Forecasting Gold Price: Evidence from Pakistan Market

M. Khalid[1,2], Mariam Sultana[1] , Faheem Zaidi[1]

1: Department of Mathematical Sciences, Federal Urdu University, Karachi

University Road, Gulshan-e-Iqbal, Karachi-75850, Pakistan, Tel: 092-21-99244141

2: E-mail of corresponding author: khalidsiddiqui@fuuast.edu.pk

Abstract

In our day to day life, predictability of gold's prices is significant in many domains such as economics financial and political environment. The main objective of this research is to forecasts the prices of gold, making use of ARIMA and two distinct versions of wavelet scheme. The monthly data consists of 221 observations starting from Dec 2005 to April 2013, has been used in this research. After evaluating the accuracy of these models by mean absolute error and mean square error, it turns out that wavelet neural transformation has better prediction accuracy than rest of the models. Also, this study utilizes the return forecasts from the above mentioned different models in a simple trading strategy and compare pay offs in order to know as to which framework serves a better forecasting model.

Keywords: Gold Price, ARIMA, Wavelet, Multiple Regression, Wavelet Neural Transform, Error Analysis

1. Introduction

Since the time man existing on the earth, gold has been preferred by men and women in several ways. The metal Gold plays an important role in various sectors (e.g., jewelry, aerospace, electronics, and medical).Governments holds gold as a standard for currency equivalents. Investors use gold reserves as a hedge against inflation, or currency fluctuation and also to create diversity their portfolio for managing risk purpose. Some manufacturers require the use of gold for its special qualification when other less expensive substitutes cannot be identified. It is not surprising if there will be growing demand in gold usage in the future. In today world, like many commodities, the price of gold is driven by supply and demand. Due to high demand and limitation supply, the prices of gold are prominently increasing in this era especially since the beginning of 2009. and hence the forecasted gold price are of great interest

The aim of this research is to forecast the monetary value of Pakistani Gold utilizing ARIMA and different versions of wavelet transforms (by using different way of calculating inverse wavelet transformation). The predicted values then error tests. This study lays a path for the comprehensive analysis of the problem of forecasting the price of gold. Section 2, shows a short literature review, section 3 shows data description and methodology used, section 4 demonstrates detailed discussion and results and finally in section 5, the paper is concluded

2. Literature Review

Studies of different literatures reveal that metal markets are often analyzed by researchers. Among all, gold has received prominent attention for the last decade. Researchers like Ball, Torous and Tschoegl (1985), Bertus and Stanhouse (2001) and Hammoudeh, Malik and McAleer (2011) have been investing dynamic properties of gold spot and futures prices. A range of different and complex methods used in this respect are mentioned in literature.[Shafiee S. and Topal E. (2010) , **Bhar**, R. and Hamori, S., (**2004**)]

Since gold is important asset for risk hedging and investment avenue, hence investors are much interested in keeping account of forecasted prices. There is no prominent research work had been done about gold market of Pakistan. Keeping the interest of investor in mind, we will be predicting gold price of Pakistan market using different methods.

3. Data and Research Methodology

The monthly data used in this research is taken from Karachi Gold Market (http://www.goldrates.pk). The Data consists of monthly gold prices per ounce consists of 221 observations starting from Dec 2005 to April 2013. Considering the importance of the utilized data in this study, a descriptive statistics related to the returns of gold prices will be analyzed first (see Table 1 for details)

Criterions	Value	Criterions	Value
Observations	221	Std. Dev.	0.05041796
Maximum	-0.136279	Skewness	0.482155
Minimum	0.235620	Kurtosis	1.423632
Mean	0.012410	Range	0.371902
Median	0.007408		

Table 1: Descriptive Statistics of Monthly Returns of Pakistan Gold Prices from 2005-2013

ARIMA is a widely adopted model for predicting and forecasting using the time series data. No other independent variable is used in this model but the prediction is made only from the historical series of a variable. Box Jenkins' ARIMA model is one of the widely used ARIMA models for forecasting [G.E.P., and G. M. Jenkins 1970]. Before the data is used for running the ARIMA model, the data is tested for stationary. Augmented Dickey- Fuller regression's unit root test is one of the widely used methods for testing if the variable is free of the trend component. If the series is non-stationary, the series needs to be transformed to first difference data and tested again. The data would be stationary at 1st difference if the null hypothesis is rejected at least at 0.05 critical value. If it is not then the series is differentiated again till it becomes stationary. The next step would be to identify the model. The regressor that would be chosen to form the model will be selected from various lag of time of AR (p) and MA (q). The selection is made on the basis of the ACF (Auto correlation function) and PACF (Partial Auto correlation Function). There are numerous possible models that could be chosen after observing the lags in AR, I and MA. One has to then choose the model which has the least MAPE value (Mean absolute percent error) in comparison with others. After the AR and MA are picked and put into definition a coefficient estimation and process of intercept occur and usually OLS is applied, where the

$$\text{Forecasted Result} = \text{Intercept} + AR(n) + MA(n) + \varepsilon \tag{1}$$

