

An Analysis of the Relationship between Inflation and Gold Prices: Evidence from Pakistan

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Abstract

In this study, we formulate a new inflation equation to capture the potential effects of gold and stock prices on inflation in Pakistan. We aim to assess the inflation-hedging properties of gold compared to other assets such as real estate, stock exchange securities, and foreign currency holdings. Applying time-series econometric techniques (cointegration and vector error correction models) to data for 1960–2010, we find that gold is a potential determinant of inflation in Pakistan. On the other hand, it also provides a complete hedge against unexpected inflation. Real estate assets are more than a complete hedge against expected inflation, although stock exchange securities outperform gold and real estate as a hedge against unexpected inflation. Foreign currency proves to be an insignificant hedge against inflation. Given the dual nature of the relationship between gold and inflation, it is increasingly important for the government to monitor and regulate the gold market in Pakistan. Moreover, stock market investment should be encouraged by the government given that asset price inflation does not pose a critical problem for Pakistan as yet.

Keywords: Gold prices, inflation hedging, assets, time series econometrics technique, Pakistan.

JEL classification: E31, E37, E4.

1. Introduction

Inflation is a worldwide macroeconomic problem owing to its adverse implications for economic expansion and income redistribution. Achieving a moderate level of inflation is, therefore, one of the main objectives of both developed and developing economies. In this context, a large body of theoretical literature has evolved over time identifying the

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determinants of inflation. There is also extensive research on this issue in Pakistan (see, for example, Rehman, 1994; Akhtar, 1990; Choudhri & Khan, 2002; Hyder & Shah, 2004; Khalid, 2005; Akbari, 2005; Kemal, 2006; Khan & Schimmelpfenning, 2006; Haque & Qayyum, 2006; Khan & Rashid, 2010). However, the dynamic and globally integrated nature of economic has altered previous relationships and led to the emergence of new phenomena affecting inflation. This means that we may require a revised inflation equation.

Gold prices have attracted considerable attention for their potential effect on inflation. Like other assets that are found to predict inflation behavior because their returns embed inflation expectations, gold prices can also serve as a leading indicator of inflation. This argument has been put forward by many researchers based on the failure of some financial assets to predict the behavior of inflation over a longer period of time (see, for instance, Stock & Watson, 1999; Cecchetti, Chu, & Steindel, 2000; Boivin & Ng, 2006; Banerjee & Marcellino, 2006).

There is very little literature on the inflation-predicting properties of gold and other financial assets in Pakistan. Gold prices have not been incorporated into inflation dynamics, nor has the relationship between inflation and asset prices been closely explored. This is because the idea is a relatively new one in the first case, while studies on the latter expect the two variables to be related in the opposite direction. However, with the heavy use of gold in Pakistan¹ and the integration of its financial markets with international markets, it is reasonable to assume that both variables may contain some information about inflation.

Along with the evolution of the determinants of inflation, another key issue concerns hedging against inflation. Various assets are considered to provide a “safe haven” against inflation, e.g., stock exchange securities, real estate, and foreign currency. Gold is also expected to be an inflation-hedging asset, given its long-run association with inflation. However, the literature on the hedging properties of gold and assets in Pakistan is limited. Only one OLS-based study (Nishat & Mustafa, 2008) has been carried out, which rejects the significance of gold and stocks in providing a hedge against inflation. Accordingly, the objectives of this study are:

¹ According to the World Gold Council, Pakistan is the tenth largest consumer of gold, which is used for industrial, ornamental, and investment purposes and also kept in physical bars for saving purposes.

- To examine the relationship between gold and stock prices and inflation in Pakistan
- To examine the inflation-hedging properties of gold and other assets such as real estate, stock exchange securities, and foreign currency.

Using time-series data for the period 1960–2010, we apply cointegration and vector error correction techniques to assess the long-run relationship between inflation and the assets mentioned above. The same techniques are applied to examine the inflation-hedging properties of these assets.

Section 2 provides a literature review, Section 3 describes the methodology used, Section 4 gives a detailed discussion of the results obtained, and Section 5 concludes the analysis and presents some policy recommendations.

2. Literature Review

This section reviews the theoretical and empirical literature.

2.1. Theoretical Viewpoint

The theoretical relationship between asset prices (gold and other stocks) and inflation can be examined through a variety of channels. Marx's theory of money was important in explaining this relationship before the adoption of a fiat money system. The theory postulates that upheavals in the intrinsic value of a money commodity (gold) can cause the general price level to rise. Subsequently, many theoretical arguments were put forward to explain the asset prices-to-inflation transmission mechanism while positing the demand side of the economy as a catalyst. However, numerous arguments have also negated this relationship over the years.

Tobin's q theory proposes that an increase in asset prices makes the installment of new capital more profitable, thus giving impetus to investment growth, which then translates into demand-pull inflation (Mishkin, 1990). The wealth effect of this asset price increase not only leads to an increase in private consumption but also in borrowing capacity and, hence, inflation (Kent & Lowe, 1997). On the other hand, the classical

dichotomy between these variables recognizes that asset prices are innately impulsive and highly vulnerable to changes in investor sentiments, quite independent of any change in the basic economic variables. Consequently, extracting correct and timely information from any observed movement in asset prices is extremely difficult (Bernanke & Gertler, 2000).

The literature on inflation hedging establishes that different assets have unique characteristics that provide safe havens against inflation. For instance, Fisher's (1930) hypothesis concerns the role of stock market securities in hedging against inflation through a one-to-one relationship between expected nominal stock returns and the interest rate.² Similarly, real estate as an investment and durable consumer good also has inflation-hedging properties. When treated as investment, its market worth represents the present value of corresponding rents on the property. Owners of real estate normally prefer to conserve real rent cash flows, and thus rental properties must provide a hedge as landlords raise the rent to deal with inflation (Hodges, Kneafsey, McFarren, & Whitney, 2011).

