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Exchange rates, bond yields and the stock market: nonlinear evidence of Indonesia during the COVID-19 period

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Abstract

Purpose – The authors explore the relationship between the exchange rate, bond yield and the stock market as well as the effect of capital market dynamics on the exchange rate before and during the COVID-19 pandemic.
Design/methodology/approach – The authors employ a non-linear autoregressive distributed lag (NARDL) methodology using daily data of the Indonesian economy over the period 2012–2021.
Findings – Whilst, over the full sample period, the authors find no cointegration between the exchange rate, the 10-year bond yield and stock market, for the COVID-19 period, evidence of cointegration is present. Furthermore, the results suggest that asymmetric effects are evident both in the short as well as the long run.
Originality/value – To the best of the authors' knowledge, this is the first time that the relationship between the exchange rate, bond yield and the stock market as well as the effect of capital market dynamics on the exchange rate before and during the COVID-19 pandemic has been explored in the case of the Indonesian economy.

Keywords Capital market dynamics, Exchange rate, Asymmetric effect, Bond market, Stock market
Paper type Research paper

1. Introduction

The increasingly integrated global economy has accelerated the growth of foreign currency transactions, notably in international transaction payments. These transactions are mostly non-physical in nature and are related to international trade payments and investment of foreign capital in the capital markets that are identified as capital flows.

The role of the capital market is crucial in helping the economy, particularly for developing countries, which generally experience a deficit and seek funds to finance economic activities from investors, especially through the stocks and bonds market. After the Asian Currency Crisis in 1997, many developing countries reduced vulnerabilities arising from external debt by issuing bonds in local currencies (Hofmann *et al.*, 2021). Due to limited funds from domestic investors, developing countries regularly issue local currency bonds as means of attracting funds from foreign investors. However, such efforts have not been able to

JEL Classification — C32, F31, G11

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eliminate currency risk issues as foreign investors have always the option of converting their assets to their preferred currency.

According to Juhro *et al.*, (2022), foreign capital flows make emerging market countries vulnerable to external shocks. In particular, inflows of foreign capital, to a great extent, are determined by the prevailing economic conditions and the level of yield offered. As such, negative investment perception entails an outflow of capital which in turn causes a disruption in the domestic economy and more vulnerable to external shocks. Engel and Wu (2018) provide evidence that liquidity yield on sovereign bonds has significant explanatory power to influence the exchange rate movements in G10 currencies. They also found that interest rates and lagged adjustment terms for the real exchange rate are important determinants of exchange rate movements. Furthermore, Bodart and Reding (1999) show that their study explains that the level of exchange rate variability influences international bonds and stock correlations in European countries.

Fundamentally, inflows of capital constitute a significant source of finance for developing countries as a means of spurring economic growth, enhancing financial sector competitiveness, enabling greater investment activities and smoothing out consumption (Juhro *et al.*, 2022; International Monetary Fund, 2012). The state of the fundamentals and the degree economic openness, the currency rate regime and the macroeconomic policies adopted are all significant factors that affect foreign capital flows. In this context, stronger economies can offer higher yields, hence attracting more foreign capital inflow. Global economic shocks, however, can disrupt a country's economy through a reversal of foreign capital flows. Countries that operate under a fixed exchange rate system or a similar system as happened in the 1990s in Latin America and Southeast Asia are prone to pronounced currency crisis stemming from exchange rate speculation. As such in optimizing the advantages of foreign capital investment whilst mitigating the risk of currency crises in the future, it is imperative that we examine the relationship between capital flows and exchange rate movements.

In this paper, we investigate the relationship between exchange rate movements and capital market transactions in the bond and stock markets and explore the possibility of nonlinearities in the underlying relationships. More specifically, we focus on the movement of bond price, the stock index – in terms of daily price returns – and the exchange rate over the period 2012–2021. In addition, this study also investigates the capital market dynamics during the COVID-19 crisis. To this objective, we investigate the asymmetric cointegration among variables using the nonlinear autoregressive distributed lag (NARDL) approach developed by Shin *et al.* (2014). Using the NARDL model will allow us to simultaneously find and analyse both negative and positive asymmetric cointegration among variables in the short and long run, simultaneously.

Several empirical studies have previously been conducted to investigate the relationship between the stock market and the exchange rate using different methodologies. However, there are still limited studies that use the NARDL method to investigate the relationship between variables, especially those related to exchange rates, government bonds and stock markets. To the best of our knowledge, this is the first study that employs the NARDL methodology in the context of the Indonesian economy and hence offers significant policy implications to be considered by policymakers, investors and portfolio managers when anticipating potential volatility in exchange rates, government bonds and stock markets.

The rest of the paper is organized as follows: section 2 touches on the relevant literature in the area whilst section 3 focuses on the empirical investigation utilized in this study. Section 4 presents and discusses the results, and finally, section 5 provides some concluding remarks.

2. Relevant literature

The literature on exchange rate determination is inundated with studies that employ macroeconomic indicators, capital market indices and microstructural approaches to

investigate the impact of the bond and stock market on currency rate movements. For instance, in an emerging market context, Jongwanich and Kohpaiboon (2013) explored the impact of capital flows on the exchange rate in Asian countries and affirmed that the structure of capital flows plays a crucial role in determining how they affect exchange rates. The study showed that capital market investment and loan from banks have a bigger influence on currency appreciation than direct investment from overseas. They argued that the relatively stable and concentrated nature of foreign direct investment flows, especially in the tradable and export-oriented sectors, caused the slow pace of adjustment in the exchange rate. Therefore, by closely observing the development of investment portfolios, it will provide us with a better understanding of the movement of exchange rates.

