Cointegration of Equity and Gold Markets: Evidence from Turkey

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ABSTRACT

Gold has been an investment vehicle over the ages and helped investors to mitigate risks arise due to market fluctuations. In order to improve financial inclusion level and increase added value of the idle gold held by investors, there have been various instruments developed in recent decades. Likewise, derivative investments, mutual funds based on gold, gold certificates, gold based sukuks and bonds are various instruments issued in Turkey in order to mobilize gold within the financial system. In this paper, we are analyzing role of the gold within financial markets for the 2009-2017 period. In order to examine long term relationship, we utilize the co-integration methodology. Based on the analysis outcomes, Turkish stock and gold markets have a long run relationship and for portfolio diversification purposes, investors may benefit from this via adding gold to their stock market portfolio. Due to its low and negative correlation, increasing the inclusion of gold into financial system will enrich investment alternatives and diminish volatilities of the portfolios.

Keywords: Gold, Portfolio Diversification, Cointegration
JEL Classifications: G10, G11, O16

1. INTRODUCTION

Gold, which has a long history as a store of value independent of the financial system, has become a natural insurance policy under political and/or financial uncertainty. Public interest generally shifts to gold as a safe haven and due to its limited supply, this excess demand during uncertain times makes gold prices volatile.

Although preference of physical safekeeping of gold by households makes gold difficult to be utilized and mobilized within the financial market as an investment instrument, shifting perceptions of gold makes financial market institutions to spend more time on developing ways to improve financial inclusion level and increase added value of the idle gold held physically by households. Improvements in financial instruments and markets based on gold make transfer of gold and ownership easier. In

this framework, there have been various areas and instruments developed in recent decades which support the use of gold as an investment vehicle by central banks, financial institutions and investors.

In this study, we investigate Turkish gold market as an alternative investment instrument. Firstly, we analyze the use of gold in the financial sector, e.g., gold exchange traded funds, gold certificates, gold participation certificates, gold based sukuk and gold based bonds. Secondly, we compare performance of the gold market with the equity market within Borsa Istanbul and USD/TRY foreign exchange rate as well as electricity and Brent oil prices as a representative of energy sector. Finally, we investigate whether gold and stock investments are alternative to each other with cointegration methodology and how they can be utilized for portfolio management purpose.

Table 1: Reserves by country (June 2018)

Country	Gold (tons)	Gold (US$ millions) (%)	FX (US$ millions) (%)	Total reserves (US$ millions) (%)
United States	8.133,50	326.991,30 (24.09)	114.057,70 (0.96)	441.049,00 (3.34)
Germany	3.369,90	135.480,00 (9.98)	59.192,40 (0.50)	194.672,40 (1.47)
IMF	2.814,00	113.133,50 (8.34)		
Italy	2.451,80	98.571,70 (7.26)	49.980,30 (0.42)	148.552,00 (1.13)
France	2.436,00	97.936,50 (7.22)	65.715,60 (0.55)	163.652,10 (1.24)
Russia	1.944,00	78.155,60 (5.76)	378.568,00 (3.20)	456.723,60 (3.46)
Mainland China	1.842,60	74.076,70 (5.46)	3.131.517,00 (26.44)	3.205.593,60 (24.28)
Switzerland	1.040,00	41.811,30 (3.08)	758.699,50 (6.40)	800.510,80 (6.06)
Japan	765,2	30.764,10 (2.27)	1.227.775,50 (10.36)	1.258.539,60 (9.53)
Netherlands	612,5	24.622,60 (1.81)	12.215,90 (0.10)	36.838,50 (0.28)
Turkey	568	22.834,60 (1.68)	75.565,70 (0.64)	98.400,30 (0.75)
India	566,1	22.758,20 (1.68)	385.400,10 (3.25)	408.158,30 (3.09)
BIS	515,7	20.733,00 (1.53)		
ECB	504,8	20.293,60 (1.50)		
Total	27.564,10	1.108.162,70 (81.66)	6.258.687,70 (52.84)	7.212.690,20 (54.63)
World total	33.461,40	1.357.122,60 (100)	11.845.430,30 (100)	13.202.552,90 (100)

