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The effect of real exchange rate misalignment on economic growth: Evidence from emerging markets

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Abstract

Purpose — This study investigates the effect of real exchange rate (RER) misalignment on economic growth performance for 21 emerging markets from 1980 through 2016.

Methods — The study measures the RER misalignment series for 21 emerging markets relying on the single-equation approach. It estimates the effect of RER misalignment, undervaluation, and overvaluation on economic growth performance using a dynamic panel system generalized method of moments approach.

Findings — The study finds that the RER of emerging markets is significantly misaligned. The study also argues that any deviation of the RER from its equilibrium value impairs economic growth. The view that overvaluation erodes growth was accepted, while a real undervaluation is found to be a deteriorating growth fact.

Implication — From the policy perspective, policymakers should advocate appropriate exchange rate policies to check its sustained misalignments over time to enrich the ability of concerned authorities to attain the growth target by using it as a policy instrument.

Originality — Apart from the lack of a unique analytical framework for determining RER misalignment, most studies on the impact of RER misalignment in emerging markets largely ignore its growth effects. The study is an attempt to address these gaps.

Keywords — economic growth, RER misalignment, single-equation approach, system GMM, emerging markets

Introduction

The real exchange rate (RER), as a summary measure of crucial economic information, has gained recognition in theoretical discussion among economists and policymakers. Despite their unanimity, the ways RER misalignment affects the macroeconomic performance of open economies are construed differently. The RER conducive to a country's internal and external equilibrium is referred to as equilibrium RER. Deviation in RER from its equilibrium value, that is, overvaluation or undervaluation in RER, also called RER misalignment, exerts a considerable impact on the macroeconomic performance of open economies. Overvaluation of RER is generally viewed as the unpredictability of the choices of macroeconomic policies that may result in an unsustainable current account deficit, a significant rise in external debt, and the risk of possible speculative attacks. However, an undervaluation in RER promotes investment and exports, strengthening

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economies' competitive position, which causes the current account position to improve and thereby stimulates output growth of the economies (Razin & Collins, 1997; Schröder, 2013).

Misalignment in RER brings about a change in trade balance through changing the competitive position of an economy at least in three possible ways, by changing the relative prices of exports and imports, by altering the relative prices of tradable and non-tradable goods, and by reallocating resources between tradable and non-tradable sectors due to the change in the relative wage rate. The price uncertainty resulting from RER misalignment also affects the aggregate level of domestic consumption and domestic investment. As they all together determine the level of the national output of an economy, RER misalignment is one of the crucial factors that describe the growth of open economies.

The consistently faster growth performance of emerging markets (EMs) as compared to the developed economies has made them the key driver of global growth over the last few decades. EMs have maintained a fairly greater growth rate than the developed economies since the 1970s. EMs experienced a higher growth around almost last five decades against the declining trend in the growth of developed economies, of which the 2000s was remarkable, as average gross domestic product (GDP) growth in these economies picked at just over 5.9 percent against the average of 1.6 percent in developed economies over the same period. The average growth rate of developed economies was around 1.9 percent in the 2010s, which was around 5.1 percent for EMs.

A relatively stable RER is a fundamental factor of economic stability as viewed by many authors (Edwards, 1989; Schröder, 2017), and hence, with the increase in the alternative exchange rate policy opportunities, the effects of the choice of exchange rate regime on macroeconomic conditions of EMs bear a great deal of attention particularly because of their divergence in exchange rate management. In this context, researchers and policymakers have a strong interest in RER misalignment, particularly because of its influence in causing instability and effects on the macroeconomic performance of economies. While emerging Asian economies have been able to achieve miraculous growth following deliberate management of their exchange rate policies, emerging Latin American economies endured persistent currency crises owing to poor manipulation of the exchange rate regime over the second half of the twentieth century (Nouira & Sekkat, 2012). However, Latin American economies were stable in the last decades and even after the great recession of 2008-09 as they took lessons from the past and actively intervened in the foreign exchange market (Damill & Frenkel, 2017). Therefore, an appropriate exchange rate regime that allows maintaining the RER adjacent to its equilibrium value results in instability in the macroeconomic performance of open economies.

Realizing the enormous significance of the conjugation of equilibrium RER and RER misalignment on macroeconomic performance, plenty of research effort has been devoted to examining RER movements and their impact on the macroeconomic performance of open economies. However, although the EMs are the major contributor to global growth, no recognized study has been found in recent years evaluating their macroeconomic performance in response to RER misalignment, particularly after the East Asian financial crisis, following which both the crisis-affected emerging Asian economies and the emerging Latin American economies passing through frequent currency crisis over the last half of the twentieth century have been able to recover through appropriate management of their exchange rate policies (Damill & Frenkel, 2017). Earlier studies relying on the country level and panel data greatly differ in terms of their analytical framework, leading to diverse findings on RER misalignment and its implication on the macroeconomic performance of EMs as well as developing economies. This current research is an attempt to bridge these voids. It is in response to the need for an analytical framework for examining misalignment in RER to make a more inclusive decision relating to its effects on the growth performance of EMs.

There is extensive empirical literature on RER misalignment and economic growth linkage, but much of the recent studies on the growth impact of misaligned exchange rates can be perceived in the context of the Washington Consensus view. This view regards both sorts of RER misalignments. That is, deviations of RER from its equilibrium values in any direction are detrimental from a long-term growth perspective, which has been supported by several empirical

studies (Aguirre & Calderon, 2005; Mazorodze, 2021; Sallenave, 2010; Schröder, 2013, 2017; Toulaboe, 2006).

Edwards (1989) was the first pioneer to estimate the impact of RER misalignment on economic growth for 12 developing countries over the period 1962-1984. The study finds misallocation of resources due to the distortions in relative prices of tradable and non-tradable sectors caused by RER misalignment, which damages economic growth. Aguirre and Calderon (2005) used the fundamentals of Edwards's (1989) model to estimate the impact of RER misalignment on the economic growth of 60 countries during 1965-2003, applying the System Generalized method of moments (SGMM) estimation approach. The results show that misalignments impact growth in a nonlinear fashion. That is, a larger size of misalignment leads to a larger decline in economic growth. Sallenave (2010) measures RER misalignments employing the behavioral approach and evaluates its growth effects for the G-20 countries over the period 1980-2006. The findings differ largely from developed to emerging economies- while it marks misalignment is relatively pronounced in Ems. Moreover, a relatively sluggish speed of convergence towards the estimated equilibrium exchange rate is evident for developed economies. However, the overall growth effects of misalignment are found to be negative. Toulaboe (2006) investigates the relationship between the mean growth rate of per capita GDP and RER misalignment for 33 developing countries from Sub-Saharan Africa, Asia, and Latin America. The results indicate that average RER misalignments are negatively correlated with economic growth. Schröder (2013, 2017) suggests that not equilibrium RER but its misalignments do affect economic growth in 63 developing countries over 1970–2007. In a most recent study, Mazorodze (2021) investigates whether currency misalignment and state fragility have a role in the sluggish growth of sub-Saharan Africa between 2009 and 2018 applying the SGMM. It suggests that RER misalignment has a significantly negative impact on growth that increases with state fragility.

However, the decomposition of misalignment indicators is focused much in recent studies to illustrate the growth effect of deviations of RER from its equilibrium values which results in a rising agreement amongst researchers to reject the view that RER misalignments are harmful from the long-term growth perspective as they have found RER overvaluation has a negative impact on economic growth, while undervaluation stimulates it. Though a depreciated RER fosters economic growth of developing and emerging economies, it may bring about a contractionary effect beyond a certain limit. Considering data for a large sample of countries over the period 1980-2009, Couharde and Sallenave (2013) identify the threshold value of devaluation for Asian and non-Asian emerging economies beyond which it harms growth. Ribeiro, McCombie, and Lima (2020) focus on one direction of RER change, the undervaluation, to examine its impact on economic growth for a panel of 54 developing countries covering the period 1990–2010 and identifies that it has an indirect impact on the growth of the selected developing countries.

Methods

The study will consider economies following floating, free-floating, or other managed exchange rate arrangements under monetary aggregate target or inflation targeting framework. EMs from all major regions of the globe have been covered in undertaking the research. Annual frequency data for the period 1980-2016 have been used for the 21 EMs, namely Argentina, Bangladesh, Brazil, Chile, China, Colombia, Egypt, Greece, Indonesia, India, Republic of Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, South Africa, Thailand, Turkey, and United Arab Emirates.

The RER is a multilateral exchange rate to measure the relative price of domestic goods and services in terms of a basket of goods and services of other major trading partners, which is the weighted-average of bilateral RER where the trade share of a trading partner in a country's total trade constitutes the weight. RER indices are based on the consumer price index (CPI). The base year is kept fixed across the economies. Terms of trade data were retrieved from the data center of the United Nations Conference on Trade and Development (UNCTAD) and International Financial Statistics (IFS) of the International Monetary Fund (IMF). The net financial assets position (NFA) and net official development assistance (ODA) are taken as the ratio to GDP and compiled from World Development Indicators (WDI) of the World Bank (WB).

The explanatory variables have to be proxied by appropriate alternatives to estimate equilibrium RER. Investment spending (INV) data is proxied by gross capital formation as a percent of GDP. Government expenditure (GOV) broadly falls into two categories: expenditure on tradable (GT) and non-tradable (GN) goods. However, the share of government expenditure in these two categories is not distinctly attainable and therefore replaced by the share of total government expenditure in GDP. The direct measure of trade policy is not available. Empirical studies substantially use the sum of exports and imports over GDP to proxy this variable. Productivity differentials have been proxied by the relative productivity between EMs and Group of Seven (G-7) countries, which is constructed as a percent of the home country's GDP per capita to the G-7 average GDP per capita for each of the EMs. Data on these variables are piled up from Penn World Table (PWT), WDI of WB, IFS of IMF, and UNCTAD

Concerning growth regression, the data on the growth rate of real GDP per capita and inflation rate (CPI-based) are collected from the WDI of the WB. Government consumption, investment spending, terms of trade, openness, and net foreign asset – all these are important fundamentals of equilibrium RER that are included in the growth regression to purge omitted variable bias. The study also considers human capital proxied by average years of total schooling and institutional quality proxied by polity variable. Data for the variables are sourced from the Barro-Lee (2020) database on educational attainment and the Center for Systemic Peace database, respectively. Finally, in $\ln(n_{i,t}+g+\delta)$, which measures the growth rate of effective labor units and the rate of depreciation, the population growth rate ($n_{i,t}$) is extracted from WDI of WB. In contrast, the rate of advancement in technology (g) and the rate of depreciation (δ) are assumed to be fixed at 0.05 following Mankiw et al. (1992).

For growth regression, the sample period is divided into non-intersecting 5-year intervals over which the data of the variables are averaged. This averaging is required to check non-seasonal components of time series variables similar to cyclical variation to embody the long-run data perspective. Consequently, it produces eight non-intersecting 5-year intervals over the sample period 1980-2016, apart from the last one that covers only two years. Outliers are identified for all of the series and excluded from the analysis to avoid any inconsistency.

