International Review of Economics and Finance 74 (2021) 138–149

Contents lists available at ScienceDirect

International Review of Economics and Finance

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

The behavior of exchange rate and stock returns in high and low interest rate environments

Afees A. Salisu[a,b,*], Xuan Vinh Vo[b,c]

[a] Centre for Econometric & Allied Research, University of Ibadan, Ibadan, Nigeria
[b] Institute of Business Research, University of Economics Ho Chi Minh City, Viet Nam
[c] Institute of Business Research and CFVG Ho Chi Minh City, University of Economics Ho Chi Minh City, Viet Nam

ARTICLE INFO

JEL classification:
F31
G12
E43
E52
D82

Keywords:
Exchange rate
Stocks returns
Interest rate environment
Asymmetry
Panel data methods

ABSTRACT

In this paper, we contribute to the literature in the following ways. First, we test whether stock returns respond differently to exchange rates in high and low interest rate environments. Second, we further probe into possible asymmetric effects of appreciation and depreciation on stock returns. Third, we examine the role of extreme (negative) low interest rate in the nexus among the low interest rate economies. Using panel data procedures that account for the salient features of the relevant variables, the following are discernible from the analyses. First, we establish contrasting evidence between low and high interest rate environments in relation to short run & long run results. Second, we find that the low interest rate group exhibits long run positive nexus while the high interest rate counterpart predominantly reveals short run negative nexus. Third, we show that all these outcomes remain true whether or not we account for the roles of macroeconomic factors including interest rate, inflation, and global oil price and alternative data frequency. Some insightful implications of our findings are highlighted and we do hope that investors and policy makers will find the results useful for decision making purpose.

1. The motivation

In this paper, our goal is to distinctively scrutinize the relationship between exchange rate and stock returns in high and low interest rate environments. The connection between exchange rate and stock returns is well established in theory. This relation is rooted in the Portfolio Balance Theory (PBT). The PBT postulates negative relationship as a result of actions of investors seeking international portfolio diversification benefits from lower to higher stock returns countries, whereby exchange rate appreciation is indicative of lower stock returns and the reverse (exchange rate depreciation) suggestive of higher yielding stocks (see Black, 1973; Boyer, 1977; Branson et al., 1977; Branson & Halttunen, 1979; Allen & Kenen, 1980; Branson & Henderson, 1985). Empirical evidence for the nexus abounds in the literature (see for example, Al-Shboul & Anwar, 2014; Aydemir & Demirhan, 2009; Dunne et al., 2010; Khan & Abbas, 2015; Leung et al., 2017; Litsios, 2013; Moore & Wang, 2014; Pavlova & Roberto, 2007; Raza et al., 2016; Sensoy & Sobaci, 2014; Živkov et al., 2016). Further evidence have also explored and established asymmetry in the relationship (see for example, Ali et al., 2015; Bahmani-Oskooee & Saha, 2016a; Chkili & Nguyen, 2014; Hsu et al., 2009; Koutmos & Martin, 2007; Naifar & Al Dohaiman, 2013; Salisu & Ndako, 2018; Walid et al., 2011) to suggest extensive discussions on the subject matter.

This paper differs in its objectives from the aforementioned studies as it seeks to understand the behavior of exchange rate and stock

* Corresponding author. Centre for Econometric & Allied Research, University of Ibadan, Ibadan, Nigeria.
E-mail addresses: aa.salisu@cear.org.ng (A.A. Salisu), vinhvx@ueh.edu.vn (X.V. Vo).

https://doi.org/10.1016/j.iref.2021.02.008
Received 9 April 2020; Received in revised form 6 February 2021; Accepted 10 February 2021
Available online 17 February 2021
1059-0560/

returns under high and low interest rates. This distinct analysis is partly due to the role of macroeconomic fundamentals in influencing the exchange rate – stock returns nexus which include changes in interest rates, inflation and global oil price that impact the investment structure of firms (and hence, stocks fundamentals) through capital flows (see Dahir et al., 2018; Wong, 2017). Two, the increased adoption of interest rate rule, in place of monetary base, for monetary policy reflects the willingness of monetary authorities to use interest rate to influence foreign exchange markets whether purposely (see Andries et al., 2017; Ince et al., 2016) or accidently in reaction to inflation dynamics and output gap in the economy (Engel et al., 2008; Molodtsova & Papell, 2009; Taylor, 1993). Three and most pertinent is that the policy of low interest rate is now fashionable among advanced economies who use it to mitigate global financial crisis that have been shown to impact the global financial markets (including stocks and currency markets), with implications for the conduct of monetary policies in such economies (see Akram & Li, 2017; Baars et al., 2020; Dotsis, 2020; Rogoff, 2017).

The contribution of this study is to demonstrate that dissimilarities in the stock returns and exchange rate nexus in high and low interest rate environments is a reality. To begin with, why should we suspect such distinct reactions? Theoretically, we reason that in low interest rate environment where the low interest rate is policy induced rather than indicative of low economic downturns, domestic investment is expected to increase. This is because the presence of low-bound discourages investment delay when interest rate volatility rises as opposed to high interest rate environment where the same condition encourages waiting and reduces investment (see Aramonte et al., 2019; Black, 1995; Dotsis, 2020). A more salient justification to conduct distinct analysis can be inferred from the difference in the nexus between interest and exchange rates between emerging and advanced economies (see Andries et al., 2017; Cociuba et al., 2016) where the latter represent low interest rate environment. This classification is not arbitrary. A number of recent studies appear to favor the choice of advanced industrialized economies including the United States, Japan, and European countries as the low interest rate environment while emerging economies may constitute the high interest rate group (see for example, Brei et al., 2020; Fleissig & Swofford, 2020; Gambacorta & Borio, 2017; Hanzlík & Teplý, 2020; Inagaki, 2009; Lecznar & Lubik, 2018; Pavasuthipaisit, 2009).

With the preceding theoretical discussions, we seek global evidence between nine industrialized economies whose interest rates are generally shown to fall significantly below the threshold for low interest rate environment as found in Claessens et al. (2016), Gambacorta and Borio (2017) and Brei et al. (2020) and nine selected emerging economies that sufficiently lie above the 1.25% threshold to qualify among the high interest rate environment (see also Ammer et al., 2019; Bilman & Karaoglan, 2020). We provide details of the countries constituting the low and high interest rate environments in the section on data description.[1] In the final analysis, we obtain results that support the need for distinct treatment of the two group of economies. We find that the relationship between exchange rate and stock returns differs between the countries in high and low interest rate environments in both the short and long run. We plan the study in subsequent sections as follows. Section 2 provides theory and evidence to support the motivation. Section 3 presents the methodology, Section 4 implements the methodology and discusses the findings while Section 5 concludes.

2. Theory and evidence

In this section, we provide further theoretical and empirical evidences to situate the study. The major contribution of the paper lies in probing the exchange rate – stocks returns nexus among more advanced countries with low interest rate environment and emerging economies with widespread higher interest rate situations. The theoretical basis rests on the Shadow-Rate Model of interest rate dynamics (see Black, 1995 and further augmented by Dotsis, 2020). The theory demonstrates the distinction between the low and high interest rate situations on firms' investments and possible implications for profitability and stocks performance. In periods of low interest rate, when interest rate volatility rises, the presence of low interest rate bound minimizes the cost of waiting to encourage firms' investment in projects with positive net present values, rather than further delaying which is obtainable when interest rates are high. Hence, we can expect domestic investment to rise in low interest rate environments especially when the low interest rate is policy-induced and not indicative of low economic downturns. In these situations, risk perceptions among firms are low due to higher risk tolerance as the search for yield increase among investors. Also, financial institutions increase investment in risky assets because they are more attractive when policy rates are low (Borio & Zhu, 2012; Cociuba et al., 2016; Chaudron, 2018).

