Asymmetric Effects of Exchange Rates on Stock Prices in G7 Countries

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Abstract: This paper examines whether there are asymmetric effects of exchange rates on stock prices in G7 countries. According to Fratzscher (2008), the G7 has been overall effective in moving the US dollar, yen and euro in the intended direction at horizons of up to three months after G7 meetings. Therefore, it is important to find out the impacts of G7 exchange rate adjustments on the stock markets. These effects can become worldwide as G7 stock markets have been the trading platform for international market capitalization for about last thirty years. A vast body of research documented that a country's currency can have a large effect on stock market movement, however the empirical findings are mixed. This study contended that exchange rates can affect stock prices asymmetrically. This study systematically discussed four views on how exchange rates can affect stock prices asymmetrically. A dataset consists of 227 monthly data from 31-12-1997 to 31-10-2016 for G7 countries, namely Canada, France, Germany, Italy, Japan, the United Kingdom and the United States are collected from Thomson Reuters DataStream and Bank for International Settlements (BIS). A nonlinear ARDL model is employed to analyse the asymmetric effects of exchange rates on stock prices. The findings showed that the exchange rate changes in all G7 countries have short-run asymmetric effects on stock prices. However, the results do not hold into the long-run, except for Germany. This paper suggests that policymakers should have a different reaction in policy decision between the depreciation and appreciation of exchange rates. Investors can make profit from stock market by buying or selling stocks according to the predicted response of stock market to exchange rate changes. Take into consideration of the importance of G7 currencies and stock markets, this paper examined and compared the asymmetric effects of exchange rates on stock prices in G7 countries.

Keywords: Exchange rates, stock prices, nonlinear ARDL, asymmetry.
JEL classification: F31, G15

1. Introduction

The group of seven (G7[1]) had played an important role in the global economy by managing the direction of their currencies. G7 has been very influential on exchange rate adjustments throughout time such as management of the USA dollar in the Plaza and Louvre accords of 1985 as well as 1987, control of the dollar trough and yen peak of 1995 and euro's trough in

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[1] This organization was founded in 1975 and consists of the wealthiest developed countries in the world, namely Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

2000 (Fratzscher, 2008; and Bracke *et al.*, 2008). The success rate of G7 in moving USA dollar, Euro and Yen in their decided direction has been found out to be about 80% since the 1970s (Fratzscher, 2008). The credibility, as well as reputation of the G7 members, has played an essential role in achieving such success rate. G7 does not only influence the direction of exchange rate movements of the members but also affects the currencies of other nations around the globe. It was in the year of 2003 that the head of international Monetary Fund (IMF) criticized G7 for creating unwarranted pressure on the currency market and specifically against Asian currencies. "Exchange rates should not be the subject of public trumpeting and organized pressure, Mr. Koehler told delegates at the G7 conference in Dubai" (Walker, 2003).

A vast body of research documented that a country's currency can have a large effect on stock market movement. The world had witnessed this during the 1997 - 1998 Asian financial crises. One of the evidence was the devaluation of the East Asian currencies that resulted in their stocks markets to decline dramatically. However, there is no obvious evidence that revaluation of currency leads to stock market boom. There are four views regarding how exchange rates affect stock prices asymmetrically. According to the first view, currency depreciation results in higher exports of domestic products and increase firms' profit. Increase in firms' profit in return lead to increases in stock prices of domestic market (Sui and Sun, 2016). The second view states that depreciation of domestic currency increases the cost of input, thus lower firms' profit and lead to decline in stock prices (Bahmani-Oskooee and Saha, 2016a). This view states the opposite effect of exchange rate on stock prices in comparison with the first view. On the other hand, the third view proposes that appreciation of domestic currency can be "a bad" news for shareholders of domestic multinational firms because appreciation of exchange rates can deteriorate their share prices (Bahmani-Oskooee and Saha, 2015). An increase in domestic currency or decrease of foreign currency may decrease the share prices for such companies, because they have factories or other assets in countries other than their home country.

Furthermore, another theory that is set to become a vital factor in consideration of the asymmetric relationship of the exchange rate and stock prices is that prices are rigid downwards and quantities are inflexible upwards (Demian and di Mauro, 2015). According to this theory during currency depreciation, companies can sell more and enjoy a trade surplus. Although corporations can reduce prices to enjoy even more sales however due to the difficulty of creating a new distribution network of sales and number of products they can produce they may not choose to do so. Higher sales can mean a potential for even higher earnings for a company when there is currency depreciation. Increase in the earnings of a corporation can lead to higher stock prices. This is due to the direct relationship between higher price earnings ratio, and stock prices (Arslan and Zaman, 2014)[2].

According to the theory of price and quantity rigidities in the case of currency appreciation, companies can reduce prices to retain sales; however, because they may incur losses, they are unable to decrease prices. Lower sales for the company can lead to lower stock prices as stock prices are affected by a company's earnings. According to this theory which states quantities are upward rigid and prices downward rigid, depreciation of exchange rate can have smaller effects on companies' exports than appreciation of exchange rates. This is because most of the exchange rate adjustments tend to happen on the quantity side rather than the price side (Demian and di Mauro, 2015). Therefore, based on these four different views, there is a need for consideration of asymmetric effects of exchange rate on stock prices. Hence, the objective of this study is to find out whether there are symmetric or asymmetric

[2] Price-earnings ratios are calculated by dividing stock prices by earnings per share. Earnings per share show how much is the earnings of a company for each individual share. This can be calculated by dividing the earnings of a company by the number of shares issued.

effects of exchange rate movements on stock prices in G7 countries.

This study chooses G7 because of the importance of G7 currencies. Table 1 shows that the currencies of G7 account for most of the transactions executed in the global economy. G7 meetings have always influenced the exchange rate adjustments. With the consideration of asymmetric effects of exchange rates on stock prices in G7, these effects can become worldwide as G7 stock markets have been the trading platform for international market capitalization for about last thirty years (Andrikopoulos *et al.*, 2014).

