Taylor series approximation and unbiased GM(1,1) based hybrid statistical approach for forecasting daily gold price demands

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Abstract

Purpose – The time series analysis is an essential methodology which comprises the tools for analyzing the time series data to identify the meaningful characteristics for making future ad-judgments. The purpose of this paper is to propose a Taylor series approximation and unbiased GM(1,1) based new hybrid statistical approach (HTS_UGM(1,1)) for forecasting time series data under the poor, incomplete and uncertain information systems in a short period of time manner.

Design/methodology/approach – The gray forecasting is a dynamical methodology which can be classified into different categories based on their respective functions. The new proposed methodology is made up of three different methodologies including the first-order unbiased GM(1,1), Markov chain and Taylor approximation. In addition to that, two different traditional gray operational mechanisms include GM(1,1) and unbiased GM(1,1) used as the comparisons. The main objective of this study is to forecast gold price demands in a short-term manner based on the data which were taken from the Central Bank of Sri Lanka from October 2017 to December 2017.

Findings – The error analysis results suggested that the new proposed HTS_UGM(1,1) is highly accurate (less than 10 percent) with lowest RMSE error values in a one head as well as weakly forecasting's than separate gray forecasting methodologies.

Originality/value – The findings suggested that the new proposed hybrid approach is more suitable and effective way for forecasting time series indices than separate time series forecasting methodologies in a short-term manner.

Keywords Grey mechanism, Hybrid statistical approach, Taylor series approximations, Time series forecasting, Unbiased GM(1,1)

Paper type Research paper

1. Introduction

References

Bhattacharyya, R. (2015), "A grey theory based multiple attribute approach for R&D project portfolio selection", *Fuzzy Information and Engineering*, Vol. 7, pp. 211-225, doi: 10.1016/j.fiae.2015.05.006.

Bin, L.I.U. and Qing-sheng, B.I. (2010), "The Verhulst model with remedy and its application in forecasting quantity of student taking entrance examination to college", *Computer Network and Information Security*, Vol. 7 No. 4, pp. 75-82.

Chang, C.J., Li, D.C., Huang, Y.H. and Chen, C.C. (2015), "A novel gray forecasting model based on the box plot for small manufacturing data sets", *Applied Mathematics and Computation*, Vol. 265, pp. 400-408, doi: 10.1016/j.amc.2015.05.006.

Chen, C.-I. and Huang, S.-J. (2013), "The necessary and sufficient condition for GM(1,1) grey prediction model", *Applied Mathematics and Computation*, Vol. 219 No. 11, pp. 6152-6162, doi: 10.1016/j.amc.2012.12.015.

Chen, C.I., Hsin, P.H. and Wu, C.S. (2010), "Forecasting Taiwan's major stock indices by the Nash nonlinear grey Bernoulli model", *Expert Systems with Applications*, Vol. 37 No. 12, pp. 7557-7562, doi: 10.1016/j.eswa.2010.04.088.

Chen, P.H.H. (2014), "The evolution of grey forecasting and its application on stock price prediction", *Journal of Stock & Forex Trading*, Vol. 3 No. 3, pp. 23-30, doi: 10.4172/2168-9458.1000124.

Ji, P. and Zhang, J. (2011), "A modified unbiased GM(1,1) model", *Grey System: Theory and Application*, Vol. 1 No. 3, pp. 192-201.

Julong, D. (1989), "Introduction to grey system theory", *The Journal of Grey System*, Vol. 1 No. 1, pp. 1-24.

Kayacan, E., Ulutas, B. and Kaynak, O. (2010), "Expert systems with applications grey system theory-based models in time series prediction", *Expert Systems with Applications*, Vol. 37 No. 2, pp. 1784-1789, doi: 10.1016/j.eswa.2009.07.064.

Li, Y. (2004), "Evolutionary search and optimisation enabled computer automated control system design", *International Journal of Automation and Computing*, Vol. 1 No. 1, pp. 76-88.

Lin, W.Z. and Xiao, X. (2008), "Using grey model GM(2,1) and pseudo amino acid composition to predict protein subcellular location", *The 2nd International Conference on Bioinformatics and Biomedical Engineering*, pp. 718-721, doi: 10.1109/ICBBE.2008.175.

Rathnayaka, R.M.K.T., Jianguo, W. and Seneviratne, D. (2014), "Geometric Brownian motion with Ito lemma approach to evaluate market fluctuations: a case study on Colombo stock exchange", *International Conference on Behavioral, Economic, and Socio-Cultural Computing, Shanghai, November 17*.

