Resources Policy 60 (2019) 255–261

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Return and volatility linkages among International crude oil price, gold price, exchange rate and stock markets: Evidence from Mexico

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ARTICLE INFO

JEL codes:
G1
G10
G11
C32

Keywords:
Crude oil price
Gold prices
Stock markets Mexico
ARDL bound cointegration test

ABSTRACT

This study investigates the dynamic relationship among international oil prices, international gold prices, exchange rate and stock market index in Mexico. Mexico is a major oil and gold exporting country and at the same time a major importer of petroleum products. ARDL Bound testing cointegration approach has been used on daily data ranging from January 2006 to April 2018. Findings of the study suggest that international gold prices positively affect the stock price of Mexico while oil price affects them negatively. Oil prices negatively influence exchange rate in the long and gold price do not have any significant impact on the exchange rate. The finding of this research have important implications and also provides some signals to monetary and fiscal policies, considering the pressure crude oil prices create on the stock markets and exchange rates.

1. Introduction

Mexico is a $2.4 trillion emerging economy growing with an average rate of 2.48% per annum from 1994 until 2018.[1] It is dependent heavily on petroleum and petroleum related products (Bueno, 1981) and the United States is the largest trading partner of Mexico. This trade is driven largely by the Mexico's sale of crude oil to the U.S. and import of refined petroleum products from the U.S. Mexico is increasingly focusing on industrialization and spending heavily on energy that accounts for fairly a large proportion of the GDP. In 2017, the value of Mexico energy (majorly crude oil) export to the U.S. was $11.1 billion while the value of energy (majorly petroleum products) imports from the U.S. was 23.2 billion.[2] Price fluctuations in energy products such as oil significantly influences the performance of key macroeconomic variables (Delgado et al., 2018). For example, oil price is taken as a prominent indicator of movements in exchange rate in the global economy (Amano and van Norden, 1998), because international transactions of oil are carried out largely in USD and hence greater oil demand results into depreciation of local currency. Over the last two decades oil price has been quite volatile in the international crude oil market. This has an immense implication for macroeconomic fundamentals of oil exporting and oil importing countries. Changing in demand and supply of oil due to variability in international oil prices impacts the exchange rates of both oil exporting and oil importing countries. Mexico interestingly a partner in international crude oil markets both an exporter as well as an importer.

Mexico is also one amongst the top 10 miners of gold in the world and gold is one amongst the top 5 commodities that are exported by Mexico. Recent evidence of dynamic co-movements in oil and gold prices in international markets (Jain and Biswal, 2016) puts forward a need to investigate linkages between these asset prices in an economy like Mexico. Moreover, Melvin and Sultan (1990b) witnessed a tendency of holding gold in international reserve portfolios particularly by oil-exporting countries and also increasing their gold investment with the increase in revenues due to rising oil prices to sustain its proportion in their diversified portfolios. Subsequently, demand for gold increases which in turn trigger an increase in its price that reflects a rise in the oil price. Tiwari and Sahadudheen (2015) show that majority of oil import countries settle their oil import via paying in gold and therefore, seems to have some relationship with each other. Moreover, depreciation of USD against key currencies may also shift investors' inclination to incorporate gold in their portfolio as a safe haven (Capie et al., 2005; Joy, 2011). This brings a boost in the demand of this metal and pushes its prices at higher level (Reboredo, 2012).

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[1] https://tradingeconomics.com/mexico/gdp-growth-annual.
[2] https://www.eia.gov/todayinenergy/detail.php?id= 35332.

https://doi.org/10.1016/j.resourpol.2019.01.004
Received 27 September 2018; Received in revised form 29 December 2018; Accepted 2 January 2019

Exchange rate may have severe economic implications for Mexico whose exports and imports of goods and services stand at 38.16% and 39.99% of its GDP, respectively.[3] Notably, events that impacted export of Mexico such as delay in NAFTA, 10% and 25% tariff levied on import of aluminum and steel, respectively by US authorities in May 2018 influenced the currency valuation in a big way.[4] As mentioned, oil and gold are among the most crucial commodities it exports and hence fluctuations in the prices of these commodities and exchange rate of Mexican peso are likely to have a linkage (Jain and Biswal, 2016; Jain and Ghosh, 2013). A depreciating peso will boost the benefits from export but will also result into higher spending in importing goods and services. Hence, resulting impact of currency exchange is expected to be critical for Mexico because despite being the thirteen largest export economy in the world, Mexico has a negative trade balance.[5] Ongoing US-China trade war originates an opportunity for Mexico to expand its exports further and a favorable exchange rate may augment the benefits further. Current literature encloses empirical evidence for linkage between oil prices and exchange rate.