In the context of developed countries, there are studies from Lace *et al.* (2015) and Engel and Wu (2018) who studied the effect of government bond yields and other macroeconomic indicators on the exchange rate. Lace *et al.* (2015) found that United States (US) and German government debt yields can be utilized to determine the EUR/US$ exchange rate movements. Similar results were also found by Engel and Wu (2018) who observed a strong causal relationship between government bond liquidity and exchange rates.

In contrast to previous studies, according to Rosnawintang *et al.* (2021), by using monthly data from 2006 to 2018, they found no long-run association among the US$/IDR currency rate and the yield on 10-year Indonesian sovereign bonds. Those factors, however, have a two-way causal association in the short run. In the same spirit, Soni *et al.* (2018) looked at the impact of various macroeconomic factors on the US$/INR exchange rates from 2000 to 2017 and found that government bonds are a significant predictor that affects the US$/INR exchange rate. Furthermore, using quarterly data from 1983 to 2014, Hsing (2016) established a positive impact between the South African government bond yield, US real gross domestic product (GDP), US stock price, South African inflation and exchange rate volatility.

In so far as portfolio investment affects exchange rate movements, a number of studies have explored the impact of changes in equity market and currency volatility (see for instance, Andersen *et al.*, 2007; Ehrmann *et al.*, 2011; Kal *et al.*, 2015; Raza and Wu, 2018). Bahmani-Oskooee and Sohrabian (1992) by using Granger causality and cointegration methodologies established a two-way association among the equity market and currency rate in the short run, but no long-run association among the equity market and the domestic currency rate was found.

Furthermore, using daily data from 1986 to 1998, Granger *et al.* (2000) examined the relationship between exchange rates and stock markets in Asian countries. The emerging evidence suggested a mixed picture as for Japan and Indonesia, no link was established, whilst in the case of Korea, the exchange rate was found to affect the stock price. For the rest of the countries in the sample, the stock price to a certain extent was found to affect the exchange rate. In another study, Nieh and Lee (2001) when investigated the interaction between stock prices and exchange rates in the G-7 economies failed to establish a long-run relationship.

When studied the relationship between the stock market and currency rate in the context of 17 Organisation for Economic Co-operation and Development economies, Hau and Rey (2006) found that better returns in the domestic equities market relative to the foreign equity market are linked to a depreciation of the domestic currency. This finding however contradicts the view that increasing stock markets are followed by rising exchange rates.

In the Indonesian context, Anggitawati and Ekaputra (2020) investigated the relationship between the total amount of net foreign investments, government securities, equity markets and movements in domestic currency. Applying Granger causality and Vector Autoregression (VAR) methodologies on daily data from 2011–2016, they found a bidirectional causality between foreign investment in Indonesia's financial securities and the US$/IDR currency rate. It was also shown that total international capital fund flows to the domestic financial market had an impact on the US$/IDR currency rate's appreciation, while foreign capital outflows caused a depreciation of the US$/IDR.

On a different note, and by using a microstructure approach, Rahman (2021) evidence suggests that the US$/IDR is significantly influenced by the time lags of foreign transactions, Non-Deliverable Forward (NDF) rate (US$/IDR), the US$/IDR spot price and the Bloomberg JPMorgan Asia Dollar index (ADXY index). In the long run, domestic individual transactions, non-deliverable forward transactions and the ADXY index were found to be important predictors of US$/IDR whilst market dominance and asymmetric information among Indonesian FOREX market participants was revealed.

In view of the evidence set our previously, it can be discerned that several macroeconomic and financial variables have been identified as determinants of the exchange rate. According to Jareño *et al.* (2019), studies using classic approaches such as cointegration, linear regression or Granger causality might indeed enable us to gain invaluable insights into the short and long-run relationships but do not capture potential asymmetries in asset price dynamics. In their study, Baek and Choi (2021) argue that the assumption of a symmetrical effect on asset prices may not necessarily hold in the capital market, since market players in the foreign currency market may respond differently to changes in asset prices. As an intuitive explanation, asset price dynamics can affect exchange rate movements differently depending on their holdings, whether they are assets of domestic or foreign investors.

It is therefore imperative that in the empirical part that will follow we address the gap in the extant literature by exploring any possible asymmetries in the interaction between capital market asset price and exchange rate movements both in the short and the long-run. In this direction, we will employ a nonlinear autoregressive distributed lag (NARDL) model suggested by Shin *et al.* (2014) which is an asymmetric extension of the already well-established linear autoregressive distributed lag (ARDL) bounds testing procedure developed by Pesaran *et al.* (2001).

3. Empirical investigation

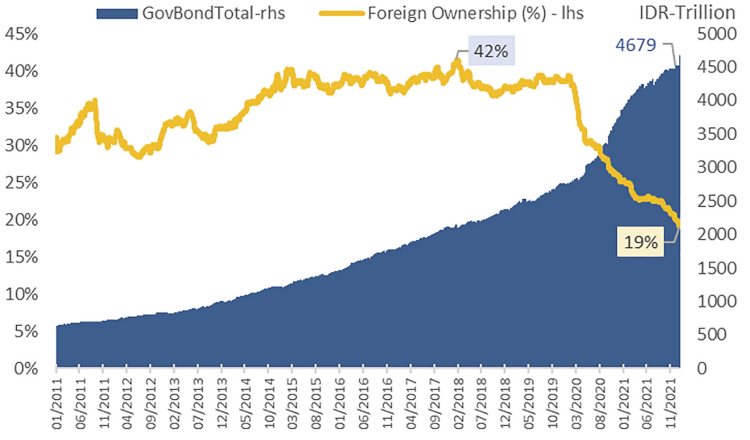
3.1 The development of capital flows in Indonesia

Before we set out to empirically explore the relationship between the capital market and the exchange rate, it would be appropriate to take a cursory glance at the development of capital inflows in Indonesia.

