Journal of Economics and Sustainable Development www.iiste.org
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.8, No.7, 2017

Gold and Exchange Rate: Causality and Predictability

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Abstract

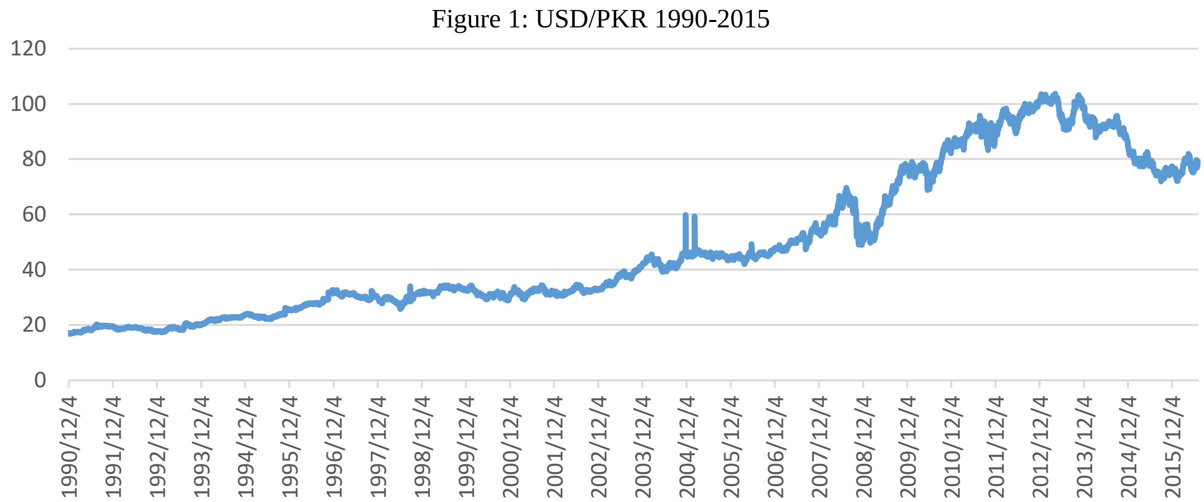
Gold prices have shown a remarkable increase along with the weakening of Pakistani rupee (PKR) over the past several years. This study investigates gold-exchange rate association in context of Pakistan. It is focused on the interrelationships of exchange rate and gold in terms of causality and predictive ability. Time series daily data for the period 1992-2015 on four foreign currencies against the PKR are being used. Applying augmented vector auto regression (VAR) and dynamic model, the study finds that the causality runs from exchange rate to gold. Moreover, exchange rate possesses the predictive ability for the gold and the predictive ability is robust across short horizons for out of sample forecasting. The findings of this study will benefit investors, policy makers and academicians.
Keywords: Exchange rate; Gold; Pakistan.

JEL Code: F3, F31, G1, G10, G15, G32

1. Introduction

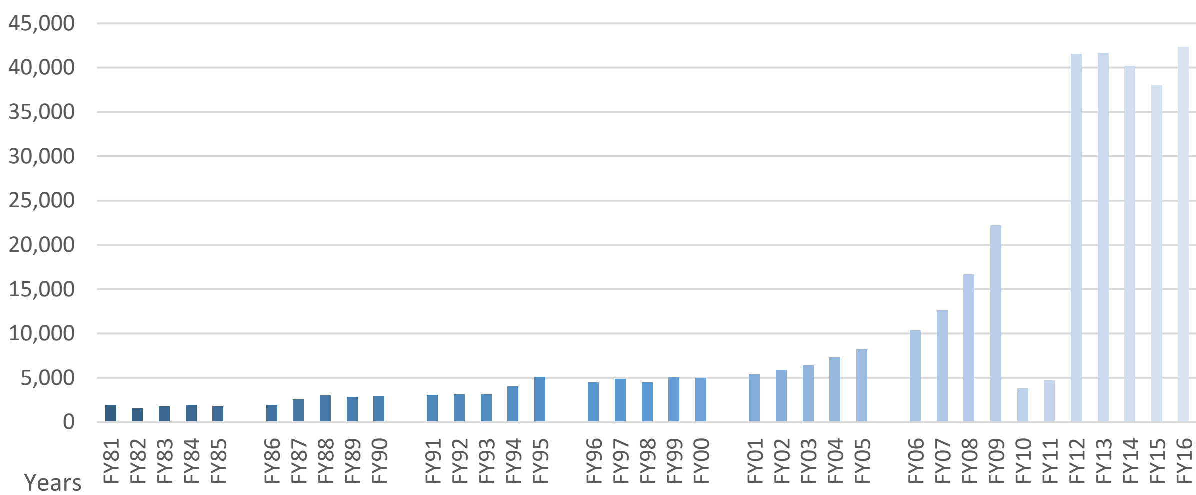
Despite the global financial crisis, particularly the stock market downfalls and economic collapses, the upsurge in demand for gold continues to be remarkable, since past several years. Gold possess idiosyncratic characteristic which makes it unique from other assets and commodities. Ghosh et al. (2004), Capie et al. (2005), Baur and Lucey (2010) and Reboredo (2013) finds that the gold is a successful hedge against political turmoil, high inflation rates and currency weaknesses. Furthermore, the gold has been associated with the dollar since last few decades and this relationship is expressed according to the law of one price which is absolute form of Purchasing power parity. The law of one price suggests that the dollar depreciations correspond to the appreciation in the gold prices. This gold exchange rate nexus has been examined in several studies (Beckers and Soenen, 1984; Sjaastad and Scacciavillani, 1996; Capie et al., 2005; Le and Chang, 2011; Zagaglia and Marzo, 2013; Reboredo and Castro, 2014). However, these studies have been more focused towards the developed nations, and the gold-exchange rate relationship has not been explored rigorously for the developing nations like Pakistan.

