The Predictive Content of Futures Prices in Iran Gold Coin Market

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Abstract

The present paper studies gold coin futures market in Iran in terms of three concepts that determine how well futures markets may perform their price discovery function. First, the martingale hypothesis is tested. The results from linear models show that current changes in futures prices cannot be predicted by past changes in futures prices. However, when nonlinearities are accounted for, we obtain evidence that reject the martingale hypothesis. The second issue is the unbiased expectations hypothesis. The findings show that futures prices are unbiased estimators of termination cash prices in the normal market condition. But when spot prices fall or rise sharply, futures traders demand risk premia although the one-for-one relationship between futures prices and termination spot prices still holds. Finally, power of the basis to predict subsequent changes in spot prices is examined. The results indicate that the basis fails unbiasedness tests when cash market enters bearish or bullish territory.

Keywords: Martingale, cointegration, unbiasedness, linear and nonlinear dependence

1. Introduction

The weak-form market efficiency implies that prices follow a random walk and that current changes in prices should not be predictable by historical sequence of price changes (Samuelson, 1965). Assuming that market participants are risk neutral and their expectations are rational, the financial theory also suggests that the *k*-period-ahead futures price at time $T-k$ and the realized spot price at time T should be cointegrated with a cointegrating vector (1, -1), i.e., they should move together one for one in the long run (Hsieh and Kulatilaka, 1982). Furthermore, given that futures prices and spot prices are nonstationary, the Granger Representation Theorem (Granger, 1986) implies that the basis might predict subsequent changes in spot prices. A large number of studies have tested the predictive content of futures prices in advanced economies. The results are often mixed due to using different methodologies and sample periods. For instance, Chow (1998) documents that futures prices are unbiased estimators of future spot prices in gold, platinum, silver and palladium markets. In contrast, Chinn and Coibion (2014) find evidence that futures prices and termination spot prices of precious and base metals are cointegrated but not with a cointegrating vector (1, -1).

Gold coins are popular in Iran as they are purchased for investment purposes and used as gifts. Each of these coins has a fineness of 90 percent, equivalent to 21.6 karats, and has an actual gold weight of 0.2354 troy ounces. The Iran Mercantile Exchange (IME) launched gold coin futures contracts in November 2008. The gold coin futures market has rapidly grown in recent years such that the contract is currently one of the most traded financial instruments in Iran. The present study aims to conduct an empirical analysis of gold coin futures market by combining linear and nonlinear methods. The rest of this research paper is organized as follows. Section 2 briefly reviews theoretical arguments and explains data and methodology. Section 3 presents empirical results and their interpretations. Finally, Section 4 sums up all discussions and makes a conclusion.

2. Data and Methodology

2.1. Martingale Hypothesis

The weak-form efficiency in financial markets requires that current prices reflect all information contained in historical sequence of prices. In other words, futures prices should follow a random walk. The random walk is an example of the martingale process that states that expectation of the next value in a sequence is equal to the present observed value given knowledge of all prior observed values (Samuelson, 1965):

$$E(F_{t+1,T}) = F_{t,T} \tag{1}$$

According to Fujihara and Mougoue (1997), the martingale hypothesis implies that traders who rely on past changes in futures prices to predict current changes in futures prices should not expect to receive risk-adjusted excess return, on average. Therefore, a typical test of the martingale hypothesis is carried out using the following model:

$$r_t = \beta_0 + \sum_{i=1}^{m} \beta_i r_{t-i} + u_t \tag{2}$$

where r_t is the log return on daily futures prices of gold coin and m denotes the lag order. Daily futures prices are obtained from the nearest-to-expiration futures contracts over the period from October 2011 to March 2017. If the martingale hypothesis holds, all regression coefficients should jointly be equal to zero and error terms should not be serially correlated. Above regression model is estimated using three different methods, namely, the ordinary least squares (OLS), the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and the quantile regression. The least squares method captures conditional mean relationship between the variables. The other two methods account for nonlinearities and asymmetries. As argued by Brock, Hsieh and LeBaron (1991), analysis of nonlinear dynamics may provide a useful description of movements in asset prices. Given that asset prices, including futures prices, may display conditional heteroskedasticity, we use the GARCH *(p,q)* which is introduced by Bollerslev (1986) in order to model conditional variance of residuals in equation (2):

$$u_t \sim N\left(0, \sigma_t^2\right)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i u_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \sigma_{t-j}^2 \tag{3}$$

where α_i and γ_j are called persistence parameters. The GARCH *(p,q)* process is stationary if the sum of persistence parameters is less than unity.

