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Analysis of the Relationship Between Precious Metals and Stock Markets: Application on Borsa Istanbul Commercial Sectors

Kıymetli Metaller ile Hisse Senedi Piyasaları Arasındaki İlişkinin Analizi: Borsa İstanbul Ticari Sektörler Üzerine Uygulama

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Abstract

The relationship between different commercial sectors' stocks and precious metals is vital in terms of diversification in portfolio investments. For this purpose, in this study, it is aimed to investigate the long-term association between stock markets belonging to commercial sectors and precious metals. One hundred nine monthly data related to the variables discussed between January 2011 and January 2020 were used. Before the cointegration analysis, the stationarities of the series were determined with Carrion-i Silvestre (2009) (CS) unit root test, which allowed up to five structural breaks. Maki (2012) cointegration analysis was applied to the series, which is the first aware stationary, with five structural breaks. Finally, the causal relationship among variables was investigated with Hatemi-J (2012) Asymmetric causality test. According to the results obtained, the stock markets were analyzed, and the prices of gold and silver were co-integrated. Besides, a bilateral causality has been reached between gold and silver prices, other than the stock market of the banking sector, and from the silver prices to the banking stock market.

Jel Codes: *G10, G11, G17*
Keywords: *Portfolio Diversification, Maki Cointegration Analysis, Hatemi-J Causality Analysis*

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Öz

Farklı sektörlere ait hisse senedi piyasaları ile kıymetli metaller arasındaki ilişki portföy yatırımlarında çeşitlendirme açısından önem arz etmektedir. Bu amaçla çalışmada ticari sektörlere ait hisse senedi piyasaları ile kıymetli metaller arasındaki uzun dönem ilişkinin araştırılması amaçlanmıştır. Ele alınan değişkenlere ilişkin Ocak 2011- Ocak 2020 dönemine ait 109 adet aylık veri kullanılmıştır. Eş bütünleşme analizinden önce serilerin durağanlıkları beş yapısal kırılmaya kadar izin veren Carrion-i Silvestre (2009) (CS) birim kök testi ile incelenmiştir. Birinci farkında durağan olan serilere beş yapısal kırılmalı Maki (2012) eş bütünleşme analizi uygulanmıştır. Son olarak da değişkenler arasındaki nedensellik ilişkisi Hatemi-J (2012) Asimetrik nedensellik testi ile incelenmiştir. Elde edilen sonuçlara göre incelenen hisse senedi piyasaları ile altın ve gümüş fiyatlarının eşbütünleşik olduğu görülmüştür. Ayrıca bankacılık sektörüne ait hisse senedi piyasası hariç diğer hisse senedi piyasaları ile altın ve gümüş fiyatları arasında çift yönlü, gümüş fiyatlarından bankacılık hisse senedi piyasasına doğru ise tek yönlü nedensellik ilişkisine ulaşılmıştır.

Jel Kodları: *G10, G11, G17*
Anahtar Kelimeler: *Portföy Çeşitlendirmesi, Maki Eşbütünleşme Analizi, Hatemi- J Nedensellik Analizi*

1. Introduction

Throughout the recent years, the impact of globalization has been felt prominently in financial markets. The liberal formation of the markets, the elimination of the barriers to capital, and the globalization experienced in every domain have increasingly integrated both emerging and developed markets. In today's world, the financial market of a country can be instantly affected by the markets of different countries. So, global markets act concurrently. Besides the expansion of the markets, financial investment instruments have also been steered in one direction and the variety of traded instruments has increased. Although the differentiation of investment instruments offers investors the opportunity to diversify their portfolios, the impact of a crisis in any market due to the enhanced dependence among markets has also accompanied a risk factor. The crises to which the markets may be exposed, the adverse impact of the crisis along with the domino effect on all markets, and the presence of global and regional uncertainties have impelled investors to seek out instruments to reduce their losses in each period. Nevertheless, due to financial globalization, as well as the fact that most financial instruments act together, it would become quite difficult for investors to diversify their portfolios and reduce their risk. These results have impelled investors and researchers to search for investment tools known as safe havens in the literature which enable investors to reduce their risk.

The concept of safe haven in financial markets is used for the financial asset purchased by investors or the ideal environment in which money is stored for the same purpose to mitigate the risk in times of increased uncertainty in the markets (Kaul & Sapp, 2006: 761). On the other hand, Baur and Lucey (2010) defined safe haven as financial assets that do not act concurrently with other financial assets due to negative correlations among them in extreme circumstances such as crisis periods. In line with this definition, investors would be able to mitigate the impact of shocks that cause losses if they hold the assets that are not associated or have an adverse relationship with other assets in their portfolios during crisis periods. Besides the benefits of the asset being a safe haven with which it provides the investors, its mitigating effect on the negative shocks would contribute to the preservation of the capital markets' stability. In addition to the safe haven element, hedging instruments are also utilized by investors as a portfolio diversification tool. Determining whether or not an investment tool is in a safe haven or hedging instrument form is crucial for investors. The financial asset, which has the safe haven feature with a powerful formation, yields positive returns to the investor due to the adverse relationship among these instruments and other portfolio instruments whenever they provide negative returns. For the weak form of investment tool, such a relationship is not present, especially in times of deep crisis. The reason for this is that the weak form of the investment tool does not have a relationship with other investment instruments during normal periods and in cases such as crisis periods where there are many losses, the direction of such non-association shifts to the positive side (Reboredo, 2013: 131-136).