Source: https://www.gold.org/research/quarterly-times-series-world-official-gold-reserves-2000. [Last accessed on 2018 Aug 24]

Table 2: Gold collective investment market in Turkey (as of July 31, 2018)

Fund name	Total value (TRY)	Number of investors
BİZİM Portfolio gold participation ETF	8,818.296	-
FİNANS Portfolio gold ETF	61,934.408	-
AK Portfolio gold fund	87,066.436	7.919
DENİZ Portfolio gold fund	10,616.280	765
FİBA Portfolio gold fund	3,630.268	78
GARANTİ Portfolio gold fund	87,934.591	6.423
HSBC Portfolio gold fund	27.431.720	-
ICBC TURKEY Portfolio gold fund	2.401.402	-
ING Portfolio gold fund	10.613.476	469
İŞ Portfolio gold fund	45.154.443	3.212
ŞEKER Portfolio gold fund	1.315.379	-
TEB Portfolio gold fund	14.677.834	2.084
YAPI KREDİ Portfolio gold fund	151.454.510	5.194
HALK Portfolio GPF	16.656.448	152
VAKIF Portfolio GPF	8.944.690	434
ZIRAAT Portfolio GPF	25.332.941	1.817

Source: http://www.spk.gov.tr/SiteApps/PortfoyDegerleri/YatirimFonlari/MKYF. [Last accessed on 2018 Aug 24]

Table 3: Collective investment market in Turkey (as of July 31, 2018) (value in TRY million)

Fund type	Number of accounts	Portfolio value
Investment funds total	329	44.458
Investment funds	321	44.329
Exchange traded Inv.Funds	8	130
Pension funds total	349	76.997
Individual pension funds	177	61.720
Gov. Contr. pension funds	23	8.939
Investment companies total	41	1.052
Securities Inv.Co.s	10	440
Real Estate Inv.Co.s	31	612

Source: http://www.spk.gov.tr/SiteApps/PortfoyDegerleri/KonsolideBilgiler. Last accessed on 2018 August 24

2. TURKISH GOLD MARKET

The history of gold is long connected with money, but gold resigned this role in developed economies after the 2nd World War after the formation of the Bretton Woods monetary system which is based on fixed exchange rate regime. This system broke down in 1971 when the US ended its gold standard (Alıç, 1985).

Based on WGC report (2018), gold's demand is often influenced by a range of social and cultural factors, local market conditions and macroeconomic movers. Regarding supply side; main gold supply comes from mine production however, newly mined gold is insufficient for annual demand and the gap is covered by recycling. Historically, gold mine production was dominated by South Africa, USA, Australia and Canada (accounted for 60% in 1987) however, nowadays these big four represent less than 30% of annual production (WGC, 2018). Based on World Gold Council figures, at country level, China was the largest producer in the world in 2016 and accounted for around 14% of total global production. Then comes Australia, Russia and USA.

Until 2012, Turkey's gold reserves had a share below 10% in its total reserves, fluctuated in between 4-6%, as depicted in the Figure 1. Beginning from 2012, it increased steadily from 12% to its highest level of 22% in 2017Q4. Turkey's official gold reserve is composed of not only from Central Bank (CBTA) but also Turkish commercial banks' gold reserves. This is because of the policy followed by the CBTA that accepting gold for reserve requirements of commercial banks since October 14, 2011.

On the demand side, one of the significant actor on the financial sector for gold is central banks. Distribution of reserves by country is shown in the Tables 1-5. In addition to hard currencies, they hold gold as a reserve asset in their portfolio. Gold reserve held by 11 central bank and IMF-International Monetary Fund, BIS-Bank for International Settlement and ECB-European Central Bank is 81.66% of total gold reserves. However within total reserves gold reserves' share is only 10%.

Turkish organized spot gold market was launched in July 26, 1995 and operated under Istanbul Gold Exchange since its merger with Istanbul Stock Exchange under Borsa Istanbul in 2013. USD, EUR and TRY denominated transactions can be executed within the spot market but as can be observed from the below graphs; most of the transactions have executed in USD/Ons (Figure 2 and 3).