The quantile regression aims to estimate the relationship between dependent variable and all regressors at either median or other quantiles of response variable. The quantile regression, developed by Bassett and Koenker (1978), minimizes the sum of absolute deviations, and hence it is also called the method of least absolute deviations (LAD):

$$\hat{\beta}_\tau = \underset{\beta}{\operatorname{argmin}} \left(\sum_{i \in \{i : Y_i \geq X_i'\beta\}}^{n} \tau \left| Y_i - X_i'\beta \right| + \sum_{i \in \{i : Y_i < X_i'\beta\}}^{n} (1-\tau) \left| Y_i - X_i'\beta \right| \right) \tag{4}$$

where τ lies within the range from 0 to 1 and it is conditional quantile of dependent variable such that:

$$Q(\tau) = F_Y^{-1}(\tau) = \inf\left\{ y : F_Y(y) \geq \tau \right\} \tag{5}$$

The main advantage of the least absolute deviations compared to the ordinary least squares is that the former gives equal emphasis to all observations, whereas the latter gives more weight to larger residuals. Hence, the quantile regression is robust in the sense that it is resistant to outliers in data. Also, it allows us to see how estimates of parameters in equation (2) may change in different quantiles of dependent variable. Lower quantiles of return series represent the bear market and upper quantiles constitute the bull market. Also, the median of return series contains the normal market condition.

2.2. Unbiased Expectations Hypothesis

Under joint assumptions of risk neutrality and rational expectations, expected returns to speculative activity in an efficient market should be zero. It implies that, in a forward or futures market, the current price of an asset for delivery at contract expiration should be the unbiased predictor of future spot price. According to Crowder and Hamed (1993), the future spot price of an asset in a particular contract is the cash price on the last trading day of the contract. Each futures contract is open for a relatively large period of time and daily futures prices reflect market expectations about termination spot price given all publicly available information. Among many daily futures prices, only one of them should be selected and matched with termination spot price for a particular contract.

This selection depends on forecast horizon that is under examination. In this study, the predictive content of gold coin futures prices is tested using forecast horizons of 5, 10, 15, 20, 25, 30, 35 and 40 days. Thus, futures prices for a particular contract are picked out by working backwards 5, 10, 15, 20, 25, 30, 35 and 40 days from contract termination date. Longer forecast horizons are not tested because Hansen and Hodrick (1980) argue that if the previous contract is still being traded when matching spot and futures prices for the next contract, wrong inferences might be made due to informational overlap. In other words, when matching spot and futures prices for a particular contract, it should be ensured that the contract under consideration is the nearest-to-expiration contract among all open contracts with the same underlying asset. The first gold coin futures contract that was traded in the IME had a delivery month of January 2009. In this study, sample data taken to test the unbiased expectations hypothesis comprises all gold coin futures contracts whose expiration dates were within the period from November 2009 to March 2017. Fama (1991) argues that to test whether prices properly reflect information, we need a model that depicts the meaning of "properly." According to Chow (1998), the conventional approach to examine the unbiasedness hypothesis requires establishing presence of cointegration between futures prices and termination spot prices, and then testing whether futures price at a specific forecast horizon is the unbiased estimator of spot price that is realized at contract termination date. Hence, a cointegrating regression is specified as follows:

$$s_T = \beta_1 + \beta_2 f_{T-k} + \varepsilon_T \tag{6}$$

where s_T is the natural logarithm of realized spot price at the last trading day of the contract and f_{T-k} is the natural logarithm of futures price at a specific forecast horizon denoted by *k*. As stated earlier, this regression model is run for multiple forecast horizons. Similar to the test of martingale hypothesis, equation (6) is estimated using OLS, GARCH and LAD methods in order to account for linear and nonlinear dependence between termination spot prices and futures prices at each forecast horizon. Given that futures prices and termination spot prices have a unit root, error terms of the cointegrating regression should be integrated of order zero to ensure that futures prices and termination cash prices have a cointegrating relationship that implies the long-run equilibrium. Therefore, the Augmented Dickey-Fuller (ADF) test is used to perform unit root tests on residuals of the cointegrating regression. Having established existence of cointegration, joint restrictions ($\beta_1 = 0$ and $\beta_2 = 1$) and single restriction ($\beta_2 = 1$) are tested. If joint restrictions are rejected but single restriction is not rejected, it indicates that termination spot price is equal to futures price plus a risk premium. This situation does not give evidence against rational expectations because the postulated one-for-one relationship between futures prices and termination spot prices still holds in the long-run equilibrium.

