the CPI in 10 years will be 3.2, then the nominal price of gold in 10 years will be \$893.28 (= 279.15 × 3.2). As a result, the “Return Given Inflation and Ending Valuation” will be -6.03% per year: Annualized return = exp[ln(Ending price/Initial price)/Time horizon] - 1 = exp[ln(\$893.28/\$1,665)/10] - 1. The bold font highlights the current real price ratio (3.2) and the current rate of inflation (2%).

Figure 6. Inflation Rates and U.S. Currency Regimes (Annual Data), 1792–2011



Sources: U.S. GDP deflator from Johnston and Williamson (2011); “currency regime” labels from Elwell (2011).

and Kydland (1995) pointed out that a gold standard rule is a contingent commitment to price stability, a commitment that can be temporarily abandoned during times of war or other national emergencies. The U.S. Civil War was financed with the creation of fiat money (greenbacks) and what seemed at the

time to be massive borrowing.¹⁴ Even though the wartime financing needs of the Civil War resulted in a high level of inflation in the North during the war, the period from 1865 to 1879 was characterized by deflation. It is possible that over the entire period of 1862–1879, given the mores of the time, the United

States was implicitly following a path of contingent commitment to a gold standard. As a result, the fiat money regime of 1862–1879 had a cumulative inflation profile different from the fiat money experience from 1973 to the present.

The devil is also in the details for the 1934–1973 “quasi-gold standard” inflation experience. McKinnon (1993) pointed out that the success of a gold standard is only as good as the willingness of the participants to abide by the “rules of the game,” whereby interest rates rise when gold reserves fall and interest rates fall when gold reserves rise. He suggested that the decades prior to 1913 are an example of gold standard countries somewhat playing by the rules of the game, and the period from 1934 to 1973 is an example of gold standard countries somewhat abusing the rules of the game. An interesting takeaway from Figure 6 is the possibility that neither a fiat money system nor a gold system is inherently prone to inflation: The long-run actions and intentions of market participants are what matter.

Figure 7 examines the real price of gold in U.S. dollars since 1791. Unlike Figure 1, which uses month-end closing prices for gold from a futures exchange, Figure 7 uses an annual gold time series that is cobbled together from a number of studies.¹⁵ The price of gold in Figure 7 is deflated (divided) by an estimate of the U.S. GDP deflator. There are at least two things to note about this price level indicator. The first is that the GDP deflator is, by definition, not the same thing as the CPI. The cumulative differences between a GDP deflator and the CPI are typically not large. The second is that GDP was first calculated in 1937, as a result of the pioneering work of economist Simon Kuznets, and was

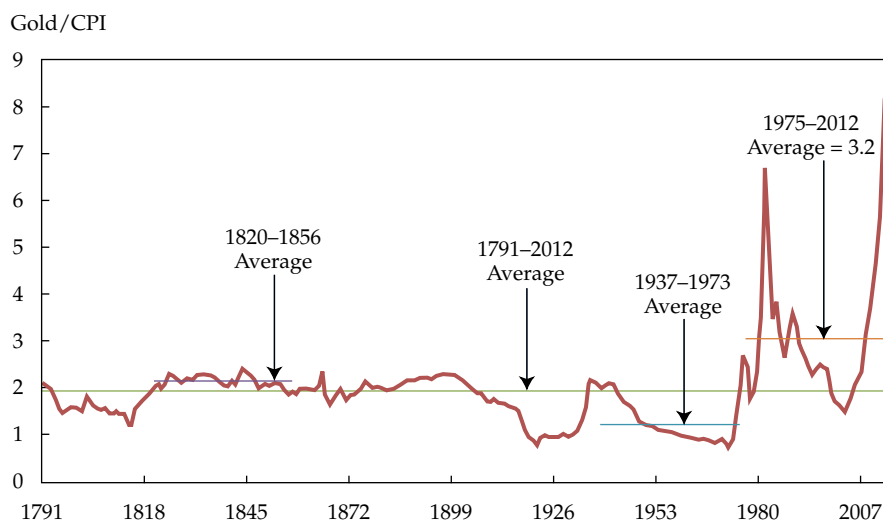
backfilled to 1929. The GDP deflator estimates for 1791–1928 are only backfilled estimates.

Figure 7 shows that the real price of gold was fairly constant until the 1970s.¹⁶ This stability was a result of the fact that the United States operated under a variety of currency regimes backed by gold and silver (bimetallism), or just gold, from 1791 until the early 1970s. The exact definition of “backed” varied over time (the U.S. dollar was on a full gold standard between 1900 and 1933 and a gold exchange standard at other times, and gold “backing” was typically suspended during wars or economic emergencies).¹⁷

Since the 1970s, the real price of gold has fluctuated wildly.¹⁸ The real price of gold is currently very high relative to the 1791–2011 average. Unsurprisingly, as is the case with many economic time series, the overall in-sample average will typically differ from individual subperiod averages. The lowest average real price of gold occurred during the 36 years from 1937 to 1973. The highest average real price of gold occurred during the 36-year time span from 1975 to 2011. The lesson of Figure 7 is that the real price of gold fluctuates and that it seems to have been more volatile recently than during the previous 200 years or so. The absence of a pronounced upward or downward trend in the real price of gold in Figure 2 and Figure 7 supports, but does not prove, the idea that gold’s real rate of return may be, on average, close to zero (statistically speaking).

Related to the idea that gold is possibly a long-term inflation hedge is the “constant price in terms of gold” argument—the idea that, for some items, prices tend to hover around some constant amount of gold. For instance, some claim that

Figure 7. The Real Price of Gold, 1791–2012



Source: MeasuringWorth.com.

over time the cost of a “high-quality” man’s suit has cost an ounce of gold (see Arends 2009). This statement is interesting but hard to prove because of such issues as quality differences over time and sumptuary laws, which once regulated the types of clothing different social and economic classes could wear. Because a man’s suit or a loaf of bread is the result of human labor, an alternative way to examine the idea that the price of goods in terms of gold remains constant is to look at per capita income measured in ounces of gold. A rising level of purchasing power could be consistent with per capita income “buying” more ounces of gold over time. A stagnant level of purchasing power could be consistent with a Malthusian trap, in which per capita income “buys” a stable number of ounces of gold.

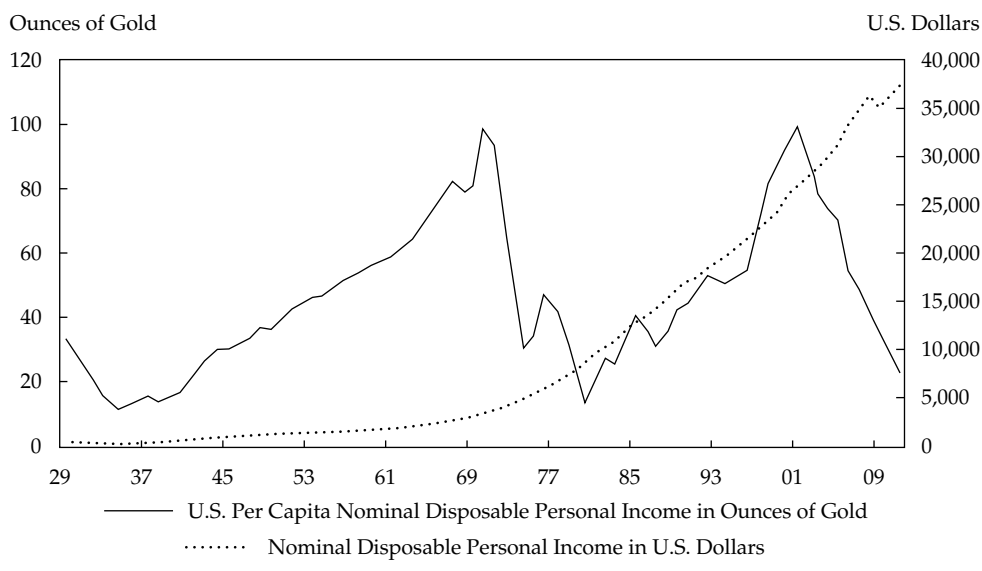
Figure 8 shows time series for nominal U.S. per capita disposable income and U.S. per capita disposable income measured in ounces of gold. Since 1929, per capita income has grown about 5% a year, the price of gold has grown about 5.5% a year, and per capita income measured in ounces of gold has fallen by about 0.5% a year.¹⁹ Looking at nominal per capita income, one can see a picture of positive and reasonably stable income gains over time. Looking at per capita income measured in ounces of gold reveals a volatile landscape of slowly declining purchasing power. Since 1929, per capita income has, on average, been worth 46 ounces of gold. Currently, per capita income can buy about 20 ounces of gold. Figure 8 suggests that in terms of ounces of gold, per capita income has been stagnant since 1929. Viewing per capita income in

ounces of gold, one can see that this observation is consistent with the assertion that the gold price of certain items is, on average, constant over time. It is perhaps gold’s way of saying that the more things change (nominal income), the more they stay the same (real income).

Why might income measured in ounces of gold have been stagnant? First, the lack of income growth could be viewed as consistent with the vision of English political economist Thomas Robert Malthus that the trade-off between technology and population growth would lead to stagnant incomes (see Hansen and Prescott 2002). A Malthusian explanation carries a lot of deadweight intellectual baggage because Malthus is often criticized for successfully describing life in the European Dark and Middle Ages and missing the transformative significance of the Industrial Revolution. So, maybe Malthus was right about stagnant incomes but wrong as to why incomes would be stagnant.

Second, it is possible to view Figure 8 as a reminder that some people might suffer from “money illusion.” The U.S. economist Irving Fisher (1928, p. 4) referred to money illusion as “the failure to perceive that the dollar, or any other unit of money, expands or shrinks in value.” Money illusion is a behavioral weakness born of the desire to prosper. Consider the following example. Imagine that you are presented with one of two ways to receive your pay. In the first case, you can take a pay cut of 10% in a world with 0% inflation; in the second case, you can take a pay raise of 10% in a world with 20% inflation. In both instances, the inflation-adjusted level of income declines by 10%;

Figure 8. U.S. Per Capita Disposable Income in Ounces of Gold, 1929–2012



Sources: U.S. Bureau of Economic Analysis; Bloomberg.

but in the second case, a decline in real income is paired with an increase in nominal income. Money illusion suggests that on average, people prefer to focus on nominal gains in income rather than observe the path of their real incomes. Money illusion does not explain why gold-denominated incomes have been stagnant, but it does provide a reason why some prefer to look at nominal rather than gold-denominated incomes. Moreover, it may be that the purchasing power of wages has been more robust than depicted in Figure 8 when measured in terms of an evolving basket of goods and services that reflects changes over time in tastes, preferences, and technology.

Third, it is possible to interpret the lack of growth in disposable income, measured in ounces of gold, as indirect evidence that gold is overvalued today. Figure 8 shows that 2011 disposable personal income equaled about 19.7 ounces of gold, which implies an income (in ounces of gold) annual growth rate of -0.6% since 1929. Alternatively, suppose the price of gold is the same today as in 1999. In this scenario, personal per capita income would command 132.3 ounces of gold, which implies an annual growth rate of 1.7% since 1929.

Figure 8 presents a picture that suggests little advancement in U.S. per capita pay when measured in ounces of gold over the last 90 years, and **Table 2** extends this framework to one of the few reasonably close wage comparisons that can be made over a long time: military pay. The Romans were skilled at building roads and aqueducts as well as recording how much it cost to staff a Roman legion. Legionaries were the lowest-ranking soldiers in a Roman legion, similar to privates in the U.S. Army. A centurion commanded a century of 80 legionaries and had a rank somewhat similar to that of a captain in the U.S. Army.

Under Emperor Augustus, who reigned from 27 BC to AD 14, a Roman legionary was paid about 2.31 ounces of gold a year (225 denarii) and a centurion was paid about 38.58 ounces of gold a year, or 3,750 denarii.²⁰ Converted to U.S. dollars, the pay of a Roman legionary was about 20% of that of a modern-day private in the U.S. Army and the pay of a centurion was about 30% greater than the pay of a captain in the U.S. Army.

Similar to the aggregate U.S. experience since 1791, there has been little or no income growth in military pay over 2,000 years. Interestingly, this conclusion is not that sensitive to the final price of gold.

There are two insights here. First, some incomes denominated in gold may be a very long-term hedge in that the real purchasing power of some wage rates is roughly preserved. Second, it helps us begin to understand what the expected return on gold is *not*. Even though 2,000 years is only a fraction of the time that gold has been mined, it provides a lot of annual compounding periods. A claim that gold could have “equity-like” returns in the future needs to be reconciled with the past. Starting 2,000 years ago, in the year 12, one dollar compounding at just 1% a year turns into \$439 million after 2,000 years. If the rate of return is increased to 1.62% , the ending value is \$100 trillion—more than today’s combined capitalization of world stock and bond markets.

In “normal” times, gold does not seem to be a good hedge against realized or unexpected short-run inflation. Gold may very well be a long-run inflation hedge. The long run, however, may be longer than an investor’s investment time horizon or life span. In the short run, the real price of gold has been the dominant driver of the price of gold and the returns from gold. We will return to the inflation argument when we explore the “safe haven” argument with respect to hyperinflation.

Gold as a Currency Hedge

There are at least two ways to interpret the “gold-as-a-currency-hedge” argument. The first interpretation suggests that gold is a foreign exchange currency hedge. In this case, the expected return on gold should offset the expected decline in the value of one’s own currency. For example, if the U.S. dollar declines 10% against the Japanese yen, the gold-as-a-currency-hedge argument would suggest that the price of gold should rise by 10% . The net result of this hedge should be a return of zero (Gold return + Currency return = 0).

There is a problem with this perspective. If the price of gold in a country is driven by its own inflation rate and if the exchange rate between two countries is driven by the difference in their inflation rates, gold will be a reliable hedge of the

Table 2. Military Pay in Ounces of Gold

	U.S. Army Private	Roman Legionary	Growth Rate	U.S. Army Captain	Roman Centurion	Growth Rate
Salary	\$17,611	\$3,704	0.08%	\$44,543	\$61,730	-0.02%
Price of gold	\$1,600	\$1,600		\$1,600	\$1,600	
Ounces of gold	11.01	2.31	0.08%	27.84	38.58	-0.02%

Sources: U.S. Army; MacMullen (1974).

foreign exchange rate only if one of the two countries always has an inflation rate equal to zero.²¹

A second way to interpret the gold-as-a-currency-hedge argument sees gold as a hedge of one's own currency, spent in one's own country, when the local government is printing money with abandon—sometimes referred to as “currency debasement.” If this debasement is a result of inflation, then this interpretation is just another version of the gold-as-an-inflation-hedge argument.

