Macro-Finance Determinants of Commodities Future Volatility

ABSTRACT

This study examine the macro-finance determinants on commodity volatility of metals, energy, and agriculture futures of Pakistan for the period of June, 2008 - October, 2020. We employ a nonlinear auto regressive distributed lag (NARDL) model to determine the asymmetric impact of independent variables on dependent variables in the short and long run. In the long-run, positive shocks to trade volume, open interest, bid ask spread, and stock prices have a significant impact on commodity futures except trade volume for crude oil and open interest for gold. These results imply that increase in trade volume, open interest, spread and stock prices leads to increase volatility in commodity futures of Pakistan. Pakistan Mercantile Exchanges are sensitive to shocks in the long run. Gold undergo positive stock price adjustments against shocks with uncertainity. The stock price index is a strong indicator of gold futures. The stock market is sensitive to any negative price/shock adjustments. Positive shocks have a great influential impact on all commodities as compared to negative shocks. In the long run, macro-finance determinants indicates the presence of asymmetric relationships for commodity futures. These results are helpful for policy makers and investors to mitigate risk and hedge against turbulence. Investors can utilize trading volume and stock price index as a tool for information flow from future exchanges which can be monitored in an unexpected trading activity.

Keywords: Macro-finance, NARDL, Commodity Futures, Energy, Metals, Agriculture

1.Introduction

Since 2000 with the equity market crash, investors consider commodities as an attractive asset class due to high volatility among stocks and other financial instruments. When the investors add commodities in their portfolios, there exist a considerable impact of financial markets shocks over commodity price dynamics (Silvennoinen & Thorp, 2013). The commodity future market started trading metals in England in 1877 and later on the trading extended to United States and other economies with several commodities futures including fuel, agriculture and metals. Commodities' futures trading showed rapid growth in 2000, when the equity market faced collapse because of dot-com bubble burst. Investment flows towards commodity futures are computed by commodity Future Trading Commission (CFTC) is about $200 billion in early 2000. However, from 2004 a rapid financialization of commodity market introduced commodities as an popular asset class relative to stocks, bonds, and derivatives (Adams et al., 2020). Trading volume of commodity futures reached their highest at the end of 2018 it was 5.64 billion (World Federation of Exchanges, 2020).

With progressive financialization in derivative markets, commodities play an important role in the real world (Kim, 2020; Hu et al., 2020; Nguyen et al., 2021). Pandemic rapidly penetrates to the financial markets and the real economy. Due to covid-19 US financial assets faced an impulsive down whereas a sharp upward trend in volatility of assets is observed. On 12th March 2020 (Black Thursday), financial markets have experienced a substantial decline in the history of the US since the 1987 crash (Black Monday). This health crisis exert a severe impact on the financial markets (Farid et al., 2022; Tiwari et al., 2022). Commodity Market Outlook published by World Bank (2020) reports health crisis impacts on commodities, e.g., energy prices declined whereas, the prices of precious metals, agriculture commodities and raw materials went upward. In 2020-Q3, volume of commodity futures increased by 23.2% as compared to 2019-Q3. This volume decreased in US, Europe, Africa and Middle East while increasing from Asia Pacific region (Borgards et al., 2021). This change in commodity future prices uncovers the significance of commodity markets in the real economy.

With respect to Adaptive market hypothesis (A-MH) the markets evolution undergoes with severe economic and financial crisis, which indicates that assertion on market effectiveness may weaken the aspect of turmoil/crisis ultimately increases investors risk aversion, leading to a shift from risky securities to riskless securities, thereby to bring synchronic movements (Bhardwaj and Dunsby, 2013; Bossman and Agyei, 2022). On the other hand, Markowitz's portfolio theory (Optimistic theory) suggest a combination of less risky (commodities) and high risky assets (equities) in portfolio for diversification benefits (H. Markowitz, 1959).

Mixture of distribution hypothesis (MODH) explains a positive relationship between trading volume and price volatility. This impact arises due to common factors, e.g., information innovation. Following (MODH) Boonvorachote and Lakmas, (2016) suggest the positive effect of trading volume (expected and unexpected) and volatility with future commodities of Asia whereas reverse (negative) found with open interest rate and volatility. On the basis of MODH, trading volume can be used as speculative activities which cause an increase in commodity futures volatility. However, open interest is a proxy for hedging activities to keep the markets stable. Studies focus commodity futures on several dynamics for developed and emerging markets. Pakistan Mercantile Exchange originate in 2002, operated in 2007 with trading commodity futures. More than 20 commodity futures (metals, energy, agriculture and financial) have international trading dynamics. Limited research (Shear et al., 2024; Iqbal and Sofi., 2022; Shear, 2020) on Pakistan commodity futures grasp the attention to understand the key determinants of commodity futures prices.