Pakistan's exchange rate has been fluctuating since long and the Pakistani Rupee (PKR) has been constantly depreciating in the international market. For example, Mahmood et al. (2011) find that Pakistan experienced devaluation of rupee by 30% in June 1955, which created a worst inflationary situation. Rupee continued to lose its worth by 58% in 1972 and 17% in 1996 respectively. Figure 1 shows the average annual exchange rate (USD/PKR) from 1990-2015. Since last few years, specifically 2008, the political issues have depressingly influenced the economic variables in Pakistan. Exchange rate as macroeconomic variable was also adversely affected during these crises.



Source: www.sbp.org.pk

Figure 2: Gold prices in PKR per 10 gram)



Source: www.sbp.org.pk

However, despite the recent economic downturns in Pakistan, an unexpected switch of investment in gold has been observed. This may be due to the fact that gold is generally believed to be a safe haven investment. Nadeem et al (2014) points that especially since February 2012, the investors seem to prefer investing in gold as it offers higher returns comparative to stocks, bonds and certificate of deposits. Figure 2 shows the gold prices in PKR over the period of 1981-2016. In addition, the significance of the gold for Pakistan cannot be ignored because the major portion of Pakistan's imports consists of gold and Pakistan has always kept sufficient gold reserves for future stability and security. According to world gold council, Pakistan has become top ten consumers of gold. Table 1 depicts the demand for gold in selected countries. At domestic level, it is observed that the gold futures are highly traded in Pakistan Mercantile Exchange (Shahbaz et al., 2014). Since, fluctuations in both gold prices and exchange rates have been frequent in Pakistan for several years, it is very much relevant to explore and understand the Gold-Exchange rate relationship in context of Pakistan.

Numerous studies exist on dynamic relationship specifically causality between gold and exchange rate (Sari et al., 2010; Pukhthuanthong and Roll, 2011; Sujit and Kumar, 2011; Jain and Ghosh, 2013). However, findings of these studies are mixed including unidirectional and bidirectional causalities. Moreover, the studies use traditional vector autoregressive (VAR) models to identify the causality which does not account for serious issues related to time series trend. These issues are discussed in detail further in section 3 of methodology. Besides causal links, predictability between gold and exchange rate has rarely been explored in literature (Chen et al., 2008; Apergis 2014). On the other hand, the studies conducted on this topic are mainly focused on developed economies. Previous studies in developed countries such as US, UK, Japan and Germany include (Capie et al., 2005; Ciner et al., 2013; Le and Chang, 2011; Pukhthuanthong and Roll, 2011; Sujit and Kumar, 2011), while handful of studies exist for developing countries specifically Pakistan (Nadeem et al., 2014) and they use only USD against PKR in this context while other foreign currencies are not taken into consideration.
This study addresses the highlighted issues by examining the gold-exchange rate nexus in terms of causality and predictability in Pakistan. The contribution of this study is mainly three folds towards the existing literature. First, the study examines dynamic relationship between gold and exchange rate in perspective of causality and predictive ability concurrently. Second, the study considers set of other currencies against PKR in addition to dollar as a foreign currency. Third, the study estimates causality and forecasting analysis based on Augmented VAR model to subdue the common time series issues. Findings of the study suggest that the exchange rate significantly causes the gold, and effectively predicts gold prices in the short run over various time horizons.
Rest of the paper is organized as follows: Brief review of the relevant literature in section 2. Description of data and methodology is discussed in section 3. Section 4 discusses empirical results and concludes in section 5.