This paper extends the existing literature in at least in two ways. First, this study added two new theoretical discussion on how exchange rates can affect stock prices asymmetrically. Most of the previous study such as Bahmani-Oskooee and Saha (2015), and Bahmani-Oskooee and Saha (2016b) had discussed only two views. Second, this study examined the issue of asymmetric effects of exchange rates on stock prices in all G7 countries. According to Fratzscher (2008), the G7 has been overall effective in moving the US dollar, yen and euro in the intended direction at horizons of up to three months after G7 meetings. Therefore, it is important to find out the impacts of G7 exchange rate adjustments on the stock markets. Although the study by Bahmani-Oskooee and Saha (2016b) covers some of the G7 members namely, Canada, Japan and the United Kingdom, however, to be able to compare the relationship among these countries, a complete study for all the countries using the dataset with a same time frame is necessary.

Table 1: Daily currency distribution of over the counter foreign exchange turnover for G7

Currency	2001	2004	2007	2010	2013	2016
USD	89.9	88.0	85.6	84.9	87.0	87.6
EUR	37.9	37.4	37.0	39.0	33.4	31.4
JPY	23.5	20.8	17.2	19.0	23.0	21.6
GBP	13.0	16.5	14.9	12.9	11.8	12.8
CAD	4.5	4.2	4.3	5.3	4.6	5.1
Others	31.16	33.06	40.96	38.95	40.13	41.47

Notes: Because two currencies are involved in each transaction, therefore, the sum of the percentage shares of individual currencies totals 200% instead of 100%.

2. Literature Review

There are many literatures regarding the linkage of exchange rates and stock prices. Although most scholars documented in the existence of either positive, negative relationship among stock prices and exchange rates, however, there have been studies that found no significant link.

Diamandis and Drakos (2011) who used a direct quote of exchange rates as their data, found positive relationship between stock prices and exchange rates in Mexico, Argentina, Chile, and Brazil. The foreign currency used in the analysis was US dollars. The study found out that the positive relationship between the two is transferred via U.S. stock market which acts as a channel in this regard. Therefore, based on the results, the study suggests the U.S. stock market drives the system of these four emerging economies which confirms the influence that the U.S. stock market has on the economies of these countries. The positive relationship between stock prices and exchange rates was found in India as well. Jain and Biswal (2016) showed that a decrease in the exchange rate of Indian Rupee using a direct quote results in a decline of Indian stock Index. By contrast, another paper used a direct quote, however, found similar results by studying India among other emerging countries such as Brazil, Chile, Colombia, Russia, South Africa and Mexico. The study reported a positive relationship between exchange rate of each local currency and their stock prices (Reboredo *et al.*, 2016). In the analysis of the paper, their domestic currencies have been evaluated in respect to USD and EUR. Therefore, appreciation of home currencies in respect to USD and

EUR result in appreciation of local stock prices while a decrease in a local currency value will lead to a fall in its prices of stocks (Reboredo *et al.*, 2016).

Despite these findings, scholars have found a negative relationship between stock prices and exchange rates as well. The article by Sensoy and Sobaci (2014) reported a negative correlation between the two. This paper found out the relationship between Turkey's domestic currency against USD (direct quote) with Turkey's stock index values. Therefore, it has been suggested that a negative relationship can help investors in the stock market to minimize their portfolio risk by holding a fair amount of foreign currency. Matsubayashi (2011) which also used a direct quote to calculate exchange rate explained that the depreciation of Japanese yen leads to increase of firm's expected profitability in Japan which can result in investments. Although the paper did not explicitly state the effect on stock prices however as investment increases, the stock prices rise. A study was done on Malaysia, Thailand, Philippines, Taiwan and South Korea found a negative relationship between their stock index prices and exchange rate as well. This study that incorporated a direct quote as the method of exchange rate measurement stated that the negative relationship is more apparent in the case where the exchange rate is either very high or very low (Tsai, 2012). As other studies that have confirmed a negative relationship between exchange rate and domestic stock prices, Wong *et al*. (2018), Moore and Wang (2014), Kubo (2012) and Litsios (2013) can be mentioned. Among these, while Litsios (2013) used an indirect quote of exchange rate while Moore and Wang (2014) and Kubo (2012) used direct quotes. Litsios (2013) was able to confirm the significant negative relationship in the UK which explained that an increase in stock prices in the UK leads to depreciation of pound sterling. Moore and Wang (2014) who studied the UK among other countries such as Australia, Canada, Japan (as developed countries) and Malaysia, the Philippines, Singapore, Thailand as well as South Korea (as emerging Asian countries) confirmed the negative relationship between stock prices and exchange.

Chkili and Nguyen (2014) who studied the relationship between exchange rate movements and market returns of BRICS countries using an indirect quote, found no significant impact from exchange return to stock market returns. Similarly, Zhao (2010) who studied this relationship in China reported that there is no long-run relationship by exploring a set of data from 1991 to 2009. This study also stated that there is no existence of mean spillover between the foreign exchange and stock market in China. Although in some studies no significant relationship was found between exchange rate and stock prices, however, most pieces of literature were able to prove that there is a relationship between the two. On the other hand, this relationship was described differently between different studies as they considered different countries and different methodologies in their studies.

Most of these studies employed linear methods, only a few studies have applied nonlinear methods. One of the popular linear methods that have been used to study the relationship between exchange rate and stock prices is VAR. It has been considered essential for variables in VAR model to be stationary, and this is due to avoiding moving average representations to be non-convergence (Abouwafia and Chambers, 2015). Groenewold and Paterson (2013) which used VAR, focused on a three-way relationship between stock prices, exchange rates, and commodity prices to find a more robust result. Yang and Doong (2004) used a VAR model for finding the short run dynamic relationship among stock prices and exchange rates (Yang and Doong, 2004). A similar methodology is used in Sensoy and Sobaci (2014) by capturing the joint dynamics through the implementation of unrestricted VAR model. Kal *et al*. (2015) demonstrates the need for using a flexible model as there might be more than one type of relationship among stock prices and exchange rates, hence for this flexibility, the study considered a Markov-switching autoregressive specification (MS-VAR).