Many researcher (Zhang, Chevallier, & Guesmi, 2017; Erb & Harvey, 2006; Gorton & Geert Rouwenhorst, 2006) found a rapid inrush of huge investment funds in commodity markets arises due to negative correlation between commodity market and stock price index. Global crisis impacts on commodity markets e.g., Bajaj (2020) found negative prices of oil futures in April 2020.

When the large investments are followed by commodity future markets, it brings a way to commodity future as assets class (Tang & Xiong, 2012). Different types of commodities (metals, energy and agriculture) are developed. Economic and financial turbulence lead to price fluctuations. This is the decade of increasing linkages between commodity and financial markets (Nissanke, 2012; Mupunga and Ngundu, 2020). For

example, due to macroeconomic uncertainty, economic, political, financial and energy crisis etc. caused enormous change and volatility in energy commodities evident by (Rahman et al., 2022; Mensi et al., 2014). Among precious metals, gold has been characterized by mixed demand. Demand for gold is determined by financial determinants, which increased due to inflationary fears (Bilgin et al., 2018; O'Connor et al., 2015) and financial markets declined (Baur and McDermott, 2010; Baur and Lucey, 2010). It is a traded commodity whose price changes frequently in large volume and is also a reserve currency in the world. The price of gold is influenced by its market relevance in jewelry, electronics and by its pure consumers. On the other hand, copper is a metal with its vast usage in electronic goods, substantially in wiring, is known as core industrial metal. Copper is much more copious compared to other metals. Therefore, it is valuable to be considered for empirical analysis. The ability of metal commodities to perform the above role has sufficient linkage to their complex economic properties. When macroeconomic shocks assert commodities and investors portfolio returns in distinct manner, commodity futures do not have similar returns and volatility due to weak linkages with financial markets.

Commodity futures are used for diversification of portfolios with bonds and stocks during the period of financial crises or in bearish equity markets. Gupta et al, (2018) examine volatility of commodity future by different macroeconomic determinants. Archer et al, (2022) determined dependence among macroeconomic variables (exchange rate) and commodity prices. Ekananda, (2022) examined macroeconomic conditions positively influence natural resource commodities future volatility of Indonesia. Financial factors (trading volume, stock market returns and Bid/Ask spread) serve as a information provider to commodity future exchanges for ultimate hedging and investment decisions. Trading activities positively effect commodity future contracts of Asian exchanges (Boonvorachote and Lakmas., 2016). Following MODH, Trading volume of commodity futures is much lower as compared to financial futures market, and have a comparably higher proportion of information traders (Foster & Viswanathan, 1994).

Previous studies determined linear relationships with macroeconomic variables for developed markets. However, Richards, Allender, & Hamilton, (2012) focused on the asymmetries of firms to commodity prices that are effected by negative and positive shocks. There are two reasons for analyzing non-linear relationships between macro-

financial and commodity futures. First, there may be hidden co-integration present in time series due to negative and positive segments (Granger & Yoon, 2005). Second, there exist nonlinearities, asymmetrical and structural breaks (bankruptcy and major credit defaults) which affects the dynamics of the market. To encounter these issues, we employ NARDL, which is helpful to uncovers long and short-term asymmetries. No study found the asymmetric determinants of commodity futures of Pakistan. With the significance of macroeconomic and financial factors that affect Asian future commodity contracts, this paper explores the asymmetric relationship between macro-financials and commodity futures for Pakistan mercantile exchange. First, these commodity future are selected for the study because they have a long trading history at stock exchange to avoid uncertain extreme price volatility that appears due to lack of trading. Second, these commodity futures (agriculture, metal, energy) are actively traded in Pakistan. With the sharp change/increase in commodity future prices attract the attention of researchers to address the key determinates of commodity futures. The following questions are addressed for this study to examine the asymmetric impact of macroeconomic and financial determinants on the commodity future traded in Pakistan Mercantile Exchange (PMEX). First, Do the macro-finance determinants have asymmetric impact on commodity future volatility in short and long-run? Second, Whether the asymmetries affect the market dynamic in short and long run?

Findings of the study uncovers significant positive shocks to commodity futures of gold, trade volume in all commodities except crude oil. Positive shocks for open interest unveil significance for all commodities except gold. However negative shocks put a short-term negative effect on rice. Positive shocks have simultaneous effect of bid ask spread on commodity futures of all commodities. In the short run bid ask spread effect positively to Rice whereas negative to Gold and Silver. It suggest that the bid ask spread for gold and silver act to minimize risk with economic uncertainty. Positive shocks to stock prices reveal positive impact on commodity futures. Whereas negative shocks render positive influence on commodity futures of gold and negative for Rice which restore itself in a short span. In the long run, Positive shocks to trade volume have a positive effect on all commodity futures. Whereas negative shock negatively affect Gold commodity futures. Positive shocks to open interest have positive and significant impact on Silver, Copper, Platinum, N.Gas, Crude oil, Rice. Positive shocks to bid ask spread reveals positively impact all commodity future. Negative shocks negatively

influence silver commodity futures at 5% significance level. Positive shocks positively effects Gold, Silver, N.Gas, Rice, Copper, Platinum, Crude oil and Wheat.

