TEST Engineering & Management

July-August 2020
ISSN: 0193-4120 Page No. 1231- 1240

Gold Price Forecasting Comparison: Study of the Box-Jenkins Method and the Holt's Method in United States of America

Kunya Bowornchockchai
Suan Sunandha Rajabhat University, Thailand
E-mail address: kunya.bo@ssru.ac.th

Article Info
Volume 83
Page Number: 1231- 1240
Publication Issue:
July-August 2020

Article History
Article Received:06 June 2020
Revised: 29 June 2020
Accepted: 14 July 2020
Publication: 25 July 2020

Abstract:
Gold production in USA is much greater than other regions of the world. It has been estimated that gold production of USA is second largest in the history. The price of gold in USA might be affected by the macroeconomic factors and thus the gold prices must be forecasted in advance so that the accurate and relatable policies can be designed by the policy makers of USA. In this context, this study is conducted to estimate the accuracy of three models used for gold price forecasting i.e. Hot Winters, Box Jenkins and ANN for USA. The accuracy of these methods has been estimated through the specific criteria such as MSE, MAE and MAPE. Time series data for 20 years has been collected regarding gold prices in USA and has been taken in two subsections i.e. monthly and yearly. It was found out that Holt Winters is the most accurate method for the forecasting purposes and especially in the forecast of gold prices and can be used to predict the future values for several years. After Holt Winters, the second accurate method was found to be ANN or artificial neural network that presented lower MAPE values as compared to Box Jenkins method.

Keywords: *Hot winters, Box Jenkins, Artificial neural network, USA, Gold price*

I.INTRODUCTION

Gold is considered as a good investment that lies in between the short term and long term. Gold has been considered as a valuable metal throughout the history of humans and is considered as a good form of asset that can be converted into the form of paper money. In other words, gold has great liquidity and other metals do not possess this level of liquidity. It is considered to be a valuable item that can be handled quite easily and is tangible. Worthington and Pahlavani (2007) suggested that there are many commodities and gold is the most durable, easily carried and universally accepted one. Moreover, gold can also be considered as a hedging tool that can cover the losses faced by investors and further reduce the risk of loss in future investments. In addition to the commodity, gold can also be considered as financial asset possessed by a person (Guha & Bandyopadhyay, 2016; Isik, 2017; Livieris, Pintelas, & Pintelas, 2020). As far as the price of gold is concerned, it depends upon various macroeconomic factors such as prices of crude oil, exchange rate of currency, GDP of a country, consumer product index CPI, per capita income, inflation level etc. All these factors are supposed to impact the prices of gold in one way or the other (Bapna, Sood, Totala, & Saluja, 2012; Y. Wang, 2013). In the same way, different researchers have worked to find out and investigate the impact of various other macroeconomic factors in the process of gold. As the context of current study is United

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

States of America USA, it must be considered that gold production in USA is much greater than other regions of the world. It has been estimated that gold production of USA is second largest in the history. Thus the price of gold in USA might also be affected by the macroeconomic factors (D. Liu & Li, 2017; Weng et al., 2020).

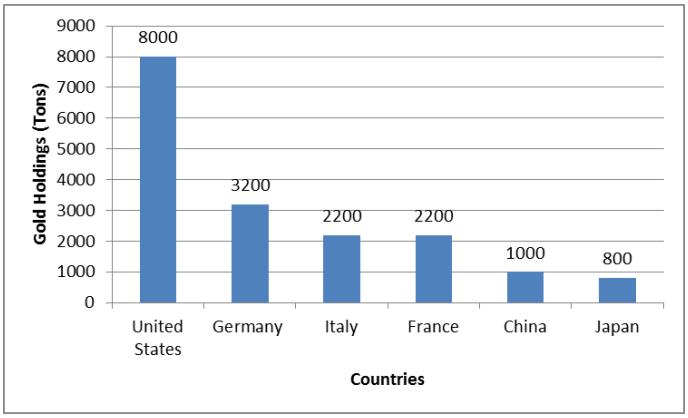

FIGURE I:
Gold Holdings Feb 2015 (Market Realist)

