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GOLD PRICES & REGIME SHIFTS WITH MARKOV MODEL: A STUDY IN THE INDIAN CONTEXT

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ABSTRACT

We use the daily gold prices from 1979 till April 2018. We use the Markov switching model to understand the shifts in the states. We observe that there are two regime states. We predict the probabilities of being in different states and the probability of moving from one state to another. We use the dynamic regression model of Markov process as our data is of high frequency. We have found two regimes in the gold prices and the probability of remaining in the same state is very high and that when there is a regime shift the probability of going back to the old regime is very less. Our results indicate that if there is shift in the regime the probability of prices going back to the first regime prices is very low. This study provides a good insight of gold prices and shifts in the regimes with probabilities and duration which would be of immense use for investors. In the review of literature, we have not come across studies in relation to regime shift of gold prices, therefore the study would be a contribution to the existing literature.

Keywords: Gold Price, Stochastic Model, Markov Model

INTRODUCTION

Maintaining the purchasing power of investment assets over time has always been of great interest for long-term investors. Since gold maintains this specific character, gold in India has become a popular investment option and it is also used heavily for ornaments. The gold market has undergone several changes ever since the abolition of Gold control act in 1992. Further authorization of commercial banks to import gold for sale purpose also has an impact. Banks do give loans on gold ornaments and helps the investors on a troublesome day; hence the investor considers this as a good option. Recent monetization of gold also had a positive impact on the gold purchases in India. Apart from the protection against the expected inflation, long-term investors also show the desire to preserve their wealth and gold is considered as an option. The 2008 world financial crisis was characterized by crashing real estate and stock market valuations as well as bank failures, while European sovereign debt crisis substantially increased the default risk of several countries. At the same time, interest rates on bank deposits were pushed to very low levels. Related to this, central banks have carried out a very expansive monetary policy addressing the refinancing problems of banks and governments, but simultaneously increasing inflation expectations. Gold is also seen as a globally accepted currency which never loses its purchasing power and maintains its value even in the face of erosion of the monetary or banking systems. This has significantly increased the interest in gold investments, globally and considered as a hedging option against many risks. This research work attempts to understand the impact of gold prices.

LITERATURE REVIEW

Over years gold prices have been a topic of research for various researchers across the globe as it occupies a special position among precious metals. Specifically, lot of research exists on the factors influencing the gold prices and their implications. Researchers have studied gold prices in relation with inflation and it dates to 1980s (Feldstein, 1980; Chua and Woodward, 1982; Kolluri, 1981; Baker & van Tassel,1985; Jaffe, 1989). Lucey (2017) examined the relation in three countries i.e. US, UK and Japan with 40 years data. They found a time-varying relationship in cointegration between gold and inflation. They also clearly observed the importance of money supply in gold/inflation relationship (Artigas, 2010). However, research on inflation and gold prices can be understood in two ways. First, there exist a longrun relationship between prices of gold and inflation (Sherman, 1982; Haubrich, 1998; Jaffe, 1989; McCown & Zimmerman, 2006). Second, there exist no relationship between gold prices and inflation (Tully & Lucey, 2007). Another stream of research proves that gold is not an indicator of inflation and there exist a negative relationship with expected inflation. With reference to Consumer Price Index (CPI) and Producer Price Index (PPI), there is no

statistically significant correlation with gold prices (Jaffe, 1989; Lawrence, 2003).

RESEARCH METHODOLOGY

We have collected the data of daily gold prices from prowess. From the review of gold market in India we understand that there could be a regime shift in gold prices with the abolition of gold control act in 1992. We first observe the data for a constant mean and later find where the structural changes occur in the data. Once observed for structural changes we propose to use the Markov Switching model to understand the regime shift in gold prices. Further during the recent past there was rapid increase in the gold prices and some volatility in prices is also observed. Hence, we feel the need to observe the price movements and how long these prices would be at this point. In addition, we want to see if the prices would move back to the past regime. We have used the dynamic model of Markov switching model as we have taken daily prices of gold, which indicates that the data is of high frequency. The Markov switching model take the immediately preceding values as more relevant in predicting the present and that the past values are of less relevance.

However, the existing research did not consider the aspect of trends in gold prices in terms of regime shift. Therefore, there is no research found in the literature, in connection with regime shift of gold prices. This paper tries to address this gap using Markov Model in the Indian Context. Hence the following research questions are formulated.

Research Questions

RQ1 Is there a regime shift in the gold prices?

RQ2 What would be the duration of each regime?

RQ3 What is the probability of being in the same regime and going back to the previous regime?

Therefore, the regime shift in gold prices were examined and estimated the probability of being in each regime with duration estimate of each regime.