It concludes that the positive shock to open interest rates play an empowering role in stimulating prices of commodity futures indices. Positive shock to bid ask spread is greater in long term as compared to short run. Wald tests reject null hypothesis of long run symmetry between bid ask spread and commodity futures (Gold, Copper, Crude oil, Rice). When there is uncertainty in the market due to negative shock to stock prices it is attributed to a hedge against gold commodity futures. The Stock market index identifies as a strong measure for commodity futures and gold prices. The stock market is sensitive to any negative shock adjustments.

It is crucial to understand how risks are transmitted and hedge against financial turbulence is vibrant for policy makers, individual investors, risk managers and institutions. Policy makers monitor the real time factors arises from macro financial conditions impacts financial markets dynamics. Which regularly monitors financial markets' stability and robustness. Individuals are less familiar with hedging funds in a cost-effective way is essential to direct them in stable market conditions. To mitigate risk, institutional investors must consider efficient hedge fund combinations irrespective of the cost. Investors can utilize trading volume and interest rate as a tool for information flow from future exchanges which can be monitored in an unexpected trading activities.

2.**Literature Review**

After the 1987 stock market crash, financial market volatility is debatable for researchers, practitioners and policymakers. Due to increased uncertainty in financial system, it induce high volatility in oil and agricultural commodity markets (Ziadat et al., 2023; Luo and Ji, 2018). Various factors (Geopolitical risk, economic and financial crisis, Global supply and demand) contribute to heightened volatility in energy prices. Increase in oil prices directly affect agricultural commodities. Oil prices surged between 2003 and 2008 to reach almost $147 per barrel from $30 (Sun and Shi, 2015; Ji et al., 2018). Similarly agricultural commodities experience the same pattern due to oil price fluctuations (Rezitis, 2015; Gong et al., 2023; Fowowe, 2016). Oil price uncertainty have a devasting effect on agricultural production, prices reviving the major event of 2007 (Fasanya and Akinbowale, 2019). During health crisis of 2019

commodity prices upsurge by 217% for rice, 136% for wheat, 125% for corn and 107% for soybeans were recorded (El Montasser et al., 2023). The determinants of commodity price changes are oil prices (Shahzad et al., 2018; Dahl et al., 2020; Tiwari et al., 2022). The financial crisis 2007-2008 justified an intensive linkage of international equity markets, bringing investors closely to explore alternate instruments for diversification and risk minimization (Rehman et al., 2023a; Makkonen et al., 2021).

Heighted volatility in oil and commodity markets (agriculture) muddles risk management for portfolio managers and agricultural suppliers (Yip et al., 2020). The historical low interdependence among commodities (oil and energy) with financial assets grasped the attention of investors towards diversification prospects (Pal and Mitra, 2019). This led to the introduction of commodity future as a diverse type of assets that provide effective portfolio diversification (Silvennoinen and Thorp, 2016; Rehman and Vo, 2020; Kang et al., 2017). Commodity future are the crucial component of future markets and a source of hedging or ease in price risks due to high volatility (Makkonen et al., 2021; Dai et al., 2022; Liu et al., 2019). A number of studies (Tiwari et al., 2022; Sun et al., 2021; Khalfaoui et al., 2023; Dahl et al., 2020; Hung, 2021 etc.) on volatility/returns connectedness between energy and agricultural commodity markets are evident. (Narayan and Zheng, 2010; Zhang and Wei, 2010; Hochman et al, 2012) found the long run relationship/ cointegration among the prices of gold, and crude oil futures. Numerous studies (Cagli, 2023; cui and Maghyereh, 2023; Tiwari et al., 2022; Samitas et al., 2022b; Zhou et al., 2022; Wu et al., 2023) identified hedging assets in different groups of metals and energy. Koirala et al, (2015) found high correlation/dependence between agricultural and energy future prices.

Han, S (2025) examined spillovers between actively traded 35 commodity futures and US stocks. Energy markets are the net transmitters of risk during Covid-19, especially after January 2020. Energy futures mitigate risk and play a hedging role. Livestock futures act as a hedge against S&P 500 EFT.