2.3. Predictive Content of the Basis

The Granger Representation Theorem (Granger, 1986) states if random variables X_t and Y_t are I(1) but there exists a linear combination of them in the form of $Y_t - bX_t$ that is I(0), an error correction representation of these cointegrated variables could be specified as follows:

$$\Delta Y_t = \beta_1 + \beta_2 \Delta X_t + \beta_3 (Y_{t-1} - bX_{t-1}) + \varepsilon_t \tag{7}$$

where the term $(Y_{t-1} - bX_{t-1})$ is the 1-period lag of linear combination of X_t and Y_t. The linear combination of X_t and Y_t is called cointegrating relationship and it represents the long-run equilibrium in the form of $Y_t = bX_t$ where coefficient b denotes cointegrating parameter. The coefficient β_3 in above equation is called adjustment coefficient and it measures how variable Y adjusts to error in the previous period. The error correction model explains short-run changes in variable Y by short-run changes in variable X and the error correction term which measures lagged deviations of variable Y from the long-run equilibrium.

Above error correction specification is applied to gold coin futures market in order to test whether the basis contains all relevant information to predict subsequent changes in spot prices. Hence, the following model is specified (Newbold, Kellard, Rayner and Ennew, 1999):

$$s_T - s_{T-k} = \beta_1 + \beta_2 (f_{T-k} - s_{T-k}) + \varepsilon_T \tag{8}$$

where the term $(f_{T-k} - s_{T-k})$ is the basis at a particular forecast horizon denoted by *k*. In this model, the basis represents the cointegrating relationship between futures prices and spot prices and the cointegrating parameter is set equal to unity due to the unbiasedness hypothesis. As stated earlier, this regression model is run for multiple forecast horizons. Similar to the test of unbiasedness hypothesis, equation (8) is estimated by OLS, GARCH and

LAD methods. If the basis is the unbiased predictor of subsequent changes in spot prices, joint restrictions ($\beta_1 = 0$ and $\beta_2 = 1$) should hold in equation (8).

3. Results and Interpretations

3.1. Martingale Hypothesis

Table I reports OLS and GARCH results for the martingale hypothesis. The lag length of 6 for equation (2) was selected by initially setting m equal to 10 and then removing lags that were insignificant at 10 percent. The least squares results show that, on average, joint restrictions on intercept and slope coefficients cannot be rejected and that regression residuals have no autocorrelation up to order 30. However, the ARCH-LM test and the Q-Statistics of squared residuals find significant evidence for heteroskedasticity in OLS residuals of equation (2). This finding motivates the GARCH method to modeling time-varying volatility. The lag length of (1,1) for the GARCH model was sufficient to remove the ARCH effects in regression residuals. The GARCH results show that when heteroskedasticity is accounted for, the Chi-squared Statistic for null hypothesis of joint restrictions on regression parameters is highly significant. Although there is no autocorrelation in GARCH (1,1) residuals, rejection of joint restrictions implies that changes in gold coin futures prices do not follow the martingale process. Besides, failure to reject null hypothesis that persistence parameters in the GARCH (1,1) sum up to unity, $\alpha + \gamma = 1$, means that volatility shocks persist over time.

Table I OLS and GARCH Results for Martingale Hypothesis

Regression Coefficients	OLS	GARCH (1,1)
β_0	0.0004 (0.0004)	0.0001 (0.0001)
β_1	0.0912 (0.0419)	0.0510 (0.0191)
β_2	-0.0613 (0.0516)	-0.0748 (0.0191)
β_3	0.0403 (0.0372)	0.0071 (0.0190)
β_4	0.0183 (0.0483)	-0.0086 (0.0185)
β_5	0.0358 (0.0362)	0.0027 (0.0174)
β_6	0.0734 (0.0378)	0.0077 (0.0168)
ω	-	0.0000 (0.0000)
α	-	0.1539 (0.0296)
γ	-	0.8535 (0.0199)
Estimation Method	ARCH Effects in Residuals	
OLS	✓	
GARCH (1,1)	✗	
Chi-squared Statistics	Hypothesis Test of Joint Restrictions on Regression Coefficients	
	OLS	GARCH (1,1)
$\chi^2(7)$	11.9259	21.6021**
$\chi^2(1)$	-	0.2275
Lag Order	Ljung-Box Q-Statistics for Serial Correlation in Residuals	
	OLS	GARCH (1,1)
1	0.0040	0.0827
2	0.0041	0.0856
3	0.0119	0.2572
4	0.0365	0.4005
5	0.0424	0.4764
10	4.5721	1.3978
30	33.1424	7.5884
50	97.6395**	21.7431