The foregoing in the context of the Portfolio Balance Theory indicates that with the intervening roles of macro variables and the state of interest rate, better performance of firms in the low interest rate setting compared with high interest rate situation suggest currency appreciation (i.e. exchange rate depreciation) in the former and the possibility of the reverse in the latter. In this context, the quantification of firms' exchange rate exposure is instructive to reveal the extent to which firms' valuation (of projected cash flows) respond to exchange rate movements (Ziivkov et al., 2015). The connection is such that exchange rate appreciation (exchange rate depreciation) reduces (increases) demand for domestic stocks and the valuation of stocks, suggesting a negative nexus between exchange rate and stock returns.

There is no subsisting empirical evidence on the nexus for countries in low and high interest rate environments. Available evidence on the connection between the two financial markets are instructive for the present study. The findings of Pan et al. (2007) corroborates our position that the nexus between foreign exchange and stocks market fundamentals are not the same across countries but could depend on the exchange rate regime, degree of financial openness and the size of the stocks market. Walid et al. (2011) and Kodongo and Ojah (2012) find that the relationship is regime-dependent (or time-varying) and therefore nonlinear in nature. Inci and Lee (2014) show that the relationship between stock returns and exchange rate movements is stronger during periods of recession than expansion. Lin (2012) also find, among emerging economies in Asia that the relationship is stronger in crisis periods than in calm periods. Sui and Sun (2016) and Dahir et al. (2018) also conclude that periods of financial crisis boosts the co-movement between exchange rates and

[1] We are grateful to the anonymous reviewers for pointing us to these insights.

stock returns. In the same vein, Tsai (2012) shows that the nexus between currency and stock markets is more evident in periods of very high or low exchange rates. Going forward on the contribution of the present paper, the empirical evidences to consider the interest rate environments rely on previous findings that link interest rate or the influence of monetary policy rate in driving the two financial markets via the investment or exchange rate channels (Ammer et al., 2019; Baars et al., 2020; Ganzach & Wohl, 2018; Kubo, 2012; Lian et al., 2019; Moore & Wang, 2014). We build on these evidences to pursue the goal of this study as motivated.

3. Data and preliminary analyses

The scope of the data for high and low interest rates environments as sourced largely from Federal Reserve (FRED) website, cover five hundred and thirteen (513) weeks – from January 9, 2011 to November 1, 2020. For robustness and the need to include additional variables (such as interest rate and inflation computed from consumer price indices that are not available over weekly data frequency), we also adopt monthly data frequency covering 129 months between January 2010 and September 2020 as instructed by data availability. Based on our discussions in the introduction, the country scope include clear distinction of countries into low and high interest rates environments as indicated by contrasts in the short term interest rate series for the two groups of countries (See comparison of parts 1&2 of Panel A & Panel B of Table 1). In addition, the interest rate figures differ markedly in the two categories of countries; 0.91 against 6.99 in the low and high interest rate categories respectively. The high interest rate environment comprise nine emerging economies: Brazil, China, Colombia, India, Indonesia, Mexico, Russia, South Africa and Turkey. On the other hand, the low interest rate environment are sampled from advanced industrialized countries, namely: Canada, Denmark, Israel, Japan, South Korea, Poland, Sweden, and UK. These are eight countries. In the analyses involving monthly data frequency, we include the Euro area as a unit among the low interest rate group.

The major data for the study are exchange rates and the all-share stock indices for the countries. Both are computed as returns (logged differences) of the price series. The exchange rates are the domestic currencies to the US dollar for the countries which are in most cases categorized as free floaters or managed floaters given significant variability of the exchange rate series as reflected in the standard deviation figures (Dąbrowski et al., 2020 provide justification for the choice of US as the reference country for exchange rates especially of managed floaters otherwise described as "under pressure"). The stock prices are captured as all-share stock indices for the

Table 1
Descriptive statistics.

A: Country-specific sample									
1./Low interest rate environment (1/09/2011–11/01/2020)									
	Canada	Denmark	Israel	Japan	Korea	Poland	Sweden	UK	
s_t	0.0371	0.2480	0.0347	0.2004	0.0327	0.0412	0.1008	−0.0037	
	(2.0409)	(2.2774)	(2.3282)	(2.6216)	(2.4393)	(2.4303)	(2.6083)	(2.2524)	
e_t	0.0564	0.0221	−0.0104	0.0460	0.0013	0.0523	0.0513	0.0349	
	(0.8470)	(0.9325)	(0.9888)	(1.0307)	(0.9110)	(1.6218)	(1.1310)	(1.0605)	
NOBS	513	513	513	513	513	513	513	513	
r_t	1.1534	0.2271	0.9495	0.1738	2.1827	2.6035	0.1782	0.6237	
	(0.4307)	(0.6143)	(1.0570)	(0.1323)	(0.7801)	(1.3098)	(0.8243)	(0.2058)	
NOBS	129	129	129	129	129	129	129	129	
2./High interest rate environment (1/09/2011–11/01/2020)									
	Brazil	China	Colombia	India	Indonesia	Mexico	Russia	South Africa	Turkey
s_t	0.1013	0.1104	−0.0833	0.1557	0.0785	0.0096	0.0272	0.1120	0.3329
	(3.2232)	(3.1006)	(2.7682)	(2.3246)	(2.3094)	(2.3414)	(2.8099)	(2.3608)	(3.0024)
e_t	0.2399	0.0030	0.1343	0.0972	0.0878	0.1066	0.1851	0.1724	0.3324
	(1.7350)	(0.3882)	(1.7309)	(0.8272)	(1.0194)	(1.4198)	(2.1273)	(1.786662)	(2.0378)
NOBS	513	513	513	513	513	513	513	513	513
r_t	9.6293	3.0506	4.7415	7.1228	6.4945	4.9463	8.3527	6.1923	12.4689
	(3.2185)	(0.1860)	(0.9974)	(1.4526)	(1.1444)	(1.7250)	(3.0399)	(0.9610)	(3.5674)
NOBS	129	129	129	129	129	129	129	129	129
B: Group/panel sample									
Low interest rate environment					High interest rate environment				
	Mean (SD)	N	T	Obs.		Mean (SD)	N	T	Obs.
s_t	0.0008	8	513	4104	s_t	0.0009	9	513	4617
	(0.0238)					(0.0271)			
e_t	0.0003	8	513	4104	e_t	0.0015	9	513	4617
	(0.0108)					(0.0155)			
r_t	0.9158	9	129	1161	r_t	6.9999	9	129	1161
	(1.1446)					(3.4147)			

Note: (1) s_t, e_t and r_t denote stock returns, exchange rate returns and interest rate respectively; where the return series are computed as $100^* \Delta \log(pt)$ and p_t is the price level series such as stock price and exchange rate. (2) The values outside and inside the parentheses represent the mean and standard deviation respectively. (3) In the country-specific analysis, interest rates are measured in monthly frequency as opposed to stock prices and exchange rate that are available in weekly data frequencies. (4) N and T denote number of cross-sections and periods while NOBS is the total number of observations obtained as N*T.

respective countries as available in weekly frequency on https://www.investing.com/and as "Total Share Prices for All Shares" for the countries as available in monthly data frequency on FRED website. The need to extend the analyses necessitates the inclusion of West Texas Intermediate (WTI) global oil price, the cross country short term interest rates (treasury bills rates) and inflation rates. We control for inflation by comparing findings for the inclusion or otherwise of inflation in the nexus as a form of robustness. This proves necessary given the findings that show the statistical significance of coefficient of inflation series in the predictive model and an attempt to prove further a group of literature that have shown that the relationship may remain the same for both nominal and real variables (see Huang et al., 2016; Wong, 2017).