Along with the growth of economic activity, the development of the capital market in Indonesia has experienced significant growth. This development is driven by the investment grade status that Indonesia received in 2011, which encourages foreign investors to invest in Indonesia's economy, particularly in the capital market. In addition, capital market's growth is inextricably linked to the growing demand for funding, which will be used to finance the government's deficit as well as for private sector activities.

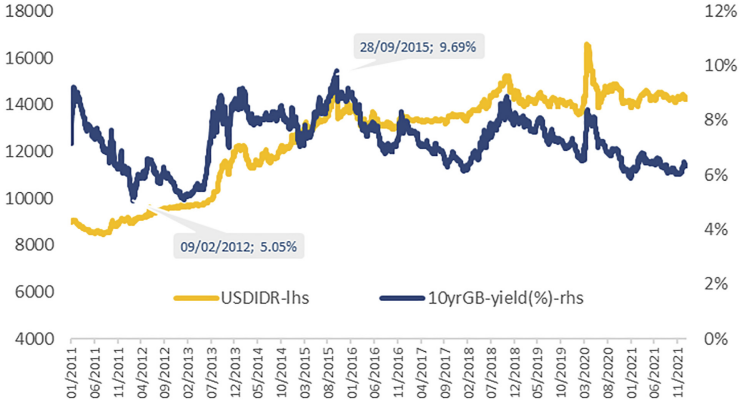
In the bond market, the Indonesian's government is the primary issuer of bonds, accounting for 91% of all issuance as of December 2021. The remaining portion is held by corporate bonds, Islamic bonds and asset-backed securities (Otoritas Jasa Keuangan, 2022). The Indonesian government has issued an increasing number of sovereign bonds in line with the expansionary stance of its fiscal policy. Government bonds have increased on average by 21% annually over the past ten years. In 2021, government bonds outstanding have reached 4.679 tn IDR or grew almost five times from the position at the end of 2012 which was recorded at 820 tn IDR.

Figures 1 and 2 suggest that the yield movement of the 10-year government bond yield has fluctuated in the last decade as a result of fundamental conditions and external sentiment. The large inflow of foreign capital in 2012 drove yields to their lowest level in February 2012 of 5.05%, while the highest yield was recorded in September 2015 at 9.69%. Moreover, a significant change in sovereign bond ownership during the last decade is observed with foreign ownership of all government bonds dwindling from 42% in 2018 to 19% at the end of 2021.



Source(s): Figure has been created by the authors using publicly available data for Indonesia's Sovereign Bonds and Foreign Ownership during 2012-202 sourced from Bloomberg Financial Data Services

Figure 1.
Indonesia's sovereign bonds and foreign ownership during 2012–2021



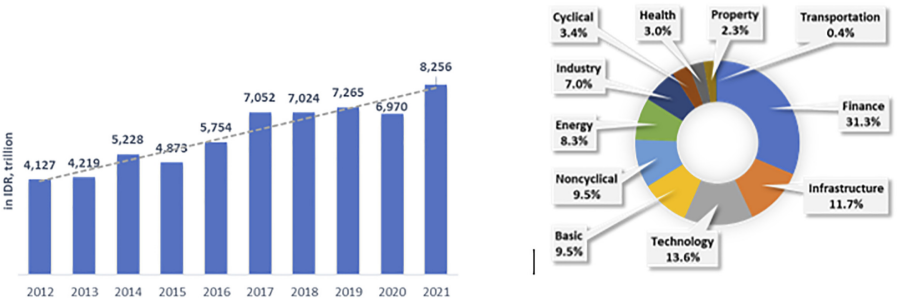
Source(s): Figure has been created by the authors using publicly available data for the 10-Year and Government Bond Yields during 2012-2021 sourced from Bloomberg Financial Data Services

Figure 2.
10-year government bond yields during 2012–2021

3.2 Indonesia's equity market development

In addition to the bond market, the Indonesian stock market has played an increasingly important role in the capital market over the past ten years, as seen by the rise in the stock market capitalization value (see Figure 3). Market capitalization increased over the previous ten years, growing by 100.04% from IDR 4,127 tn (equivalent to US$ 427 bn) in 2012 to IDR 8,256 tn (equivalent to US$ 579 bn) in 2021.

Despite the Euro crisis in 2015 and COVID-19 in 2020 having a big negative impact on the stock market, the Jakarta Composite Index (JCI) index has greatly increased over the last 10 years (see Figure 4). JCI index was able to continue to grow at an average of 6.16% per year to reach 6,581 until the end of 2021 or grow 52% compared to the 2012 position which was



Source(s): Figure has been created by the authors using publicly available data for Indonesia's Equity Market Capitalization 2012-2021 and Composite Index Sector Weights as of June 2022 sourced from Bloomberg Financial Data Services

Figure 3.
Indonesia's equity market capitalization 2012–2021 and composite index sector weights as of June 2022

Source(s): Figure has been created by the authors using publicly available data for Indonesia's Composite Index (JCI) from 2012 to 2021, sourced from Bloomberg Financial Data Services

Figure 4.
The dynamics and growth of the Indonesia composite index (JCI) from 2012 to 2021

recorded at 4,317. The weight of the Indonesian stock market is dominated by the financial, infrastructure and technology sectors, which reach 57%, while the weight of other sectors is less than 10%.

Based on the composition of ownership, there has been a substantial change in equity ownership composition in the Indonesian stock market (KSEI, 2022). Foreign investors held 45.50% of the total value shares at the end of December 2017, while domestic investors held 54.50%. In 2021, these figures changed to 41.24% and 58.76%, respectively.

The number of domestic investors in the Indonesian capital market has increased as a result of the rapid growth of retail investors in Indonesia. In comparison to the position in the previous year (3.88 million investors), the number of domestic investors in the capital market increased significantly by 92.99% (or an increase of 3.61 million investors) to 7.49 million investors in 2021, of which 81.48% were young investors.