**Table 4: Investor preference in Turkish financial system**

Years	Foreign residents investments* - %			Local residents investments* - %		
	Stocks	Debt securities	Bank deposits	Stocks	Debt securities	Bank deposits
2014	46	36	18	6	28	66
2015	44	30	26	5	28	67
2016	45	28	25	5	27	69
2017	48	25	27	5	26	68
March 2018	47	24	29	6	26	68

(*) Foreign residents' total savings: TRY 0.5 trillion; local residents' total savings: TRY 2.5 trillion as of 03/2018. Source: https://www.tspb.org.tr/wp-content/uploads/2015/07/Turkish-Capital-Markets-2018-10-TR.pdfn. [Last accessed on 2018 Aug 24]

Table 5: Summary statistics

Statistics	XAUTRY	BIST 100	USD/TRY	BRENT	Electric
Mean	0.0668	0.0565	0.0491	0.0724	5.0605
Median	0.0438	0.0838	0.0026	0.0320	2.1211
Standard deviation	1.0788	1.4194	0.7289	1.9312	18.5137
Kurtosis	4.5027	3.4113	2.2764	2.8363	112.7772
Skewness	−0.0492	−0.3516	0.4760	0.3811	7.7013
Minimum	−8.8546	−10.4737	−3.1322	−8.3467	−76.9284
Maximum	6.7472	7.1384	4.7045	11.2724	345.6358

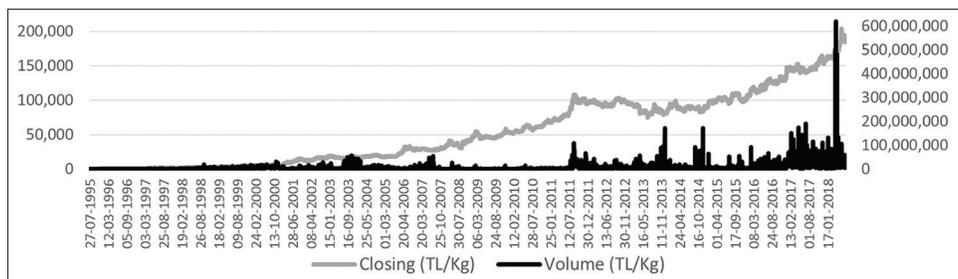**Figure 1:** Gold as a percentage of total reserves
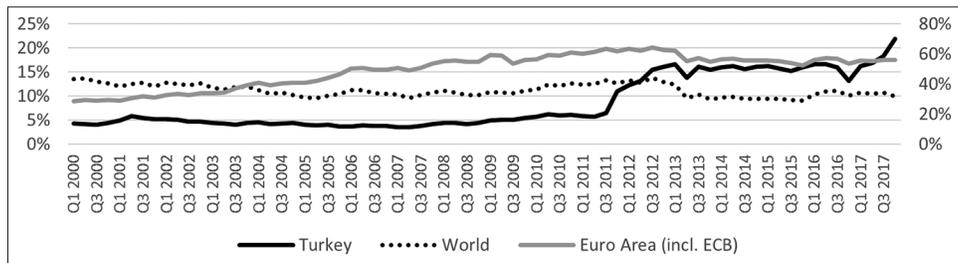
Source: World gold council, 2018 (Left axis: Turkey, World; right axis: Euro area)

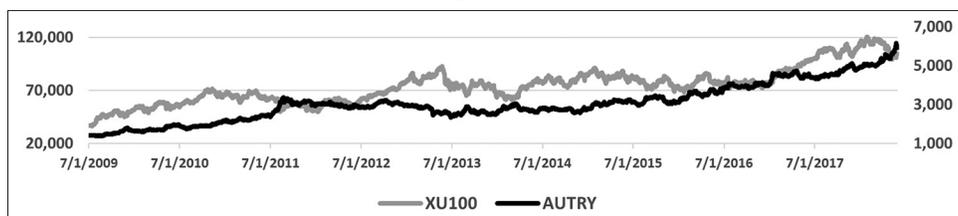**Figure 2:** Borsa Istanbul gold market USD/Ons transactions
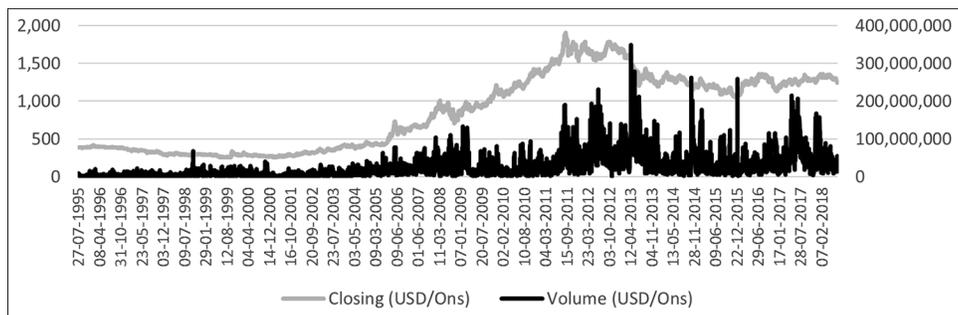
Source: https://evds2.tcmb.gov.tr/accessed on 24.08.2018 (left: Closing; right: Volume)

