How do Stock Prices and Metal Prices Contribute to Economic Activity in Turkey? The Importance of Linear and Non-linear ARDL

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Abstract: This study explores the association between stock prices, metal prices and economic activity, i.e. industrial production, for the Turkish economy for the period 1896_{M1}-2016_{M12}. The linear and non-linear analysis is conducted by applying the autoregressive distributed lag (ARDL) and non-linear autoregressive distributed lag (NARDL) approaches. The combined cointegration approach is applied to test the robustness of the ARDL and NARDL approaches. The FMOLS, DOLS and CCR regressions are applied to examine the long-run effect of stock prices and metal prices on economic activity. The empirical results reveal that metal and stock prices have a positive impact on economic activity. Metal prices have a negative impact and economic activity has positive effects on stock prices. Furthermore, the NARDL model corroborates the findings obtained from the ARDL model. This paper presents policy guidelines to utilise metals as an economic tool to boost economic activity and stock prices.

Keywords: Stock Price, Metals Price, Industrial Production, ARDL, NARDL

I. Introduction

Like all other prices, commodity prices also are showing changes in value. Furthermore, it is normal to believe that those price[1] changes are affecting the macroeconomic factors that represent economic activity, i.e. industrial production in a country. To investigate the connection between stock prices and economic activity, Tursoy and Faisal (2016) analysed the association between stock prices and economic activity, and found that there is a robust long-run relationship between stock prices and economic growth. Also, there are significant studies that have investigated the prices' disequilibrium adjustment to the macroeconomic and local disturbances, such as the study by Holly et al. (2011). Not only is the connection with macroeconomic factors essential in the economic environment, but the interaction between financial markets and economic issues are also discussed. For instance, the paper by Holly and Jones (1997) studied the effects of factors on prices in the concepts of cointegration and asymmetries. The study adopted linear and nonlinear/asymmetries together to investigate the relationship between the economic theory in order to observe the effects of cointegration and economic modelling. Likewise, the current study will examine the relationship between metal prices which its decided as a critical component for the production and connection with economic activity. Lastly, the financial market interaction is added in this connection in order to also observe the role of finance in cointegration and asymmetries. Financial markets such as stock market are crucial in this context for the reason that most of the companies in the economic environment are corporations and publicly listed companies. Therefore, all those activities which improve the production in the manner of economic growth will also have effects on stock prices. Combining economic environment events with financial markets also creates the motivation to drive the importance of financial markets into economic development. The most crucial concept in every country is to have prosperity with industrial production. Although only improving the stock market may increase the wealth in the nation, connecting the available funds in the financial market to the most profitable projects in the

[1] The paper by Dees, Holly, Pesaran and Smith (2007) focused on testing the long-run macreeconomic relationship between prices within a model of the global economy.

economy could lead to economic growth. In this connected, metals are also included to analyse the effects of metal price movements on that activity. Meanwhile, one of the most discussed concepts in economic development these days is the industrial revolution; therefore, including and examining metal prices, which is a critical component for industrial production, and also its price movements are essential indicators for the market participants and will therefore be an important contribution to the existing literature. For instance, Pindyck and Rotemberg (1990) confirmed the existence of a puzzling phenomenon, which is that the prices of raw commodities have a persistent tendency to move together. They concluded that prices are showing co-movements, and it is therefore crucial to account for the effects of any common macroeconomic shocks. Pindyck and Rotemberg (1990) stated that all the current and expected future values of economic variables (i.e., industrial production) affect current and expected future demands of all commodities and their prices. This is the main rational for researchers to connect industrial output and metal prices together to investigate the effects of co-movements along with stock prices.

Moreover, Hammoudeh et al. (2008) explained that some commodities are related in the sense that they are complements or substitutes in consumption, and inputs in the production of others. As previously explained, examples of these commodities are oil and metals. Oil, gold and stock prices which are some complement and substitutes in consumption and input in production, coordinately investigate by Tursoy and Faisal (2017). Although with those study showed above, some of the commodities such as oil, gold and stock prices significantly investigated, while this paper innovatively examines the input metals (iron ore, aluminium and copper), economic activity and stock prices for Turkish economy. Over the last decade, Turkey has been one of the emerging economies that has demonstrated steady growth. To achieve economic growth, economies generally require resources. One of the most important resources is the metals utilised in the industrial sector. The foreign trade statistical data for 2016 produced by the Turkish Statistical Institute indicates that manufacturing sector exports accounted for 94% of total exports in Turkey and, more importantly, the second[2] largest export products in manufacturing were metals (13%). Therefore, based on the fact that metals account for a significant amount of exports in Turkey's overall trade, this study uses various important global metal prices (iron ore, aluminium and copper) to create a composite index for metal prices to investigate the impact of global metal prices as an exogenous variable on the stock market and industrial production in Turkey.

This study contributes to the existing literature in three important dimensions: (i), This paper examines the association between metal prices, stock prices and economic activity, i.e. industrial production in Turkey; (ii), In doing so, linear and non-linear analysis is conducted by applying the ARDL and NARDL approaches; (iii) The robustness of ARDL cointegration is tested by applying the combined cointegration approach developed by Bayer-Hanck (2013) (iv) FMOLS, DOLS and CCR regressions are employed to examine the long-run impact of metal prices on economic activity and stock prices. The empirical findings show the presence of cointegration between metals prices, stock prices and economic activity, i.e. industrial production. Furthermore, metal prices and stock prices stimulate economic activity. Conversely, metal prices are negatively linked with stock prices, but economic activity has a positive relationship. The empirical results reveal that metal and stock prices have a positive impact on economic activity. Metal prices have a negative impact and economic activity has a positive effect on stock prices.

[2] The largest sector in total manufacturing is the manufacturing of motor vehicles, trailers and semi-trailers with a 16% share.

The remainder of the article is organised as follows. Section-II explains the literature review. Section-III explains the data and the methodology is detailed in Section-IV. Section-V provides the empirical results and discussion. Finally, Section-VI concludes with policy implications.

II. Literature Review

There are important studies in the literature that have connected the prices of precious metals and stock markets, such as the study by Apergis et al. (2014). This paper found that developed countries have usually used gold and silver as the basis to investigate the interaction between metal prices and stock prices. Contrary to the existing literature, there are few studies that have used different metals in the investigation of the relationship between metal prices, stock prices, and the economy. For instance, Zevallos and Carpio (2015) and Kim and Ando (2012) used different metal prices (aluminium, iron ore, copper, tin, nickel, zinc, lead and uranium) to investigate the interaction between the stock market and the economy. Moreover, another study by Panas (2001) investigated price behaviour in the London Metal Exchange market for metals, including aluminium, copper, lead, tin, nickel and zinc. Panas (2001) stated that financial time series exhibits irregular behaviour and the economic theory suggests that this irregular behaviour could be due to the existence of nonlinear dependence in the market. In summary, this study's results showed that metal prices' series contain nonlinear dynamics. Johnson and Soenen (2009) provided an explanation detailing that the significant importance of commodities compared to manufactured goods trade cannot be ignored in South American countries and they stated that stock markets reflect the current and anticipated state of the economy. Johnson and Soenen (2009) tested the effect of world commodity prices on stock market returns. Baffes and Savescu (2014) tested the relationship between nominal price of metals (aluminium, copper, lead, nickel, tin and zinc), interest rates, industrial production, stock level of metal, price index of manufacturing goods and exchange rates. This study's results provided evidence for strong cointegration, which demonstrated the presence of a long-run relationship between fundamentals and metal prices. Furthermore, a study by Tursoy and Faisal (2016) analysed the relationship between the stock market and economic growth in Turkey by using quarterly data on stock prices and GDP with the ARDL framework and ECM. The results from this study revealed that there is a strong positive relationship between stock prices and economic growth. Also, Tursoy and Faisal (2017) investigated the relationship between oil prices and gold prices with stock markets. Their empirical findings confirmed the relationship between the variables; gold prices affect stock markets negatively and oil prices positively.