Movements in oil prices and exchange rate are also expected to impact the performance of firms across various industries in Mexico. For instance, oil price variability can impact the corporate cash flow, because crude oil is a substantial input in the production process; consequently influence the stock market performance (Miller and Ratti, 2009). Additionally, current literature suggests that response of stock market towards change in oil price depends upon various factors such as type of economy (oil-exporting, oil-importing, emerging, developed), degree of change in oil price, reasons that drive changes in oil price etc (Degiannakis et al., 2017). Mexican currency exchange rate is observed to influence its stock market significantly (Delgado et al, 2018). Moreover, investors are increasingly considering commodities as an investment asset and including them in their investment portfolio. Gold is taken as a safe asset and investors prefer it more under stressed economic conditions and vice-versa. This way commodities and stocks are considered as substitutes for investment purposes (Jain and Biswal, 2016). In view of the above, this study makes an attempt to examine the dynamic relationships among the prices of gold, oil, stock market and exchange rate in Mexico.

Mexican economy is unique because crude oil contributes the most towards commodities that it exports and refined oil products are one among the most substantial commodities that it imports. Therefore, being an oil-exporting and oil-importing country, oil price movements are likely to exert an influence on its economy in diverse ways. Oil price is crucial for Mexican economy in two ways as oil happens to be an important industrial input and Mexico is increasingly focusing on manufacturing activities and, crude oil is the top most commodities that it exports as well as imports. Literature till date has focused on an economy either from an oil exporting country or oil importing country. However, Mexican economy plays role both ways which till date has not been addressed in literature. Gold is also the second largest commodity (after crude oil) that Mexico exports.[6] Exchange rate is a crucial policy variable and may have implications for the economic growth of an oil and gold exporting nation like Mexico. Similarly, due to involvement in two way trade in oil, Mexico provides a unique setting to explore the linkage of stock market with exchange rate, prices of oil and gold. A comprehensive review of existing literature indicates towards the need to investigate the interplay of commodity markets (oil and gold), exchange rate and stock market in Mexico. Research on interaction of exchange rate with oil, gold prices and stock market movement will put forward comprehensive understandings to the central bank for managing the currency rates that complements the twin objective of maximizing economic growth and keeping inflation restricted under the desired range.

This study will contribute to the literature in the following ways. Firstly, this is the first study in context of Mexico to explore the dynamic movements from international crude oil price and international gold price to Mexican exchange rate and its stock markets. Secondly, this study is based on daily data from January 2006 to December 2017. Delgado et al. (2018) study linkage between oil prices, nominal exchange rate and stock market in Mexican setting with monthly data, however in our study we have used daily data. Thirdly, apart from international crude oil this study also examines the impact of gold prices on Mexico macroeconomic variable. Previous studies in this context have focused only upon impact of crude oil price. As gold is amongst the top five commodities exported by Mexico, it has been considered in our study. Finally our study uses ARDL approach, which has various advantages over Johansen Co integration test (Le and Chang, 2016) to investigate the long run relationship among gold prices, exchange rate, stock market and crude oil prices. Unlike other methods of testing co integration, ARDL bound can be used irrespective of whether the variables of the study are I(0) or I(1) or a combination of both. However, the series must not be I(2), otherwise we can't use ARDL bound test. Once the lag order of the model is identified, cointegation can be tested using bound test procedure of ordinary least square (OLS). In ARDL approach, the lagged variables are used which helps in avoiding the problem of endogenity. This model performs better and avoids issues of weak power in modelling the co-integrating relationship with small samples (Romilly et al., 2001; Pesaran, 1997).

The rest of the paper is organized as follows: Section 2 presents the related review of literature. Section 3 presents the empirical models used Section 4 presents the results and policy implications Section 5 concludes.

2. Literature review

Association between oil price, gold, exchange rate and stock market index has been taken up by various researchers. This section is comprises of three parts. Initially, studies that have focused primarily upon a pair of the variable under consideration has been reviewed. Next part discusses findings and conclusion of studies that have simultaneously considered more than two variables, followed by studies focusing on desired variables in Mexican.

Various studies has observed a linkage between oil price and exchange rate and found that oil prices has implication for exchange rates (Amano and Van Norden, 1998; Chen and Chen, 2007; Chaudhuri and Daniel, 1998). Al-mulali and Che Sab (2012), in their study came to the conclusion that a surge in oil prices triggered a real exchange rate appreciation for oil export countries. Another more recent study conducted by Mensah et al. (2017) demonstrate the existence of a long-run equilibrium relationship between exchange rate and oil prices for oil dependent economies. Camarero and Tamarit (2002), Cologni and Manera (2008), and Rautava (2004) also exhibited a long-term correlation between exchange rate and oil prices.

Researchers have also explored the relationship between gold price and exchange rate. Gold price is found to be dominated by euros in 1980s (Sjaastad and Scacciavillani, 1996). Whereas, in 1990s these were largely determined by USD (Sjaastad, 2008). Findings of Tully and Lucey (2007) also suggested that USD is a major macro-economic element to guide gold price volatility. On the other hand, in Indian context exchange rate and oil prices and gold prices remain significantly independent from each other (Seyyedi, 2017).