Table 3 highlights the historical gold betas of seven currencies (the Australian dollar, the Canadian dollar, the Bloomberg-estimated deutsche mark, the Japanese yen, the New Zealand dollar, the Swiss franc, and the British pound). These gold betas are the result of regressing the monthly changes in the exchange rate (foreign units per dollar) on the monthly change in the price of gold. There are three things to note. First, all the coefficients are negative, which is the correct sign for a U.S. dollar investor who assumes that gold is a currency hedge. For example, if the U.S. dollar price of gold increases by 10%, the yen/dollar beta says that the yen appreciates, on average, by about 1.4% (or alternatively, that on average, the dollar depreciates by about 1.4%).²² Second, the average coefficient is small—about -0.15 across the seven currency pairs. The average beta coefficient is significantly different from zero but also significantly different from -1.0 . Technically, these small average gold betas are driven by low gold–currency return correlations and by the fact that the currency return standard deviations are about one-half the size of the gold return standard deviation. Third, if gold is a good currency hedge, the statistical fingerprint of this belief should be supported by high regression R^2 s. For this universe of currencies, however, there seems to be little connection between currency returns and gold returns. In addition, from a broad perspective, the “gold up/currency down” idea sometimes misfires. Since 1975, the U.S. dollar price of gold has risen and the

U.S. dollar has depreciated against the Japanese yen. However, the Japanese yen price of gold has risen and the Japanese yen has appreciated against the U.S. dollar.

Figure 9 shows how the local currency real price of gold has fluctuated in a number of countries: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the United Kingdom, and the United States. In each case, the local currency price of gold is divided by a local inflation index (using inflation index data from the International Monetary Fund), and the resulting ratio is normalized to an initial value of 1.0. The message of Figure 9 is that since 1975, the real prices of gold in these eight countries seem to have moved largely in tandem.²³ In an earlier study (Erb and Harvey 2012a), we looked at a broader universe of 23 developed and emerging countries and found that the real price of gold rises and falls at the same time. The real price of gold reached a high level in 1980 in all eight countries. The real price of gold fell to a low level in each of the eight countries in the 1990s; more recently, the real price of gold has risen to very high levels in all eight countries. The historical evidence of a seemingly common local currency movement in the real price of gold does not lend itself to a convenient gold-as-a-currency-hedge explanation. In fact, the change in the real price of gold seems to be largely independent of the change in currency values. Furthermore, because the real price of gold seems to move in unison across currency perspectives, it is unlikely that currency movements can help explain why the real price of gold fluctuates.

Is gold a currency hedge? It appears the answer is no. Do currency returns help explain movements in the real price of gold? No.

Gold as an Alternative to Assets with Low Real Returns

The “gold as an alternative to other assets with low real returns” argument is a competing assets argument. The most frequent manifestation of this

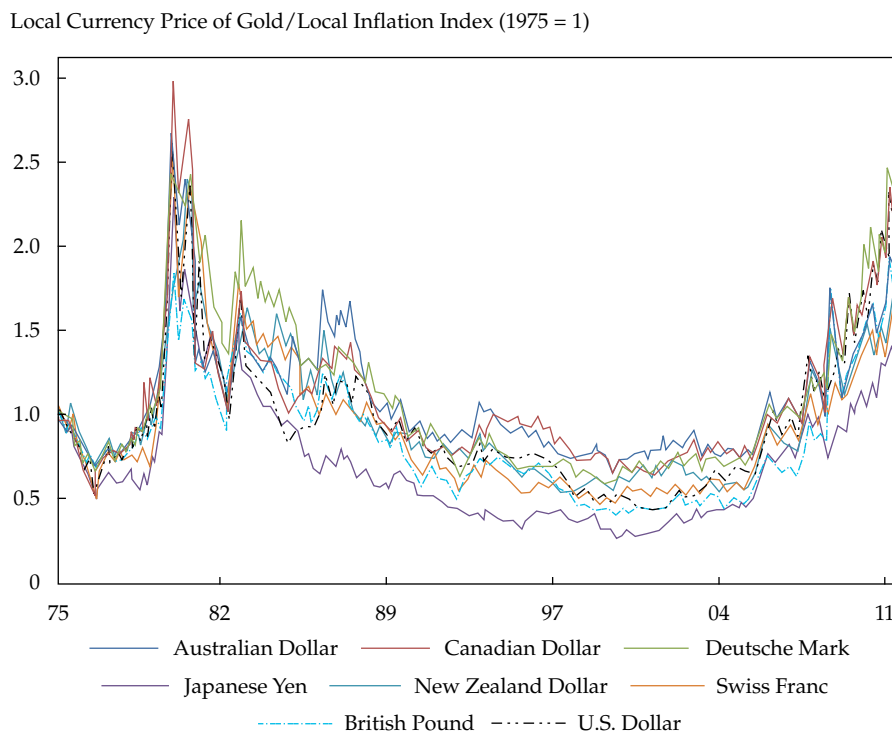
Table 3. Gold as a Currency Hedge, 1975–2012

	Gold	AUD	CAD	DEM	JPY	NZD	CHF	GBP
Gold beta	1.00	-0.16	-0.09	-0.21	-0.14	-0.17	-0.24	-0.15
<i>t</i> -Statistic		-5.95	-5.62	-8.47	-5.46	-5.63	-8.85	-6.12
Correlation with gold	1.00	-0.27	-0.26	-0.37	-0.25	-0.26	-0.39	-0.28
Standard deviation	19.8%	11.7%	6.6%	11.3%	11.3%	12.7%	12.3%	10.4%
R^2	100.0%	7.4%	6.6%	13.9%	6.3%	6.7%	15.0%	7.8%
Indexed USD value ^a	\$9.51	\$1.29	\$1.00	\$0.63	\$0.28	\$1.62	\$0.36	\$1.49

Note: DEM represents a splice of DEM and the euro.

^aUSD/Foreign currency value in 1975 = 1.0.

Source: Bloomberg.

Figure 9. The Real Local Price of Gold, 1975–2012

Source: Bloomberg.

story is the “price of gold rose because nominal or real interest rates fell” argument.²⁴ Barsky and Summers (1988), DeLong (2011), Krugman (2011), and Elfenbein (2012) all looked to Gibson’s paradox (see Keynes 1930) for a link between the price of gold and interest rates.

Figure 10 illustrates the historical relationship between the real price of gold in U.S. dollars (using the observations from Figure 2) and the real yield of a generic 10-year Treasury Inflation-Protected Security (TIPS). Month-end observations since the inception of TIPS trading in 1997 are used. Superficially, the message of Figure 10 seems to be fairly obvious. When real interest rates are high—as they were during the late 1990s, when TIPS were introduced in the United States—the real price of gold is low. Now that the real yield on a 10-year TIPS is low (close to zero), the real price of gold is high. The correlation between 10-year TIPS real yields and the real price of gold is -0.82 . Is it possible to disagree with the view that low real yields caused the real price of gold to be high? Yes.

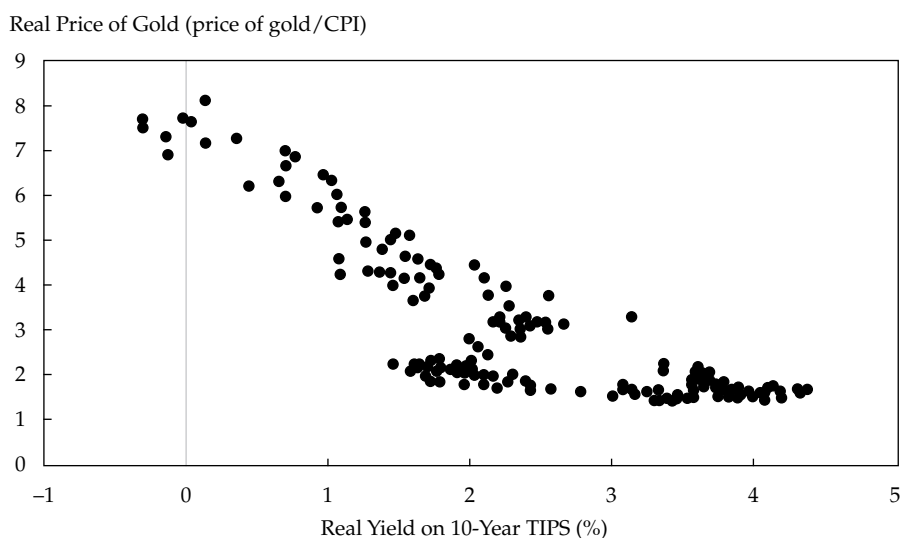
Figure 10 illustrates what seems to be a compelling pattern. An obvious question is how robust the correlation between real yields and the real price of gold is to alternative perspectives. Does the finding hold up if a longer period is examined? A longer data sample from the United Kingdom shows that the correlation between real yields and

the real price of gold falls to -0.31 .²⁵ A “glass half full” interpretation of this result means that real yields explained 9% of the variation in the U.K. real price of gold, and a “glass half empty” interpretation means that real yields explained very little of the variation in the U.K. real price of gold.

Returning to the U.S. experience over the past 15 years, the historical correlation between real yields and a time trend is about -0.90 and the correlation between the real price of gold and a time trend is about 0.87 . The highly positive correlation between the real price of gold and a time trend suggests that the real price of gold increases with the passage of time, with no limit. A challenge with the time trend story is that, even though it “fits” the data better than the real yield story, the possibility of an infinite real price of gold is hard to grasp. Rather than focusing on fragile correlations, a closer look at the real yield/real price of gold story may help.

A number of stories suggest a connection between the real price of gold and the level of interest rates: central bank gold leasing, low opportunity cost, and Gibson’s paradox. Each of these stories has an air of plausibility.

Historically, some central banks “leased” part of their gold reserves.²⁶ Working with “bullion banks,” gold leasing allowed central banks to turn part of their gold holdings into interest-earning assets. To some, such as the Gold Anti-Trust Action

Figure 10. The Real Price of Gold and the Real Interest Rate, 1997–2012

Source: Bloomberg.

Committee,²⁷ the pursuit of gold leasing looked as if central banks were actively trying to suppress the price of gold by effectively selling gold. It is certainly possible that as interest rates fall, gold leasing becomes less attractive for a central bank. The gold-leasing story basically comes down to saying that as interest rates fall, less gold is “sold” (leased). Central banks, however, have little reason to publicly disclose their gold-leasing activities. In fact, IMF (1999) accounting rules state that a central bank gold lease does not result in a “statistical” change of ownership and that a gold lease is similar to a repurchase agreement (repo). So, in the absence of hard data on the amount of gold leasing, assessing the marginal impact of central bank gold leasing on the real price of gold is like searching for a black cat in a dark room and not knowing which room to look in.

DeLong (2011) expressed the “opportunity cost” view by pointing out that “gold . . . is . . . expensive to hold in your portfolio when real interest rates are high, and cheap to hold in your portfolio when real interest rates are low.” This story is somewhat different from the gold-leasing story. It suggests that an investor should be more inclined to buy gold as the level of interest rates falls. But why? If the real price of gold is constant, mapping out the interest rate–determined cost of owning gold is easy. If the real price of gold fluctuates, the exercise becomes more challenging. Figure 10 illustrates a correlation between the real price of gold and real interest rates. Yet Figure 5 shows a historical propensity for low real gold returns to follow high real gold prices. Asness (2003) argued that the popularity of the “Fed model” illustrates how a

compelling story empowers investors to set stock market price-to-earnings ratios by using nominal, rather than real, interest rates. To Asness, these investors suffer from money illusion. It is entirely possible that the opportunity cost view is to investing in gold what the Fed model is to investing in stocks: an entertaining and compelling story that seems to be out of sync with future real returns.

Yet another Fed model–type story is Gibson’s paradox, an observation that during the gold standard years of 1821–1913 in the United Kingdom, nominal interest rates were positively correlated with the aggregate price level (rather than the inflation rate). Barsky and Summers (1988, p. 529) interpreted this result to mean that under a gold standard, “the price level is the reciprocal of the real price of gold.” Keynes (1930, p. 198) referred to Gibson’s paradox as “one of the most completely established facts in the whole field of quantitative economics.” There are at least two challenges with applying Gibson’s paradox to the current world of fiat money. First, Gibson’s paradox is an explanation of how the real price of gold fluctuates under a gold standard when the nominal price of gold is a constant. It is not a model of the behavior of the real price of gold under a fiat money regime. Second, Barsky and Summers found no evidence of Gibson’s paradox under a fiat money regime.

For investors who want to believe that interest rates drive the real price of gold, the good news is that they can cherry-pick the story that most appeals to their sensibilities. However, investors are still left with the unappetizing fact that a time trend seems to explain the real price of gold better than these stories do.

It is important to avoid the “correlation implies causation” trap. The negative TIPS real yield/real price of gold correlation of -0.82 is a measure of the linear correlation of real yields with real gold prices. Although it is possible to argue that historical data suggest that low real yields “cause” high real gold prices (Gibson’s paradox), it is equally possible to argue that causality runs in the other direction and that high real gold prices actually “cause” low real yields. Alternatively, it is possible that both low real yields and high real gold prices are driven by some other influence, such as a possibly immeasurable fear of hyperinflation.²⁸

Does the competing assets argument explain the nominal price of gold? No. Does the competing assets argument explain the real price of gold? No.

The “Gold as a Safe Haven/Tail Risk Insurance” Argument

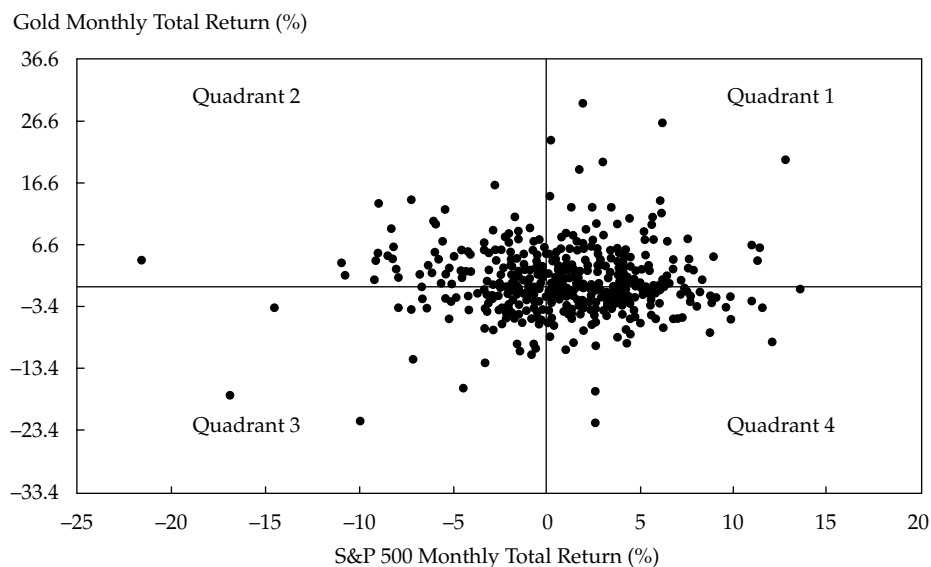
The safe haven/tail protection argument has already appeared three times. First, it is possible that gold does not hedge day-to-day inflation surprises but provides some protection in a hyperinflationary environment. Second, gold may not provide very effective hedging for currencies in usual circumstances but may provide some protection in situations of significant debasement—such as one associated with hyperinflation. Third, the negative correlation between real gold prices and real interest rates may be driven by the fear of a large negative macroevent—such as hyperinflation.