The hedging properties of foreign currency can be explained in terms of dollarization. This takes place when the residents of a country use a foreign currency—along with or as a replacement for the domestic currency—as a store of value, medium of exchange, and/or unit of account in the face of uncertainty in the domestic economy. This provides a hedge against inflation. Similarly, gold, which has always been a symbol of wealth, is preferred in times of economic uncertainty arising due to inflation; it thus provides protection against inflation.

2.2. Empirical Viewpoint

The literature on the relationship between gold prices and inflation is very limited because the phenomenon is relatively new. Mahdavi and Zhou (1997) study the role of gold prices and commodity prices in predicting inflation and find some evidence of cointegration between commodity prices and the consumer price index (CPI). However, the relationship between the CPI and gold prices is not found to be significant.

² This relationship is given in the form of the Fisher equation, which states that the real interest rate equals the nominal interest rate minus expected inflation. Assuming the real interest rate remains constant, the nominal interest rate (returns on stocks) must change points one-to-one with every change in expected inflation.

Ghosh, Levin, Macmillan, and Wright (2004) test the existence of a stable long-run relationship between the monthly price of gold and inflation in the US from 1945 to 2006 and from 1973 to 2006. Given that both the price of gold and the CPI have been subject to structural changes over time, instead of assuming these structural changes to be exogenous, they apply a unit root test that allows them to estimate the timing of significant breaks. The inclusion of endogenously determined structural breaks provides evidence of a cointegrated relationship between gold and inflation both for the postwar period and since the 1970s.

Ranson (2005) argues that gold is a better indicator of inflation than oil and a sound alternative for investors seeking an asset to hedge against inflation. Dempster and Artigas (2009) also find evidence that supports the existence of a relationship between gold prices and inflation from 1974 to 2008, and show that peaks in the gold price and inflation tend to occur simultaneously.

The empirical evidence confirms that, other than gold, the price of other financial assets also determines inflation. Feldstein (1983) examines the role of expected and unexpected future inflation in stock prices and observes a positive relationship between the former and a negative one between the latter. Kent and Lowe (1997) find that a rapid decline in asset prices, when the intermediary role of the financial sector is undermined, creates a negative output gap and causes deflation in the economy.

Although market reports on inflation hedging often regard gold to be a safe haven, very few academic studies have looked at this issue. Mahdavi and Zhou (1997) study the performance of gold prices and commodity prices in predicting inflation, and find that the role of gold as a hedge against inflation seems to have diminished over time. Ranson (2005) holds that gold, along with silver and platinum, are excellent inflation-immunizing assets. However, investors using gold to hedge against inflation should take into account two important caveats. First, due to one period lead correlation between gold prices and t-bond prices, the investment in gold must be done a year before the expected level of inflation is realized. Second, gold should not be kept in the portfolio during deflationary pressure as the price of gold is leveraged on either side.

Baur and Lucey (2006) acknowledge the role of gold in providing a hedge against losses experienced in the bond and stock markets. Dempster and Artigas (2009) establish that gold has a role to play both as a tactical inflation hedge and as a long-term strategic asset. If the world economy were to experience a revival in inflation, then gold, like other traditional inflation hedges, would likely outperform conventional financial assets. Moreover, it could enhance the investor's risk-controlled returns even in a low- to medium-inflation environment.

The empirical evidence maintains that a range of assets have inflation-protecting characteristics. Real estate is regarded as a strong inflation hedge on the conceptual basis that it actually performs better than other inflation-sensitive assets. Its prices can also change in response to several factors, especially exogenous supply or demand shocks, endogenous cycles within the real estate market, and assigned rents (Case & Wachter, 2011). When real estate markets are in balance, it tends to offer a hedge against expected inflation, but there is little relationship between returns and unexpected inflation (Wurtzbaach, Mueller, & Machi, 1991; Hartzell, 2001).

Adrangi, Chatrath, and Christie-David (2000) find a negative relationship between stock returns and inflation rates in industrialized economies. The Johansen and Juselius cointegration tests validate the presence of a long-run equilibrium between the general price level, stock prices, and real economic activity. In addition, stock prices and the general price level demonstrate a strong long-run equilibrium with real economic activity and each other. These findings lend support to Fama's proxy hypothesis³ for the long run.

Mahmood and Dinniah (2009) investigate the relationship between stock prices and three macroeconomic variables—inflation, exchange rates, and output—for six countries in the Asian-Pacific region. They find that these variables have a negligible effect on the performance of stock market returns, except for Thailand and Hong Kong. Most earlier studies point out that stock prices, real economic activity, and consumer price levels have strong long-run equilibrium relationships (Adrangi, Chatrath, & Sanvicente, 2000). Hondroyiannis and Papapetrou (2001) establish, however, that there is no long-run relationship among these economic variables. There is evidence though, that suggests a negative relationship

³ Fama's proxy hypothesis states a negative relationship between stock returns and inflation.

between stock returns and both expected and unexpected inflation particularly for the US (Lintner, 1975; Fama & Schwert, 1977; Fama, 1981; Geske & Roll, 1983; Ajayi & Mougoue, 1996; Yu, 1997).

The literature provides a valuable insight into the role of gold as both a commodity and an asset, and shows why it is important to explore its relationship with inflation and compare its hedging properties with those of other assets for Pakistan.

3. Methodology

This section presents a model to determine the relationship between gold prices and inflation, and then describes the methodology used to examine the inflation-hedging properties of different assets.

3.1. Gold Prices and Inflation

Numerous studies have examined the determinants of inflation in Pakistan. Khalid (2005), Khan and Schimmelpfennig (2006), Hossain (1990), and others consider inflation to be a monetary phenomenon determined by money supply, the exchange rate, and inflationary expectations. Other studies have identified the fiscal deficit and total bank borrowing by the government sector, imported inflation, openness, adaptive inflation, and expectations as the determinants of inflation (see Agha & Khan, 2006; Haque & Qayyum, 2006; Khan, Bukhari, & Ahmed, 2007). Bilquees (1988) points to structural factors as the cause of inflation in Pakistan, while Mahdavi and Zhou (1997) find that gold and asset prices are leading indicators of the inflation rate.