Rathnayaka, R.M.K.T., Seneviratna, D.M.K.N. and Jianguo, W. (2015), "Grey system based novel approach for stock market forecasting", *Grey Systems: Theory and Application*, Vol. 5 No. 2, pp. 178-193, doi: 10.1108/GS-04-2015-0014.

Rathnayaka, R.M.K.T., Seneviratna, D.M.K.N. and Jianguo, W. (2016), "Grey system based novel forecasting and portfolio mechanism on CSE", *Grey Systems: Theory and Application*, Vol. 6 No. 2, pp. 126-142, doi: 10.1108/GS-02-2016-0004.

Rathnayaka, R.M.K.T., Seneviratna, D.M.K.N., Jianguo, W. and Hasitha, I.A. (2015), "A hybrid statistical approach for stock market forecasting based on artificial neural network and ARIMA time series models", *International Conference on Behavioral, Economic and Socio-Cultural Computing, Nanjing, November 13*, doi: 10.1109/BESC.2015.7365958.

Rathnayaka, R.M.K.T., Seneviratna, D.M.K.N., Jianguo, W. and Hasitha, I.A. (2016), "An unbiased GM (1,1)-based new hybrid approach for time series forecasting", *Grey Systems: Theory and Application*, Vol. 6 No. 3, pp. 322-340, doi: 10.1108/GS-04-2016-0009.

Sheu, T., Nguyen, P., Nguyen, P. and Pham, D. (2014), "Using the combination of GM (1,1) and Taylor approximation method to predict the academic achievement of student", *Grey Model*, Vol. 1 No. 2, pp. 1-14.

Valipour, M., Banihabib, M.E. and Behbahani, S.M.R. (2013), "Comparison of the ARMA, ARIMA, and the autoregressive artificial neural network models in forecasting the monthly inflow of Dez Dam reservoir", *Journal of Hydrology*, Vol. 476, pp. 433-441.

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Wang, J., Ma, X., Wu, J. and Dong, Y. (2012), "Optimization models based on GM (1,1) and seasonal fluctuation for electricity demand forecasting", *International Journal of Electrical Power and Energy Systems*, Vol. 43 No. 1, pp. 109-117, doi: 10.1016/j.ijepes.2012.04.027.

Wu, W.Y. and Chen, S.P. (2005), "A prediction method using the grey model GMC(1, n) combined with the grey relational analysis: a case study on internet access population forecast", *Applied Mathematics and Computation*, Vol. 169 No. 1, pp. 198-217, doi: 10.1016/j.amc.2004.10.087.

Xu, W., Gu, R., Liu, Y. and Dai, Y. (2015), "Forecasting energy consumption using a new GM-ARMA model based on HP filter: the case of Guangdong Province of China", *Economic Modelling*, Vol. 45, pp. 127-135, doi: 10.1016/j.econmod.2014.11.011.

Zhang, J., Lo, W.L. and Chung, H. (2006), "Pseudocoevolutionary genetic algorithms for power electronic circuits optimization", *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. 36 No. 4, pp. 590-598.

Zhang, Y., Li, F. and Yang, Y. (2012), "Different Zhang functions leading to different Zhang dynamics models illustrated via time-varying reciprocal solving", *Applied Mathematical Modelling*, Vol. 36, pp. 4502-4511.

Zhao, Z., Wang, J., Zhao, J. and Su, Z. (2012), "Using a grey model optimized by differential evolution algorithm to forecast the per capita annual net income of rural households in China", *Omega*, Vol. 40 No. 1, pp. 525-532.

Zhong, T., Guo, W., Wang, D. and Du, Y. (2011), "A novel Nonlinear Grey Bernoulli Forecast Model NGBM(1,1) of underground pressure for working surface", *Electronic Journal of Geotechnical Engineering*, Vol. 16, pp. 1441-1450.

Zhou, W. and He, J.M. (2013), "Generalized GM(1,1) model and its application in forecasting of fuel production", *Applied Mathematical Modelling*, Vol. 37 No. 9, pp. 6234-6243, doi: 10.1016/j.apm.2013.01.002.

Further reading

Rathnayaka, R.M.K.T. and Seneviratna, D.M.K.N. (2014), "GM(1,1) analysis and forecasting for efficient energy production and consumption", *International Journal of Business, Economics and Management Works*, Vol. 1 No. 1, pp. 6-11, available at: https://doi.org/10.5281/zenodo.18402

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