In compliance with the explanation above, the determination of the investment instrument that mitigates the risk factor with the portfolio diversification function or is seen as a hedging tool against risks in the literature has always been one of the research topics attracting utmost attention. One of the most emphasized issues in the literature is whether or not gold has a safe harbor feature. Gold has been perceived as the sole representative of wealth and power for long centuries. In fact, in the mercantilist thought, it was argued that the wealth of countries could have been measured by their gold stocks and that the only way for nations to prosper was to increase their gold stocks. Although the function of gold in the markets has changed since then, its importance still prevails. The fact that gold is seen as a safe haven against the risk factors dates far back to the determination made by Fisher (1896). Fisher (1896) stated that inflation would have adversely affected the purchasing power of money, as well as the value of other financial assets. Besides, the plunge of the stock markets during the Great Depression of 1929 triggered the investors' urge to identify the risk factor and to avoid risk. In this context, the researchers have first tried to figure out whether or not gold could be used as a safe haven or hedging tool against inflation. Therefore, many studies have concluded that gold had a safe haven feature against inflation (Fama & Schwert, 1977; Chua & Woodward, 1982; Harmston, 1998; Baur & Lucey, 2010). Following this detection, many researchers have investigated whether gold has a safe haven feature against the stock market, government bonds, or other commodities such as oil, as well as inflation, and the findings reveal that gold would also be used for hedging purposes for other investment instruments (Koutsoyiannis, 1983; Fortune, 1987; Srinivasan, 2014; Bredin, Conlon & Potì, 2015).

Jaffe (1989) tested whether or not gold and gold-based assets were risk diversification factors against stock markets using the correlation analysis method. The analysis result is in favor of the notion that the inclusion of gold and gold-based assets in corporate portfolios would increase the average returns of investors, but would also increase the standard error coefficient. Chua, Sick & Woodward (1990) investigated the question of whether or not investors can diversify their risks against inflation by including gold-based assets in their portfolios. In their study covering the period 1971 - 1988, the return of gold-based assets, systematic risk variables, and stock returns were analyzed using the regression model. The findings of the study revealed that, both in the short- and long-run, gold could be used by investors in portfolio diversification. Baur & Mcdermott (2010) explicated the position of gold in the international financial system. It was tested with the help of the GARCH model whether gold was a safe financial instrument for the stock markets of both developing and developed countries. The findings of the study, covering the period 1979 - 2009, indicated that gold was a safe haven regarding the stock markets of the USA, as well as major European countries. Moreover, it was also investigated whether gold has the safe haven feature for the stock markets in countries such as Japan, Canada, and Australia, as well as the BRIC country group. Many researchers emphasized in their studies that gold could be considered as a safe haven or hedging instrument in different country groups and against different investment instruments. Besides these studies, there are also several studies asserting that gold poses as a safe haven or hedging instrument against stocks (Hussin, Muhammad, Razak, Tha & Marwan 2013; Hood & Malik, 2013; Ghazali, Lean & Bahari, 2013; Gürgün & Ünalmış, 2014; Beckmann, Berger, & Czudaj, 2015; Śmiech & Papież, 2017; Ming, Yang, Li, & Zhu., 2018), and protects against inflation as well as foreign exchange risk (Joy, 2011; Reboredo, 2013; Reboredo & Castro, 2014) in the literature. Nonetheless, there are also studies in the literature that revealed findings in the opposite direction (Tully & Lucey, 2007; Ghazali, Lean & Bahari, 2015; Van Hoang Lahiani & Heller, 2016; Iqbal, 2017). The absence of a general consensus on the subject can be expressed as a general result of the conditions such as the econometric method used, the time interval, the different features of the countries or country groups, and the difference in the shocks experienced throughout the period.

The question of whether gold is a safe haven has become one of the interesting topics in Turkey's economy. Against various investment instruments, many researchers have conducted studies on this subject utilizing different econometric methods and time intervals. Balı & Cinel (2011) analyzed the association between ISE 100 index and gold over the period between August 1995 and March 2011 using the panel data analysis method. The findings of the study indicated that the ISE 100 index was not directly affected by gold prices. Tomak (2013) examined whether or not gold was a safe haven or a hedging instrument against dollar-denominated exchange rates, the State Domestic Borrowing Notes (SDBNs), and other financial investment instruments such as stocks via the DCC-GARCH model. The findings of the model revealed that gold could be used for hedging against stocks, but such a feature did not exist for negative stock returns lower than 1%. Another result of the study was that gold did not have the function of hedging against government securities and the US dollar. On the other hand, in their studies covering the period between July 2000 and November 2014 using the TARCH method, Akel & Gazel (2015) emphasized that gold was not a safe haven against stocks, however, could be used as a diversification tool in hedging. In their study, Doğru & Uysal (2015) investigated the short- and long-term association between BIST 100 index and gold over the period January 2000 - September 2012 performing both the Johansen cointegration analysis and the Granger causality test. It was stated that a long-term association existed between the stock return index and gold before and after the global financial crisis of 2008. Furthermore, while there was a positive relationship between the two variables before the crisis, such a relationship became adverse following the crisis. In that direction, another result of the study involved the fact that the causality ran from gold to BIST100 index prior to the crisis, whereas the direction of the causality changed following the crisis. In another study, Çoşkun & Ümit (2016) tried to determine the relationship between stock and gold prices via the Johansen (1990) cointegration and Maki (2012) multiple break cointegration tests utilizing the monthly data obtained over the period January 2000-July 2014. Cointegration results indicated that no long-term association existed between the stock market and gold. Nagayev & Dinç (2018) utilized the Wavelet Coherence technique to investigate whether or not gold was a safe haven or a hedging instrument against traditional and Islamic stock indexes. The result of the study concluded that gold could be considered as a safe haven. Başarır (2019) examined the relationship between gold and BIST100 index by courtesy of the Toda-Yamamoto causality test and the VAR model over the period between April 2006 and August 2018. The findings of the study were that gold could be used in risk diversification for investors.