Figure 3: Borsa Istanbul gold market TRY/Kg transactions

Source: https://evds2.tcmb.gov.tr. [Last accessed on 2018 Aug 24]. (Left: Closing; right: Volume)

Source: https://evds2.tcmb.gov.tr/. Last accessed on 24.08.2018

In the Gold Market of Borsa Istanbul, for the 27.07.1995 - 29.06.2018 period; USD/Ons volume is USD 141.6 billion and value 4.9 million Kg. (daily average values are USD 25.7 million and 886 kg). For the same period, TRY/Kg volume is TRY 35.2 billion TRY and 1.7 million Kg (daily average values are TRY 7 million and 343 kg).

In addition to spot trading and lending platform for gold within Borsa Istanbul; with the regulations dated 19 December 1996 by the capital markets board, "gold mutual funds" was also introduced to the Turkish financial sector. Exchange traded gold funds are another form of funds for those seeking collective investment schemes in gold and these products emerged in the global stage in 2003. Although it has expanded significantly, there is still significant potential for further growth (WGC, 2017/12).

Analyzing share of gold in collective investment business size, it is very obvious that gold based investment business does not represent its potential in Turkey. Gold funds, Gold Exchange Traded Funds and Gold Participation Funds altogether has a 0.4% share (TRY 564 million over TRY 126 billion sector size) in TRY total value terms as of July 31, 2018 figures. 4 gold funds (1 participation ETF and 3 Gold Participation Funds) are managed within Sharia-compliant Islamic principles represent 10.6% of the gold collective investment business in TRY value (9% belongs to participation funds and 1.6% share belongs to the ETF). Gold ETFs have a share of 13% in the gold collective investment business.

Gold certificates issued by commercial banks for interest income and gold participation certificates issued by participation banks (operating in line with Islamic rules) for profit sharing are also available gold investment vehicles. The Turkish Treasury was also joined the market via issuing gold bonds and gold sukuk certificates in 2017 in order to channel idle gold safe kept by individuals. Based on Treasury figures, with the 2017 issue, 12,800 individual investors convert their gold with the bond/certificates with a value of TRY 370 million and 2.5 tons.

Based on investment preference figures of local and foreign investors in Turkish market, major share in the investment belongs to bank deposits with 68% for local investors. Stock market comes third with a 6% share as of 2017 figures. This ratio didn't vary in 2014-2017 period.

3. LITERATURE REVIEW

Literature on gold market is very rich. In this regard, we provide not only information on some of these studies but also analysis on gold price and other factors relationship with cointegration methodology which has gained significant acceptance then correlation for examining common trends in time series (Alexandre and Dimitriu, 2004). Intention to utilize this methodology is to detach common stochastic trends in return series and correlation may not confirm whether there is a long term relationship between various assets or markets since cointegrated series can have quite low correlation (Alexandre et al., 2001).

Gold market price regime is expected to be driven by market mechanism of demand and supply based on technical uses and investments. Long term supply is also very important factor in gold market and price formation thereof and; long term supply source is expected to shift to recycling. In this regard, efficient recycling is essential for the functioning of the market for physical gold (Sverdrup et al., 2012). However, demand for gold is also effected from the instability of gold prices. Extraordinary increase in gold price during January-April 2006 period, demand for gold and consequently gold import decreased in Turkey (Gökdemir and Ergün, 2007).