The Safe Haven. Although there is no formal definition of what makes an asset a safe haven asset,

it should be possible to list at least two characteristics that a safe haven asset may have. One characteristic may be that a safe haven asset should have a stable value during “times of stress.” Of course, there is no simple definition of a time of stress. Baur and Lucey (2010) suggested that gold is a safe haven from losses in financial markets. Specifically, they proposed that gold does well during periods of negative stock market returns. Another characteristic may be that a safe haven asset is something that can be accessed during times of stress. These two conditions provide ways to think about the “gold as a safe haven” argument: If gold is a safe haven, its value should be stable when other asset markets falter, and gold’s stable value should be dependably accessible during times of stress. Finally, a safe haven should be liquid—something that investors believe can be bought or sold at any time without affecting the price of the safe haven asset.

First, let us examine the safe haven with respect to financial stress. **Figure 11** shows the joint distribution of U.S. stock and gold returns. How does gold hold up in Quadrant 3 (negative equity returns matched with negative gold returns)? The simple safe haven test states that there should be very few observations in Quadrant 3. In fact, 17% of the monthly stock and gold return observations fall in Quadrant 3. This finding suggests that gold may not be a reliable safe haven asset during periods of financial market stress. Figure 11 illustrates that nominal gold returns have historically had a low correlation with nominal U.S. equity market returns. Interestingly, depending on how one

Figure 11. Gold and the S&P 500 Index, 1975–2012



Source: Bloomberg.

defines a safe haven, a good portfolio diversifier may not be a safe haven asset.

A possible second condition for a safe haven is that during times of stress, it should be possible to access the safe haven asset. Consider the famous Hoxne Hoard, which is on display at the British Museum. The Hoxne Hoard is an example of what can happen when trying to make a safe haven investment. The Hoxne Hoard is the largest collection of Roman gold and silver coins ever discovered in England. Evidence suggests that the hoard was buried sometime after AD 400 by a wealthy family seeking a safe haven for some of its wealth.²⁹ The fifth century was a time of great social stress and political turmoil in England during which the Western Roman Empire unraveled.³⁰ The fact that the hoard was discovered in 1992 means that the family failed to reclaim its safe haven wealth. Indeed, the Hoxne Hoard is an example of an “unsafe haven.”

Jeffrey Gundlach has astutely pointed out that the weight of gold limits its portability, both during normal times and during times of stress. Thinking in terms of the ratio of market value to weight (somewhat like a “flight capital” Sharpe ratio), he observed that many precious gems are a more efficient store of flight capital than gold (see Or and Phillips 2011).³¹ Although gold is viewed by many as durable and largely imperishable—characteristics that make gold its own safe haven against the ravages of the world—it is not necessarily a safe haven for the owner of gold. As analyst Marc Faber once put it, “When Timur sacked Aleppo and Damascus in 1400, it didn’t help to have your savings in gold. You lost your life and your gold” (see Ash 2009).³²

Tail Risk and Hyperinflation. Does gold provide some protection against tail risk (see World Gold Council 2010b)? Montier (2011) noted that there is no clear-cut definition of tail risk: It is important to define what specific risk one is concerned about and to take a stab at defining what tail risk means in the context of that risk. Given Montier’s observation, it is possible to define inflation risk as

the risk of unexpected inflation and inflation tail risk as the risk of hyperinflation.

For some proponents of gold investment, the hyperinflation of the Weimar Republic stands as an electrifying example of the risks of a fiat currency regime. The hyperinflation of the Weimar Republic in 1922–1924 is an example of a possible endgame for a country that spends much more than it earns. The deutsche mark–U.S. (gold) dollar exchange rate rose from 430 in 1922 to about 433 billion by 1924. If such hyperinflation unfolded in the United States today—if gold moved exactly in line with the inflation rate and if the real price of gold was unchanged—the price of gold would exceed \$1.68 trillion an ounce.

So, does the price of gold provide hyperinflationary tail risk protection? Is gold a hyperinflationary talisman? Not surprisingly, the answer to a large degree depends on how the question is asked and the specific scenario that unfolds. It is perhaps instructive to think about how an absolutely clairvoyant investor might assess the ability of gold to provide a hedge against hyperinflation. It is also useful to be aware of the historical frequency and magnitude of hyperinflationary episodes.

Imagine a Brazilian investor in 1980 who possessed perfect foresight of how Brazilian inflation would unfold between 1980 and 2000. **Table 4** shows that from 1980 to 2000, Brazil had an average annual inflation rate of about 250%, the currency was renamed and devalued numerous times, and the nominal price of gold rose substantially in Brazilian currency terms. Yet, using the IMF’s measure of Brazilian inflation, the real price of gold fell by about 70% between 1980 and 2000. Broadly and illustratively speaking, this means that by the year 2000, an ounce of gold had 30% of its 1980 inflation-adjusted purchasing power. This experience is similar to the real price decline of gold faced by a U.S. investor over the same period.

So, if purchasing power declined 70%, was gold a successful hedge against Brazilian hyperinflation? It depends on one’s perspective. Compared with an expectation that gold would move one-for-one with

Table 4. Real Gold Price Risk and Brazilian Hyperinflation

	1980	2000	2000/1980 Ratio	Annualized Growth Rate
Cruzeiro/USD	65.50	5,362,500,000,000.00	81,870,229,007.63	251.28%
Gold (USD)	589.75	272.25	0.46	-3.79
Gold (cruzeiro)	38,628.63	1,459,940,625,000,000.00	37,794,268,499.07	237.96
IMF inflation index	86.50	11,092,888,909,767.90	128,238,525,233.73	259.25
Real price ratio	446.56	131.61	0.29	-5.93

Notes: Data begin in 1980. In 1980, the currency of Brazil was the cruzeiro. In 1986, 1 cruzado replaced 1,000 cruzeiros. In 1989, 1 cruzado novo replaced 1,000 cruzados. In 1990, the cruzeiro replaced the cruzado novo. In 1983, 1 cruzeiro real replaced 1,000 cruzeiros. In 1994, 1 real replaced 2,750 cruzeiro reals. The real price of gold is calculated as the local currency price of gold divided by the IMF inflation index for Brazil. See World Bank (1994).

the Brazilian price level, gold was not a successful hedge against hyperinflation between 1980 and 2000. However, investors who kept their cash under a mattress or invested in a portfolio of Brazilian nominal bonds probably lost most of the real value of their assets from 1980 to 2000. Compared with an almost 100% decline in real value for cash and nominal bonds, the 70% decline in the real value of gold was a great alternative. A key takeaway from Table 4 is that even though such countries as the United States and Brazil may have very different inflation experiences, their real gold return experiences will probably be similar—and there is no reason to expect that the real gold return will be positive when a country experiences hyperinflation.

Table 5 provides a list of 56 major and minor country hyperinflationary experiences catalogued by Hanke and Krus (2012). Earlier research by Bernholz (2006) and McGuire (2010) mentions about 30 cases of hyperinflation. Hanke and Krus identified multiple bouts of hyperinflation in a country, whereas Bernholz and McGuire primarily focused on broader start and end points. These four researchers followed the lead of Cagan (1956) in defining hyperinflation as a situation in which a country experiences a monthly inflation rate greater than 50% (an annualized rate of about 13,000%). Within each country's hyperinflationary experience, Hanke and Krus identified the highest monthly inflation rate, the equivalent daily inflation rate during the month of the highest inflation rate, and the required time for prices to double at the rate of the highest monthly inflation rate. Hungary experienced a highest daily inflation rate of 207%, and Zimbabwean daily inflation soared as high as 98%. Excluding the French *mandats* and *assignats* issued during the French Revolution in the 1790s, all the reported instances of hyperinflation have occurred since 1900—during the era of fiat currency regimes. A key question for investors is, Is it possible to estimate the probability of hyperinflation under a fiat currency regime? There is obviously no easy way to answer this question, but looking at history can be somewhat illuminating. It is also worth reemphasizing that even if one has a firm grasp on the probability of hyperinflation in a country, that says nothing about whether the real price of gold will maintain its purchasing power during the hyperinflationary experience.

What broad observations arise from Table 5? First, most of the countries listed could be described as minor, not major, countries. This observation does not mean that hyperinflation is more likely in a minor country than in a major country because there are many more minor countries than there are major countries. It is hard to embrace the idea

that a country could never experience a hyperinflationary episode, but accepting the possibility of a nonzero probability of hyperinflation is not the same thing as estimating a specific probability of hyperinflation. Second, many of the hyperinflationary situations seem to occur after stressful times in a country, such as losing a war (Germany and Austria following World War I) or a significant change in the way that a society is governed. Third, many investors are concerned about high inflation—and hyperinflation (at least 13,000% annualized inflation) is simply an extreme version of high inflation. According to Table 5, Brazil had two hyperinflationary years (1989 and 1990), yet during the two decades from 1980 to 2000, Brazil experienced many years of high inflation. And finally, even if the real purchasing power of gold rose in each of the historical instances of hyperinflation, it would be hard to figure out why that fortunate circumstance would hold in the future.

The “*De Facto* Gold Standard/Gold Is Money” Argument

The CEO of Barrick Gold, the world's largest gold-mining company, once announced that gold was the “default global currency” (see Regent 2011, p. 4). In an unduly literal sense and in a world where no country has been on the gold standard since the Swiss ended convertibility in 2000, gold is not an “official” default currency (see Roth 1999). One characteristic of an official currency is that it is possible to pay taxes and purchase goods and services with the official currency. For most people, it is probably difficult to pay income taxes with bars of gold or to get a soft drink from a vending machine with a quarter grain of gold.³³

Although it is possible to debate whether the world is on a “*de facto* gold standard,” it seems likely that this insight is basically another version of the gold-as-an-inflation-hedge argument. If the “*de facto* gold standard” argument is just another version of the gold-as-an-inflation-hedge argument, and if the gold-as-an-inflation-hedge argument provides no explanation for the high real price of gold, then it is reasonable that the “*de facto* gold standard” argument does little to explain variation in the real price of gold.

Why is no country on the gold standard? Some of the supposed possible benefits of a gold standard are “life without inflation, an end to the business cycle, rational economic calculation in accounting and international trade, an encouragement to savings, and a dethroning of the government-connected financial elite” (see Rockwell 2002). Other researchers, such as DeLong (1996), have highlighted a

Table 5. Hyperinflation Risk

Country	Highest Daily Inflation			Highest Daily Inflation			Highest Daily Inflation				
	Start Year	End Year	Inflation	Start Year	End Year	Inflation	Start Year	End Year	Inflation		
Angola	1994	1997	2.1%	Danzig	1922	1923	11.4%	Philippines	1944	1944	1.6%
Argentina	1989	1990	3.7	Estonia	1992	1992	2.1	Poland	1923	1924	4.5
Armenia	1992	1992	1.9	France	1795	1796	4.8	Poland	1989	1990	1.9
Armenia	1993	1994	5.8	Georgia	1992	1992	3.7	Russia	1992	1992	4.2
Austria	1921	1922	2.8	Georgia	1993	1994	3.9	Soviet Union	1922	1924	3.9
Azerbaijan	1992	1994	2.6	Germany	1922	1923	20.9	Srpska	1992	1994	64.3
Belarus	1992	1992	3.2	Germany	1920	1920	1.5	Taiwan	1945	1945	5.5
Belarus	1994	1994	1.4	Greece	1941	1945	17.9	Taiwan	1947	1947	1.4
Bolivia	1984	1985	3.5	Hungary	1923	1924	2.3	Taiwan	1948	1949	2.5
Bosnia	1992	1993	4.9	Hungary	1945	1946	207.0	Tajikistan	1992	1993	3.7
Brazil	1989	1990	2.0	Kazakhstan	1992	1992	3.0	Tajikistan	1995	1995	1.7
Bulgaria	1991	1991	2.7	Kazakhstan	1993	1993	1.5	Turkmenistan	1992	1993	5.7
Bulgaria	1997	1997	4.2	Kyrgyzstan	1992	1992	3.2	Turkmenistan	1995	1996	1.6
Chile	1973	1973	2.1	Latvia	1992	1992	1.7	Ukraine	1992	1994	4.6
China	1943	1945	4.8	Lithuania	1992	1992	1.5	Uzbekistan	1992	1992	2.6
China	1947	1949	14.1	Moldova	1992	1993	4.2	Yugoslavia	1989	1989	1.6
Congo (Zaire)	1991	1992	2.6	Nicaragua	1986	1991	4.4	Yugoslavia	1992	1994	64.6
Congo (Zaire)	1993	1994	4.3	Peru	1988	1988	2.6	Zimbabwe	2007	2008	98.0
Congo (Zaire)	1998	1998	2.0	Peru	1990	1990	5.5				

Note: The sources of these data used a definition from Cagan (1956) that says hyperinflation exists when a country's monthly inflation rate exceeds 50%. Sources: Data are from Hanke and Krus (2012); Bernholz (2006); McGuire (2010).

belief that a gold standard would result in a loss of “normal” monetary policy options (such as the possible Phillips curve trade-off between inflation and employment) and impart a recessionary and deflationary bias to countries with balance of payments deficits. This line of thought relates to the work of Eichengreen and Temin (2010), who noted that during the Great Depression, those countries that abandoned the gold standard earliest suffered the least economic harm. One view of the “*de facto* gold standard” argument is that the gold standard is the worst form of currency except for all those other forms that have been tried from time to time.³⁴

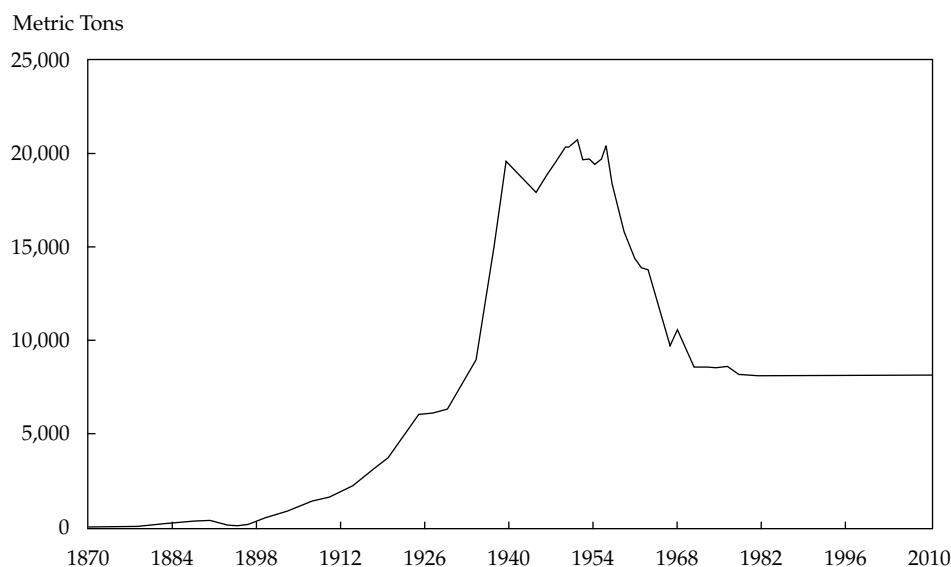
If a gold standard exists, then gold is money, but the “gold is money” argument does not require the existence of a gold standard. The “gold is money” argument is essentially another way of stating the “constant price when measured in gold” argument. For instance, investors Brodsky and Quaintance (2009) and hedge fund manager Dalio (2012) have argued that gold is money without arguing that the world is on a *de facto* gold standard.³⁵ For Brodsky and Quaintance (2011), the “shadow price of gold,” the price they believe gold should trade for, is equal to the amount of the U.S. monetary base divided by the official gold holdings of the United States. Given a monetary base of \$2.7 trillion and official U.S. gold holdings of 8,300 metric tons, this yields a “shadow gold price” of about \$10,000 an ounce. Similarly, Dalio has asserted that “the price of gold approximates the total amount of money in circulation divided by the size of the gold stock” (see Cassidy 2011).³⁶

The “shadow price of gold,” or “gold is money,” argument is an intriguing concept. The “gold is money” argument is influenced by Milton Friedman’s assertion that “inflation is always and everywhere a monetary phenomenon” (1968, p. 39). As a result, the “gold is money” argument is essentially a restatement of the gold-as-an-inflation-hedge argument, and it should not be expected to more successfully explain the variation in the real price of gold. However, the “shadow price of gold,” or “gold is money,” argument yields a fairly specific prediction: a view of where the price of gold should be if the world actually accepted this specific view. From a U.S. standpoint, all that is needed to know where the price of gold is headed is a sense of the size of official U.S. gold holdings and the size of the U.S. “money supply.”