In general, upon considering the literature, gold is determined as a powerful safe haven for developed country markets and a poor safe haven for emerging markets. Investors' desire to diversify risks has rendered it necessary to investigate whether or not other commodities besides gold would also be safe havens. The facts that commodities are not only traded in financial markets, but also used in the production phase, and they do not have a certain standard, and they are not prone to price manipulations have opened up other commodities besides gold for risk diversification. The fact that the general courses of commodity prices are in the same direction reinforces the risk diversification functions. Lawrence (2003) analyzed the relationship of the gold price index, silver, aluminum, petroleum, zinc, and the S&P 500 with the Dow Jones index and macroeconomic indicators over the period 1997 - 2001. The study concluded that only gold would have been used in asset diversification. Hillier, Draper, & Faff (2006) explicated the relationship of precious metals with the stock market over the period 1976 - 2004. According to the findings of the study, they determined that precious metals had low correlations against stock returns, hence, they could be used in investment diversification. Conover, Jensen, Johnson & Mercer (2009), however, concluded that if precious metals were to be included in the portfolio, the annual returns would have risen, and the risk would have declined over the period 1973 - 2006. Sensoy (2013) stated in his study that gold, silver, platinum, and palladium acted concurrently and exhibited high correlations among themselves. This situation emphasizes that the aforementioned assets became convergent towards a single asset class. In their studies, Lucey & Li (2015) tested whether or not silver, platinum, and palladium, as well as gold, were safe havens. The findings indicated that, between 1989 - 2013, the commodities besides gold were safe havens. In their studies covering various country groups, Ildirar & İşçan (2016) concluded that commodities such as natural gas, iron, rubber, and wheat were unrelated to the stock markets of 15 continental European and Asian countries. Besides these studies, various studies revealed that other precious metals and commodities besides gold could be used in risk diversification for investors (Abanomey & Mathur, 2001; Gorton & Rouwenhorst, 2006; Hammoudeh, Malik & McAleer, 2011; Mensi, Hammoudeh & Kang 2015).

Gold prices, which increased following the 2008 global financial crisis, continue to move upwards due to global and regional disturbances, tensions in international trade, and political uncertainties experienced by countries in recent years. Besides these shocks, other factors such as enhanced gold reserves of central banks in the countries and the investors' everlasting interest in gold also tend to positively affect gold prices. In this context, gold upholds its feature of being an investment tool that hopes for achieving high returns, as well as as a hedging tool in portfolio diversification by keeping a place in the investors' portfolios (Doğru & Uysal, 2015). Also, silver is another precious metal that has been historically highly correlated with gold. In this regard, upon examining the literature, no study investigating the relationship between the commercial sector stock markets and precious metals in Turkey has been encountered. In the context of more detailed portfolio diversification for investors, it is apparent that this study would contribute to both the market and the literature. In this study, 109 monthly data obtained over the period January 2011 - January 2020, based on spot prices of precious metals, are analyzed using the Hatemi-J Asymmetric causality and Maki Cointegration test methods. This study is organized into five parts. In the second and third parts of the study, the utilized data and the methods by which these data are analyzed are introduced. The obtained findings are presented in the fourth part, and in the last part, evaluations are made in compliance with these obtained findings.

2. Data

The long-term association between precious metals and commercial sectors[2] is analyzed in this study. Thus, it is tried to determine whether or not precious metals would be efficient portfolio diversification instruments. Precious metals and commercial sectors included in the analysis are presented in Table 1. In the study, where the monthly data of closing prices of monthly spot[3] and stock indexes regarding precious metals are handled, 109 data are analyzed over the period of January 06, 2011 - January 24, 2020. The data utilized in the study have been obtained from www.finnet.com website.

Table 1. Indexes and Precious Metals included in the Study

Index Code	Index Name	Precious Metals
XINDR	BIST INDUSTRY	GOLD
XCHEM	BIST CHEMICAL, PETROLEUM, PLASTIC	SILVER
XBANK	BIST BANKING	
XPAPR	BIST WOOD, PAPER, PRINTING	
XTRAN	BIST TRANSPORTATION	

Table 2 indicates that the highest stock market price and standard deviation value belong to the banking stock market. Therefore, although this market offers higher returns than other stock markets, it is much riskier. Among the precious metals, gold has the highest price,

[2] The sectors included in the study were obtained from studies such as Jiang, Jiang, Nie, and Mo (2019); Naifar, (2018); and Mensi, Hammoudeh., Al-Jarrah, Sensoy, Kang, (2017).
[3] In the study, spot prices were used instead of forward prices in terms of reflecting current volatility along with future volatility (Pindyck, 2004; Sarwar, Khalfaoui, Waheed, & Dastgerdi, 2019).