Tkacz (2007) has developed a model that posits the rate of return on gold and the exchange rate as the major determinants of inflation. The basic framework we use to examine the relationship between gold prices, stock prices, and inflation is adapted from this model, which is constructed as follows:

$$\pi_t = R_t - r_t \tag{1}$$

π is the inflation rate, which is calculated as follows:

$$\pi_t = [\text{Log}P_t - \text{Log}P_{t-1}]$$

where P_t is the CPI, R_t refers to the nominal annualized rate of return on gold, and r_t is the real annualized rate of return.

As the price of gold determined in world markets is usually expressed in US dollars, it is multiplied by the prevailing exchange rate to compute its rate of return in local currency units. Henceforth, we denote the domestic rate of return on gold by R_D while R_t is the US dollar rate of return on gold. G denotes the price of gold (per ounce) in US dollars and E is the domestic currency against the US dollar exchange rate. The international (US) and domestic annualized rates of return on gold are, respectively, given by:

$$R_t = [\text{Log}G_t - \text{Log}G_{t-1}] \quad (2)$$

$$R_t^D = [\text{Log}(G_t * E_t) - \text{Log}(G_{t-1} * E_{t-1})] \quad (3)$$

$$R^D = R_t + \dot{E}_t \quad (4)$$

where EY_t is the annualized percentage change in the exchange rate. The following equation shows whether the return on gold contains information on realized inflation:

$$\pi_t = \alpha + \beta R_{t-1} + \epsilon_t \quad (5)$$

$$\pi_t^D = \alpha + \beta R_{t-1}^D + \epsilon_t \quad (6)$$

$$\pi_t = \alpha_0 + \beta_1 R_t + \beta_2 ER_t + \mu_t \quad (7)$$

where R_t is the return on gold and ER_t is the rate of change in the exchange rate.

Next, we modify the above model to achieve the objectives of this study. Instead of taking the return on gold, which is calculated as the difference between gold prices in two successive periods, we incorporate gold prices as a direct determinant of inflation. For the purpose of comparison between gold and stocks to explain inflation, stock prices are also incorporated in the equation. The final form of the model is:

$$inf_t = \alpha_0 + \alpha_1 G_t + \alpha_2 GI_t + \alpha_3 ER_t + \epsilon_t \quad (8)$$

The variables are given in natural logarithmic form where G is the gold price, GI is the general index of stock prices, and ER is the exchange rate.

It is worth mentioning that oil prices are included in the equation as an exogenous variable. The large price hike witnessed in the 1970s was triggered by the increase in oil prices. Similarly, the decline in inflation in the 1980s and 1990s followed a decrease in oil prices. Therefore, there is enough historical proof of the relationship between oil prices and inflation to support the inclusion of oil prices in our model. Oil-importing countries such as Pakistan are highly sensitive to fluctuations in oil prices, given that oil is a major input for its industries. However, it has no influence over the supply of oil, given that the Middle East oil cartels are able to affect prices. Additionally, its demand for oil cannot influence oil prices (unlike China, where an increase in the consumption of oil is likely to lead to an oil price rise). Therefore, oil is taken as an exogenous variable.

3.2. Theoretical Justification of Variables

We incorporate stock prices measured by the general share price index as a potential determinant of inflation in Pakistan. Financial asset prices are also useful leading indicators of inflation as their rates of return incorporate inflation expectations. Moreover, through their effect on aggregate demand, they are expected to have a positive relationship with inflation. We also expect a positive relationship between the exchange rate and inflation based on the exchange rate pass-through, i.e., the percentage change in import prices in local currency as a result of a one-percentage point change in the exchange rate between the exporting and importing countries (Jaffri, 2010). Given this strong theoretical relationship, the exchange rate becomes a pertinent variable in the inflation equation.

Gold serves as a good store of value that is expected to affect the inflation rate positively. We include gold prices in our analysis because they contain information about the expected rate of inflation and are determined in complete information financial markets where agents are assumed to form rational expectations. This is not the case with other commodities (Mahdavi & Zhou, 1997). The price of gold is a leading indicator of inflation because gold is usually retained as a store of value owing to its durability and attractiveness (Ghosh et al., 2004).

3.3. Assets as an Inflation Hedge

Capie, Mills, and Wood (2004), Levin and Wright (2006), Khan et al. (2007), and Worthington and Pahlavani (2007) find that gold has inflation-hedging properties, mainly for the US economy. Nishat and Mustafa's (2008) study explores which assets serve as an inflation hedge in Pakistan; we adapt their methodology for this part of the research.

First, total inflation is decomposed into expected inflation and unexpected inflation. This step is essential for disaggregating different assets on the basis of their explanatory power for expected and unexpected inflation. Expected inflation is the return on risk-free assets while unexpected inflation is taken as the difference between total observed inflation and expected inflation. Mathematically, this is represented by

$$inf_t = \beta_0 + \beta_1 RD_t + \sigma_t \quad (9)$$

where inf_t is inflation and RD_t is the return on risk-free assets.

Next, we specify the inflation-hedging properties of different assets by regressing the return on specific assets on both expected and unexpected inflation. This is represented by

$$R_t = \gamma_0 + \gamma_1 I_E + \gamma_2 I_U + \epsilon_t \quad (10)$$

where R_t is the total return on assets, I_E is expected inflation, and I_U is unexpected inflation.

The total return on assets is calculated as follows:

$$R_t = \text{Rate of return} + \text{capital gain (or loss)}$$

where the capital gain or loss is measured by the rate of change of the price of a particular asset.

Whether an asset serves as protection against inflation depends on the sign and magnitude of γ_1 and γ_2 . The following situations can arise:

1. γ_1 and γ_2 are both equal to 1. In this case, the asset provides a complete hedge against both expected and unexpected inflation.