In this n is the number of lags that is selected. Mathematically, it can be written as:

$$\left(1-\sum_{i=1}^{p}\phi_i L^i\right)(1-L)^d Y_t = \left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t \tag{2}$$

Where q is the order of the moving average, p is the order of the autoregressive, d represents the order of differencing and ε_t is the random error.

Wavelet analysis, is purely, is not a forecasting technique, however it helps in the transformation of a suspected signal into various levels of resolution. Wavelets localize a procedure in frequency and time. This is done utilizing a wavelet transform function (the mother wavelet).

$$\psi_{(a,b)}(t) = \frac{1}{\sqrt{a}}\psi\left(\frac{t-b}{a}\right); \qquad a>0\ ,\ b\in R \tag{3}$$

Here "a" is the scaling parameter and "b" is the translation parameter. The coefficient of this expression can be obtained through the usual projection

$$\psi_{(a,b)} = \int_{-\infty}^{+\infty} f(t)\psi_{(a,b)}(t)\,dt \tag{4}$$

These coefficient measure the variation of the field $f(t)$ about the point "b", with the scale given by "a".It helps to indicate low and high frequency features in a time series when decomposition take places at successive levels. When the wavelet transform is high in frequency it captures detailed incidents. It is ideal for analyzing non-stationary time series, as its role is to capture detailed incidents at high frequency and long in time incidents when frequency is low . For decomposing the return series, we used Daubechies wavelet of order 2. The Daubechies wavelet transforms are defined in a similar way as the Haar wavelet transform by computing the running averages and differences via scalar products with scaling signals and wavelets. The main difference between them consists in how these scaling signals and wavelets are described. This wavelet produce balanced frequency responses but non-linear phase responses. Daubechies wavelets make use of overlapping windows, so the high frequency coefficient spectrum reflects all high frequency changes. It seems that Daubechies of order 2 visually matches with gold returns better than the others. To decide how many levels the return should be decomposed, the Shannon entropy criterion was used. Then, they were forecasted using the recursive ARIMA

The essence of wavelet analysis is in inverse transformation. The inverse transformation reconstructs the original suspected signal. This process is called reconstruction and it is undertaken using a method called Inverse Discrete Wavelet Transform (IDWT). After finding the approximation and the details they are all independently forecasted using an approximation series and each detail series, we used ARIMA model. Normally, the forecasted values are all then added together to get the forecasted values of the original series, but, in this paper we apply two different techniques to get series and compare the results of these three techniques by four different error tests. We used (1) summation method (2) Neural network method for finding forecasted value of original signal.

4. Discussion of Results

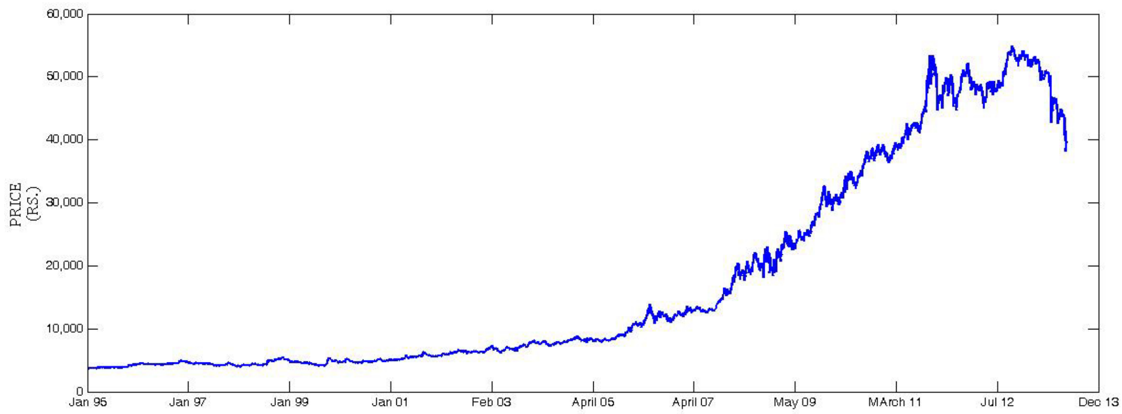

Figure 1 shows the original data of daily gold prices in time duration 2005-2013

The objective of all financial time series modeling is to present its ability to forecast to nearest accuracy based on measure of performance; as MAE and MSE. Mean Square Error(MSE) and Mean Absolute Error (MAE) which are defined by