As USA produces a large amount of gold and the macroeconomic factors affect the prices of the gold, therefore it is necessary to forecast or predetermine the prices of gold in an accurate fashion so that the future planning can be conducted in an effective way and the policies can be designed accordingly. There are various methods that have been introduced by the researchers in different contexts because the trend of forecasting of events has been dramatically increased. It includes different forecasting mechanisms such as the non regression methods i.e. simple average, moving average, exponential adjustment etc. Moreover, regression methods such as GARCH, ARIMA, ARCH, ANN etc. have also been introduced (Najafi Nab & Tarazi, 2006). However, the price of gold in context of USA has not been effectively measured before. Therefore, this study has been conducted to predict or forecast the gold prices in USA through the methods of Holt winters, ARIMA and ANN. This study has the following objectives:

- To forecast the gold prices in USA using the forecast methods of Holt Winters, Box Jenkins and ANN
- To compare the accuracy of the gold price forecast results obtained by these methods in the study

As the forecast of gold prices has become very important especially in second largest gold producer in the world, this study will assist to evaluate different forecasting methods of gold price and point out the most accurate one. This will be helpful in forecasting the gold prices with high level of accuracy (D. Liu & Li, 2017; Weng et al., 2020).

TABLE 1:
Daily Correlation Rolling One Month Basis Gold Prices (BullionVault)

	10 Year Average	**10 Year Median**	**Last 3 Year Ave**
EUR/USD	0.39	0.54	0.37
USD/JPY	-0.33	-0.43	-0.60
Broad Dollar Index	-0.46	-0.63	-0.44

II. LITERATURE REVIEW

2.1. Gold Price

In the past, various studies have been conducted that have researched on the price ofgold and different factors associated with it. A similar study has suggested that the determination of gold price and different factors associated with it must be well studied because the interest of investors has been increased towards the investment in gold from the past few years. The study analyzed different macroeconomic factors that might impact the gold price in Malaysia through multiple linear regressions. The results indicated that inflation rate and exchange rate negatively impact the gold prices but crude oil price positively impacted the gold price (Ibrahim, Kamaruddin, & Hasan, 2014). In the same way, another study was taken place in which the impact of different factors on gold prices was discussed. The results indicated that inflation rate,

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

international gold price and oil price are having positive relation with the gold prices in Pakistan (Nadeem, Zakaria, & Kayani, 2014). In almost similar context, a study suggested that US dollars exchange rate has negative impact on the gold prices but inflation rate has positive impact on gold rates (Bin Sukri, 2015).

Studies have suggested that gold coin has various types and one of these types has been recently introduced in Malaysia i.e. Kijang Emas. The study was conducted to evaluate different kinds or forms of gold and to determine which type can be used as a better investment tool. The results suggested that gold bar is a form of investment and its price is comparable to the gold prices in the world. On the other hand, gold coins are convenient because they are easy to handle. Bapna et al. (2012) discussed that just like the price of gold; its demand also depends upon different macroeconomic aspects or factors. To find out the impact of these factors on the price and demand of gold, the researcher used different tests such as unit root test, Granger casualty test etc. and suggested that exchange rate and GDP do not affect the gold prices so much. A study from the past indicated that gold has a significant role in determining the economy of a country. Purpose of the study was to find out the relationship between gold and oil prices. The results of the study suggested that there is strong relation between these two commodities and this was found out using the Granger Casualty test (Šimáková, 2011). These studies have suggested that the gold prices are very crucial to be studied along with different factors having impact on these prices (Y. Liu, Yang, Huang, & Gui, 2020; J. Wang & Li, 2018; Yussof, Ahmad, & Osman, 2016).