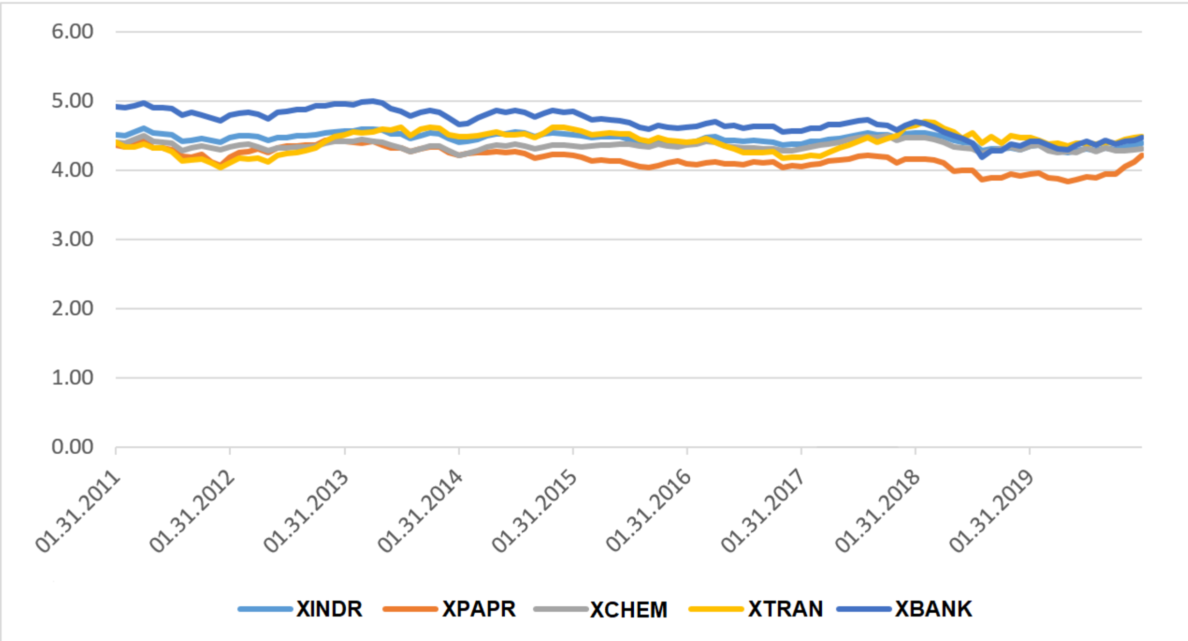
whereas silver has the lowest price. Upon considering the riskiness of these metals, it can be asserted that gold as a hedging instrument has the lowest standard deviation, and therefore it has a lower risk compared to other metals and the stock markets under consideration.

Table 2. Descriptive Statistics of the Price Series

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
XINDR	4.456	4.469	4.608	4.262	0.081	-0.523	2.504
XCHEM	4.356	4.351	4.506	4.215	0.060	0.370	2.854
XBANK	4.690	4.706	4.998	4.184	0.190	-0.559	2.528
XPAPR	4.168	4.167	4.448	3.837	0.149	-0.243	2.404
XTRAN	4.416	4.431	4.708	4.048	0.147	-0.433	2.454
GOLD	3.130	3.115	3.252	3.025	0.056	0.552	2.335
SILVER	0.853	0.804	1.504	0.347	0.298	0.269	1.956

As seen in Figure 1, there have been extreme price fluctuations of the entire stock markets, unlike other periods, before and after the exchange rate shocks that occurred in Turkey as of 2018. This period offers opportunities for significant returns, especially for risk-seeking investors, whereas it may also result in significant losses. Although the moderate fluctuations have occurred in line with the signs of recovery in all markets throughout the post-2018 period, prices still have been lower than of the pre-2018 period.

Figure 1. Change in the Prices of Commercial Sector Stock Markets



It is observed that the banking stock market had the highest price fluctuation during the overall period, whereas the chemical, petroleum, plastic stock markets had the lowest. Nonetheless, the stock market of the wood, paper, and printing sector had the lowest price.

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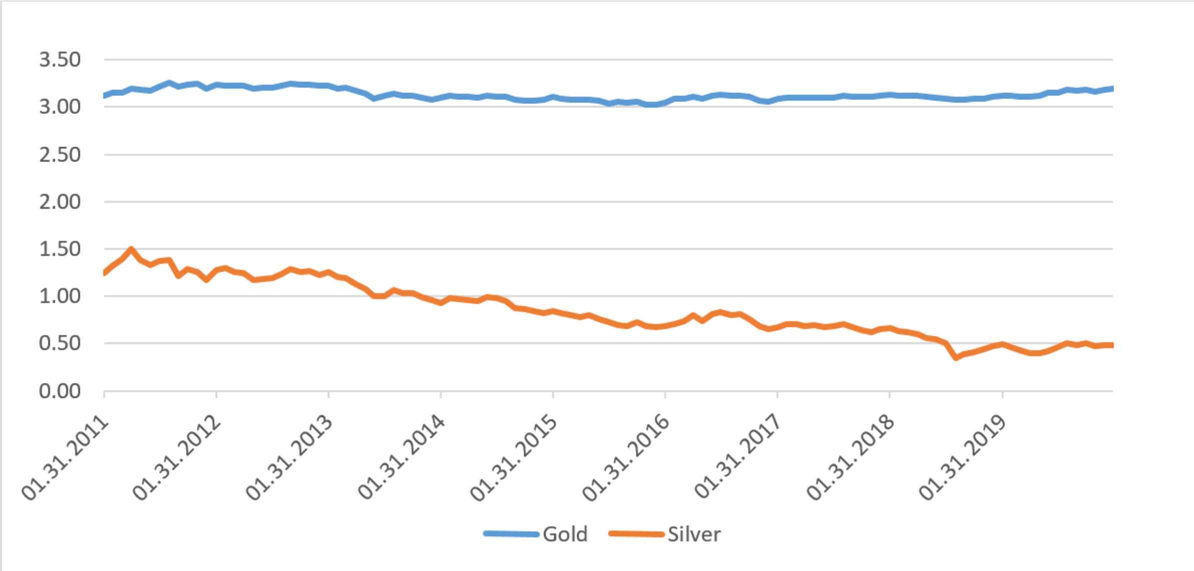
Figure 2. Change in Prices of Precious Metals



According to Figure 2, there has been a significant fluctuation in silver prices compared to gold during the overall period and it has reached its lowest value as of 2018. Despite the limited rise in gold prices particularly during and after the period of 2018, through which the exchange rate shock that was experienced in Turkey, the prices have remained stable, in general, throughout the course of the entire period. Following the year 2018, there has been a rise in silver prices, but such an increase was lower than of the year 2015. Therefore, it is essential to explicate the existence of any relationship between precious metals and the stock markets in order to achieve optimal portfolios for investors.