Stock markets bid/ask spread brings together buyers and sellers at a common price. Market participants usually pay that for that spread, are concerned with market structure. So, it is closely related to the costs related to trading and also receives much attention from investors. It is surprising to know that accurate estimates of bid-ask spreads are useful for realistic evaluation of hedging, speculating, and arbitrage strategies (Sun, Wang, Zhou, & Yang, 2019).

In emerging markets, the role of trading volume and open interest rates is interesting due to thin trading activity and large price volatility. it reflects the information in future exchanges regarding aggregate change in market participants expectations e.g., hedge options, market depths, hedging demands and alternative traders opinions. Developed and emerging financial markets have advanced financial reforms, capital movement and advanced technology. This relationship between trading activity and commodity future volatility is suggested by Boonvorachote and Lakmas, (2016). Investors believe that in future exchanges (FEX), derivatives are not the key determinant for appropriate decision making. For accurate decision making, it is important to examine price change relationship with trading activity (volume and open interest rate). A positive relationship trading volume and commodity price is evident by previous studies (Clark, 1973; Harris, 1986; Epps and Epps, 1976; Tauchen and Pitts, 1983; Lamoureux and Lastrapes, 1990). Unexpected trading volume has a positive impact on volatility whereas unexpected open interest rate minimizes volatility in future contracts of well-developed future markets (Bessembinder and Seguin., 1993; Fung and Patterson, 1998). For emerging markets future exchanges Chan and Leung, (2004) reported a positive correlation of volatility and volume with Chinese futures exchanges (FEX). Whereas opposite relations exist in open interest rate and volatility. in a similar way Kumar and Pandy (2010) determined positive association between volatility and volume. Although open interest rate does not reflect information. Boonvorachote and Lakmas (2016) examine the effect of trading volume and open interest rate in Asian Future exchanges (FEX) on the volatility of commodity futures. There exist a positive association between trading volume (expected and unexpected) and volatility. While open interest rate reduces volatility. Creti et al, (2013) determined correlation among commodity and stock markets increases with time and are highly volatile during global crisis of 2007-2008. This trend upsurges with the accentuating financialization of commodity markets. Studies (Park and Ratti, 2008; Jones and Kaul, 1996; Sadorsky, 1999; Papapetrou, 2001; Filis et al., 2011; Choi and Hammoudeh, 2010) provide significance of commodity price relationship with stock market returns in several ways. The asymmetric impact of oil prices on stock market returns of S &P 500 is evident by Chiou and Lee, (2009).

Literature (Archer, 2022; Ekananda, 2022; Gupta et al., 2018) found linear relationship between commodities and macroeconomic factors. Lin and Su (2021) determined

macro-financials of Shanghai oil commodity market futures using dynamic average method but left to explore nonlinear asymmetric behaviour. There is need to control the effects of macro-finance variables due to structural breaks. Moreover, to explore the asymmetrical relationship between financial and macroeconomic factors and commodity future (energy, metals and agriculture) future prices is viable. Pakistan macro-financials are related to the state of economy/inflation and have influence on commodity futures. They reflect the financial risk, liquidity and investors sentiments of Pakistan. Pakistan commodity futures have a centralized financial system.

3. Data and Methodology

3.1. Data

To examine the asymmetric behaviour of macro-finance determinants in long- and short run on commodity future prices, data is sourced from PMEX (Pakistan mercantile exchange) and PSX (Pakistan stock price index) for June, 2008 to October, 2020. Three main categories of future commodities: Agriculture commodities (wheat and rice), Energy (crude oil and natural gas), Metal (gold, copper, silver SP and platinum) are taken as dependent variables. Stock return (SR), open interest rate (OI), bid ask spread (BS), trading volume (TV) of commodity futures are taken as independent variables to determine the source of uncertainty that is most prone to causing global risk. The prior studies focused on analysing the severe impact of volatilities (i.e., gold and crude oil) on stock returns (R. Bibi et al., 2024; Raza et al., 2017). The present study explain that these volatilities will result in policy changes of emerging economies.

3.2. Methodology

Previous studies (Gupta et al., 2018; Liu et al., 2015; Amendola et al., 2019; Du & McPhail, 2012s) used GARCH models to examine the asymmetric relationship between the macroeconomic variables and volatility. Shear et al., (2024) found price co movements in approximately 40 commodity futures of metals, energy, agriculture and financials using ARDL approach. With respect to this study DCC, ADCC, and asymmetric GARCH type models are not reliable because it is challenging for the large data set due to curse of dimensions. Some of them only capture the time varying correlation but failed to identify the transmission effect between commodity future prices and macrofinance variables. In above mentioned models long run and short run asymmetric behavior does not account for decomposed positive and negative sum of independent variables. For such a purpose NARDL best serve for this purpose.