Moreover, Sadorsky (2014) discussed the prominent concept of financial integration across nations and also the financialization of commodity markets that provides investors a new way of diversifying their portfolios. Based on the above explanation, this paper investigates the economic models (volatilities and conditional correlations) for the prices of stocks, metals such as copper, oil and wheat. This study explains that there are more studies that have examined the dynamics between equities and commodities like gold, oil and stocks than have investigated the relationship between emerging market stock prices and commodities. Moreover, few have conducted significant analyses to examine the relationship between stocks and commodities in the concept of portfolio diversification. For instance, Erb and Harvey (2006) showed evidence that a portfolio with stocks and commodities could have higher returns and lower risks in the concept of choosing the commodities for investing some part of your wealth in your portfolio to have better diversification and hedging against the risk. Allocating a certain portion of the investment with commodities is seen as a way of diversifying a portfolio in order to reduce risks Idzorect (2006) found that investing commodities in portfolio opportunity sets resulted in an increasingly efficient frontier. All those studies showed that commodities have important effects on portfolio diversification; therefore, including and pursuing the commodities prices like metals have a significant contribution to diversification. Although studies in the literature have investigated precious metals and their connections with the necessary components, few studies have included minerals like iron ore, aluminium and copper, which are important metals for both industry and investment. Not only oil, but gold and silver are critical components that are followed by investors for their investment decision revisions; also, there are essential metals that market consciously monitors. Therefore, this article will also add the prices composite index to investigate the connection between the economy and the market. The contribution from Idzorek (2007) showed that proponents of investing in commodities claim that including these should have better diversification properties than a similar portfolio which excludes commodities.

Elder et al. (2012) used the intra-day data for the period 2002 through 2008 to examine the intensity, direction, and speed of impact of US macroeconomic news announcements on the return, volatility and trading volume of crucial commodities futures. They found that metal futures responded to economic news. Therefore, this study confirmed that metals instruments are responding to the macroeconomic events in the US. More importantly, the relationship between information and the perception of the investors' revising portfolio has been investigated by Fama (1970) to explain the return structure of the assets. Starting with Markowitz (1952), modern portfolio theory and others[3] provide the necessary models to explain the portfolio selection, and the efficient diversification even also explain the factors are determining the expected return of an asset or portfolio. To explain the expected return, Sharpe (1964) with a single-factor model and Roll and Ross (1980) and Chen et al. (1986) with multi-factor models, proposed and verified the relationship between macroeconomic factors and asset prices. In particular, Chen et al. (1986) provided macroeconomic factors such as industrial production to explain the asset returns.

Past studies have investigated Turkey's stock market in the framework of Arbitrage Pricing Theory, such as Tursoy et al. (2008), who connected certain commodities - oil and gold - with the portfolio returns. Also, Rjoub et al.'s (2009) paper investigated the confirmation of APT in the framework of Chen et al. (1986) for the Turkish market. Moreover, Soytac et al. (2009) investigated the precious metals and oil on the connection between the macroeconomy and markets in Turkey.

III. Estimation Strategy and Data

III.I Unit Root Analysis

In order to determine the correct order of integration of the variables, the Augmented Dickey-Fuller test created by Dickey and Fuller (1979, 1981) is applied. Furthermore, in order to examine the robustness of the unit root analysis, the KPSS and ERS unit root tests developed by Kwiatkowski et al. (1992) and Elliott, Rothenberg, and Stock (1996) are applied. These unit root tests determine the correct order of integration for the variables.

III.II The ARDL Bounds Testing to Cointegration

This study utilises the ARDL bounds testing approach developed by Pesaran et al. (2001) to investigate the relationship between metals prices, equity prices and industrial production. The ARDL bounds testing approach is more flexible compared to traditional cointegration

[3] It can be discuss extensively the capital market theory and multi-factor models such as APT etc.

methods. This approach can be applied to any series that has a mixed order of integration. However, it must be ensured that none of the variables is $I(2)$ and the dependent variable must be $I(1)$. This cointegration approach provides a short-run and long-run relationship between the variables without affecting the long-run association between the variables. The ARDL model for the standard log-log functional specification between metals prices, industrial production and equity prices is as follows:

$$\Delta \text{lnIPR} = \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta ln\text{IPR}_{t-i} + \sum_{i=1}^{n2} \beta_{2i} \Delta \text{lnEQ}_{t-i} + \sum_{i=1}^{n3} \beta_{3i} \Delta \text{lnM}_{t-i} + \lambda_1 \text{lnIPR}_{t-1} + + \lambda_2 \text{lnEQ}_{t-1} + \lambda_3 \text{lnM}_{t-1} + \upsilon_1 t, \quad (1)$$

$$\Delta \text{lnEQ} = \beta_0 + \sum_{i=1}^{n1} \beta_{1i} \Delta \text{lnEQ}_{t-i} + \sum_{i=1}^{n2} \beta_{2i} \Delta \text{lnIPR}_{t-i} + \sum_{i=1}^{n3} \beta_{3i} \Delta \text{lnM}_{t-i} + \lambda_1 \text{lnEQ}_{t-1} + \lambda_2 \text{lnIPR}_{t-1} + \lambda_3 \text{lnM}_{t-1} + \upsilon_2 t, \quad (2)$$

where $\upsilon_1 t$ and $\upsilon_2 t$, are the error terms that must be white noise, while Δ is the first difference operator. The existence of cointegration between the variables will be determined by using the bounds test of cointegration. The bounds test of cointegration, which depends on the Joint F-statistic test, is applied to investigate the null hypothesis of no cointegration, $H_0\ \partial_t = 0$, against the alternative hypothesis H_1: $\partial_t \neq 0$ where t = 1, 2, 3... If there is more than one short-run coefficient of the same variable, then in this case, the Wald test is applied to check the joint significance of the short-run coefficients. For this reason, the F-statistic obtained from the estimation is compared with the lower and upper bounds critical values. If the F-statistic value lies above the upper bounds critical values, then the null hypothesis of no cointegration is rejected. This further implies the evidence of cointegration between the variables. However, if the F-statistic value lies in between the upper and lower bounds critical values, then the result regarding the cointegration is indecisive. However, if the F-statistic lies below the lower critical bounds values, then it implies that the null hypothesis of no cointegration is accepted. This further implies the evidence of no cointegration among the selected variables in the model. Once the cointegration is confirmed between the variables, the short-run coefficients can be estimated including the error correction term using the following equations:

$$\Delta lnIPR_t = \gamma_0 + \sum_{j=1}^{p1} \gamma_{1i} \Delta lnIPR_{t-i} + \sum_{j=1}^{p2} \gamma_{2i} \Delta lnEQ_{t-i} + \sum_{j=1}^{p3} \gamma_{3i} \Delta lnM_{t-i} + \psi ECT_{t-1} + \vartheta 1t, \quad (3)$$

$$\Delta lnEQ_t = \gamma_0 + \sum_{j=1}^{p1} \gamma_{1i} \Delta lnEQ_{t-i} + \sum_{j=1}^{p2} \gamma_{2i} \Delta lnIPR_{t-i} + \sum_{j=1}^{p3} \gamma_{3i} \Delta lnM_{t-i} + \psi ECT_{t-1} + \vartheta 2t, \quad (4)$$

where ECT_{t-1} signifies the error correction term that shows the speed of adjustment of a system to converge back to its original position. Whereas $\vartheta 1t$ and $\vartheta 2t$ are the error terms obtained from the short-run models that must be white noise, and are not serially correlated. The error correction term must be negative and statistically significant with the coefficient value ranging from 0-1. The negative sign of the error correction term highlights the convergence of the system back to the original position after experiencing a short-run shock.

III.III The Bayer and Hanck Cointegration Approach

To analyse the robustness of the ARDL bounds test of cointegration, this study further applies the recently developed Bayer and Hanck (2013) combined cointegration method. Engle and Granger (1987) identified a residual based cointegration method that detects the presence of a long-run relationship between the variables. This method can only be applied to the series that have a similar order of integration. However, this method has a problem of low explanatory power, which can lead to biased results being produced. Subsequently, Johansen (1988) presented the *maximum Eigen-value test* that is capable of identifying more than one cointegrating relationship among the series. Phillips and Ouliaris (1990), after Johansen (1988), outlined a new approach for examining the cointegration among the estimated variables, which was earlier known as the *Phillips and Ouliaris* cointegration test.

Boswijk (1994) introduced the ECM model based on the F-Statistic, and Banerjee et al. (1998) developed the ECM model based on t-test. In order to overcome some of the weaknesses as outlined in the previous cointegrating methods, including the ARDL cointegration method, this study applied the Bayer and Hanck (2013) combined cointegration method. Similar to earlier methods of cointegration, this method also requires the series to have a unique order of cointegration. However, the advantage of this method is that the null hypothesis of no cointegration in Bayer-Hanck combined cointegration is based on the Banerjee et al. tests (BDM, 1998), Boswijk (BO, 1994), Johansen (JOH, 1988), and Engle and Granger (EG, 1987), which produces more consistent and reliable results. The Bayer and Hanck (2013) combined cointegration is based on Fisher's formulas. This test also gives the statistical significance of the individual test along with the respective *p*-values as shown below*:*

$$\text{ENG\&GRA - JOHAN} = -2[\ln(P_{ENG\&GRA}) + \ln(P_{JOHAN})] \quad (5)$$

$$\text{ENG\&GRA} - \text{JOHAN} - \text{BOS} - \text{BDM} = -2[\ln(P_{ENG\&GRA}) + \ln(P_{JOHAN}) + \ln(P_{BOS}) + \ln(P_{BDM})] \quad (6)$$

where $P_{ENG\&GRA}$, P_{JOHAN}, P_{BOS}, P_{BDM} are *p*-values for various cointegration tests. If the estimated Fisher statistic value exceeds the critical values at 1%, 5% and 10%, this implies that the null hypothesis is rejected. The critical values have been obtained from the Bayer and Hanck (2013) combined cointegration method.

III.IV Long-Run Elasticities

The long-run relationship among the predetermined cointegrated variables can be analysed by estimating a single cointegrating vector. However, many techniques can be utilised in this regard for estimating the long-run relationship. Therefore, in this study, the long-run impact can be analysed using Fully Modified OLS (FMOLS), as proposed by Phillips and Hansen (1990). This technique has the advantage of achieving asymptotic efficiency by consideration the serial correlation that arises and eliminating the endogeneity problem among the explanatory variables. Additionally, the robustness of the FMOLS will be analysed using Dynamic OLS (DOLS) techniques, as suggested by Stock and Watson (1993), as well as Canonical Cointegrating Regression (CCR). The DOLS technique also has the advantage of avoiding the possible consequence of the endogeneity of the regressors that may arise. The single cointegrating equations can be applied to the unique order of series provided that the long-run relationship is confirmed among the estimated variables. Therefore, this study will utilise FMOLS, DOLS, and CCR to estimate the long-run elasticities.

III.V The NARDL Bounds Testing Approach for Cointegration

Many studies in the literature have applied the linear models such as ARDL to investigate the linear relationship among the variables. However, Faisal et al. (2018) argued in their study that the linear ARDL does not take into account the non-linear relationship between the variables. Since, the non-linear relationship takes into the account of positive and negative shocks into the economy. Therefore, most of the economic agents respond more to the negative events (bad news) in comparison to positive shocks (positive news). Therefore, this study also applies the NARDL approach to cointegration in addition to the ARDL to investigate the effects of positive and negative shocks in the economy. The multivariate non-linear ARDL (NARDL) bounds testing approach developed by Shin et al. (2014) has the ability to identify the asymmetric cointegration and non-linear relationship between the variables. The NARDL model allows simultaneous distinction between the short-term and long-term effects of the independent variables on the dependent variables. The NARDL asymmetric error correction model, as proposed by Shin et al. (2014), can be written as follows:

$$\begin{aligned}\Delta IPR_t = {} & \gamma_0 + \partial_{t-1} + \emptyset_1^+ \mathrm{IPR}_{t-1}^+ + \emptyset_2^- \mathrm{IPR}_{t-1}^- + \emptyset_3^+ \mathrm{EQ}_{t-1}^+ + \emptyset_4^- \mathrm{EQ}_{t-1}^- + \emptyset_5^+ \mathrm{M}_{t-1}^+ + \emptyset_6^- \mathrm{M}_{t-1}^- \\ & + \sum_{h=1}^{p} \gamma_1 \Delta Y_{t-i} + \sum_{h=1}^{q} \gamma_2 \Delta \mathrm{IPR}_{t-1}^+ + \sum_{h=1}^{q} \gamma_3 \Delta \mathrm{IPR}_{t-1}^- \\ & + \sum_{h=1}^{q} \gamma_4 \Delta \mathrm{EQ}_{t-1}^+ + \sum_{h=1}^{q} \gamma_5 \Delta \mathrm{EQ}_{t-1}^- + \sum_{h=1}^{q} \gamma_6 \Delta \mathrm{M}_{t-1}^+ + \sum_{h=1}^{q} \gamma_7 \Delta \mathrm{M}_{t-1}^- + \mu_t \quad (7)\end{aligned}$$