3. Methodology

The efficiency of precious metals in portfolio diversification is investigated in this study. To this end, it is crucial to examine the relationship between precious metals and other variables considered in portfolio diversification carried out with precious metals. Using the cointegration analysis to be performed to detect such a relationship, the appropriate assets to be included in the portfolio would be determined. Therefore, the Maki (2012) cointegration analysis is conducted to investigate the long-term association among the variables. To determine the causal relationship, the Hatemi-J (2012) causality test, which considers the impacts of negative and positive shocks separately, is performed. Thus, the direction of the causality among the variables is revealed in more detail. Prior to the investigation of the long-term relationship among the variables, the stationarity of the analyzed series is determined by the CS (2009) unit root test.

3.1. Carrionni-Silvestre (CS) Unit Root Test

The CS (2009) unit root test, in which the break dates are determined internally, allows for a maximum of five structural breaks. Structural breakpoints are obtained utilizing the Bai & Perron (2003) algorithm and the Generalized Least Squares method. The method, in which the sum of error squares is minimized, uses the dynamic programming process and can be successfully applied to small samples (Göçer & Peker, 2014: 114).

The stochastic data generation process used in given below (Carrion-i Silvestre, Kim & Perron, 2009: 1757):

$$y_t = d_t + u_t \tag{1}$$

$$u_t = \alpha u_{t-1} + v_t\ ,\ \ t = 0,1,......,T \tag{2}$$

For testing the stationarity of the series, the following five different test statistics were developed (Carrion-i-Silvestre, Kim & Perron, 2009: 1759-1762):

$$P_T(\lambda^0) = \{S(\bar{\alpha},\ \lambda^0) - \ \bar{\alpha}\, S(1,\lambda^0)\ \}/\ s^2(\lambda^0) \tag{3}$$

$$MP_T(\lambda^0) = [c^{-2}T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2 + (1-\tilde{c})T^{-1}\tilde{y}_T^2]/s(\lambda^0)^2 \tag{4}$$

$$MZ_\alpha(\lambda^0) = (T^{-1}\tilde{y}_T^2 - \ s(\lambda^0)^2)(2T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2)^{\ -1} \tag{5}$$

$$MSB(\lambda^0) = (s(\lambda^0)^{-2}\ T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2)^{\ \frac{1}{2}} \tag{6}$$

$$MZ_t(\lambda^0) = (T^{-1}\tilde{y}_T^2 - \ s(\lambda^0)^2)(4s(\lambda^0)^2\ T^{-2}\ \sum_{t=1}^{T}\tilde{y}_{t-1}^2)^{\ -\frac{1}{2}} \tag{7}$$

The Test Hypotheses:

H_0: The unit root exists under structural breaks.

H_1: The unit root does not under structural breaks.

If the test statistic, which is calculated as a result of the analysis, is lower than the critical value; the H_0 hypothesis is rejected and it is stated that the analyzed series is stationary in the presence of structural break (Göçer, Mercan & Peker, 2013: 8).

3.2. Maki Cointegration Test

By courtesy of the cointegration test developed by Maki (2012), in which five structural breaks are determined internally, t statistics are estimated, and then the points where t value is the lowest are determined as the break dates. The series examined in the Maki cointegration test should be I(1) (Göçer, Mercan & Peker, 2013: 10). The following models have been developed to analyze the cointegration relationship (Maki, 2012: 2011-2012):

Model 0: A model without trend, with a break in the constant term.

$$y_t = \mu + \sum_{i=1}^{k}\mu_i D_{i,t} + \beta' x_t + u_t \tag{8}$$

Model 1: A model without trend, with a fixed term and a break in the slope.

$$y_t = \mu + \sum_{i=1}^{k}\mu_i D_{i,t} + \beta' x_t + \sum_{i=1}^{k}\beta'_i\ x_t D_{i,t} + u_t \tag{9}$$

Model 2: A model with the trend, with a break in the fixed term and the slope.

$$y_t = \mu + \sum_{i=1}^{k}\mu_i D_{i,t} + \gamma t + \beta'\ x_t + \sum_{i=1}^{k}\beta'_i\ x_t\ D_{i,t} + u_t \tag{10}$$

Model 3: A model with a break in the constant term, slope, and trend.

$$y_t = \mu + \sum_{i=1}^{k}\mu_i D_{i,t} + \gamma t + \sum_{i=1}^{k}\gamma_i\ tD_{i,t} + \beta'\ x_t + \sum_{i=1}^{k}\beta'_i\ x_t\ D_{i,t} + u_t \tag{11}$$

The test hypotheses:

H_0: There are no cointegration relationships among the series under structural breaks.

H_1: There are cointegration relationships among the series under structural breaks.

The test statistic value calculated at the end of the cointegration test is compared with the Maki (2012) table critical values. If the obtained test value is lower than the critical value, the H_0 is rejected, and it is stated that cointegration exists among the series (Göçer & Peker, 2014: 117).