The main purpose of the study is to examine the impact of RER misalignments on the macroeconomic performance of the EMs. Therefore, the first order of business is to determine the misalignment series of RER. Equilibrium RER is an unobservable entity, and therefore, its estimation is inevitable to produce the misalignment series.

Deriving RER misalignment series

The study is concerned with the long-run equilibrium RER, and based on Koukouritakis' (2013) comparative analysis, it decides to employ the single-equation approach (SEA) offered by Baffes, Elbadawi, and O'connell (1999), Edwards (1989), and Elbadawi, (1994) to determine the equilibrium RER and corresponding misalignment. The SEA estimates the long-run equilibrium RER directly drawing a vector of sustainable values for the fundamentals that include terms of trade (TOT), government spending on non-tradable goods (GN), government spending on tradable goods (GT), investment (INV), trade openness (OPEN). However, the theory underlying this approach offers a relatively wide range of fundamentals to choose from in developing the model. Consider with literature from developing and emerging economies (for instance, Schröder, 2013; Toulaboe, 2006), the study identifies NFA, the relative productivity in the tradable sector to non-tradable sector (PROD) to incorporate the Balassa-Samuelson effect, and official development assistance (ODA) apart from the aforesaid fundamentals in modeling equilibrium RER. Hence, the theoretical model of equilibrium RER (q*) determination takes the following form:

$$q^* = q(TOT, G_N, G_T, INV, OPEN, NFA, PROD, ODA) \quad (1)$$

The empirical model for estimating the relationship between RER and its fundamentals can, therefore, be given as:

$$lnq_{it}^* = \beta' F_{it}^s \quad (2)$$

Where q^*_{it} is the equilibrium RER of country i at time t, β' is the vector of coefficients of the long-run parameters to be estimated, F_{it}^{s} is the vector of permanent or sustainable values for the set of fundamentals of country i at time t. The empirical model presented below is nothing but the replication of equation 2:

$$lnq_t^* = \beta_0 + \beta_1 lnTOT_t + \beta_2 G_{Nt} + \beta_3 G_{Tt} + \beta_4 INV_t + \beta_5 OPEN_t + \beta_6 NFA_t + \beta_7 lnPROD_t + \beta_8 ODA_t + \varepsilon_t \quad (3)$$

This current study expects that government spending on non-tradable goods, net financial assets position, relative productivity in the tradable sector to non-tradable sector, and official development assistance have a positive impact on RER while it is inversely related to government spending on tradable goods and trade openness. However, the impact of terms of trade and investment can either be positive or negative.

In order to estimate the equilibrium RER empirically as modeled in equation 3 for each of the countries separately, the study proceeds in three steps: firstly, it examines the stationarity of the variables. Then it estimates the long-run co-integration relationship among the variables that are integrated at order 1. As a unique combination of fundamentals may not always form a long-run co-integration relationship with RER irrespective of countries, the study considers their alternative combinations, and the final choice is based on criteria proposed by Montiel (2007): Specification for which there exists a long-run co-integration relationship among the variables must comply with all necessary diagnostic checks, the estimated parameters must be stable, signed according to economic theory, and statistically significant. For more than one such specification, preference will be given to the one that minimizes the information criteria. Once the long-run co-integrating relationship is confirmed, the sustainable values of the fundamentals derived by detrending the fundamentals using Hodrick & Prescott (1997) filtering is used to arrive at the long-run equilibrium values of RER (Schröder, 2013). Finally, the misalignment series can be derived by simply taking the difference between the actual and long-term equilibrium values of RER in terms of percent.

Empirical model for growth regression

A critical issue in investigating the impact of misalignment on macroeconomic performance is the potential endogeneity. The endogeneity problem is encountered when some regressors are expected to be explained by unobserved common factors and must be checked to eliminate prospective bias in the estimated parameters. This current study employs the dynamic panel Generalized method of moments (GMM) estimation approach to address endogeneity and to estimate the dynamic relationship between growth and misalignment (Nouira & Sekkat, 2012; Sallenave, 2010; Schröder, 2017). The general form of the dynamic model is much as follows:

$$y_{i,t} = \alpha + \beta y_{i,t-1} + \gamma X_{i,t} + \theta m_{i,t} + \varepsilon_{it} \quad (4)$$
$$\varepsilon_{it} = \mu_i + \lambda_t$$

Where $y_{i,t}$ is the economic growth, the performance of which will be evaluated in response to RER misalignment $m_{i,t}$, $y_{i,t-1}$ refers to the value of y at the initial period, $X_{i,t}$ is a set of control variables that explain $y_{i,t}$. The error term $\varepsilon_{i,t}$ is composed of two different orthogonal elements, the country fixed effects μ_i and the idiosyncratic time effects λ_t. The dynamic panel model also provides superior results compared to the static models like random and fixed effect models as these models are sensitive to the existence of a correlation between lagged dependent variable and error term and therefore contain deep econometric bias.

The standard GMM estimator proposed by Arellano and Bond (1991) ponders the first-difference transformation of all variables while explanatory variables are used at lagged levels as instrumental variables:

$$\Delta y_{i,t} = \alpha + \beta \Delta y_{i,t-1} + \gamma \Delta X_{i,t} + \theta \Delta m_{i,t} + \Delta \varepsilon_{it} \quad (5)$$

This model eliminates the country-fixed effect as it is time-invariant, but this instrumenting process works poorly in the presence of autocorrelation among errors due to which the resulting

estimators could be imprecise or even biased. This swayed Arellano and Bond (1991)and Blundell and Bond (1998) to develop an SGMM estimator. They extend the Arellano-Bond estimator based on the assumption of no correlation between instrumenting variables at first differences and fixed effects which allow them to introduce more instruments that boosts the efficiency of estimators sharply. Arellano and Bover (1995) propose to take forward orthogonal deviation transforming the regressors to obliterate fixed effects which improve control over the instrument matrix minimizing data losses and thereby results in a better GMM estimator from that of the first difference model. To have a more precise estimator, Blundell & Bond (1998) resort to the approach drawn by Arellano and Bover (1995) just by reverting the instrumentation, instrumenting regressors in levels with differences so that the instrumenting variables become uncorrelated (exogenous) to the fixed effects. The study, therefore, decides to rely on Blundell and Bond's (1998) estimation approach to investigate the macroeconomic performance of the EMs while RER misalignment is present.

Similar to the specifications of Razin and Collins (1997) and Couharde and Sallenave (2013), the empirical specification of the growth equation can be given as:

$$g_{i,t} = \alpha + \beta g_{i,t-1} + \gamma X_{i,t} + \theta m_{i,t} + \mu_i + \lambda_t + v_{it} \quad (6)$$

Here, $g_{i,t}$ is the real GDP per capita growth rate, $g_{i,t-1}$ is the per capita growth rate of real GDP at the initial period, $X_{i,t}$ is a set of variables that explain economic growth, misalignment in RER is shown by $m_{i,t}$, μ_i is to represent country fixed effects, λ_t shows time-specific effects and v_{it} is an error term. The model is designed in a dynamic fashion, confirmed by the inclusion of lagged dependent variable as a regressor.

However, Schröder (2013) identifies some perceptible drawbacks of models stipulated in this manner. Most importantly, the model specified in this way ignores the corresponding growth effects of undervaluation and overvaluation. Therefore, to identify the respective impact of undervaluation and overvaluation of RER on growth, the study develops undervaluation and overvaluation indices and incorporates them together in the growth equation. The growth equation becomes:

$$g_{i,t} = \alpha + \beta g_{i,t-1} + \gamma X_{i,t} + \theta_1 UNDER_{i,t} + \theta_2 OVER_{i,t} + \mu_i + \lambda_t + v_{it} \quad (7)$$

where $under$ and $over$ represent undervaluation and overvaluation, respectively. The undervaluation and overvaluation series are constructed, decomposing the misalignment series of RER into its two counterparts- one incorporating the negative values or zero otherwise for the former, and another is incorporating the positive values or zero otherwise for the later series.

The selection of growth determinants is substantially influenced by the evolution of exogenous growth theories following the work of Barro and Lee (1994). The initial value of per capita real GDP growth rate, that is, $g_{i,t-1}$ is taken to account the initial position of the economy following the neoclassical growth theory to control for conditional convergence. Among the voluminous literature on cross-country growth regression, the study consults with the studies conducted by Schröder (2013, 2017), and the factors found to have a significant influence on economic growth are inflation rate, government spending, human capital, institutional quality, investment, terms of trade, trade openness, and net foreign asset position. The study also considers the growth rate of effective labor units and the rate of depreciation by taking ($n_{i,t}+g+\delta$) into account where n is the growth rate of labor, g is the advancement in technology ($n_{i,t}+g$ defines the effective labor growth rate) and δ is the rate of depreciation. Among these factors, terms of trade, openness, net foreign assets position, and government spending are equilibrium RER determining fundamentals, and their inclusion in the growth regression will help remove the omitted variable bias (Schröder, 2013). Along with these determinants, the study comprises the undervaluation and overvaluation series into the model to examine their growth effects. The empirical model for growth regression can therefore be given as:

$$\begin{aligned} g_{i,t} = {} & \alpha + \beta g_{i,t-1} + \gamma_1 INF_{it} + \gamma_2 GOV_{it} + \gamma_3 INV_{it} + \gamma_4 lnHC_{it} + \gamma_5 INST_{it} + \\ & \gamma_6 \ln\left(n_{i,t} + g + \delta\right) + \gamma_7 lnTOT_{it} + \gamma_8 OPEN_{it} + \gamma_9 NFA_{it} + \theta_1 UNDER_{i,t} + \theta_2 OVER_{i,t} + \\ & \mu_i + \lambda_t + v_{it} \end{aligned} \quad (8)$$

where INF stands for the inflation rate, GOV is for government expenditure, INV represents investment, HC is the human capital, INST is a proxy of institutional quality, TOT stands for terms of trade, OPEN refers to trade openness, NFA is the net foreign assets position.

This current study then considers the following regression comprising the RER misalignment ($m_{i,t}$) into the model to examine its growth effect:

$$g_{i,t} = \alpha + \beta g_{i,t-1} + \gamma_1 INF_{it} + \gamma_2 GOV_{it} + \gamma_3 INV_{it} + \gamma_4 lnHC_{it} + \gamma_5 INST_{it} + \gamma_6 \ln(n_{i,t} + g + \delta) + \gamma_7 lnTOT_{it} + \gamma_8 OPEN_{it} + \gamma_9 NFA_{it} + \theta m_{i,t} + \mu_i + \lambda_t + v_{it} \quad (9)$$

The coefficients of both undervaluation and overvaluation have to be negative to support the view that undervaluation fosters economic growth while overvaluation weakens economic growth (Razin & Collins, 1997; Rodrik, 2008; Schröder, 2013). Inflation, government final consumption expenditure, the growth rate of effective labor units, rate of depreciation, and net foreign asset are expected to deter economic growth Barro, 1997; Devarajan, Swaroop, and Zou, 1996 and Fischer (1993). On the other hand, investment, human capital, and institutional quality are expected to have a favorable contribution to economic growth and, therefore, should be accompanied by positive signed coefficients (Barro & Lee, 1994; Lim, 1994). However, the impact of trade openness and terms of trade are left undetermined both in theory and empirical literature, and hence their coefficients can take on both signs (Blattman, Hwang, & Williamson, 2003; Cooke, 2010; Stiglitz, 1996).