In Equation-7, $\emptyset_h$ denotes the long-run coefficients, while the short-run coefficients are represented by γ_h with $h = 1.....7$. It is important to note here that the reason behind estimating the long-run coefficients is to analyse the response time and the speed with which it will converge back to its original position following a short-run shock. However, the short-run coefficients are estimated in order to investigate the impact of the independent variables over the endogenous variable. The Wald test of joint significance is utilized to investigate the long-run asymmetry ($\emptyset^+ = \emptyset^- = \emptyset$) and short-run asymmetry ($\gamma^+ = \gamma^- = \gamma$) for all the variables, as identified in Equation-7. *p* shows the lag for the endogenous variable (industrial production), while q represents the lag for the exogenous variable (equity (EQ) and metal index (M)), respectively. The Akaike information criterion (AIC) will be used to select the optimal lags for both the dependent and independent variables. The exogenous variables (EQ, M) will be disintegrated into negative and positive sums, as shown below:

$$J_x^+ = \sum_{l=1}^{t} \Delta j_x^+ = \sum_{l=1}^{t} \max(\Delta J_x, 0) \text{and } J_x^- = \sum_{l=1}^{t} \Delta j_x^- = \sum_{l=1}^{t} \min(\Delta J_x, 0) \ (8)$$

while J_x represents EQ and M.

To investigate the evidence of the long-run asymmetric cointegrating relationship, the bounds test was proposed by Shin et al. (2014) to analyse the joint significance of the short-run lagged coefficient of regressors. In this regard, two tests were introduced that are used to investigate this long-run relationship: F-Statistic by Pesaran et al. (2001) and t-statistics by Banerjee et al. (1998). The F-statistics tests the null hypothesis ($\emptyset^+ = \emptyset^- = \emptyset = 0$), while the t-statistics tests the null hypothesis of $\emptyset = 0$ against the alternative hypothesis of $\emptyset < 0$. These two tests are utilised to determine possible evidence of cointegration. If both the tests reject the null hypothesis of no cointegration, this implies that a long-run association exists between the variables in the model.

After the confirmation of cointegration, the long-run coefficients are estimated under the framework of an asymmetric model on the basis of Lm = $\emptyset^{+}/\partial$ and Lm = $\emptyset^{-}/\partial$. The coefficients that are obtained from the previous formulas are the long-run asymmetric coefficients. The long-run coefficients of the independent variables are generated with respect to positive and negative changes, which analyse the long-run association between the variables. In order to measure the asymmetric dynamic multiplier effect, the following equations are used:

$$mu_i^{+} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta IPR_t^{+}},\ mu_i^{-} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta IPR_t^{-}},\ mu_i^{-} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta EQ_t^{+}},\ mu_i^{-} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta EQ_t^{-}}$$

$$mu_i^{-} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta M_t^{+}},\qquad mu_i^{-} = \sum_{k=0}^{i} \frac{\delta y_{t+k}}{\delta M_t^{-}}$$

where u=0, 1, 2…. Where if $u \rightarrow \infty$, then $mu_i^{+} \rightarrow Lm_i^{+}$ and $mu_i^{-} \rightarrow Lm_i^{-}$.

The dynamic multiplier depicts the asymmetric reactions of the endogenous variables to both negative and positive shocks of the exogenous variables. On the basis of these estimated dynamic multipliers, the adjustments show the possible reactions of the variables in a system that effects the system from the initial equilibrium position to the final equilibrium position.

III.VI The Data

The data is obtained from the International Monetary Fund (IMF, CD-ROM, 2018) database of primary commodity prices for metals (iron ore, aluminium and copper). Furthermore, data is collected from International Financial Statistics for stock prices (CD-ROM, 2018), i.e. equity price) and industrial production. The data set is on a monthly basis and covers the period of 1986-2016. This study utilises the data for metals that are considered to be important, as discussed in the previous section. However, it is impossible to use all the metals separately, as they are grouped into a similar category. Therefore, in order to measure their impact jointly, this study generates an index of metals, which consists of iron ore, copper and aluminium.

This study utilises the principal component method (PCM), which depicts the relative importance of each series. The result of the principle component analysis (PCA) is explained in Table-1. The PCA indicates that the 1st principal component, as indicated by PAC1, explains 92.84 %, the 2nd component PAC2 shows 6.22 %, and the 3rd indicates 0.95% of the standard variance. It can be seen that the 1st principal component is better than the other indicators of metals because a high level of variance is described by the 1st principal component. Hence, we utilise the values of the 1st eigenvector as a weight to construct an index of metals, which is represented by Mt. All the variables are transformed into natural-log before proceeding with the empirical analysis.

Table-1. Principal Component Analysis

	PAC 1	PAC 2	PAC 3
Eigenvalue	1.1972	0.0801	0.0122
Variance Proportion	0.9284	0.0622	0.0095
Cummulat. Proportion	0.9284	0.9905	1.0000
Eigen Vectors			
Metals	Vector 1	Vector 2	Vector 3
AL	0.1412	0.6258	0.7670

CO	0.5274	0.6081	-0.5932
IR	0.8377	-0.4883	0.2442
Note: Al, CO and IR show aluminium, copper and iron, respectively.			

IV. Results and Discussion

Before proceeding to the cointegration approach for examining the long-run cointegration association between the variables, it is necessary to test the integration order of the variables. In doing so, we have applied the ADF unit root test and the results are shown in Table-1. Economic activity, metals prices and stock prices are found to be non-stationary at level using intercept and trend. The results indicate that all the variables are stationary at first difference. This implies that economic activity, metals prices and stock prices have a unique order of integration. We have applied the KPSS and ERS unit root tests to examine the robustness of the unit root analysis. It is found that the KPSS and ERS unit root tests confirm the empirical findings reported by the ADF test (see Table-2)[4].

Table-2. Unit Root Analysis

Variables	ADF	KPSS	ERS
$\ln IPR_t$	-3.1208	3.771***	6.2418
$\Delta\ln IPR_t$	-4.3240***	0.0048	0.0013***
$\ln MI_t$	-2.0592	49.4691***	10.6036
$\Delta\ln MI_t$	-14.5918***	0.0363	0.5346***
$\ln EQ_t$	-1.2753	396.2919***	51.7283
$\Delta\ln EQ_t$	-13.1544***	0.0267	0.4879***
Note: ***, ** and * denote the significance at 1%, 5% and 10% levels, respectively.			

This implies the robustness of the unit root analysis. The order of integration is important for the ARDL approach in order to identify that none of the selected variables is $I(2)$. This further implies that all unit root tests suggest that the estimated variables are integrated of order 1 and none of the variables is $I(2)$. This shows the possibility for proceeding to the ARDL bounds testing approach for examining cointegration between the variables.