Literature indicates towards a strong relationship between gold market and crude oil prices (Cashin et al., 1999; Lescaroux, 2009; Šimáková, 2011; Ye, 2007; Zhang and Wei, 2010). Hammoudeh and Yuan (2008) discovered a calming effect of oil shocks on precious metals. Narayan et al. (2010) observed the hedging properties of gold

[3] https://wits.worldbank.org/CountryProfile/en/MEX.

[4] https://www2.deloitte.com/insights/us/en/economy/americas/mexico-economic-outlook.html#endnote-6.

[5] https://commodity.com/mexico/.

[6] https://commodity.com/country-profiles/mexico/.

against inflation and found that gold and oil markets can predict each other. Zhang and Wei (2010) witnessed a causal relationship among crude oil price and gold price volatility. Although, Soytas et al. (2009) observed that no causal relationship exist between gold and oil prices in short term as well as long term.

A number of studies investigated the linkage between oil and stock prices. During 1970s and 1980s, oil price volatility was found to exert a negative influence on stock prices for United States (Kaul and Seyhun, 1990; Papapetrou, 2001; Sadorsky, 1999). Basher and Sadorsky (2006) observed that stock price of non-oil producing companies also gets affected by oil price. Because, decreasing/increasing oil price influences company profits via changing cost. Fang and You (2014), concluded that oil price shocks impact stock returns for emerging economies. On the other hand, Huang et al. (1996) pointed towards non-existence of any substantial link between oil prices and stock returns. Gogineni (2008) indicated that degree of oil price change define the direction and extent to which stock market will react. He observed that oil price changes led by supply shocks exert a negative effect on stock returns. However, if oil price changes due to shift in aggregate demand levels, it influences market returns of the same day positively. Wei and Guo (2017) also demonstrated that stock market responds in a variety of ways towards oil shocks and these reactions significantly align with the reasons of oil price changes. However, Sadorsky (2001) observed a positive association between oil prices and Canadian stock returns during the 1990s. This finding is conflicting to most of the literature. While oil price variability is considered as significant factor to understand stock market volatility, there is a lack of a definite consensus about the link between oil prices and stock market returns.

Researchers considered more than two of these variables as well to understand the dynamics further. Basher and Sadorsky (2006) analyzed the dynamic relationship of stock prices, oil prices and exchange rates in emerging markets. Their results back the fact that oil price risk influences stock returns. Sari et al. (2010) explored information transmission and co-movements among the spot prices of selected precious metals, USD/euro exchange rate and oil price. They concluded a weak long-run equilibrium relationship in long-run and on the contrary, strong feed backs in the short-run. Basher et al. (2012) also analyzed the relationship of oil prices, exchange rates, and stock markets and concluded that positive shocks in oil prices are likely to hurt stock prices in emerging markets and USD exchange rates in short run. They found that positive oil production shock pulls down oil prices and a positive shock to real economic activity surges oil prices. Chang et al. (2013) examined the correlation between gold prices, oil prices and exchange rate and indicated the independence among the taken variables. Jain and Ghosh (2013) investigated a long-run association and causality among global oil prices, precious metals prices, and INR/USD exchange rate. Among these variables a long-run relationship was found when gold price and exchange rate rests as dependent variables. Whereas, granger causality tests in the study indicates that exchange rate causes precious metal prices and oil price in India. Aloui and Aïssa (2016) and Kayalar et al. (2017) studied the structural dependence among crude oil prices, stock market indices and exchange rates for United States, and emerging economies and oil exporter/importers countries, respectively. Aloui and Aïssa (2016) documented evidences of a significant and symmetric association among these variables. They also observed this relationship to be time varying. Kayalar et al. (2017) observed that exchange rates and stock indices of most oil exporting countries exhibit higher dependency on oil prices. Whereas, oil importing emerging markets are less susceptible to oil price fluctuations. Jain and Biswal (2016) concluded that fall in gold prices and crude oil prices triggers downside movement in Indian currency valuation and benchmark stock index.

The Mexican economy is studied as part of oil export countries or emerging economies. Lizardo and Mollick (2010) conducted that increasing trend in real oil prices causes a remarkable depreciation of USD against Mexican peso. Jahan-Parvar and Mohammadi (2013) suggested a weak association between oil prices and real exchange rates. Volkov and Yuhn (2016) a strong linkage between oil price shocks and exchange rate in Mexican context. It was also observed that exchange rate take quite a long time to attain the initial equilibrium level in Mexico. Efficiency of financial markets is likely to be responsible for this asymmetric behavior of exchange rate volatility among countries and not the importance of oil revenues for the economy. A number of studies have observed that oil prices influence Mexican stock market returns (Filis et al., 2011; Hammoudeh and Li, 2005; Jawadi and Bellalah, 2011; Raza et al., 2016; Santillán et al., 2017). The most recent study conducted in Mexican context has analyzed dynamics of oil prices (Mexican Mayan Crude Oil), stock market index, consumer price index and exchange rate for Mexican economy is conducted by Delgado et al. (2018). This study indicates that currency exchange rate of Mexican peso per USD has a negative and statistically significant impact on Mexican stock market. They have also observed that oil price increase causes an appreciation in exchange rate and tend to evaporate over time.

