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Forecasting World Gold Prices: Evidence in Eight Countries

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ABSTRACT

The study seeks to monitor global gold prices on the demand side using time-series analysis. Moreover, the study intends to elicit from mining key players the value of gold price forecasting at the production level. Quarterly data from 2010 on the prevailing prices of gold prices from eight key countries were estimated using regression against time (RAT) model patterned from the simple linear regression equation. Results revealed that the eight gold price time-series are fluctuating at various months, depending on the demand for gold. while time is a significant function for world gold prices in terms of U.S. dollars, Swiss francs and the Chinese RMB find time as an insignificant predictor of gold price fluctuation. Implications were discussed.

Keywords: forecasting, world gold prices, time-series forecasting, regression-against-time, Philippines

INTRODUCTION

In the last five years, gold mine production has been dropping while the price of gold has increased considerably. Forecasts of sustained high demand for gold, as well as the current U.S. involvement in adopting some "gold standard," have focused explicitly on additional gold supply (Hao, Sheng & Zhang, 2019; Sharma, Gupta & Gopal, 2019; Zhang, Ding, Liu & Chang, 2017). On the other hand, gold has a supply and demand pattern that is significantly distinct from other metals. Even though the price of gold has grown significantly faster than the price of other metals over the last decade, gold mine production has decreased. The extraordinary rise in gold prices after 1973 represented a lack of faith in paper currency in the context of inflationary pressures and expectations and international political instability. The recent significant decrease in gold prices manifests high U.S. interest rates, money market instability, and Soviet and Middle Eastern gold sales (Laakso, 2019).

The daily average of international gold prices increased to 24.7% year-over-year in 2021, comparatively higher than the 16% growth from the previous fiscal year. The unprecedented spread of COVID-19 around the globe was perceived as the principal cause of this increase (Atri, Kouki & Imen Gallali, 2021; Depren, Kartal & Depren, 2021; Gharib, Mefteh-Wali & Jabeur, 2021). In January 2020, international gold prices jumped 5.2% (Dec-19 to Jan-20). With each passing day, as more individuals have tested positive for the virus, several authorities in developed and developing nations enforced stringent nationwide lockdowns resulting in negative public sentiment. This also resulted in a surge in investment preferences in safe-haven asset classes, like precious metals, by withdrawing funds from riskier alternatives (Syahri & Robiyanto, 2020).

Indeed, gold has many features in its current condition. The desire for gold convertibility might contribute to the notion that restoring a full and automated gold standard locally and internationally will address the issues of economic and social balance in some inexplicable but inescapable way (Ansari & Sensarma, 2019; Eryigit, 2017; Raza, Shah & Shahbaz, 2018). In times of uncertainties, all macroeconomic concerns caused investors to be apprehensive, and gold became more popular in their portfolios. For the past 12 months, global prices of this precious metal have significantly increased because of the increasing demand. Domestic prices also increased, but they began to fall in the last two months of the year as import taxes were reduced in the Union Budget (Bouri, Shahzad, Roubaud, Kristoufek & Lucey, 2020).

The mining sector contributes significantly to the country's economic growth. It plays a considerable role in providing employment opportunities to the community, both internally and externally. In 2018, roughly 20.8 kilograms of gold were produced in the Philippines. The entire production of this kind of metal has improved since 2013. Baguio and Paracale in Luzon, as well as Masara, Surigao, and Masbate in Mindanao, are the leading gold mining regions in the Philippines. Since worldwide prices are driven by gold production, producers must maintain a consistent production level in the face of global demand.

There is a predetermined official gold price to which world currencies are linked directly or indirectly for monetary reasons, with the mutual ties between currencies signifying their relationship to gold. Therefore, the price of gold in terms of any currency has a monetary significance of great import, both domestically and internationally. Whether the fixed gold price continues to serve its purpose entirely must accordingly be judged solely from the monetary viewpoint of gold

producers. In electing to produce the world's primary monetary metal, one must be prepared to accept both the windfalls and the risks of their very specialized type of industry (Parimi, 2018).

Given the importance of gold in the world today, it is clear that the ability to make accurate predictions value of gold will be critical. Furthermore, there are advantages to selecting a suitable approach that forecasts the gold price more precisely than others (Chen & Xu, 2019; Tripathy, 2017; Liu & Li, 2017). Out-of-sample forecasting provides monetary and policymakers, hedge fund managers, and international portfolio managers with information that can be used to forecast future inflation, estimate jewelry demand, choose precious metals as well as various commodities to invest in, and assess the future movement of the dollar exchange rate (Jeribi & Ghorbel, 2021).