Nonlinear Auto Regressive distributed lag (NARDL) model is suggested by Shin et al, (2014). We employ it to determine the short and long-run dynamics between commodity future prices (CF) and Trade volume (TV), open interest (OI), bid ask spread (BS) and Pakistan's stock price index (SP). It is irrespective of integration order with the exclusion that series are integrated of maximum order one (Ghatak & Siddiki, 2001). The unit root tests further verify integration order. Thus, the nonlinear co-integration implies if the time series are co-integrated using positive and negative components (Granger & Yoon, 2005). The asymmetric relation arises due to extreme volatility or asymmetric adjustment process, nonlinear transaction cost and international noise trader. The time series becomes highly reliable if the sample contain high volatile regimes such as financial crisis. The nonlinear co-integration approach proposed by Shin et al, (2014) is:

$$CF = f(TV^{+}, TV^{-}, OI^{+}, OI^{-}, BAS^{+}, BAS^{-}, SP^{+}, SP^{-}) \qquad (1)$$

This allows to detect the asymmetries in both short and long-run using positive and negative partial sum decomposition ((Narayan, 2005) which provides the robust results (Pesaran et al. 2001, Lahiani et al., 2016 and Raza et al., 2017). It permits a joint

analysis of the problem of non-stationary and non-linearity with respect to unrestricted error correction model. Non-linear co-integration regression is as follows[1]:

$$y_t = \beta^+ \chi_t^+ + \beta^- \chi_t^- + \mu_t, \qquad (2)$$

where β^+ and β^- show the long-term parameters of k x 1 vector of regressors x_t, decomposed as:

$$\chi_t = \chi_0 + \chi_t^+ + \chi_t^- \qquad (3)$$

where χ_t^+, (χ_t^-) are the partial sums of positive (negative) change in x_t as follows:

$$\chi_t^+ = \sum_{j=1}^{t} \Delta\chi_j^+ = \sum_{j=1}^{t} \max(\Delta\chi_j, 0) \qquad (4)$$

$$\chi_t^+ = \sum_{j=1}^{t} \Delta TV_j^+, \ \sum_{j=1}^{t} \Delta OI_j^+ , \sum_{j=1}^{t} \Delta BS_j^+ , \ \sum_{j=1}^{t} \Delta SP_j^+ = \ \sum_{j=1}^{t} \max(\Delta\chi_j, 0)$$

$$\chi_t^- = \sum_{j=1}^{t} \Delta\chi_j^- = \sum_{j=1}^{t} \min(\Delta\chi_j, 0) \qquad (5)$$

$$\chi_t^- = \ \sum_{j=1}^{t} \Delta TV_j^- , \sum_{j=1}^{t} \Delta OI_j^- , \sum_{j=1}^{t} \Delta BS_j^- , \sum_{j=1}^{t} \Delta SP_j^- \ = \ \sum_{j=1}^{t} \max(\Delta\chi_j, 0)$$

The NARDL (p, q) form of the Eq. (3), in the form of asymmetric error correction model (AECM) can be specified as:

$$\Delta y_t = \rho y_{t-1} + \vartheta^+ \chi_{t-1}^+ + \vartheta^- \chi_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q} \left(\pi_j^+ \Delta\chi_{t-j}^+ + \pi_j^- \Delta\chi_{j-t}^-\right) + \varepsilon_t \qquad (6)$$

Where, $\vartheta^+ = -\rho\beta^+$ and $\vartheta^- = -\rho\beta^-$.

However, to determine the co-integration relation between the variables in nonlinear framework, the first two steps remains the same as in linear (ARDL) framework i.e. estimating equation (6) using OLS and conducting the joint null ($\rho = \theta^+ = \theta^- = 0$) hypothesis test.

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial \chi_t^+}, m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial \chi_t^-}, h = 0,1,2, \ldots \ldots \qquad (7)$$

Where as $h \to \infty$, the $m_h^+ \to \beta^+$and $m_h^- \to \beta^-$. Recall that β^+ and β^- are the asymmetric long-run coefficients and here can be calculates as $\beta^+ = -\vartheta^+/\rho$and $\beta^- = -\vartheta^-$, respectively.

Moreover, the Wald test is used to examine the long run ($\vartheta^+ = \vartheta^-$) and short-run ($\pi^+ = \pi^-$) asymmetries in the relationship in nonlinear (NARDL) model. Finally, the asymmetric cumulative dynamic multiplier effects of a unit change in χ_t^+ and χ_t^- on y_t is studied.

4. Results and Discussion

This section shows the results using NARDL to examine the impact of macro-finance variables on commodity future of Pakistan mercantile exchange.