We describe the statistical features, both the mean and standard deviation of the variables considered under the country-specific and panel samples as presented in Table 1. Following the results presented in the table, the average stock return is highest in Denmark and Japan with the average returns of 0.25, 0.20 respectively, and the least being the UK (−0.004) in the panel of low interest rate. In the high interest rate environment, Turkey (0.33) and India (0.16) are among the best performers while Colombia is the least (−0.08). These statistics appear to be in tandem with the CNN Business Report (2015) of "Best performing global markets".[2] The report of 74 stock markets worldwide shows that the best two markets in the low interest rate group (Denmark and Japan) are ranked 4th and 11th respectively with the UK and Colombia presented as sluggish, ranking 51st and 74th respectively in the report. The United States stock market is ranked 47th followed by Canada in 48th position among the 74 countries considered. On the exchange rate returns, only the Israeli shekel show appreciation against the US dollar during the period of analysis with an average of −0.01. The Canadian dollar (0.056), Polish zloty (0.052), Swedish krona (0.051) among the low interest rate and Turkish lira (0.33), Brazilian real (0.23), and Russian ruble (0.18) among the high interest rate environment show the biggest depreciations against the US dollar over the sample period.

4. Methodology and results

This section is structured into a number of sub-sections based on the research objectives/questions of the study. Consequently, for ease of analysis and to facilitate the comprehension of our results, we present the methodological approaches for the research objectives under relevant sub-sections and the results obtained from the estimation process are discussed accordingly. Essentially, four research objectives are pursued and the first of them constitutes the main objective. The first objective addressees the question whether exchange rate influences stock returns of high and low interest rate environments differently. The main analysis involves weekly frequency that allows us to further take care of the role of global business dynamics represented by global crude oil price. Second, we test whether the results are not sensitive to data frequency using monthly data frequency for robustness check. The choice of monthly data frequency allows us to account for the role of inflation in the nexus, which would have been elusive if the analysis was limited to weekly data frequency. The third objective evaluates whether appreciation and depreciation of the same magnitude will have differential effects on stock returns. Further, we examine an extreme case for the low interest rate environment where interest rate is negative. The idea is to test whether this extreme point has any implication on exchange rate-stock returns nexus. Let us take each in turn.

4.1. Does exchange rate influence stock returns differently in high and low interest environments?

Following the Portfolio Rebalancing Theory of Hau and Rey (2006) [3] as previously espoused in this paper, we formulate a Panel Autoregressive Distributed Lag (PARDL) model which has a number of attractions. First, it allows for long time series dimension (T) which is one of the features of our data.[4] Second, due to long T, one should suspect nonstationarity. Like the time series ARDL, the panel variant also accommodates mixed order of stationarity (precisely, I(0) and I(1)) and reduces to long run model if the series are strictly I(0) and short run model if they are strictly I(I) with no evidence of cointegration. In other words, both long run and short run estimates can be determined from the Panel ARDL model even in the presence of mixed order of integration. Third, the model allows for heterogeneity in the regression coefficients both in the long and short run including the cointegration equations using the Mean Group estimator.[5] Fourth, any inherent endogeneity bias in the model possibly arising from reverse causality between the two variables in focus is resolved in the estimation.[6] This approach has been used in the literature to evaluate economic relationships (see for oil-stock

[2] See the link to the report: https://money.cnn.com/interactive/investing/best-performing-global-markets/.

[3] This theory was originally formulated by Dornbusch and Fischer (1980), Branson (1983) and Frankel (1983) and assumes that causality can run either way. While this reverse causality can easily be captured in the estimation process, the relationship between the two series can be either positive or negative depending on whether we are looking at it from the perspective of macroeconomic stability or trade competitiveness.

[4] The asymptotic distribution of the Panel ARDL is based on the sequential-limit theory, in which T is taken to infinity before N is. This implies that the model may be justified in cases where T is substantially larger than N which is the case in this paper (Westerlund, 2007; see also; Salisu & Ndako, 2018).

[5] There are other alternative estimators for Panel ARDL such as Pooled Mean Group estimator and Dynamic Fixed Effects estimator which impose some restrictions on the coefficients. For instance, the Pooled Mean Group estimator assumes that the long run coefficients as constrained to be equal for all the cross-sections while the short run coefficients are allowed to vary. A more extreme case is the Dynamic Fixed Effects estimator where only the intercepts are allowed to vary across units while their slope coefficients are assumed to be identical both in the long run and short run. Perhaps, the restrictions on the other estimators (PMG and DFE) is responsible for the results of the PMG unable to converge and thus limit the study to the use of MG estimator and prevent the use of Hausman test for model selection.

[6] A good example is documented in the recent study of Salisu and Ndako (2018) where the model construct expresses exchange rate as a function of stock returns which is a reverse of the subject in focus. The underlying intuition behind resolving endogeneity bias this way in finance is well formalized in Lewellen (2004) with further extensions by Westerlund and Narayan (2012, 2015).

nexus - Salisu & Isah, 2017; Swaray & Salisu, 2018; for oil-inflation nexus - Salisu et al., 2017; for stock-exchange rate nexus – Salisu & Ndako, 2018).

Drawing from previous arguments, the mathematical representation of a bivariate Panel ARDL model for the exchange rate-stock returns nexus is given below:

$$\Delta s_{it} = \rho_i (s_{i,t-1} - \varphi_{0i} - \varphi_{1i} e_{i,t-1}) + \sum_{j=1}^{p} \lambda_{ij} \Delta s_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij} \Delta e_{i,t-j} + \mu_i + \upsilon_{it} \tag{1}$$

$$i = 1, 2, \ldots, N; \quad t = 1, 2, \ldots, T.$$

where s_{it} is the stock returns; e_{it} is the exchange rate return both of which are computed as log return; μ_i country-specific effects; while υ_{it} is the stochastic disturbance. Also, Δ is the first difference operator; φ_i and γ_{ij} measure the long run and short-run reactions of stock returns to exchange rate returns respectively; ρ_i is a measure of long run equilibrium in the model and it is also described as the speed of adjustment in the system which corrects for deviations of short-run dynamics from the long-run equilibrium.[7]

Technical evaluation of the results begin with the behavior of the ρ_i, the speed of adjustment also known as the coefficient of error correction term. In absolute value, it measures the proportion of short run deviations to the system adjusted for weekly or monthly (as the case may be) to achieve long run equilibrium. In all the estimations presented across Table 2 through 6, the coefficient of error correction term behaved in support of the norm expected as conditions for Cointegration to exist where the coefficient of ECT(-1) is negative, less than one (in absolute value) and statistically significant. This good behavior is established across all specifications and variations considered, indicating that the system can absorb shocks and that long run equilibrium can be reached after correcting for short term deviations. On the basis of the consistency of the error correction term, we proceed with the discussion of findings.