2. γ_1 and γ_2 are both greater than 1. In this case, the asset is an over-hedge against both expected and unexpected inflation.
3. γ_1 and γ_2 are both less than 1. In this case, the asset is a partial hedge against both expected and unexpected inflation.
4. γ_1 is 1 and γ_2 is less than 1. In this case, the asset is a partial hedge against unexpected inflation but a complete hedge against expected inflation.
5. γ_1 is less than 1 and γ_2 is 1. In this case, the asset is a partial hedge against expected inflation but a complete hedge against unexpected inflation.

We study the inflation-hedging properties of four assets. On the basis of equation (10), the following four equations are formulated for the final regression:

$$Tg_t = p_0 + p_1Ie_t + p_2Iu_t + \epsilon_t \quad (11)$$

$$Tr_t = \sigma_0 + \sigma_1Ie_t + \sigma_2Iu_t + \epsilon_t \quad (12)$$

$$Ts_t = \tau_0 + \tau_1Ie_t + \tau_2Iu_t + \epsilon_t \quad (13)$$

$$Fc_t = \gamma_0 + \gamma_1Ie_t + \gamma_2Iu_t + \epsilon_t \quad (14)$$

where Tg is the total return on gold, Tr is the total return on real estate, Ts is the total return on stock exchange securities, and Fc is foreign currency.

Oil prices and the exchange rate are taken as exogenous variables in all four models. Both variables can dampen (increase) the inflation-hedging properties of different assets. For instance, high oil prices may hamper the functioning of the stock market and the country's economic activity as a whole.

The same theory applies to gold prices. Oil prices can interact with gold prices in the following ways. A high oil price can drag down share prices and change the inflation-hedging abilities of stock returns. In response to the capital loss on stocks, investors will look for alternative assets, such as gold. Thus, the oil price can indirectly affect the price of gold and reduce its ability to protect against inflation. The exchange rate can

also affect prices and returns on different assets by changing the relative strength of a particular currency. However, since there is no evidence that these variables are affected by the inflation rate in Pakistan,⁴ we take oil prices and the exchange rate as exogenous variables.

3.4. Theoretical Justification of Variables

If gold is a perfect internal hedge, its nominal price and domestic inflation will rise at the same time. For it to be an external hedge, the magnitude and time of price change has to be perfectly aligned with the change in the exchange rate but in the opposite direction. This implies that one can protect against exchange rate fluctuations by investing in gold. Many empirical studies suggest that direct and indirect gold investment serves as an effective inflationary hedge.

Real estate was considered a separate asset class by institutional investors in the 1990s. Gordon's (1962) growth model suggests that real estate can also protect investors against inflation as both its value and income generated adjust to inflation. We expect a short-run positive and long-run negative relationship between inflation and real estate.

Theoretically, stock returns appear to act as a good hedge against inflation both in the long and short run. The relationship between stock returns and inflation suggests that investment in equity markets can act as a good hedge against inflation if firms' revenues and earnings grow over time. There is ample evidence in favor of a positive relation between inflation and stock returns, supporting a generalized Fisher hypothesis. Moreover, the black economy raises stock market returns, which is significant in the long and short run. This can be explained as the effort of black money holders to 'clean' their assets by channeling them through the stock market.

The importance of foreign currency holdings as a hedge against inflation emerged after the final breakdown of the Bretton Woods system in 1971 when the exchange rates of the major currencies varied persistently against each other. Investors diversified their portfolios by holding

⁴ Inflation in Pakistan does not translate into higher world oil prices (Section 3.1). The same argument applies to the effect of inflation on the exchange rate, as the value of the dollar is determined in international markets.

different currencies to seek profit and to protect themselves against the risk arising from currency fluctuations. These currencies are known as “safe havens” and their inflation-hedging properties are worth examining.

4. Estimation and Discussion of Results

This section examines the relationship between gold prices and inflation and the inflation-hedging properties of different assets.

4.1. Data Sources

We have used annual data for 1960 to 2010 retrieved from the *Handbook of Statistics on Pakistan Economy* (2010) published by the State Bank of Pakistan. The CPI uses 2000/01 as the base year, the exchange rate is given in Pakistani rupees per US dollar (annual average), the weighted average rate of return on precious metals is used as a proxy for the rate of return on gold, and stock exchange securities and real estate are given in percent per annum. Gold prices are given in rupees per 10 grams and the general index of stock prices is used to represent stock prices.

4.2. Descriptive Statistics

Gold prices are taken in growth rate form while the exchange rate, inflation rate, and returns on different assets are taken as absolute values. For each decade, we calculate the average of each variable to determine its average behavior. The standard deviation for each decade is also calculated to capture the extent of fluctuation in each variable. Table 1 presents the behavior of all the variables used.

Table 1: Descriptive analysis of variables

Variable	1960–69	1970–79	1980–89	1990–99	2000–09
Gold prices					
Average	15.18	11.23	38.98	7.97	15.54
Standard deviation	17.18	34.27	62.30	7.17	24.60
Inflation					
Average	1.58	5.55	10.56	5.88	12.17
Standard deviation	0.97	2.18	0.23	0.22	12.14
Exchange rate					
Average	4.76	7.33	15.50	34.02	61.09
Standard deviation	0.00	3.63	7.91	17.30	5.22
Return on gold					
Average	7.88	8.67	8.51	10.74	12.51
Standard deviation	1.59	0.13	0.84	0.85	34.16
Return on securities					
Average	6.62	10.44	10.50	10.75	12.51
Standard deviation	1.97	3.06	1.97	0.85	34.16
Return on real estate					
Average	6.25	9.395	10.67	12.00	13.20
Standard deviation	0.66	1.97	0.09	2.53	32.49

Source: State Bank of Pakistan (2010).