A comprehensive review of existing literature indicates towards the need to investigate the interplay of commodity markets (oil and gold), exchange rate and stock market. Oil is crucial for Mexican economy in two ways: a) oil happens to be an important industrial input and Mexico is increasingly focusing on manufacturing activities and, b) crude oil is the top most commodity that is exported by Mexico. Exchange rate is an important economic variable and may have severe implications for the economic growth of an oil exporting and gold exporting nation like Mexico. Therefore the objective of this study is to explore the dynamic relationship among international oil prices, international gold prices, exchange rate and stock market index in Mexico.

3. Data and methodology

In this paper, we examine the long run association of international oil and gold prices with exchange rate and stock markets in Mexico. As United States is the largest trading partner of Mexico for energy products, therefore WTI crude spot price benchmark of oil price in US is taken as a proxy for international oil price movements. It is measured in USD/barrel and represented by OIL in our study. Gold is among the top five commodities exported by Mexico, therefore for gold price movements, the international gold spot price is taken as proxy. It is measured in USD/ounce and represented by GOLD. Majority of the export and import from Mexico is done in US Dollars, therefore for exchange rate movements the Mexican peso (MXN) and US dollar (US $) currency pairs is used. They are measured as MXN/USD and represented by ER. Mexican stock exchange also known as Mexican Bosla (BMV), is one of the major stock exchanges of Mexico. IPC is the market weighted benchmark index of Mexican stock exchange and representative of all shares listed on Mexican Bosla from various sectors. Therefore, in our study for stock market movements, benchmark index of Mexican Stock Exchange BMV IPC (represented by STOCK) is used. We have used price data on levels for all the series without any statistical transformation for this study. The sample period ranges from January 2006 to April 2018 and the data is obtained from Bloomberg Terminal.

4. Methodology

4.1. ARDL Bound Cointegration test

The objective of this study is to explore and model the dynamic movements among international oil price, international gold price, exchange rate and stock market index in Mexico. In order to test the long run relationship among Oil, exchange rate, stock price and gold

price ARDL bound approach (Pesaran et al., 1996) is used in the study Cointegration validates the systemic co-movement among two or more macroeconomic variables over the long run. After the cointegration is established among variables, cointegrating equation is estimated using long term error, also known as error correction term in the Error correction model. It indicates the speed of adjustment of the variables in the long run which in turn gives an idea of the stability of the relationship. The ARDL approach has several advantages. Unlike other methods of testing co integration, ARDL bound can be used irrespective of whether the variables of the study are I(0) or I(1) or a combination of both. However, the series must not be I(2), otherwise we can't use ARDL bound test. Secondly, once the lag order of the model is identified, cointegation can be tested using bound test procedure of ordinary least square (OLS). Thirdly in ARDL approach, the lagged variables are used which helps in avoiding the problem of endogenity. Lastly, this model performs better and avoids issues of weak power in modelling the co-integrating relationship with small samples (Romilly et al., 2001; Pesaran, 1997).

In our study, initially unit root test (ADF, KPSS and Phillip Person) were applied on both the series at the levels and at the first difference. This is done to check the stationary of the variables and to ensure that none of the variables is integrated of order (2). In the second step, the ARDL model is developed to specifications based on the Akaike information criterion (AIC). This is followed by bounds testing to check for a co-integrating relationship between the dependent and the explanatory variables. Since there has been no consensus about the directions of the long-run relationships due to the scarcity of related literature, unrestricted error correction model (UECM) regressions are estimated as follows:

$$\Delta OIL_t = \alpha_0 + \alpha_1 OIL_{t-1} + \alpha_2 GOLD_{t-1} + \alpha_3 ER_{t-1} + \alpha_4 SP_{t-1} + \Sigma_{i=1}^{n}\alpha_5 \Delta OIL_{t-1} + \Sigma_{i=1}^{n}\alpha_6 \Delta GOLD_{t-1} + \Sigma_{i=1}^{n}\alpha_7 \Delta ER_{t-1} + \Sigma_{i=1}^{n}\alpha_8 \Delta SP_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta GOLD_t = \beta_0 + \beta_1 GOLD_{t-1} + \beta_2 OIL_{t-1} + \beta_3 ER_{t-1} + \beta_4 SP_{t-1} + \Sigma_{i=1}^{n}\beta_5 \Delta GOLD_{t-1} + \Sigma_{i=1}^{n}\beta_6 \Delta OIL_{t-1} + \Sigma_{i=1}^{n}\beta_7 \Delta ER_{t-1} + \Sigma_{i=1}^{n}\beta_8 \Delta SP_{t-1} + \varepsilon_{2t} \quad (2)$$