Table-3. Bounds Testing Analysis of Cointegration

<table>
<tr><td>Estimated Model</td><td colspan="2">F_{LnIPR}(LnIPR/LnM, LnEQ)</td><td colspan="2">F_{LnEQ}(LnEQ/LnM, LnIPR)</td></tr>
<tr><td>Optimal Lag Length (AIC)</td><td colspan="2">(3,1,0,)</td><td colspan="2">(4,1,0,)</td></tr>
<tr><td>F-Statistic (Bound Test)[5]</td><td colspan="2">4.1423**</td><td colspan="2">5.1661*</td></tr>
<tr><td>Critical Values</td><td>1 Percent</td><td>2.5 Percent</td><td></td><td>10%</td></tr>
</table>

[4] The Schwarz information criterion was utilized to select the optimal lag, while the Newey-West Bartlett kernel was utilized to determine the bandwidths for KPSS. For spectral estimation method, the AR spectral OLS is utilized.

[5]The ARDL model in this study was performed with restricted intercept with no trend (Case II).

Lower Bounds $I(0)$	4.13	3.55	3.1	2.63
Upper Bounds $I(1)$	5.00	4.38	3.87	3.35
R^2	0.985		0.998	
Adj. R^2	0.985		0.998	
DW	1.99		1.97	
F-Statistics	4144.81*		46870.13*	
Note: *, ** and *** represent significance level at 1%, 5% and 10% respectively. The optimal lag length for the ARDL model was chosen on the basis of AIC. The critical values mentioned in Table-3 are obtained from Pesaran et al. (2001).				

The unique order of integration of variables leads us to apply the ARDL bounds testing approach to cointegration and the empirical results are reported in Table-3. The computed ARDL-F statistic is sensitive to lag length selection. In doing so, we choose lag length of the variables by using unrestricted VAR based on Akaike Information Criterion (AIC). The lag length selection is shown in the second row of Table-3. It is found that the computed ARDL-F statistic is greater than the upper critical bounds at 5% and 1%, respectively. This implies that the null hypothesis of no cointegration is rejected as we treated economic activity and equity prices as dependent variables. The empirical analysis confirms the presence of two cointegration vectors, thus validating that cointegration is present between the variables for the period of 1896_{M1}-2016_{M12} in the case of Turkey.

In order to confirm the robustness of the cointegration analysis, we have applied the Bayer-Hanck combined cointegration approach to examine the cointegration between economic activity, stock prices and metals prices. The empirical results of the Bayer-Hanck combined cointegration are reported in Table-4. The empirical analysis indicates that Fisher statistics for *ENG&GRA* and *ENG&GRA–JOHAN–BOS–BDM* are greater than the critical value at 5% and 10%. This rejects the null hypothesis of no cointegration for all three models. The results therefore show evidence of cointegration in both cases. This suggests that the estimated variables are cointegrated. This further implies that economic activity, stock prices and metals prices are cointegrated for the long-run relationship. This confirms the reliability and robustness of the cointegration analysis.

Table-4. Bayer–Hanck Combined Cointegration Analysis

Model Specification	Fisher statistics		Lags	Cointegration Decision
	ENG & GRA	ENG & GRA – JOHAN – BOS – BDM		
F_{LnIPR}= *f(LnIPR/LnM,LnEQ)*	110.5240*	178.9286*	4	Cointegration Exists
F_{LnEQ}= *f(LnEQ/LnM,LnIPR)*	71.4854*	128.1571*	4	Cointegration Exists
Significance level	Critical values			

Significance level at 1%	16.651	31.793
Significance level at 5%	10.838	20.776
Significance level at 10%	8.457	16.171
Note: *, represents significance level at 1%.		

After the confirmation of cointegration, the short-run coefficients are estimated under the ARDL framework. The short-run results are shown in Table-5, in which economic activity is taken as the dependent variable. A positive and significant effect of stock prices on economic activity is noted. Likewise, metals prices also have a positive impact on economic activity in the short run. This implies that if stock prices and metal prices rise by 1%, then economic activity will increase by 0.0047% and 0.0269%, respectively. Since, the error correction term is negative and statistically significant, this implies that economic activity converges back to its original position by 6.73% speed of adjustment using the channel of stock prices and metals prices. This indicates the stability of the system after a short-run shock. Table-5 shows that DW is 1.99, indicating that there is no problem of autocorrelation, with the statistically significant F-statistics value proving the overall good fit of the short-run model.

Table-5. ARDL Short-run Analysis

Dependent Variable: ΔLnIPR			
Cointegrating Form			
Variable	Coefficient	Standard Error	T-Statistics
Constant	0.2864	0.1008	2.8413*
$LnIPR_{t-1}$	-0.0671	0.0242	-2.7695*
ΔLnEQ	0.0047	0.0020	2.2991*
ΔLnM_{t-1}	0.0053	0.0024	2.1524*
$\Delta LnIPR_{t-1}$	-0.6947	0.0529	-3.6235*
$\Delta LnIPR_{t-2}$	-0.1849	0.0510	-3.6235*
ΔLnM	0.0269	0.0129	2.1512*
ECT_{t-1}	-0.0673	0.0166	-4.0480*
R-Squared	0.4195	Adj-R-Squared	0.4147
S.E of regression	0.0428	D.W	1.99
F-Statistic	43.6986*		
Note: *, ** and *** represent significance at 1%, 5% and 10% levels, respectively.			

Table-6. Diagnostic Analysis (ARDL short-run)

Diagnostic Test	χ^2_{SC}	χ^2_{HW}	Ramsey Reset Test (F-Statistics)
	0.1482 (0.9285)	23.8905 (0.6364)	0.8566 (0.3553)
Note: χ^2_{SC}, and χ^2_{HW}, are the Lagrange multiplier for serial correlation and white test for heteroscedasticity, respectively. The numbers in the brackets are the P-Values. The F-Statistics was taken into account when the Ramsey RESET test was performed.			

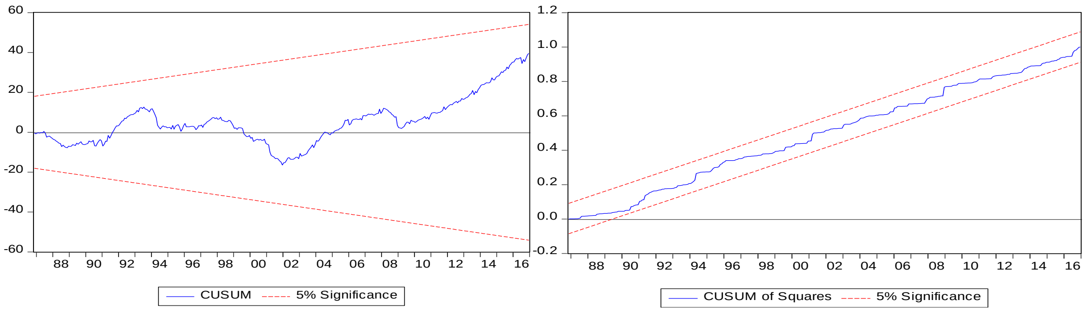


Figure-1. CUSUM and CUSUM SQ

Finally, Table-6 shows the results of the diagnostic tests for the short-run models under the ARDL framework. For the purposes of convenience, Panel-A represents the model where economic activity is taken as the endogenous variable. In Panel-B, stock prices are taken as the endogenous variable. There are no problems of serial correlation in either model, except for heteroscedasticity in Panel-B, as shown by the White test for heteroscedasticity. The Ramsey RESET test suggests that both the models are well-specified and implies the stability of the model. Furthermore, the robustness of the stability of the model for Panel-A was conducted by using CUSUM and CUSUMsq, as suggested by Brown et al. (1975). Figure-1 shows the plots of CUSUM and CUSUMsq. This indicates that both the CUSUM and CUSUMsq lie in between the two red bonded lines at 5% significant level.