Gold prices have shown an increasing trend over the last five decades. The average value increased continuously and peaked in the 1980s, which can be explained by the Iran crisis and the invasion of Afghanistan by the Soviet Union. In 1982, China allowed its citizens to own gold, which led to record gold prices after the previous 28 years. The volatility experienced during this period was 38.98—the highest point in this time. This also led to higher returns (the standard deviation is 62.30), implying higher risk. Since 2001, the price of gold has risen steadily. This surge has an obvious association with the expansion of US national debt and the weakening of the US dollar relative to other currencies. In 2005, gold reached PRs 8,216 for the first time and by 2008, the rate was more than PRs 15,000 per 10 grams. The financial crisis also fueled the demand for gold and exchange-traded funds.

Recently, gold prices have set a new record of PRs 29,587 per 10 grams, the reasons for which are rooted in the US uncertainty about a

sustainable economic recovery, increasing inflation, possible corporate insolvency and default of corporate bonds, growing national debt, low interest rates, and the expansion of the money supply. The decrease in gold production by 10 percent since 2001 and high demand for jewelry as well as higher demand for gold and by institutional investors are other factors that have pushed up the value of gold (“History of gold,” 2011). The average growth in price was 15.54 percent with a much higher volatility (24.60) compared to the previous decade (7.17). This also shows that the return on gold was much higher during this decade (Bhose, 2012).

Inflation has followed a mixed trend for the last five decades, rising during 1960–90, but remaining low in the 1990s. The reasons for this include the slow pace of economic growth, output delays, expansionary monetary policies, heavy duties and taxes, a depreciating rupee, and frequent adjustments in the administered prices of gas, electricity, petroleum oil and lubricants, and gas products. An improved supply position, strict budgetary measures, and depressed international market prices led to a meltdown in the inflation rate in the late 1990s (Rehman, 2010).

Inflation showed much greater volatility during the 2000s than in the previous decades. The inflation rate fell to 3.1 percent in 2002/03 (from 5.7 percent in 1998/99)—the lowest in the last three decades. This low level of inflation was an outcome of strict fiscal discipline, output recovery, a reduction in duties and taxes, the low monetization of the budget deficit, and the appreciation of the exchange rate. 2003/04 witnessed a boost in the inflation rate to 9.3 percent due to an increase in the support price of wheat, wheat shortages, and a rise in international prices, specifically oil prices. The inflation rate then dropped to 7.9 percent at the end of 2005/06.

Subsequently, despite a tight monetary policy and the resolution of supply blockages, nonfood-nonenergy inflation (core inflation) remained high at 7.5 percent in 2007/08 on account of rising house rents and other factors. Various domestic and international factors contributed to the astonishing surge in domestic price levels in Pakistan to an average of 12.17 percent—the highest point in this period.

Even with an overall slowdown in world economic growth, crude oil prices have continued to grow. Oil prices increased from USD 55 per barrel in January 2007 to over USD 130 per barrel in May 2008—a surge of

more than 145 percent. The dollar depreciated against major currencies throughout the year along with rising oil prices. This correlation between oil prices and the dollar caused Pakistan to face huge import bills, driving up inflation (Haque & Qayyum, 2006).

4.3. Estimation

In this section, we estimate a model revealing the relationship between gold prices and inflation, and then examine empirically the inflation-hedging properties of different assets.

4.3.1. Gold Prices and Inflation

The long-run relationship between gold prices and inflation for the period 1960–2010 is determined based on Johansen (1998) and Johansen and Juselius (1990). These studies use cointegration to determine the long-run relationship between two or more variables that are individually nonstationary but have a stationary linear combination. Two prerequisites must be met in order to obtain reliable results: (i) cointegration requires all the variables to be integrated of the same order, and (ii) the appropriate lag length must be determined.

Time-series data is usually nonstationary and thus subject to spurious regression. To carry out a cointegration analysis, the first step is to check the stationary properties of the data. We conduct an augmented Dickey-Fuller unit root test to check the order of integration for each variable (see Table 2). The results show that all the series are integrated of order one, $I(1)$, and we can proceed with our cointegration analysis.

Table 2: Results of ADF test

Variable	Level t-statistic	1st difference t-statistic	Order of integration
inf_t	2.41	-3.63*	I(1)
G_t	3.07	-3.57*	I(1)
GI_t	0.69	-3.17*	I(1)
ER_t	2.94	-6.13*	I(1)

Note: * = significant at 1%.

The second step is to determine the optimal lag length based either on the Akaike information criterion or the Schwarz information criterion (SIC). Table 3 gives the results for the SIC. The appropriate lag length selected for this model is 1.

Table 3: Lag length selection

Lag	SIC
0	3.62
1	-4.45*
2	-4.27
3	-3.80

Note: * = minimum value of SIC.

Johansen’s cointegration technique proposes two tests—the trace test (λ_{trace}) and maximum eigenvalue test (λ_{max})—which are used to determine the existence and number of cointegrating vectors. In the case of the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r where $r = 0, 1, 2, 3, \dots$, etc. In each case, the null hypothesis is tested against the general hypothesis (full rank $r = n$). In the case of the maximum eigenvalue test, the null hypothesis of the existence of r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors (Mukhtar & Ilyas, 2009). The multivariate cointegration test is expressed as:

$$Z_t = K_1 Z_{t-1} + K_2 Z_{t-2} + \dots + K_{k-1} Z_{t-k} + u + v_t$$

where $Z_t(\text{inf}_t, G_t, GI_t, ER_t)$ is a 4×1 vector of variables that are integrated of order one, i.e., $I(1)$, μ is a vector of the constant term, and v_t is a vector of normally and independently distributed error terms (see Mukhtar, 2010). The results in Table 4 indicate the existence of one cointegrated vector among the selected time series.