3.3 Data and methodology

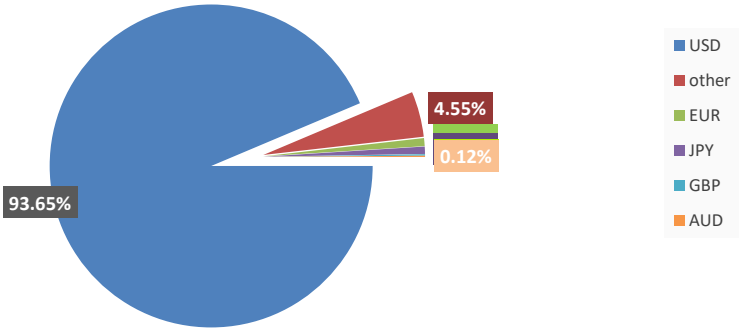
3.3.1 Data. In line with the objective of this study, which is to investigate the relationship between the capital market and the exchange rate, we make use of the following data: (a) the closing price of US$ to IDR, (b) the closing price of Indonesia 10-year government bond yield – being the most transacted and used as a benchmark in bond trades (DJPPR, 2021) and (c) the closing price of Indonesia Stock Index Composite (IDX) which is a composite index of all equities listed on the Indonesia Stock Exchange are included in this index (previously referred to as the Jakarta Stock Exchange). The currencies used in this study are determined by their transaction market share, which is US$/IDR (see Figure 5). With a proportion of 93.65% in April 2019, US$/IDR transactions are the most traded currency pairs in Indonesia's foreign exchange market (Bank for International Settlements, 2019).

To provide more clarity about the relationship among variables, the data series used in this study is based on daily data, which is divided into two parts as follows: *full sample*, with a period of 10 years, starting from the early January 2012 to end of December 2021, which have 2,610 observations and *a subsample*, with a period of two years, starting from the early January 2020 to end of December 2021, which have 523 observations. The subsample is intended to examine the dynamics during the COVID-19 pandemic period. See Tables A1 and A2 in Appendix for summary statistics and correlation matrix.

Given that this study employs daily data as means of acquiring a better understanding of the variables that drive the movement of the US$/IDR currency rate and to examine the impact of independent variable transmission more concretely we have left out potentially other key macroeconomic variables such as inflation, trade imbalance (export/import), GDP and unemployment rate due to the lower frequencies available. The main data sources were Bloomberg Financial Data Services, the Bank Indonesia (www.bi.go.id), Directorate General of Budget Financing and Risk Management – Indonesia's Ministry of Finance (https://www.djppr.kemenkeu.go.id) and Indonesia Stock Exchange (www.idx.co.id).

The fact that Indonesia has the world's 16th largest economy and the largest economy in Southeast Asia is the main reason why we selected Indonesia as the focal economy in this study country. Furthermore, Indonesia implements a free-floating exchange rate and free capital flow regime, and in 2030, according to McKinsey (2021), it is expected to become the seventh largest economy in the world.

3.3.2 Methodology. For the empirical investigation, the NARDL approach developed by Shin *et al.* (2014) will be used [1]. The NARDL approach offers several advantages: in contrast



Source(s): Figure has been created by the authors using publicly available data for Indonesia's Foreign Exchange Turnover by Currency as of April 20191, sourced from BIS Triennial Survey 2019

Figure 5.
Indonesia's foreign exchange turnover by currency as of April 2019

to the normal VAR technique, which can lose information contained in connections between series levels, the NARDL approach can show variances in the regressors' responses to positive and negative shocks from the asymmetric dynamic multipliers (Jareño *et al.*, 2019 and Allen and McAleer, 2021); we are able to test simultaneously the long and short-run asymmetric over the negative and positive partial sum decompositions of the regressors (Jareño *et al.*, 2019) because the NARDL approach lacks residual association, and this model is unsusceptible to the omission of lag bias (Arize *et al.*, 2017).

To ensure that the requirements to conduct non-linear ARDL methodologies are fulfilled, the series were tested for unit roots to determine the level of integration (see Jareño *et al.*, 2020: Baek and Choi, 2021).

The generic form of the regression equation to examine the asymmetric link between Indonesian bond yield and equity market price with the exchange rate is expressed as follows:

$$EXC_t = \beta_0 + \beta_1 BON_t + \beta_2 JCI_t + \varepsilon_t \tag{1}$$

where EXC_t is the US$/IDR currency rate, BON_t is the 10-year Indonesian government bond yield, JCI_t is the Indonesian Stock Exchange market price, β_0 is the constant term, t is the time index (trading day), β_1 and β_2 are the slope coefficients and ε_t is the error term. It should also be stressed that we have taken the natural logarithm all variables used in this study and hence reflecting relative changes.

The explicit model that considers long-run asymmetries is expressed in the following terms:

$$Y_t = \beta^{+X_t^{++\beta^{-X_t^{-+\varepsilon_t}}}} \tag{2}$$

where Y_t indicates dependent variable, β + and β^- are the long-run parameters to be evaluated, whereas ε_t is the error term and X_t^+ and X_t^- are the partial sums of the vectors of positive and negative changes of independent variables.