Since the cointegration vectors were identified among the variables in both the models, the long-run elasticity can be derived from the estimated variables. In this regard, the FMOLS will be applied to investigate the long-run relationship between the estimated variable, as discussed in the previous section. The DOLS and CCR will be applied to analyse the robustness of the FMOLS. The results of the FMOLS, DOLS and CCR tests are shown in Tables-7 and 8. The long-run models are differentiated from each other on the basis of Panel-A (Table-7), Panel-B (Table-9) and diagnostic analysis. In Panel-A, economic activity is taken as the regressand, while metal prices and stock prices have been taken as the regressors. A 1% rise in metal prices will cause economic activity to increase by 0.072%. There is a positive and statistically significant relationship between metals prices and economic activity for the case of Turkey. Likewise, in the case of stock prices, a 1% increase will cause economic activity to rise by 0.076%. The positive sign of stock prices with economic activity is in line with the existing literature. Furthermore, this finding is in concordance with the study of Tursoy and Faisal (2016) for Turkey. This further suggests that stock prices play an important role in determining economic activity for the case of Turkey. Moreover, the coefficients of stock prices and metals prices are very similar. This further implies that equity prices and metals prices are important factors for strengthening the Turkish economy. The DOLS and CCR Regressions showed similar results to FMOLS. The Adjusted R^2 is sufficient that stock prices and metals prices jointly explain the change in economic activity by 92.61%.

Table-7. Long-Run Analysis

Panel-A: Dependent Variable: LnIPR			
Variables	FMOLS	DOLS	CCR
LnM	0.0722* (0.0090) [7.9566]	0.0709* (0.0092) [7.6957]	0.0722* (0.0090) [7.9896]

LnEQ	0.0766* (0.0041) [18.5881]	0.0764* (0.0041) [18.3836]	0.0766* (0.0040) [18.7361]
Constant	4.1654* (0.0125) [331.7832]	4.1661* (0.0013) [310.5119]	4.1654* (0.0124) [333.8765]
R^2	0.9265	0.9296	0.9265
Adj. R^2	0.9261	0.9281	0.9261
S.E. of regression	0.0975	0.0955	0.0975
Note: * represents significance at 1%. The value in the parenthesis and square brackets are standard errors and T-statistics, respectively. FMOLS, Fully Modified Ordinary Least Squares; CCR, Canonical Cointegration Regression; DOLS: Dynamic Ordinary Least Squares.			

However, today, there is increasing popularity for measuring the non-linear relationship, since the relationship between the variables is not always linear. In this regard, this study applied the non-linear asymmetric cointegration test (NARDL) developed by Shin et al. (2014). The results of NARDL are shown in Table-9. First, it is noted that metal prices and stock prices explain 93% (Adjusted R^2 = 93.4%), which only takes the significant coefficients into account, while disregarding the insignificant ones. This suggests that stock prices and metal prices explain 93.4% of economic activity (which is taken as a proxy to measure economic growth), while 6.6% of the variations in economic activity is explained by the error term. The NARDL model is free from the heteroscedasticity problem and the residuals are homoscedastic. The functional form of the model is confirmed by the Ramset RESET test. This diagnostic test further implies the stability, validity and reliability of the estimated results. It was noted that the estimated F-statistic lies above the upper bounds critical value, which indicates the presence of cointegration among the estimated variables. This further confirms that metals prices, stock prices and industrial production are in a long-run relationship with each other. The Wald test further identifies the asymmetry in the short run and long run as well by analysing their corresponding *p*-values. This suggests that asymmetry and non-linearity must be taken into the account when analysing the relationship between metals prices, stock prices and economic activity. The t-statistics (T_{BDM}), developed by Banerjee et al. (1998) and F_{PSS} statistics is from Pesaran et al. (2001) bounds test values are upper critical bounds, even at 1%. This confirms the evidence of asymmetric cointegration among the estimated variables, which implies that metals prices, stock prices and economic activity are in a long-run asymmetric cointegrating relationship in the Turkish economy. The empirical analysis confirms the significance of considering not only the linear relationship but also the asymmetric relationship among these variables. It is necessary to mention here that the authors' previous estimation under the ARDL framework approach failed to predict this asymmetric long-run relationship among the estimated variables.

Table-9. NARDL Cointegration Analysis

	Coefficient	Standard error	T-Stat
Constant	1.6555	0.1779	9.31*

LIPR(-1)	-0.4391	0.0497	-8.82*
LEQ_P(-1)	0.0200	0.0036	5.49*
LEQ_N(-1)	0.0350	0.0047	7.34*
LM_P(-1)	0.0412	0.0048	8.46*
LM_N(-1)	0.0239	0.0055	4.35*
ΔLIPR(-1)	-0.0580	0.0524	-1.11
ΔLEQ_P	0.0165	0.0085	1.94*
ΔLEQ_P(-1)	-0.0292	0.0080	-3.62*
ΔLEQ_N	0.0943	0.0030	30.45*
ΔLEQ_N(-1)	0.0028	0.0061	0.46
ΔLM_P	0.0192	0.0070	2.73*
ΔLM_P(-1)	-0.0179	0.0084	-2.12*
ΔLM_N	0.0602	0.0096	6.27*
ΔLM_N(-1)	0.0196	0.0098	1.99*
Cointegration test statistics			
T_{BDM}	-8.820*	F_{PSS}	17.9126*
Note: * represents the significance at 1%.			

Once the cointegration has been confirmed, the long-run coefficients will be analysed to predict its effect. As far as the long-run coefficients are concerned, a positive and a negative shock to stock prices have a positive and significant effect on economic activity. This implies that both positive and negative shocks on stock prices cause economic growth in the long-run, which is expected. These findings in terms of stock prices are in line with the findings from the ARDL model. This suggests that the stock market has a positive impact on economic growth in the long-run, which is a positive sign for a healthy economy. This also implies that investors can invest in new projects producing more wealth and they are relatively optimistic about future activities. These findings are concordant with the recent study conducted by Tursoy and Faisal (2016) for Turkey. Similarly, when analysing the long-run coefficient of metals prices, it was found that positive and negative shocks applied to metals prices also affected economic activity positively and significantly. This suggests that the importance of metals prices in the development of the Turkish cannot be ignored in the long-run. As such, policymakers should consider the role and importance of metals prices in the Turkish economy, which should be efficiently managed in the long run. Furthermore, a negative shock to metals prices (0.0602, 0.0196) has a positive and significant impact in both the previous period and current period.