$$\Delta ER_t = \gamma_0 + \gamma_1 ER_{t-1} + \gamma_2 OIL_{t-1} + \gamma_3 GOLD_{t-1} + \gamma_4 SP_{t-1} + \Sigma_{i=1}^{n}\gamma_5 \Delta ER_{t-1} + \Sigma_{i=1}^{n}\gamma_6 \Delta OIL_{t-1} + \Sigma_{i=1}^{n}\gamma_7 \Delta GOLD_{t-1} + \Sigma_{i=1}^{n}\gamma \Delta SP_{t-1} + \varepsilon_{3t} \quad (3)$$

$$\Delta SP_t = \mu_0 + \mu_1 SP_{t-1} + \mu_2 OIL_{t-1} + \mu_3 GOLD_{t-1} + \mu_4 ER_{t-1} + \Sigma_{i=1}^{n}\mu_5 \Delta SP_{t-1} + \Sigma_{i=1}^{n}\mu_6 \Delta OIL_{t-1} + \Sigma_{i=1}^{n}\mu_7 \Delta GOLD_{t-1} + \Sigma_{i=1}^{n}\mu \Delta ER_{t-1} + \varepsilon_{4t} \quad (4)$$

Where, OIL stands for international crude oil price, GOLD stands for international gold spot prices, ER stands for MXN/USD and SP stands for Mexican stock market price.

The null hypothesis in all the above equations is as follows:

OIL Equation: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$
GOLD Equation: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$
ER Equation: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$
SP Equation: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$

In the above equations, null hypothesis is that no long run relationship exists among the variables in the equation. In order to test this, Wald F-test is used. It detects the joint significance of lagged values of variables in the equation and provide us with the F-statistic and upper and lower critical values. The evidence of cointegration is found when F-statistics is above the upper critical value and vice versa. In case F-statistics is between upper and lower bound values, result is inconclusive. After the cointegration is established among variables, cointegrating equation is estimated using long term error, also known as error correction term in the Error correction model. It indicates the speed of adjustment of the variables in the long run which in turn gives an idea of the stability of the relationship.[7]

$$\Delta OIL_t = \alpha_0 + \Sigma_{i=1}^{n}\alpha_5 \Delta OIL_{t-1} + \Sigma_{i=1}^{n}\alpha_6 \Delta GOLD_{t-1} + \Sigma_{i=1}^{n}\alpha_7 \Delta ER_{t-1} + \Sigma_{i=1}^{n}\alpha_8 \Delta SP_{t-1} + \theta ECT_{t-1} + \varepsilon_{1t} \quad (5)$$

Where, ECTt-1 term represents the long-run equilibrium speed of adjustment after the shock in short-run. The diagnostic tests including functional form, serial correlation, non-normality, and heteroskedasticity test are conducted to check the goodness of fit of the model. The Cumulative sum (CUSUM), and the CUSUMSQ (cumulative sum of squares) stability tests were applied and the statistical are inside the critical bound at 5%, indicating that the regression equation is stable.

5. Results and discussion

Fig. 1 shows daily price movements of the variables under study. It is noticed that there is a steep fall in oil prices in 2008 and sudden trend reversal in exchange rate movement. Gold price continue to rise sharply after 2008 crises till 2011. Similarly, in 2015–16 while there was a downfall in oil prices, exchange rate rises sharply. Stock prices in Mexico follow an upward trend continuously except a small downward movement during recession. This indicates that the price movements of these variables are time varying in nature.

The descriptive statistics of all the variables are reported in Table 1. Among all the variables stock prices shows the highest volatility followed by gold, oil and exchange rate. Table 2 presents the correlation among the variables. Oil price is found to be negatively correlated with stock price and exchange rate movement. This can be considered as a signal for investors looking for portfolio diversification. However, gold price is found to be positively correlated with oil prices. Exchange rate is highly correlated with stock prices. Similarly, gold prices are significantly correlated with stock prices. This indicates that exchange rate, gold prices and stock prices tend to move in the same direction. All these correlations are found to be statistically significant which provides an indication of the presence of cointegration among the variables. Further, in order to test whether the movements of these variables are associated in the long run or not, Cointegration test is used. Cointegration validates the systemic co-movement among two or more macroeconomic variables over the long run. Presence of cointegration rules out the possibility of spurious correlation among the variables.

Before proceeding with the ARDL-Bounds test, unit root test is used to check the order of integration of the variables. In case of ARDL test, the variables must not be I(2), otherwise the results will be spurious. Therefore, as a caution three unit root tests namely ADF, PP and KPSS are used. These tests are applied on the levels by including constant and time trend as well as only constant at first difference of the variables. The results are presented in Table 3. In case of ADF and PP, null hypothesis is that the series is non stationary while it is reverse in case of KPSS test. Results of these tests indicates that none of the series is I(2) and hence, we can proceed with ARDL analysis.