3.3. Hatemi-J Asymmetric Causality Test

By performing this causality test, which was developed by Hatemi-J (2012) and which is the unbundled state of both negative and positive shocks of the Hacker & Hatemi-J (2006) Bootstrap Granger causality test, positive and negative shocks are distinguished (Çevik & Zeren, 2014: 202). The model developed for causality analysis can be described as follows (Hatemi-J, 2012: 449): Supposing that the causal relationship between two cointegrated series, namely y_{1t} and y_{2t}, is examined:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i} \tag{12}$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i} \tag{13}$$

Negative and positive shocks are indicated as $\varepsilon_{1i}= \varepsilon_{1i}^{+}+\varepsilon_{1i}^{-}$ and $\varepsilon_{2i}= \varepsilon_{2i}^{+}+\varepsilon_{2i}^{-}$, respectively, when ε_{1i}^{+} = max (ε_{1i},0) , ε_{2i}^{+}= max (ε_{2i}, 0), ε_{1i}^{-} = min (ε_{1i}, 0), ε_{2i}^{-}= min (ε_{2i}, 0). In compliance with this information, the equations y_{1t} and y_{2t} can be rearranged as follows:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-} \tag{14}$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{15}$$

Subsequently, the negative and positive shocks of each series can be cumulatively described as follows:

$$y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+} \text{ , } y_{1i}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-} \text{ , } y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+} \text{ and } y_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{16}$$

4. Findings

Prior to conducting the cointegration analysis between stock markets and precious metals, a unit root test is performed to determine the stationary of the variables. For this purpose, the CS (2009) unit root test allowing for a maximum of five structural breaks is used. The unit root test results for precious metals and stock markets are shown in Table 3. According to the results, it is seen that the H_0 is accepted in the level values of all variables, meaning that, the series is not stationary. Therefore, the first differences of all variables are taken, and the variables become stationary. Besides, the break dates for each variable are presented in Table 3.

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Table 3. Carrion-i-Silvestre Multiple Structural Break Unit Root Test Results for Variables

Country Name	Level Values		Break Dates	First Differences	
BANK	**MSB**	0.156 (0.105)	01.31.2017	**MSB**	0.100*(0.103)
	MZ_t	-3.019 (-4.736)	08.31.2018	**MZ_t**	-4.913* (-4.801)
PAPR	**MSB**	0.150 (0.102)	03.31.2017	**MSB**	0.099*(0.103)
	MZ_t	-2.850 (-4.823)	04.30.2018	**MZ_t**	-5.018*(-4.828)
CHEM	**MSB**	0.129 (0.103)	08.31.2017	**MSB**	0.098*(0.104)
	MZ_t	-3.855 (-4.808)	08.31.2018	**MZ_t**	-5.065*(-4.798)
TRAN	**MSB**	0.114 (0.101)	10.31.2016	**MSB**	0.101*(0.103)
	MZ_t	-4.242 (-4.894)	03.29.2018	**MZ_t**	-4.922*(-4.816)
INDR	**MSB**	0.131 (0.103)	01.31.2018	**MSB**	0.103*(0.104)
	MZ_t	-3.756 (-4.819)	12.31.2018	**MZ_t**	-4.829*(-4.798)
GOLD	**MSB**	0.112 (0.103)	10.31.2016	**MSB**	0.997*(0.104)
	MZ_t	-4.449 (-4.831)	11.30.2018	**MZ_t**	-5.008*(-4.781)
SILVER	**MSB**	0.136 (0.103)	09.30.2016	**MSB**	0.101*(0.103)
	MZ_t	-3.661 (-4.821)	08.31.2018	**MZ_t**	-4.940*(-4.814)

Note: * indicates stationarity at the 5% significance level. Values in parentheses are generated using bootstrap with 1,000 iterations. Structural break dates are detected by the test method, and the break dates in level values are presented in the table to indicate the breaks in the original state of the series.

The Maki (2012) cointegration analysis is performed for the variables that become stationary in the first difference to reveal the long-term relationship among them. Table 4 presents the cointegration analysis results. The H_0 hypothesis is accepted by the results of the cointegration analysis performed between precious metals and stock markets. So, no cointegration association is detected among the variables under examination. Therefore, stock markets that are examined in terms of such precious metals as gold and silver do not act concurrently in the long-run. This situation indicates that gold and silver can be effective portfolio diversification tools for INDR, TRAN, PAPR, CHEM, and BANK stock markets.

Table 4. Results of the Maki Cointegration Test with Multiple Structural Breaks Regarding the Variables

Countries	Test Statistic	Results	Break Dates
Bank-Gold	-5.93	No Cointegration	06.30.2014; 05.31.2017 07.31.2018; 04.30.2019
Bank-Silver	-6.76	No Cointegration	02.28.2013; 04.29.2016 10.31.2016; 11.30.2018 06.28.2019
Papr-Gold	-7.43	No Cointegration	12.30.2011; 07.31.2012 12.30.2016; 11.30.2018 08.30.2019
Papr -Silver	-5.96	No Cointegration	10.31.2012; 11.29.2013 03.29.2018; 11.30.2018
Chem-Gold	-5.41	No Cointegration	07.31.2012; 09.30.2013 03.31.2014; 04.30.2018 11.30.2018
Chem-Silver	-6.10	No Cointegration	06.29.2012; 11.30.2012

			08.30.2013; 03.31.2014 02.28.2019
Tran-Gold	-5.72	No Cointegration	02.27.2015; 09.30.2016
Tran-Silver	-6.19	No Cointegration	10.31.2014; 07.31.2015 06.30.2016; 03.29.2018
Tran-Gold	-6.93	No Cointegration	07.29.2011; 11.30.2012 06.30.2014; 02.29.2016 04.30.2018
Indr-Silver	-5.40	No Cointegration	08.30.2013; 03.31.2014 11.28.2014; 11.30.2018

	1%	5%	10%
Critical Values in 1 Structural Break	-6.04	-5.54	-5.28
Critical Values in 2 Structural Breaks	-6.62	-6.10	-5.84
Critical Values in 3 Structural Breaks	-7.08	-6.52	-6.26
Critical Values in 4 Structural Breaks	-7.55	-7.00	-6.71
Critical Values in 5 Structural Breaks	-8.00	-7.41	-7.11

Note: Critical values under structural breaks are obtained from the Maki (2012) Table 1**.** Critical values are generated using bootstrap with 1,000 iterations. Structural break dates were determined by Maki (2012). *indicates the presence of cointegration at a 1% significance level.