The test for cointegration by Johansen (1991) is another popular test among scholars to examine the relationship between exchange rate and stock prices. Among the works of literature that followed Johansen (1991) are Tsagkanos and Siriopoulos (2013), Diamandis and Drakos (2011) and Kubo (2012). Although the studies done by Diamandis and Drakos (2011) and Kubo (2012) are of linear nature, however, non-linearity cointegration was considered in the study by Tsagkanos and Siriopoulos (2013).

Johansen cointegration test is subject to asymptomatic properties therefore many scholars with smaller sample datasets used Autoregressive Distributed Lag (ARDL) which was introduced by (Pesaran and Shin, 1995). Among these scholars are Lee and Wang (2015), Jiranyakul (2012) and Lin (2012). ARDL can handle data with integrals of different orders due to structural breaks issue. Linear ARDL model assumes a linear relationship between exchange rate and stock prices.

Bahmani-Oskooee and Saha (2015) which reviewed many pieces of literature recommended a non-linear ARDL (NARDL) framework. Following this, asymmetry relationship of the exchange rate and stock prices in the USA was studied by Bahmani-Oskooee and Saha (2016a). The paper found that there is a significant asymmetric effect in the short run. The paper examined Brazil, Canada, Chile, Indonesia, Japan, Korea, Malaysia, Mexico, and the United Kingdom. The findings of the paper indicated that although the effects of exchange rate on stock prices are asymmetric in these countries but mostly they are short-run effects. Using Nonlinear Autoregressive Distributed Lag (NARDL) approach of Shin *et al.* (2014), Cuestas and Tang (2015) found that the evidence of asymmetries of exchange rate on stock returns in China.

Most of the previous research conducted on the impacts of exchange rates on stock prices assumed that the adjustment when exchange rate change is symmetrical. A few papers investigated asymmetric effects of exchange rates on stock prices, among these none have studied all G7 countries in one setting.

3. Methodology

This study adopts a nonlinear ARDL (NARDL) model used by Bahmani-Oskooee and Saha (2016b). The methodology of choice is set out to examine the symmetric or asymmetric relationship among stock prices and exchange rates. The main equation that this paper adopts is as follows:

$$LnSP_t = a + bLnEX_t + cLnIPI_t + dLnCPI_t + eLnM2_t + \varepsilon_t \tag{1}$$

where SP stands for Stock Prices, EX represents exchange rate, IPI is industrial production index, which used to measure the economic activity of domestic market, CPI is Consumer Price Index that was used to measure price levels, and M2 is nominal money supply. The logarithms of variables have been taken, hence writing them in the "Ln" format.

In equation 1, the estimate of b could be both positive and negative. In the case that exchange rate declines firms might be able to gain more competitiveness internationally and hence increase their export and profit or it can be influenced negatively by increased in their cost of production if inputs are imported.

There is also a relationship between stock prices and economic activity in an economy. Based on theories, existence of a strong stock market can lead to a rise in savings which can in return result into efficient allocation of capital that can be used for investment purposes. A rise in stock prices can also increase the collateral of businesses and consumers that enables them to borrow more money hence spending increases, this in return leads to higher economic activity or in other words growth in a country and vice versa. This is known as the wealth effect model as rise in stock prices result in making profit and wealth creation. This is directly related to economic activity (Janor *et al.*, 2005). The other way around holds true as well, meaning a better economy with more growth, can result into better performance of its stock market (Chandra Padhan, 2007). Based on the explained theory, it is expected there is a positive relationship among economic activity and stock prices.

Empirical results by Cai *et al.* (2009) proved existence of relationship among stock prices and price levels. Inflation which is representative of upward change in price levels can influence the stock prices in an economy (Geetha *et al.*, 2011). Inflation creates a problem for investors in a stock market as it leads to a natural bias in the stock market's performance. In the case of inflation, dividends normally increase less than the rise of consumer prices which results into a lower overall return for investors (Geetha *et al.*, 2011). Inflation effects stock prices in two ways: firstly, through increase of prices and lower profitability of companies, secondly controlling inflation via currency measures such as contractionary monetary policy which may result significantly on capital flows (Hu *et al.*, 2013). Therefore, it is expected to have a negative relationship with stock prices (Bahmani-Oskooee and Saha, 2016b).

According to Zare and Azali (2015) there is a relationship between stock price and monetary policy. The relationship between monetary policy and stock prices can be affected by the business cycle (Andersen *et al.*, 2007; Basistha and Kurov, 2008). Changes in money supply can lead to changes in business cycles hence since changes in money supply can result in economic swings, therefore money supply can have an impact on stock prices as the result (Friedman and Schwartz, 1963). Money supply also affects stock prices through the changes of liquidity in a country, as any adjustment to money supply alters the level of liquidity in a market that leads to changes in stock prices (Chung and Ariff, 2016). The expected sign for money supply is positive since increase of money supply can result in more investment.