Results and Discussion

Misalignment Series

The key macroeconomic fundamentals that are found to cause equilibrium RER include terms of trade, government expenditure, productivity differentials, investment spending, trade openness, net foreign assets position, and official development assistance.[1] The estimated coefficients of the long-run co-integration equation bear appropriate signs and are also statistically significant. In other words, fundamentals bearing theoretically expected and statistically significant signs are considered to model the equilibrium RER. The estimated models pass all necessary robustness checks. They are structurally stable and correctly specified. The study suggests that RERs for each of the EMs were substantially misaligned throughout the sample period.

Among the underlying factors that determine equilibrium RER, TOT is common for all economies. The next most common fundamentals in terms of their inclusion in the normalized co-integration equation are government expenditure (17), PROD (16), INV (12), OPEN (11), NFA (9), and ODA (8), respectively, where figures in brackets show the number of countries.

Specifications for which estimated parameters are signed in line with economic theory and significance are considered for estimating long-run equilibrium RER. Hence, negative productivity differentials coefficients for all countries approve the Balassa-Samuelson effect, which states that productivity growth appreciates RER. Productivity growth in emerging economies is expected to be more intense in the tradable sectors, which increases the demand for labor in these sectors and thereby persuades the wage rate to rise in the non-tradable sectors (Jongwanich, 2009). Such an increase in wage rate in the non-tradable sectors of the selected emerging economies appreciates RER causing inflation. The positive signs associated with coefficients of openness variable for eleven emerging economies approve that greater liberalization depreciates RER by increasing demand for foreign currency through reducing prices of importable goods nationally.

An increase in the rest of the fundamentals can influence RER in either direction. Following inferences can be drawn based on the number of times the fundamentals are included in the normalized cointegration equation. For about half of the countries, the RER depreciating income effect due to terms of trade improvement appears to be more powerful than its corresponding RER appreciating substitution effect. For the rest of the countries, the substitution effect dominates over the income effect. For about two-thirds of the economies, domestic investment and government

[1] Co-integration results and RER misalignment series are not reported here for brevity reasons.

expenditure markedly flow into tradable goods. Theory anticipates that an increase in net foreign asset depreciates RER, which is found true for two-third of the economies under study. The study finds that the way official development assistance affects RER is consistent with theory. An increase in official development assistance depreciates RER of most of the economies except China and hence supports the existence of Dutch Disease phenomena for China.

What is common for most of the EMs under investigation is that the RER was overvalued in the wake of the national and regional financial crisis, and the shift in exchange rate regime from fixed to floating depreciates the RER of the concerned economy. These observations stand to mean that misalignment in RER belongs to the key indicators of an economy's susceptibility to the financial crisis. As misalignment of RER is fairly evident in EMs, therefore, its impact on the economic growth of these economies could be a matter of interest to researchers, which will be dealt with in the next section.

Growth Regressions

Equation 8 examines the impact of overvaluation and undervaluation on growth (Table 1). The study deals with a variant of specifications to examine the consistency of results. It gradually augments the baseline model in columns 1 and 2 with human capital in columns 3 and 4 and then with institutional quality in columns 5 and 6. The standard fixed effect (FE) estimators are reported in columns 1, 3, and 5, and SGMM estimators are in columns 2, 4, and 6 for alternative specifications together with the pre and post-diagnostic test results of the SGMM estimations. The Wooldridge test accepts the null hypothesis of 'no autocorrelation' at a 1 percent level of significance for all possible specifications, and therefore the models are free from the autocorrelation problem. However, the Breusch-Pagan test and Wu-Hausman test show that the regression specifications are subject to heteroscedasticity and endogeneity between GDP growth rate per capita and regressors, which justifies the application of SGMM in examining the impact of over and undervaluation on growth.

Concerning the post-diagnostic checks, the significant AR (1) test statistic implies that residuals are correlated at first order. However, insignificant AR (2) test statistic confirms no autocorrelation among the residuals at second order, which is desirable for the validity of the internal instrumentation structure SGMM uses. The study uses lagged per capita GDP growth rate as endogenous, human capital and intuitional quality as predetermined, and the other regressors as extremely exogenous. The Hansen test statistic accepts the null hypothesis of over-identifying restrictions and hence approves the overall validity of instruments. Besides, with additional instruments (compared to the numbers of cross-sections), the augmented model in column 6 bears the over-fitting bias problem, which is efficiently addressed by the other two SGMM models with sufficiently low numbers of instruments.

A negative and significant undervaluation coefficient confirms that undervaluation enhances growth. The result obtained in this study is quite contrasting, as, in Table 1, the undervaluation coefficient is positive for all cases and significant for five specifications, meaning that undervaluation decreases economic growth in EMs. Undervaluation, stimulating technological progress and knowledge spillovers, can promote economic growth. However, undervaluation deters the economic growth of EMs, impacting the functional distribution of income negatively, which has recently been approved by Ribeiro et al. (2020) and hence supports the findings of this study. The growth deteriorating impact of overvaluation is approved by the negative sign of the overvaluation coefficients, though the coefficients are found to be significant only for SGMM specification. Thus, both undervaluation and overvaluation have a negative association with the growth of EMs.

Inflation is found to bear expected negative signs for all cases, but it is significant only for SGMM specifications of the baseline model and the model that includes human capital and institutional quality. Government expenditure maintains a negative but insignificant coefficient for all variants of regression specifications. Investment spending has to bear expected positive coefficients that are insignificant for standard fixed effect estimation but significant for all cases of SGMM. The impact of terms of trade on economic growth is theoretically undetermined. It can

either foster or tone down economic growth. The coefficient of the trade openness variable is negative and significant for all estimations except for SGMM. Therefore, the more outward orientation of EMs causes lower economic growth. The results of net foreign assets accumulation differ across estimates. From standard fixed effect estimation, net foreign asset accumulation is statistically significant, showing that net foreign asset accumulation deters growth. However, the SGMM estimates, though significant, turn out to be the opposite.

Table 1. Growth regression: with undervaluation & overvaluation

Regressors	FE (1)	SGMM (2)	FE (3)	SGMM (4)	FE (5)	SGMM (6)
Growth(-1)	-0.097	-0.033	-0.091	0.013	-0.089	0.211*
	(0.95)	(0.48)	(0.88)	(0.18)	(0.85)	(1.82)
Inflation	-0.033	-0.024**	-0.035	-0.018	-0.035	-0.066***
	(1.46)	(2.09)	(1.50)	(1.5)	(1.50)	(2.89)
Government Expenditure	-0.056	-0.121	-0.058	-0.154	-0.060	0.265
	(0.60)	(1.15)	(0.62)	(1.43)	(0.63)	(1.39)
Human Capital			-0.530	-1.541	-0.488	-4.044***
			(0.37)	(1.59)	(0.34)	(2.88)
Institutional Quality					-0.010	0.115
					(0.16)	(1.24)
ln (n+g+d)	-2.632***	-1.178**	-2.689***	-2.191**	-2.680***	-1.178*
	(3.44)	(2.81)	(3.43)	(2.72)	(3.39)	(2.01)
Investment	0.058	0.132***	0.056	0.106***	0.056	0.106**
	(1.35)	(4.94)	(1.30)	(3.04)	(1.28)	(2.25)
Terms of Trade	-0.233	0.140	-0.195	-0.163	-0.183	-6.196*
	(0.24)	(0.25)	(0.20)	(0.25)	(0.19)	(1.98)
Openness	-0.033**	-0.013***	-0.031**	-0.011**	-0.031**	-0.001
	(2.45)	(3.43)	(2.17)	(2.69)	(2.14)	(0.14)
Net Foreign Assets	-0.050**	0.013**	-0.048**	0.028***	-0.048**	0.029**
	(2.53)	(2.15)	(2.29)	(2.89)	(2.28)	(2.61)
Undervaluation	0.057*	0.053*	0.058*	0.035	0.057*	0.048*
	(1.72)	(1.81)	(1.72)	(1.08)	(1.71)	(1.93)
Overvaluation	-0.021	-0.019**	-0.022	-0.017*	-0.023	-0.036**
	(1.00)	(2.3)	(1.06)	(1.97)	(1.06)	(2.30)
Hausman Test	62.270***		59.730***		58.250***	
(p-value)	(0.000)		(0.000)		(0.000)	
Observations	136	136	136	136	136	136
Cross Section	21	21	21	21	21	21
Adj R-Square	0.547		0.543		0.539	
AR(1) p-value		0.098		0.084		0.047
AR(2) p-value		0.835		0.903		0.13
Hansen Test		9.85		8.81		8.14
(p-value)		(0.363)		(0.359)		(0.615)
Instrument		20		20		23
Wooldridge Test		1.125		1.163		1.359
(p-value)		(0.301)		(0.294)		(0.257)
Breusch-Pagan Test		108.57***		104.98***		104.20***
(p-value)		(0.000)		(0.000)		(0.000)
Wu-Hausman Test		16.00***		14.99***		15.03***
(p-value)		(0.001)		(0.002)		(0.002)

Notes: entries in ***, **, * are statistically significant at 1%, 5% and 10% significance levels, respectively. Figures below the coefficients in parentheses are t-ratios.

The polity variable used to proxy the institutional quality is included only in the most augmented case. Its coefficient varies from standard fixed effect to SGMM estimates but is insignificant for both situations. The study finds that human capital harms economic growth, which is significant only in one case of SGMM. However, the result is not surprising as studies performed

by Razin and Collins (1997), Sallenave (2010), and Toulaboe (2006) also drew similar conclusions. The negative association between per capita GDP growth rate and the growth rate of effective labor units and the rate of depreciation together suggested by Mankiw, Romer, and Weil (1992) is approved.