The short-term dynamics among the series, in which no long-term relationships can be obtained, are examined by performing the Hatemi-J (2012) analysis. The obtained findings of the analysis performed between precious metals and stock markets are shown in Table 5. Among the analyzed variables, a unilateral causality from silver prices to the banking stock market, and a bilateral causal relationship between all other stock markets except for the banking stock market and gold and silver prices are observed.

Table 5. Hatemi-J Asymmetric Causality Test Results for Variables

Direction of Causality	Test Stat.	Critical Values			Direction of Causality	Test Stat.	Critical Values		
		1%	5%	10%			1%	5%	10%
Bank^{+} → Gold^{+}	1.741	7.022	4.352	3.204	Gold^{+} → Bank^{+}	0.216	7.383	4.192	3.101
Bank^{-} → Gold^{-}	0.599	8.698	5.217	3.419	Gold^{-} → Bank^{-}	0.156	7.268	4.080	2.904
Bank^{-} → Gold^{+}	0.874	9.442	4.721	3.145	Gold^{-} → Bank^{+}	2.606	7.556	4.512	3.175
Bank^{+} → Gold^{-}	2.083	6.730	4.250	2.820	Gold^{+} → Bank^{-}	0.297	6.971	4.003	2.785
Bank^{+} → Silver^{+}	2.519	7.238	4.225	3.089	Silver^{+} → Bank^{+}	1.122	7.962	4.047	2.762
Bank^{-} → Silver^{-}	0.360	7.681	3.992	2.890	Silver^{-} → Bank^{-}	3.811***	7.508	3.982	2.756
Bank^{-} → Silver^{+}	0.040	9.972	4.344	2.850	Silver^{-} → Bank^{+}	0.433	6.810	4.140	2.832
Bank^{+} → Silver^{-}	1.808	6.865	4.312	2.872	Silver^{+} → Bank^{-}	0.000	6.971	4.304	3.041
Papr^{+} → Gold^{+}	0.492	8.046	4.806	2.970	Gold^{+} → Papr^{+}	3.882***	6.843	3.953	2.662
Papr^{-} → Gold^{-}	0.250	6.620	4.074	2.893	Gold^{-} → Papr^{-}	8.522*	7.508	4.370	3.098
Papr^{-} → Gold^{+}	6.628**	8.307	4.547	3.214	Gold^{-} → Papr^{+}	0.397	6.813	4.001	2.625
Papr^{+} → Gold^{-}	1.045	7.128	3.899	2.673	Gold^{+} → Papr^{-}	3.168***	7.645	4.282	2.872
Papr^{+} → Silver^{+}	0.420	8.495	4.585	3.189	Silver^{+} → Papr^{+}	0.007	7.548	3.986	2.602
Papr^{-} → Silver^{-}	11.951**	13.080	8.418	6.378	Silver^{-} → Papr^{-}	11.749*	9.689	6.155	4.816
Papr^{-} → Silver^{+}	2.452	9.333	5.237	3.287	Silver^{-} → Papr^{+}	16.702*	14.547	9.322	7.526
Papr^{+} → Silver^{-}	0.993	7.049	3.869	2.684	Silver^{+} → Papr^{-}	4.206	13.125	9.110	7.174
Chem^{+} → Gold^{+}	1.831	6.824	4.459	3.225	Gold^{+} → Chem^{+}	0.602	7.935	4.794	3.169
Chem^{-} → Gold^{-}	0.046	7.840	4.370	2.968	Gold^{-} → Chem^{-}	3.099***	6.960	3.960	2.725
Chem^{-} → Gold^{+}	2.434	8.886	4.608	3.233	Gold^{-} → Chem^{+}	0.527	7.531	4.516	3.283