2.2. Forecasting Methods

In addition to the factors impacting the gold prices, the forecasting of these gold prices is also a growing area of interest in recent years. In the past researches, various researchers have used different tools and methods to forecast the gold prices accurately. Some of these studies have been reviewed in this section. Co and Boosarawongse (2007) conducted a similar study with the aim to forecast the rice exporting in Thailand by using different forecast models such as seasonal Holt Winters, artificial neural network, ARIMA etc. The results of the study suggested that Holt Winters method was most suitable method at the modeling stage but thus method did not provide very good forecasts. The ANN method, on the other hand, found out to be more accurate in context of forecasting of rice export (Alameer, Abd Elaziz, Ewees, Ye, & Jianhua, 2019; Baranova & Bogatyreva, 2019; Chen & Zhang, 2019;). In the same way, Deetae (1991) wanted to forecast the rice price in farm and for this purpose, the researcher applied two methods i.e. analysis and Bok Jenkins method. The results of the study suggested that Box Jenkins model provided more accurate results. In the exact similar fashion, Kerdsomboon and Varaphakdi (1999) also applied different forecasting models for the forecasting purpose of rice production. The results of this study also proved that Box Jenkins method is more accurate for forecasting purposes. Moreover, Sangpattaranate (2005) used Holt Winter method, Box Jenkins method and regression analysis method to predict or forecast the rice prices in Thailand. The researcher indicated that no doubt the regression analysis provided good results but still Box Jenkins method was considered to be the best method used for the forecasting purpose (Hafezi & Akhavan, 2018; Mitra, 2018).

Another study was conducted having the title of choosing exponential smoothing model of prediction. In this study, the researcher had used the MAPE method to be the best and accurate method to choose the forecasting model during the evaluation procedure of these models. It was indicated in the study that this method was suitable for the study in case of annual data while the seasonal method was found as useful for time series data (Billah, King, Snyder, & Koehler, 2006). Hyndman, Koehler, Snyder, and Grose (2002) is a similar study compared the methods of single exponential smoothing and ARIMA for forecasting purposes.

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

The results of the study suggested that exponential smoothing method is more accurate as compared to ARIMA. In the similar way, Najafi Nab and Tarazi (2006) used the ANN and ARIMA methods in the study for forecasting of pistachio export in Iran and after forecasting, the results of the methods were evaluated. It was found out in the results of the study that ANN has shown better results among all neural networks as well as ARIMA. It was also indicated that the Iranian exports of pistachio is more accurately predicted by ANN (Atsalakis, Atsalaki, Pasiouras, & Zopounidis, 2019; Singh & Kumar, 2017).

III. METHODOLOGY

The purpose to conduct this study is to estimate the accuracy of three models used for gold price forecasting i.e. Hot Winters, Box Jenkins and ANN for USA. The accuracy of these methods has been estimated through the specific criteria such as MSE, MAE and MAPE. Time series data for 20 years has been collected regarding gold prices in USA and has been taken in two contexts i.e. monthly and yearly (Hameed, Basheer, Iqbal, Anwar, & Ahmad, 2018; Ul-Hameed, Mohammad, & Shahar, 2018).

3.1. Exponential Smoothing

The method started with the working on Holt Winters method in 1950 and after that the model went through various changes and has shown good performance in different studies. Different methods can be classified on the basis of the types of trends such as none, additive, damped additive, multiplicative, damped multiplicative. Total of 15 exponential smoothing methods are known and the best performing of them include simple exponential smoothing, Holt's linear method, Holt's additive method and Holt's multiplicative method (De Gooijer & Hyndman, 2006). These methods involve the estimation of parameters such as α (level), β (trend) and γ (seasonal indices). Many researchers have contributed in this method (Gardner Jr & McKenzie, 1988; Hyndman et al., 2002; Razzaq, Maqbool, & Hameed, 2019).

3.2. Single Exponential Smoothing

This method is actually single parameter method and is suitable for the series. If the parameters i.e. α (level), β (trend) and γ (seasonal indices) are having values closer to one then it will be considered as a random step. It must be noted that the aforementioned variables are having the values ranging from 0 to 1.

$$y_t = \alpha \sum_{s=0}^{t-1} (1-\alpha)^s \, y_{t-s}$$

This explains why the method is called exponential smoothing. In this equation, y_t prediction is actually the weighted average of the previous values and this average reduces with time. In addition, these can be used for any observation in the future. In this method, the alpha values must be in the range of 0.01 and 0.3.