Figures in parentheses are standard errors;
$\chi^2(7)$ is the test statistic for $H_0: \beta_i = 0$ for $i = 0,1,2,\ldots,6$;
$\chi^2(1)$ is the test statistic for $H_0: \alpha + \gamma = 1$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

The GARCH and LAD methods capture nonlinear dynamics. The GARCH results confirmed existence of time-varying volatility in the martingale process of changes in daily futures prices. Table II reports results of estimating equation (2) in three different quantiles, namely, median, 15th percentile and 85th percentile. The median represents the normal market condition, whereas lower and upper tails constitute the bear market and the bull market, respectively. The lag length at each quantile was selected by initially setting m equal to 10 and then removing lags that were insignificant at 10 percent. The LAD results indicate existence of nonlinear dynamics in the sense that estimates of regression parameters and inferences about the martingale hypothesis vary among quantiles. In the normal market condition, findings show that gold coin futures market has weak-form efficiency because joint restrictions on regression parameters cannot be rejected and residuals have no serial correlation at least up to order 10. This evidence is in line with OLS results shown in Table I. Therefore, estimates of equation (2) in conditional mean and conditional median reveal that the martingale hypothesis holds.

Table II LAD Results for Martingale Hypothesis

Regression Coefficients	Lower Tail	Median	Upper Tail
β_0	-0.0089 (0.0005)	-0.0001 (0.0002)	0.0086 (0.0007)
β_1	0.0429 (0.0470)	0.0736 (0.0456)	0.1283 (0.0521)
β_2	-0.0856 (0.0496)	-0.0693 (0.0424)	-0.0372 (0.0671)
β_3	-	-	0.1024 (0.0461)
β_4	-	-	0.0527 (0.0459)
β_5	-	-	0.1157 (0.0464)
Chi-squared Statistics	Hypothesis Test of Joint Restrictions on Regression Coefficients		
	Lower Tail	Median	Upper Tail
$\chi^2(3)$	325.9726**	5.7833	-
$\chi^2(6)$	-	-	161.1405**
Lag Order	Ljung-Box Q-Statistics for Serial Correlation in Residuals		
	Lower Tail	Median	Upper Tail
1	4.8168*	1.0534	1.3557
2	6.6177*	1.4027	1.8302
3	9.4014*	3.9938	6.5834
4	10.4205*	4.8102	8.2487
5	12.2480*	6.3089	16.6493**
10	24.3964**	18.6467*	26.8283**
30	45.6282*	40.0614	56.5917**
50	111.6624**	105.3016**	127.5248**

Lower tail is the 15th percentile;
Upper tail is the 85th percentile;
Figures in parentheses are standard errors;
$\chi^2(.)$ is the test statistic for $H_0: \beta_i = 0$ for $i = 0,1,2,\ldots,p$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

In contrast, the situation is different in tails of the distribution. In both bear market and bull market, the Chi-squared Statistic becomes significant and joint restrictions on regression coefficients are rejected. Also, results detect serial correlation in residuals since the Q-Statistics are highly significant. It means that when gold coin futures market enters bearish or bullish territory, traders might be able to predict current changes in futures prices using historical data.

Although gold coin futures market shows some elements of weak-form efficiency in the normal market condition, past changes in futures prices could be used to forecast current changes in futures prices as the market enters extreme conditions. In other words, when futures market volatility increases, historical sequence of price changes might predict current changes in prices. Thus, the martingale hypothesis does not hold in both tails.

3.2. Unbiased Expectations Hypothesis

Table III shows that both futures and cash prices are nonstationary because null hypothesis of unit root cannot be rejected. Table IV reports OLS results of the cointegrating regression. The ADF test reveals that residuals have no unit root. It implies that futures prices and termination spot prices are cointegrated at all forecast horizons. The hypothesis test of joint restrictions on parameters of the cointegrating regression shows that, apart from forecast horizons of 10, 15 and 20 days, futures prices are unbiased estimators of termination spot prices. The single restriction on the slope coefficient is rejected at forecast horizons of 10, 15 and 20 days. Therefore, least squares results show that futures prices, in 5 out of 8 forecast horizons under examination, correctly predict termination cash prices, on average. The GARCH was not used to model conditional heteroskedasticity since no ARCH effects were found in error terms.