There are also various researches on finding out factors effecting gold prices. Regarding inflation and gold price relationship; McDonald and Bruno (1977) found positive correlation for 1970-1976 period and Koutsoyiannis, (1983) for 1979-1981 period. Koutsoyiannis (1983) also found negative correlation of gold with USD, interest rate and Dow Jones index for 1979-1981 period. Dooley et al. (1992), based on 1976-1990 period, it was found that gold price and FX rates have long term relationship Long-run relationship for US.

Aziz (1999) found that oil price moves same direction with gold prices and according to Aslan (1999) oil and gold influence one another. For 1991-2001 period, USA equity market index and gold price were found cointegrated by Smith (2001). Consumer price index and gold price were also observed for 1976-1999 period by Ghosh et al. (2002). Another study for the 1990-2001 period on London Gold Market showed that gold market followed a random walk in the closing prices however morning and afternoon sessions' prices' did not (Smith, 2002).

Poyraz and Didin (2008) included exchange reserve and rate in addition to oil to their analysis and found that gold prices are effected from these three factors. Topcu (2010) included USA real interest rate and global monetary supply into his analysis, in addition to DJ Industrial Index and USA inflation rate and; found that DJ Industrial Index and USD return have negative impact while global money supply has positive impact on gold prices.

Ibrahim (2010) examines the relation between gold and stock market returns in times of consecutive negative market conditions market. Result showed that there is a significant positive but low correlation between gold and once-lagged stock returns which supports the potential benefits of gold investment during periods of stock market falls. Toraman et al. (2011) investigated effects of USD, US inflation rate and US reel interest rate on gold prices in addition to oil prices and, highest correlation was found between gold and oil prices.

Relationship between gold prices with oil prices was analyzed by Simakova (2011) and reveals the presence of a long-run relationship between them. Aksoy and Topçu (2013) examines relationship between consumer price index, production index, stocks and bonds for 2003/01–2011/12 period and found a long term relationship between these variables as well as significant negative relation with stocks and positive relation with production index.

Akel and Gazel (2015) assessed that in the long run, gold is not a hedging instrument but a diversification tool due its low correlation between stock returns and gold returns. Regarding studies on Turkish gold market efficiency level during 1997-2014 period, weak-form efficiency was not observed in Republic, Reşat and Gold Bullion sub-markets by Uyar and Uzuner (2015). Özkan and Kolay (2016) evaluated basket exchange rate, Borsa Istanbul XU100 equity index, deposit interest rate and inflation rate and; found the equity index as statistically significant impact on gold market prices.

Coşkun and Ümit's (2016) studied over the period of January 2000 to July 2014 in Turkey on whether the return of Borsa Istanbul XU100 equity index has long term relations with USD to TRY exchange rate, gold fixing price of the London Bullion Market Association, house price index and interest rate on TL saving deposits. Although there were long term relationships among the variables with Johansen cointegration test, Maki cointegration estimation didn't support this outcome. Öğet and Şahin (2017) analysis result didn't support long term relationship between gold and Borsa Istanbul XU100 equity index either. For BIST 100 index in TRY, USD/Ons gold and USD oil prices causality relationship analysis for the period of 2005-2015; no long-run relationship was found among the variables by Sandal et al. (2017).

After examining the effect of oil prices, silver prices, Dow Jones industrial index, dollar-sterling parity and FED funds interest rate on the gold prices with vector auto regression model, Küçükaksoy and Yalçın's (2017) findings showed that gold price history data is an important indicator for speculators. Historically, a weak dollar tends to provide a stronger boost to gold's performance then a strong dollar (WGC, 02/2018).

4. DATA AND METHODOLOGY

This study covers the progress of the spot gold market performance against alternative instruments and assets. The data covers 2177 daily observations for July 1, 2009-May 29, 2018 period (business days that all variables have observations are added to the analysis) and includes spot gold price in TRY, BIST 100 Equity Index, spot Turkish electricity price, spot Brent oil price in TRY and USD/TRY

FX spot rate. For estimating the relationships among variables, multivariable regression analyze is employed in the analysis. All series are converted to TRY and return series are used in the model. The Stata statistical software is used to analyze the data.