Figure 12 shows a time series of official U.S. gold holdings since 1870. Official gold holdings peaked at about 20,000 metric tons following implementation of President Roosevelt’s Executive Order 6102 (signed 5 April 1933), which outlawed the private ownership of gold in the United States.³⁷ Official gold holdings entered a period of decline during the Eisenhower administration that continued until 1971, when President Nixon officially took the United States off the gold standard (see Nixon 1971).³⁸ Since that time, the official gold holdings of the United States have been slightly greater than 8,000 metric tons.

The shadow price of gold is simply the money supply divided by the official gold holdings of the United States. There is, of course, some ambiguity as to which definition of the money supply to use.

Figure 12. Official U.S. Gold Holdings, 1870–2012



Sources: World Gold Council; data from Green (1999).

The Federal Reserve currently publishes three versions of the money supply: the monetary base, M1, and M2. Furthermore, the Federal Reserve once published an M3 money supply number, but M3 was discontinued in 2006. Using the monetary base as the money supply value with which to calculate the shadow price of gold yields a current gold price target of about \$10,000 an ounce. Using M1 as the money supply value with which to calculate the shadow price of gold yields a current gold price target of about \$8,000 an ounce. Using M2 as the money supply value with which to calculate the shadow price of gold yields a current gold price target of about \$37,000 an ounce.

These shadow prices of gold may seem alarming because each shadow price is much higher than the current price of gold. Additionally, part of the “shadow price of gold” argument is that the higher the shadow price of gold relative to the market price of gold, the greater the latent inflationary pressures faced by the United States.

There are a few obvious challenges with this line of reasoning. First, in the United States, there has been an abundance of research that has found little evidence of a link between money supply growth rates and inflation rates.³⁹ Second, why just focus on the United States? The U.S. official holdings are only about 5% of the world gold supply. In summary, the shadow price of gold is an engaging concept, but because it relies on a vague model (the theory of exchange) and poorly defined monetary aggregates, it does not help us understand the underlying dynamics of the gold price.

The “Gold Is Underowned” Argument

Of the six arguments to own gold, the “gold is underowned” argument offers probably the best way to understand why the real price of gold may vary. In order to explore the nuances of the “gold is underowned” argument, it is important to address a number of subsidiary issues: How much gold exists, who owns the gold, and have demand trends changed over time? Of course, the “gold is underowned” argument is somewhat ambiguous because all the gold in the world is currently owned by someone (see Madura 2011). In its simplest version, the “gold is underowned” argument asserts that not enough people own gold, that maybe everyone should own some gold, and that the move toward universal gold ownership should cause the nominal and real prices of gold to skyrocket.

The Stock of Gold. How much gold is there? Gold exists both above and below the ground. Above-ground gold is gold that has already been mined. Below-ground gold is gold ore that

has yet to be mined. No one knows exactly how much above-ground gold exists. The World Gold Council (2012b) has estimated that 171,300 metric tons of gold have been mined since the beginning of civilization. The World Gold Council estimate provides a convenient anchor for measuring the number of tons of gold, but given the Herculean task of enumerating gold holdings “since the beginning of civilization,” the actual unknown number could be much lower or higher. Buffett (2011) pointed out that 171,300 metric tons of gold would create a cube measuring 67 feet on each side. The U.S. Geological Survey (USGS 2011) has suggested that there may be 51,000 metric tons of below-ground gold reserves that could be mined in the future. If the USGS estimate is correct, more than 76% of the world’s actual and potential gold has already been mined. This balance of already-mined gold and yet-to-be-mined gold once prompted the CEO of Barrick Gold to speculate about the possibility of entering a period of “peak gold” (see Evans-Pritchard 2009).⁴⁰ The estimate of below-ground gold reserves is more uncertain than the estimate of above-ground gold. The USGS reserve estimate is a best-efforts estimate of how much gold might be mined in the future given existing technology.⁴¹

Of course, future technological change might usher in opportunities to mine more than the 51,000 metric tons of gold reserves. For instance, there is considerable interest in near-Earth asteroids. In an important study, Brennan and McDonough (2009) argued that much of the Earth’s precious metals are a result of asteroid collisions. The near-Earth asteroid 433 Eros might contain up to 125,000 metric tons of gold (see Whitehouse 1999). The website www.asterank.com catalogues 580,000 asteroids in our solar system and provides estimates of both the mineral value and the estimated profits from harvesting. According to the website, there are currently 15 near-Earth asteroids with expected profit greater than \$1 trillion.⁴² Closer to home, perhaps someday in the future, someone will figure out how to implement Nobel Prize winner Fritz Haber’s plan to electrochemically recover some of the estimated 8 million tons of gold in the world’s oceans (see Miller 2012).

The USGS keeps track of estimated annual global gold mine production. **Figure 13** presents the USGS gold mine production time series, which starts with the year 1900. Annual global mine production has averaged about 2,500 tons per year for the last few years. In 1900, about 30,000 metric tons of gold had already been mined, which means that more than 80% of the current above-ground supply of gold has been mined since 1900 and that the

above-ground stock of gold has increased by about 1.5% a year. If global production of gold continues at a rate of 2,500 metric tons a year and if the USGS is correct in its estimate that there are only 51,000 metric tons of exploitable gold reserves, then gold production will be exhausted in about 20 years.

There are basically three uses for the above-ground supply of gold: jewelry, investment, and technology. The investment category encompasses the holdings of central banks, individuals, and other institutions. Jewelry claims about 50% of the outstanding above-ground stock of gold, central banks and private investment each claim about 18% of the above-ground stock of gold, and fabrication accounts for about 12%.

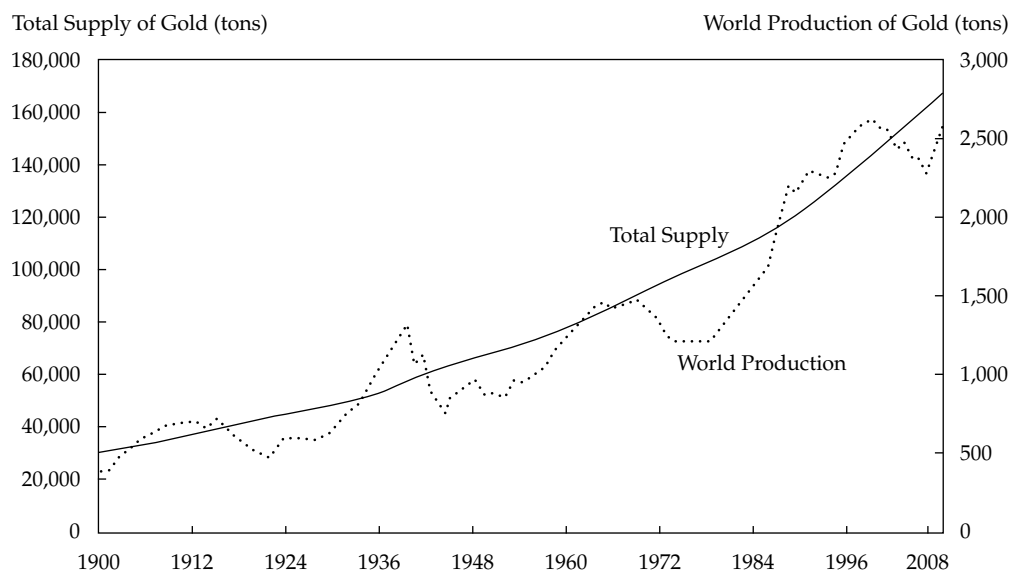
Demand and Supply. The World Gold Council tracks annual demand for gold from the jewelry, investment (central bank and private investment), and technology (fabrication) sectors. **Table 6** provides a sense of how the demand for gold from these sectors has varied since 2001. As the price of gold per ounce rose from \$279 in 2001 to \$1,567 in 2011, the annual demand from the jewelry sector declined from 3,009 metric tons in 2001 to 1,963 metric tons in 2011, annual demand from the investment sector rose from 357 metric tons to 1,641 metric tons, and annual demand from the technology sector barely changed, going from 363 metric tons to 464 metric tons. On average, gold mine production was about 2,500 metric tons per year. The difference between production and demand was made up from scrap, sourced primarily from the jewelry and technology sectors.

Table 6 also provides a rough approximation of the price elasticity of demand for gold. This measures the percentage change in demand for gold in response to a 1% change in the price of gold. The estimate of jewelry's price elasticity of demand is only -0.24 , which means that a 10% increase in the price of gold is associated with less than a 2.4% decrease in demand for gold. This is likely overstated, however, because we do not control for wealth increases and population changes.⁴³ The price elasticity of investment demand is *positive* and has a value of 0.98, which means that a 10% increase in the price of gold is met with about a 9.8% increase in the investment demand for gold. The price elasticity of technology demand is close to zero. Interestingly, both the production and the supply of scrap gold are insensitive to the price of gold.

Table 6 shows that the investment demand for gold seems to rise with the price of gold. This upward-sloping investment demand is striking. Although it is possible that the upward-sloping investment demand for gold is an example of a Giffen good or a Veblen good, there are two other explanations that might be more plausible: the impact of momentum-based investors and "too much" demand, totally divorced from a momentum motive, chasing "too little" supply.

Asness, Moskowitz, and Pedersen (2013) have written extensively about the momentum effect, the possibility of an attractive financial payoff from buying an asset that has performed well in the past. Research by Asness and others over the last 20 years has created an environment that is increasingly accepting of momentum-based

Figure 13. Annual Gold Mine Production and the Total Supply of Gold, 1900–2011



Source: USGS.

Table 6. Demand and Supply of Gold, 2001–2011

Year	Demand (metric tons)			Production (metric tons)	Implied Scrap (metric tons)	U.S. Dollar Gold Price
	Jewelry	Investment	Technology			
2001	3,009	357	363	2,600	1,129	279
2002	2,662	343	358	2,550	813	348
2003	2,484	340	382	2,540	666	416
2004	2,616	485	414	2,420	1,095	438
2005	2,718	601	433	2,470	1,282	519
2006	2,298	676	462	2,370	1,066	638
2007	2,417	688	465	2,360	1,210	838
2008	2,192	1,181	439	2,290	1,522	884
2009	1,760	1,360	373	2,450	1,043	1,096
2010	2,060	1,333	420	2,560	1,253	1,421
2011	1,963	1,641	464	2,821	1,247	1,567
Price elasticity	-0.24	0.98	0.10	0.01	0.20	

Source: World Gold Council.

strategies. There are at least two ways to think about the rationale for momentum investing: Some view it as a payoff from the slow transmission of meaningful fundamental information in a somewhat efficient market, and others view momentum as a proxy for expected returns in an efficient market. Although there is no precise estimate of how much capital has been allocated to momentum-based strategies, it is fair to believe that there is more capital allocated to momentum-based strategies today than in the past.

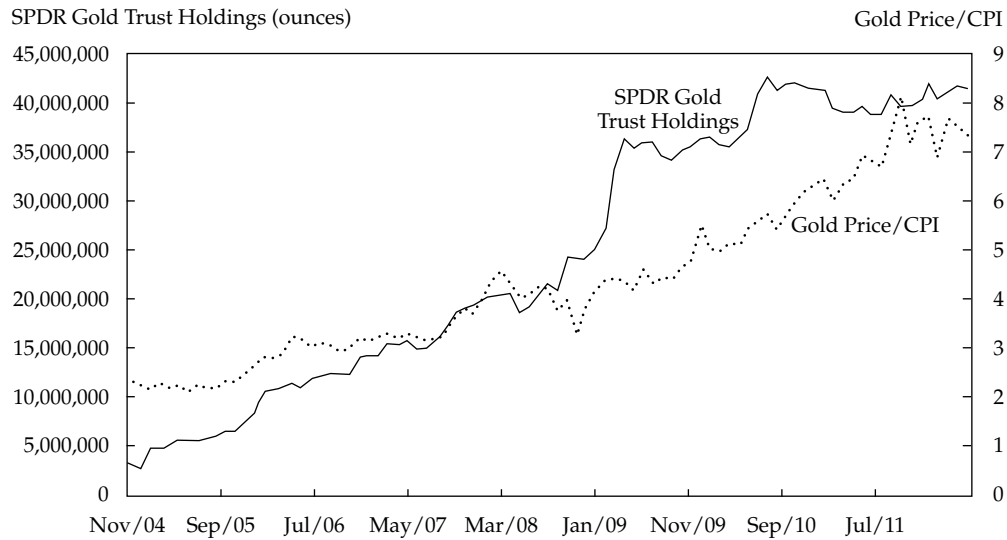
A momentum investor faces an upward-sloping demand curve: The higher the past return of an asset, the higher the momentum investor's demand for the asset. There is another type of momentum investor, one who attempts to replicate the payoff from a call option. As Perold and Sharpe (1995) showed, an investor pursuing a call option replication strategy will buy more of an asset as its price rises and sell the asset as its price falls.