The descriptive statistics is reported in Table 1, which show that the CF indices have positive mean values for Gold, Silver, Copper, Platinum, Crude oil and Wheat which indicates that these are highly significant commodity futures among commodities. The mean N.Gas and CF indices are negative which presents negative correlation. The standard deviation is highest for silver, oil, rice and stock prices is quite high, depict high volatility. The kurtosis greater than three indicate that all the time series are positively skewed (right tailed) except oil. Moreover, all these stylized facts are also supported by the J-B statistics which rejects the null hypothesis of normally.

Table: 1 Descriptive Statistics

	Mean	**Med**	**Max.**	**Min.**	**S. D**	**Skew**	**Kurt**	**J-Bera**
Gold	0.661	-3.136	68.486	-66.910	27.642	0.354	3.138	2.172***
Silver	0.865	2.261	165.606	-176.689	51.169	-0.087	4.510	9.627***
Copper	0.780	0.043	88.477	-100.004	34.050	-0.170	3.285	6.822***
Platinum	0.350	2.532	123.291	-72.375	35.791	0.193	3.142	5.702***
N.Gas	-0.229	0.402	99.506	-82.373	30.480	0.301	4.263	8.158***
Crude oil	0.152	2.301	85.257	-80.298	37.008	-0.074	2.286	2.212***
WHEAT	1.082	1.233	71.059	-81.082	28.562	-0.190	3.072	3.621***
RICE	-1.017	-11.289	170.180	-197.606	64.604	0.069	3.269	3.381***
TV	-0.822	-2.195	58.074	-30.805	17.668	0.987	4.315	23.432***
OI	-0.096	-0.777	34.940	-39.252	15.745	0.208	3.000	6.723***
BS	-0.549	-1.216	49.163	-32.262	14.699	0.582	4.228	11.935***

SP	-0.632	-2.043	85.259	-48.597	22.897	0.647	4.343	14.485***

The asterisks ***, ** and * represent significance at the 1%, 5%, and 10% levels, respectively.

Table 2: Bounds test for nonlinear specifications

Market	$\mathbf{FPSS_{Nonlinear}}$	t_{BDM}
Gold	5.080***	-5.668***
Silver	5.594***	-6.569***
Copper	5.830***	-6.936***
Platinum	6.984***	-7.604***
N.Gas	6.981***	-7.776***
Crude oil	7.526***	-7.822***
Wheat	3.409***	-5.284***
Rice	13.449***	-10.585***

Note: The exact specification of the asymmetric ARDL model is presented analytically in Table 5. *** and ** indicate significance of bound test and t statistics at 1% and 5% levels, respectively. 99% upper (lower) bound with k=4 is 5.06 (3.74). 95% upper (lower) bound with k=4 is 4.01 (2.86).

Table 2 presents the results of the bounds test for co-integration between commodity futures and independent variables (trade volume, open interest bid ask spread and stock prices). The F_{PSS} and t_{BDM} statistics for NARDL model are higher than the upper bound critical value at conventional levels of significance for all the sample commodities. It indicates the presence of long run asymmetric relations for all the commodities. On the recommendation of Shin et al, (2014) we select a traditional method for choosing critical values in F_{PSS} and t_{BDM} statistics, therefore taking a maximum of four lags on each first differenced variable in testing the null hypothesis of no co-integration.

Table 3: NARDL Estimation Results – dependent variable ΔCF_t

	Gold	**Silver**	**Copper**	**Platinum**	**N.Gas**	**Crude oil**	**WHEAT**	**RICE**
Constant	2.079***	2.705***	3.544***	3.452***	3.660***	3.732***	2.424***	5.320***
CF	-0.457***	-0.637***	-0.693***	-0.777***	-0.806***	-0.813***	-0.473***	-0.364***
TV_{t-1}^{+}	0.360**	0.261**	0.267**	0.129**	0.134**	0.152	0.106**	0.21**
TV_{t-1}^{-}	-0.329	-0.021**	0.011	-0.292	0.180	0.147	0.061	0.068
OI_{t-1}^{+}	0.181	0.804***	0.688**	0.824***	0.488**	0.508**	0.300**	0.772***
OI_{t-1}^{-}	-0.105	-0.288	-0.169	0.161	-0.270	0.143	0.087	0.029
BAS_{t-1}^{+}	0.369**	0.783**	0.430**	0.637**	0.346**	0.352**	0.596***	1.029***
BAS_{t-1}^{-}	-0.299**	-0.548**	0. 038	0.391	-0.437	0.361	-0.036	-0.510**
SP_{t-1}^{+}	0.595***	1.256***	0.373**	1.155***	0.247***	0.474**	0.408**	0.861***
SP_{t-1}^{-}	0.386**	0.413	-0.201	0.364	0.179	-0.406	-0.140	-0.362
ΔCF_{t-2}		-0.330***						
ΔCF_{t-3}								0.193***
ΔTV_t^{+}			0.719***		0.725***			
ΔTV_{t-1}^{+}	0.595**							
ΔTV_{t-4}^{+}	1.007***							
ΔTV_{t-1}^{-}					0.081			
ΔTV_{t-5}^{-}								.535***
ΔOI_{t-4}^{-}								-.033***
ΔBAS_{t-1}^{+}								1.503***
ΔBAS_{t-2}^{+}								2.503***
ΔBAS_{t-6}^{+}								1.094**
ΔBAS_t^{-}					-.150			
ΔSP_t^{+}				0.763***		0.611***		1.546***
ΔSP_{t-3}^{+}	0.366**							
ΔSP_{t-1}^{-}			-0.579			-0.705		
ΔSP_{t-5}^{-}								-.392***
Long-run asymmetric effects and Wald test results								
L_{TV}^{+}	0.787***	0.410***	0.397***	0.178***	0.167***	0.191	0.225***	0.580***
L_{TV}^{-}	-0.720***	-0.033	0.016	-0.376	0.223	0.181	0.129	0.187
W_{LR}(TV)	2.901**	6.797**	2.28***	2.838**	4.132**	1.915**	0.270*	1.289***
L_{OI}^{+}	0.396	1.262***	0.993**	1.060***	0.605***	0.625**	0.636***	2.121***
L_{OI}^{-}	-0.237	-0.452	-0.244	0.207	-0.335	0.176	0.185	0.080
W_{LR}(OI)	1.098***	4.340**	2.066**	4.044**	2.245***	1.116***	1.072***	6.247**