ARDL regression can be derived from equation (1) as follows:

$$\begin{aligned}\Delta LnSP_t = a &+ \sum_{k=1}^{n1} \beta_k \,\Delta LnSP_{t-k} \\ &+ \sum_{k=0}^{n2} \delta_k \,\Delta LnEX_{t-k} + \sum_{k=0}^{n3} \varphi_k \Delta LnIPI_{t-k} \\ &+ \sum_{k=0}^{n4} \theta_k \Delta LnCPI_{t-k} + \sum_{k=0}^{n5} \pi_k \,\Delta LnM2_{t-k} + \lambda_1 LnSP_{t-1} \\ &+ \lambda_2 LnEX_{t-1} + \lambda_3 LnIPI_{t-1} + \lambda_4 LnCPI_{t-1} + \lambda_5 LnM2_{t-1} \\ &+ \mu_t\end{aligned} \qquad (2)$$

Based on the literature, exchange rates have asymmetric effect on stock prices instead of a symmetric one (Bahmani-Oskooeei and Saha, 2015). Therefore, this study develops a NARDL to examine both long-run as well as short-run nonlinearities. The model calculates the negative and positive partial sum decompositions of exchange rates to develop the nonlinear model. To take into consideration, the asymmetric effect of exchange rates, the nonlinear ARDL model shall be derived from equation (2). In equation (3), to measure the asymmetric effects of exchange rate, two new variables shall be derived from the exchange rate variable and replace it. These two variables intend to represent the appreciation and depreciation of exchange rate separately. The concept of cumulative sum is used in this process whereby the partial sum of negative values is calculated as $NEG = \sum_{j=1}^{t} \Delta LnEX_j^-$ and replacing negative values with zero. The partial sum of positive values is calculated as $POS = \sum_{j=1}^{t} \Delta LnEX_j^+$. Therefore, $LNEX_j^-$ and $LNEX_j^+$ respectively stand for negative and positive values. Comparisons of λ_2 and λ_3 similarly can indicate long run asymmetry or symmetry between the generated variables (POS and NEG).

$$\Delta LnSP_t = a + \sum_{k=1}^{n1} \beta_k \, \Delta LnSP_{t-k} + \sum_{k=0}^{n2} \delta_{1,k} \, \Delta POS_{t-k} + \sum_{k=0}^{n3} \delta_{2,k} \, \Delta NEG_{t-k} + \sum_{k=0}^{n4} \varphi_k \Delta LnIPI_{t-k} + \sum_{k=0}^{n5} \theta_k \Delta LnCPI_{t-k} + \sum_{k=0}^{n6} \pi_k \, \Delta LnM2_{t-k} + \lambda_1 LnSP_{t-1} + \lambda_2 POS_{t-1} + \lambda_3 NEG_{t-1} + \lambda_4 LnIPI_{t-1} + \lambda_5 LnCPI_{t-1} + \lambda_6 LnM2_{t-1} + \mu_t \quad (3)$$

This study used a monthly time series with the based year of 2010. The variables are Industrial Production Index (IPI), Consumer Price Index (CPI), nominal money supply (M2), and nominal effective exchange rate index (NEER). Increase in NEER accounts for appreciation and decrease in NEER accounts for depreciation of the relative currency. The collected dataset for stock price indices are S&P/TSX Composite, France CAC 40, Frankfurt DAX, FTSE MIB, NIKKEI 225, FTSE 100 and S&P 500 Composite for Canada, France, Germany, Italy, Japan, the United Kingdom and the United States, respectively. A dataset consists of 227 monthly data for each variable for 7 countries are collected which starts from 31-12-1997 to 31-10-2016. In other words, the dataset consists of 1135 observations for all variables per country hence 7945 observations in total. It is worth mentioning that there is no gap or missing date within the selected period across all selected countries. The source for datasets of Production Index (IPI), Consumer Price Index (CPI), nominal money supply (M2) and Stock Price Indices is Thomson Reuters DataStream while the datasets for nominal effective exchange rate is collected online from Bank for International Settlements (BIS).

4. Results and Discussion

The study needs to fulfil the requirements of ARDL before estimating the proposed NARDL models. One of the assumptions of these methods is that variables can be I(0) and I(1) but not I(2). The variables can be either stationary at level or the first difference (Pesaran *et al.*, 2001). The results for the ADF tests for all variables at level and first difference are summarized in the Table 2. The table shows that almost all the variables are not stationary and have a unit root at the level. However, the variables are stationary after first difference. Since there is no I(2) variable in our dataset, the assumption of NARDL model in this regard is fulfilled.

The study proceeds with the application of NARDL where the variables of LEX_POS and LEX_NEG are estimated to check for any nonlinearity in the effects of exchange rate on stock prices in G7 countries. The results of ARDL short run estimation for G7 are shown in Table 3. It can be observed that LEX_POS and LEX_NEG variables are both significant for all countries in explaining both sided effect of exchange rate on stock prices (the effect of increase and the effect of decrease in exchange rates) except for Italy whereby only LEX_POS (increase in the exchange rate) affects the stock prices.

In the short run, exchange rates in all G7 countries were found to have an asymmetric effect on stock prices. Both positive changes and negative changes in exchange rates are found to have short run effects on stock prices in France, Germany, UK and USA. However, only positive changes in exchange rates are found to have short run effects on stock prices in Italy, Japan; while negative changes in exchange rates are found to have short run effects on stock prices in Canada.