More studies need to be connecting forecasting and sustainable environmental protection and policy, especially in extractive industries like mining. World gold price monitoring studies usually stem from economic and econometric concerns, devoid of social and environmental fibers. This study would address this dearth in the literature for two crucial reasons: first, the study aims to integrate forecasting and trend analysis with concerns about the utility of these tools in the production and extraction activities of the gold mining industry in a localized setting. In terms of social relevance, as this study aims to monitor (and technically forecast) world gold prices, this would benefit mining companies. They can use substantial information in the forecast for their production and extraction activities, especially in preparing technical reports, feasibility studies, and mine explorations submitted to pertinent authorities.

On a policy level, the Mines and Geosciences Bureau will also benefit from the study, as the institution will be

provided with a reasonable and sound study intended to improve its reports. The MGB can use the study as an accomplishment, and they can also participate and eventually use the localized, sustainable mining policy based on the findings of the study. Policymakers in the locality can also use the developed policy to review local mining industry operations. Finally, as mentioned above, the study could contribute to the dearth of discussion on world gold prices and local gold production. Future research can use the study's findings as part of their literature, discussion of contexts, or as a support/negation of their findings.

With the implication of gold in the current time, monitoring the prices of this precious metal drives the mining activities of a country that produces the metal. This would drive the country to find better technologies in mining and develop sound and sustainable policies. Moreover, as one of the key players of the government institution that oversees mines and geosciences, it is of interest for the researcher to investigate gold production and its prices in the global market to see the possible demand the country could contribute to the global sphere. Finally, the study could contribute to the discussion of forecasting global prices vis-à-vis the country's gold production. With this, this research seeks to monitor global gold prices as the basis for a localized responsible mining policy. Specifically, the study seeks to: (1) establish the trend of world gold prices; and (2) predict possible world gold prices. Time-series forecasting will be the fundamental approaches to ultimately predict future gold prices for immediate periods.

METHOD

Data Sources. The setting of the study depends on the aspect of data analysis since the locale was considered as the source and unit of analysis. The study involved the use of secondary data as reported by the World Gold Council, which means that the price data are coming from participating countries, namely, the United States (US$/oz), European Union (€/oz), United Kingdom (£/oz), Switzerland (CHF/kg), Japan (¥/g), India (Rs/10g), China (RMB/g), and Turkey (TL/g). For the qualitative phase, the locale of the study is Region XI or the Zamboanga Peninsula Region.

The quarterly data on world gold prices were taken from the published report of the World Gold Council, which can be downloadable online from their website. In a published report entitled Gold Demand Trends Data Tables, secondary data on quarterly world gold prices were used.

Design and Procedure. This study used a descriptive research method to characterize a situation or condition. Despite the use of quantitative and qualitative data, the descriptive approach is suitable for better understanding research problems (Blessing & Chakrabarti, 2009). In this study, quantitative data used was world gold prices, which was analyzed by means of descriptive means. The study involved trend analysis and a regression-against-time (RAT) model in the forecasting of world gold prices in the quantitative phase.

Meanwhile, for the proper conduct of the study, the researcher first wrote a letter to the Dean of the Professional Schools to ask for permission to conduct the study and to the U.M. Ethics Review Committee (UMERC) to secure clearance to conduct the study. Upon approval, the researchers proceeded in performing statistical analysis of the downloaded world gold price dataset. Data from the quantitative phase was processed

using graphical and statistical approaches. The study used trend analysis, which was used to establish if the world gold prices follow a specific linear trend and regression-against-time (RAT) model, which would become an input to determine future values of world gold prices based on historical data.

Ethical Consideration. The researchers strictly observed full ethical standards in conducting the study, contingent on UMERC approval number 2022-266.

RESULTS AND DISCUSSION

The Trend of World Gold Prices

Descriptive statistics for the prevailing world gold prices were computed to determine the properties of the time-series dataset. Table 1 summarizes descriptive statistics for the eight world gold prices.

Analysis reveals that the average gold price in the United States per ounce (U.S. $/oz) since 2010 is U.S. $ 1,385.39 (SD=211.72), €1,138.68 per ounce (SD=180.56) in the European Union, £961.85 (SD=181.51) per ounce in the case of United Kingdom, CHF 42,554 per kg in Switzerland (SD=5,583.49), ¥4,481.20 per gram in Japan (SD=645.79), Rs 27,301.16 per 10 grams in India (SD=6,032.32), RMB 291.51 per gram in China (SD=291.51), and TL 148.97 per gram in Turkey (SD=100.29).