Table III Results for Unit Root

Forecast horizon (days)	Futures Price
	ADF
5	-1.3491
10	-1.4323
15	-1.4339
20	-1.4743
25	-1.6669
30	-1.4767
35	-1.5435
40	-1.4615
Unit Root Test	Termination Spot Price
ADF	-1.6388

ADF stands for Augmented Dickey-Fuller;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

Table IV OLS Results for Unbiased Expectations Hypothesis

Forecast Horizon (days)	Cointegration	Unbiasedness	
	ADF	$\chi^2(2)$	$\chi^2(1)$
5	-7.1934**	2.5211	-
10	-7.3494**	6.3634*	6.3382*
15	-7.2671**	12.2801**	12.1249**
20	-7.3191**	9.2292**	9.1947**
25	-7.4309**	5.1055	-
30	-6.3249**	4.9442	-
35	-6.4464**	4.1569	-
40	-5.9755**	3.4741	-

ADF stands for Augmented Dickey-Fuller;
$\chi^2(2)$ is the test statistic for $H_0: \beta_1 = 0$ and $\beta_2 = 1$;
$\chi^2(1)$ is the test statistic for $H_0: \beta_2 = 1$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

Table V shows null hypothesis of nonstationary residuals is rejected at 1 percent significance level for all forecast horizons. It means that futures prices and termination spot prices are cointegrated at all forecast horizons in the median and in both tails. In the normal market condition, represented by the median, the unbiasedness hypothesis is rejected at forecast horizons of 10, 15 and 25 days. The joint restrictions on parameters of the cointegrating regression cannot be rejected at other forecast horizons. The LAD results in the case of median are similar to OLS results. However, results of unbiasedness tests are different in lower and upper tails because joint restrictions are rejected at most forecast horizons. For example, joint restrictions are rejected but single restrictions are not rejected when spot market enters bearish territory. It means that intercept coefficient of the cointegrating regression is significant when cash market is bearish. The significance of intercept coefficient in lower tail implies that futures traders expect risk premia when spot prices are falling sharply. However, since the single restriction on the slope coefficient cannot be rejected, it is inferred that there exists a long-run one-for-one relationship between futures prices and termination spot prices at all forecast horizons even when spot market is bearish. The results are similar at forecast horizons of 5, 10, 25, 35 and 40 days in upper tail. The risk premium is insignificant in mean and median but it is significantly larger than zero in both tails. So, it is concluded that when spot prices become more volatile, futures traders often expect risk premia but the one-for-one relationship between futures prices and termination spot prices usually holds in the long run. This evidence also implies that gold coin is considered as a safe-haven asset in the normal market condition, and hence has no systematic risk. But when spot prices fall or rise sharply, a positive risk premium should compensate futures traders for the systematic risk of gold coin.

Table V LAD Results for Unbiased Expectations Hypothesis

Lower Tail			
Forecast Horizon (days)	Cointegration	Unbiasedness	
	ADF	$\chi^2(2)$	$\chi^2(1)$
5	-7.0291**	13.4865**	1.2161
10	-7.3182**	6.4284*	0.3026
15	-7.2623**	13.3848**	0.8831
20	-6.9827**	14.5286**	2.5525
25	-7.4138**	15.5269**	2.1788
30	-6.3151**	25.6130**	3.3480
35	-6.4487**	11.8158**	2.0280
40	-6.0668**	7.2634*	0.8233
Median			
Forecast Horizon (days)	Cointegration	Unbiasedness	
	ADF	$\chi^2(2)$	$\chi^2(1)$
5	-7.2136**	0.2876	-
10	-7.3135**	8.2954*	6.2868*
15	-7.2806**	9.7946**	9.4066**
20	-7.2172**	5.2678	-
25	-7.4232**	7.3399*	4.9707*
30	-6.4321**	3.9162	-
35	-6.5026**	5.9166	-
40	-6.0252**	4.7011	-
Upper Tail			
Forecast Horizon (days)	Cointegration	Unbiasedness	
	ADF	$\chi^2(2)$	$\chi^2(1)$
5	-7.2061**	12.3834**	0.5692
10	-7.3606**	9.0484*	3.1800
15	-7.2035**	6.4845*	5.2832*
20	-7.3789**	4.1493	-
25	-7.5494**	10.2806**	0.1483
30	-6.4304**	4.3875	-
35	-6.5381**	12.5232**	0.3279
40	-6.0918**	26.9268**	0.1237