$$\varepsilon_{MSE} = \frac{1}{N}\sum_{1}^{N}(y_{real} - y_{forecast})^2$$

$$\varepsilon_{MAE} = \frac{1}{N}\sum_{1}^{N}\left|y_{real} - y_{forecast}\right|$$

where y_{real} shows the real gold price, $y_{forecast}$ is the predicted gold price, $\bar{y}$ is the mean of y_{real}, and N is the number of data points.

These errors can be calculated for above mentioned models and comparison are shown in table 2. With the assistance of the accuracy statistics, conclusive results are drawn; i.e. the wavelet neural model surpassed the other two models discussed/worked on. It is also observed, that MAE and MSE calculates using wavelet neural model, demonstrates a small deviation; proposing a slight difference in the actual and calculated values.

	ARIMA	Wavelet (Simple)	Wavelet(Neural)
MSE	0.0024693	0.0015077	0.0012639
MAE	0.0379354	0.0305029	0.0274887

Table 2: Error analysis of gold price returns; prediction by different forecasted method

Fig 2,3,4,5 show the comparative analysis of all above mentioned methods with original values of gold price. Graphical representation and error analysis both support that wavelet neural transform is better than any other method.

"Trend following" strategies were used to display the performance of the three used models. In this case trading simulation was of much help as it allowed the virtual investors to trade into Pakistan gold market by glaring at the next day's return predicted by the three models. The motive was to form a single as to when on investor should buy or sell. Hence, with the help of his study an investor should buy when the forecast return is +ve, an sell if –ve.

Table 3 below presents a competitive comparison of the three models.

Methodology	Total No.of true forecasting	Percentage
ARIMA	126	58.06
Wavelet	154	70.97
Wavelet Neural	169	77.89

Table 3 :Forecasting returns by trend strategy using three models

From the above, it is noted that the outcomes of the wavelet, neural model not on my out beats the rest of the two models, but also out performs the benchmark model.
Conclusive results can be ultimately drawn on the three used model: wavelet neural estimates the direction of the index over 77%. ARIMA model forecast the direction a little more than 58% of the time and finally simple wavelet predicted the direction of index return upto 70%.

5. Conclusion

In this paper, monetary value of Pakistani gold is discussed using ARIMA and different version of wavelet transformation. While working on this, we come across the drawbacks of ARIMA which are also highlighted. Therefore, with the assistance of the methodology used and output of the data, we conclude with the fact that wavelet with neural transform has clear advantages over all other methods. Besides, this paper makes use of the return forecast on the basis of various models in a trading strategy and proposes wavelet neural model is a better look for forecasting.

Acknowledgement:
Thanks to Ms Erica Kartha for lending a helping hand during this research work.

References

Ball C., Torous W. and Tschoegl A. (1985), "The degree of price resolution: the case of the gold market", Journal of Futures Markets 5,pp. 29-43.
Bertus M. and Stanhouse B. (2001), "Rationale speculative bubbles in the gold futures market: an application of dynamic factor analysis", Journal of Futures Markets 21, pp. 79-108.
Hammoudeh S., Malik F. and McAleer M. (2011), "Risk management of precious metals", Quarterly Review of Economics and Finance 51, pp.435-441.
Shafiee S. and Topal E. (2010), "An overview of global gold market and gold price forecasting", Resources Policy 35(3), pp. 178-189.
Bhar, R. and Hamori, S., (**2004**) "Information Flow between Price Change and Trading Volume in Gold Futures

Contracts," with Ramaprasad Bhar, International Journal of Business and Economics, Vol. 3, pp. 45-56.
Bertus, M., and Stanhouse, B., (2001) rational speculative bubbles in the gold futures market: An application of dynamic factor analysis, Journal of Futures Market, 21, 79-108.
G.E.P., and G. M. Jenkins. *Time series analysis: forecasting and control control*, Holden Day, San Francisco, 1970.