Table 4: Cointegration test (Johansen's maximum likelihood method) for equation (8)

$$\text{Equation (8): } \inf_t = \alpha_0 + \alpha_1 G_t + \alpha_2 GI_t + \alpha_3 ER_t + \varepsilon_t$$

Null hypothesis	Alternative hypothesis	Eigenvalues	λ trace rank value	Critical values (0.05 %)	P-values*
λ trace rank tests			λ trace rank value		
H0: $r = 0$	H1: $r = 0$	0.527	63.88	54.07*	0.005
H0: $r = 1$	H1: $r = 1$	0.416	34.66	35.19	0.060
H0: $r = 2$	H1: $r = 2$	0.193	13.66	20.26	0.310
H0: $r = 3$	H0: $r = 3$	0.126	5.26	9.14	0.250
λ max. rank tests			λ max. eigenvalue		
H0: $r = 0$	H1: $r > 0$	0.527	29.22	28.58*	0.040
H0: $r \leq 1$	H1: $r > 1$	0.416	21.00	22.29	0.070
H0: $r \leq 2$	H1: $r > 2$	0.193	8.39	15.89	0.500
H0: $r \leq 3$	H1: $r > 3$	0.126	5.26	9.16	0.250

Note: * = MacKinnon-Haug-Michelis p-values. Trace test indicates one cointegrated equation at 0.05 level. Max. eigenvalue test indicates one cointegrated equation at 0.05 level.

A vector error correction model (VECM) is a general framework used to depict the dynamic relationship among variables that are stationary in their differences, i.e., $I(1)$. We use the VECM because the time series are not stationary at level but are stationary in differences, and the variables are cointegrated, which means that they are likely to be engaged in a long-run relationship.

Adding error correction features to a multifactor model can tell us how much the error in the variables is corrected each year. The equation generated by the VECM takes the following form:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \dots + \Gamma_{k-1} \Delta Z_{t-k-1} + \Pi Z_{t-1} + u + v_t$$

where $\Gamma_i = (I - A_1 - A_2 \dots - A_i)$, $i=1,2,3 \dots k-1$, and $\Pi = -(I - A_1 - A_2 - A_3 \dots A_k)$. The coefficient matrix Π provides information on the long-run relationships among the variables in the data. Π can be factored into $\alpha\beta$ where α gives the speed of adjustment to the equilibrium coefficients while β is the long-run matrix of coefficients. The presence of r cointegrating vectors between

the elements of Z implies that Π is of the rank r ($0 < r < 3$) (Mukhtar, 2010). The results of the VECM are presented in Table 5.

Table 5: Results of VECM for equation (8)

Variable	Coefficient	t-statistic
C	0.91*	4.56
G_t	0.33*	6.70
GI_t	0.02	0.31
ER_t	0.73*	9.80
ECT	-0.20*	-4.51

Note: * = significant at 1%.

The results reveal a positive and significant relationship between gold prices and inflation, where a one-percent increase in gold prices causes a 0.33 percent increase in inflation. These results are consistent with those of Levin and Wright (2006) and Ghosh et al. (2004), both of who find a long-term relationship between gold prices and inflation in the US. Our results also show a positive but insignificant relationship between share prices and inflation, implying that asset price inflation is thus far not a crucial issue in Pakistan. Moreover, the results verify the insignificant intermediary role of the capital market in Pakistan.

Our results also indicate that a one-percent increase in the exchange rate causes a 0.73 percent increase in inflation, and the variable is significant at 1 percent. These results correspond to numerous empirical studies that have found a long-run relationship between inflation and the exchange rate (see, for example, Choudhri & Khan, 2002; Honohan & Lane, 2003; Capie et al., 2004; Khalid, 2005; Khan & Schimmelpfenning, 2006; Dlamini et al., 2011; Laryea & Sumaila, 2011).

The reason for this positive relationship depends on a number of factors. For instance, a decrease in the exchange rate makes imported goods and services more expensive in the resident country. Producers then shift the higher cost of imported items and raw materials onto consumers in the form of high prices, thus causing cost-push inflation. The extent to which a depreciation of the domestic currency causes inflation depends on

producers' degree of dependency on their imported components and on their willingness to forward higher costs to consumers.

The time path of cointegrated variables is affected by any deviation in the long-run equilibrium. The error correction term represents the percentage of correlation with any deviation in the long-run equilibrium and the deviation's speed of correction in the long run. The error correction term for overall inflation is negative and significant with a 0.2 percent speed of convergence towards equilibrium.

4.3.2. Inflation Hedging

Johansen (1998) and Johansen and Juselius's (1990) cointegration technique will now be used to assess the inflation-hedging properties of different assets, with particular focus on gold. As mentioned earlier, there are two prerequisites for applying this technique: (i) checking the stationary properties of the data and (ii) selecting an appropriate lag length. The ADF unit root test is performed to check the order of integration of each variable. Table 6 shows that all the variables are integrated of order one.

Table 6: Results of ADF test

Variable	Level	1st difference	Order of integration
	t- statistic	t- statistic	
Tg_t	0.55	-4.12*	I(1)
Tr_t	0.73	-8.70*	I(1)
Ts_t	0.48	-11.29*	I(1)
Fc_t	0.88	-5.78*	I(1)
Ie_t	-0.76	-4.62*	I(1)
Iu_t	-1.37	-2.06**	I(1)

Note: * = significant at 1%.

The second step is to determine the optimal lag length. We use the SIC, the results for which are given in Table 7. The appropriate lag length selected for equations (11), (12), (13), and (14) is 1.

Table 7: VAR lag order selection criteria

Lags	Equation (11)	Equation (12)	Equation (13)	Equation (14)
	SIC	SIC	SIC	SIC
0	14.28	13.29	13.91	27.79
1	14.05*	12.90*	13.79*	27.61*
2	14.54	13.00	13.93	27.65

Note: * = minimum value of SIC.

The trace test (λ_{trace}) and maximum eigenvalue test (λ_{max}) are used to determine the existence and number of cointegrating vectors. The results for all four equations are reported in Tables 8 to 11. The tables indicate the existence of one cointegrating vector for all the equations except equation (13), for which there are two cointegrating vectors.