Table 2: The results of Augmented Dickey-Fuller test

		Level					First difference				
		LSP	LM2	LIPI	LEX	LCPI	LSP	LM2	LIPI	LEX	LCPI
Canada	Intercept	-1.67 (1)	0.65 (3)	-2.64 (3)	-1.44 (1)	-1.27 (5)	-11.92* (0)	-6.45* (2)	-6.68* (2)	-11.17* (0)	-8.43* (6)
	Intercept & Trend	-2.89 (1)	-2.00 (3)	-2.58 (3)	-1.10 (1)	-2.85 (1)	-11.90* (0)	-6.48* (2)	-6.69* (2)	-11.21* (0)	-8.59* (6)
France	Intercept	-2.47 (1)	-0.80 (6)	-1.29 (3)	-1.85 (2)	-1.72 (1)	-13.19* (0)	-6.35* (5)	-7.76* (2)	-10.20* (1)	-12.35* (0)
	Intercept & Trend	-2.54 (1)	-0.81 (6)	-2.53 (3)	-1.80 (2)	0.44 (1)	-13.17* (0)	-6.39* (5)	-7.75* (2)	-10.21* (1)	-12.54* (0)
Germany	Intercept	-1.15 (0)	0.52 (3)	-1.59 (5)	-1.97 (2)	-0.67 (1)	-13.73* (0)	-5.83* (2)	-5.93* (4)	-10.25* (1)	-20.14* (0)
	Intercept & Trend	-1.89 (0)	-1.88 (3)	-3.17 (5)	-1.89 (2)	-1.76 (1)	-13.71* (0)	-5.89* (2)	-5.91* (4)	-10.27* (1)	-20.11* (0)
Italy	Intercept	-1.56 (4)	-1.14 (6)	-1.61 (5)	-1.99 (2)	-2.44 (2)	-8.39* (2)	-5.33* (6)	-4.29* (4)	-10.27* (1)	-7.14* (1)
	Intercept & Trend	-2.63 (4)	-0.91 (6)	-3.21 (5)	-1.91 (2)	0.83 (2)	-8.35* (2)	-5.47* (6)	-4.28* (4)	-10.30* (1)	-7.68* (1)
Japan	Intercept	-1.81 (1)	1.17 (4)	-3.23* (2)	-2.39 (1)	-1.46 (6)	-13.26* (0)	-9.63* (3)	-8.62* (1)	-7.69* (4)	-5.62* (5)
	Intercept & Trend	-1.80 (1)	-0.49 (2)	-3.33 (2)	-2.40 (1)	-0.93 (6)	-13.30* (0)	-9.72* (3)	-8.60* (1)	-7.71* (4)	-6.04* (5)
UK	Intercept	-1.72 (0)	-3.26* (3)	-0.93 (1)	-0.84 (3)	0.26 (6)	-14.69* (0)	-6.65* (2)	-17.87* (0)	-6.65* (2)	-4.44* (5)
	Intercept & Trend	-1.95 (0)	-0.15 (3)	-2.29 (1)	-2.08 (3)	-1.99 (6)	-14.67* (0)	-7.54* (2)	-17.83* (0)	-6.69* (2)	-4.47* (5)
USA	Intercept	-1.03 (3)	-0.26 (4)	-2.69 (4)	-1.16 (2)	-1.66 (2)	-7.86* (2)	-7.04* (3)	-3.81* (6)	-9.42* (1)	-10.09* (1)
	Intercept & Trend	-1.83 (3)	-2.39 (4)	-3.57 (5)	-0.78 (2)	-1.02 (2)	-7.88* (2)	-7.02* (3)	-3.83* (6)	-9.47* (1)	-10.24* (1)

Notes: The numbers in parentheses represent the length of lag utilized in the ADF test (as determined from the set of AIC to a maximum of 6 lags). Critical value at 5% level for ADF with Intercept is about – 2.87 while the critical value at 5% level for ADF with Intercept and trend is about -3.43. The symbol of * indicates significance at 5%.

Table 3: Cointegrating (short run) for NARDL

Countries	Variables	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Canada	LSP						
ARDL	LEX_POS	0.005 (0.03)					
(1, 0, 6, 4, 1, 0)	LEX_NEG	1.13*** (0.31)	0.98** (0.43)	-0.35 (0.43)	-0.25 (0.43)	1.31*** (0.43)	-0.84*** (0.29)
	LCPI	1.03 (0.78)	1.53* (0.80)	-0.13(0.79)	3.18*** (0.78)		
	LIPI	-0.21 (0.28)					
	LM2	-0.12 (0.85)					
	CointEq(-1)		-0.93 (0.07)				
France	LSP		0.11 (0.07)				
ARDL	LEX_POS	-1.47* (0.87)					
(2, 1, 0, 4, 2, 0)	LEX_NEG	0.20* (0.12)					
	LCPI	-4.01*(0.16)	1.04 (0.18)	3.97* (0.18)	3.81* (0.19)		
	LIPI	0.73*** (0.27)	-0.73*** (0.28)				
	LM2	0.52* (0.27)					
	CointEq(-1)		-1.04*** (0.09)				
Germany	LSP						
ARDL	LEX_POS	0.21* (0.11)					
(1, 0, 1, 0, 0, 6)	LEX_NEG	-2.03** (0.75)					
	LCPI	1.73 (0.30)					
	LIPI	0.48 (0.30)					
	LM2	-1.63** (0.72)	0.55 (0.72)	0.23 (0.74)	0.69 (0.72)	-0.73 (0.72)	-2.19*** (0.71)
	CointEq(-1)		-1.02*** (0.07)				
Italy	LSP	0.12* (0.07)					
ARDL	LEX_POS	-1.91** (0.73)					
(2, 1, 0, 4, 4, 0)	LEX_NEG	0.11 (0.14)					
	LCPI	0.63 (0.32)	-0.97 (0.44)	2.95 (0.33)	4.80** (0.30)		
	LIPI	0.149 (0.33)	-0.7** (0.32)	-0.42 (0.33)	0.47 (0.32)		
	LM2	0.1 (0.26)					
	CointEq(-1)		-1.1*** (0.09)				

Notes: *, ** and *** stands for 10%, 5%, 1% of significance level. The number in parenthesis shows the standard error for the respective coefficient. The selected ARDL model based on automatic lag selection is written after the name of each respective country.