Before running the regression with the data set in our model, we analyzed whether these time series are individually stationary or not. Augmented Dickey-Fuller (ADF) Test is the main test applied in determining whether time series are stationary or not. The null hypothesis of the Test is that time series have a unit root. If the series are not stationary then mean and variance of a series are not well defined, making any influences about their coefficient unreliable (Küçükçolak, 2008). The formulation of the ADF regression is as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{J=1}^{p} \gamma_j \Delta\ Y_{t-j} + \varepsilon_t \qquad (1)$$

Where ε_t is the random error term. For the ADF test H_0: $\alpha_1 = 0$ hypothesis is tested against H_1: $\alpha_1 < 0$. If H_0 isn't accepted, Y_t is stationary, if null hypothesis is accepted, then the series is not stationary (Küçükçolak, 2008). As depicted in the Appendix 1, the test statistics are smaller than the critical values and we don't accept the null hypothesis. We run our regression model below with the stationary series:

$$XAUTRY_{(t)} = \alpha + \beta_1 XU100_{(t)} + \beta_2 USDTRY_{(t)} + \beta_3 Brent_{(t)} + \beta_4 Electric_{(t)} + e_{(t)} \qquad (2)$$

Where,
$XAUTRY_{(t)}$: Gold price in TRY at t
$XU100_{(t)}$: BIST 100 stock index price at t
$USDTRY_{(t)}$: USD/TRY FX spot price at t
$Brent_{(t)}$: Spot Brent price in TRY at t
$Electric_{(t)}$: Day ahead market electric price at t
α: Constant
β: Coefficient of the relevant independent variable.

For analyzing gold and equity market long-term interaction part of our study, we utilize cointegration test as a measure for market integration. For this purpose, the Engle-Granger methodology (Engle and Granger, 1983) is used. The methodology suggests to make a cointegration test consists of estimating the cointegration regression by ordinary least square, obtaining the residual $\hat{u}_t$ and applying unit root test for $\hat{u}_t$. In order to perform the cointegration test whether the gold and equity index series have a long-term relationship, we examine residuals of the below regression with Dickey-Fuller Test. The cointegration test is applicable if they are integrated at the same order.

$$XAUTRY_{(t)} = \alpha + \beta_1 XU100(t) + e_{(t)} \qquad (3)$$

Where,
$XAUTRY_{(t)}$: Gold price in TRY at t
$XU100_t$: BIST 100 stock index price at t
α: Constant
β: Coefficient of the relevant independent variable.

The ADF is used in order to analyze whether there is a presence of unit root in the error terms from this regression or not. The variables are cointegrated if error terms are stationary I(0), meaning that even if the variables in the system are not stationary, the system consisting of these variables has a long run equilibrium point (Küçükçolak, 2008).

5. EMPIRICAL ANALYSIS

Based on the summary statistics, the mean and median of each variables are very close to zero and not have large standard deviations, except the ones for electric price series. Highest standard deviation is observed in electric price series and lowest standard deviation is observed in USD/TRY FX price series. Gold and BIST 100 index return series have negative skewness and all of them have excess kurtosis.

Model variables showed similar patterns in line with the international literature and gold has showed low and negative correlation with the BIST 100 equity (−22.50%) as shown in the Table 6. Gold's highest correlation is with USD/TRY with 41.43% and then comes Brent oil prices with 18.29%.

Table 6: Pairwise correlation matrix

Variables	AUTRY	XU100	USDTRY	BRENT	Electric
AUTRY	1				
BIST 100	−0.2250	1			
USD/TRY	0.4143	−0.4452	1		
BRENT	0.1829	0.0225	0.2031	1	
Electric	0.0032	0.0522	−0.0184	−0.0074	1

Table 7: Cointegration test result

(a) Test result on the residuals of the regression of AUTRY on BIST 100				
Score	Test stat.	1% Critical Value	5% critical value	10% critical value
Z (t)	−43.362	−3.430	−2.860	−2.570