Note that although momentum may work for a talented portfolio manager, it is questionable that momentum can work for most people. The U.S. residential housing "bubble" can be thought of as a momentum-based strategy in which many people participated. For a while, there was an upward-sloping demand curve for residential housing—the higher the average price of housing, the higher the demand for housing—but ultimately, things changed. The dot-com bubble at the turn of the century is another possible example of a momentum-based market characterized by an upward-sloping demand curve for "internet stocks." A key point is that although an upward-sloping demand curve is inconsistent with certain textbook microeconomic principles, it is consistent with the presence of momentum investors.

Figure 14 displays the trajectory of the real price of gold and the physical gold holdings of the world's largest gold exchange-traded fund (ETF), the SPDR Gold Trust. The SPDR Gold Trust (ticker symbol GLD) was launched in 2004. Since then, its holdings of physical gold (stored in vaults in London) have grown from nothing to more than 1,000 metric tons. GLD currently holds a little less than 1% of the world's known supply of above-ground gold. GLD's purchases of gold represent about 15% of the total investment demand for gold since 2004. As we will soon see, this ETF has more gold than the official holdings of China. Figure 14 illustrates a rising amount of gold investment as the price of gold rises, which is consistent with an upward-sloping demand curve for gold. Although momentum investing is consistent with an upward-sloping demand curve from traditional financial investors, in which a rising price leads to rising demand, it is also possible that there has been too much "central bank momentum" gold demand relative to supply and that excess demand has driven the real price of gold to historically high levels.

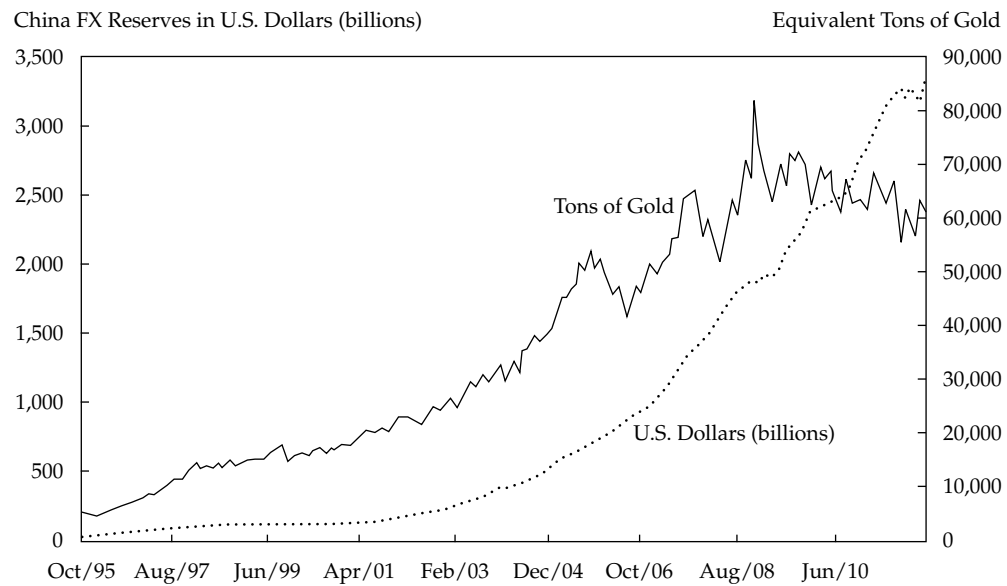
BRIC and Gold. One possible source of "too much demand" for gold may be the efforts of the Chinese government to reduce the size of its U.S. dollar foreign exchange reserves. **Figure 15** shows the reported size of Chinese foreign exchange reserves since 1995 and the hypothetical metric ton reserve equivalent. For instance, in 1995, if 100% of China's foreign exchange reserves had been invested in gold, China would have owned about 6,000 tons of gold (assuming no price impact). Under the same sort of hypothetical framework, China's current foreign currency reserves would "buy" about 66,000 tons of gold at current prices, which would

Figure 14. The Real Price of Gold and SPDR Gold Trust Gold Holdings, 2004–2012



Source: Bloomberg.

Figure 15. Chinese Foreign Exchange Reserves in U.S. Dollars and in Equivalent Metric Tons of Gold, 1995–2012



Source: Bloomberg.

represent about one-third of the total above-ground stock of gold.⁴⁴ Of course, in this hypothetical and simplified example of China pursuing an “all-in” gold allocation, the gold purchases needed to effect this foreign exchange reserve reallocation would likely drive the price of gold higher. For a fixed amount of foreign exchange reserves, the higher the price of gold, the fewer the tons of gold that must be purchased.

There is another important nuance. Given that the above-ground stock of gold has recently increased about 1%–2% a year, a move to acquire

up to one-third of all the gold in the world would mean that the current owners of gold would have to be offered a price for their gold that makes them happy to part with it. In an earlier study (Erb and Harvey 2012b), we pointed out that massive gold accumulation by the Chinese will do much to increase the wealth of existing, largely non-Chinese, owners of gold (see also Zhang 2012). In this sense, if there is a wealth effect, Chinese gold purchases could marginally stimulate global GDP outside China. It is entirely possible that the current owners of gold know nothing about its value

and that only the Chinese know the true value of gold. In that case, the current owners of gold will one day regret parting with the gold they sell to the Chinese. Or it could be that Chinese accumulation of gold could ultimately resemble the attempts of the Hunt brothers to corner the silver market in 1980.

Have the Chinese been buying gold? **Figure 16** shows World Gold Council estimates of the central bank gold holdings for Brazil, Russia, India, and China (the BRIC countries). China's estimated central bank gold holdings are currently more than 1,000 metric tons. There is no reason to believe that Chinese central bank gold holdings are more accurately reported than any other Chinese government statistic. Even though China's gold holdings have risen sharply over the last few years, as just noted, China holds less gold than the SPDR Gold Trust. China's gold holdings may still be rising.⁴⁵

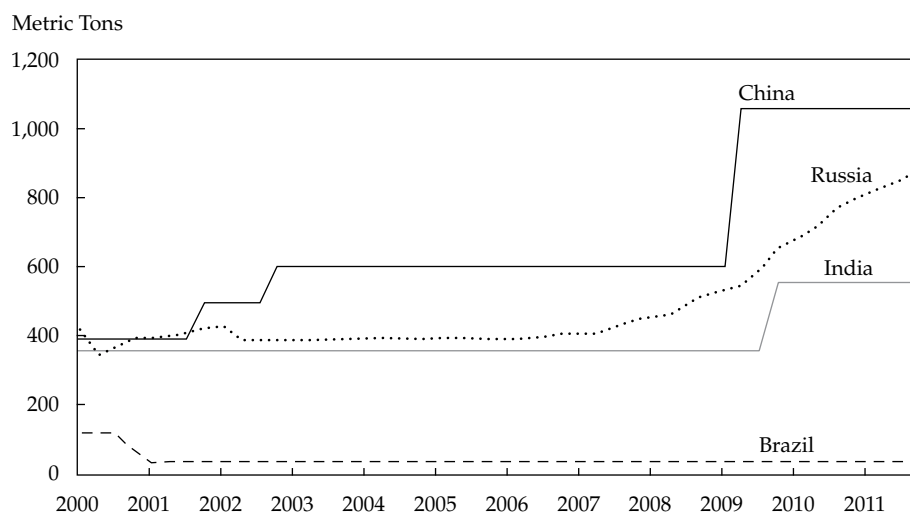
Central Banks. **Figure 17** provides a snapshot of estimated central bank gold holdings of 33 official entities holding more than 100 tons of gold. Overall, the central banks of the world hold a little more than 30,000 metric tons of gold, somewhat less than 20% of the estimated above-ground gold stock. The United States, viewed by some as a profligate debtor country, has about 8,000 tons of gold, and Switzerland, viewed by some as a model of financial probity, has a little more than 1,000 tons of gold.

Figure 18 profiles the entities that have either purchased or disposed of the largest gold holdings since 2000. China, Russia, and Saudi Arabia have been enthusiastic purchasers of gold, and the Netherlands, France, and Switzerland lessened

their gold holdings. For many years, the central banks of Western countries viewed gold as a "barbarous relic" that cluttered up their balance sheets.⁴⁶ Some Western central banks sought to lessen their gold holdings, but the lack of liquidity in the gold market forced them into a series of central bank gold agreements (CBGAs). The essence of the CBGAs was that the central banks that wished to sell gold collectively agreed that they would not sell more than some set amount of gold in any one year. Depending on the terms of the specific CBGA, the typical amount of sales was limited to 400 or 500 metric tons per year. The motive for limiting the number of tons of gold sold in any one year was a belief that the gold market could not absorb more gold sales without the price of gold falling significantly.

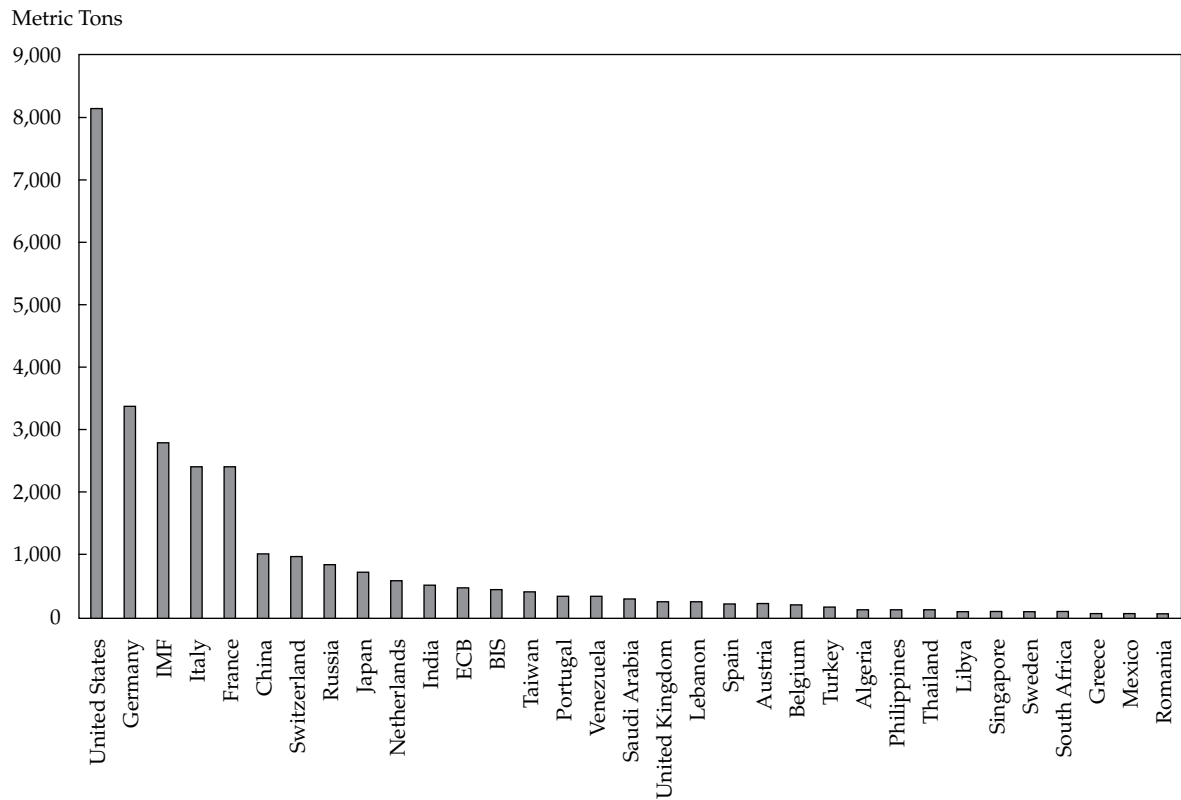
Just as OPEC attempts to keep oil prices as high as possible by matching supply to demand, the CBGAs were an attempt to prevent the price of gold from collapsing by matching supply to demand. Western country CBGA gold sales have declined substantially over the last few years because the central banks of Western countries have reassessed the wisdom of selling their gold holdings in an environment characterized by rapidly rising gold prices. The CBGAs existed because large holders of gold realized that fairly small gold sales (400 tons annually) could upset the price of gold in what supposedly is a large market (171,300 tons). The CBGAs focused on limiting the negative price impact of "excess supply." At the margin, the gold market has been affected by central bank "excess demand" for the last few years, and it is possible that this excess demand could persist well into the future.

Figure 16. BRIC Central Bank Gold Holdings, 2000–2011



Source: World Gold Council.

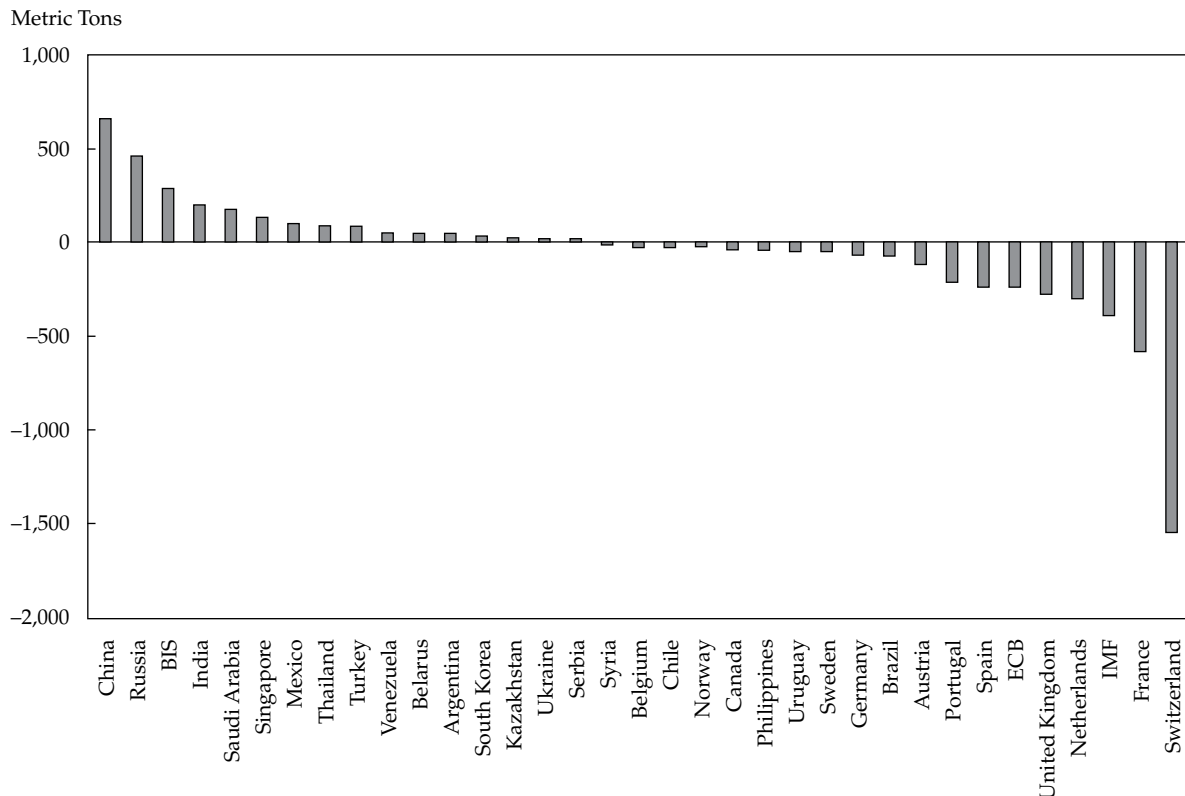
Figure 17. Central Bank Gold Reserves, March 2011



Notes: ECB stands for European Central Bank. BIS stands for Bank for International Settlements.