Lower tail is the 15th percentile;
Upper tail is the 85th percentile;
ADF stands for Augmented Dickey-Fuller;
$\chi^2(2)$ is the test statistic for $H_0: \beta_1 = 0$ and $\beta_2 = 1$;
$\chi^2(1)$ is the test statistic for $H_0: \beta_2 = 1$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

3.3. Predictive Content of the Basis

Table VI reports OLS and GARCH results for equation (8). In terms of conditional mean dependence, the basis is the unbiased estimator of subsequent changes in spot prices at all forecast horizons except 15- and 25-day horizons. The OLS residuals have ARCH effects at forecast horizons of 15 and 30 days only. The lag length of (1,1) for the GARCH model was sufficient to remove the ARCH effects in error terms. The GARCH results show that when heteroskedasticity is modeled, the Chi-squared Statistic for null hypothesis of joint restrictions on regression parameters becomes insignificant at 15-day forecast horizon. Therefore, the basis seems to be the unbiased estimator of subsequent changes in spot prices at all forecast horizons except 25-day horizon. Also, failure to reject null hypothesis that persistence parameters in the GARCH (1,1) sum up to unity provides evidence for persistent time-varying volatility.

Table VI OLS and GARCH Results for Predictive Content of the Basis

Forecast Horizon (days)	OLS		GARCH (p,q)			
	$\chi^2(2)$	ARCH Effects	(p,q)	$\chi^2(2)$	$\chi^2(1)$	ARCH Effects
5	1.5015	×	-	-	-	-
10	3.3416	×	-	-	-	-
15	6.8801*	✓	(1,1)	4.4900	1.3981	×
20	0.5646	×	-	-	-	-
25	358.6844**	×	-	-	-	-
30	0.4480	✓	(1,1)	0.7356	0.0736	×
35	0.3661	×	-	-	-	-
40	2.9009	×	-	-	-	-

$\chi^2(2)$ is the test statistic for $H_0: \beta_1 = 0$ and $\beta_2 = 1$;
$\chi^2(1)$ is the test statistic for $H_0: \alpha + \gamma = 1$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

The LAD results for equation (8) are shown in Table VII. The results in the case of median are similar to those of least squares. In contrast, evidence shows that the basis fails to provide unbiased predictions of subsequent changes in spot prices in bear and bull markets. In other words, the basis does not seem to have significant predictive content when cash prices fall or rise sharply.

Table VII LAD Results for Predictive Content of the Basis

Forecast Horizon (days)	Lower Tail	Median	Upper Tail
	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$
5	10.9560**	0.5563	21.1852**
10	24.3664**	5.2753	6.1584*
15	15.9588**	4.1666	4.0703
20	14.9394**	2.5618	5.7436
25	8.8052*	0.4251	14.4553**
30	14.0477**	0.3801	8.5525*
35	4.6316	0.4259	21.3342**
40	4.4146	6.1434*	21.7706**

Lower tail is the 15th percentile;
Upper tail is the 85th percentile;
$\chi^2(2)$ is the test statistic for $H_0: \beta_1 = 0$ and $\beta_2 = 1$;
* Denotes statistically significant at 5% level; and
** Denotes statistically significant at 1% level.

4. Conclusion

The objective of the present paper was to test martingale, cointegration and unbiasedness hypotheses in Iran gold coin market using linear and nonlinear methods. The results from analysis of nonlinear dynamics imply that changes in daily futures prices are forecastable by past sequence of changes in futures prices in bear and bull markets even though linear models show that the martingale hypothesis holds. Also, when conditional heteroskedasticity is accounted for, we obtain evidence that rejects the martingale hypothesis. The results of estimating the cointegrating regression in conditional mean and conditional median reveal that futures prices are unbiased estimators of termination spot prices at most forecast horizons. It is concluded that in the normal market condition, futures prices and termination spot prices are often cointegrated with a cointegrating vector (1, -1). But when cash market enters bearish or bullish territory, futures traders demand risk premia although the one-for-one relationship between futures prices and termination spot prices still holds in the long run. Overall, it seems that gold coin futures market has so far provided relatively fair estimates of future cash prices. Also, evidence shows that the basis fails unbiasedness tests when cash market enters bearish or bullish territory.

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