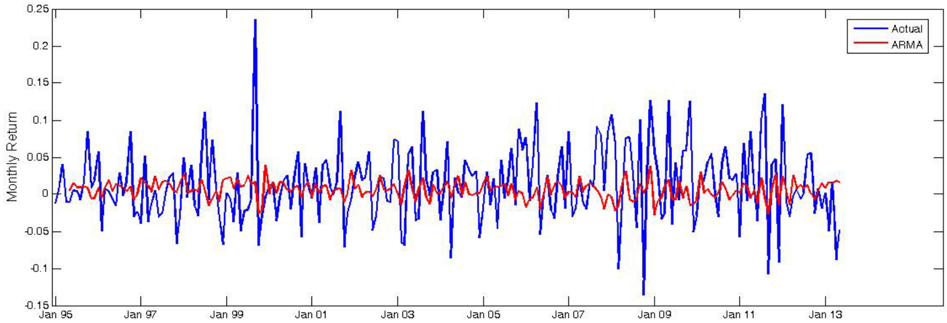

Figure 2: Shows comparison of original values and forecasted values by ARIMA of gold monthly returns from year 2005-2013

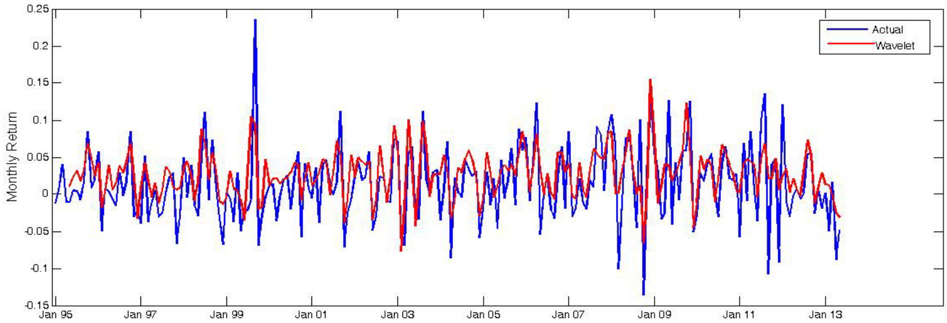

Figure 3: Shows original and forecasted values of gold monthly returns by wavelet (Simple) form year 2005-2013

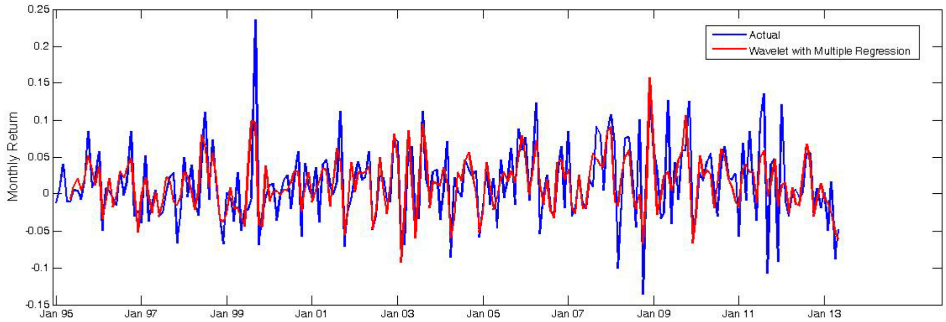

Figure 4: Shows original and forecasted values of gold monthly returns by wavelet(Multiple Regression) from 2005-2013

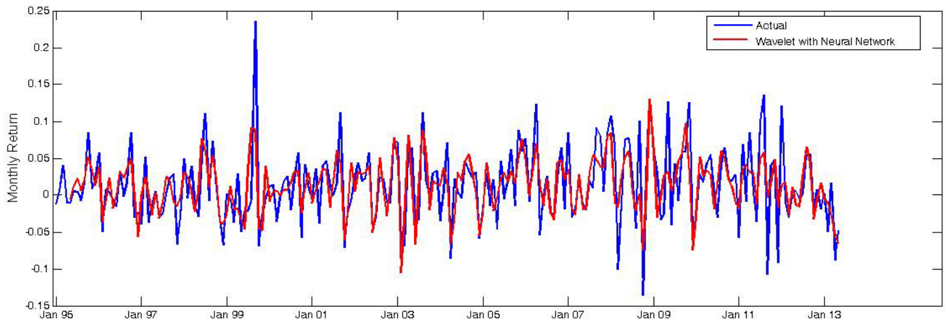

Figure 5: Comparative analysis of original prices with forecasted prices of gold monthly returns by wavelet (Neural) form year 2005-2013