Table 8: Cointegration test (Johansen’s maximum likelihood method) for equation (11)

$$\text{Equation (11): } Tg_t = p_0 + p_1 Ie_t + p_2 Iu_t + \varepsilon_t$$

Null hypothesis	Alternative hypothesis			Critical values	P-values*
λ trace rank tests			λ trace rank value	0.05%	
H0: $r = 0$	H1: $r = 0$	Eigenvalues 0.48	52.13	42.91*	0.004
H0: $r = 1$	H1: $r = 1$	0.29	25.70	25.87	0.060
H0: $r = 2$	H1: $r = 2$	0.25	11.75	12.51	0.060
λ max. rank tests			λ max. eigenvalue		
H0: $r = 0$	H1: $r > 0$	0.48	26.42	25.82*	0.040
H0: $r \leq 1$	H1: $r > 1$	0.29	13.95	19.38	0.250
H0: $r \leq 2$	H1: $r > 2$	0.25	11.75	12.51	0.060

Note: * = MacKinnon-Haug-Michelis p-values. Trace test indicates one cointegrating equation at the 0.05 level. Max. eigenvalue test indicates one cointegrating equation at the 0.05 level.

Table 9: Cointegration test (Johansen's maximum likelihood method) for equation (12)

$$\text{Equation (12): } Tr_t = \sigma_0 + \sigma_1 Ie_t + \sigma_2 Iu_t + \varepsilon_t$$

Null hypothesis	Alternative hypothesis	Eigenvalues	λ trace rank value	Critical values	P-values*
λ trace rank tests				0.05%	
H0: $r = 0$	H1: $r = 0$	0.49	40.07	24.27*	0.0002
H0: $r = 1$	H1: $r = 1$	0.29	13.50	12.32*	0.031
H0: $r = 2$	H1: $r = 2$	0.0005	0.02	4.12	0.906
λ max. rank tests			λ max. eigenvalue		
H0: $r = 0$	H1: $r > 0$	0.49	26.57	17.79*	0.0019
H0: $r \leq 1$	H1: $r > 1$	0.29	13.48	11.22*	0.019
H0: $r \leq 2$	H1: $r > 2$	0.0005	0.02	4.12	0.90

* Note: * = MacKinnon-Haug-Michelis p-values. Trace test indicates one cointegrating equation at the 0.05 level. Max. eigenvalue test indicates one cointegrating equation at the 0.05 level.

Table 10: Cointegration test (Johansen's maximum likelihood method) for equation (13)

Null hypothesis	Alternative hypothesis	Eigenvalues	λ trace rank value	Critical values	P-values*
λ trace rank tests				0.05%	
H0: $r = 0$	H1: $r = 0$	0.49	45.57	42.91*	0.02
H0: $r = 1$	H1: $r = 1$	0.26	19.15	25.87	0.27
H0: $r = 2$	H1: $r = 2$	0.16	7.14	12.51	0.32
λ max. rank tests			λ max. eigenvalue		
H0: $r = 0$	H1: $r > 0$	0.49	26.41	25.82*	0.01
H0: $r \leq 1$	H1: $r > 1$	0.26	12.01	19.38	0.41
H0: $r \leq 2$	H1: $r > 2$	0.16	7.14	12.51	0.32

Note: * = MacKinnon-Haug-Michelis p-values. Trace test indicates one cointegrating equation at the 0.05 level. Max. eigenvalue test indicates one cointegrating equation at the 0.05 level.

Table 11: Cointegration test (Johansen’s maximum likelihood method) for equation (14)

$$\text{Equation (14): } Fc_t = \gamma_0 + \gamma_1 Ie_t + \gamma_2 Iu_t + \varepsilon_t$$

Null hypothesis	Alternative hypothesis	Eigenvalues		λ trace rank value	Critical values	P-values*
λ trace rank tests						
H0: $r = 0$	H1: $r = 0$	0.52		30.82	29.79*	0.03
H0: $r = 1$	H1: $r = 1$	0.34		11.44	15.49	0.18
H0: $r = 2$	H1: $r = 2$	0.02		0.64	3.84	0.42
λ max. rank tests						
H0: $r = 0$	H1: $r > 0$	0.52		19.37	21.13*	0.08
H0: $r \leq 1$	H1: $r > 1$	0.34		10.80	14.26	0.16
H0: $r \leq 2$	H1: $r > 2$	0.02		0.64	3.84	0.42

Note: * = MacKinnon-Haug-Michelis p-values. Trace test indicates one cointegrating equation at the 0.05 level. Max. eigenvalue test indicates one cointegrating equation at the 0.05 level.

An asset serves as a complete hedge against expected or unexpected inflation if the Fisher coefficient (i.e., γ_1 and γ_2) in a regression of asset returns on expected and unexpected inflation is not statistically different from unity. The asset is an inflexible hedge for $\gamma < 0$; for $0 < \gamma < 1$, it is an incomplete hedge and a more-than-perfect hedge in case $\gamma > 1$.

The results for the VECM are given in Table 12.

Table 12: Results of VECM

Variable	Eq. (11)		Eq. (12) 1st cointeg. eq.		Eq. (12) 2nd cointeg. eq.		Eq. (13)		Eq. (14)	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff.	t-stat
I_E	-0.220	-0.29	1.26*	3.13	3.98		-4.28	-1.39	144.12	0.39
I_U	1.06*	5.24	-0.45*	-3.52	1.23*	2.91	4.09*	5.55	106.84	0.54
ECT	-0.221*	-3.23	-0.24*	-4.07	-0.24*	-4.07	-0.03***	-1.94	-1.17*	-4.3

Note: * = significant at 1%, ** = significant at 5%, *** = significant at 10%.

In investigating the hedging properties of different assets, we have focused on the return on gold. The results reveal a negative and

insignificant relationship between the return on gold and expected inflation, and a significant and positive relationship with unexpected inflation. The Fisher coefficient for unexpected inflation is almost 1 ($\gamma_2 = 1.06$), implying that gold provides a complete hedge against unexpected inflation.