Table 0.1: Gold demand in tones

	2014(Q4)	2015(Q1)	2015(Q2)	2015(Q3)	2015(Q4)	%change(Q4'15 vs Q4'14)
Sri Lanka	1.5	1.7	2.1	1.6	1.7	16
Pakistan	9.7	8.4	7.9	9.2	10.4	7
India	219.7	191.7	154.8	269.1	233.2	6
China	243.7	280.2	215.7	238	250.6	3
Hong Kong	17.9	14	10.8	14.2	13.9	-22
Taiwan	4.4	3.6	2.9	3.2	3.7	-15

Note: Table reports the demand for gold in selected countries. Source: www.sbp.org.pk

2. Review of Relevant Literature

Literature explores various aspects of gold exchange rate nexus. Beckers and Soenen (1984), Sjaastad and Scacciallani (1996), Sjaastad (2008), Capie et al (2005), Pukthuanthong and Roll (2011), Wang and Lee (2016) identifies gold price association with currency rates. Former two studies propose the relationship based on law of one price and the latter studies confirming this established negative gold-exchange rate association. These underlying results on hedging property of the gold have been extended in studies of Joy (2011), Ciner et al. (2013), Reboredo (2013) and find that gold is useful in portfolio risk management and are an effective safe haven in times of extreme USD movements. Yet, most of these studies are conducted in developed economies including US, UK, Japan and Germany. Literature is particularly silent in context of developing economies in this regard. Limited studies address gold and exchange rate relationship in developing country like Pakistan (Jan et al., 2012; Nadeem et al., 2014). However, studies examine only USD/PKR exchange rate without taking into account other foreign currencies.

The forecasting and causal relation of gold and exchange rate has also been focused in numerous studies (Chen et al., 2008; Sari et al., 2010; Sujit and Kumar, 2011; Pukthuanthong and Roll, 2011; Jain and Ghosh, 2013; Badshah et al., 2013; Apergis, 2014; Jain and Biswal, 2016; Zhang et al., 2016). Studies on causality and forecast are summarized in Table 2; the key findings along with methodologies of the studies are briefly listed. Studies find that causality runs from exchange rate to goldsuch as (Sari et al., 2010; Pukhthuanthong and Roll, 2011; Jain and Ghosh, 2013; Beckmann et al., 2015). On the other side, studies that identify that gold causes exchange rate for example (Sujit and Kumar, 2011; Jain and Biswal, 2016; Zhang et al, 2016). Bidirectional causalities have also been observed in studies of Badshah et al. (2013) and Sujit and Kumar (2011)1. Though, the overall results on causalities remain mixed. In addition, the studies estimate different VAR models including traditional VAR models. Still, integration and cointegration order issues in time series are ignored except study of Jain and Ghosh (2013) which studies gold and exchange rate relationship in India. There is also scarce research on forecasting relationships in this subject matter. Chen et al. (2008) confirms that exchange rates are better predictors of gold prices whereas Apergis (2014) concludes that forecasting ability of gold is robust for exchange rate.

While previous studies apply traditional VAR and granger causality to examine causal relation, the current study applies augmented VAR and Toda- Yamamoto granger causality which has additional advantage over traditional VAR since it overcomes biased results irrespective of integration and cointegration issues common in time series methodologies. Further, this study is not limited to bilateral rate against dollar but several other bilateral rates are also taken into consideration.

[1] Study of Sujit and Kumar (2011) uses two models i.e. gold prices in dollar and euro and find different results for both models