Equation (2) can be reformulated to an asymmetric long-run regression equation (3) as follows:

$$EXC_t = \beta_0 + \beta_1 BON_{POSt} + \beta_2 BON_{\neg t} + \beta_3 JCI_{POSt} + \beta_4 JCI_{\neg t} + \varepsilon_t \tag{3}$$

where EXC_t denotes the US$/IDR exchange rate, β_0, β_1, β_2, β_3 and β_4 are coefficient of long-run parameters to be estimated and ε_t represents the error term. Moreover, BON_POS_t *and* BON_NEG_t are the partial sum of positive and negative changes in the bond yield, whereas JCI_POS_t and JCI_NEG_t are the partial sum of positive and negative changes in the stock price, and the values are formulated as follows:

$$BON_{POSt} = \sum_{j=1}^{t} \Delta lnBON_j^{+=\sum_{j=1}^{t} max} \tag{4}$$

$$BON_{\neg t} = \sum_{j=1}^{t} \Delta lnBON_j^{-=\sum_{j=1}^{t} min} \tag{5}$$

$$JCI_{POSt} = \sum_{j=1}^{t} \Delta lnJCI_j^{+=\sum_{j=1}^{t} max} \tag{6}$$

$$JCI_{\neg_t} = \sum_{j=1}^{t} \Delta lnJCI_j \quad -= \sum_{j=1}^{t} min \tag{7}$$

Since equation (3) provides only the possible long-run correlations to assess the short-run effects, we follow Pesaran *et al.* (2001) to transform equation (3) into an error-correction model as follows:

$$\begin{aligned} \Delta EXC_t = {} & \beta_0 + \sum_{k=1}^{p} \beta_{i1,t-k} \Delta EXC_{t-k} + \sum_{k=0}^{p} \beta_{i2,t-k} \Delta BON_{POSt-k} + \sum_{k=0}^{p} \beta_{i3,t-k} \Delta BON_{\neg_{t-k}} \\ & + \sum_{k=0}^{p} \beta_{i4,t-k} \Delta JCI_{POSt-k} + \sum_{k=0}^{p} \beta_{i5,t-k} \Delta JCI_{\neg_{t-k}} + \theta_0 EXC_{t-1} + \theta_1 BON_{POSt-1} \\ & + \theta_2 BON_{\neg_{t-1}} + \theta_3 JCI_{POSt-1} + \theta_4 JCI_{\neg_{t-1}} + \varepsilon_t \end{aligned} \tag{8}$$

where ΔEXC_t denotes the dynamic of US$/IDR exchange rate, β_0 represents the constant, $\theta_0, \theta_1, \theta_2, \theta_3$ and θ_4 represent the long-run coefficients, $\beta_{i1}, \beta_{i2}, \beta_{i3}, \beta_{i4}$ and β_{i5} are the short-run coefficients and ε_t represents the error term.

According to Shin *et al.* (2014), the parameters in the NARDL model are the same as those in linear ARDL model established by Pesaran *et al.* (2001). Therefore, to run or estimate equation (8), the typical *F*-test criteria of Pesaran *et al.* (2001) will be used in this study to investigate whether a long-run relationship exists among the selected variables. We then test if the F-statistic value exceeds the upper critical value, i.e. indicating that there is cointegration between the selected variables. Furthermore, we conduct some diagnostic tests to ensure that the model meets the assumptions of classical regression and the specification of the model is well justified. We finally estimate the dynamic multipliers to establish the transmission effect both for the short and the long run.

4. Results

To ensure that the required conditions are met when applying the NARDL approach, we employed the augmented Dickey–Fuller (ADF) unit root test on the selected variables to check the order of integration. Table 1 presents the results of the ADF unit root test for all variables in the model for both sample periods. In the full sample period, the test statistic for all variables is less than the critical value at first difference form or I (1). Whilst, in the sub-sample period, only exchange rate that stationary at level form or I (0), whereas the others at first difference form or I (1). As a result, it is clear that there are no second difference form or I (2) variables, and this satisfies the requirement to proceed to the NARDL technique [2].

Following the unit root test, the next step is to evaluate the presence of a stable long-run relationship using a bound testing approach. Table 2 presents the bound test outcomes of all variables. When the F-statistic value exceeds the upper bound, the null hypothesis is rejected, hence indicating that cointegration exists. On the basis of the Akaike Information Criterion (AIC), the best lag specification for the full sample and subsample periods are (3, 2, 1, 4, 4) and (3, 4, 1, 4, 3), respectively.

As it can be observed from Table 3 when the full sample model is considered, the test for cointegration is inconclusive, i.e. the upper bound critical value 3.49 is greater than the computed F-statistics value 2.14. In the case of the subsample, however, the calculated F-statistic value 3.56 is greater than the 95% upper bound critical value of 3.49, indicating that there is a cointegrating relationship between financial market indicators and the Indonesian currency rate fluctuations.

Variables	Form	ADF statistics	10% critical value	Stationary
Full-sample: 1/02/2012 12/31/2021				
EXC	Level	−2.432	−2.567	N
BON	Level	−2.321	−2.567	N
JCI	Level	−1.797	−2.567	N
EXC	First difference	−12.926	−2.567	Y
BON	First difference	−40.269	−2.567	Y
JCI	First difference	−15.043	−2.567	Y
Subsample: 1/01/2020 12/31/2021				
EXC	Level	−3.884	−2.570	Y
BON	Level	−1.797	−2.570	N
JCI	Level	−1.471	−2.570	N
EXC	First difference	−4.755	−2.570	Y
BON	First difference	−6.659	−2.570	Y
JCI	First difference	−8.358	−2.570	Y

Source(S): Authors' calculations

Table 1.
ADF unit root tests

Model	Lag	F-stat	(Lower bound–upper bound) at significance level 10%	5%	1%	Conclusion
Full sample	NARDL (3, 2, 1, 4, 4)	2.14	2.20–3.09	2.56–3.49	3.29–4.37	Inconclusive
Subsample	NARDL (3, 4, 1, 4, 3)	3.56***	2.20–3.09	2.56–3.49	3.29–4.37	Cointegration

Note(s): *** = $p \leq 0.01$, ** = $p \leq 0.05$ and * = $p \leq 0.10$
Source(s): Authors' calculations

Table 2.
The bound test of nonlinear ARDL

The results for the NARDL estimation are given in Table 3.