Table 2. Growth regression with misalignment

Regressors	FE (1)	SGMM (2)	FE (3)	SGMM (4)	FE (5)	SGMM (6)
Growth(-1)	-3.852***	0.305***	-4.221***	0.358***	-4.218***	0.384***
	(6.73)	(3.42)	(6.95)	(3.70)	(6.91)	(3.85)
Inflation	-0.036*	-0.016	-0.030	-0.024**	-0.030	-0.023**
	(1.93)	(1.39)	(1.60)	(2.42)	(1.60)	(2.32)
Government	-0.134*	-0.175**	-0.134*	-0.124	-0.135*	-0.101
Expenditure	(1.68)	(2.78)	(1.70)	(1.62)	(1.69)	(1.34)
Human Capital			2.105*	-2.589***	2.132*	-2.849***
			(1.70)	(3.46)	(1.68)	(4.38)
Institutional Quality					-0.006	0.012
					(0.11)	(0.30)
Ln (n+g+d)	-2.734***	-1.735***	-2.523***	-1.798***	-2.517***	-1.764***
	(4.26)	(7.47)	(3.90)	(3.97)	(3.86)	(3.50)
Investment	0.105***	0.072***	0.113***	0.057*	0.112***	0.053
	(3.08)	(2.83)	(3.30)	(1.81)	(3.27)	(1.41)
Terms of Trade	0.589	-0.129	0.505	-0.455	0.512	-0.472
	(0.73)	(0.33)	(0.63)	(0.84)	(0.64)	(0.79)
Openness	0.002	-0.015***	-0.002	-0.003	-0.002	-0.001
	(0.17)	(5.96)	(0.17)	(0.55)	(0.16)	(0.12)
Net Foreign Assets	-0.010	0.019**	-0.016	0.023**	-0.016	0.027**
	(0.58)	(2.10)	(0.89)	(2.57)	(0.88)	(2.80)
RER misalignment	-0.030**	-0.017**	-0.025*	-0.029***	-0.025*	-0.030***
	(1.99)	(2.27)	(1.67)	(3.30)	(1.66)	(3.29)
Hausman Test	48.887***		56.021***		52.271***	
(p-value)	(0.000)		(0.000)		(0.000)	
Observations	137	137	137	137	137	137
Cross Section	21	21	21	21	21	21
Adj R-Square	0.676		0.682		0.679	
AR(1) p-value		0.099		0.085		0.077
AR(2) p-value		0.655		0.722		0.735
Hansen Test		12.2		10.35		11.75
(p-value)		(0.272)		(0.323)		(0.228)
Instrument		20		20		21
Wooldridge Test		1.159		1.229		1.336
(p-value)		(0.294)		(0.281)		(0.261)
Breusch-Pagan Test		109.18***		105.84***		105.16***
(p-value)		(0.000)		(0.000)		(0.000)
Wu-Hausman Test		15.83***		14.97***		15.03***
(p-value)		(0.001)		(0.002)		(0.002)

Notes: entries in ***, **, * are statistically significant at 1%, 5% and 10% significance levels, respectively. Figures below the coefficients in parentheses are t-ratios.

Equation 9 examines the impact of RER misalignment on economic growth and the results presented in Table 2. This study takes alternative specifications to look at the consistency of findings. Pre and post-diagnostic checks for SGMM estimations are given at the bottom of table 2. The Wooldridge test fails to reject the null hypothesis of non-autocorrelation, and therefore, there is no autocorrelation problem in the models. The Breusch-Pagan test and Wu-Hausman test imply that the regression specifications suffer from heteroskedasticity and endogeneity between GDP growth rate per capita and regressors.

It is worth mentioning that the non-episodic absolute RER misalignment is used for the study because of its superior performance over episodic measures of RER misalignment in explaining its growth effects. The conventional post-diagnostic econometric test finds that the residuals are correlated at first order but not at second order, which is necessary for the cogency of internal instrumentation of the SGMM estimation technique. The insignificant Hansen test statistic points to the overall validity of instruments by accepting the null hypothesis of over-identifying restrictions. Finally, the numbers of instruments in all SGMM cases are low enough to handle the 'over-fitting bias' problem.

A negative misalignment coefficient infers that distortion in RER from its equilibrium value erodes growth. The misalignment coefficients are unanimously negative and statistically significant irrespective of specifications and estimation. Therefore misalignment in RER undermines the growth of EMs, and hence it confirms the findings obtained by Mazorodze (2021), Nouira and Sekkat (2012), and Schröder (2017). Therefore, we conclude that any kind of distortions in RER exerts an adverse impact on economic growth, which is further warranted by the growth deteriorating effects of undervaluation and overvaluation.

Concerning other growth determinants, inflation allows the expected coefficient in all cases, which is negative, but the coefficient is significant for standard fixed effect estimation and extended SGMM cases. The government expenditure is significant for all standard fixed effect and baseline SGMM estimations. It predicts that growth is dismayed by an increase in government expenditure, which justifies the growing agreement among policymakers. So that the private sector can serve better for economic growth and increased government expenditure, particularly borrowing from the domestic financial institutions squeezes opportunity for the private entrepreneurs and of thereby hampering the economic growth. On the same ground, the investment variable is expected to support economic growth. As for this current study, the investment coefficient is also positive for all regression specifications and significant for five of them. The sign of the coefficient of terms of trade variable varies across estimation methods, and hence its impact on economic growth is inconclusive. However, none of the coefficients are significant, which is exactly what Toulaboe (2011) obtains in his study. The negative coefficient of the trade openness variable except for the baseline standard fixed effect estimate indicates that the outward orientation of EMs hampers their growth.

The coefficient of net foreign assets is negative but insignificant for standard fixed effect estimators, while the SGMM estimator is positive and significant. The coefficient of the institutional quality differs from the fixed effect model to SGMM estimation but is insignificant for both cases. Human capital coefficients show a negative significance in SGMM regression specifications, where this result is confirmed by the previous study (Razin & Collins, 1997; Sallenave, 2010; Toulaboe, 2006). As for the effect of the growth rate of effective labor units and the depreciation rate on economic growth, the results confirm Mankiw et al.'s (1992) suggestion. Negative and significant coefficients of the variable for all variants of regression specification confirm its anti-growth effect for EMs.

Conclusion

Misalignment of RER and its role in open economies is one of the widely researched topics in open economy macroeconomics, and its impacts on different macroeconomic variables are well documented in the literature. But there are few studies found in recent years evaluating the growth performance of EMs in response to misaligned RER. However, these economies have been able to raise their contribution to global growth in the last few decades dealing with frequent currency crises by managing their exchange rate policies appropriately following the macroeconomic challenges they faced. Most of the contemporary studies on the impact of RER misalignment in EMs are limited to the export performance that has diverse findings owing to several reasons- the disparity in fundamentals they accept, dissimilarity of the period they cover, and disagreement on the methodology they use to determine the equilibrium RER. These help the researchers of the present study to be precautious in delineating the misalignment series to produce the most representational results. Among the different approaches of equilibrium RER determination, the

study chooses to employ the SEA that estimates the long-run equilibrium RER directly drawing a vector of sustainable values for the fundamentals.

The study finds that the RER of EMs is significantly misaligned, which allows proceeding for evaluating its impact on the growth performance of the economies. To this end, the study adopts the dynamic panel SGMM estimation approach to estimate the dynamic relationship between the economic growth and RER misalignment of EMs. In line with the traditional view, the present study argues that any deviation of RER from its equilibrium value impairs economic growth. The view that overvaluation erodes growth is accepted. While a good number of recent empirical researches identify the beneficial effects of a real undervaluation on economic growth, the study stands against those as no such evidence is observed for EMs. Rather a real undervaluation hampers the growth of EMs. Literature suggests that undervaluation may hurt economic growth, exerting an adverse impact on domestic consumption by creating income inequality. Hence, the study opens for future research on income distributional consequences of undervaluation along with misalignment for the selected emerging economies. From the policy perspective, policymakers should advocate appropriate exchange rate policies to make sure that its sustained misalignments over time so that it can enrich the ability of concerned authorities to attain the growth target by using it as a policy instrument.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Nexus between real effective exchange rate misalignment and rubber export in Nigeria

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Abstract

Purpose — This study examines the nexus between the real effective exchange rate misalignment (REERM) and rubber exports in Nigeria. The effects of equilibrium real exchange rate (ERER) and some economic fundamentals on rubber exports are also investigated.

Methods — Johansen cointegration, vector error correction model and Granger causality test are employed as methods of data analysis.

Findings — The results show that a long-run relationship exists between REERM and rubber export. REERM influenced rubber export negatively while ERER had a positive effect on rubber export. The past values of REERM can be used to predict the present volume of rubber export, and the past values of ERER and rubber export can be used to forecast the present values of each other. Trade openness positively influences rubber export while the term of trade has a negative effect on rubber export.

Implication — REERM worsens the performance of rubber export in Nigeria while ERER improves its performance. Thus, rubber export can be enhanced through measures such as trade openness, improved term of trade and monitoring of exchange rate to reduce the REERM and maintain a stabilized equilibrium exchange rate system.

Originality — This study focuses on the effect of deviation of the exchange rate from equilibrium, ERER and economic fundamentals on rubber export which has not been previously investigated.

Keywords — exchange rate misalignments, equilibrium real exchange rate, rubber export, trade openness.

Introduction

The nexus between agricultural export and exchange rate is an important issue, this is because the exchange rate determines the volume and worth of agricultural export in any nation. In developing nations, the management of exchange rate has always been at the centre of policy debate on topics such as macroeconomic stabilisation, promotion of export and economic development (Atingi-Ego & Sebudde, 2004; Essien, Uyaebo, & Omotosho, 2017). It has remained among the most closely watched economic indicators by policymakers, industries and financial market participants involved in international trade (Khomo & Aziakpono, 2020). Foreign exchange policies affect economic activities and determine the course of macroeconomic variables in a country to a large extent. Globally, the importance and role of the exchange rate on international agricultural trade have been recognized by researchers over time (Alegwu, Aye, & Asogwa, 2018; Awe, Akinlana, Yaya, & Aromolaran, 2018). In Nigeria, the exchange rate is one of the main drivers of agricultural

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export levels and economic strength. Its role in the scale of trade cannot be overemphasised because it influences export and import, reduces income purchasing power and influences other income factors (Güzel & Arslan, 2019; Nwachukwu, Adebayo, Shettima, Anigwe, & Udechukwu-Peterclaver, 2016).

The real effective exchange rate (REER) has traditionally performed a major role in economic growth and monetary policy in Nigeria due to its key impact on the country's international trade. For this purpose, the Central Bank of Nigeria had engaged in fixed and flexible exchange rate adjustment policies on several occasions for the attainment of its stability (Ajao & Igbekoyi, 2013). The REER is a measure of competitiveness in international trade and a major macroeconomic relative price. It determined the volume of the export sector globally and performs a vital role in spending and production resource allocation behaviour in the economy. It is as a result of these roles that the International Monetary Fund (IMF) encouraged developing and emerging economies to maintain their REER close to its equilibrium. Maintaining the REER around its equilibrium will also prevent a nation from banking and currencies crisis. Thus, effective exchange rate management requires that policymakers understand a vital reference value known as equilibrium real exchange rate (ERER) (Ali, Ajibola, Omotosho, Adetoba, & Adeleke, 2015).

The ERER is the value of REER consistent with the simultaneous attainment of both external and internal equilibrium (Essien et al., 2017). The deviation of actual REER from its equilibrium values is the real effective exchange rate misalignment. Misalignment in REER could either be overvalued or undervalued, any of these have implications on the trade and economy of a nation as a whole. The failure of REER to perform the role of allocative and provide adequate signals to direct resource allocation resulted in REERM (Edwards, 1988). There are at least two possible ways through which REERM might affect economic growth. Firstly, they could affect both foreign and domestic investment which further affects the accumulation of capital. On the other hand, REERM could influence the tradable sector and its competitiveness in the global market (Razin & Collins, 1997). Thus, the real exchange rate misalignment creates serious distortions and affects several sectors of an economy negatively. For instance, exchange rate misalignments in the form of overvalued domestic currency serve as a tax on prices of traded commodities globally, especially the developing countries which export primary products.