MacKinnon approximate P value for Z (t)=0.0000

(b) Test result on the residuals of the regression of BIST 100 on AUTRY				
Score	Test stat.	1% critical value	5% critical value	10% critical value
Z (t)	−45.315	−3.430	−2.860	−2.570

MacKinnon approximate P value for Z (t)=0.0000

In the regression model, return series are multiplied with 100, as percentage change in the price. We run the regression model in two ways: Gold is dependent and the others are independent variables and BIST 100 equity index is dependent and the others are independent variables. Based on the regression results, independent variables don't explain gold's movement entirely however, all variables are significant in explaining the dependent variable except electric for gold. For gold equation (Appendix 2/a); among the coefficients of the independent variables, USD/TRY has highest and positive value (0.5360406) in explaining price behavior of gold while BIST100 equity index has the lowest and negative (−0.0509583) effect. As depicted in the BIST100 index regression results in Appendix 2/b; among the coefficients of the independent variables, USD/TRY has highest negative effect (−0.8625147) and gold (AUTRY) has also negative but low effect (−0.0848426) in explaining BIST100 index price behavior.

Dickey-Fuller test result on the residual series is given in the Table 7. To test the cointegration, we examine the residuals of regression on gold price on BIST 100 index. When we plot the residuals (Figure 5), they showed a characteristics of a stationary process since they cross their mean value quite frequently.

The study result showed that gold and stock has long-run relationship and Turkish investors can add gold in addition to stock, in order to improve portfolio diversification. This kind of strategy will diminish volatility of the relevant portfolio.

6. CONCLUSION

The Gold market has reshaped over decades due to an increase in economic developments in emerging markets, increase in gold backed exchange traded funds and expansion of central bank reserves as well as its safe heaven feature under stressed market conditions. Gold has shown resilience during elevated systemic risk, outperforming alternative instruments and becoming a strategic asset especially in periods of higher uncertainty due to its low correlation with other assets. With this feature, it is an important alternative for diversification, hedging as well as risk reduction and adjustment purposes.

Increase in income growth, structural changes in the world gold market and continuing developments of Sharia-compliant gold products will also encourage the outlook of the gold as a financial as well as physical investments instrument. Increasing

Figure 5: Plot of the test residuals
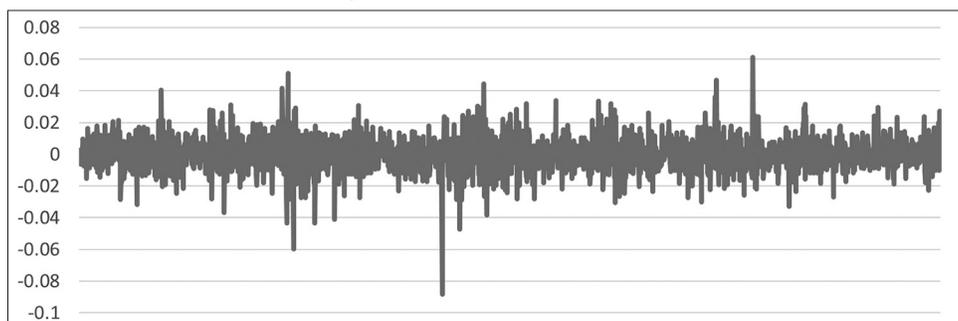
the inclusion of gold into financial system efficiently will not only enrich investment alternatives but also diminish portfolio volatilities (e.g., gold's high correlation and low standard deviation with USD/TRY returns).

Compared to other instruments in Turkish financial system, inclusion level of gold is very low which is leaving an important source and vehicle out of the financial system utilization. In this paper, we have analyzed the long-run relationship of the Turkish gold market with the Turkish equity market for the 2009-2017 period via employing the Co-integration econometric analysis. Based on our analysis, Turkish stock and gold markets are cointegrated in the long run, in line with Smith (2001) and Aksoy and Topçu's (2013) findings. As argued by Alexandre et al. (2001), although gold and equity markets are cointegrated, they have quite low and negative correlation. Having long-run relationship between markets is an advantage for portfolio diversification purpose and investors may benefit from this via adding gold to their investment portfolio. As assessed by Akel and Gazel (2015), low correlation between stock returns and gold returns also supports the strategy of using gold as a portfolio diversification tool.