The test results for the full sample period revealed that there is evidence of an asymmetric effect in long and short run. The estimation results, in Table 3-Panel A, suggest that only the bond yield was found to be positive and highly significant. For the subsample, the evidence suggests that there is asymmetrical effect over the long run. Panel A suggests that both independent variables are statistically significant in terms of the positive change (LN_BON_POS and LN_JCI_POS) in the long run. In particular, the coefficient of bond yield (LN_BON_POS) bears a positive sign whereas the coefficient of the stock market price (LN_JCI_POS) exhibits a negative association. As for the coefficients reflecting the negative changes they were found to be statistically insignificant, i.e. LN_BON_NEG and LN_JCI_NEG, respectively. In both models, the evidence of an asymmetrical effect that appears in the long run is confirmed by the Wald test, i.e. the null hypothesis of equality is rejected.

Panel B in Table 3 reports the estimation results in the short run. Consistent with the long run results, a change in bond yield (ΔLN_BON_POS and ΔLN_BON_NEG) positively impacts the US$/IDR exchange rate. In addition, the results of the stock market price (ΔLN_JCI_POS and ΔLN_JCI_NEG) are significant and bear negative signs hence implying that all else being equal, a change in the stock market, will cause the US$/IDR exchange rate to appreciate.

Moving to short-run analysis of the subsample in Panel B of Table 3, all variables but ΔLN_BON_POS (−2) are found to be significant. A change in the bond yield will cause the US$/IDR currency rate to depreciate in the short run, ceteris paribus whilst a change in the stock market price (ΔLN_JCI_POS and ΔLN_JCI_NEG) will causes the US$/IDR currency rate to appreciate in the short.

Full-sample: 1/02/2012 to 12/31/2021			Sub-sample: 1/01/2020 to 12/31/2021		
Lag structure	ARDL (3, 2, 1, 4, 4)			ARDL (3, 4, 1, 4, 3)	
Variables	Coeff.	Std. error	Variables	Coeff.	Std. error
Panel A: long run					
LN_BON_POS	0.405***	0.088	LN_BON_POS	0.312***	0.141
LN_BON_NEG	0.316***	0.141	LN_BON_NEG	−0.056	0.214
LN_JCI_POS	0.090	0.179	LN_JCI_POS	−0.239***	0.117
LN_JCI_NEG	0.138	0.144	LN_JCI_NEG	−0.038	0.103
C	9.183***	0.041	c	9.514***	0.021
Panel B: short run					
Δ(LN_EXC(−1))	0.029	0.019	Δ(LN_EXC(−1))	0.095***	0.039
Δ(LN_EXC(−2))	0.044***	0.018	Δ(LN_EXC(−2))	0.212***	0.038
Δ(LN_BON_POS)	0.165***	0.012	Δ(LN_BON_POS)	0.336***	0.033
Δ(LN_BON_POS(−1))	−0.033***	0.012	Δ(LN_BON_POS(−1))	−0.059***	0.035
Δ(LN_BON_NEG)	0.147***	0.013	Δ(LN_BON_POS(−2))	0.038	0.036
Δ(LN_JCI_POS)	−0.106***	0.013	Δ(LN_BON_POS(−3))	−0.107***	0.028
Δ(LN_JCI_POS(−1))	0.017	0.012	Δ(LN_BON_NEG)	0.262***	0.034
Δ(LN_JCI_POS(−2))	0.012	0.012	Δ(LN_JCI_POS)	−0.043**	0.022
Δ(LN_JCI_POS(−3))	−0.031***	0.012	Δ(LN_JCI_POS(−1))	0.037**	0.021
Δ(LN_JCI_NEG)	−0.076***	0.012	Δ(LN_JCI_POS(−2))	0.065***	0.021
Δ(LN_JCI_NEG(−1))	−0.038***	0.012	Δ(LN_JCI_POS(−3))	−0.056***	0.019
Δ(LN_JCI_NEG(−2))	−0.042***	0.012	Δ(LN_JCI_NEG)	−0.065***	0.024
Δ(LN_JCI_NEG(−3))	−0.023***	0.012	Δ(LN_JCI_NEG(−1))	−0.051***	0.024
ECT(−1)	−0.006***	0.002	Δ(LN_JCI_NEG(−2))	−0.060***	0.024
			ECT(−1)	−0.036***	0.008
Panel C: diagnostic tests					
Symmetry	$5.1(0.04)_{BON}/6.6(0.01)_{JCI}$		$2.1(0.10)_{BON}/3.9(0.05)_{JCI}$		
LM	1.283		LM		0.029
ARCH	34.687		ARCH		5.812
RAMSEY	8.897		RAMSEY		0.591

Note(s): *** = $p \leq 0.01$, ** = $p \leq 0.05$ and * = $p \leq 0.10$
Source(s): Authors' calculations

Table 3.
Estimation results–NARDL models

The error correction term in both models is found to be negative and significant reflecting the speed at which the dependent variable returns to equilibrium after a change in other variables. The Cumulative Sum (CUSUM) tests suggest that all estimated coefficients are stable during the full and subsample periods (see Figures 6 and 7).