African countries are known for the production and exportation of primary goods which has performed a crucial role in Africa economy (Alegwu et al., 2018). Thus, the most important single activity for African nations is still the agricultural sector (Amoro & Shen, 2013). Agriculture serves as a major engine for the growing economy in middle-income countries (Güzel & Akin, 2021). The role of agricultural commodity trade in developing Africa's economy is prominent as a supplier of raw materials to many western countries (Nwachukwu et al., 2016). In Nigeria, the role of the agricultural sector is very vital as it employs over 70 per cent of the labour force and contributes significantly to the GDP (Obetta, Achike, Mukaila, & Taru, 2020). Prior to the oil discovery in Nigeria in the 1960s, rubber is one of the major cash crops in the country which was exported to others countries and served as means of foreign exchange rate earnings. In the 1960s and early 1970s, it contributed immensely to the Gross Domestic Product of Nigeria in conjunction with other cash crops such as cocoa, oil palm and groundnut. Agricultural sector contributions to GDP in Nigeria have reduced due to a decline in agricultural exports as a result of crude oil export which replaced agricultural exports. Though, recently, the country is striving to diversify its economy back to agriculture and finding ways of improving and transforming the agricultural sector. To achieve effective economic diversification, improve and transform the agricultural sector, effective management of the exchange rate is needed. This is because an effective exchange rate will play a competitive role for agricultural export in the world market. The extent to which maintaining the exchange rate at its equilibrium value and how exchange rate misalignments affect agricultural export has not gained much attention, especially in Nigeria.

Most studies on the nexus between exchange rate and agricultural export concentrated on the exchange rate volatility without examining the effect of maintaining the REER at equilibrium and its departure from equilibrium value on the agricultural export performance (e.g., A. Adaramola, 2016; Alegwu et al., 2018; Gatawa & A., 2017; Huchet-Bourdon & Korinek, 2011).

Also, past studies on ERER and REERM did not investigate its effect on agricultural trade performance (e.g., Barbosa, Jayme, & Missio, 2018; Elbadawi, Kaltani, & Soto, 2012; Essien et al., 2017; Gan, Ward, Ting, & Cohen, 2013; Khomo & Aziakpono, 2020; Libman, 2018; Mahraddika, 2020; Nouira & Sekkat, 2015; Nwachukwu et al., 2016; Palić, Dumičić, & Šprajaček, 2014; Saadaoui, Mazier, & Aflouk, 2013; Udah & Ite, 2016)

Alegwu et al. (2018) investigated the effects of exchange rate fluctuation or volatility on agricultural export in Nigeria using the vector error correction model (VECM). The study revealed that exchange rate volatility affected agricultural exports negatively. Gatawa and Mahmud (2017) also examined the effect of exchange rate volatility on crop export using GARCH and ARDL. They also reported that the exchange rate volatility hurt crop export volume. In the same vein, Adaramola (2016) examined the effect of the volatility of the exchange rate on Nigeria agricultural export. This study used the GARCH, ARCH, error correction model, co-integration and Johansen Multivariate as methods of data analysis. The study revealed that the exchange rate was volatile and had a positive effect on trade. Huchet-Bourdon and Korinek (2011) also examined the effect of exchange rate volatility on trade flows in the United States, China and the Eurozone in the manufacturing and mining sector and agricultural sector. They found that currency volatility affected the trade flows in the sectors investigated in the countries.

Khomo and Aziakpono (2020) examined the level of South African exchange rate misalignment following the behavioural equilibrium exchange rate (BEER) approach. They employed a cointegration technique and a Markov regime-switching method. They discovered that the South Africa exchange rate was misaligned. Essien et al. (2017) and Nwachukwu et al. (2016) also used the BEER to compute the ERER and REERM in Nigeria. The study revealed that Nigeria exchange rate was misaligned with episodes of undervaluation and overvaluation. Saadaoui et al. (2013) identified the drivers of exchange rate misalignment using the fundamental equilibrium exchange rate approach. Their study revealed that regional specialization, trade openness and financial openness are the drivers of misalignment of the exchange. The reviewed literature revealed that the past studies did not examine either the effect of REERM or ERER on agricultural export. There is thus a need to compute the ERER and REERM and examined their effect on agricultural export performance in Nigeria using rubber export as a case study.

Upon this background, this study was poised to compute the ERER and REERM, and investigate their effect on the performance of rubber export in Nigeria. The effect of some economic fundamental variables, such as trade openness, term of trade, capital inflows and government expenditure on rubber export were also investigated. The effects they have on agricultural export can transpose to other tradeable sectors of the economy. Also, the effects they have on Nigeria agricultural export performance can be related to other developing countries and emerging markets that are homogenous and engaged in exporting primary produce.

The organization of this paper is as follows: The next section explained the methodology used which includes a brief description of the study area, data source, econometric procedures, and model specifications. Section 3 presents the results and discussion of the study. The last section draws conclusions and policy implications.

Methods

The study was carried out in Nigeria. Nigeria is Africa's most populous nation with a population of over 202 million and a total area of 923.768km^2 landmass (World Bank, 2019). The majority of the population engaged in agricultural activities. Rubber is one of the cash crops grown and exported in Nigeria.

This study employed annual time-series secondary data covering 1980-2019 (that is thirty-nine years). The data on rubber exports and REER were sourced from the Food and Agriculture Organization and the International Financial Statistics database of IMF, respectively. Data on trade openness index, capital inflows, term of trade and government expenditure were sourced from the World Bank database. All the series were transformed into natural logarithms to stabilize the variance of the series.

Estimation of The Equilibrium Real Exchange Rate and Exchange Rate Misalignment

To model the ERER, the study was based on the BEER approach. This model was enunciated by Edwards (1988), also used by Gan et al. (2013), Montiel (1997), and Khomo and Aziakpono (2020). This model was used because it is most appropriate and widely used in developing nations. It involves the use of some economic fundamental variables, such as trade openness, government expenditure, capital inflows and terms of trade, affecting the ERER to model the equilibrium path of the exchange rate. To estimate a reduced form REER, the economic fundamentals were regressed against the REER. Before estimation of the reduced form REER, the study computed long-run sustainable or normal values for the economic fundamentals by decomposing the fundamental variables into transitory and permanent components.
The reduced form REER is thus specified as:

$$REER = a + \beta_1 TOP + \beta_2 TOT + \beta_3 FLOWS + \beta_4 GE + \varepsilon_t \quad (1)$$

Where TOP is trade openness, TOT is the term of trade, FLOWS is capital inflows, GE is government expenditure, β_1 to β_4 are their corresponding coefficients and ε_t is the error term.

The permanent components of the fundamental variables and the estimated regression coefficients, β_i, were used to construct the equilibrium path for the REER. Thus,

$$ERER = \beta_i xp_{it} \quad (2)$$

Where β_i are the coefficient of the fundamental variables and xp_{it} is the permanent component of the economic fundamentals.

After the estimation of the ERER, the real effective exchange rate misalignment was estimated which is the difference, at any moment in time, between the ERER and the actual REER.

$$REERM = ERER - REER \quad (3)$$

If ERER is greater than REER, it implies currency overvaluation; On the other hand, if ERER is less than REER, the currency is undervalued. In another word, a positive value of REERM implies overvaluation of the exchange rate while a negative REERM implies undervaluation of the exchange rate. A zero value of REERM implies that the exchange rate is at equilibrium.

Description of The Economic Fundamental Variables

Government expenditure measured the national expenditure within a year and serves as a proxy for demand pressure in an economy. It, however, contains a higher non-tradable component than the total domestic spending. Thus, an increase in government spending will exert an increase in non-tradable prices and result in real exchange rate appreciation (Edwards, 1989). When government spending is channelled to tradable imports such as capital equipment, it would result in exchange rate depreciation (Goldfajn & Valdés, 1999).

Term of trade is the price of a country's exports relative to imports. It has effects on real effective exchange rates due to substitution effects and income. An increase in income due to improved terms of trade result in high non-tradable demand which causes REER appreciation. Meanwhile, if the substitution effect is higher than the income effect, there would be a depreciation of REER (Edwards, 1989).

Trade openness reflects trade liberation. This is because it measures the level at which a nation is connected to the world. It is calculated by adding a country's total export plus import and divide by the GDP. The extent of trade openness affects the REER, volume and price of export and imports (Khomo & Aziakpono, 2020). The effect of trade openness on the REER depends on export and import volume. When the substitute effect is greater than the income effect, under the assumption that non-tradable and tradable are substitutes, the REER will have a positive relationship with trade openness (Edwards, 1989). Thus, an increase in trade openness will increase

tradable goods demand which will, in turn, require depreciation of exchange rate to shift the demand from tradeable goods to non-tradable goods.

The capital inflow to a country reflects the nation's external position. A continuous increase in capital inflows will improve the nation's net capital position which will, in turn, appreciate the exchange rate over time.

Econometric Procedures

A stationary series is a key term in analysing a time series (Ahmed, Rostam, & Mohammed, 2020). Before using time-series data, it is necessary to ascertain the level of stationarity of the series to employ an appropriate analysis model and to avoid spurious regression. This would also allow us to understand the order of integration, behaviour, and nature of the series. The Augmented Dickey-Fuller (ADF) and Philips-Perron tests were, therefore, used to test the stationarity of the variables. Philips-Perron was used to confirm and supplement the results of the ADF test because the ADF test may not identify non-stationary when there is a structural break in the series (Perron, 2006).

After ascertaining the unit root property of the series, the study proceeded to test for the long-run relationships among the variables. Based on the unit root property of the series which revealed that the series are integration of order 1, the Johansen cointegration test was employed. This was because the Johansen cointegration test can effectively test for the existence of long-run relationships among variables of the same order. The appropriate lag length was selected based on the Schwarz information criterion (SIC) and the Akaike information criterion (AIC). The criterion for lag length selection was AIC because it has the least value. Due to the nature of series, annual time series, to avoid losing the degree of freedom, the maximum lag length selected was 2. Wooldridge (2013) stated that annual time series have a small lag typically between 1 and 2 not to lose degree of freedom. The final lag length selected was 1 because it has the least AIC value.