In ARDL model, lag structure of the examined variables remains quite crucial. Therefore, AIC (Akaike Information Criterion) is used to ascertain the maximum lag length of four lags. However, lag length is different when different variables are treated as dependent variables. After determining the appropriate lag length for each dependent variable, ARDL bound test is applied.

Results of ARDL Bound test are presented in Table 4. Cointegration is found among the variables when stock price is kept as dependent variable. This indicates that whenever there is a shock in the system, oil price, gold price and exchange rate will move first and their movement is followed by the stock market. When exchange rate is taken as dependent variable, cointegration is significant at 10% level of significance. This is due to the fact that F- statistics for stock price and

[7] Similar equations were formulated for other variables.

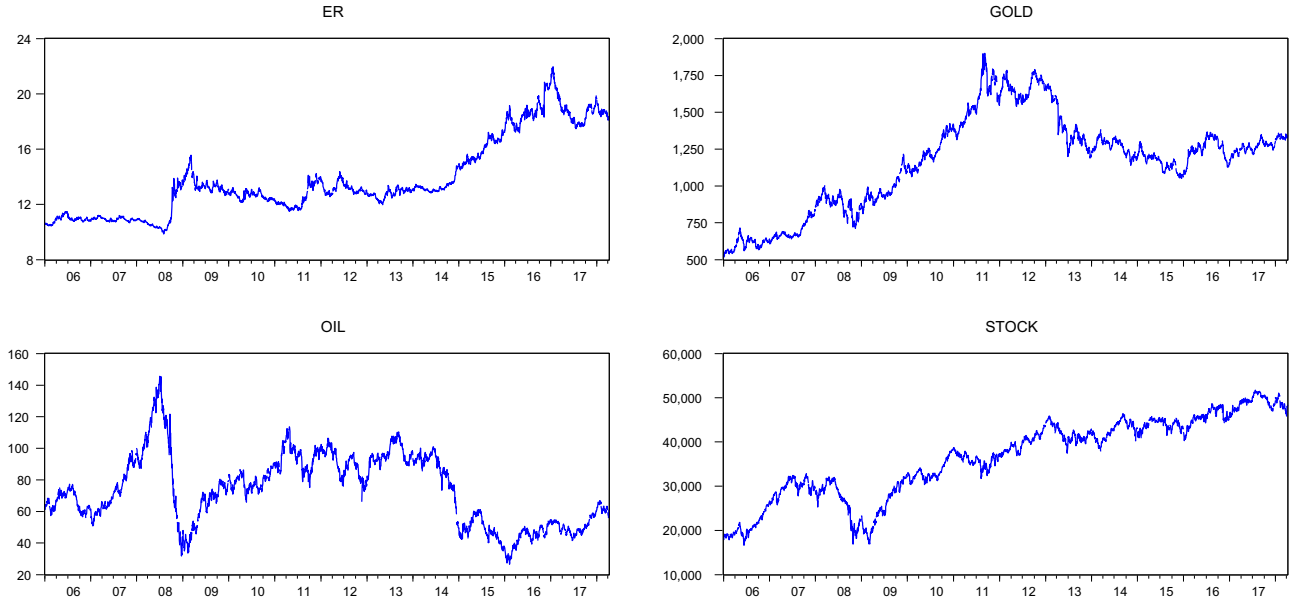

Fig. 1. Daily price movement of variables.

Table 1
Descriptive statistics of the prices series.

	OIL	GOLD	STOCK	ER
Mean	73.83	1167.38	36,490	13.79
Median	74.09	1223.25	37,903	13.03
Maximum	145.5	1900	51,713	21.95
Minimum	26.51	516.88	16,653	9.85
Std. Dev.	22.30	320.25	9049	2.78
Skewness	0.22	−0.15	−0.40	0.91
Kurtosis	2.48	2.36	2.10	2.77
Jarque-Bera	58.72	65.61	186.1	437.3
Probability	0.00	0.00	0.00	0.00

Note: The daily price data ranges from Jan 2006 to April 2018.

Table 2
Correlation Matrix of the variables.

Correlation				
Probability	**OIL**	**GOLD**	**STOCK**	**ER**
OIL	1.00			
GOLD	0.241	1.00		
	0.00*	–		
STOCK	−0.166	0.658	1.00	
	0.00*	0.00*	–	
ER	−0.648	0.319	0.704	1.00
	0.00*	0.00*	0.00*	–

* indicates significant correlation at 5% significance level.

exchange rate is higher than the upper bound critical value at 5% and 10% respectively. Cointegration is found insignificant when Oil and Gold are taken as dependent variable. This indicates that in the long run, movement in oil prices and gold prices are independent of the movement of stock prices and exchange rate.

Long run coefficient estimates of cointegration equation (Stock price equation and Exchange rate equation) is presented in Table 5. The results of stock price equation suggest that gold prices positively affect the stock price. Jain and Biswal (2016) put forward the similar findings for the study conducted in Indian context. They observed that negative movements in gold prices triggers a downward trend in Indian stock market (Sensex) also. Mexico is a gold exporting country. Increasing global price of gold is likely to add to the economic growth of the nation

Table 3
Results of Unit Root test.