Table 3 *(continued)*

Countries	Variables	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Japan	LSP						
ARDL	LEX_POS	-1.45*** (0.25)	0.55** (0.27)				
(1, 2, 2, 0, 0, 1)	LEX_NEG	-0.13 (0.30)	-0.57* (0.30)				
	LCPI	1.78 (0.57)					
	LIPI	0.49*** (0.15)					
	LM2	0.19 (0.72)					
	CointEq(-1)		-1*** (0.06)				
UK	LSP						
ARDL	LEX_POS	-1.24*** (0.35)	0.59 (0.49)	-0.76 (0.47)	0.8** (0.34)		
(1, 4, 0, 5, 0, 2	LEX_NEG	-0.06* (0.04)					
	LCPI	0.52 (0.72)	-1.26* (0.72)	2.53*** (0.72)	1.19 (0.74)	1.22* (0.73)	
	LIPI	0.69** (0.28)					
	LM2	1.59** (0.61)	1.11* (0.61)				
	CointEq(-1)		-0.98*** (0.07)				
USA	LSP						
ARDL	LEX_POS	-1.86*** (0.45)					
(1, 1, 1, 4, 2, 0)	LEX_NEG	-0.73* (0.44)					
	LCPI	-1.56 (0.14)	-0.15 (0.19)	-0.68 (0.17)	3.33*** (0.04)		
	LIPI	-0.26 (0.43)	-0.92** (0.45)				
	LM2	-0.58 (0.78)					
	CointEq(-1)		-1.05*** (0.07)				

Notes: *, ** and *** stands for 10%, 5%, 1% of significance level. The number in parenthesis shows the standard error for the respective coefficient. The selected ARDL model based on automatic lag selection is written after the name of each respective country.

Above all, it can be stated that exchange rates have asymmetric effects in short run in all countries included in G7 since the coefficients for LEX_POS and LEX_NEG differs in all the countries and at least one of them is significant in all the countries. To find out whether these relationships will continue to long run, the relationship of these variables in the long run are analysed and summarized in Table 4.

Table 4 showed the results of the long run estimation of NARDL for G7. It can be seen that both positive changes and negative changes in exchange rates are found to have long run effects on stock prices in Germany. While negative changes in exchange rates are found to have long run effects on stock prices in France and UK. By comparing short run and long run NARDL, we found asymmetric effect of exchange rates existed in both short run and long run for Germany. The asymmetric effect of exchange rates does not last into long run for other G7 countries.

Table 4: NARDL Long run form for G7

Countries	LEX_POS	LEX_NEG	LCPI	LIPI	LM2	C
Canada	0.005485	0.005059	-5.623***	0.708634*	-0.12754	0.022329**
ARDL	(0.030112)	(0.038383)	(0.805329)	(0.415919)	(0.720802)	(0.008584)
(1, 0, 6, 4, 1, 0)						
France	0.156341	0.19572*	-12.89***	2.108604***	0.496878*	0.022735**
ARDL	(0.103137)	(0.116529)	(0.1669)	(0.582352)	(0.263285)	(0.009833)
(2, 1, 0, 4, 2, 0)						
Germany	0.20758*	0.20715*	1.698403	0.472864	-0.506965	-0.018158*
ARDL	(0.110576)	(0.123194)	(0.273635)	(0.292392)	(0.317898)	(0.010493)
(1, 0, 1, 0, 0, 6)						
Italy	0.061435	0.107853	-7.6578**	1.286489**	0.094814	0.023371*
ARDL	(0.110349)	(0.130603)	(0.686799)	(0.584897)	(0.232627)	(0.012647)
(2, 1, 0, 4, 4, 0)						
Japan	0.022868	0.017053	1.776303	0.49601***	-1.0662	-0.00458
ARDL	(0.033504)	(0.035067)	(0.571878)	(0.158589)	(0.039716)	(0.010218)
(1, 2, 2, 0, 0, 1)						
UK	-0.07109	-0.06643*	-3.88048*	0.697421**	0.886224	0.000118
ARDL	(0.047725)	(0.039498)	(0.225466)	(0.283245)	(0.209923)	(0.011194)
(1, 4, 0, 5, 0, 2)						
USA	-0.014	-0.02208	-4.2226**	1.656985***	-0.55538	0.013064
ARDL	(0.039849)	(0.034042)	(0.821117)	(0.615669)	(0.742623)	(0.009188)
(1, 1, 1, 4, 2, 0)						

Notes: *, ** and *** stands for 10%, 5%, 1% of significance level. The number in parenthesis shows the standard error for the respective coefficient. The selected ARDL model based on automatic lag selection is written after the name of each respective country.

The tests for bounds test, Breusch-Godfrey serial correlation LM test, RESET test as well as stability tests are provided in Table 5. Results from bounds test indicate that cointegration among these variables for all G7 countries in the NARDL model. There is no problem of autocorrelation by checking the LM test applied. Equally important, the results for Ramsey test shows no misspecification in the model except for Canada. The model of Canada had the same issue when applying linear ARDL as well. The same scenario for Ramsey RESET test of NARDL for Canada has been noted in Bahmani-Oskooee and Saha, (2016b). The results of long run Wald test do not support the asymmetric effects of exchange rate changes of France in the long run. The long run Wald test results show that the asymmetric effects exist in all the G7 countries except for France and USA.

Table 6 showed the comparison results on the asymmetrical effects of exchange rates on stock prices for selected countries, namely Canada, Japan, UK and US. Generally our results were very similar to the findings of Bahmani-Oskooee and Saha (2016a) and Bahmani-Oskooee and Saha (2016b). For Canada, we found negative asymmetrical effect in the short-run while Bahmani-Oskooee and Saha (2016b) found positive and negative asymmetrical effects in the short-run; and both fail to find significant asymmetrical effects in the long run. The results of Japan were very similar too. This study found positive and negative asymmetrical effects in the short-run while Bahmani-Oskooee and Saha (2016b) only found positive impact; and both fail to find significant asymmetrical effects in the long run. Bahmani-Oskooee and Saha (2016b) failed to find any significant asymmetrical effect of exchange rates on stock prices for UK in both short run and long run, however this study managed to capture the positive and negative asymmetrical effects in the short-run; and the negative asymmetrical effect last into the long run. For US, this study found positive and negative asymmetrical effects in the short-run, while Bahmani-Oskooee and Saha (2016a) only found positive impact. This study failed to find any significant asymmetrical effects in the long run but Bahmani-Oskooee and Saha (2016a) found positive asymmetrical effect of exchange rates on stock prices.