In addition, gold prices in Japan, India, and Turkey are mesokurtic, given that their kurtosis values are close to 3. In contrast, gold prices in the United States and Switzerland exhibited a negative kurtosis value, indicating platykurtic (McLeod, 2019). Moreover, gold prices in the United States, European Union, Switzerland, United Kingdom, and China are slightly skewed (values between 0.50 to 1.0). At the same time, Japan, India, and Turkey are highly skewed (values greater than

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Table 1. *Summary statistics of prevailing world gold prices (T=44)*

Statistic	***US$/oz***	***€/oz***	***£/oz***	***CHF/kg***	***¥/g***	***Rs/10g***	***RMB/g***	***TL/g***
Mean	1385.39	1138.68	961.85	42554.19	4481.20	27301.16	291.51	148.97
S.E.	31.92	27.22	27.36	841.74	97.36	909.41	7.17	15.12
S.D.	211.72	180.56	181.51	5583.49	645.79	6032.32	47.55	100.29
Variance	44826.30	32601.73	32946.22	31175412.68	417042.57	36388842.52	2261.08	10058.17
Kurtosis	-0.24	0.87	1.13	-0.26	2.87	2.69	0.38	3.01
Skewness	0.89	0.97	1.03	0.84	1.22	1.27	0.98	1.83
Minimum	1106.45	802.43	712.37	34875.90	3234.13	16369.08	227.17	53.84
Maximum	1908.56	1632.51	1477.59	56436.82	6511.76	45639.98	424.51	475.68
C.I. (95.0%)	64.37	54.90	55.18	1697.54	196.34	1833.99	14.46	30.49

1.0). This indicates the behavior variance if world gold prices are at specific times. Finally, world gold prices for all countries have a consistent, gradual increase over time, showing a steady increase in the first eight quarters starting in 2010, followed by a gradual decline of prices in the middle quarters, and a steady increase after that.

The behavior of the world gold price series was determined by plotting the values using a line graph in order to validate the descriptive statistics. As seen in Figure 1, world gold prices for all countries have consistent, gradual increases over time, with similar patterns despite differences in values and measurement units. The graph shows a steady increase in the first eight quarters starting in 2010, followed by the gradual decline of prices in the middle quarters and a steady increase thereafter.

Results of Prediction of World Gold Prices

Table 2 shows the RAT model statistics for the analyses made for the eight time-series data. Five of the eight prevailing gold prices exhibit a linear association of time and quarterly gold price as revealed in the RAT models' respective ANOVA tables – European Union ($F(1,42)= 15.42$, $p<0.05$), United Kingdom ($F(1,42)=17.91$, $p<0.05$), Japan ($F(1,42)=70.93$, $p<0.05$), India ($F(1,42)=51.60$, $p<0.05$), and Turkey ($F(1,57)=94.39$, $p<0.05$). As also seen in the R^2 of these world gold prices, time *T* explains 26.8% of the variance of gold price in the European Union, 29.9% of the variance of gold price in the United Kingdom, 62.8% of the variance for Japan, 55.1% of the variance of gold price in India, and 69.2% of the variance of gold price in Turkey.

On the other hand, Table 3 shows the regression analysis results showing the slope and intercept values for the eight world gold prices. Determining these values is important