Table 2: Summary of Causal/forecasts Studies

Author(s)	**Research Purpose**	**Sample period**	**Methodology**	**Findings**
Chen et al. (2008)	Assesses exchange rate role of forecasting for gold and whether gold forecast exchange rate	Australia (1984:1 to 2008:1), Canada (1973:1 to 2008:1), Chile (1989:3 to 2008:1), New Zealand (1987:1 to 2008:1), and South Africa (1994:1 to 2008:1).	Granger Causality tests, Random walk and Autoregressive model	Exchange rates predict commodity pricesin sample and out of sample while commodity prices are less anticipating.
Sari, Hammoudeh and Soytas (2010)	This study analyzes information transmission and co movement among precious metals (gold), oil price and dollar/euro exchange rate	1/4/1999-10/19/2007	ARDL bounds testing and cointegration	There exist weak long run relationship however in the short run strong feedbacks are found. The metal market respond significantly to a shock in metal prices and exchange rate
Sujit and Kumar (2011)	Examines dynamic relationship among gold prices, stock returns, exchange rate and oil prices	1/2/1998-6/5/2011	Cointegration test, Vector Autoregressive, Granger causality	Causality runs from gold euro to exchange rate. However for gold index in dollar, bidirectional causality is observed.
Pukthuanthong and Roll (2011)	Aims to prove law of one price for other major currencies i.e. Euro, Pound, and Yen	2/1/1971-12/10/2009	Dynamic Conditional Correlation, Bivariate regression, VAR	Exchange rate causes gold returns
Jain and Ghosh (2013)	This study surveys co integration and causality between gold, oil, and Indian Rupee/Dollar rate	1/2/2009–12/30/2011	ARDL bounds test and Granger causality	Transmission effects found between the global oil prices, Indian precious metals and foreign exchange market. Unidirectional causality, exchange rate causes gold returns
Badshah et al. (2013)	Study examines volatility spillover for stocks, gold and dollar exchange rate using implied volatility indices	3/6/2008-12/30/2011	VAR and Structural VAR, Granger Causality	Bidirectional causality between volatility indices of exchange rate and gold
Apergis (2014)	Explores whether gold prices predict real and nominal	2000-2012	Error Correction Model, VAR	Forecasting ability of gold is robust.

	Australian$/US$ exchange rates			
Beckmann et al (2015)	Examines causality and volatility transmission between gold prices and exchange rates using bilateral rates i.e. US$, EUR, JPY, GBP, INR	1979-2013	GARCH in mean SVAR	Results reveal that impact of exchange rate depreciation negatively affects gold price. However, this impact is regressed to positive after one day. While there is mixed finding on impact of volatility in gold price on exchange rate
Anshul Jain andP.C.Biswal (2016)	The study examines relation between global prices of gold, crude oil, USD–Indian rupee rate, and the stock market in India.	2006-2015	DCC GARCH, Nonlinear causality test	Analyses indicate that fall in gold prices and crude oil prices cause the value of the Indian Rupee to fall thus confirming that gold causes exchange
(Zhang, Dufour et al. 2016)	Study examines causal relationships empirically, using data on three commodities (crude oil, gold, copper) and four countries (Canada, Australia, Norway, Chile) over multiple horizon	1986-2015	Granger non causality tests	Causal effects are much stronger in the direction of commodity prices to exchange rates, in short term this causality is observed to be stronger, but becomes weaker with the increase in time period

Note: This table displays the comparison of studies on causality and predictability of gold and exchange rate

3. Data and Methodology

Study uses daily data on gold prices and bilateral rupee exchange rates against foreign gold consuming and International currency countries (US dollar, Euro, UAE dirham and Saudi riyal). As currency appreciation or depreciation leads to changes in the prices of foreign compared with domestic goods and movements in exchange rate influence the decisions of investors, gold producers and gold consumers to hold gold; the study particularly considers four gold consuming currencies. Where, UAE and Saudi Arabia are included in group of gold consumers while US dollar and European Union are included in groups of both gold consumers and international currencies. Moreover, Pakistan also shares close trading association with these currencies. Zhang et al (2016) and Jain and Biswal (2016) explain that high frequency data effectively utilize and comprehend causal relation therefore study uses daily data and the sample period starts from 2/4/1992-7/28/2015. Gold price and exchange rate data is obtained from data stream and International financial statistics respectively. To standardize the series, all variables are converted to log form. Augmented Dickey Fuller (ADF) unit root test in the series and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) for cross check analysis is used to check the order of integration in the variables. Unit root tests is mainly conducted for the Toda and Yamamoto test so that the extra lags to be added to the vector autoregressive (VAR) model is determined.

Table 3 reports the results at level and at first difference and shows that there exists unit root at level for all the variables. The data is stationary at first difference which suggests the integration of order 1. Moreover, using cointegration tests (Engle & Granger, 1987; Johansen, 1988) for gold and bilateral exchange rates as shown in Table 4, both the trace statistic and maximum Eigen value statistic indicates that there is no long run association found between variables. Similar results are found in study of Beckmann et al (2015); Sujit and Kumar (2011); for stock prices and exchange rate in study of Alagidede et al (2011). Therefore, the study focuses short term relationship. In order to understand short term association, augmented vector autoregressive model is estimated.