Source: World Gold Council.

Figure 18. Change in Central Bank Gold Reserves, 2000–2011



Source: World Gold Council.

What If Emerging Markets Emerge? The United States is the world's largest debtor country, and it has the world's largest gold reserve. Switzerland is a model country for financial conservatism. How might the size of BRIC gold holdings evolve over time if they diversify their central bank holdings in a manner similar to either the United States or Switzerland?

Table 7 examines this question by looking at two possible "keeping up with the Joneses" measures, gold holdings relative to the size of a country's GDP as well as relative to its population. The BRIC countries currently hold 2,457 tons of gold. If these four countries each targeted the same ratio of gold holdings relative to GDP as exists in the United States, then the gold holdings of the BRIC countries would rise to 6,233 metric tons. If the BRIC countries targeted the U.S. ratio of gold holdings relative to population, then the BRIC countries would hold 77,811 metric tons of gold. If the BRIC countries targeted the Swiss ratio of gold holdings relative to GDP, then the BRIC countries would hold 22,191 metric tons of gold. And finally, if the BRIC countries targeted the Swiss ratio of gold to population, then they would own 415,812 metric tons of gold. Of course, this would suggest the challenging prospect of the BRIC countries owning more than twice the entire amount of gold in the world. Interestingly, if a country pursues a "keeping up with the Joneses" approach to owning gold, targeted holdings based on the size of population or GDP will not be affected by changes in the price of gold.

Gold in a Diversified Portfolio. There are at least two reasons one might consider gold in a diversified portfolio. First, gold has low correlations with other tradable assets. **Figure 19** shows five-year rolling correlations of gold and a number of standard global equity and bond market benchmarks. Although these correlations vary over time, they are, on average, low. The recent equity correlations with the MSCI ACWI, MSCI EAFE Index, and S&P 500 were around 0.2. The fixed-income correlations were somewhat higher; the correlations with the Barclays Capital U.S. Aggregate Bond Index and the Merrill Lynch Global Government Bond ex-U.S. Index were about 0.4. Historically, the fixed-income correlations have been lower than the equity correlations. The message here is that on average, gold has low, if unstable, correlations with equity and fixed-income benchmark returns.

A second reason for holding gold in a diversified portfolio has to do with one of the key insights of the capital asset pricing model: Investors should hold the "market portfolio." This is one

way to think of the "gold is underowned" argument. For instance, **Table 8** shows that a measure of world stock market value (the Bloomberg World Exchange Market Capitalization Index) was recently about \$48 trillion and a measure of world bond market value (the Barclays Capital Global Aggregate Bond Index) was about \$41 trillion, which means that the "global stock and bond market" is about 54% stocks and 46% bonds. Although some individual investors may own more than 46% bonds in their portfolios and some may own more than 54% stocks in their portfolios, the "average investor" has a 54%/46% stock/bond mix (even if no individual investor is an "average investor"). As a result, one portfolio asset allocation recommendation is that on average, an investor's portfolio should look like "market-capitalization weights" because that is the aggregate market reality. For all intents and purposes, the average stock and bond investor owns about 0% gold. In a world in which all the above-ground gold is already owned, how much gold should market-capitalization-oriented stock and bond investors own?

Depending on how one defines the size of the gold market, there are at least three "float-adjusted market-capitalization weight" answers. One way to think about the size of the gold market is to think about the value of all the gold in the world (about \$9 trillion). Another is to think about only the gold held by central banks and other investors (about \$3.5 trillion), and yet another way is to think about the gold held by "investors" only (about \$1.8 trillion).

Roll (1977) noted that it is easier to invoke the phrase "market portfolio" than it is to get agreement on how to define and measure the "market portfolio." **Table 8** shows that if the "gold market" is taken to be the noncentral bank investment amount, then it would represent about 2% of the total market capitalization of a narrowly defined "market portfolio" consisting of stocks, bonds, and gold. There are elements of good news and bad news in this measure that highlight some of the challenges of creating macro-consistent portfolio allocations. The good news is that the 2% represents already-existing investment by what the World Gold Council calls investors, so it is possible to think in an abstract way that the world already follows a 53%/45%/2% stock/bond/gold allocation model. If this is the case, then "investors" already own all the gold they need. The bad news is that the idea that investors in aggregate already have a "market allocation" to gold probably seems odd to those who argue that gold is "underowned," such as Ray Dalio.

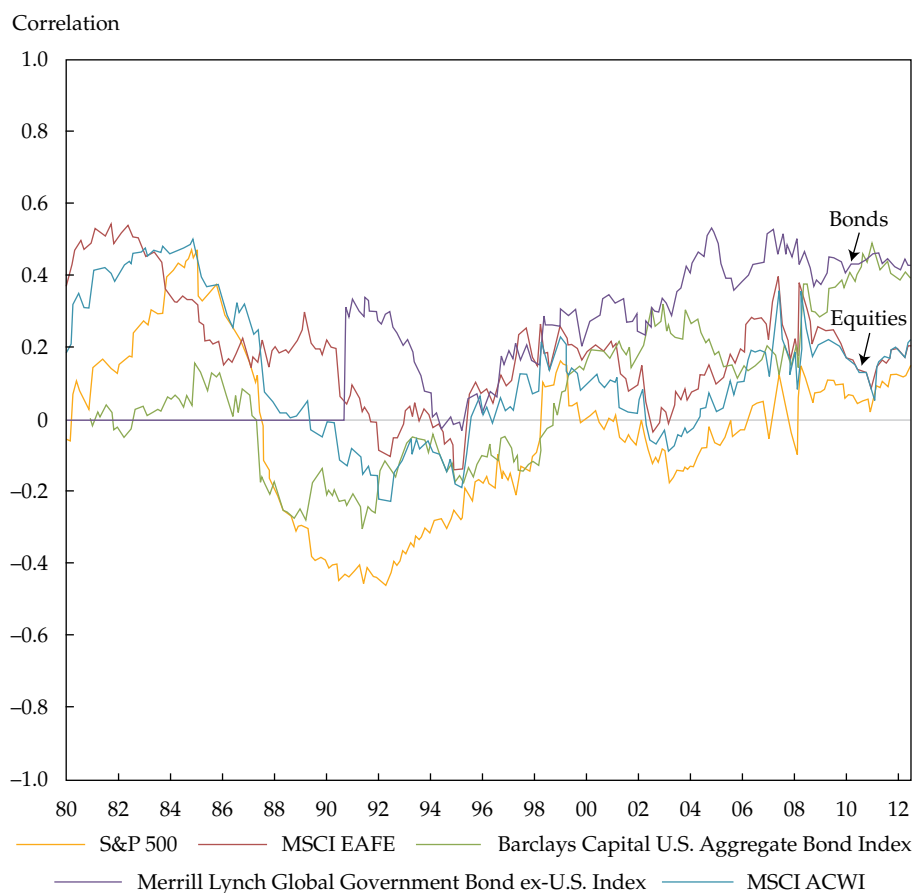
Table 7. BRIC as Developed Markets and Gold

	2010 GDP (US\$ billions)	2010 Population (millions)	2010 Central Bank Gold Reserves (metric tons)	2010 Gold/GDP Ratio	2010 Gold/Population Ratio	Estimated Reserves (metric tons)			
						If Move to U.S. Gold/GDP Ratio	If Move to U.S. Gold/Population Ratio	If Move to Swiss Gold/GDP Ratio	If Move to Swiss Gold/Population Ratio
United States	14,582	317.6	8,133	0.56	25.61	8,133	8,133	28,957	43,464
Switzerland	524	7.6	1,040	1.99	136.85	292	195	1,040	1,040
Brazil	2,088	199.5	34	0.02	0.17	1,165	5,109	4,146	27,302
Russia	1,480	140.4	811	0.55	5.78	825	3,596	2,939	19,214
India	1,729	1,316.3	558	0.32	0.42	964	33,709	3,433	180,139
China	5,879	1,382.2	1,054	0.18	0.76	3,279	35,397	11,673	189,157
Total			11,630			14,659	86,139	52,188	460,316
BRIC only			2,457			6,233	77,811	22,191	415,812
CBGA years ^a						9	188	49	1,033

^aCBGA years = Incremental tons of gold to purchase / 400 tons a year.

Sources: Bloomberg; World Gold Council.

Figure 19. Global Equity and Fixed-Income Benchmark Correlations with Gold, 1980–2012



Source: Bloomberg.

Table 8. Gold in Asset Allocation, March 2012

	Global Market Capitalization (US\$ trillions)			Global Market Capitalization (share of total)		
	All Gold	Available Gold: Central Bank and Investments	Only Investment	All Gold	Available Gold: Central Bank and Investments	Only Investment
Global equity	\$51.40	\$51.40	\$51.40	50.5%	53.5%	54.5%
Global fixed income	41.20	41.20	41.20	40.5	42.9	43.6
Gold	<u>9.14</u>	<u>3.40</u>	<u>1.79</u>	<u>9.0</u>	<u>3.5</u>	<u>1.9</u>
Total	\$101.74	\$96.00	\$94.39	100.0%	100.0%	100.0%
Required tons of gold				171,300	63,614	33,588
Percentage of existing gold stock				100%	37%	20%
CBGA-like annual purchases (years)				417	155	82
Likelihood				Impossible	Impractical	Unlikely

Source: Bloomberg.

There are most likely very few pension plans, defined contribution plans, or stock and bond investors pursuing what in aggregate looks like a 53%/45%/2% stock/bond/gold allocation. If

these “underallocated” investors were to invest in gold, they might use Table 8 as a guide in moving to a 2% allocation to gold. Yet, if the data from the World Gold Council are to be trusted, other

investors have already laid claim to this gold. Given the small size of the gold market relative to the stock and bond markets, this 2% portfolio allocation to gold would represent 19% of the gold market, or about 30,000 metric tons of gold. Given the illiquidity of the gold market as indicated by the existence of the CBGAs and a seeming positive elasticity of investment demand, a broad-based move by “underallocated” investors to a 2% portfolio allocation to gold would probably result in much higher nominal gold prices. What would happen if the price of gold doubled and the value of the stock and bond markets stayed the same? Gold’s target portfolio weight would rise to about 4%, and the target number of tons of gold to own would be unchanged. What would happen if the price of gold fell by 50%? Gold’s target weight would decline to about 1%, and the target number of tons of gold to own would be unchanged. Finally, if a 2% allocation were pursued by buying no more than 400 tons of gold per year, it would take in excess of 70 years to complete the 2% allocation.

The “gold is underowned” argument has probably been an important driver of the increase in the real price of gold. A rising level of gold investment by emerging market central banks in an illiquid gold market could lead to a rising real price of gold. A rising level of “keeping up with the Joneses” gold purchases could lead to a rising real price of gold. The rising real price of gold could act as a signal to momentum-based investors to allocate capital to gold. So long as some central banks are insensitive to the real price they pay for gold, the possible move into gold could drive the real price of gold much higher.

Conclusion

Investing in gold is potentially a way to maintain purchasing power. The purchasing power of gold rises and falls as the real price of gold rises and falls. Investing in gold entails a bet as to the future real price of gold, whether or not an investor even thinks about the bet. It is a fact that the real price of gold is very high compared with historical standards. A number of reasons have been advanced to explain the current real price of gold; some of these stories argue that the real price of gold is too high, and others suggest the real price could go even higher. The goal of our study was to analyze these competing narratives.

We found little evidence that gold has been an effective hedge against unexpected inflation, whether measured in the short term or the long term. The gold-as-a-currency-hedge argument does not seem to be supported by the data. The

fluctuations in the real price of gold are much greater than the changes on foreign exchanges. We suggest that the argument that gold is attractive when real returns on other assets are low is problematic. Low real yields—say, on TIPS—do not mechanically cause the real price of gold to be high. Although there is possibly some rational or behavioral economic force—perhaps a fear of inflation—influencing variation in both TIPS yields and the real price of gold, the impact may be more statistically apparent than real. We also parsed the safe haven argument and came up empty-handed. We examined data on hyperinflation in both major and minor countries and found that it is certainly possible for the purchasing power of gold to decline substantially during a highly inflationary period. When the price of gold is high in one country, it is probably high in other countries. Keynes pointed out that “the long run is a misleading guide to current affairs.” Even if gold is a “golden constant” in the long run, it does not have to be a golden constant in the short run. Conversely, current affairs are possibly a misleading guide to the long run.

In search of “new era” explanations for the current and future real price of gold, we analyzed the demand for and the supply of gold. The USGS estimates that only a 20-year supply of gold exists below the ground given current technology. Indeed, gold mine output has not significantly increased even though the price of gold has substantially appreciated over the past decade. A common commodity cliché is that “the best cure for high prices is high prices.” But the deluge of price-incented supply conjured up by this bit of wisdom has yet to manifest itself. Interestingly, the investment demand for gold has increased dramatically as the price of gold has gone up. A single exchange-traded fund, GLD, holds more gold than the official reserves of China. We asked the question, What happens if key emerging market countries boost their gold holdings, on either a per capita or a per GDP basis, to levels that more closely reflect the experience of more developed markets? Our calculations suggest that such a move would exert substantial upward pressure on the nominal and real prices of gold. Finally, we examined the asset allocation problem of the average investor in a world subject to macro-consistency. The estimated value of all the gold in the world is about 9% of today’s combined capitalization of world stock and bond markets. If we look at investable gold, the share is about 2%. It is also a fact that very few investors hold 2% of their portfolios in gold. A widespread move to increase gold in diversified portfolios would lead

to upward pressure on the real and nominal prices of gold.

In the end, investors are faced with a golden dilemma. Will history repeat itself and the real price of gold revert to its long-term mean—consistent with a “golden constant”? Alternatively, have we entered a new era, where it is dangerous to extrapolate from history? Those are the uncertain outcomes that gold investors have to grapple with, and the passage of time will do little to clarify which path investors should follow.

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This article qualifies for 1 CE credit.