Following Shin *et al.* (2014), we also employ the dynamic multipliers that trace the dynamic flow of the adjustment. Figure 8 depicts the effect of the dynamic multiplier on positive and negative changes in LN_BON and LN_JCI in the full sample model. The influence of positive changes in bond yield and the stock market price is captured by the solid green line, while the

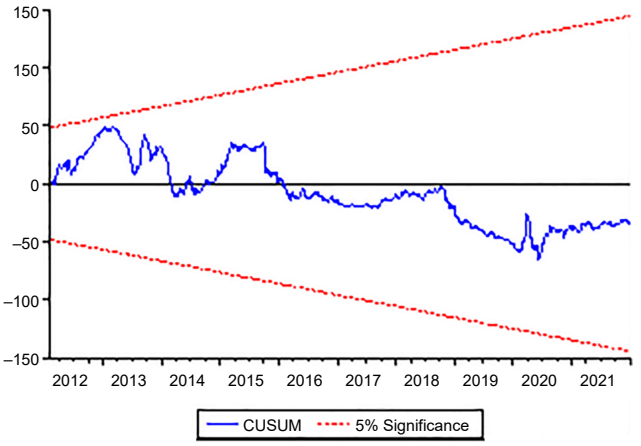


Figure 6.
CUSUM test results – full sample period

Source(s): Created by the authors

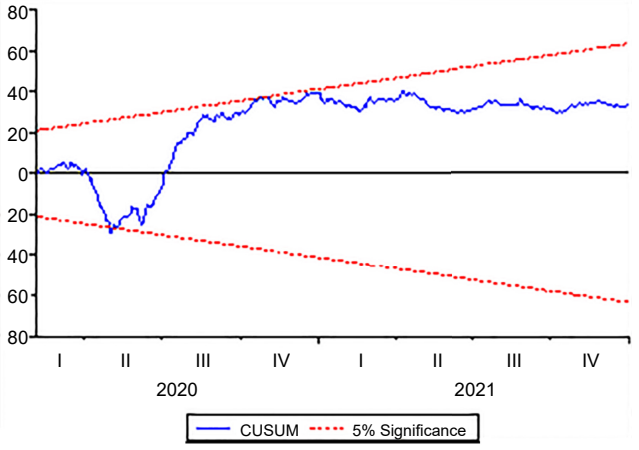


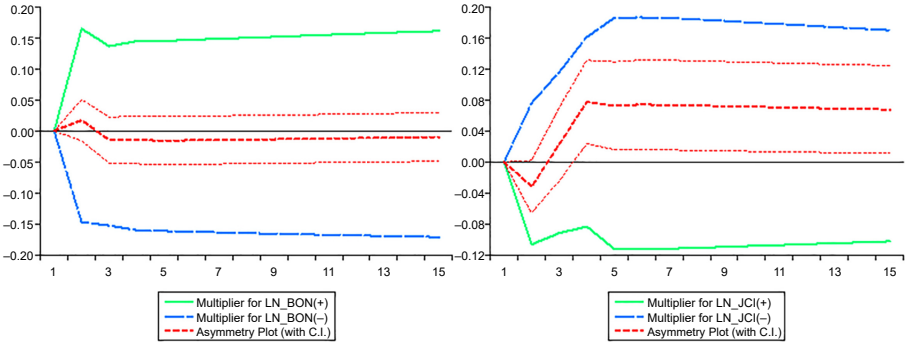
Figure 7.
CUSUM test results – subsample period

Source(s): Created by the authors

solid blue line captures negative changes. Further, the red perforated line depicts the difference between positive and negative changes in the independent variable.

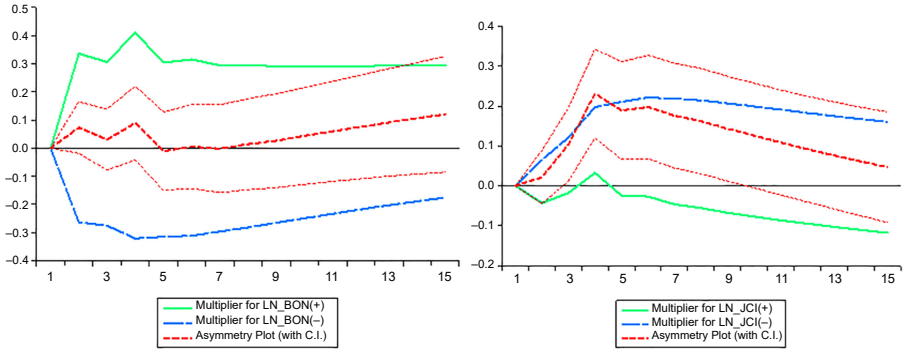
According to the figure, it takes around two days for the multiplier to impact the fluctuation of the US$/IDR currency rate, and the impact on the yield on 10-year Indonesian government bond begins to diminish on the next day. In the meantime, it takes about five days for the stock market price shock to fully adjust the US$/IDR exchange rate movement. Dwindling bond yield tends to influence the US$/IDR exchange rate more than bond yield increases. Meanwhile, declining stock market prices affect US$/IDR exchange rate movements more than rising stock market prices.

The effect of the dynamic multiplier on positive and negative changes in LN_BON and LN_JCI in the subsample model is illustrated in Figure 9 on the basis of which the stock



Source(s): Created by the authors

Figure 8.
Dynamic multipliers – full sample period



Source(s): Created by the authors

Figure 9.
Dynamic multipliers – subsample period

market shock takes roughly four days to impact the US$/IDR currency rate movement before stabilizing in the following days, whereas for the bond yield, it takes about four days. In the subsample model, bond yield increases tend to have a greater effect on the US$/IDR currency rate than bond yield declines. Meanwhile, a decrease in the equities market index has a higher effect on US$/IDR currency rate movements than an increase in the equity market pricing.

Based on the results of the long-run estimate, the bond yield affects the US$/IDR exchange rate. This piece of evidence is in line with Lace *et al.* (2015), Engel and Wu (2018) and Soni *et al.* (2018), who found that government bonds are a significant predictor that influences the domestic currency of Germany, G10 countries and India, respectively. Meanwhile, the stock market price was found to have no impact on the exchange rate. This finding is consistent with the results of Bahmani-Oskooee and Sohrabian (1992), Granger *et al.* (2000) and Nieh and Lee (2001), which reported that there is no long-run association among equity markets and domestic currency in the USA, G7 countries and Japan, respectively. In the short run, even though most of the estimated coefficients are found to be significant with evidence of asymmetry, the sign of the bond yield however remains rather ambiguous.