Table 5: Diagnostics tests for NARDL

G7 members	F (bounds test)	LM test-Prob. chi-square(2)	RESET F-statistics probability	CUSUM (CUSUM^2)	Wald test-short run F-statistic (Probability)	Wald test-long run F-statistic (Probability)
Canada	30.88805	0.1001	0.0057	S (U)	6.40*** (0.0001)	-12.43*** (0.0005)
France	21.26512	0.1234	0.5391	S (U)	3.800037 (0.0526)	3.800037 (0.0526)
Germany	36.39448	0.1827	0.4337	S (U)	3.893882** (0.0219)	5.402303** (0.0211)
Italy	22.36773	0.0828	0.5997	S (S)	2.839156 (0.0608)	4.850585** (0.0288)
Japan	34.92049	0.8182	0.3785	S (S)	13.42415*** (0)	8.335664*** (0.0043)
UK	34.80809	0.3772	0.6446	S (S)	6.978611*** (0.0002)	11.66508*** (0.0008)
USA	44.66293	0.7320	0.3492	S (U)	14.85740*** (0)	2.265889 (0.1338)

Notes: Critical value at 5% level for bounds test is 2.62 for I (0) bound and 3.79 for I (1) bound. For CUSUM and CUSUM^2, S stands for stable and U stands for unstable.

Table 6: Comparison on the asymmetrical effects of exchange rates

	Short run		Long run	
	ΔPOS	ΔNEG	POS	NEG
Canada				
This study	+NS	+/-	+NS	+NS
Bahmani-Oskooee and Saha (2016b)	+	+	+NS	-NS
Japan				
This study	-/+	-	+NS	+NS
Bahmani-Oskooee and Saha (2016b)	-/+	+NS	-NS	+NS
UK				
This study	-/+	-	-NS	-
Bahmani-Oskooee and Saha (2016b)	-/+NS	-NS	+NS	-NS
US				
This study	-	-	-NS	-NS
Bahmani-Oskooee and Saha (2016b)	-	+NS	+	-NS

Notes: NS denotes insignificant.

5. Conclusion and Policy Implications

This paper examines whether there are asymmetric effects of exchange rates on stock prices in G7 countries. The results of NARDL showed that exchange rates in all G7 countries were found to have an asymmetric effect on stock prices in the short sun. However, the asymmetric effect of exchange rates does not last into long run, except for Germany. The results of this study provide some insights for policy makers as well as stock market traders. Based on Bahmani-Oskooee and Saha (2016b), for countries which at least either one of the asymmetric effects lasts into long run, floating exchange rate is recommended. Because any adjustment in exchange rate can have effects on the stock prices of these countries which may not be desirable. For countries such as Italy where negative asymmetrical changes does not affect stock prices in the short-run and long run, policy makers could depreciate the exchange rate to achieve government's aim such as improve export competitiveness without worrying too much reaction to the stock market and investors. For stock market traders, they can strategize to buy or sell stocks according the predicted response of stock market. For example, negative asymmetrical effect of exchange rates affect stock prices of UK in the short-run and long run, therefore if the Pound Sterling is depreciating, traders can predict that stock price will decline.

References

Abouwafia, H. E., & Chambers, M. J. (2015). Monetary policy, exchange rates and stock prices in the Middle East region. *International Review of Financial Analysis*, *37*, 14–28.

Andersen, T. G., Bollerslev, T., Diebold, F. X., & Vega, C. (2007). Real-time price discovery in global stock, bond and foreign exchange markets. *Journal of International Economics*, *73*(2), 251–277.

Andrikopoulos, A., Angelidis, T., & Skintzi, V. (2014) Illiquidity, return and risk in G7 stock markets: Interdependencies and spillovers. *International Review of Financial Analysis, 35*, 118–127.

Arslan, M., & Zaman, R. (2014). Impact of dividend yield and price earnings ratio on stock returns: A study non-financial listed firms of Pakistan. *Research Journal of Finance and Accounting, 5*(19), 2222–2847.

Bahmani-Oskooee, M., & Saha, S. (2015). On the relation between stock prices and exchange rates: A review article. *Journal of Economic Studies, 42*(4), 707–732.

Bahmani-Oskooee, M., & Saha, S. (2016a). Asymmetry cointegration between the value of the dollar and sectoral stock indices in the U.S. *International Review of Economics & Finance, 46*, 78–86.

Bahmani-Oskooee, M., & Saha, S. (2016b). Do exchange rate changes have symmetric or asymmetric effects on stock prices? *Global Finance Journal, 31,* 57-72.

Basistha, A., & Kurov, A. (2008). Macroeconomic cycles and the stock market's reaction to monetary policy. *Journal of Banking and Finance*, *32*(12), 2606–2616.

Bracke, T., Skala, M., & Thimann, C. (2008). *Thirty years of exchange rate communication: How, when and why does the G7 speak?* Mimeo, European Central Bank. Retrieved from http://www.martinskala.de/G7_exchange_rate_communication.pdf

Cai, Y., Chou, R. Y., & Li, D. (2009). Explaining international stock correlations with CPI fluctuations and market volatility. *Journal of Banking and Finance, 33*(11), 2026–2035.

Chandra Padhan, P. (2007). The nexus between stock market and economic activity: An empirical analysis for India. *International Journal of Social Economics, 34*(10), 741–753.

Chkili, W., & Nguyen, D. K. (2014). Exchange rate movements and stock market returns in a regime-switching environment: Evidence for BRICS countries. *Research in International Business and Finance, 31,* 46–56.

Chung, T. F., & Ariff, M. (2016). A test of the linkage among money supply, liquidity and share prices in Asia. *Japan and the World Economy,* 39, 48–61.