Table 3: Unit Root Tests

Variables	**ADF**		**KPSS**	
	Level	**First Difference**	**Level**	**First Difference**
Gold				
Intercept	-0.5341	-82.7662***	9.6304***	0.1765
Intercept and Trend	-1.4429	-82.7604***	1.5954***	0.1826
RDo				
Intercept	-2.0389	-88.7014***	9.2284***	0.3167
Intercept and Trend	-1.5472	-88.7307***	1.1249***	0.08416
RDir				
Intercept	-2.0385	-88.7229***	9.2285***	0.3167
Intercept and Trend	-1.5475	-88.7525***	1.1251***	0.0849
RR				
Intercept	-2.0396	-88.9767***	9.2295***	0.3162
Intercept and Trend	-1.5467	-89.7045***	1.1262***	0.0838
RE				
Intercept	-1.3621	-84.1095***	9.7461***	0.1314
Intercept and Trend	-2.0331	-84.1146***	0.3856***	0.0583

Note: Table shows the unit root test for variables. Subscripts ***, ** and * show the significant at 1%, 5% and 10% level respectively. KPSS null hypothesis is that variable is stationary. Non-rejection of null indicates that variable is stationary

Table 4: Cointegration tests

Cointegrating Equation		**TR Statistic**	**95%**	**ME Statistic**	**95%**
0	r = 0	6.667	15.4947	6.3889	14.2647
1	r ≤ 1	0.2789	3.8414	0.2789	3.84147

TR = Trace Statistic, ME = Maximum-Eigenvalue statistic. Likelihood ratio tests is used to determine number of lags

a. Toda Yamamoto (TY) Granger Test

One of the suitable approaches for identifying causal link between variables is granger causality. (X) In time series Granger cause another variable (Y) if the prediction error of current Y declines by past values of X and past values of Y. Yet, traditional granger causality has its limits. A two way granger causality which does not take effect of other variables in consideration possesses possibility of specification bias. Gujarati (1995) explains sensitivity of a causality test to specification of model and number of lags. Hence, empirical evidence of two way granger causality is frail. Gujarati (2006) points that the procedure of F test becomes invalid when variables are integrated since the test statistic have no standard distribution. Though testing the individual significance is permissible but jointly testing the Granger causality is unacceptable. Further, Enders (2004) confirms that F statistics can be used to jointly test first difference VAR but only when one variable is nonstationary. Maddala (2001) states that because data is often nonstationary in time series which leads to problem of spurious regression. Toda and Phillips (1994) discuss such other weaknesses of these tests.

For the reason that TY is effective irrespective toI (0), I (1) or I (2) order of the series, and co-integration of any order, the study employs (Toda and Yamamoto, 1995) form of Granger non-causality in study following Jain and Ghosh (2013).

TY uses modified Wald test for restriction on the parameters of the vector autoregression (VAR) (k) (where k is the lag length). The (k) is augmented by the maximal order of integration (dmax) in the system. This is further estimated with the coefficients of the last lagged dmaxthus ignoring the vector. The chi square distribution with degrees of freedom equal to the number of the excluded lagged variables is then followed by Wald statistic. As the procedure does not requires pretesting of properties of cointegrating in the model, therefore it avoids associated biasness of unit root and cointegration tests. (Zapata and Rambaldi, 1997; Clarke and Mirza, 2006). Disparate to traditional VAR model, this procedure employs Augmented VAR model and as a result tests the causality with a possible integrated and cointegrated system. (Clarke and Mirza, 2006; Rambaldi and Doran, 2006). If order of the integration exceeds the lag length of the model, (MWALD) statistic is not valid in that case (Toda and Yamamoto, 1995). Yet, the TY process experiences issues that is loss of power. Inefficiency is due to intentionally over-fitted VAR model (Toda and Yamamoto, 1995). For small sample size,the asymptotic distribution might out a poor approximation of the test statistic distribution (Kuzozumi and Yamamoto, 2000).

Var of order p is constituted as

$$y_{t} = a_0 + a_1 t + \sum_{i=1}^{p} \emptyset i \, y_{t-1} + \varphi v_t + u_t \qquad (1)$$

where y_t is a (n x 1) vector of endogenous variables, t is the linear time trend, a_o and a_1 are (n x 1) vectors, v_t is a (q x 1) vector of exogenous variables and u_t is a (n x 1) vector of unobserved disturbances. TY version (k + dmax) can be represented as

$$\begin{bmatrix} Lgold \\ Lex \end{bmatrix} = \begin{bmatrix} \propto_1 \\ \propto_2 \end{bmatrix} + \begin{bmatrix} A_{11,1} & A_{12,1} \\ A_{21,1} & A_{22,1} \end{bmatrix} \begin{bmatrix} Lgold_{t-1} \\ Lex_{t-1} \end{bmatrix} + \ldots\ldots\ldots\ldots + \begin{bmatrix} A_{11,k} & A_{12,k} \\ A_{21,k} & A_{22,k} \end{bmatrix}$$

$$\begin{bmatrix} Lgold_{t-k} \\ Lex_{t-k} \end{bmatrix} + \begin{bmatrix} A_{11,p} & A_{12,p} \\ A_{21,p} & A_{22,p} \end{bmatrix} \begin{bmatrix} Lgold_{t-p} \\ Lex_{t-p} \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \quad (2)$$