Notes

1. This calculation uses the market capitalizations from both the Bloomberg World Exchange Market Capitalization Index (WCAUWRLD) and the Barclays Capital Aggregate Bond Index.
2. See World Gold Council (2010a).
3. Other contrasting views include the notion of Howard Marks (Outlook Business 2013) that “there is nothing intelligent to be said about gold” and the authoritative history of the societal footprint of gold by Peter Bernstein (2000).
4. The World Gold Council (2012b) estimated that at year-end 2011, there were about 171,300 metric tons of gold above ground—a widely referenced estimate of the cumulative amount of gold that has been mined over time. The fact that this estimate is widely referenced does not mean that it is accurate. Given 32,150 troy ounces per metric ton and a price of \$1,650 per ounce, one arrives at a value of about \$9 trillion.
5. Harmston (1998) pointed out that in 562 BC, during the reign of the Babylonian king Nebuchadnezzar, an ounce of gold could purchase 350 loaves of bread. At the recent price of \$1,600 an ounce, an ounce of gold could buy 350 loaves of bread priced at \$4.57 a loaf.
6. Greer (1997) argued that there are three asset “super classes”: capital assets, consumable/transformable assets, and store of value assets. As an asset, gold falls into Greer’s “store of value” super class.
7. The possibility that the U.S. government will make gold ownership illegal once again or even confiscate gold held by individuals is a popular anxiety-inducing gold-investing theme. For instance, in August 2011, analyst Marc Faber suggested that U.S. citizens owning physical gold should make sure that their gold was stored outside the United States (see Cox 2011).
8. Officer (2006) showed that the official U.S. gold price has been set only a few times: 1792 (\$19.39), 1834 (\$20.67), 1934 (\$35.00), 1972 (\$38.00), and 1973 (\$42.22). Fama and French (1987) examined the performance of gold futures from February 1975 to July 1984. Our monthly U.S. gold futures data start with the introduction of legal gold trading in January 1975. Elwell (2011, p. 13) noted that from 1934 to 1973 (during what he called a “quasi-gold standard” period), “although there was no private market for gold in the United States, such markets did exist abroad. By the late 1960s, prices in these markets were tending to deviate from official currency prices.” The Bank for International Settlements’ annual reports (1966–1970) have referred to “market prices” in London and Zurich. Historical London market prices going back to 1968 can be found on the London Bullion Market Association website (www.lbma.org.uk/pages/index.cfm?page_id=15&title=market_history). The first London gold “fixing” occurred in 1919; five gold bullion dealers collectively decided what the price of gold should be on a given day. The London gold fixing was suspended in 1939 and reinstated in 1954. As part of the Bretton Woods system of fixed exchange rates, participating governments had an option to settle balance-of-payments differences with gold reserve transfers. An attempt in the 1960s by the central banks of eight countries to maintain the Bretton Woods fixed exchange rates by selling gold to “the market” at \$35 an ounce led to an arrangement called the London Gold Pool. For various reasons, the London price of gold rose above \$40 an ounce in 1968, leading to losses for the members of the London Gold Pool and a decision to end the operation of the pool. Minutes of U.S. Federal Reserve Board (1967) discussions in December 1967 chronicle the challenges the United States faced in trying to support the London Gold Pool. The United States ended the convertibility of the U.S. dollar into gold in 1971, when the year-end gold price was about \$43 an ounce in London. In 1973, the United States officially ended its adherence to the gold exchange standard. The year-end 1973 price of gold was about \$106 an ounce in London. Barsky and Summers (1988, p. 543) chose 1973 as the start date for their analysis of Gibson’s paradox, noting that “we focus on the period from 1973 to the present, after the gold market was sufficiently free from government pegging operations and from limitations on private trading for there to be a genuine ‘market’ price of gold.”
9. The price of gold was regressed on the contemporaneous value of the U.S. Consumer Price Index, which illustrates the best in-sample fit between the price of gold and an inflation index.
10. Bekaert and Wang (2010) illustrated a way to think about an inflation hedge in the context of a simple linear regression model. They regressed the nominal return of an asset on the rate of inflation: $\text{Nominal return} = \text{Inflation alpha} + \text{Inflation beta} \times \text{Inflation rate} + \text{Error}$. An asset with an inflation beta of 1.0 is defined as a “perfect hedge against inflation.” An inflation beta of 1.0 is another way of thinking about “moving in lockstep with inflation.” There are at least three ways to think about the idea of the price of gold and inflation moving in lockstep. One possibility is Jastram’s (1978) idea of the golden constant. One interpretation views gold as having an inflation beta of 1.0 and an inflation alpha of zero. The golden constant is consistent with the idea that the purchasing power—the real price—of gold is constant. Alternatively, gold’s inflation beta could be 1.0 and its inflation alpha could be positive, which would suggest that in the long run, an ounce of gold has a rising real purchasing power and a rising real price. A third possibility is that gold’s inflation alpha is negative and the purchasing power, or real price, of gold declines over time. This third case would be problematic. An inflation beta of 1.0 would seem to suggest that gold is an inflation hedge, whereas a negative inflation alpha would suggest that purchasing power declines to zero given a sufficiently long time horizon. There

- are, of course, other nuances, such as attributing any inflation alpha to overlooked risk factors, time horizon issues (monthly, annual, etc.), how to measure inflation, and the stability of inflation betas.
11. Note that the base of the CPI was set to 100 in 1982–1984.
 12. Many investors use Bloomberg terminals. An investor using Bloomberg's GGR US (U.S. Generic Government Rates) function will see "breakeven rates" calculated as the difference in yields between maturity-matched nominal and real Treasury Inflation-Protected Securities. For example, Perold (2012) used expected inflation and breakeven inflation interchangeably. Such usage does not mean that this approach is correct, but it does indicate that many Bloomberg users are exposed to this measure and method of calculation. A more precise calculation might incorporate an estimate of a possible "liquidity premium." The liquidity premium would increase the breakeven inflation level. See the analyses in Christensen and Gillan (2011) and Fleckenstein, Longstaff, and Lustig (forthcoming).
 13. Indeed, von Mises (1953, p. 744) believed that the natural response of "the common man" to a fiat money system was to "flee into real values" by investing in commodities as an inflation hedge.
 14. On 25 February 1862, the U.S. government issued its first paper notes that were not backed by coin and were considered legal tender. These notes were known as "greenbacks." See *Statutes at Large, 1789–1875*, vol. 12 (<http://memory.loc.gov/ammem/amlaw/lwllink.html>); see also Mitchell (1903).
 15. See <http://measuringworth.com/gold/>.
 16. See also the analysis in Barro and Misra (2013).
 17. For an analysis of the gold standard, see Schwartz (1987).
 18. In 1971, President Richard Nixon ended the convertibility of U.S. dollars into gold. In effect, Nixon brought to an end the 1944 Bretton Woods Accord, which allowed (1) the conversion of foreign currencies into U.S. dollars at fixed exchange rates and (2) the convertibility of U.S. dollars into gold.
 19. The year 1929 is the earliest year for which the U.S. Bureau of Economic Analysis reports such macroeconomic data as GDP and its constituents (personal disposable income and personal disposable income per capita; see www.bea.gov).
 20. Goldsworthy (2003) noted that from the time of the Emperor Augustus, the number of Roman legions fluctuated "a little above or below 30 for the next 300 years" (p. 50). A legion typically consisted of 4,800 legionaries (which can alternatively be viewed as consisting of 10 cohorts of 480 legionaries or 60 centuries of 80 legionaries). Under Augustus, a legion was usually commanded by a legate, who, in turn, was assisted by a camp prefect (a former senior centurion) and up to six tribunes. There seems to be little evidence as to the pay of these officers, but there is a consensus as to the pay of legionaries and centurions. The consensus could, of course, be wrong. It is common to assert that a legionary typically was paid 225 denarii a year and a centurion was paid 3,750 denarii a year. MacMullen (1974) referred to three pay levels for centurions: 3,750 denarii a year for 50 "regular centurions," 7,500 denarii a year for 9 "primi ordinis" centurions, and 15,000 denarii a year for one "primus pilus" centurion. Speidel (1992) referred to legionary pay of 225 denarii a year but mentioned 3,375 denarii (13,500 sestertii) a year as the pay of a "centurio legionis," what MacMullen referred to as an ordinary centurion. There seem to be more references to "basic" centurion pay of 3,750 denarii a year (e.g., see Wachter [2002]; Stoke-on-Trent Museums [2013]; Adkins and Adkins [1998]) than to centurion pay of 3,375 denarii a year. For this reason, Table 2 uses centurion pay of 3,750 denarii a year. Another assumption used in Table 2 is that an aureus contains roughly 8 grams of gold (a Roman pound was about 329 grams, and an aureus was 1/40 of a pound). An aureus of the same vintage in the British Museum weighs 7.950 grams and is 99% gold—effectively 24 carats. See www.britishmuseum.org/explore/highlights/highlight_objects/cm/g/gold_aureus_of_octavian.aspx.
 21. Given this framework, let us assume that the inflation rate in Country A is I_A and the inflation rate in Country B is I_B . Then, if we assume that inflation differences drive currency moves, the assumed change in the currency exchange rate will be $I_A - I_B$ and the nominal gold price appreciation in Country A will be I_A . If I_A is greater than I_B , more of Currency A is needed to buy one unit of Currency B, which means that the change in the exchange rate will equal the change in the price of gold when $I_A = I_B$. This will occur when I_B equals zero.
 22. From a U.S. perspective, the Japanese yen is quoted in terms of the number of yen in a U.S. dollar. If the yen/dollar exchange rate starts at 100 and falls to 98.6, the yen has appreciated by 1.4% and the dollar has depreciated by 1.4%, absent any important Siegel's paradox effect (for a review of Siegel's paradox, see the discussion of "universal currency hedging" in Black 1995).
 23. Pukthuanthong and Roll (2011) found that on average, a higher gold price is correlated with not only a weaker U.S. dollar but also a weaker euro, yen, and pound.
 24. See, for example, www.commodityonline.com/news/Real-interest-rates-are-the-prime-driver-of-gold-price-24907-3-1.html, www.crossingwallstreet.com/archives/2010/10/a-model-to-explain-the-price-of-gold.html, and www.crossingwallstreet.com/archives/2011/09/gold-and-gibsons-paradox.html.
 25. Figure 10 covers the 15 years since the inception of trading in inflation-protected fixed income in the United States. Using U.K. data (where inflation-linked bonds started trading in the early 1980s), the correlation between the real yield of the Barclays U.K. government inflation-linked bond index and the U.K. real price of gold is -0.31 .
 26. For a history of gold leasing, see Szabo (2007).
 27. The Gold Anti-Trust Action Committee was "organized in 1998 to expose, oppose, and litigate against collusion to control the price and supply of gold and related instruments" (see www.gata.org/about).
 28. It is possible that the correlation between real gold returns and 10-year real yields was a data-mined, after-the-fact, spurious correlation, such as the finding by Leinweber (2007) that butter production in Bangladesh historically "explained" 75% of the variation in the S&P 500 Index.
 29. There is no record of the fate of the owner of the Hoxne Hoard.
 30. See William of Malmesbury (1847, p. 6).
 31. At the current price of \$1,600 an ounce, \$5 million in gold would weigh 215 pounds.
 32. Polleschi (2012) reported a recent incident in which an Italian businessman and his daughter were caught trying to smuggle 50 kilograms (110 pounds) of gold into Switzerland in what was supposed to be a hidden compartment in his car. This incident highlights the importance of having an effective way to get one's gold across "the border." Some may be successful in getting their gold across the border by asking others to help transport a cache of gold.
 33. Gold ATMs are available in a number of cities, such as Boca Raton, Florida. Some dispense gold coins and others dispense small gold bars.
 34. To paraphrase a comment Winston Churchill made to the U.K. House of Commons in 1947, *Democracy is the worst form of government, except for all those other forms that have been tried from time to time*.
 35. Dalio (2011) referred to the workings of financial markets and economies as an "economic machine." By viewing the world as a machine, Dalio sought to find "timeless principles" that are independent of personal experience. Dalio's view (2012) that "almost all important events never happen in your life

- before" can be seen as an attempt to deal with the possible limits of induction from personal experience.
36. It is possible to argue that ideally, one should look at the total gold and money supplies of all countries over all time periods.
 37. The order was posted with the preamble "All persons are required to deliver ON OR BEFORE 1 MAY 1933 all GOLD COIN, GOLD BULLION, AND GOLD CERTIFICATES now owned by them to a Federal Reserve Bank, branch or agency, or to any member bank of the Federal Reserve System." The notice (signed by the secretary of the Treasury) also detailed the criminal penalties for violating the order: "\$10,000 fine or 10 years imprisonment, or both." The secretary of the Treasury, William H. Woodin, was a coin collector and inserted an exception in Section 2 of the order to exempt "gold coins having a recognized special value to collectors of rare and unusual coins." Note that the \$10,000 fine was very punitive. Using the ratio of 2011 and 1933 per capita nominal GDPs, the fine was equivalent to \$1.1 million in today's terms.
 38. In a speech on 15 August 1971, President Nixon declared, "I have directed Secretary Connally to suspend temporarily the convertibility of the dollar into gold or other reserve assets, except in amounts and conditions determined to be in the interest of monetary stability and in the best interests of the United States." Note that this directive was not an executive order. Executive Order 11615, signed on 15 August 1971, dealt with wage and price controls. Proclamation 4074, signed on 15 August 1971, dealt with tariffs. Ironically, Proclamation 4071, signed on 2 August 1971, established "National Clown Week."
 39. Anderson, Rasche, and Loesel (2003, p. 39) noted that "it is commonplace today for monetary policy analysis, both in theory and practice, to be conducted without reference to the monetary base or other monetary aggregates."
 40. The fact that a CEO of the world's largest gold-mining company once referred to "peak gold" does nothing to demonstrate the existence of "peak gold." It is simply an observation that a CEO used a colorful metaphor to illustrate his personal view that the supply of gold was likely to be constrained in the future.
 41. Barrick reported 2011 cash gold-mining costs of \$460 an ounce and expected 2012 cash gold-mining costs to be in the range of \$520–\$560 an ounce (www.barrick.com/company/profile/default.aspx).
 42. Two companies have been formed to mine asteroids: Planetary Resources (supported by Larry Page, Eric Schmidt, and James Cameron; <http://planetaryresources.com>) and Deep Space Industries (<http://deepspaceindustries.com>).
 43. Our elasticity estimates are based on a regression of the log of a variable, such as the log of the investment demand for gold, on the log of the gold price. Batchelor and Gulley (1995) estimated the price elasticity of demand for gold jewelry to be between -1.0 and -0.5.
 44. The ratio of gold reserves to total foreign exchange reserves is only 1.7% in China, compared with 76.1% in the United States and 73.2% in Germany; see World Gold Council (2012c).
 45. China is perceived to be the world's largest producer of gold, with possible annual gold mine output of about 350 tons in 2011. The Chinese government could conceivably increase its gold holdings by purchasing all of China's gold output. Is it in China's interest to purchase gold in secret? Perhaps. It is also possible to ask what, if anything, China might gain by disclosing the size of its gold holdings. It is hard to believe that Chinese government gold holdings and Chinese gold output are reported any more reliably than other official Chinese statistics.
 46. The "barbarous relic" phrase was made popular by Keynes. To be precise, Keynes was referring to the gold standard, not gold itself: "In truth, the gold standard is already a barbarous relic" (see Keynes 1924, p. 172).