3.3. No Seasonal Holt *Winters*

No seasonal Holt Winters method used in the current study is based on double parameter and is suitable to be used in this study because of the time trend series and no seasonal pattern. Therefore, the forecast is done without trend and seasons.

$$y_{t+k} = a + bk$$

$$a(t) = ay_t + (1-t)[a(t-1) + b(t-1)]$$

$$Intercept = a, b(t) = \beta[a(t) - a(t-1)] + 1 - \beta b(t-1)$$

In this method, two parameters are used for smoothing and making predictions based on the equation;

$$y_{t+k} = a(t) + b(t)k$$

3.4. Box Jenkins

There are different ways through which stationary time series can be modeled. If it is stationary, then ARIMA method can be applied and the time series of the study will be converted to integrated moving average time series where p denotes the autoregressive order and q denotes the rank of moving average:

$$y_t = \theta + \alpha_1 y_{t-1} + \beta_0 U_t + \beta_1 U_{t-1}$$

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

Box Jenkins method is based on four phases. The first stage involves the identification of real values of p, d and q. The second stage involves the estimation of parameters. The third stage is the recognition control sought in which it is estimated that which ARIMA model will be best suited. For this purpose, Box Pieres and Lijang Box tests are used. In the last stage, the best method is selected.

3.5. Artificial Neural Network ANN

The ANN structure resembles with the human brain in which numerous neurons are connected with each other. The set of neurons may be called as the layers. In a sample ANN, there are three layers i.e. inner, middle and outer layers with their varied functions. These are connected to each other through rotative arch. Different researchers have presented different methods to find out the total number of layers of ANN such as n/2, 2n, 2n+1 etc. where n is the number of neurons. Trail and error has also been discussed for the same purpose.

$$F = F\left[\beta_0 + \sum_{j=1}^{j} \beta_j G\left[\sum_{k=1}^{k} k\gamma_j X_j\right]\right]$$

Activation function is used in ANN to find out the impact of inputs on outputs (Zhang, Patuwo, & Hu, 1998). This method offers very less error in the prediction of different aspects.

3.6. Comparison of Prediction Methods

In order to compare the accuracy of the prediction or forecasting by different models, the criteria such as MAPE, MAE and MSE are generally used.

Mean Absolute Error MAE;

$$MAE = \sum \frac{|e_i|}{n}$$

Mean Square Error MSE;

$$MSE = \sum \frac{e_i^2}{n}$$

Mean Absolute Percent Error MAPE;

$$MAPE = \frac{1}{N}\sum_{i=1}^{n}\left|\frac{e_i}{y_i}\right|$$

IV. DATA ANALYSIS

4.1. Holt Winters Method Results

The results of model fitting and model validation have been presented in the table 1. The MAPE, MSE and MAE values have been provided for both the subsections i.e. yearly and monthly data. It it quite evident that the values of MAPE are very low which suggests that exponential smoothing method has provided good and authentic results.

TABLE I:
Smoothing parameters and error criteria of modeling and model validation stages

	Time	α (Average)	β (Trend)	MAP	MSE	MAE
Model Fitting	Monthly	0.97	0.06	7.6	388443.6	428.6
	Yearly	0.81	0.63	4.46	118333.1	189.87
Model Validation	Monthly	0.97	0.06	6.07	289499	1438.33

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

Yearly	0.81	0.63	3.56	28383.7	432.34

4.2. Box Jenkins Method Results

In the same way, when the model fitting and model validation was checked using the ARIMA process for both subsections i.e. yearly and monthly, for which the data was collected, the results obtained have been presented in table 2. According to the table, it is clear that again the MAPE values for both subsections are very low as compared to the other criteria of evaluation this suggesting that ARIMA has provided accurate predictions for out of sample data.

TABLE II:
ARIMA process and error criteria of modeling and model validation stages

	Time	MAP	MSE	MAE	ARIMA
Model Fitting	Monthly	32.4	537664	2343	(3,1,3)
	Yearly	44.3	392994	1883	(2,2,1)
Model Validation	Monthly	21.9	857884	2933	(3,1,3)
	Yearly	12.3	588393	324	(2,2,1)

4.3. Artificial Neural Network Results

When the results obtained were tested by applying ANN method, the error criteria calculated in case of both testing and learning stages has been obtained and presented in table 3. According to the table, it can be seen that the value of MAPE is higher in case of learning and lower in case of testing. This suggests that the ANN method can be effectively used for the prediction of future values.