Given the different states S, S, S the current state S would be$^{ot\text{-}1\,t\text{-}2}$ more dependent predicting the future state S. This model…..$^{t+1}$ considers the random walk, where theory prediction of near future is possible than far future. Therefore, the model takes the form of

$$P\{S_{t-1}=j \mid S_{:}=i, S_{t-1}=i_{t-1}, S_{t}=i, S_{o=o}\ i\}$$

$$= P\{S_{t+1}=j \mid S_{t}=i\} = P_{ii} \ldots\ldots\ldots\ldots\ldots (1)$$

So, the i would be the preceding state for j. In other words, if the preceding state is i there is a probability of moving from i to j. The probabilities of transition from one state to another would take a matrix form:

p11 p12 p1n
p21 p22 p2n…….. (2)
pn1 pn2 pnn

These probabilities would be positive and transmit into some state including the current state. The summation of transition probabilities from state i into all states, then from all states into j would be:

$$\sum_{j=1}^{N} P\{S_{t+2}=j \mid S_{t+1}=k\}\ P\{S_{t+1}=k \mid S^{t}=i\} \ldots\ldots\ldots\ldots\ldots (3)$$

Thus, the two chain Markov process would have

$$Y_t = \mu_1 S_1 + \mu_2 S_2 + \Sigma_t \ldots\ldots\ldots\ldots\ldots (4)$$

Where y_t is outcome variable gold price and S_1 is state one and $S_2$is state 2. Σ is the white noise residual.

We estimate the duration of state with the given probabilities of the states as

$E[D] = 1 / 1 - p_{ii}$

Where, pii is the probability of being in the mean of 11701 in first state and 74615 in the second state. These results are significant same state.

RESULTS & DISCUSSION

The descriptive statistics of the gold prices from 1979 to 2018 April is shown in table 1.

Table 1: Descriptive Statistics of Gold Prices

Description	Gold Price per troy ounce
Mean	26583.93
Standarddeviation	28476.61
Max	97581
Min	1782
50 Percentile	12456
75 Percentile	37767
99 Percentile	91150

From the descriptive statistics we see a huge gap between the minimum and the maximum daily prices of gold. The 99 percentile shows a price of 91150. We observe a huge change in the gold prices. We therefore observe for the structural break by using the Markov switching model. The results are presented in table 2.

Table 2: Markov Switching Model for Gold Prices

No. of states: 2 AIC 21.22

No. of Obs: 10274 HQIC: 21.22

SBIC: 21.22 Log likelihood: -109004

Gold Prices	Coef	Std. Err	P > z
State 1 Cons	11701	110.87	0.00
State 2 Cons	74615	200.12	0.00
Sigma	9797	68.35	
P_{11}	0.999	0.000	
P_{21}	0.001	0.000	

Source: Calculated from daily gold prices taken from Prowess

The table 2 shows that there are two states with mean of 11701 in first state and 74615 in the second state. These results are significant for both the states. The probabilities show that if the gold prices are in state 1 the probability of staying in the same state is 0.999. If there is regime shift to state 2 the probability of moving back to state 1 is 0.001. We therefore understand that the gold prices would not move back to the previous state as the probability is very low.

Further we observe for the transition probabilities to understand the transition from state 1 to 2 and all possible combination of transition. The results are presented in table 3.

Table 3: Transition Probabilities

Transition Probabilities	Estimate	Std Err
P_{11}	0.9999	0.00
P_{12}	0.0001	0.00
P_{21}	0.0002	0.00
P_{22}	0.9998	0.00

Source: Calculated from Daily Gold Prices Taken from Prowess

From the above table we observe that the probability of being in the same state is very high and moving from state 1 to state is having a very less probability. When there is shift in the regime to state 2, we observe that the probability of being in state 2 is very high and the probability of going back to state 1 is very low. So, we understand that the gold prices would not go back to the past regime and would remain in the same regime still there is shift to the new regime.

We now observe for the duration of the given states. The results are presented in table 4.

Table 4: Estimate of Duration

State	Estimate in days
State 1	10000
State 2	5000

Source: Calculated by Authors

The estimated duration shows that the state would have a longer duration then the second state. As we see from the data the rapid increase in the gold prices started from the years 2000's.

CONCLUSION

The Markov regime shift model application to gold prices, show that there is a regime shift. There are two regime shifts and the probability of being is the same regime is high and if there is a regime shift the probability of going back to the previous regime is very low. This shows that the change in regime would be more or less permanent in nature. The duration shows that the first regime was a longer duration when compared to the second regime. This is because the policy changes happened in the 90's. Based on the results we therefore conclude that change in prices of gold would be more stable.

IMPLICATIONS OF THE STUDY

The understanding of the mean prices of gold and volatility would be useful to the investors in diversifying their portfolio. It is understood from the review of literature that investors invest in gold as hedge against inflation and stocks. This information on regime shift would help the investors in planning their strategies for minimizing the risk. Further the understanding whether the prices would go back to the previous regime too is an additional value for making an investment decision. The duration of each regime with the probabilities would aid investors in taking better decisions.

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