Unit Root (Levels)	**ADF**	**PP**	**KPSS**
Oil	− 2.323	− 2.340	0.739*
	0.420	0.411	
Gold	− 1.671	− 1.672	0.438*
	0.7639	0.763	
Stock	− 3.512	− 3.151	0.245*
	0.038	0.094	
Ex rate	− 4.0571		
	0.336		
Unit Root (First Difference)	**ADF**	**PP**	**KPSS**
D(Oil)	− 58.658	− 58.72	0.075
	0.00*	0.00*	
D(Gold)	− 54.81	− 54.81	0.021
	0.00*	0.00*	
D(Stock)	− 51.96	− 52.19	0.062
	0.00*	0.00*	
D(Ex rate)	− 56.85	− 57.01	0.067
	0.00*	0.00*	

* Indicates that null hypothesis is not accepted at 5% level of significance. In ADF and PP, null Hypothesis is that series is non stationary or possesses unit root. However in KPSS reverse is true.

and stock market is likely to reflect this by exhibiting an upward movement.

Also at 10% level of significance oil prices negatively affects the stock prices. This means that when the oil prices moves up stock prices will decline. Basher et al. (2012) found similar result for emerging stock markets. However, our finding is contradictory to findings of Jain and Biswal (2016) in context of association between stock market and oil prices. Although, Mexico is an oil exporting country but, crude oil accounts to approximately 6% of its total export only. Whereas, manufactured items contribute to the extent of about 70% towards its total exports. This indicates that increasing oil prices benefits the nation via its oil export. On the other hand, it can put the profits of manufacturing industry under pressure due to increasing cost of production. Since predominantly manufacturing contributes more significantly towards the GDP of Mexico therefore, decreasing oil prices get reflect into increasing stock prices and vice-versa. It is also likely that investors might react towards the opportunity/threat of increasing/decreasing profits of companies they have invested in/want to invest in.

Results of exchange rate cointegrating equation suggest that oil

Table 4
ARDL Bound Co integration test results.

Dependent Variable	Co integration Null Hypothesis	Lag Structure	F-statistics	Outcome
Oil	$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$	(2, 1, 2, 2)	2.409	No Co integration
Gold	$\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$	(1, 4, 4, 1)	1.291	No Co integration
Ex rate	$\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$	(4, 2, 1, 4)	3.654	Co integration**
SP	$\mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$	(4, 2, 1, 1)	5.555*	Co integration*

Optimal lag length is based on the AIC criterion. The maximum lag length was fund to be 4.
* indicates statistical significance at 5%.
** indicates statistical significance at 10%.

Table 5
Estimated long run coefficients using the ARDL approach.

Stock Price Equation	Coefficient	Prob.	Ex Rate Equation	Coefficient	Prob.
ER	− 589.15	0.708	**GOLD**	0.002	0.198
GOLD	25.48	0.00*	**OIL**	− 0.121	0.000*
OIL	− 423.60	0.07**	**STOCK**	0.000	0.237
C	50,624.09	0.10**	**C**	17.463	0.000*

* indicates statistical significance at 5%.
** indicates statistical significance at 10%.

Table 6
Error correction representation for the selected ARDL models.

	Stock Price Equation	Ex Rate Equation
ECM(−1)	− 0.000910	− 0.000910
	[− 3.42142]*	[− 1.23785]
D(STOCK(−1))	0.012471	9.48E− 06
	[0.61373]	[1.47668]
D(STOCK(−2))	− 0.009232	− 1.24E− 05
	[− 0.45361]	[− 1.92574]
D(STOCK(−3))	− 0.039581	− 1.85E− 06
	[− 1.96706]*	[− 0.29069]
D(ER(−1))	− 442.8292	− 0.003433
	[− 6.84568]	[− 0.16793]
D(ER(−2))	58.77254	− 0.022863
	[0.89918]	[− 1.10677]
D(ER(−3))	64.41121	− 0.058349
	[0.99090]	[− 2.84030]*
D(OIL(−1))	− 8.074763	0.001561
	[− 1.92290]	[1.17609]
D(OIL(−2))	− 3.789410	0.002031
	[− 0.90014]	[1.52645]
D(OIL(−3))	0.110444	− 0.000534
	[0.02635]	[− 0.40334]
D(GOLD(−1))	− 0.101375	0.000181
	[− 0.19789]	[1.11798]
D(GOLD(−2))	1.085037	− 0.000213
	[2.11788]*	[− 1.31634]
D(GOLD(−3))	1.132575	− 0.000363
	[2.21023]*	[− 2.24441]*
C	10.24426	0.002846
	[1.52269]	[1.33870]

* indicates statistical significance at 5%.

prices negatively influences exchange rate in the long run. This indicates that increase in oil price prompts currency appreciation of oil exporting countries. Al-mulali and Che Sab (2012), found the similar results in their study conducted to explore the linkage of oil price and real exchange rate for oil exporting countries. Jain and Biswal (2016), also indicated that rising oil price leads to depreciation of oil importing countries. Increasing oil price is likely to boost Mexico's oil revenues and as a result, trigger currency appreciation.