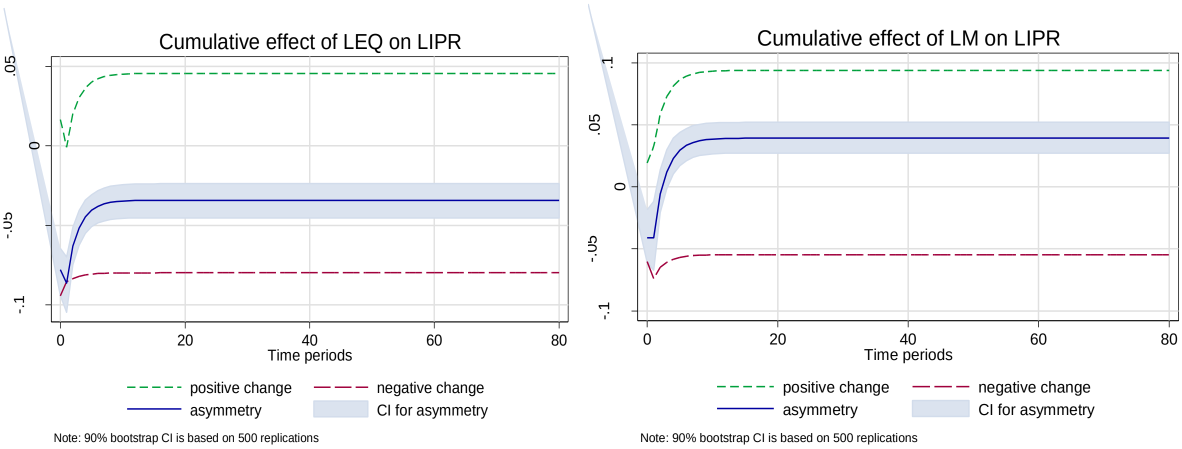
In the short run, it is noted that stock prices (positive shock) are positively linked with economic activity; however, a positive shock on stock prices (at lag 1) has a negative and significant effect on economic activity. This finding suggests that any positive shock on stock prices in the previous period has a negative impact in the following period. However, a negative shock to stock prices (0.0943, 0.0028) has a positive and significant impact on current and previous periods (lag 1). Similarly, a positive shock to metals prices has a positive and significant impact on economic activity, although this impact (-0.0179) is negative in the previous period at lag 1. Therefore, in summary, it has been concluded that stock prices and metals prices have a positive and significant impact on economic activity, which is in line with the findings derived from the ARDL model.

Table-10. Long-Run Coefficients and Asymmetry Tests

Long-run Coefficient:		Long-run effect [+]		Long-run effect [-]		
Exogenous Variable	Coefficient	F-Stat	P-value	Coefficient	F-Stat	P-value
LEQ	0.046	77.74	0.000	-0.080	253.3	0.000
LM	0.094	152.5	0.000	-0.055	22.14	0.000
Asymmetry tests:		test Long-run asymmetry		Short-run asymmetry		
		W_{LR} F-Stat	P-value	W_{SR} F-Stat		P-value
LEQ		22.9	0.000	50.7		0.000
LM		22.94	0.000	13.74		0.000
Model Diagnostic test		Stat		P-value		
Breusch/Pagan Heteroscedasticity test (Chi^2 value)		0.2355		0.6275		
Ramsey Reset test (F)		2.211		0.0866		
Jarque-Bera test for normality (Chi^2 value)		9.032		0.0109		
R-squared		0.936				
Adjusted R-squared		0.934				
F-Statistics		373.73*				
Root mean square error		0.0594				
Note: * represents the significance at 1%.						

The empirical results of the long-run coefficients and asymmetry tests are shown in Table-10. The long-run coefficients on LEQ^+ and LEQ^- are 0.046 and -0.080, respectively, and are also statistically significant. This implies that if stock prices rise by 1%, this increases the economic activity by 0.046%. However, a decline of 1% in stock prices would cause economic activity to decrease by 0.080%. Similar findings were also confirmed for metals prices. The long-run coefficient on metals prices LM^+ and LM^- are 0.094 and -0.055, respectively. It was further noted that stock prices and metals prices (composite index) adjust asymmetrically in the long-run and short-run under the framework of the asymmetric test. Finally, multiple dynamic adjustments are also applied. The empirical results for the cumulative dynamic multiplier have been shown in Figure-2. The plot identifies the adjustment of economic activity to the new equilibrium position following a negative or positive shock in stock prices and metals prices, respectively. The plots of the dynamic multiplier are estimated on the basis of NARDL model using the AIC criterion. The green small dashed line represents the positive change and the negative shock is shown by the red dashed line, which depict the adjustment of economic activity to the long-run equilibrium position following positive and negative shocks, respectively. The blue solid curve in the middle of the positive and negative lines represents the asymmetric curve that measures the differences between the positive and negative shocks of the mu_i^+-mu_i^-.

Figure-2. The Dynamic Multipliers Cumulative Effects



Note: LEQ, LIPR, LM represent equity prices, industrial production and metals, respectively.

Figure-2 confirms the overall existence of a positive relationship between economic activity and stock prices. The effect of a positive shock in stock prices is dominant over the negative shock. Furthermore, an asymmetric reaction to stock prices is also observed. Additionally, a positive relationship between metal prices and economic activity was found, because the negative shocks in the metal prices have a positive effect on economic activity as the positive shock is dominant over the negative shock. This implies that metal prices positively affect economic activity. These findings also corroborate the findings obtained from the ARDL model.

V. Conclusion and Policy Implications

This study analyses the long-run and short-run relationship between stock prices, metal prices and economic activity in Turkey. The study utilises monthly data and covers the period from January 1986 until December 2016. The linear long-run relationship was analysed using the ARDL bounds test, while the robustness of the ARDL bounds test was verified by applying the Bayer-Hanck combined cointegration test. These cointegration tests confirmed the strong evidence of cointegration between the variables. The empirical results of FMOLS indicated that metals prices and equity prices have a positive relationship with economic activity. The robustness of FMOLS was performed using DOLS and CCR. Furthermore, the asymmetric relationship between metals prices, stock prices and economic activity was investigated further using the non-linear asymmetric ARDL cointegration developed by Shin et al. (2014). This approach can assist with the identification of the impact of the positive and negative shocks on economic activity of stock prices and metals prices. It was observed that a strong asymmetric cointegration exists among the examined variables. A positive and statistically significant impact of stock prices and metals prices on economic activity was observed. Positive and negative shocks in stock prices and metals prices have a positive impact on economic activity, which corroborates the findings obtained from FMOLS, DOLS, and CCR. Finally, diagnostic analysis suggests the validity and reliability of the empirical findings. The dynamic multiplier also implies the overall existence of a positive impact of stock prices and metals prices on economic activity.