Chem^{+} → Gold^{-}	3.324***	7.404	4.285	2.958	Gold^{+} → Chem^{-}	1.193	7.234	4.080	2.798
Chem^{+} → Silver^{+}	1.022	7.010	3.966	2.947	Silver^{+}→ Chem^{+}	1.043	7.798	4.340	3.024
Chem^{-} → Silver^{-}	2.498	12.045	7.287	5.278	Silver^{-} → Chem^{-}	14.659*	9.274	6.287	4.769
Chem^{-} → Silver^{+}	2.291	9.479	4.740	3.102	Silver^{-} → Chem^{+}	0.958	8.829	4.375	2.996
Chem^{+} → Silver^{-}	1.454	8.097	4.183	3.143	Silver^{+} → Chem^{-}	0.417	7.697	4.088	2.755
Tran^{+} → Gold^{+}	0.008	7.592	3.982	2.758	Gold^{+} → Tran^{+}	1.512	7.478	3.995	2.880
Tran^{-} → Gold^{-}	0.577	7.432	3.944	2.939	Gold^{-} → Tran^{-}	2.230	8.210	4.290	3.025
Tran^{-} → Gold^{+}	4.627**	7.968	4.385	3.392	Gold^{-} → Tran^{+}	0.957	7.385	3.950	2.640
Tran^{+} → Gold^{-}	0.902	6.305	4.115	3.206	Gold^{+} → Tran^{-}	3.542***	6.809	3.990	2.868
Tran^{+} → Silver^{+}	1.349	6.996	3.820	2.825	Silver^{+} → Tran^{+}	0.217	9.396	4.116	2.834
Tran^{-} → Silver^{-}	0.507	7.919	4.050	2.858	Silver^{-} → Tran^{-}	4.924**	8.062	4.130	2.922
Tran^{-} → Silver^{+}	0.844	7.448	4.258	3.133	Silver^{-} → Tran^{+}	0.910	7.339	3.906	2.764
Tran^{+} → Silver^{-}	0.614	7.982	4.372	2.812	Silver^{+} → Tran^{-}	0.028	6.853	3.792	2.880
Indr^{+} → Gold^{+}	0.501	7.233	4.372	3.224	Gold^{+} → Indr^{+}	0.802	8.196	4.391	3.008
Indr^{-} → Gold^{-}	0.009	7.841	4.407	2.995	Gold^{-} → Indr^{-}	1.534	7.530	4.282	2.881
Indr^{-} → Gold^{+}	5.767**	8.461	4.574	3.140	Gold^{-} → Indr^{+}	0.872	8.182	4.229	2.966
Indr^{+} → Gold^{-}	0.977	6.675	4.213	3.075	Gold^{+} → Indr^{-}	1.690	7.050	4.015	2.742
Indr^{+} → Silver^{+}	0.634	7.016	4.028	2.951	Silver^{+} → Indr^{+}	1.233	7.092	4.368	2.941
Indr^{-} → Silver^{-}	0.097	7.874	4.328	2.902	Silver^{-} → Indr^{-}	6.407**	8.271	4.443	2.848
Indr^{-} → Silver^{+}	4.179***	9.374	4.188	2.974	Silver^{-} → Indr^{+}	1.605	8.186	3.887	2.723
Indr^{+} → Silver^{-}	1.024	7.972	3.935	2.854	Silver^{+} → Indr^{-}	0.405	8.573	3.976	2.781

Note: ***, **, and * indicate significance at 10%, 5% and 1% significance levels, respectively. 10,000 bootstrap replications.

The obtained results reveal that the changes in gold and silver prices of PAPR, CHEM, TRAN, and INDR stock markets can be used as the factor in explaining the changes in gold and silver prices of all stock markets under examination. In other words, it can be claimed that the price changes in both markets would provide useful information in explaining each other.

5. Conclusion

Upon creating a portfolio, investors prefer the assets in their portfolios to be negatively correlated with each other. In this regard, similar reactions of the entire assets in the portfolio to the risks that may occur would be prevented, in turn, the maximum risks of their returns would be minimized. For this purpose, it is necessary for stock investors to monitor price changes in other investment tools while venturing portfolio investments in order to develop investment strategies.

The long-term association between stock markets (Bank, Indr, Tran, Chem, Papr) and precious metals is analyzed in this study. The monthly dataset is included in the analysis. Upon considering the CS (2009) unit root test results, it is observed that the level values of all variables under examination contain unit-roots, and upon taking their first differences, they become stationary. According to the Maki (2012) cointegration test, which was performed to detect the long-term association between precious metals and stock markets, it is concluded that stock markets and gold and silver prices of the relevant sectors do not act concurrently. This obtained result poses similarity with of the studies such as Hillier, Draper & Faff (2006), Conover, Jensen, Johnson & Mercer (2009), and Lucey & Li (2015), whereas it differs with of the studies such as Akel & Gazel (2015) and Heller (2016). These obtained findings assert that precious metals are efficient portfolio diversification instruments for the related stock markets. Therefore, investors who wish to obtain the highest return with the lowest risk in the stock markets of the sectors under examination can also use gold and silver in their portfolios.

According to the findings obtained from the Hatemi-J (2012) asymmetric causality test, a bilateral causality is detected among the other stock markets, except for the stock market of the banking sector, and the gold and silver prices. Moreover, a unilateral causality running only from silver prices to the banking sector stock market is determined. This situation asserts that both the general level of stock prices of the relevant sectors affect the gold and silver prices, and the gold and silver prices affect the general level of stock prices. Furthermore, the bilateral causality relationship obtained between stock markets and gold and silver prices indicates that each one would provide useful information in explaining the price changes in the other. Therefore, it can be stated that investors who would venture portfolio investments in the stock markets of the relevant sectors may utilize the changes in gold and silver prices as a parameter while creating their portfolios. This result is partially similar to of Doğru & Uysal (2015), and differs with of Ballı & Cinel (2011).

The obtained results of the study posit noteworthy implications for academics and portfolio investors. The obtained implication for investors, in particular, involves the fact that using new investment instruments for portfolio diversification in the stock markets of the relevant sectors may reduce portfolio risk and increase returns. In future studies, by considering precious metals such as palladium and platinum besides gold and silver, more up-to-date methods can be used for both different and more industry-specific stock markets. These studies would enable more efficient portfolio selections.

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Ethics Statement: The authors declare that ethical rules are followed in all preparation processes of this study. In case of detection of a contrary situation, Fiscaoeconomia has no responsibility and all responsibility belongs to the authors of the study.

Etik Beyanı: Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara uyulduğunu yazarlar beyan eder. Aksi bir durumun tespiti halinde Fiscaoeconomia Dergisinin hiçbir sorumluluğu olmayıp, tüm sorumluluk çalışmanın yazarlarına aittir.