Vector Error Correction Model (VECM)

To estimate the causal effect and the time it will take rubber export to converge to its equilibrium value as a result of shocks to the system, the vector error correction equation was employed. VECM was used because the series indicate the existence of a long-run relationship. This was specified for the case of a cointegration relationship among the variables, i.e., rubber export, ERER, REER, government expenditure, trade openness, term of trade and capital inflow:

$$\Delta lRE_t = \alpha_1 + \sum_{i=1}^{p} \beta_i \, \Delta lRE_{t-1} + \sum_{i=1}^{p} y_i \, \Delta lREERM_{t-1} + \sum_{i=1}^{p} \theta_i \, \Delta lTOT_{t-1} + \sum_{i=1}^{p} \delta_i \, \Delta lTOP_{t-1} + \sum_{i=1}^{p} \emptyset_i \, \Delta lFLOW_{t-1} + \sum_{i=1}^{p} \vartheta_i \, \Delta lGE_{t-1} + \sum_{i=1}^{p} y_i \, \Delta lERER_{t-1} + \varphi_1 \mu_{t-i} + \varepsilon_{1t} \quad (4)$$

Where RE is rubber export, Δ is difference operator, *l* is *the* natural logarithm, φ_i is the speed of adjustment, μ_{t-i} is the error correction term, ε_{1t} and ε_{2t} are the error or random term. Other variables as previously defined

Granger Causality Test

Granger (1969) proposed the Granger causality test to examine the causal relationships between variables and to know the direction of causality. This has been widely accepted and used by financial analysts and economists to test plausible economic relationships between variables (Awe et al., 2018). Variable Y is Granger causing X if Y can predict X using all available information. On the other hand, variable X granger cause Y if the past and current values of X facilitate the prediction of Y when used with the past value of Y as compared with when only past values of Y are used (Granger, 1969).

To explore the causality between REERM and rubber export, and ERER and rubber export, the bivariate Granger causality test was used. It further provides the direction of causality between REERM and rubber export, ERER and rubber export. The study employed the bivariate Granger causality test to capture the major variables of interest. The Granger causality between rubber export and REERM was specified as:

$$\Delta \mathrm{l}\,(RE)_t = \alpha_1 + \sum_{i=1}^{n} \beta_i\, \Delta \mathrm{l}(RE)_{t-i} + \sum_{i=1}^{m} \delta_j\, \Delta \mathrm{l}(REERM)_{t-j} + r_1(EC_1)_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta \mathrm{l}(REERM)_t = \alpha_2 + \sum_{i=1}^{n} c_i\, \Delta \mathrm{l}(REERM)_{t-i} + \sum_{i=1}^{m} g_j\, \Delta \mathrm{l}\,(RE)_{t-j} + r_2(EC_2)_{t-1} + \mu_t \quad (6)$$

The Granger causality between rubber export and ERER was specified as:

$$\Delta \mathrm{l}\,(RE)_t = \alpha_1 + \sum_{i=1}^{n} \beta_i\, \Delta \mathrm{l}(RE)_{t-i} + \sum_{i=1}^{m} \delta_j\, \Delta \mathrm{l}(ERER)_{t-j} + r_1(EC_1)_{t-1} + \varepsilon_t \quad (7)$$

$$\Delta \mathrm{l}(ERER)_t = \alpha_2 + \sum_{i=1}^{n} c_i\, \Delta \mathrm{l}\,(ERER)_{t-i} + \sum_{i=1}^{m} g_j\, \Delta \ln\,(RE)_{t-j} + r_2(EC_2)_{t-1} + \mu_t \quad (8)$$

Where α_1 and α_2 are intercept, β_i, δ_i, g_i, and c_i are coefficient, $(EC_1)_{t-1}$ and $(EC_2)_{t-1}$ are error correction terms that represent the lag residuals from the co-integration equations, *n* and *m* are numbers of lag lengths chosen by AIC, and ε_t and μ_t are error term. Other variables as previously defined.

Results and Discussion

Table 1 presents the results of Augmented Dickey-Fuller and Philips-Perron tests used to examine the unit root properties of the series. As shown from the result, all the variables included in the model were not stationary at their level form, but the series became stationary after the first difference. These suggest that the variables (rubber export, ERER, REER, REERM, government expenditure, trade openness, term of trade and capital inflows) are integrated of order one, that is I(1). To investigate the long-run relationship among these variables of the same order, the Johansen cointegration test became appropriate for these variables.

Table 1. Unit roots test results

Variables	Augmented Dickey-Fuller		Philips-Perron	
	Level	First Difference	Level	First Difference
RE	-2.165	-6.753***	-2.257	-6.754***
	(0.222)	(0.000)	(0.190)	(0.000)
FLOW	-1.573	-11.384***	-2.554	-11.702***
	(0.488)	(0.000)	(0.110)	(0.000)
GE	-0.584	-6.071***	-0.883	-6.222***
	(0.862)	(0.000)	(0.790)	(0.000)
REERM	-2.381	-4.729***	-2.381	-4.627***
	(0.153)	(0.001)	(0.153)	(0.005)
REER	-2.344	-5.188***	-1.823	-5.095***
	(0.163)	(0.000)	(0.365)	(0.000)
ERER	-1.429	-3.666***	-1.353	-3.650***
	(0.560)	(0.008)	(0.597)	(0.008)
TOT	-2.063	-7.081***	-2.070	-7.217***
	(0.260)	(0.000)	(0.258)	(0.000)
TOP	-2.197	-8.238***	-2.296	-8.108***
	(0.210)	(0.000)	(0.178)	(0.000)

*** denotes stationarity at the first difference (at 1% significant level). Probability values of test statistics are in parenthesis.
Source: Author's computation

Long-run nexus between real effective exchange rate and rubber exports

After performing the unit root tests, the Johansen cointegration test was performed due to the nature of the variables which were stationary at first different. The cointegration test results for the variables were presented in Table 2 for Maximal eigen and Trace statistics. The cointegration test result for the variables revealed that co-integration (long-run relationship) exists among rubber export, ERER, REERM, trade openness, term of trade, government expenditure and capital inflows. This was indicated by the value of Trace statistics (159.354) which was higher than the critical value (125.615) at a 5% level of significance and the value of Max-Eigen statistics (52.150) which was greater than the critical value (46.231) at 5% level. The null hypothesis of no

cointegration was rejected. These results suggest the estimation of the vector error correction model due to the existence of a long-run relationship among the variables.

Table 2. Johansen cointegration result

		Trace test		Maximal eigenvalue test	
H_0	H_1	Statistic	5% C.V.	Statistic	5% C.V.
r = 0	r ≥ 1	159.354**	125.615	52.150**	46.231
r ≤ 1	r ≥ 2	107.204**	95.754	36.435	40.078
r ≤ 2	r ≥ 3	70.765	69.819	27.748	33.877
r ≤ 3	r ≥ 4	43.017	47.856	24.108	27.584
r ≤ 4	r ≥ 5	18.909	29.797	10.537	21.132
r ≤ 5	r ≥ 6	8.371	15.495	8.164	14.265
r ≤ 6	r ≥ 7	0.207	3.841	0.207	3.841

Source: Author's computation

Effect of real effective exchange rate misalignment on rubber export

The empirical estimates of VECM for the causal effect of exchange rate misalignment, ERER, capital inflows, term of trade, trade openness and government expenditure on rubber export were presented in Table 3. As shown from the VECM results, the error correction coefficient (CointEq(-1)) had a negative sign and was significant at 5% which is a good sign. The VECM results appeared within the expectation and had correct signs. The adjustment term (the adjustment factor of the cointegration equation) was -0.335 and significant which shows that the reversion to long-run equilibrium is at an adjustment speed of 33.5%. This implies that 33.5% of disequilibrium error in the rubber export was corrected within a year and rubber export returns to its equilibrium level in about three years in absence of any other shocks. The R-square of 0.680 implies that 68.02 per cent of the variation in rubber export were explained by ERER, REERM, government expenditure, trade openness, the term of trade and capital inflows. The F-statistic of 5.53 was however statistically significant at 1%, this shows that the model generally has a good fit.

Table 3. Effect of real effective exchange rate misalignment on rubber export

Error correction	Coefficient	Stand. Error	T-Statistic
CointEq(-1)	-0.335**	0.122	-2.749
LNREERM	-0.020**	0.008	-2.552
LNERER	0.202*	0.117	1.725
LnFLOW	0.005	0.004	1.184
LNGE	0.263	0.165	1.599
LnTOT	-0.828**	0.369	-2.242
LnTOP	1.138**	0.482	2.360
C	0.025	0.046	0.556
R-squared	0.680		
F-statistic	5.045		
Diagnostic Tests			
Test		F-stat	Probability
Breusch-Godfrey Serial Correlation LM Test		0.718	0.888
Breusch-Pagan-Godfrey Heteroskedasticity Test		1.63	0.41
Ramsey RESET Test		1.59	0.31

*** p<0.01, ** p<0.05 and * p<0.1

Source: Author's computation

Real effective exchange rate misalignment had a negative and significant *(P<0.05)* effect on rubber export. This suggests that a 1% increase in REERM decrease rubber export in Nigeria by 2.552%. This implies that misalignments in the exchange rate reduce the volume of rubber export and worsen its performance in Nigeria. Thus, REERM hurt agricultural trade and agricultural transformation in the country. This is because an overvalued exchange rate (Naira) will make

rubber export very expensive to other countries. This will thus reduce the international demand for rubber export from the country. On the other hand, although an undervalued exchange rate will increase the demand for rubber from Nigeria in the international market, but a continuous undervalued exchange rate will lower the morale of rubber farmers and exporters as this would reduce their profit and may not even cover their cost of production. These results further imply that for the effective performance of rubber export in Nigeria, a stable exchange rate at its equilibrium value is needed to better the performance of rubber export in the country and other developing countries which were homogenous in nature and export primary produce. This is in line with the findings of Atingi-Ego and Sebudde (2004) who reported that exchange rate misalignments negatively affects non-traditional export in Uganda. A similar result was reported by Jongwanich (2009) that exchange rate misalignments had a negative effect on trade in Asia.

Equilibrium real exchange rate had a positive and significant *(P<0.10)* effect on rubber export. This suggests that ERER increases rubber export volume significantly. This implies that maintaining the exchange rate at its equilibrium value increase the rubber export. This will, therefore, improve the agricultural sector performance in the country. Maintaining the exchange rate around its equilibrium value will make trading of rubber and other exports in Nigeria with other countries effective because the trading partners will pay exactly the monetary value for rubber and the rubber exporters will also get the value for their products.

Term of trade had a negative and significant *(P<0.05)* effect on rubber export. This suggests that a 1% increase in terms of trade will reduce rubber export by 2.2418%. This implies that a high term of trade reduces the performance of rubber export in Nigeria. This is because a high term of trade is usually associated with exchange rate overvaluation which will make rubber export in Nigeria highly expensive to other countries in the international market. A higher price will attract low demand, *ceteris paribus.* This will thus reduce the volume of rubber export in the country and lower the agricultural transformation.

Trade openness had a positive and significant effect *(P<0.05)* on rubber export. This suggests that a 1% increase in trade openness will increase rubber export by 2.360%. This result implies that trade openness with other countries will favour and improve rubber export in Nigeria. An increase in agricultural export will help in diversifying the economy and agricultural transformation agenda in the country. This result is against the findings of Alegwu et al. (2018) who found that trade openness had a negative effect on rubber export in Nigeria.