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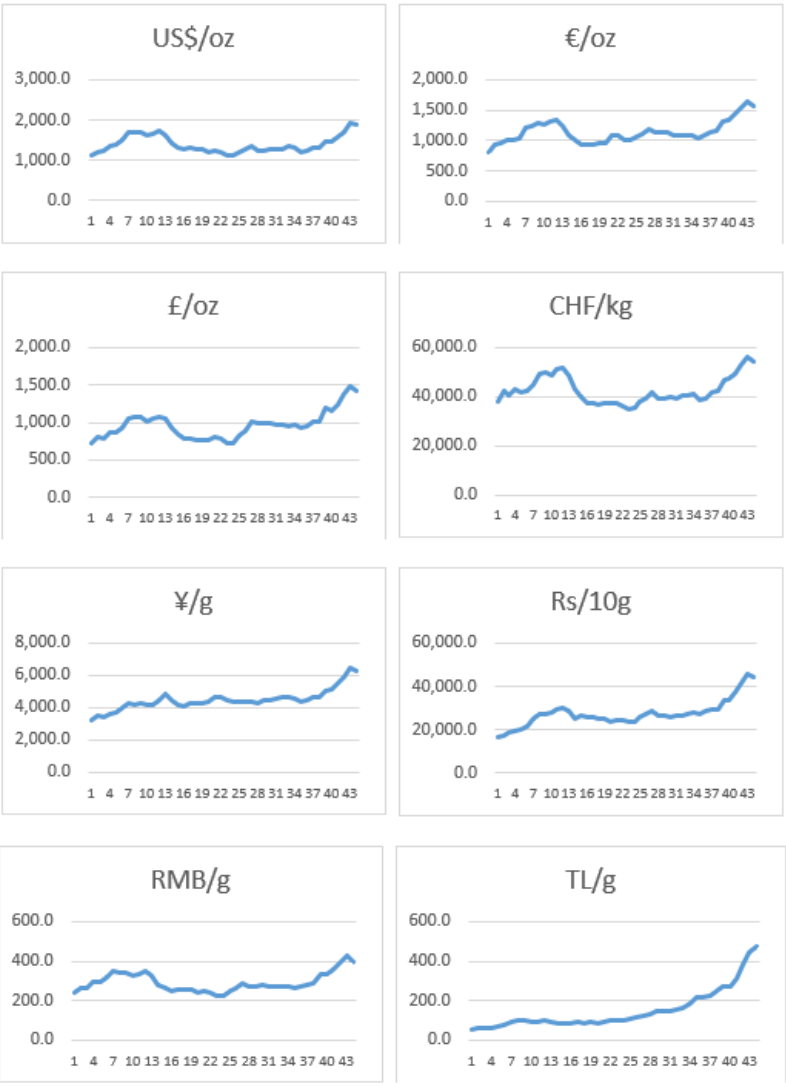

Figure 1. *Line graphs showing values of the world gold prices in eight countries*

Table 2. *Regression goodness of fit statistics for gold prices (T=44)*

Statistic	***US$/oz***	***€/oz***	***£/oz***	***CHF/kg***	***¥/g***	***Rs/10g***	***RMB/g***	***TL/g***
Multiple R	0.07	0.52	0.55	0.15	0.79	0.74	0.23	0.83
R^2	0.01	0.27	0.30	0.02	0.63	0.55	0.05	0.69
Adjusted R^2	-0.02	0.25	0.28	0.00	0.62	0.54	0.03	0.68
S.E.	213.64	156.25	153.77	5586.84	398.50	4088.59	46.85	56.31
Observations	44	44	44	44	44	44	44	44

in the deseasonalization process. This is to create a forecast based on the increase or decrease of slopes at a given time. The regression follows the formula $y = mx + b$, where y is the world gold price for the concerned country for a specific period/time, m is the slope, b is the intercept, and x is any given time.

In this study, forecasting was performed using the regression-against-time (RAT) model, where succeeding values are dependent as time goes by. In forecasting, regression analysis is the most used approach of causal modeling (Montgomery, Jennings & Kulahci, 2015) and to perform deseasonalization or eliminate a data series' seasonal component. Furthermore, parameters are based on historical data, and future estimates utilize the same values.

Under Model 1 (**US$/oz**), the slope is 1.220, and the intercept is 1,357.947. Under Model 2 (**€/oz**), the slope is 7.284, and the intercept is 974.788. Under Model 3 (**£/oz**), the slope is 7.727, and the intercept is 788.005. Under Model 4 (**CHF/kg**), the slope is 64.595, and the intercept is 41,100.798. Under Model 5 (**¥/g**), the slope is 39.843, and the intercept is 3584.720. Under Model 6 (**Rs/10g**), the slope is 348.686, and the intercept is 19,455.714. Under Model 7 (**RMB/g**), the slope is 0.843, and the intercept is 272.540. Lastly, under Model 8 (**TL/g**), the slope is 6.495, and the intercept is 2.832. All models indicate that an increase in time insinuates an increase in world gold prices regardless of the significance of the equations.