Theoretically, the expected sign between the two series can be either positive or negative as explained. This depends on whether we are analyzing the issue from the perspective of macroeconomic stability or trade competitiveness. Although, the former is widely supported in finance based on the Capital Asset Pricing Model and the Arbitrage Pricing Model which prominently argue for the role of systemic risk or macroeconomic risk in the valuation of stock prices and thus we lean more towards this assumption. It can be negative in which case countries with the most prospect in the foreign exchange market may be more likely to attract investors seeking to invest in their stock exchanges in order to maximize investment returns than those with weakly performed currencies in the foreign exchange market. It can also be positive if exchange rate of a home country depreciates; this enhances trade competitiveness which increase scales of operation, output, profits, and by extension stock returns, where stock return is defined as the net present value of the future cash flow of a company (Salisu & Oloko, 2015a). Thus, both signs are theoretically plausible and can be explained.

In Table 2, we report the results of the nexus between exchange rate and stock returns for the two panels where the panel units are each characterized as low interest rate and high interest rate situations. In addition, the short run and long run results are presented with and without the inclusion of oil price as an intervening variable in the predictive model to reveal whether oil price has a role to play in the nexus. We report significant differences in the responses of stocks returns of low and high interest rate environments to exchange rate movements across short and long time horizons. Our results clearly show the negative nexus between stock returns and exchange rate for both low and high interest rate group in the short run, which is only statistically significant for the high interest rate group consisting of fast-growing emerging economies. Conversely, positive responses are reported for the two groups of countries in the long run but this is consistently statistically significant in the low interest rate group of industrialized countries. This distinction is shown irrespective of whether the underlying model accounts for the intervening role of global oil price rate or ignores it.

In whole, although bearing negligible incidences of statistical insignificance, we validate the negative relationship as proposed in the Portfolio Balance Theory for the short run. The implication of this result aligns with ideas put forward in the extant literature that investors in their drive for optimal returns seek high-yielding stocks where exchange rates are stronger, and vice versa.[8] The short run relationships are found to be stronger in high interest rate environments than in low interest rate environments, before and after accounting for the role of intervening variable in the model. This finding appears to be in consonance with studies such as Lin (2012), Inci and Lee (2014), Sui and Sun (2016), and Dahir et al. (2018) which show that the nexus between stock returns and exchange rate movements is stronger during uncertainty, a condition that often characterize emerging economies. The long run positive relationship which appear more prominent for the more advanced economies also follow our previous theoretical discussion.[9] In this case, investors are presented with better opportunity to earn more returns on investment in stronger economies given consistent currency appreciations that enhance trade competitiveness among the comity of nations. We dig further into the nexus in the next sub-sections.

[7] The underlying asymptotic distribution of Panel ARDL and other relevant technical details are provided in Blackburne and Frank (2007).

[8] See for example, Black (1973), Boyer (1977); Branson et al. (1977), Branson and Halttunen (1979), Allen and Kenen (1980), Branson and Henderson (1985).

[9] The differences in the magnitudes of the long run exchange rate between low and high interest rate environments and between the models with and without oil price may not be associated with the Panel ARDL technique adopted. We may attribute such differences to the sharp distinctions between the two groups of countries characterized by distinct exchange rate regimes, degrees of financial openness, financial market sizes, and other market conditions (see Dahir et al., 2018; Inci & Lee, 2014; Pan et al., 2007; Sui & Sun, 2016; Walid et al., 2011).

Table 2
Exchange rate-stock returns nexus for both baseline & extended models.

VARIABLES	Baseline		With oil price	
	Low	High	Low	High
Short run				
ECT(-1)	−0.0203***	−0.0248***	−0.0229***	−0.0281***
	(0.00436)	(0.00638)	(0.00420)	(0.00689)
EXR	−0.0392	−0.376***	−0.0252	−0.391***
	(0.128)	(0.133)	(0.127)	(0.132)
WTI			−0.000523	−0.00748***
			(0.00308)	(0.00260)
Long run				
EXR	1.669***	1.063*	0.665**	0.846***
	(0.610)	(0.588)	(0.258)	(0.329)
WTI			−0.345**	0.136
			(0.139)	(0.207)
Constant	0.0838	0.166***	0.151***	0.182***
	(0.0660)	(0.0595)	(0.0547)	(0.0597)
N	8	9	8	9
T	512	512	512	512
Obs.	4096	4608	4096	4608

Note: Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. ECT = error correction term; N = Number of cross-sections; T = Time dimension; EXR = exchange rate; WTI = oil price; Low and High denote Low and High interest rate environments respectively; Obs. = Total number of observations.

Table 3
Exchange rate-stock returns nexus for monthly frequency.

VARIABLES	Baseline		With oil price	
	Low	High	Low	High
Short run				
ECT(-1)	−0.0626***	−0.0509***	−0.0602***	−0.0623***
	(0.00615)	(0.00859)	(0.00835)	(0.0146)
EXR	−0.303	−0.828***	−0.102	−0.683***
	(0.250)	(0.122)	(0.227)	(0.127)
WTI			0.128***	0.105***
			(0.00926)	(0.0140)
Long run				
EXR	1.322***	0.167	1.845***	0.527
	(0.369)	(0.494)	(0.591)	(0.470)
WTI			0.153*	0.121
			(0.0825)	(0.163)
Constant	0.141*	0.220***	0.192	0.166
	(0.0810)	(0.0701)	(0.124)	(0.106)
N	9	9	9	9
T	128	128	128	128
Obs.	1152	1152	1152	1152

Note: Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. ECT = error correction term; N = Number of cross-sections; T = Time dimension; EXR = exchange rate; WTI = oil price; Low and High denote Low and High interest rate environments respectively; Obs. = Total number of observations.

4.2. Are the estimates sensitive to data frequency?

We evaluate the confidence reposed in the findings before proceeding to other estimations to achieve further objectives of the study using alternative data frequency. The motivation for this consideration is drawn from the studies of Narayan and Liu (2015), Narayan and Sharma (2015), Salisu and Adeleke (2016) and Salisu et al. (2016) indicating that the nature of data frequency may matter in empirical analyses. Thus, the previous analyses are replicated for monthly data frequency and the results are presented in Table 3 and the consideration of the role of inflation in Table 4. Interestingly, the results of the nexus between exchange rate and stock returns are largely identical. The distinction between the low and high interest rate environments where the negative relationship between stocks returns and exchange rate exists only in the short and the positive nexus is obtained in the long run are upheld. Also, the result indicates that the industrialized countries characterized as low interest rate environment present consistent exchange rate depreciations to make them the more competitive investment destinations with better returns on investment. Hence, these results have now put the earlier findings into proper perspective. The previous studies indicate that the nexus between interest and exchange rates could differ between emerging and advanced economies given the interest rate diversity (see Ammer et al., 2019; Andries et al., 2017; Bilman & Karaoglan, 2020; Cociuba et al., 2016).

Table 4
Accounting for the role of inflation in the nexus.