Cuestas, J. C., & Tang, B. (2015). *Asymmetric exchange rate exposure of stock returns: Empirical evidence from Chinese industries* (SERPS No. 2015021). Retrieved from University of Sheffield website: https://www.sheffield.ac.uk/economics/research/serps/articles/2015_021

Demian, C.-V. & di Mauro, F. (2015). *The exchange rate, asymmetric shocks and asymmetric distributions* (ECB Working Paper No. 1801). Retrieved from European Central Bank website: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1801.en.pdf?8830c306be5cbebfd1990e2ad1140 92a

Diamandis, P. F., & Drakos, A. A. (2011). Financial liberalization, exchange rates and stock prices: Exogenous shocks in four Latin America countries. *Journal of Policy Modeling*, *33*(3), 381–394.
Fratzscher, M. (2008). *How successful is the G7 in managing exchange rates ?* (ECB Working Paper No. 952). Retrieved from European Central Bank website: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp952.pdf?459810ae03292409d45f41d619dea089
Friedman, M., & Schwartz, A. J. (1963). Money and business cycles. *The Review of Economics and Statistics (Supplement), 45*(1), 32-64.
Geetha, C., Mohidin, R., Chandran, V., & Chong, V. (2011). The relationship between inflation and stock market: Evidence from Malaysia, United States and China. *International Journal of Economics and Management Sciences*, *1*(2), 1–16.
Groenewold, N., & Paterson, J. E. H. (2013). Stock prices and exchange rates in Australia: Are commodity prices the missing link? *Australian Economic Papers*, *52*(3–4), 159–170.
Hu, L., Sha, Z. J., Liu, X. Y., & Chen, W. J. (2013). An empirical study on the overreaction of Shanghai Stock Market. *Chinese Studies*, *2*(1), 32–35.
Jain, A., & Biswal, P. C. (2016). Dynamic linkages among oil price, gold price, exchange rate, and stock market in India. *Resources Policy, 49*, 179–185.
Janor, H., Halid, N., & Abdul Rahman, A. (2005).Stock market and economic activity in Malaysia. *Investment Management and Financial Innovations*, *2*(4), 116–123.
Jiranyakul, K. (2012). Linkages between Thai stock and foreign exchange markets under the floating regime. *Journal of Financial Economic Policy, 4*(4), 305-319.
Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive Models. *Econometrica*, *59*(6), 1551–1580.
Kal, S. H., Arslaner, F., & Arslaner, N. (2015). The dynamic relationship between stock, bond and foreign exchange markets. *Economic Systems*, *39*(4), 592–607.
Kubo, A. (2012). The US tech pulse, stock prices, and exchange rate dynamics: Evidence from Asian developing countries. *Journal of Asian Economics*, *23*(6), 680–687.
Lee, Y. M., & Wang, K. M. (2015). Dynamic heterogeneous panel analysis of the correlation between stock prices and exchange rates. *Economic Research-Ekonomska Istraživanja*. 28(1), 749–772.
Lin, C.-H. (2012). The comovement between exchange rates and stock prices in the Asian emerging markets. *International Review of Economics and Finance, 22*(1), 161-172.
Litsios, I. (2013). Exchange rate determination and equity prices: Evidence from the UK. *The Journal of Economic Asymmetries*, *10*(2), 115–128.
Matsubayashi, Y. (2011). Exchange rate, expected profit and capital stock adjustment: Japanese experience. *The Japanese Economic Review*, *62*(2), 215–247.
Moore, T., & Wang, P. (2014). Dynamic linkage between real exchange rates and stock prices: Evidence from developed and emerging Asian markets. *International Review of Economics & Finance, 29,* 1–11.
Pesaran, M. H. & Shin, Y. (1995). An autoregressive distributed lag modeling approach to co-integration analysis. In S. Strom, A. Holly, & P. Diamond (Eds.), *Centennial Volume of Rangar Frisch*. Cambridge, MA: Cambridge University Press.
Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289–326.
Reboredo, J. C., Rivera-Castro, M. A., & Ugolini, A. (2016). Downside and upside risk spillovers between exchange rates and stock prices. *Journal of Banking & Finance*, *62*, 76–96.
Sensoy, A., & Sobaci, C. (2014). Effects of volatility shocks on the dynamic linkages between exchange rate, interest rate and the stock market: The case of Turkey. *Economic Modelling*, *43*, 448–457.
Shin, Y., Yu, B. & Greenwood-Nimmo, M. (2014). Modeling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In R.C. Sickles & W.C. Horrace (Eds), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications* (pp. 281-314). New York, NY: Springer.
Sui, L., & Sun, L. (2016). Spillover effects between exchange rates and stock prices: Evidence from BRICS around the recent global financial crisis. *Research in International Business and Finance*, *36*, 459–471.
Tsagkanos, A., & Siriopoulos, C. (2013). A long-run relationship between stock price index and exchange rate: A structural nonparametric cointegrating regression approach. *Journal of International Financial Markets, Institutions and Money*, *25*, 106–118.

Tsai, I.-C. (2012). The relationship between stock price index and exchange rate in Asian markets: A quantile regression approach. *Journal of International Financial Markets, Institutions and Money*, *22*(3), 609–621.

Walker, A. (2003, September 24). IMF attacks G7 over exchange rates. *BBC,* Retrieved from http://news.bbc.co.uk/2/hi/business/3136198.stm

Wong, H. T., Lee, H. A., & Abd. Rahim, D. A. (2018). Real exchange rate return and real stock price returns: An investigation on the stock market of Malaysia. *International Journal of Economics and Management, 12*(2), 421-442.

Yang, S.-Y., & Doong, S.-C. (2004). Price and volatility spillovers between stock prices and exchange rates: Empirical evidence from the G-7 countries. *International Journal of Business and Economics*, *3*(2), 139–153.

Zare, R., & Azali, M. (2015). The association between aggregated and disaggregated stock prices with monetary policy using asymmetric cointegration and error-correction modeling approaches. *Review of Development Finance*, *5*(1), 64–69.

Zhao, H. (2010). Dynamic relationship between exchange rate and stock price: Evidence from China. *Research in International Business and Finance*, *24*(2), 103–112.