What will be the forecasted values for world gold prices in the immediate/successive quarters? To answer this question, the functional equations based on the regression results were used, and respective *x*-values were substituted by the specific quarter in the next two years (45 to 52). Table 4 shows that forecast gold price values for the 45th quarter are US$ 1,412.85 per ounce, €1,302.57 per ounce, £1,135.72 per ounce, CHF 44,007.57 per kg, ¥5,377.66 per gram, Rs 35,146.58 per 10

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Table 3. *Regression statistics showing the slope and intercept values for world gold prices*

	B	*S.E.*	*t*	*p-value*	*Lower 95%*	*Upper 95%*
Model 1: ***US$/oz***						
(Constant)	1357.947	65.529	20.723	0.000	1225.705	1490.190
Time	1.220	2.536	0.481	0.633^{ns}	-3.899	6.338
Model 2: ***€/oz***						
(Constant)	974.788	47.927	20.339	0.000	878.067	1071.508
Time	7.284	1.855	3.927	0.000***	3.540	11.028
Model 3: ***£/oz***						
(Constant)	788.005	47.165	16.707	0.000	692.821	883.188
Time	7.727	1.826	4.232	0.000***	4.042	11.411
Model 4: ***CHF/kg***						
(Constant)	41100.798	1713.626	23.985	0.000	37642.562	44559.035
Time	64.595	66.327	0.974	0.336^{ns}	-69.258	198.449
Model 5: ***¥/g***						
(Constant)	3584.720	122.229	29.328	0.000	3338.053	3831.387
Time	39.843	4.731	8.422	0.000***	30.296	49.391

Model 6: ***Rs/10g***						
(Constant)	19455.714	1254.072	15.514	0.000	16924.894	21986.535
Time	348.686	48.540	7.184	0.000***	250.729	446.643
Model 7: ***RMB/g***						
(Constant)	272.540	14.370	18.966	0.000	243.541	301.540
Time	0.843	0.556	1.516	0.137^{ns}	-0.279	1.966
Model 8: ***TL/g***						
(Constant)	2.832	17.273	0.164	0.871	-32.026	37.689
Time	6.495	0.669	9.715	0.000***	5.146	7.844

grams, RMB 310.48 per gram, and TL 295.11 per gram, respectively. In addition, in the same table, forecast gold price values for the 52nd quarter would have increased to US$ 1,421.39 per ounce, €1,353.56 per ounce, £1,189.81 per ounce, CHF 44,459.74 per kg, ¥5,656.56 per gram, Rs 37,587.39 per 10 grams, RMB 316.38 per gram, and TL 340.57 per gram. This means that prices of world gold, regardless of units of measurement, have steadily increased over time, which could be attributed to growing demand and decreasing global supply for the precious mineral.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concludes that world gold prices can be subjected to forecasting. The time-series datasets for each world gold price are seen to have increased prices over time, which could be driven by increased demand and gradual depletion of the precious mineral. It can also be seen that the fluctuations in gold prices, regardless of the world price, country standard, and unit of measurement, are consistent. Furthermore, while time is a significant function for world gold prices in terms of U.S. dollars, Swiss francs and the Chinese RMB find time as an insignificant predictor of gold price fluctuation.

Recommendations

The study's findings could result in various implications for the improvement of mining practices and future research. As a scholarly basis, the findings provided theoretical and practical insights as to how forecasting can aid in the decision-making of mining key players, especially in preparing mineral exploration programs that are critical requirements for mine

Table 4. *Forecast values for world gold prices in the next eight quarters*

If *x* is…	***US$/oz***	***€/oz***	***£/oz***	***CHF/kg***	***¥/g***	***Rs/10g***	***RMB/g***	***TL/g***
45	1,412.85	1,302.57	1,135.72	44,007.57	5,377.66	35,146.58	310.48	295.11
46	1,414.07	1,309.85	1,143.45	44,072.17	5,417.50	35,495.27	311.32	301.60
47	1,415.29	1,317.14	1,151.17	44,136.76	5,457.34	35,843.96	312.16	308.10
48	1,416.51	1,324.42	1,158.90	44,201.36	5,497.18	36,192.64	313.00	314.59
49	1,417.73	1,331.70	1,166.63	44,265.95	5,537.03	36,541.33	313.85	321.09
50	1,418.95	1,338.99	1,174.36	44,330.55	5,576.87	36,890.01	314.69	327.58
51	1,420.17	1,346.27	1,182.08	44,395.14	5,616.71	37,238.70	315.53	334.08
52	1,421.39	1,353.56	1,189.81	44,459.74	5,656.56	37,587.39	316.38	340.57

exploration applications to the Mines and Geosciences Bureau. For future researchers, further studies on the value of forecasting gold prices are encouraged in the demand and supply side of mining operations.

The study provides specific urgent and long-term recommendations. On the part of the Mines and Geosciences Bureau, close coordination with the mining sector, the National Economic and Development Authority, and the local governments is encouraged, as world gold prices are highly dependent on global macroeconomic situations and the availability of supply in mining areas. In mining key players, further training on quantitative data analysis and forecasting is necessary, as qualitative results revealed them to be important in better decisions pertaining to production and extraction planning.

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