The Mercantile Exchange gives the following reasons for the tendency to invest in gold in Pakistan. Gold is highly liquid, and the historical evidence confirms that investing in gold is, universally, an ideal means of hedging uncertainty.⁵ It allows portfolio diversification and risk mitigation, and is not affected by political or social stability because it never loses its intrinsic value. The estimate for the error correction term is -0.22 and significant at 1 percent, indicating a quick reversion toward the long-run relationship following a deviation.

The results for real estate are entirely different from those for gold: the first cointegrating equation shows that it provides a more-than-complete hedge against expected inflation with a significant Fisher coefficient equal to 1.26. The second cointegration equation reveals that real estate provides a more-than-complete hedge against both expected and unexpected inflation.

The estimate for the error correction term is -0.24 , which shows a reversion toward the long-run relationship following a deviation. The rapid increase in real estate assets may be due to the global real estate bubble. These take longer to deflate and prices fall more slowly because the real estate market is less liquid. Investors then perceive that real estate assets will yield higher returns in the future. Moreover, in Pakistan, the income earned from a real estate investment trust is exempted from income tax and at least 90 percent of its income is distributed among the unit holders of the trust. This implies that people find it safe to invest in real estate assets, which is why their performance as an inflation hedge is noteworthy.

In the case of stock exchange securities, the results indicate a negative and insignificant relationship with expected inflation. The Fisher coefficient (4.09) shows that the return on stock exchange securities is not a hedge against expected inflation. Fama and Schwert (1977) suggest that

⁵ The Pakistan Mercantile Exchange is involved in the exchange of goods, specifically gold, silver, cotton, wheat, etc.

there is no proper explanation for this negative relationship but they do cite the possibility of unidentified phenomena or market inefficiency in delivering the available information on future stock prices. Our results support the proxy hypothesis, which posits that the negative relationship between stock returns and inflation reflects the harmful effects of inflation on real economic activity. However, securities provide a significantly more-than-complete hedge against unexpected inflation in Pakistan. The estimate for the error correction term is -0.03 , thus implying a slow reversion to long-run equilibrium.

The performance of foreign currency as an inflation hedge in Pakistan is surprising. The magnitude of the Fisher coefficient for both expected and unexpected inflation are implausibly large: $\gamma_1 = 144.12$ and $\gamma_2 = 106.84$, establishing that foreign exchange is a complete and outstanding inflation hedge although the results are insignificant. The hedging property of foreign currency is supported by the extent of dollarization, which is indicated by foreign currency deposits (FCDs) in the domestic country. Pakistan has faced a decline in FCDs for a number of reasons, including low exports, high imports, foreign debt, and low FDI. This large but insignificant role of foreign currency as an inflation hedge can be explained by the fact that currency swapping in Pakistan also occurs in informal markets, not just through banks or the central bank. Such currency swaps are usually not reported, thus undermining the importance of foreign currency as an inflation hedge. The insignificance can also be explained by the fact that holding foreign currency as an inflation hedge is a relatively new concept.

The results with reference to our focus variable, gold, are important. Some important and surprising findings emerge for stock exchange securities and foreign currency, which show that securities are potentially a crucial indicator of the capital market as they provide an over-hedge against unexpected inflation. The foreign exchange market in Pakistan, however, needs to be organized such that currency swaps and the inflation-hedging property of foreign currency are visible officially.

5. Conclusion and Recommendations

If not stabilized at a moderate level, inflation can have severe consequences for the economy. While an abundant body of literature

exists on the determinants of inflation, this study contributes to the literature by investigating the role of gold prices and share prices in determining inflation. It also examines the inflation-hedging properties of gold and other assets.

We use time series data for 1960–2010 and apply cointegration and VECMs to assess the determinants of inflation and the inflation-hedging properties of different assets. The results reveal that gold prices are positively and significantly related to inflation in Pakistan. Share prices have a positive but insignificant relationship with inflation.

As gold prices are positively related to inflation, the study widens its analysis to examine the hedging properties of assets in the capital market against expected and unexpected inflation. The total returns on gold, stock exchange securities, real estate, and foreign currency are taken as dependent variables. The results suggest that all these assets, except foreign currency, provide a hedge against inflation (either expected and/or unexpected). Gold provides a complete hedge against unexpected inflation but not against expected inflation. Real estate provides a significantly more-than-complete hedge against expected inflation, but not against unexpected inflation where the relationship is negative and insignificant.

Stock exchange securities appear to potentially outperform other assets in providing a hedge against unexpected inflation. The results indicate a negative but insignificant relationship with expected inflation. The results for foreign currency imply a positive but insignificant relationship with both expected and unexpected inflation. The insignificant role of foreign currency as an inflation hedge can be explained by the fact that currency swapping in Pakistan also occurs through informal markets and not just through banks. Such currency swaps are not reported but their contribution is enormous.

Based on these findings, we present some recommendations:

- The study establishes that gold is a complete hedge against unexpected inflation in Pakistan. Therefore, speculative behavior regarding gold prices should be observed carefully since it could undermine the hedging properties of gold and lead to inflation. Gold prices are determined in organized markets internationally. Given

that Pakistan is one of the largest consumers of gold, its gold market should be organized to eliminate the consequences of speculation.

- Given the insignificant relationship between share prices and inflation, investors should potentially be advised to invest in stocks rather than gold. The insignificant relationship implies that their expectations regarding share prices will not translate into inflation. In this way, stock investment can potentially increase without having any inflationary effect on the economy.
- The coefficient of foreign currency for both expected and unexpected inflation is insignificant but its magnitude is large, indicating that foreign exchange can potentially be a complete hedge. The coefficient is insignificant because most currency swaps take place in the informal market. Foreign remittances increased dramatically from USD 1 billion to USD 4.3 billion in 2002/03 as a result of tighter controls over illegal transfers and scrutiny of foreign accounts. Similar controls could also be imposed on illegal currency swapping to enable foreign currency to play its role significantly as a hedge against inflation.

The issue under study could be explored further by subsampling the data or using high-frequency datasets. This may yield many interesting results about the dynamics of inflation and the hedging properties of different assets. The exercise could also be replicated for different exchange rate regimes in Pakistan.

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