Where,order of p denotes (k + dmax). The Toda Yamamoto procedure begins with identifying order of integration so that an extra lag to be added in VAR is confirmed because the model takes extra lag of each variable as exogenous. It is obvious from ADF and KPSS test results that integration order is I (1), therefore m = 1. The maximum lag length has been determined using Bayesian Information Criterion (BIC) for lags one to twenty, and the optimum lag length is 8. For checking stability, LM Residual serial correlation test is used and it is found that there is no issue which satisfies specification of the VAR. Furthermore, inverse roots of AR characteristic polynomial lie within the circle which indicates well specification and stability of VAR model[2]. The modulus values are 0.16, 0.16, 0.07, 0.07, 0.05, 0.05, 0.01 and 0.01. Disregard of the conclusion obtained for cointegration tests, the additional lags 'm' is added in VAR model. M Wald test is used to estimate Toda Yamamoto granger causality. The 8 degree of freedom according to lag length criteria is followed by chi square distribution.

4. Results and Discussion

Toda Yamamoto granger causality results are shown in Table 5. It is clearly evident that causality runs from exchange rate to gold which implies that lagged values of exchange rate influence gold suggesting that exchange rate increase or decrease will affect the purchasing power of the rupee, including the quoted gold prices for import and investment. The exchange rate fluctuations affect the behavior of those investors who use gold to hedge against depreciations of the rupee. On the other hand, there is less evidence for predictability of exchange rate. The plausible reason is that since gold is a precious metal with no substitutes available domestically, gold consumers may continue to purchase even after price hikes and rupee may not depreciate as expected thus value of exchange rate remain unaffected. Since gold has more traditional usage in the form of jewelry (Shahbaz et al., 2014), as a result short run elasticity of demand tends to be inelastic in this case. Nevertheless in long run this may not be the case because gold is safe haven asset. Another reason could be the imposition of trade barriers by Pakistan's government therefore exchange rates may not adjust to change in the prices. Khan et al. (2012) find long run equilibrium relationship between exchange rate and trade in Pakistan and assert that there is no evidence for causality between both in short run.

Further, the exact magnitude of feedback between gold and exchange rate is examined by employing variance decomposition which explains the extent of the feedback in shocks of one variable contributed by other variables in VAR system. Results are reported in Table 6. It is observed that shocks in gold is 99% contributed by own shocks in gold while 0.89, 0.45, 1.27 and 1.43% is explained by Rdo, Rdir, RR, and RE respectively. The results display that the extent of the exchange rate feedback is negligible however it is noticeable that the magnitude tends to increase with increase in horizon. The findings are also supported in Figure 3 which shows the impulse response of one variable due to shocks in other variables (Results displayed in Appendix). It can be inferred that gold responds negatively to exchange rate movements and the negligible response to shocks in the variables suggests that the overall magnitude is weak.

a. Predicting Gold prices

The study generates out of sample short run forecasts of gold prices based on lagged values of exchange rate. Model is estimated from 1992 to 2014 and the forecasts are generated for two quarters ahead in 2015. Observation of first day is added to the sample and model is estimated recurrently until the last observation of the sample. Augmented VAR forecast results are then compared with Bayesian VAR model[3] results because literature validates that Bayesian VAR performs better forecasting comparative to other forecasting models. Root mean square error (RMSE), Mean absolute error (MAE), Mean absolute percent error (MAPE) and U Theil inequality coefficient ratios are the basis for comparison. In addition, Diebold-Mariano (DM) test has also been used to evaluate predictive performance of both the models (Diebold and Mariano, 1995). Results are displayed

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[2] Results are available upon request

[3] For detailed discussion on Bayesian VAR, see for studies of Litterman (1979); Litterman (1986) and Koop and Korobilis (2010)

in Table 7. Findings clearly indicate that exchange rates contain information for predicting gold prices. Results are robust across various forecasting periods however it is manifested that Bayesian VAR provides better forecast results and predictive accuracy is effective as indicated by DM test statistic.