TABLE III:
Error criteria of test and learn stages of artificial neural network

	Time	ME	MAE	MSE	MAP
Learn	Monthly	2426.65	25531.65	7556965 4.55	28.75
	Yearly	1376.36	1275.64	364357.85	20.544
Test	Monthly	1065.47	29645.64	3864896 6.65	19.45
	Yearly	476.65	1475.56	46346.76	11.74

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

4.4. Comparison of Accuracy through MAPE Values

Finally after the application of all the forecasting methods, the comparison of all these methods in context of MAPE values has been presented in table 4. The comparison shows results for both model fitting and model validation. In case of model fitting, it is quite clear that the Holt Winters method has provided most accurate results than the other two methods and its MAPE value is less than 7% in model fitting. In the similar fashion, in case of model validation, the Holt Winters method again has provided most accurate results than the other two methods and its MAPE value is less than 4% in model validation. As far as the other two models are concerned, in case of model fitting, ANN has provided more accurate results as compared to Box Jenkins method and the MAPE value of ANN is less than 30% and the MAPE value of Box Jenkins method is less than 52% in case of model fitting. On the other hand, in case of model validation, again ANN has provided better results with MAPE value of maximum 20.64% while the MAPE value of Box Jenkins method is maximum 20.65% in case of model validation. However, this difference is very less and can be ignored. Thus based on these results, the most accurate method has been used to predict the future values from six years i.e. 2014 to 2019. These predicted values have been presented in the table 5 of the study.

TABLE IV:

Comparison of Holt-Winters and Box-Jenkins and artificial neural network mean absolute value percent error.

Model	Model Fitting	Model validation
Monthly		
Exponential smoothing	4.64	3.67
Box-Jenkins	22.65	20.65
Artificial neural network	16.74	13.13
Yearly		
Exponential smoothing	6.56	3.96
Box-Jenkins	51.75	17.64
Artificial neural network	29.46	20.64

TABLE V:

Predicted value using best model until 2019

Year	Monthly	Yearly
2014	1863.297	764.875
2015	1287.278	664.788
2016	1863.208	736.287
2017	1983.294	833.374
2018	1298.484	766.379
2019	1398.309	866.309

V. DISCUSSION AND CONCLUSION

5.1. Discussion

The purpose behind the current study was to find out the level of accuracy shown by different methods of forecasting such as Box Jenkins, Holt Winters and ANN. These methods are generally used for forecasting in different cases but in the current study the context of forecast was the gold prices in USA. The time series data for gold prices was collected and the techniques and tools underlying the three basic models were applied on

the collected data and the results were obtained (Jianwei, Ye, & Jin, 2019; Zainal & Mustaffa, 2016). This leads towards the achievement of first objective of the current study. The second objective was regarding the evaluation of the results and the comparison of the models used for forecasting purposes. This objective was achieved by using MAPE criterion and on the basis of this criterion the three major methods were evaluated on the basis of the results presented by them. It was found out that Holt Winters is the most accurate method for the forecasting purposes and especially in the forecast of gold prices and can be used to predict the future values for several years. After Holt Winters, the second accurate method was found to be ANN or artificial neural network that presented lower MAPE values as compared to Box Jenkins method. In this way, the second research objective has also been achieved. The studies that have been conducted in the past in which these methods have been used also show comparable results and thus support the results of the current study (BAO, 2020; Baur, Beckmann, & Czudaj, 2016).

5.2. Conclusion

The researcher wanted to find out the most accurate method of forecasting that can be used to forecast the gold price values and for this purpose, trend series data was collected from USA for gold prices for the time period of twenty years. The methods used for the forecasting were Box Jenkins, Holt Winters and ANN methods. The results of the comparison of the accuracy of these methods on the basis of MAPE values show that the most accurate method to forecast is Holt Winters method. Thus it can be concluded that in order to predict the future value of gold price in USA, Holt Winters Method can be used. However, it must be noted that it is better to use more study or comparison criteria so that more accurate and reliable results can be obtained. This is because of the reason that in some cases different criteria provide different accuracy results so it is better to confirm the results using more criteria.