References

- Adkins, Lesley, and Roy A. Adkins. 1998. *Handbook to Life in Ancient Rome*. New York: Oxford University Press.
- Anderson, Richard G., Robert H. Rasche, and Jeffrey Loesel. 2003. "A Reconstruction of the Federal Reserve Bank of St. Louis Adjusted Monetary Base and Reserves." *Review* (Federal Reserve Bank of St. Louis), vol. 85, no. 5 (September):39–70.
- Arends, Brett. 2009. "What Price Suits Gold." *Wall Street Journal* (16 September).
- Ash, Adrian. 2009. "The Golden Constant" (www.safehaven.com/article/15058/the-golden-constant).
- Asness, Clifford S. 2003. "Fight the Fed Model." *Journal of Portfolio Management*, vol. 30, no. 1 (Fall):11–24.
- . 2012. "An Old Friend: The Stock Market's Shiller P/E." Working paper, AQR (November).
- Asness, Clifford S., Tobias J. Moskowitz, and Lasse Heje Pedersen. 2013. "Value and Momentum Everywhere." *Journal of Finance*, vol. 68, no. 3 (June):929–985.
- Barro, Robert J., and Sanjay P. Misra. 2013. "Gold Returns." NBER Working Paper 18759 (February).
- Barsky, Robert B., and Lawrence H. Summers. 1988. "Gibson's Paradox and the Gold Standard." *Journal of Political Economy*, vol. 96, no. 3 (June):528–550.
- Batchelor, Roy, and David Gulley. 1995. "Jewellery Demand and the Price of Gold." *Resources Policy*, vol. 21, no. 1 (March):37–42.
- Baur, Dirk G., and Brian Lucey. 2010. "Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold." *Financial Review*, vol. 45, no. 2 (May):217–229.
- Bekaert, Geert, and Xiaozheng Wang. 2010. "Inflation Risk and the Inflation Risk Premium." *Economic Policy*, vol. 25, no. 64 (October):755–806.
- Bernholz, Peter. 2006. *Monetary Regimes and Inflation: History, Economic and Political Relations*. Cheltenham, U.K.: Edward Elgar Publishing.
- Bernstein, Peter. 2000. *The Power of Gold: The History of an Obsession*. New York: Wiley.
- Black, Fischer. 1995. "Universal Hedging: Optimizing Currency Risk and Reward in International Equity Portfolios." *Financial Analysts Journal*, vol. 51, no. 1 (January/February):161–167.
- Bordo, Michael D., and Finn E. Kydland. 1995. "The Gold Standard as a Rule: An Essay in Exploration." *Explorations in Economic History*, vol. 32, no. 4 (October):423–464.
- Brenan, James M., and William F. McDonough. 2009. "Core Formation and Metal–Silicate Fractionation of Osmium and Iridium from Gold." *Nature Geoscience*, vol. 2:798–801.
- Brodsky, Paul, and Lee Quaintance. 2009. "Trade of the Century?" (www.gata.org/files/QBAssetManagement-07-2009.pdf).
- . 2011. "Your Gold Teeth" (www.gata.org/files/QBAMCO-YourGoldTeeth2-08-2011.pdf).

- Buffett, Warren. 2011. CNBC interview (2 March): www.cnbc.com/id/41867379/CNBC_Buffett_Transcript_Part_2_The_Zebra_That_Got_Away.
- . 2012. "2011 Berkshire Hathaway Shareholder Letter" (www.berkshirehathaway.com/letters/2011ltr.pdf).
- Cagan, Philip. 1956. "The Monetary Dynamics of Hyperinflation." In *Studies in the Quantity Theory of Money*. Edited by Milton Friedman. Chicago: University of Chicago Press.
- Campbell, John Y., and Robert J. Shiller. 2001. "Valuation Ratios and the Long-Run Stock Market Outlook: An Update." NBER Working Paper 8221 (April).
- Cassidy, John. 2011. "Mastering the Machine." *New Yorker* (25 July): www.newyorker.com/reporting/2011/07/25/110725fa_fact_cassidy.
- Christensen, Jens H.E., and James M. Gillan. 2011. "A Model-Independent Maximum Range for the Liquidity Correction of TIPS Yields." Federal Reserve Bank of San Francisco Working Paper 2011-16 (23 June).
- Cox, Jeff. 2011. "'Very Muted Growth' Coming for Next 10 Years: Faber." CNBC (23 August).
- Dalio, Ray. 2011. "A Template for Understanding What's Going On."
- . 2012. CNBC interview by Andrew Ross Sorkin (21 September).
- DeLong, Bradford. 1996. "Why Not the Gold Standard?" (<http://delong.typepad.com/sdj/why-not-the-gold-standard-talking-points-on-the-likely-consequences-of-re-establishment-of-a-gold-st.html>).
- . 2011. "Gibson's Paradox and the Gold Boom" (<http://delong.typepad.com/sdj/2011/09/gibsons-paradox-and-the-gold-boom.html>).
- . 2012. "Campbell-Shiller Regressions: Future S&P Price Changes Regressed on Ratios of Prices to Long-Run Moving Averages of Past Earnings" (14 October): <http://delong.typepad.com/sdj/2012/10/campbell-shiller-regressions-future-sp-price-changes-regressed-on-ratios-of-prices-to-long-run-moving-averages-of-past-earn.html>.
- Eichengreen, Barry, and Peter Temin. 2010. "Fetters of Gold and Paper." NBER Working Paper 16202 (July).
- Elfenbein, Eddy. 2012. "Reprise: The Elfenbein Gold Model" (5 April): www.crossingwallstreet.com/archives/2012/04/reprise-the-elfenbein-gold-model.html.
- Elwell, Craig K. 2011. "Brief History of the Gold Standard in the United States." Congressional Research Service (23 June).
- Erb, Claude B., and Campbell R. Harvey. 2012a. "An Impressionist View of the 'Real' Price of Gold around the World." Working paper (18 September).
- . 2012b. "Sound Economic Policies Outweigh Big Gold Reserves." *Shanghai Daily* (2 November).
- Evans-Pritchard, Ambrose. 2009. "Barrick Shuts Hedge Book as World Gold Supply Runs Out." *Telegraph* (11 November).
- Fama, Eugene F., and Kenneth R. French. 1987. "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage." *Journal of Business*, vol. 60, no. 1 (January):55–73.
- Fisher, Irving. 1928. *The Money Illusion*. New York: Adelphi Company.
- Fleckenstein, Matthias, Francis A. Longstaff, and Hanno N. Lustig. Forthcoming. "The TIPS–Treasury Bond Puzzle." *Journal of Finance*.
- Friedman, Milton. 1968. "Inflation: Causes and Consequences." Reprinted in *Dollars and Deficits: Living with America's Economic Problems*. Englewood Cliffs, NJ: Prentice Hall.
- Goldsworthy, Adrian. 2003. *The Complete Roman Army*. London: Thames & Hudson.
- Green, Timothy. 1999. "Central Bank Gold Reserves: An Historical Perspective since 1845." World Gold Council Research Study 23.
- Greer, Robert J. 1997. "What Is an Asset Class, Anyway?" *Journal of Portfolio Management*, vol. 23, no. 2 (Winter):86–91.
- Hanke, Steve H., and Nicholas Krus. 2012. "World Hyperinflations." Working paper, Cato Institute (15 August).
- Hansen, Gary D., and Edward C. Prescott. 2002. "Malthus to Solow." *American Economic Review*, vol. 92, no. 4 (September):1205–1217.
- Harmston, Stephen. 1998. "Gold as a Store of Value." World Gold Council Research Study 22 (November).
- Ibbotson, Roger G., and Peng Chen. 2003. "Long-Run Stock Returns: Participating in the Real Economy." *Financial Analysts Journal*, vol. 59, no. 1 (January/February):88–98.
- IMF. 1999. "Twelfth Meeting of the IMF Committee on Balance of Payment Statistics." Santiago, Chile (27–29 October).
- Jastram, Roy W. 1978. *The Golden Constant: The English and American Experience 1560–1976*. New York: John Wiley & Sons.
- Johnston, Louis D., and Samuel H. Williamson. 2011. "What Was the U.S. GDP Then?" MeasuringWorth.
- Keynes, John Maynard. 1924. *A Tract on Monetary Reform*. London: Macmillan.
- . 1930. *A Treatise on Money*. London: Macmillan.
- . 1936. *The General Theory of Employment, Interest and Money*. London: Macmillan.
- Krugman, Paul. 2011. "Treasuries, TIPS, and Gold (Wonkish)." *New York Times* (6 September).
- Leinweber, David J. 2007. "Stupid Data Miner Tricks: Overfitting the S&P 500." *Journal of Investing*, vol. 16, no. 1 (Spring):15–22.
- MacMullen, Ramsay. 1974. *Roman Social Relations: 50 B.C. to A.D. 284*. New Haven, CT: Yale University Press.
- Madura, Liana. 2011. "IVA's de Vault: Gold Still Seems Underowned." *Morningstar Advisor* (16 September).
- Malkiel, Burton G. 2003. "The Efficient Market Hypothesis and Its Critics." *Journal of Economic Perspectives*, vol. 17, no. 1 (Winter):59–82.
- McGuire, Shayne. 2010. *Hard Money: Taking Gold to a Higher Investment Level*. Hoboken, NJ: Wiley.
- McKinnon, Ronald I. 1993. "The Rules of the Game: International Money in Historical Perspective." *Journal of Economic Literature*, vol. 31, no. 1 (March):1–44.
- Miller, John W. 2012. "Exhausting the Earth's Resources? Not So Fast." *Wall Street Journal* (5 June).
- Mitchell, Wesley Clair. 1903. *A History of the Greenbacks*. Chicago: University of Chicago Press.

- Montier, James. 2011. "A Value Investor's Perspective on Tail Risk Protection: An Ode to the Joy of Cash." White paper, GMO (June).
- Nixon, Richard M. 1971. "Address to the Nation Outlining a New Economic Policy: 'The Challenge of Peace'" (15 August).
- Norris, Floyd. 2010. "Strange Tales in the Land of No Return." *New York Times* (28 October).
- Officer, Lawrence H. 2006. "What Was the Price of Gold Then? A Data Study." Working paper, University of Illinois at Chicago.
- Or, Amy, and Matt Phillips. 2011. "Forget Gold. How About Gemstones?" *Wall Street Journal* (25 May).
- Outlook Business. 2013. "Bargain Hunter: Howard Marks." *Outlook India* (2 February): <http://business.outlookindia.com/article.aspx?283882>.
- Paul, Ron, and Lewis Lehrman. 2007. *The Case for Gold*. Auburn, AL: Ludwig von Mises Institute.
- Perold, André F. 2012. "Negative Real Interest Rates: The Conundrum for Investment and Spending Policies." *Financial Analysts Journal*, vol. 68, no. 2 (March/April):6–12.
- Perold, André F., and William F. Sharpe. 1995. "Dynamic Strategies for Asset Allocation." *Financial Analysts Journal*, vol. 51, no. 1 (January/February):149–160.
- Polleschi, Ilaria. 2012. "Italian Caught at Swiss Border with 50 kg of Gold." Reuters (18 June).
- Pukthuanthong, Kuntara, and Richard Roll. 2011. "Gold and the Dollar (and the Euro, Pound, and Yen)." *Journal of Banking & Finance*, vol. 35, no. 8 (August):2070–2083.
- Regent, Aaron. 2011. "Investor Day Presentation" (www.barrick.com/files/doc_presentations/2011/Barrick-Investor-Day-Transcript.pdf).
- Rockwell, Llewellyn H. 2002. "Is the Gold Standard History?" (www.lewrockwell.com/rockwell/goldstandard.html).
- Roll, Richard. 1977. "A Critique of the Asset Pricing Theory's Tests Part I: On Past and Potential Testability of the Theory." *Journal of Financial Economics*, vol. 4, no. 2 (March):129–176.
- Roth, Jean-Pierre. 1999. "A View on Switzerland in the Run Up to the Demonetization of Gold." 22nd Annual FT World Gold Conference, London (14 June).
- Saad, Lydia. 2012. "Gold Still Americans' Top Pick among Long-Term Investments." Gallup (27 April).
- Saxe, John Godfrey. 1872. "The Blind Men and the Elephant."
- Schwartz, Anna J. 1987. *Alternative Money Regimes: The Gold Standard*. Chicago: University of Chicago Press.
- Speidel, M. Alexander. 1992. "Roman Army Pay Scales." *Journal of Roman Studies*, vol. 82 (November):87–106.
- Stoke-on-Trent Museums. 2013. "How Much Did Things Cost?"
- Szabo, Tom. 2007. "Gold and Silver 'Leasing' Examined" (17 September): www.silveraxis.com/commentary/gold_silver_leasing.pdf.
- Tversky, Amos, and Daniel Kahneman. 1971. "Belief in the Law of Small Numbers." *Psychological Bulletin*, vol. 76, no. 2 (August):105–110.
- U.S. Federal Reserve Board. 1967. "Memorandum of Discussion" (12 December): www.federalreserve.gov/monetarypolicy/files/fomcmod19671212.pdf.
- USGS. 2011. "Gold: Mineral Commodity Summaries." U.S. Geological Survey (<http://minerals.usgs.gov/minerals/pubs/commodity/gold/mcs-2011-gold.pdf>).
- von Mises, Ludwig. 1953. "Gold versus Paper." *Freeman* (13 July).
- Wacher, John. 2002. *The Roman World*. London: Routledge.
- Ward, Sandra. 2011. "Observing a Bipolar World." *Barron's* (12 March).
- Whitehouse, David. 1999. "Gold Rush in Space?" BBC Online (22 July).
- William of Malmesbury. 1847. *Chronicle of the Kings of England from the Earliest Period to the Reign of King Stephen*. London: Henry G. Bohn.
- World Bank. 1994. "Brazil: An Assessment of the Private Sector." Research report (24 June).
- World Gold Council. 2010a. "An Investor's Guide to the Gold Market (U.S. Edition)."
- . 2010b. "Gold: Hedging against Tail Risk."
- . 2012a. "About Gold."
- . 2012b. "Facts about Gold."
- . 2012c. "Latest World Official Reserves" (3 December).
- Zhang, Zhouxiang. 2012. "Does China Need to Buy More Gold?" *China Daily* (9 October).