Regarding the diagnostic test for the model used. The Breusch-Godfrey Serial Correlation LM Test was used to check autocorrelation among the variables. The null hypothesis (Ho) was that there is no serial correlation in the model. The null hypothesis is not rejected as the P=0. 718>0.01 is not significant (either at 1, 5 or 10 per cent level). This implies that there is no serial correlation in the model. Heteroskedasticity in the model was tested using the Breusch-Pagan-Godfrey test. The null hypothesis was that the model has a constant variance (Homoskedasticity). The result further showed that P=0.41>0.01 is not significant. Therefore, the null hypothesis of constant variance is not rejected. This implies that the variance of the error term in the model is constant. In testing the model specification error, the regression specification error test (RESET) enunciated by Ramsey was employed. The null hypothesis (Ho) was that the model has no omitted variables. From the result (P=0.31>0.01) shown in Table 3, the probability is not statistically significant, therefore, the null hypothesis of no omitted variable(s) in the model is not rejected. This result indicates that none of the variables was omitted in the model, the estimated model has corrected functional form and no irrelevant variables were added. This implies that there is no serious error of specification, and the model is well specified.

Table 4 presents the result of the Granger causality test between REERM and rubber exports, and ERER and rubber export in Nigeria. The Granger causality test results revealed a unidirectional causality that runs from the real effective exchange rate misalignment to rubber export. This implies that REERM granger caused rubber export and the past value of REERM can be used to predict or forecast the current value of rubber export. Bidirectional causality exists between equilibrium real exchange rate and rubber export. This implies that the past values of equilibrium real exchange rate can be used to forecast the present value of rubber export and the

past values of rubber export can also be used to forecast the current value of equilibrium real exchange rate.

Table 4. Granger causality test results

Null hypothesis	F-Statistics	P-value	Decision
REERM does not granger cause rubber export	5.375	0.006	Reject
Rubber export does not granger cause REERM	0.741	0.483	Accept
ERER does not granger cause rubber export	3.988	0.041	Reject
Rubber export does not granger cause ERER	2.588	0.084	Reject

Source: Author's computation

Conclusion

This study explored the nexus between the real effective exchange rate misalignment and rubber export in Nigeria. The effect of maintaining the exchange rate at equilibrium including trade openness, term of trade, government expenditure and capital inflows on rubber export were also examined. The results revealed that there exists a long-run relationship between rubber export and real effective exchange rate. Also, real effective exchange rate misalignment had a negative and significant effect on rubber export. Misalignments in exchange rate worsen and reduce the performance of rubber export in Nigeria thus bad for the trade and agricultural sector in the country. An overvalued exchange rate will make rubber export very expensive to other countries which will result in a reduction in rubber export demand in the international market. On the other hand, a continuous undervalued exchange rate will reduce the morale of rubber farmers and exporters as this would reduce their profit, thus worsen the performance of rubber export and agricultural transformation. This study further revealed that maintaining the exchange rate towards its equilibrium value increase the rubber export thereby improving its performance in Nigeria. Maintaining the exchange rate around its equilibrium value will make trading of rubber in Nigeria with other countries effective. Its effect could also transpose to other sectors of the economy in the county in a bid to improve their performance. Term of trade had a negative effect on rubber export which shows that a high term of trade reduces the performance of rubber export in Nigeria. Trade openness had a positive effect on rubber export. This shows that trade openness with other countries will favour and improve rubber export in Nigeria. It can, therefore, be inferred from this study that real effective exchange rate misalignment is a strong determinant of the volume of rubber export in Nigeria, when the real effective exchange rate is highly misaligned there is a greater probability that rubber export will reduce. This is because REERM will lead to the reduction of export activities, especially by risk-averse exporters. On the other hand, when the exchange rate is at equilibrium, there is a high probability that the rubber export volume will increase.

Therefore, for the effective performance of rubber export and other agricultural export in Nigeria and other developing countries, a stable exchange rate at its equilibrium value is needed to better the performance of rubber export in the country. This would go a long way in transforming agriculture in Nigeria and other African countries and increase the contribution of the agricultural sector, through agricultural export, to the nation's economy. In addition, more trade openness with other countries is very important in transforming agriculture, through export, in Nigeria and other African nations. Improved term of trade is also needed to improve the performance of rubber export in a bid to diversify the economy and transform agriculture in Nigeria.

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The spillover of shadow interest rate to the excess returns in emerging markets

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Abstract

Purpose — This study focuses on the monetary policy transmission of the U.S. on the excess returns in emerging markets by estimating the impacts of changes in the shadow interest rate in the U.S. on the Barclays Benchmark EM FX Trend Excess Return Index and the Barclays Cross Asset Trend Index.

Methods — To account for the spillover effects of the macroeconomic and financial variables, this study employs a bivariate VARMA–AGARCH approach. This study employs 206 daily observations, from February 22, 2002, to July 5, 2019 sourced from The Barclays database and the Reserve Bank of New Zealand.

Findings — This study finds that the shocks in shadow interest rates will decrease the Barclays Benchmark EM FX Trend Excess Return Index and the Barclays Cross Asset Trend Index in the short term. The results of VARMA–BEKK–AGARCH model show that changes/shocks in shadow interest rates will reduce the excess returns in the financial markets of emerging countries in the long term.

Implication — The study reveals that a high-interest rate policy could be used as a tool by the FED to prevent excessive returns on emerging countries' financial markets

Originality — This study contributes to the existing literature by addressing the issue of whether the monetary policy stance of the U.S. after the Global Financial Crisis (GFC) can be recognized as the primary source of the currency excess returns and multiple-asset class excess returns for emerging countries.

Keywords — shadow interest rates, excess returns, emerging countries, VARMA–BEKK–AGARCH model

Introduction

As a result of the unconventional policies implemented by major central banks, researchers have begun to derive shadow interest rates (Krippner, 2014; Wu & Xia, 2016). In this context, the assessment of the international spillover effect of monetary policy has come to the forefront of empirical analysis. More specifically, in the presence of unconventional monetary policies, the exchange rates and asset prices of emerging countries have become more sensitive to the interest rate decisions of the FED (Ammer, Claessens, Tabova, & Wroblewski, 2019; Inoue & Rossi, 2019). Thus, it has become essential to examining the relationship impacts of the U.S. shadow interest rate on excess returns in the financial markets of emerging countries.

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In the context of macroeconomics, the shadow interest rate is used as an indicator of unconventional monetary policy; for instance, Inoue and Rossi (2019) adopted a new approach to identifying monetary policy shocks. Their study defined monetary policy shocks as shifts in the entire term structure of interest rates on the day of a monetary policy announcement, and the relevant approach captured the effects of forward guidance and asset purchase program announcements. Using a Vector Auto Regression (VAR) model with daily data of the U.S., Inoue and Rossi (2019) found that expansionary monetary policy shocks caused the depreciation of exchange rates in both conventional and unconventional periods. The results highlighted the usage of time-varying models to assess the effects of the monetary policy on interest rates and exchange rates. However, it is well known that the monetary policy leads to news effects and other macroeconomic developments. Although news effects are considered in GARCH-type models, Cheung, Fatum, and Yamamoto (2019) considered whether the influence on the exchange rate of "good" versus "bad" news could be asymmetric. Using daily data, the authors evaluated the relative influence of U.S. and Japanese macro news on the JPY/USD rate before, during, and after the global financial crisis and revealed that U.S. macro news was more important than before the crisis and the influence of Japanese macro news started to disappear after the GFC.

Herein, it should also be noted that the relationship between exchange rates and interest rates may vary over time. In this respect, Hacker, Karlsson, and Månsson (2014) showed that the nominal interest rate differential was Granger cause the exchange rate as the wavelet time scale increased by proving evidence from the values of five major currencies against the Swedish krona (SEK). Moreover, by conducting impulse response analysis, they found that an increase in the Swedish interest rate compared with that of another country was associated with a lower Swedish krona price of the other country's currency in the short run. Most recently, Lee (2019) employed asset-pricing models for the cases of the UK, France, and the U.S. More specifically, the author considered smooth transition regimes in volatilities to examine the excess dollar returns and found that the expected excess returns could negatively correlate with the interest differential. Lee (2019) stressed the importance of uncertainty in macroeconomic variabilities and revealed that the uncovered interest parity theory could be explained if the economic agent achieved an early resolution of uncertainty. In a similar effort, Ames, Bagnarosa, and Peters (2017) considered the effects of capital flows on stochastic features in the joint behavior of the currency exchanges with respect to the level of short-term interest rates. Using daily data for developed and developing countries, they found that both upper- and lower-tail dependence features consequently displayed a significant association with and asymmetries to each other in periods of both financial stability and financial instability.

Contrary to the studies in the scientific literature, Caraiani & Călin (2018) suggested that, when the shadow interest rate was included in the time-varying Bayesian VAR model, the impact of monetary policy shocks on asset prices was negative and the impact on asset price bubbles was smaller in the aftermath of the GFC. On the other hand, Sugimoto and Matsuki (2019) showed a significant international spillover effect of monetary policy on the asset price bubbles in emerging countries. More specifically, Sugimoto and Matsuki (2019) employed the measure of Diebold and Yilmaz (2012), and they found that both conventional and unconventional monetary easing raised the US-to-Asia and Japan-to-Asia stock return spillovers. Since they also found that the reaction of bubbles to shadow interest rate was lower than the federal funds rate, the importance of detecting the effects of shadow interest rates on financial variables was suggested.

The critical message found in the reviewed literature is that the conventional and unconventional monetary policy of the U.S. may cause considerable variations in the exchange rates and the asset prices of emerging countries and may lead to excess returns. The previous literature also indicated that the transmission of interest rates of the U.S. on the macroeconomic and financial variables of emerging countries could be exposed to non-linear effects. In this context, in line with Lee (2019), who considered excess returns, this study evaluates the effects of the shadow interest rates of the U.S. on the foreign exchange/currency and multiple-asset class excess returns in emerging countries in the presence of a decrease in the effectiveness of conventional monetary policies as a result of the expansionary monetary policies. More specifically, it investigates the effects of the shadow interest rate in the U.S. to the Barclays Benchmark EM FX

Trend Excess Return Index (FXERI) and the Barclays Cross Asset Trend Index – EM FX ER (CRASERI) in terms of volatility, shock, and asymmetric spillovers. However, this study differentiates itself from Lee (2019) in that it considers the roles of asymmetry and news effects. This study also differs from all studies available in the scientific literature, as the impact of the shadow interest rate of the U.S. on the multiple-asset class of the emerging markets is assessed through the international spillover effect of the monetary policy.