Therefore, with the empirical analysis, we can conclude that all the variables anyhow is affecting the each other. The most important aspect of the findings is that metals prices affect industrial production and stock prices. The empirical evidence supports the view that metals prices positively effect economic activity. The industrial sector represents the production of the economy and the economic activity that directly affects output. In the beginning, we assumed that metals are the most critical component for the production; therefore, we can conclude that metal prices as an indicator, adding a positive impact of final output of the economy. This shows the importance of metal prices that needed to follow by the market participant to having information about countries' production level. Consequently, metals prices are a significant indicator for market participants and the firms that are engaged in the production of the economy. For the market participants, metal prices also provide relevant information for the decision-making process. With the industrial revolution, metals prices kept significant share into the global trade competition to produce more innovative products. Moreover, to following any kind of prices are more important for the market participants to giving proper decisions. Meanwhile, there is a negative relationship between stock prices and metals prices for the studied period in Turkey. From the perspective of the market participants, equity and metals price move in opposite directions. Investment activities, in general, are based on information. All these indices which are followed by the market participants provide critical information for them to make proper decisions about their investments. In particular, investment activities are defined by information-based decision making, and these are connected to the Efficient Market Hypothesis. Therefore, to investigate the market prices and provide new empirical evidence are important to guide the market participants to give a proper decision about their investments and portfolios.

References

Apergis, N., Christou, C. and Payne, J. E. (2014). Precious metal markets, stock markets and the macroeconomic environment: a FAVAR model approach. *Applied Financial Economics*, 24(10), 691-703.

Banerjee, A., Dolado, J. and Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis*, *19*(3), 267-283.

Bayer, C. and Hanck, C. (2013). Combining non-cointegration tests. *Journal of Time Series Analysis*, *34*(1), 83-95.

Boswijk, H. P. (1994). Testing for an unstable root in conditional and structural error correction models. *Journal of Econometrics*, *63*(1), 37-60.

Brown, R. L., Durbin, J. and Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society*, 149-192.

Chen, N. F., Roll, R. and Ross, S. A. (1986). Economic forces and the stock market. *Journal of Business*, 383-403.

Dees, S., Holly, S., Pesaran, M. H. and Smith, L. (2007). Long run macroeconomic relations in the global economy.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Erb, C. B. and Harvey, C. R. (2006). The strategic and tactical value of commodity futures. *Financial Analysts Journal*, *62*(2), 69-97.

Elder, J., Miao, H. and Ramchander, S. (2012). Impact of macroeconomic news on metal futures. *Journal of Banking & Finance*, *36*(1), 51-65.

Elliott, G., Jansson, M. and Pesavento, E. (2005). Optimal power for testing potential cointegrating vectors with known parameters for nonstationarity. *Journal of Business & Economic Statistics*, *23*(1), 34-48.

Engle, R. F. and Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Faisal, F., Tursoy, T. and Berk, N. (2018). Linear and non-linear impact of Internet usage and financial deepening on electricity consumption for Turkey: empirical evidence from asymmetric causality. *Environmental Science and Pollution Research*, *25*(12), 11536-11555.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, *25*(2), 383-417.

Hammoudeh, S., Sari, R. and Ewing, B. T. (2009). Relationships among strategic commodities and with financial variables: A new look. *Contemporary Economic Policy*, *27*(2), 251-264.

Ho, S. Y. (2017). The Macroeconomic Determinants of Stock Market Development: Evidence from Malaysia.

Holly, S. and Jones, N. (1997). House prices since the 1940s: cointegration, demography and asymmetries. *Economic Modelling*, *14*(4), 549-565.

Holly, S., Pesaran, M. H. and Yamagata, T. (2011). The spatial and temporal diffusion of house prices in the UK. *Journal of Urban Economics*, *69*(1), 2-23.

Idzorek, T. (2006). Strategic asset allocation and commodities. *Ibbotson Associates, March*, *27*.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2-3), 231-254.

John, B. and Cristina, S. (2014). Monetary conditions and metal prices. Applied Economics Letters, 21, 447-452.

Johnson, R. and Soenen, L. (2009). Commodity prices and stock market behavior in South American countries in the short run. Emerging Markets Finance and Trade, 45(4), 69-82.

Kim, P. and Ando, T. (2012). Oil and metal price movements and BRIC macro-economy: an empirical analysis. *International Journal of Business and Globalisation*, *8*(2), 187-206.

Kwiatkowski, D., Phillips, P. C., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of econometrics*, *54*(1-3), 159-178.

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, *7*(1), 77-91.

Panas, E. (2001). Long memory and chaotic models of prices on the London Metal Exchange. Resources Policy, 27(4), 235-246.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289-326.

Phillips, P. C. and Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. *Econometrica: Journal of the Econometric Society*, 165-193.

Phillips, P. C. and Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I (1) processes. *The Review of Economic Studies*, *57*(1), 99-125.

Pindyck, R. S. and Rotemberg, J. J. (1990). The Excess Co-Movement of Commodity Prices. *The Economic Journal*, *100*(403), 1173-1189.

Rjoub, H., Türsoy, T. and Günsel, N. (2009). The effects of macroeconomic factors on stock returns: Istanbul Stock Market. *Studies in Economics and Finance*, *26*(1), 36-45.

Roll, R. and Ross, S. A. (1980). An empirical investigation of the arbitrage pricing theory. *The Journal of Finance*, *35*(5), 1073-1103.

Shin, Y., Yu, B. and Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in Honor of Peter Schmidt* (pp. 281-314). Springer New York.

Sadorsky, P. (2014). Modeling volatility and correlations between emerging market stock prices and the prices of copper, oil and wheat. *Energy Economics*, *43*, 72-81.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, *19*(3), 425-442.

Soytas, U., Sari, R., Hammoudeh, S. and Hacihasanoglu, E. (2009). World oil prices, precious metal prices and macroeconomy in Turkey. *Energy Policy*, *37*(12), 5557-5566.

Stock, J. H. and Watson, M. W. (1993). A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica: Journal of the Econometric Society*, 783-820.

Tursoy, T., Gunsel, N. and Rjoub, H. (2008). Macroeconomic factors, the APT and the Istanbul stock market. *International Research Journal of Finance and Economics*, *22*, 49-57.

Tursoy, T. and Faisal, F. (2016). Causality between stock price and GDP in Turkey: An ARDL Bounds Testing Approach. *Romanian Statistical Review*, *64*(4), 3-19.

Tursoy, T. and Faisal, F. (2018). The impact of gold and crude oil prices on stock market in Turkey: Empirical evidences from ARDL bounds test and combined cointegration. *Resources Policy*. Vol. 55, pg. 49-54

Zevallos, M. anddel Carpio, C. (2015). Metal Returns, Stock Returns and Stock Market Volatility. *Revista Economía*, *38*(75), 101-122.