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Forecasting the price of gold: An error correction approach

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Abstract Gold prices in the Indian market may be influenced by a multitude of factors such as the value of gold in investment decisions, as an inflation hedge, and in consumption motives. We develop a model to explain and forecast gold prices in India, using a vector error correction model. We identify investment decision and inflation hedge as prime movers of the data. We also present out-of-sample forecasts of our model and the related properties.

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Introduction

India is one of the major gold consuming countries in the world and high demand from India is acknowledged to be a major factor in determining international gold prices. High import demand is also cited as the primary reason for the country's persistent current account deficit. To the best of our knowledge, there is little previous research about what determines gold prices in India. Understanding the determinants of gold price will help in developing a predictive model for forecasting future prices. This can be useful for the purpose of portfolio decision-making of investors and also as a critical input for policy making.

We submit that this paper is the first of its kind to develop a model for explaining and forecasting gold prices in India.

We estimate the nature of the relationship of gold price in India with key determinants such as the stock market index, oil prices, exchange rate, interest rate, and consumer price index (CPI). We find that gold is useful as a portfolio hedge as well as a hedge against inflation. Our model is able to predict future gold prices with reasonable levels of accuracy.

Research background

Among all precious metals, gold might be the most popular choice for investment. It has stood the test of time, and performed well during crisis situations such as market decline, currency failure, high inflation, war, and so on. It is regarded as a good hedge both against inflation as well as fall in value of other assets. The usefulness of gold as an inflation hedge would imply that when general prices are high, gold prices will also be high so that the asset can be sold in order to finance general spending activity. However the role of gold as a hedge against other assets (such as stocks, bonds, foreign currency) would mean that when the prices of other

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assets fall, the price of gold rises such that the resulting portfolio is diversified.

Many studies have looked into the pattern of gold prices (see e.g. [Capie, Mills, & Wood, 2005](#); [Worthington & Pahlavani, 2007](#); [Baur & Lucey, 2010](#)) to identify the factors that influence gold prices. Some of the factors that influence gold prices include inflation, exchange rate, bond prices, market performance, seasonality, income, oil prices, and business cycles. However, to the best of our knowledge, there is no work that has been done to examine gold prices in India.

We carry out an analysis to study the factors influencing gold prices in India by collecting monthly data on gold prices and other factors over a long time period. While the hedge factors are expected to work in India as in other countries, there is an additional role of gold that may not be relevant elsewhere and has been hitherto ignored in literature. Indians buy gold not just for investment but also for personal reasons, to be used as a luxury good (to wear as jewellery, to gift in weddings, for religious reasons and so on). If this reason to buy gold is significant, then higher affordability should lead to increased demand and therefore higher price for gold. We capture the wealth effect through the stock market index.

The time series variables that we study are, largely, non-stationary variables. Therefore, we need to analyse them in a cointegrating framework. We use a vector error correction approach to model and forecast the price of gold. Our benchmark estimates are for the period April 1990–August 2013.

We find that gold price has a cointegrating relationship with the stock market index, exchange rate, CPI, US bond rates, and oil price. The stock market index has a negative relationship with gold price, contradicting the argument for gold being a luxury good but supporting the role of gold as a portfolio hedge. This is consistent with [Baur and McDermott \(2010\)](#). The exchange rate has a negative relationship with gold price implying that a stronger rupee is associated with costlier gold. Our finding demonstrates that gold is a good hedge against the dollar from the point of view of domestic investors, which is also the case for developed countries ([Reboredo, 2013a](#)).

Oil price has a negative relationship with gold price implying that gold is a good hedge against oil as an investment, in contrast to existing evidence from developed countries (see for example, [Reboredo, 2013b](#)). The CPI has a positive relationship with gold indicating that gold is a good inflation hedge, a result that has been previously obtained for developed countries ([Ghosh, Levin, Macmillan, & Wright, 2004](#); [Worthington & Pahlavani, 2007](#)). Finally, US bond rates are negatively related to gold price, indicating that when returns from international investments fall, investors may switch to gold.

We tested for robustness of the results of our exercise. We have taken some commonly used transformations of the variables, for example, the logarithmic one. We have added difference polynomials of independent variables. Our findings are quite robust to these alternative specifications. The relationship established by us provides interesting insights into the role of gold in portfolio diversification and as a hedge against inflation in the Indian context. The predictive capacity of our error correction model beats alternative specifications such as the random walk, using different sub-periods, and forecasting horizons.

Data and methodology

Data source

The gold price data are obtained from the Reserve Bank of India's website. It is taken in real terms by deflating it, using the CPI. The CPI data we use are for urban non-manual employees and later for industrial workers maintained by the Labour Bureau, Government of India.¹ We have taken the equity market index Sensex as a proxy for the stock market. Whenever Sensex suffers a decline, the loss stricken investors may move towards gold, which increases the demand for gold, which in turn increases the price of gold. On the other hand, if Sensex represents the wealth of the people, then a higher value of the Sensex may indicate that the purchasing power of people increases, so they may be able to afford more gold, whose price increases. Sensex data are obtained from the website of the Bombay Stock Exchange.²

When the exchange rate increases, it makes gold imports more expensive, leading to an increase in the domestic price of gold. The US Dollar–Indian Rupee (USD–INR) exchange rate is collected from [Indexmundi website](#)³ and [Bloomberg](#). However if gold were a good hedge against the exchange rate then we would expect gold prices to be negatively related with the exchange rate. This would mean that a fall in the dollar value would induce investors to move towards gold thereby leading to higher gold prices.

When oil prices increase, then the cost of production increases which reduces the profits of investors who then switch to gold for safety. Therefore, oil prices are expected to have a positive effect on gold prices. But people do not buy oil simply as a factor of production; many trade it as a commodity for capital gains. So an increase in oil prices would be beneficial for such investors and they would not invest in gold. Again, this means a negative relationship between gold prices and oil prices. (Oil prices are obtained from the [Indexmundi website](#)).

The Indian bond market is still in its nascent stage. A select group of authorised domestic financial institutions are the only players in the secondary market and liquidity is limited across maturities. Therefore, the effect of the bond rates was not analysed; another reason is the lack of data on the bond market, which was available only from 2004 after the setting up of the Clearing Corporation of India Ltd (CCIL). However we used interest rates on US bonds to control for international investment prospects and the data are obtained from the US treasury website. We use monthly data on the above variables between April 1990 and August 2013.

Data transformations

We consider real price of gold (GLP) which is free from the influence of general price movements. We have normalised gold price by dividing the nominal value by the consumer price index. For example, if the gold price in a particular month is INR 4508.91 and CPI is 2093, then GLP is calculated as INR

¹ <http://labourbureau.nic.in/indexes.htm>

² <http://www.bseindia.com>

³ <http://www.indexmundi.com>

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