This study will be practically beneficial for the governments and policy makers because they will be able to accurately forecast the gold price values using the most accurate method as shown by this study so that they can make the policies accordingly. In addition, it will also be beneficial for the researchers who can use the information provided in the current study in their researches.

VI. REFERENCES

1. Alameer, Z., Abd Elaziz, M., Ewees, A. A., Ye, H., & Jianhua, Z. (2019). Forecasting gold price fluctuations using improved multilayer perceptron neural network and whale optimization algorithm. *Resources Policy*, *61*, 250-260.
2. Atsalakis, G. S., Atsalaki, I. G., Pasiouras, F., & Zopounidis, C. (2019). Bitcoin price forecasting with neuro-fuzzy techniques. *European Journal of Operational Research*, *276*(2), 770-780.
3. BAO, K. K. (2020). *GOLD PRICE FORECASTING: A FORECAST COMBINATION APPROACH*.
4. Bapna, I., Sood, V., Totala, N. K., & Saluja, H. S. (2012). Dynamics of macroeconomic variables affecting price innovation in gold: A relationship analysis. *Pacific Business Review International*, *5*(1), 1-10.
5. Baur, D. G., Beckmann, J., & Czudaj, R. (2016). A melting pot—Gold price forecasts under model and parameter uncertainty. *International review of financial analysis*, *48*, 282-291.
6. Billah, B., King, M. L., Snyder, R. D., & Koehler, A. B. (2006). Exponential smoothing model selection for forecasting. *International journal of forecasting*, *22*(2), 239-247.
7. Bin Sukri, M. K. A. (2015). The relationship between selected

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

macroeconomic factors and gold price in malaysia.

8. Baranova, N. & Bogatyreva, L. (2019). the study of the dynamic series of financial indicators of enterprises in the hotel sector. *International Journal of business tourism and applied sciences.* 7(2), 47-54
9. Chen, L., & Zhang, X. (2019). *Gold Price forecasting based on projection pursuit and neural network.* Paper presented at the Journal of Physics: Conference Series.
10. Co, H. C., & Boosarawongse, R. (2007). Forecasting Thailand's rice export: Statistical techniques vs. artificial neural networks. *Computers & Industrial Engineering, 53*(4), 610-627.
11. De Gooijer, J. G., & Hyndman, R. J. (2006). 25 years of time series forecasting. *International journal of forecasting, 22*(3), 443-473.
12. Deetae, N. (1991). Comparative study of forecasting techniques on rice, cassava and mungbean farm gate prices.
13. Gardner Jr, E. S., & McKenzie, E. (1988). Model identification in exponential smoothing. *Journal of the Operational Research Society, 39*(9), 863-867.
14. Guha, B., & Bandyopadhyay, G. (2016). Gold price forecasting using ARIMA model. *Journal of Advanced Management Science, 4*(2).
15. Hafezi, R., & Akhavan, A. (2018). Forecasting gold price changes: Application of an equipped artificial neural network. *AUT Journal of Modeling and Simulation, 50*(1), 71-82.
16. Hameed, W. U., Basheer, M. F., Iqbal, J., Anwar, A., & Ahmad, H. K. (2018). Determinants of Firm's open innovation performance and the role of R & D department: an empirical evidence from Malaysian SME's. *Journal of Global Entrepreneurship Research, 8*(1), 29. doi:https://doi.org/10.1186/s40497-018-0112-8
17. Hyndman, R. J., Koehler, A. B., Snyder, R. D., & Grose, S. (2002). A state space framework for automatic forecasting using exponential smoothing methods. *International journal of forecasting, 18*(3), 439-454.
18. Ibrahim, S. N., Kamaruddin, N. I., & Hasan, R. (2014). The determinants of gold prices in Malaysia. *Journal of Advanced Management Science Vol, 2*(1).
19. Isik, I. (2017). The level of development in the Muslim world: A financial inquiry. *International Journal of Business Tourism and Applied Sciences.* 5(2), 35-41.
20. Jianwei, E., Ye, J., & Jin, H. (2019). A novel hybrid model on the prediction of time series and its application for the gold price analysis and forecasting. *Physica A: Statistical Mechanics and Its Applications, 527*, 121454.
21. Kerdsomboon, M., & Varaphakdi, M. (1999). *Forecasting of agricultural products and prices.* MS thesis, Department of Statistics, Faculty of Science, Chulalongkorn ….
22. Liu, D., & Li, Z. (2017). *Gold price forecasting and related influence factors analysis based on random forest.* Paper presented at the Proceedings of the Tenth International Conference on Management Science and Engineering Management.
23. Liu, Y., Yang, C., Huang, K., & Gui, W. (2020). Non-ferrous metals price forecasting based on variational mode decomposition and LSTM network. *Knowledge-Based Systems, 188*, 105006.
24. Livieris, I. E., Pintelas, E., & Pintelas, P. (2020). A CNN–LSTM model for gold