L^{+}_{BAS}	0.807**	1.229**	0.620**	0.820***	0.429**	0.433***	1.261***	2.827***
L^{-}_{BAS}	-0.653	-0.864**	0.055	0.503	-0.542	0.444	-0.076	-1.401
W_{LR}(BS)	0.383	11.343***	1.000	3.519**	3.811**	0.436	4.721**	1.720
L^{+}_{SP}	1.301***	1.973***	0.538**	1.486**	0.307***	0.582**	0.863**	2.365***
L^{-}_{SP}	0.843**	0.649	-0.290	0.469	0.222	-0.499	-0.297	-0.995
W_{LR}(SP)	1.336**	6.950**	6.774***	11.659***	4.119***	13.046***	6.766***	5.892**
Statistics and diagnostics								
Adj. R^2	0.454	0.485	0.467		0.472	0.468	0.259	0.709
Normality	3.469***	6.661***	3.264***	2.404***	2.565***	5.335***	2.188***	4.890***
LM Test	0.467	0.537	1.233	0.897	0.668	1.898	0.900	1.103
HET	0.415	0.216	0.151	1.848	0.518	4.293	1.572	0.382
FF	2.210	0.563	0.172	2.120	0.022	0.093	0.005	0.058
CUSUM	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
CUSUMSQ	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable

Note: This table reports the results of the estimation of the best-suited NARDL model for the adjustment of the CF index. The superscripts "+" and "-" denote positive and negative partial sums, respectively. L^{+}_{x} and L^{-}_{x} are the estimated long-run coefficients associated with positive and negative changes of the variable *x*, respectively, defined by $\hat{L} = -\hat{\theta}/\hat{\rho}$. Adj. R^2 represents the value of the adjusted R^2 coefficient of the estimated model. W_{LR} denotes the Wald statistics for the long-run symmetry, which tests the null hypothesis of $\theta^{+} = \theta^{-}$ for each explanatory variable in Eq. (9).

Table 3 reports the short and long run estimates of non-linear impact of commodity future prices with Trade volume (TV), open interest (OI) bid ask spread (BS), and stock prices (SP). It is evident from the results that Wald test rejects the null hypothesis of a long-term symmetric relationship between CF and TV, OI, SP for Gold, Silver, Copper, Platinum, N.Gas, Crude oil, Wheat, Rice and between BS and CF of Silver, Platinum, N.Gas and Wheat. Whereas Short-run results uncovers the significance for positive shocks to Trade volume (TV^{+}_{t-1}) with the commodity futures of Gold, Silver, Copper, Platinum, N.Gas, Wheat, Rice. Results provide evidence that with increased uncertain behavior of trade volume, the CF prices increases in all commodities except crude oil. Positive shocks to trade volume cause business contractions and consumers to postpone large purchases. In the short run, positive shocks (TV^{+}_{t-1}) uncover significant influence on gold commodity futures at lag (1 and 4) in the short run. A positive event causes a progressive change in commodity future which is not consistent and bounces back in a short period of time. It is concluded that trade volume is being affected by uncertainty in the commodities, and it act as a significant determinant of economic policy.