VARIABLES	Low		High	
	Without inflation	With inflation	Without inflation	With inflation
Short run				
ECT(-1)	−0.0626***	−0.0880***	−0.0509***	−0.0663***
	(0.00615)	(0.00893)	(0.00859)	(0.0138)
EXR	−0.303	−0.287	−0.828***	−0.828***
	(0.250)	(0.243)	(0.122)	(0.129)
INF		0.611**		0.0758
		(0.295)		(0.431)
Long run				
EXR	1.322***	0.822***	0.167	−0.216
	(0.369)	(0.218)	(0.494)	(0.470)
INF		2.356***		0.841
		(0.832)		(0.788)
Constant	0.141*	−0.585*	0.220***	0.105
	(0.0810)	(0.299)	(0.0701)	(0.154)
N	9	9	9	9
T	128	128	128	128
Obs.	1152	1152	1152	1152

Note: Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. ECT = error correction term; N = Number of cross-sections; T = Time dimension; EXR = exchange rate; INF = inflation rate computed from the countries' consumer prices; Low and High denote Low and High interest rate environments respectively; Obs. = Total number of observations.

Table 5
Differential effect of appreciation and deprecation on stock returns.

VARIABLES	Baseline		With oil price	
	Low	High	Low	High
Short run				
ECT(-1)	−0.0665***	−0.0539***	−0.0649***	−0.0669***
	(0.00686)	(0.00996)	(0.00977)	(0.0160)
EXR	−0.329	−0.832***	−0.117	−0.644***
	(0.271)	(0.113)	(0.233)	(0.104)
EXR_DUM	0.0554	−0.00213	0.116	−0.0296
	(0.0991)	(0.0667)	(0.156)	(0.0483)
EXR_INTRCT	0.00245	0.0142	0.00382	0.0146
	(0.0439)	(0.0301)	(0.0459)	(0.0220)
WTI			0.127***	0.103***
			(0.00991)	(0.0152)
Long run				
EXR	1.627**	0.359	2.635**	0.496
	(0.771)	(0.375)	(1.193)	(0.471)
EXR _DUM	−1.572	−1.322	0.559	−0.455
	(3.107)	(0.989)	(3.289)	(0.642)
EXR _INTRCT	−0.426	0.354	−1.457	0.372
	(1.367)	(0.331)	(1.902)	(0.343)
WTI			0.154*	0.133
			(0.0788)	(0.159)
Constant	0.218**	0.234***	0.159	0.150
	(0.109)	(0.0747)	(0.272)	(0.108)
N	8	9	8	9
T	512	512	512	512
Obs.	4096	4608	4096	4608

Note: Note: Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. ECT = error correction term; N = Number of cross-sections; T = Time dimension; EXR = exchange rate; WTI = oil price; Low and High denote Low and High interest rate environments respectively; EXR _DUM is the dummy variable for negative exchange rate returns; EXR _INTRCT is the interaction between exchange rate returns and the dummy; Obs. = Total number of observations.

The findings from our paper are significant improvements that settle the controversies in the numerous studies earlier conducted (for example, Pavlova & Roberto, 2007; Aydemir & Demirhan, 2009; Dunne et al., 2010; Litsios, 2013; Sensoy & Sobaci, 2014; Moore & Wang, 2014; Al-Shboul & Anwar, 2014; Khan & Abbas, 2015; Raza et al., 2016; Zivkov et al., 2016; Leung et al., 2017). We underline the stronger long run (positive) impacts of exchange rate on stock returns in the low interest rate environment compared with stronger short run (negative) impacts in the high interest rate environment and attribute it to (1) the lesser risky nature of the low interest environments than their high interests' counterparts revealed in the descriptive statistics, (2) in the low interest rate environment, the low

Table 6
Differential effect of negative and non-negative low interest rates on stock returns.

VARIABLES	Interaction with INTR		Interaction with EXR	
	Baseline	With oil price	Baseline	With oil price
Short run				
ECT(-1)	−0.0837***	−0.0837***	−0.0756***	−0.0763***
	(0.0121)	(0.0119)	(0.0124)	(0.0109)
EXR	−0.308	−0.108	−0.455*	−0.255
	(0.239)	(0.213)	(0.249)	(0.229)
INTR_DUM	0.0616***	−0.00110	−0.0763	−0.200
	(0.0194)	(0.0186)	(0.179)	(0.197)
INTR_INTRCT	−0.114	−0.00385	0.218	0.277
	(0.0943)	(0.0594)	(0.165)	(0.169)
WTI		0.133***		0.138***
		(0.0127)		(0.0115)
Long run				
EXR	0.883***	1.416***	2.249**	2.677**
	(0.231)	(0.442)	(1.071)	(1.176)
INTR_DUM	−0.598	−0.188	0.438	2.099
	(0.646)	(0.308)	(2.754)	(2.355)
INTR_INTRCT	2.757	1.243	0.424	−1.179
	(2.602)	(1.086)	(1.822)	(1.361)
WTI		0.138*		0.0550
		(0.0729)		(0.0970)
Constant	0.188**	0.224*	0.133	0.196
	(0.0824)	(0.128)	(0.144)	(0.153)
N	9	9	9	9
T	128	128	128	128
Obs.	1152	1152	1152	1152

Note: Note: Note: Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. ECT = error correction term; N = Number of cross-sections; T = Time dimension; EXR = exchange rate; INTR = short term interest rate; WTI = oil price; Low and High denote Low and High interest rate environments respectively; INTR _DUM is the dummy variable for negative interest rate; INTR _INTRCT is the interaction between the dummy and either of interest rate and exchange rate; Obs. = Total number of observations.

policy rates are policy-induced and not indicative of economic downturns, hence, the occurrence of investment delay during interest rate volatility is generally low (see Aramonte et al., 2019; Black, 1995; Dotsis, 2020), (3) in many of the emerging markets who are mostly high interest rate environments, the financial markets are mostly driven by trade balance, rather than by interest rate differential in advanced markets with low interest rate situations (Moore & Wang, 2014).

4.3. Do depreciation and appreciation of the same magnitude have differential effects on stock returns?

We also construct the unrestricted model variants for equation (1) where exchange rate return series is decomposed into appreciation and depreciation series. This allows us to estimate any possible differential effect of appreciation and depreciation on stock returns and whether the outcome differs between low and high interest rate environments.[10] The unrestricted model variant for equation (1) is specified in equation (2) below:

$$\begin{aligned}\Delta s_{it} &= \rho_i\left(s_{i,t-1} - \varphi_{0i} - \varphi_{1i}e_{it} - \psi_{i1}D_{it} - \psi_{i2}D_{it}{*}e_{it}\right) + \sum_{j=1}^{p}\lambda_{ij}\Delta s_{i,t-j} \\ &\quad + \sum_{j=0}^{q_1}\gamma_{ij}\Delta e_{i,t-j} + \sum_{j=0}^{q_2}\phi_{ij}\left(D_{i,t-j}{*}\Delta e_{i,t-j}\right) + \mu_i + \upsilon_{it}\end{aligned} \tag{2}$$

where all the variables are as previously defined except that $D_{i,t-j} = 1$ if $e_{i,t-j} < 0$ and zero otherwise for $t = 1,2,...,T; j = 0,1,2,...,q$ and $\forall\ t > j$. Therefore, the captured effect in equation (2) is for appreciation of exchange rate and the differential effect between appreciation and depreciation is estimated as ψ_{i2} and ϕ_{ij} for long run and short run respectively. In other words, the long run and short run effects of appreciation are evaluated at $D_{i,t-j} = 1$ and are restively estimated as $(\varphi_{1i} + \psi_{i2})$ and $(\gamma_{ij} + \phi_{ij})$. However, those of depreciation are determined at $D_{i,t-j} = 0$ and are basically φ_{1i} and γ_{ij} for long run and short run respectively. The difference between the coefficients for appreciation and depreciation whether for long run or short run gives the differential effect, hence, the description of same as ψ_{i2} and ϕ_{ij} for long run and short run respectively.