5. Conclusions

Previous studies determine gold exchange rate association mostly in developed economies and identify mixed results on causal links by estimating traditional VAR methodology. Using Toda Yamamoto causality in augmented VAR model, the causality analysis confirms that exchange rates cause gold in Pakistan. The findings support Sari et al (2010), Pukthuanthong and Roll (2011), Jain and Ghosh (2013) but contradict the studies by Sujit and Kumar (2011) and Jain and Biswal (2016). Further, exchange rate also possesses out of sample predictive ability for gold over the short run. The exchange rate stability is a macroeconomic indicator and is closely monitored by economic analysts and policy makers therefore by analyzing movements in exchange rate, investors and portfolio managers may benefit in their investment decisions and maintaining optimum portfolio accordingly. The findings of this study is also of interest to the State Bank of Pakistan which is mainly responsible for devising monetary policy and maintain the value of local currency against foreign currencies. Exploring causal links with volatility transmissions into account is an interesting way to proceed in future.

Table5: Modified Wald Test in Toda Yamamoto Causality

Hypothesis	DF	Chi-Square	Prob
Rdo does not granger cause gold	8	29.22	0.0003
Gold does not granger cause Rdo	8	6.45	0.5966
Rdir does not granger cause gold	8	29.47	0.0003
Gold does not granger cause Rdir	8	6.81	0.5573
RR does not granger cause gold	8	30.93	0.0001
Gold does not granger cause RR	8	6.01	0.6453
RE does not granger cause gold	8	0.75	0.0002
Gold does not granger cause RE	8	0.48	0.7846

Note: Table shows TodaYamamotogranger causality results between gold and exchange rate

Table6: Variance decomposition of Gold at various horizons

Variance Decomposition of Gold Horizon	Gold	RDo	Decomposition of Gold Horizon	Gold	RDir
10	99.76618	0.233816	10	99.76526	0.234738
20	99.77297	0.227031	20	99.80586	0.194135
30	99.67838	0.321619	30	99.77492	0.225085
40	99.52867	0.471332	40	99.71558	0.284415
50	99.33609	0.663911	50	99.63832	0.361681
60	99.10715	0.892845	60	99.54764	0.452362

Note: Table displays shocks in gold explained by exchange rate at different time horizons

Variance Decomposition of Gold Horizon	Gold	RR	Decomposition of Gold Horizon	Gold	RE
10	99.77288	0.227116	10	99.93541	0.064590
20	99.74965	0.250353	20	99.78667	0.213326
30	99.59893	0.401066	30	99.56281	0.437191
40	99.36874	0.631257	40	99.27596	0.724036
50	99.07379	0.926213	50	98.93972	1.060277
60	98.72328	1.276717	60	98.56834	1.431663

Note: Table displays shocks in gold explained by exchange rate at different time horizons

Table7: Forecasts: Gold prices

Augmented VAR					Bayesian VAR				
RMSE	MAE	MAPE	Theil	DM Statistic	RMSE	MAE	MAPE	Theil	DM Statistic
0.054	0.038	0.339	0.002	0.2373	0.049	0.038	0.327	0.002	1.5417
0.689	0.381	0.142	0.416	1.2253	0.532	1.454	0.036	0.039	2.9986
0.784	0.426	0.015	0.433	1.5455	0.638	0.485	0.059	0.291	6.2622
0.838	0.524	0.025	0.557	2.7554	0.538	0.252	0.037	0.327	3.4211

Note: Table displays different ratios as forecast comparison base of Augmented VAR and Bayesian VAR