The short run negative shocks to Trade volume (TV_{t-1}^{-}) reveals negative contemporary effect on silver and positive to Rice at lag 5. There are many factors identified, impacting commodity futures but trade volume is one of major determinants that play a significant role. Wald test W_{LR} (TV) rejects the null hypothesis of long and short run symmetry for trade volume.

Positive shocks for open interest (OI_{t-1}^{+}) unveil significance for all commodities except gold. These short-term adjustments are more likely the result of uncertainties e.g., market crisis and climatic conditions (Zhang, Lai, and Wang, 2008). It is evident that oil price uncertainty reduces asymmetric effect on the financial system. Any shock (positive, negative) to open interest does not play an enabling role in stimulating future contract of Gold in the short term due to stabilized system. However negative shocks put a short-term negative effect on rice. Following Boonvorachote and Lakmas, (2016) we found that trade volume and open interest rate significantly effect commodity futures. On the basis of MODH, trading volume is a barometer of speculative activities which cause increase in commodity futures volatility. However, open interest is a measure for hedging activities to keep the markets stable.

Positive shocks to (BAS_{t-1}^{+}) have simultaneous/positive effect on CF of all commodities a t 1% and 5 % significance level. Whereas negative shocks (BAS_{t-1}^{-}) we have derived negative results with the CF of Gold, Rice and Silver. We conclude that these commodities hold BS to minimize risk in case of market uncertainty.

Positive shocks to (SP_{t-1}^{+}) reveal positive impact on all commodity futures. Stock price index (SP) is the indicator of investor expectations with the uncertainty of commodity future prices, Investors are encouraged to optimize their portfolio returns with the occurrence of any good event. Moreover, the intensity of positive shocks is high as compared to negative shocks. Negative shocks (SP_{t-1}^{-}) render positive influence on commodity futures only for gold. It suggests that financial market disorders have positive impact for gold future prices and negative in case of Rice at lag 5 for a short period of time and restore itself in a short span.

The lower part of table 3 presents findings of long run estimates of positive and negative shocks. Positive shocks to trade volume have a positive effect on commodity futures for all commodities. The results of positive shocks to (L_{TV}^{+}) Gold, Silver, Copper,

Platinum, N.Gas, Wheat and Rice are significant with commodity futures at 1% except. Negative shock to (L_{TV}^{-}) are negatively linked to Gold. These findings indicate negative shocks to trade volume do not have a marginal impact on commodity future for gold.

Positive shocks to open interest (L_{OI}^{+}) positively affect commodity future of Silver, Copper, Platinum, N.Gas, Crude oil, Wheat, Rice at 1% and 5% significance level. It reveals that any positive shock to open interest rates play an empowering role in stimulating prices commodities. Positive shocks undergo no influence on Gold.

In the long run, positive shocks to (L_{BAS}^{+}) reveals positive effect on commodity's future of all commodities. Positive shock to bid ask spread is greater in long term investments for these commodities. Negative shocks (L_{BAS}^{-}) have a negative impact on Silver. Wald tests reject null hypothesis of long run symmetry between bid ask spread (BS) and four commodities (Gold, Copper, Crude oil, Rice).

Positive shocks to (L_{SP}^{+}) exhibit positive impact on all commodities. Gold undergo positive stock price adjustments against both positive and negative shocks with an uncertain economic situation. When there is uncertainty in the market due to negative shock to SP index it attributes Gold commodity future prices. Stock price index is a strong indicator of Gold futures. The stock market is sensitive to any negative price/shock adjustments.

5. Conclusion

By using the proposed technique NARDL, this study determine the short and long-run dynamics between commodity futures and macro-financial determinants. The results of bound testing indicate the presence of asymmetric behavior in the long run for all commodities. There exist short run and long run nonlinear impact of trading volume, open interest, bid/ask spread, and stock prices on commodity futures of Pakistan. The long-run estimates show that the positive shocks to trade volume, open interest, bid ask spread, and stock prices have a significant impact on commodity futures index, except trade volume for crude oil and open interest for gold. These results imply that a rise in trade volume, open interest, spread and stock prices leads to an increased uncertainty in commodity future prices. Gold undergo positive stock price adjustments against shocks with an uncertain economic situation. The stock price index is a strong indicator of gold futures. The stock market is sensitive to any negative price/shock adjustments. Positive shocks have a great influential impact on all commodities as compared to negative shocks. Positive shocks have more intensity with the change/volatility in prices as compared to negative shocks. In the long run, macro-finance determinants indicates the presence of asymmetric relationships for commodity.

5.1.Limitations and Future Directions

When we consider the Pakistan's market, the main problem is collection of data because in emerging markets data collection is restricted to state institutions. And the statistical departments of these countries faces internal and external problems. Internal due to lack of institutional setup and weak infrastructure while the external are the low literacy rate and lack of awareness regarding the data.

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