The prevalence of negative nexus traceable to the PBT has been established in the short run and positive relationship in the long run

[10] The underlying economic intuition for estimating possible nonlinear relationship between stock returns and exchange rate is well documented in the studies of Salisu and Oloko (2015b). Bahmani-Oskooee and Saha (2016a,b); Salisu and Ndako (2018), among others.

for the symmetric relationship between stocks returns and exchange rate movements in the previous sub-section. Probing further, we seek results for the role of asymmetry in the findings earlier shown. This helps to differentiate between the effects of positive changes (appreciation) and negative changes (depreciation) to stock returns, which should be expected in reality. This research objective has been argued on the basis of previous studies that explore the implications of asymmetry in the relationship (see Ali et al., 2015; Bahmani-Oskooee & Saha, 2016a; Chkili & Nguyen, 2014; Hsu et al., 2009; Kodongo & Ojah, 2012; Koutmos & Martin, 2007; Naifar & Al Dohaiman, 2013; Salisu & Ndako, 2018; Walid et al., 2011) although in restricted form unlike the various facets considered in the present study. In this study, rather than the asymmetry approach where the exchange rate series is decomposed into positive and negative changes, we adopt the dummy variable approach to demonstrate the differential effects between the impacts of exchange rate appreciation and depreciation on stocks returns. We report findings from this effort in Table 5.

Our findings remain largely unchanged as shown by the established differences between the low and high interest rate environments. The sharp contrast between the impacts of exchange rate on stock returns which alternates from negative to positive in the short and long term respectively is further reinforced. However, we fail to establish further asymmetric relationship in the nexus, for example, the divergence in the impacts of exchange rate appreciation and depreciation. In the results contained in Table 5, we find that the coefficients of the exchange rate depreciation dummy as well as the coefficients of the interaction terms for the short and long run are statistically insignificant. Hence, there is no evidence to establish any differences between the impacts of exchange rate depreciation/appreciation on stock returns in the two groups defined by the level of interest rates. This finding adds weight to the distinction in the responses of stocks to exchange rate changes between the low and high interest rate groups reported in the previous section. These findings are consistent for the baseline model and the extension that consider the role of oil price in the nexus While the findings reinforce the PBT in the short run for the high interest rate environment, the long run positive relationship is further established for the low interest rate environment thereby corroborating arguments in the literature that lower interest rate improve the supply of loanable funds to enhance investment returns (see Andries et al., 2017; Dahir et al., 2018; Ince et al., 2016; Wong, 2017)).

4.4. Testing for an extreme scenario where the low interest rate is negative

We attempt to probe further for the case of low interest rate environments given the presence of some extreme cases where some low interest rates are extremely low and negative. Negative interest rates occur when borrowers are credited interest rather than paying interest to lenders. This unusual scenario is most likely to occur during a deep economic recession when monetary policy and market forces have already pushed interest rates to their nominal zero bound (Beers, 2020). The negative interest rate is a response to economic downturn targeted at preventing capital flight and depreciation of currency exchange rates. Thus, countries with negative interest rate may experience stable currency exchange rates, better economic prospects and by extension greater returns on investment. The idea pursued here may be linked to the literature that show that risk taking falls with interest rates (see Lian et al., 2019; Ganzach & Wohl, 2018; Baars et al., 2020) although the scenario of negative interest rate has not been previously explored. The reformulation of the model is similar to what we did for the appreciation-depreciation dichotomy in equation (2) but with a slight twist as expressed below:

$$\begin{aligned}\Delta s_{it} &= \rho_i(s_{i,t-1} - \varphi_{0i} - \varphi_{1i}e_{it} - \psi_{i1}D_{it} - \psi_{i2}D_{it}{*}e_{it}) + \sum_{j=1}^{p}\lambda_{ij}\Delta s_{i,t-j} \\ &+ \sum_{j=0}^{q_1}\gamma_{ij}\Delta e_{i,t-j} + \sum_{j=0}^{q_2}\phi_{ij}\left(D_{i,t-j}{*}\Delta e_{i,t-j}\right) + \mu_i + \upsilon_{it}\end{aligned} \tag{3}$$

Unlike equation (2), $D_{i,t-j} = 1$ if $r_{i,t-j} < 0$ and zero otherwise for $t = 1, 2, ..., T$; $j = 0, 1, 2, ..., q$ and $\forall\ t > j$. Thus, the effect of exchange rate on stock returns for negative interest rate environments, which is evaluated at $D_{i,t-j} = 1$, are estimated as $(\varphi_{1i} + \psi_{i2})$ and $(\gamma_{ij} + \phi_{ij})$ for long run and short run respectively. Consequently, those of non-negative low interest rate environments, evaluated at $D_{i,t-j} = 0$, are obtained as φ_{1i} and γ_{ij} for long run and short run respectively. The difference between the coefficients for negative and non-negative low interest rate environments represents the differential effect and are obtained as ψ_{i2} and ϕ_{ij} for long run and short run respectively.

The results for equation (3) is presented in Table 6 which shows the interaction of the interest rate dummy with both interest rates and exchange rates produced side by side. We attempt further robustness by comparing findings for the baseline models for the two scenarios with the extended models incorporating the role of oil price. The consideration of the implication of negative interest rate become relevant in the low interest rate situations of advanced industrialized economies. These countries have crossed the low bound on several occasions since the adoption of the policy of low interest rate to stabilize the financial markets in the aftermath of the Global Financial Crisis (see Akram & Li, 2017; Baars et al., 2020; Dotsis, 2020; Rogoff, 2017). The results show that the impacts of interest rate on the stocks returns of low interest rate countries is still negative (although statistically insignificant at the conventional level of significance) in the short run as previously shown. The negative relationship espoused in the PBT still holds for the short run with consideration of extreme case of negative interest rate situations in low interest rate environments. Also, the positive nexus is reinforced for the long run as previously established for the industrialized economies comprising the low interest rate group. However, there is no enough evidence to suggest divergence between the nexus in low interest rate environments between negative and non-negative low interest rate zones given the statistical insignificance of the interaction coefficients.

5. Conclusion

In this study, we conduct a distinct analysis of the exchange rate-stock returns nexus between low and high interest rate environments, which are profiled as advanced industrialized countries and fast growing emerging economies respectively. The low interest rate environment comprise of Canada, Denmark, Israel, Japan, South Korea, Poland, Sweden, UK and the Euro area considered as a unit. The high interest rate environment on the other hand consist of Brazil, China, Colombia, India, Indonesia, Mexico, Russia, South Africa and Turkey. We explore four research objectives as follows: one, investigate whether exchange rate influences stock returns of high and low interest rate environments differently; two, examine the differential impacts of exchange rate appreciation and depreciation on stock returns; three, examine the sensitivity of the results to alternative data frequency; and four, explore an extreme case for the exchange rate-stock returns nexus when low interest rate environment drops to negative. The models are estimated with weekly data frequency for the main analysis and monthly frequency for robustness.

We report significant findings that are instructive to policy making and future researches. One, we show clear difference in the nexus for the low interest rate group and for the high interest rate group across the short and long run periods. This distinction is shown irrespective of whether the underlying model accounts for the intervening roles of interest rate, inflation and global oil price. Two, we show difference in the impacts of exchange rates on stock returns as demonstrated by more prominent negative relationship in the short run in the high interest rate group. Three, we show widespread positive nexus in the long run with stronger impacts in the low interest rate environment compared with high interest rate environment. Four, the comparison of exchange rate appreciation & depreciation and negative & non-negative low interest rates show that no further asymmetric effects may be expected other than the distinct findings found for the short run & long run as well as the dissimilar findings found for the low and high interest rate environments.

