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A statistical approach to assess faceted blue sapphire gemstones

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The gem industry is a promising contributor to Sri Lankan economic development. The gemstone market prices are set by professional gem evaluators based on their tacit knowledge. Although the valuation of gemstones is complex due to the high variability in their characteristics, establishing a standard model that minimizes overpricing or under-pricing of gemstones helps stakeholders and preserves the reputation of the gem industry. This research aims to develop a statistical model to assess faceted blue sapphires based on affecting factors of gemstones such as colour, inclusions, cracks, cut, weight, state of treatment, and calibration. All exported gemstone records from February to September 2022 were collected from the National Gem and Jewellery Authority. A total of 881 records composed of single (409) and batch assessments (472) of faceted blue sapphire were utilized for modelling. Multiple linear regression (MLR), quantile regression (QR), support vector regression (SVR), feedforward neural network (FFNN), and generalized regression neural network (GRNN) were employed in developing pricing models. However, MLR and QR models showed a reduction of some important variables from the model. Further, the MLR model was not adequate due to the violation of the assumptions for both heteroscedasticity and autocorrelation. The performances of SVR, FFNN, and GRNN models were compared using mean squared error (MSE), root mean squared error and mean absolute percentage error. MSE for SVR, FFNN, and GRNN were 0.0697, 0.0733, and 0.0730 respectively. Even though all three models exhibit similar performances, GRNN provided a closer approximation for most of the cases. Further SVR (MSE=0.0419) and GRNN (MSE=0.0700) models were separately developed to address the most common single-piece assessment. Results revealed that the SVR model with Gaussian kernel outperforms in single assessments while GRNN provides closer predictions to all assessments. Future studies can be conducted to develop a model using the generalized method of moments which is widely used in violation of both heteroscedasticity and autocorrelation. Moreover, this study can be extended to developing statistical models to assess other varieties of gemstones. Finally, developing and implementing an application decision support tool to assess gemstones would be highly beneficial.

Keywords: Multiple linear regression (MLR), Quantile regression (QR), Support vector regression (SVR), Feedforward neural network (FFNN), Generalized regression neural network (GRNN)