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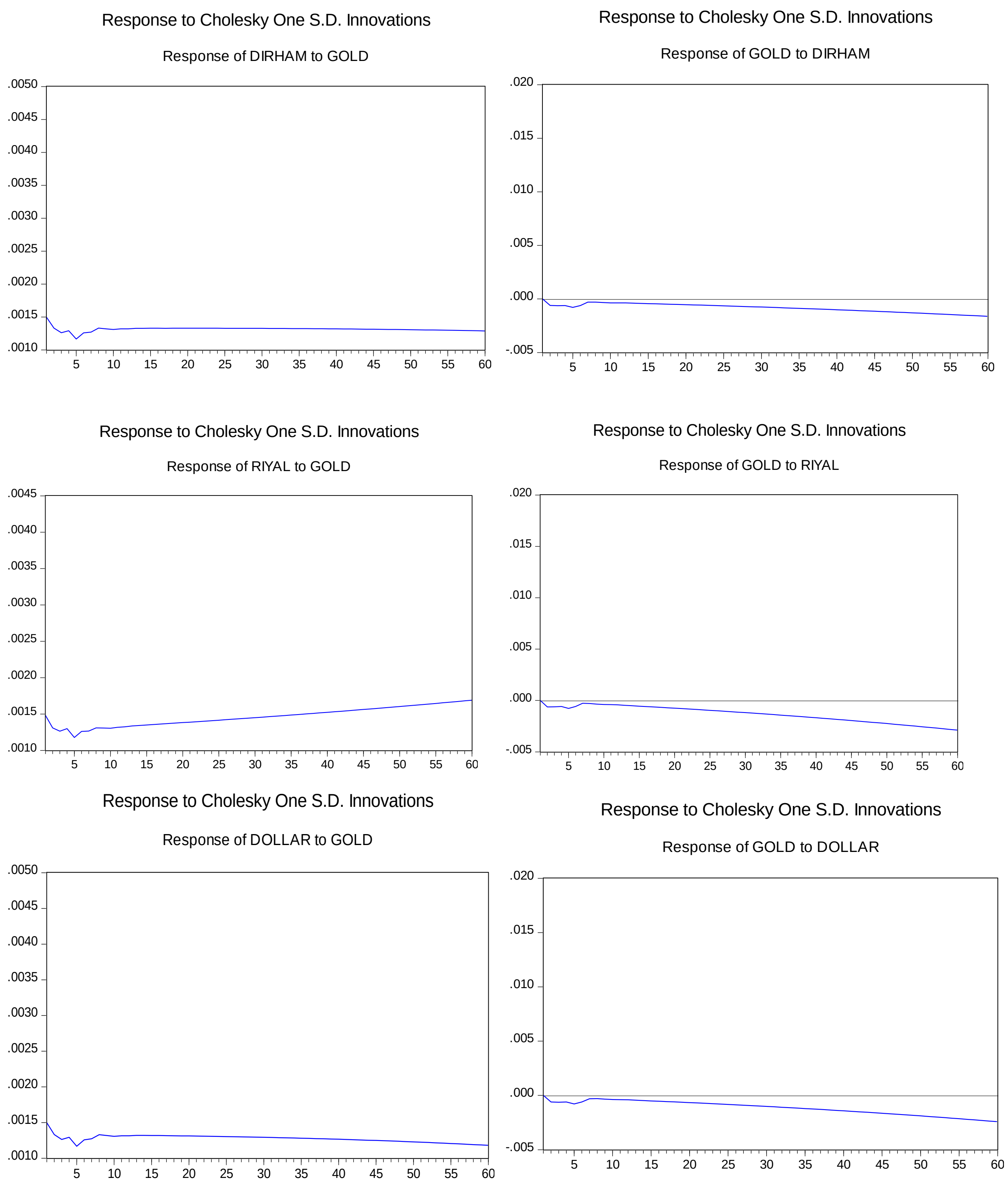
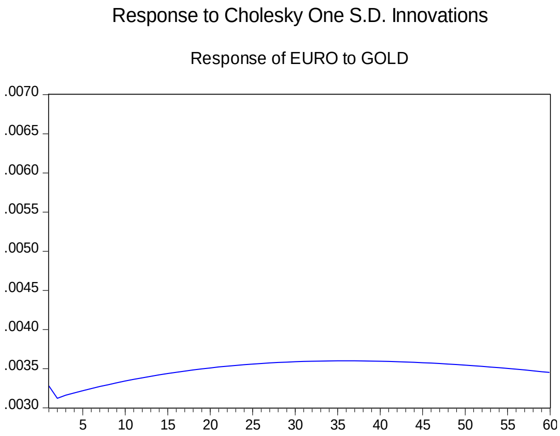
Appendix 1

Figure3: Impulse response




Response to Cholesky One S.D. Innovations
Response of EURO to GOLD
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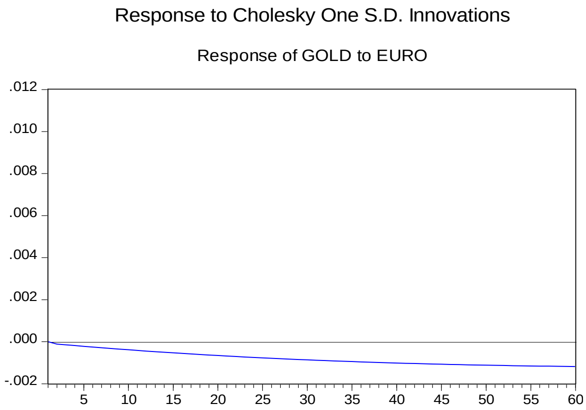
Response to Cholesky One S.D. Innovations
Response of GOLD to EURO
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