These findings have implications to guide both policy makers in shaping monetary policy and international investors in targeting profitable investment decisions. For the first category, the findings indicate that monetary policy rule which traditionally targets inflation and the level of output in the economy may need to be augmented to also consider happenings in the foreign exchange market. This is so since strong connection (whether in the short or long run) is established between the currency markets and the stock markets, which are major components of the capital markets in the respective economies. Second, the emerging economies can take a cue from the advanced economies who have systematically pursued deliberate low interest rate policy that appear to favor businesses (by removing uncertainties) and resulted in consistent investment yields. For the second category, investors in their future portfolio diversification decisions (especially for short run profits) can take a hint from the findings which show that consistent exchange rate appreciations may indicate sluggishness of the underlying stock exchanges in the less advanced economies.

Author statement

Afees Salisu: Conceptualization, Methodology and Data Analysis, Editing and Results validation.
Xuan Vinh Vo: Data curation, Reviewing & Editing and Results validation.

Acknowledgements

This research work was funded by the University of Economics Ho Chi Minh City, Vietnam.

References

Akram, T., & Li, H. (2017). What keeps long-term U.S. interest rates so low? *Economic Modelling, 60*, 380–390.
Al-Shboul, M., & Anwar, S. (2014). Time-varying exchange rate exposure and exchange rate risk pricing in the Canadian Equity Market. *Economic Modelling, 37*, 451–463.
Ali, H. S., Muktar, U., & Maniam, G. S. (2015). Dynamic links between exchange rates and stock prices in Malaysia: An asymmetric cointegration analysis. *Journal of Economics and Political Economy, 2*(3), 411–417.
Allen, P., & Kenen, P. (1980). *Asset markets, exchange rates, and economic integration*. New York: Cambridge University Press.
Ammer, J., Claessens, S., Tabova, A., & Wroblewski, C. (2019). Home country interest rates and international investment in U.S. Bonds. *Journal of International Money and Finance, 95*, 212–227.
Andries, A. M., Căpraru, B., Ihnatov, I., & Tiwari, A. K. (2017). The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. *Economic Modelling, 67*, 261–274.
Aramonte, S., Lee, S. J., & Stebunovs, V. (2019). Risk taking and low longer-term interest rates: Evidence from the U.S. syndicated term loan market. *Journal of Banking & Finance*. https://doi.org/10.1016/j.jbankfin.2019.02.010
Aydemir, O., & Demirhan, E. (2009). The relationship between stock prices and exchange rates evidence from Turkey. *International Research Journal of Finance and Economics, 23*(2), 207–216.
Baars, M., Cordes, H., & Mohrschladt, H. (2020). How negative interest rates affect the risk-taking of individual investors: Experimental evidence. *Finance Research Letters, 32*. https://doi.org/10.1016/j.frl.2019.04.035
Bahmani-Oskooee, M., & Saha, S. (2016a). Do exchange rate changes have symmetric or asymmetric effects on stock prices? *Global Finance Journal, 31*, 57–72.
Bahmani-Oskooee, M., & Saha, S. (2016b). Asymmetry cointegration between the value of the dollar and sectoral stock indices in the U.S. *International Review of Economics & Finance, 46*, 78–86.
Beers, B. (2020). Negative interest rate definition. Retrieved from https://www.investopedia.com/terms/n/negative-interest-rate.asp.
Bilman, M. E., & Karaoglan, S. (2020). Does the twin deficit hypothesis hold in the OECD countries under different real interest rate regimes? *Journal of Policy Modeling, 42*(1), 205–215.
Black, F. (1973). Capital market equilibrium with restricted borrowing. *Journal of Business, 45*(3), 444–454.
Black, F. (1995). Interest rates as options. *The Journal of Finance, 50*(5), 1371–1376.
Blackburne, E. F., & Frank, M. W. (2007). Estimation of nonstationary heterogeneous panels. *STATA Journal, 7*(2), 197–208.
Borio, C., & Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism? *Journal of Financial Stability, 8*(4), 236–251.