In the subsample, the results point to a long-run asymmetry between the bond yield, stock market prices and the US$/IDR currency rate movements. This finding is in line with Hsing (2016) who found that the domestic currency is positively related to the yield on local government bonds and negatively to the local stock market price in the case of South Africa.

As for the short-run, the evidence which is in line with Nusair and Al-Khasawneh (2022), suggests that the Indonesian currency rate fluctuations are asymmetrically responding to Indonesian bond yield and stock market prices in both the short and long run.

5. Conclusions

This study investigates nonlinearities, using a NARDL methodology, between the yield on 10-year Indonesian sovereign bonds, stock market price and the US$/IDR currency rate over the period 2012–2021. In addition, in the subsample period, this study investigated the dynamics of the capital market during the COVID-19 crisis. Based on the bound test constructed, it may be concluded that there is no cointegration between the exchange rate and the Indonesian bond yield and stock market price over the full sample period. Further, this result is also consistent with Rosnawintang *et al.* (2021) research which found no long-run cointegration among the US$/IDR currency rate and the yield on 10-year Indonesian sovereign bond. However, cointegration was established during the subsample period (COVID-19 crisis).

These results reveal that a relationship between exchange rate fluctuations and capital market transactions in the Indonesian bond and stock markets exists. Furthermore, it shown that an asymmetric effect of bond yield and stock market price changes in the US$/IDR currency rate occurs in the long and short run, simultaneously. The positive relationship between the US$/IDR currency rate and bond yield and the negative relationship appears between the US$/IDR exchange rate and stock market price in the subsample suggest that when bond yields rise and stock market prices fall, the US$/IDR rate falls. This finding revealed an asymmetric effect and showed that increasing and decreasing equities composite index have a long-run impact on the US$/IDR currency rate, i.e. declining stock prices leads to currency depreciation.

An exploration of the dynamic effects confirms that a positive change in bond yield has a larger impact on the transmission of the US$/IDR exchange rate than a negative change in the sub sample period whilst a bond yield has a stronger effect compared to changes in the equity index prices on the US$/IDR exchange rate movements. This is an important finding as to a large extent justifies the central bank's exchange rate policy that employs the triple intervention strategy to stabilizes the foreign exchange market (spot and domestic non-deliverable forward) and purchases of local currency bonds from the secondary market in order to ensure the stability of exchange rates (Bank Indonesia, 2022).

Finally, the effect of changes in the capital markets on the US$/IDR exchange rate movements when investors assemble their portfolios in Indonesia as well as the challenging conditions to stabilize the exchange rate when the bond yield surges can have significant policy implication for both investors and regulators. Information provided by the dynamic multiplier about the duration of the impact of changes in the bond and stock markets is invaluable when designing strategies and draft policies.

Future research directions could be to examine the impact of central bank policies, such as interest rate decisions or quantitative easing programs, on exchange rates, bond yields and the stock market. Researchers could explore how these policies influence these three variables and whether they have different effects on different countries or regions.

Notes

1. It should be highlighted that the ARDL approach to cointegration is primarily used to determine the long run relationship between series with different order of integration. The short-run dynamics and long run relationship of the variables are given by the reparametrized model. Specifically, the NARDL model is a single-equation error correction model that can accommodate asymmetry in the long-run equilibrium relationship and/or the short-run dynamic coefficients via the use of partial

sum decompositions of the independent variable(s). Potentially, due to presences of asymmetric impact, the usual ARDL may not able to capture this whilst the bounds test may show absence of co-integration. As such we have opted for the NARDL approach to capture possible asymmetries in the interaction between capital market asset price and exchange rate movements both in the short and the long run.

2. The data set is available upon request for those who wish to replicate the results of this study.

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Appendix

	EXC	BON	JCI	LN_EXC	LN_BON	LN_JCI
Full Sample: 1/02/2012 to 12/31/2021						
Number of observations	2,610	2,610	2,610	2,610	2,610	2,610
Mean	12,900	7.22	5,312	9.45	1.97	8.57
Median	13,384	7.21	5,247	9.50	1.97	8.57
Maximum	16,575	9.83	6,723	9.72	2.29	8.81
Minimum	8,935	5.05	3,655	9.10	1.62	8.20
Std. Dev	1,735	0.98	769	0.15	0.14	0.15
Sub Sample: 1/01/2020 to 12/31/2021						
Number of observations	523	523	523	523	523	523
Mean	14,419	6.66	5,731	9.58	1.89	8.65
Median	14,343	6.55	5,986	9.57	1.88	8.70
Maximum	16,575	8.38	6,723	9.72	2.13	8.81
Minimum	13,583	5.89	3,938	9.52	1.77	8.28
Std. Dev	488	0.54	653	0.03	0.08	0.12

Source(s): Authors' calculations

Table A1.
Descriptive statistics

	Full-sample: 1/02/2012 12/31/2021				Sub-sample: 1/01/2020 12/31/2021		
	LN_BON	LN_EXC	LN_JCI		LN_BON	LN_EXC	LN_JCI
LN_BON	1			LN_BON	1		
LN_EXC	0.443***	1		LN_EXC	0.683***	1	
LN_JCI	−0.033**	0.690***	1	LN_JCI	−0.846***	−0.682***	1

Note(s): *** = 1% level of significance, ** = 5% level of significance, * = 10% level of significance
Source(s): Authors' calculations

Table A2.
Correlation matrix

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