However, in contrast to the previous studies (Jain and Biswal, 2016; Jain and Ghosh, 2013; Sjaastad, 2008) gold price does not have found to exert any significant impact on the exchange rate. However, Chang et al. (2013) observed findings that are similar to the results of current study. They witnessed that no co-integration relationship exist between exchange rate and gold price. Despite gold being the second largest commodity exported, gold price movement does not influence the currency exchange rate in Mexico. Gold and oil price are tend to move in the same direction (Melvin and Sultan, 1990a). Both crude oil and gold contribute towards Mexican GDP though export and crude oil is comprises larger chunk in country's export than gold. Therefore, impact of oil price is likely to overlap and shadow the influence of gold price on currency exchange rate.

After the co integrated relationship is established, Error correction model is estimated (see Table 6) to study the short run dynamics. Results of stock price equation indicate that error correction term is significant at 5% level of significance. This indicates that after a shock in the system, stock price return to their equilibrium. However, small value of coefficient of error term signifies that the speed of adjustment to the equilibrium is relatively small. However, in case of Exchange rate equation, error correction term is not significant.

5.1. Implications of the study

Current study has practical implications for investment professional and policy makers. In long run, movement in oil prices and gold prices are independent of fluctuation in stock market and exchange rate. However, oil price influences stock market as well as exchange rate in long term and gold price exert an influence on stock market movements. These results hold important implications for investors. Increasing gold price in international market impacts stock market positively. Therefore, investing in gold does not offer hedging and portfolio diversification benefits to equity investors. Crude oil price influence stock markets negatively hence, trends in global crude oil price must be accounted to define entry and exit points for investors in equity segment. International oil price influences exchange rate. Rising oil price stimulates appreciation of Mexican currency. This finding is relevant for policy makers. Mexican economy is heavily dependent upon exports of various industrial produce and commodities including crude oil. Appreciation of domestic currency is likely to bring down the benefits of increasing oil prices as an oil exporting country. Therefore, it is suggested to manage the currency valuation in order to take full advantage of higher oil prices.

This is also evident from the fact that peso has lost its value against US dollar by almost 22% since early 2015, primarily due to decreasing global oil prices. Further, weaker peso makes imports costlier for the emerging economy which in turn triggers rising trend in inflation. Moreover, increasing oil prices also puts inflationary pressure via increasing cost of fuel prices and transportation services as Mexico imports refined oil products. This indicate that increasing as well as decreasing trend in oil prices can stimulate inflation in country via different routes and therefore, has important policy implications.

For instance, inflationary pressure in Mexico during the recent times, is an outcome of rising fuel price and weakening peso. Mexican government is in its preparatory phase to lift price controls from fuels and increased gasoline and diesel price by 14% and 20% in January

2017. Annual Inflation in Mexico reached 6.77%, highest in almost past 17 years, well above Central Bank's target of 3%. The recent interest rate hike by central bank is an outcome of worries towards high inflation levels. On February 08 (2018), Banxico announced hike of 25 basis points in its benchmark interest rate to 7.50%, highest in past nine years and indicated intentions of future rise, if required. Stock market fell for five consecutive sessions around this announcement, with highest downfall of 2.28% in BMC IPC on the day of announcement. Inflation rate has fallen to 4.51 subsequently in May 2018.

6. Conclusion

Crude oil and gold are among the top five exported commodities in Mexico, therefore current study empirically investigates the long-term dynamic relationships among WTI crude oil and International Gold price movements on macroeconomic indicators of Mexico namely Exchange rate and Stock market Index. Daily data ranging from January 2006 to April 2018 has been used in the study. Long-run equilibrium among the variables is tested using ARDL bound test of cointegration. Findings of the study suggest that international gold prices positively affect the stock price of Mexico while oil price affects them negatively. This means that when global oil prices move up stock prices will decline.

Oil prices negatively influence exchange rate in the long run which is evident from the fact that peso has lost its value against US dollar by almost 22% since early 2015, primarily due to decreasing global oil prices. Further the results of this study concludes that gold price do not have any significant impact on the exchange rate.

The findings of this research have important implications for the Mexican portfolio management, as well as the financial risk management. It also provides some signals to monetary and fiscal policies, considering the pressure crude oil prices create on the stock markets and exchange rates. This research helped in the clear understanding of the effects of fluctuations of crude oil prices on the Mexican economy. Finally, it can be concluded that crude oil, being the most volatile among all variables, plays a significant role in creating a pressure on the exchange rate and stock market index of Mexico.

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