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APPENDICES

Appendix 1: Test variables' time series unit root test results

Dickey-fuller test for unit root		Number of obs.=1678		
		Interpolated dickey-fuller		
Variables	Test stat.	1% critical value	5% critical value	10% critical value
AUTRY Z (t)	−43.319	−3.430	−2.860	−2.570
XU100 Z (t)	−45.294			
USDTRY Z (t)	−42.858			
Brent Z (t)	−39.525			
Electric Z (t)	−60.032			

MacKinnon approximate P value for Z (t)=0.0000

Appendix 2: Regression results

(a) Gold is dependent variable: Reg autry xu100 usdtry brentspottry electric

Source	SS	df	MS	Number of obs.	2177
Model	0.046954842	4	0.011738711	F (4, 2172)	123.61
Residual	0.206270338	2172	0.000094968	Prob.>F	0.0000
Total	0.253225180	2176	0.000116372	R-squared	0.1854
				Adj. R-squared	0.1839
				Root MSE	0.00975

AUTRY	Coefficient	Standard error	t	P>t	(95% confidence interval)	
XU100	−0.0509583	0.0165932	−3.07	0.002	−0.0834984	−0.0184181
USDTRY	0.5360406	0.0329616	16.26	0.000	0.4714009	0.6006802
Brent spot	0.0620073	0.011141	5.57	0.000	0.0401592	0.0838553
Electric	0.0008261	0.00113	0.73	0.465	−0.0013899	0.0030421
_cons	0.0003474	0.0002175	1.60	0.110	−0.0000791	0.0007739

(b) BIST 100 Equity Index is dependent variable: reg xu100 autry usdtry brentspottry electric

Source	SS	df	MS	Number of obs.	2177
Model	0.095016218	4	0.023754054	F (4, 2172)	150.23
Residual	0.343428454	2172	0.000158116	Prob.>F	0.0000
Total	0.438444672	2176	0.000201491	R-squared	0.2167
				Adj. R-squared	0.2153
				Root MSE	0.01257

XU100	Coefficient	Standard error	t	P>t	(95% confidence interval)	
AUTRY	−0.0848426	0.0276267	−3.07	0.002	−0.1390201	−0.0306651
USDTRY	−0.8625147	0.041069	−21.00	0.000	−0.9430533	−0.7819761
Brent spot	0.0915604	0.0143437	6.38	0.000	0.0634316	0.1196892
Electric	0.003465	0.0014564	2.38	0.017	0.000609	0.006321
_cons	0.0008043	0.0002803	2.87	0.004	0.0002547	0.001354

Appendix 3: Gold and equity index regression residuals unit root test results

D-Fuller residuals, trend regress lags (0)				
Dickey-fuller test for unit root		Number of obs.=1678		
		Interpolated dickey-fuller		
Score	Test stat.	1% critical value	5% critical value	10% critical value
Z (t)	−43.347	−3.960	−3.410	−3.120

MacKinnon approximate P value for Z (t)=0.0000

D. residuals	Coefficient	Standard error	t	P>t	(95% confidence interval)	
Residuals						
L1.	−1.031608	0.23799	−43.35	0.000	−1.078287	−0.9849289
_trend	8.71e-08	2.65e-07	0.33	0.742	−4.32e-07	6.07e-07
_cons	−0.0005527	0.0005006	−1.10	0.270	−0.0015345	0.0004291

D-Fuller residuals, trend regress lags (1)				
Dickey-Fuller test for unit root		Number of obs.=1211		
		Interpolated dickey-fuller		
Score	Test stat.	1% critical value	5% critical value	10% critical value
Z (t)	−25.782	−3.960	−3.410	−3.120

MacKinnon approximate P value for Z (t)=0.0000

D. Residuals	Coefficient	Standard error	t	P>t	(95% confidence interval)	
Residuals						
L1.	−1.058049	0.0410362	−25.78	0.000	−1.138559	−0.9775387
LD.	0.0083793	0.0290179	0.29	0.773	−0.0485518	0.0653104
_trend	3.73e-07	3.13e-07	1.19	0.234	−2.41e-07	9.86e-07
_cons	−0.0011251	0.0005934	−1.90	0.058	−0.0022893	0.000039