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

price time-series forecasting. *Neural Computing and Applications*, 1-10.

25. Mitra, A. (2018). Gold Price Forecasting in the USA. *Vilakshan: The XIMB Journal of Management*.
26. Nadeem, W., Zakaria, M., & Kayani, F. (2014). Impact of Macroeconomic Factors upon Gold Prices in Pakistan. *Pakistan Journal of Social Sciences (PJSS) Vol, 34*, 383-395.
27. Najafi Nab, R., & Tarazi, M. (2006). Forecasting of Iran pistachio Export: application of artificial neural network. *J. Trading Bulletin, 29*, 191-214.
28. Razzaq, S., Maqbool, N., & Hameed, W. U. (2019). Factors Effecting The Elasticity Of Micro Credit Demand In Southern Punjab, Pakistan. *International Journal of Social Sciences and Economic Review*, *1*(2), 46-53. doi:https://doi.org/10.36923/ijsser.v1i2.34
29. Sangpattaranate, P. (2005). *Forecasting of rice prices in Thailand.* Master Thesis. Thailand: Kasetsart University.
30. Šimáková, J. (2011). Analysis of the relationship between oil and gold prices. *Journal of finance*, *51*(1), 651-662.
31. Singh, K., & Kumar, A. (2017). Autoregressive Integrated Moving Average Model for Gold Price Forecasting: Evidence from the Indian Market. *Indian Journal of Research in Capital Markets*, *4*(3), 33-43.
32. Ul-Hameed, W., Mohammad, H., & Shahar, H. (2018). Microfinance institute's non-financial services and women-empowerment: The role of vulnerability. *Management Science Letters*, *8*(10), 1103-1116. doi:https://doi.org/10.5267/j.msl.2018.7.001
33. Wang, J., & Li, X. (2018). A combined neural network model for commodity price forecasting with SSA. *Soft Computing*, *22*(16), 5323-5333.
34. Wang, Y. (2013). An empirical study in the relationship between crude oil and gold futures.
35. Weng, F., Chen, Y., Wang, Z., Hou, M., Luo, J., & Tian, Z. (2020). Gold price forecasting research based on an improved online extreme learning machine algorithm. *Journal of Ambient Intelligence and Humanized Computing*, 1-11.
36. Worthington, A. C., & Pahlavani, M. (2007). Gold investment as an inflationary hedge: Cointegration evidence with allowance for endogenous structural breaks. *Applied Financial Economics Letters*, *3*(4), 259-262.
37. Yussof, F. N. M., Ahmad, M. H., & Osman, H. (2016). *Modelling and Forecasting Malaysian Gold Price Using Hybrid ANN-GARCH.* Paper presented at the International Mathematical Forum.
38. Zainal, N. A., & Mustaffa, Z. (2016). *Developing a gold price predictive analysis using Grey Wolf Optimizer.* Paper presented at the 2016 IEEE student conference on research and development (SCOReD).
39. Zhang, G., Patuwo, B. E., & Hu, M. Y. (1998). Forecasting with artificial neural networks:: The state of the art. *International journal of forecasting*, *14*(1), 35-62.