Boyer, R. S. (1977). Devaluation and portfolio balance. *The American Economic Review, 67*(2), 54–63.
Branson, W. H. (1983). Macroeconomic determinants of real exchange risk. In R. J. Herring (Ed.), *Managing foreign exchange risk*. Cambridge, United Kingdom: Cambridge University Press.
Branson, W. H., & Halttunen, H. (1979). Asset-market determination of exchange rates: Initial empirical and policy results. In J. P. Martin, & A. Smith (Eds.), *Trade and payments adjustment under flexible exchange rates*. London: Macmillan.
Branson, W., Halttunen, H., & Masson, P. (1977). Exchange rates in the short run: The dollar-deutschemark rate. *European Economic Review, 10*(3), 303–324.
Branson, W. H., & Henderson, D. W. (1985). The specification and influence of assets markets. In R. W. Jones, & P. B. Kenen (Eds.), *Handbook of international economics, 2*. Amsterdam: Elsevier.
Brei, M., Borio, C., & Gambacorta, L. (2020). Bank intermediation activity in a low-interest-rate environment. *Economic Notes, 49*(2), Article e12164. https://doi.org/10.1111/ecno.12164
Chaudron, F. D. D. (2018). Bank's interest rate risk and profitability in a prolonged environment of low interest rates. *Journal of Banking & Finance, 89*, 94–104.
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.
Claessens, S., Coleman, N., & Donnelly, M. S. (2016). *"Low-for-Long" interest Rates and net interest Margins of Banks in advanced foreign economies (No. 2016-04-11-1)*. Board of Governors of the Federal Reserve System (US).
CNN Business Report. (2015). Best performing global markets. https://money.cnn.com/interactive/investing/best-performing-global-markets/.
Cociuba, S. E., Shukayev, M., & Ueberfeldt, A. (2016). Collateralized borrowing and risk taking at low interest rates. *European Economic Review, 85*, 62–83.
Dahir, A. M., Mahat, F., Ab Razak, N. H., & Bany-Ariffin, A. N. (2018). Revisiting the dynamic relationship between exchange rates and stock prices in BRICS countries: A wavelet analysis. *Borsa Instanbul Review, 18*(2), 101–113.
Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *The American Economic Review, 70*(1), 960–971.
Dotsis, G. (2020). Investment under uncertainty with a zero lower bound on interest rates. *Economics Letters, 188*. https://doi.org/10.1016/j.econlet.2020.108954
Dunne, P., Hau, H., & Moore, M. (2010). International order flows: Explaining equity and exchange rate returns. *Journal of International Money and Finance, 29*(2), 358–386.
Dąbrowski, M. A., Papież, M., & Śmiech, S. (2020). Classifying de facto exchange rate regimes of financially open and closed economies: A statistical approach. *Journal of International Trade & Economic Development, 29*(7), 821–849.
Engel, C., Mark, N. C., & West, K. D. (2008). Exchange rate models are not as bad as you think. In *NBER macroeconomics annual 2007* (pp. 381–441). University of Chicago Press.
Fleissig, A. R., & Swofford, J. L. (2020). The demand for assets through a low-interest rate environment. *Applied Economics, 52*(60), 6540–6551.
Frankel, J. A. (1983). Monetary and portfolio-balance models of exchange rate determination. In J. S. Bhandari, & B. H. Putnam (Eds.), *Economic interdependence and flexible exchange rates* (pp. 84–115). Cambridge: MIT Press.
Gambacorta, L., & Borio, C. (2017). Monetary policy and bank lending in a low interest rate environment: Diminishing effectiveness? *Journal of Macroeconomics, 54*(B), 217–231.
Ganzach, Y., & Wohl, A. (2018). A behavioral theory of the effect of the risk-free rate on the demand for risky assets. *Journal of Behavioral and Experimental Economics, 76*, 23–27.
Hanzlík, P., & Teplý, P. (2020). Key factors of the net interest margin of European and US banks in a low interest rate environment. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2299 (in press).
Hau, H., & Rey, H. (2006). Exchange rates, equity prices, and capital flows. *Review of Financial Studies, 19*(1), 273–317.
Hsu, C., Ruey, Y., & Jyun-Yin, W. (2009). Asymmetric exchange rate exposure and industry characteristics: Evidence from Japanese data. *Hitotsubashi Journal of Economics, 50*(1), 57–69.
Huang, W., Mollick, A. V., & Nguyen, K. H. (2016). U.S. Stock markets and the role of real interest rates. *The Quarterly Review of Economics and Finance, 59*, 231–242.
Inagaki, K. (2009). Estimating the interest rate semi-elasticity of the demand for money in low interest rate environments. *Economic Modelling, 26*(1), 147–154.
Ince, O., Molodtsova, T., & Papell, D. H. (2016). Taylor rule deviations and out-of-sample exchange rate predictability. *Journal of International Money and Finance, 69*, 22–44.
Inci, A. C., & Lee, B. S. (2014). Dynamic relations between stock returns and exchange rate changes. *European Financial Management, 20*(1), 71–106.
Khan, A., & Abbas, Z. (2015). Portfolio balance approach: An empirical testing. *Journal of Economics and International Finance, 7*(6), 137–143.
Kodongo, O., & Ojah, K. (2012). The dynamic relation between foreign exchange rates and international portfolio flows: Evidence from Africa's capital markets. *International Review of Economics & Finance, 24*, 71–87.
Koutmos, G., & Martin, A. D. (2007). Modelling time variation and asymmetry in foreign exchange exposure. *Journal of Multinational Financial Management, 17*(1), 61–74.
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.
Lecznar, J., & Lubik, T. A. (2018). Real rates and consumption smoothing in a low interest rate environment: The case of Japan. *Pacific Economic Review, 23*(5), 685–704.
Leung, H., Schiereck, D., & Schroeder, F. (2017). Volatility spillovers and determinants of contagion: Exchange rate and equity markets during crises. *Economic Modelling, 61*, 169–180.
Lewellen, J. (2004). Predicting returns with financial ratios. *Journal of Financial Economics, 74*(2), 209–235.
Lian, C., Ma, Y., & Wang, C. (2019). Low interest rates and risk taking: Evidence from individual investment decisions. *Review of Financial Studies, 32*(6), 2107–2148.
Lin, C. H. (2012). The comovement between exchange rates and stock prices in the Asian emerging markets. *International Review of Economics & 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.
Molodtsova, T., & Papell, D. H. (2009). Out-of-sample exchange rate predictability with Taylor rule fundamentals. *Journal of International Economics, 77*(2), 167–180.
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.
Naifar, N., & Al Dohaiman, M. S. (2013). Nonlinear analysis among crude oil prices, stock markets' return and macroeconomic variables. *International Review of Economics & Finance, 27*, 416–431.
Narayan, P. K., & Liu, R. (2015). A unit root model for trending time-series energy variables. *Energy Economics, 50*, 391–402.
Narayan, P. K., & Sharma, S. S. (2015). Does data frequency matter for the impact of forward premium on spot exchange rate? *International Review of Financial Analysis, 39*, 45–53.
Pan, M., Fok, R. C., & Liu, Y. A. (2007). Dynamic linkages between exchange rates and stock prices: Evidence from East Asian markets. *International Review of Economics & Finance, 16*(4), 503–520.
Pavasuthipaisit, R. (2009). Optimal exchange-rate policy in a low interest rate environment. *Journal of the Japanese and International Economies, 23*(3), 264–282.
Pavlova, A., & Roberto, R. (2007). Asset prices and exchange rates. *Review of Financial Studies, 20*(4), 1139–1180.
Raza, N., Shahzad, S. J., Tiwari, A. K., & Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. *Resources Policy, 49*, 290–301.
Rogoff, K. (2017). Monetary policy in a low interest rate world. *Journal of Policy Modeling, 39*(4), 673—679.
Salisu, A. A., & Adeleke, A. I. (2016). Further Application of Narayan and Liu (2015) unit root model for trending time series. *Economic Modelling, 55*, 305–314.
Salisu, A. A., & Isah, K. O. (2017). Revisiting the oil price and stock market nexus: A nonlinear panel ARDL approach. *Economic Modelling, 66*, 258–271.
Salisu, A. A., Isah, K. O., Oyewole, O. J., & Akanni, L. O. (2017). Modelling oil price-inflation nexus: The role of asymmetries. *Energy, 125*(C), 97–106.
Salisu, A. A., & Ndako, U. B. (2018). Modelling stock price–exchange rate nexus in OECD countries: A new perspective. *Economic Modelling, 74*, 105–123.
Salisu, A. A., Ndako, U. B., Oloko, T. F., & Akanni, L. O. (2016). Unit root modeling for trending stock market series. *Borsa Istanbul Review, 16*(2), 82–91.

Salisu, A. A., & Oloko, T. F. (2015a). Modelling oil price-US stock nexus: A VARMA-BEKK-AGARCH approach. *Energy Economics, 50*, 1–12.
Salisu, A. A., & Oloko, T. F. (2015b). Modelling spillovers between stock market and FX market: Evidence for Nigeria. *Journal of African Business, 16*(1–2), 84–108.
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.
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.
Swaray, R., & Salisu, A. A. (2018). A firm-level analysis of the upstream-downstream dichotomy in the oil-stock nexus. *Global Finance Journal, 37*(C), 199–218.
Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series On Public Policy, 39*, 195–214.
Tsai, I. (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.
Walid, C., Chaker, A., Masood, O., & Fry, J. (2011). Stock market volatility and exchange rates in emerging countries: A Markov-state switching approach. *Emerging Markets Review, 12*(3), 272–292.
Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics & Statistics, 69*(6), 709–748.
Westerlund, J., & Narayan, P. K. (2012). Does the choice of estimator matter when forecasting returns? *Journal of Banking & Finance, 36*(9), 2632–2640.
Westerlund, J., & Narayan, P. K. (2015). Testing for predictability in conditionally heteroskedastic stock returns. *Journal of Financial Econometrics, Society for Financial Econometrics, 13*(2), 342–375.
Wong, H. T. (2017). Real exchange rate returns and real stock price returns. *International Review of Economics & Finance, 49*, 340–352.
Živkov, D., Njegić, J., & Mirović, V. (2016). Dynamic nexus between exchange rate and stock prices in the major East European economies. *Prague Economic Papers, 25*(6), 686–705.
Živkov, D., Njegić, J., & Pavlović, J. (2015). Dynamic correlation between stock returns and exchange rate and its dependence on the conditional Volatilities–The case of several Eastern European countries. *Bulletin of Economic Research, 68*(S1), 28–41.