Additionally, this study assumes non-linear relationships among the variables for the time horizon and enhances the empirical approach (Hacker et al., 2014), who used wavelet analysis. In this context, firstly, this study employs the VARMA–BEKK–AGARCH model deriving from the VARMA–AGARCH model (McAleer et al., 2009). More specifically, by estimating the coefficients of the relevant model, thus study examines the relationships among the model variables and thus, assesses the roles of volatility and shock spillovers and asymmetric effects. The BEKK version captures both own-market and cross-market asymmetric effects. The BEKK version captures the asymmetric impacts both in the context of a variable of the model and between variables of the model. The BEKK version captures own-variable asymmetric impacts and also incorporates between variables of the model. The BEKK version captures the asymmetric effects in each variable on its volatility and incorporates asymmetric impacts between variables of the model. Herein, parallel to Cheung et al. (2019), it should be noted that the influence on the exchange rate of "good" versus "bad" news could be asymmetric. However, this study investigates whether the news effect related to one variable may induce higher (lower) volatility in another variable, unlike the CCC and DCC versions of the VARMA–AGARCH model. Hence, this study focuses on the probability of a financial crisis in emerging countries due to the changes in the monetary policy stance of the U.S. and the presence of asymmetric impacts and news effects. Secondly, this study uses the non-linear VAR model (Kilian & Vigfusson, 2011) and implement slope-based tests to ascertain the robustness of the VARMA–BEKK–AGARCH estimations in terms of asymmetry.

This study contributes to the existing literature by addressing the issue of whether the monetary policy stance of the U.S. after the Global Financial Crisis (GFC) can be recognized as the primary source of the currency excess returns and multiple-asset class excess returns for emerging countries. Within this theoretical and empirical framework, the main hypothesis of this paper aims to test whether the shadow interest rate has significant effects on financial stability and thus leads to changes in economic policy implementation.

Methods

To account for the spillover effects of the macroeconomic and financial variables, this study employs a bivariate VARMA–AGARCH approach. The conditional mean and conditional variance equations are derived below in the specification of a VARMA(1,1)–BEKK–AGARCH(1,1) model.

$$y_t = \Phi + \upsilon y_{t-1} + \Theta B_t + \varepsilon_t + \gamma \varepsilon_{t-1} \quad (1)$$

$$\varepsilon_t = D_t \eta_t \quad (2)$$

In equation (1), the vector y_t contains two variables that can be specified as $y_t = (y_t^1, y_t^2)'$ with the shadow interest rate of the U.S. and the excess returns in the emerging markets at time t, respectively. Additionally, υ corresponds to a (2×2) coefficient matrix as $\upsilon = \begin{pmatrix} \upsilon_{11} & \upsilon_{12} \\ \upsilon_{21} & \upsilon_{22} \end{pmatrix}$, Φ refers to a (2×1) vector including the constant variables of the model as $(\Phi^1, \Phi^2)'$, Θ is a (2×2) matrix of coefficients $\begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix}$ and $B_t = (b_t^1, b_t^2)'$ refers to a vector of structural break dummies.[1] Additionally, the error terms from the mean equations are ε_t written as $\varepsilon_t = (\varepsilon_t^1, \varepsilon_t^2)'$, γ is also a (2×2) matrix as $\begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{pmatrix}$, and it shows the shock spillovers between the model variables. In terms of equation (2), the vector of independently and identically distributed errors is (2×1) can be specified as $\eta_t = (\eta_t^1, \eta_t^2)'$, while $D_t = diag\left(\sqrt{h_t^1}, \sqrt{h_t^2}\right)'$ with h_t^1 and h_t^2 as the conditional

[1] In equation (2), $g_t = 1 \text{if } t \geq breakdate$.

variances of the model variables. Equations (1) and (2) constitute the conditional mean equation of the model, while the conditional variance equation can be written as below:

$$H_t = \Omega'\Omega + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + C'I_{t-1}\varepsilon_{t-1}\varepsilon'_{t-1}C + B'H_{t-1}B \quad (3)$$

where $A, B,$ and C correspond to the square matrices and Ω is a lower triangular matrix as $\begin{pmatrix} \varsigma_{11} & 0 \\ \varsigma_{21} & \varsigma_{22} \end{pmatrix}$. Accordingly, the volatility of the markets is incorporated into the conditional variance-covariance matrix H_t.[2] Matrix A includes the coefficients of the ARCH term and thus shows the effect of a shock in the shadow interest rate of the U.S. and a shock spillover from the variable reflecting the excess returns in emerging markets on the conditional volatility of the relevant variable. Similarly, the B matrix has the coefficients of the GARCH term, which represent the effect of past volatility in the shadow interest rate of the U.S. and the spillover of the remaining variable on the conditional volatility of the variable. Matrix C has asymmetric effect coefficients, indicating both the significance of an asymmetric effect for the shadow interest rate of the U.S. and the significance of asymmetric effect spillovers between the two variables of the model. It assumed that negative and positive shocks do not have identical effects on the conditional variance, while $I_t = diag(I_t^1, I_t^2)$ is a function of an independently and identically distributed error term. It should be noted that the BEKK–VARMA–AGARCH holds when matrix C is not null.[3] Moreover, there can be differences between the BEKK, CCC, and DCC types in their variance equations.[4]

This study focuses on the monetary policy transmission of the U.S. on the excess returns in emerging markets by estimating the impacts of changes in the shadow interest rate in the U.S. on the FXERI and the CRASERI. The analysis would be in the short run and long run. This study employs 206 daily observations, from February 22, 2002, to July 5, 2019. The data on the FXERI and the CRASERI are collected from The Barclays database, while the data on the shadow interest rate of the U.S. is collected from the Reserve Bank of New Zealand. Following Salisu and Oloko (2015), we employed the breakpoint unit root test.[5] In order to determine the break dates, the relationships between model variables were assessed using a VARMA–BEKK–AGARCH approach. Break dates are suggested for the model variables, and the unit root properties of the series are shown in Table 1.

Table 1. Breakpoint unit root test results

Variables	Test statistic	Number of lagged differences by the Akaike Information Criterion (AIC)	Suggested break date
sh_t^f	-2.10		July 7 6, 2007
gsh_t^f	-71.17	0	October 11, 2008
$fxeri_t^f$	-3.96		September 26 16, 2008
$gfxeri_t^f$	-60.29	0	December 3, 2008
$craseri_t^f$	-3.86		August 20 22, 2007
$gcraseri_t^f$	-57.30	0	August 3, 2008

Note: According to the 1%, 5%, and 10% significance levels, the critical values of the unit root with a structural break test are -4.94, -4.44, and -4.19, respectively.

According to Table 1, all the variables are not stationary at levels, while they became stationary when their first differences were taken. As a result of the Johansen cointegration test, no

[2]The parameterization of the VECH and the Diagonal VECH (DVECH) models does not enforce positive definiteness since the relevant models may have some (typically highly unlikely) sequences of residuals that may cause them to produce a non-positive definiteness covariance matrix. On the other hand, the BEKK model imposes positive definiteness by construction. More specifically, the BEKK specification guarantees that if the matrices $H_{t-i}, i = 1, \dots, p,$ are almost indeed positively definite, and thus is H_t. For details, please see Francq and Zakoïan (2010).

[3] For the details of VARMA–GARCH and VARMA–AGARCH, (please see McAleer et al. (2009).

[4] For the details of the specifications of CCC–VARMA–AGARCH and DCC–VARMA–AGARCH, please see Salisu and Oloko (2015) and Bala and Takimoto (2017).

[5] The breakpoint unit root test is a modified augmented Dickey-Fuller test, allowing for levels and trends that differ across a single break date., EViews 10.0 was employed in this study in order to perform the relevant test.

cointegration is found in terms of the $(sh_t, fxeri_t)'$ and $(sh_t, craseri_t)'$; thus, the variables used in the empirical exercise are in percentage changes from the previous observation and are denoted as gsh_t, $gfxeri_t$and $gcraseri_t$. On the other hand, the break dates for the relevant variables are in the second half of 2008, which coincides with the GFC. Thus, this splits the entire sample into a particular subsample in line with the break dates found in Table 1, and model estimations are carried out for both the entire sample and in the presence of structural breaks. In this respect, this study generates the mean equation of the multivariate GARCH model by including dummy variables to capture the identified break dates. The impacts of the shadow interest rate of the U.S. on the FXERI and the CRASERI are examined within the $(gfxeri_t^f, gsh_t^f)'$, $(gfxeri_t^s, gsh_t^s)'$, $(gcraseri_t^f, gsh_t^f)'$ and $(gcraseri_t^s, gsh_t^s)'$ vectors, respectively.

In line with equations (1)–(3), the elements of the resulting variance and covariance equations for the estimates of the bivariate VARMA–BEKK–AGARCH can be evaluated using the equations below:

$$h_{11,t} = \varsigma_{11}^2 + a_{11}^2\varepsilon_{1,t-1}^2 + a_{21}^2\varepsilon_{2,t-1}^2 + 2a_{11}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + c_{11}^2\varepsilon_{1,t-1}^2 I_{1,t-1} + c_{21}^2\varepsilon_{2,t-1}^2 I_{1,t-1} + 2c_{11}c_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1}I_{1,t-1} + b_{11}^2 h_{11,t-1} + b_{21}^2 h_{22,t-1} + 2b_{11}b_{21}h_{21,t-1} \quad (4)$$

$$h_{21,t} = \varsigma_{21}\varsigma_{22} + a_{11}a_{22}\varepsilon_{1,t-1}^2 + a_{21}a_{22}\varepsilon_{2,t-1}^2 + (a_{21}a_{12} + a_{11}a_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} c_{11}c_{22}\varepsilon_{1,t-1}^2 I_{1,t-1} + c_{21}c_{22}\varepsilon_{2,t-1}^2 I_{1,t-1} + (c_{21}c_{12} + c_{11}c_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1}I_{1,t-1} + b_{11}b_{22}h_{11,t-1} + b_{21}b_{22}h_{22,t-1} + (b_{21}b_{12})h_{12,t-1} \quad (5)$$

$$h_{22,t}=\varsigma_{22}^2 + a_{12}^2\varepsilon_{1,t-1}^2 + a_{22}^2\varepsilon_{2,t-1}^2 + 2a_{12}a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + c_{12}^2\varepsilon_{1,t-1}^2 I_{1,t-1} + c_{22}^2\varepsilon_{2,t-1}^2 I_{1,t-1} + 2c_{12}c_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1}I_{1,t-1} + b_{12}^2 h_{1,t-1} + b_{22}^2 h_{22,t-1} + 2b_{12}b_{22}h_{21,t-1} \quad (6)$$

Results and Discussion

In the context of equations (1) and (6), this study exposes the impacts of the shadow interest rate on the FXERI and the CRASERI by focusing on the short-run return impacts in terms of the coefficient matrices υ and γ. Long-run effects of the shadow interest rate of the U.S. are also assessed in terms of the coefficient matrices $A, B,$ and C, indicating the shock, volatility, and asymmetric spillovers, respectively.

In this study, following Salisu and Oloko (2015), the effects of the shadow interest rate in the U.S. on excess returns in the currency and multiple-asset classes were analyzed within separate vectors as $(sh_t, fxeri_t)'$ and $(sh_t, craseri_t)'$, respectively. In this context, since the statistical criteria revealed that the BEKK version of the VARMA–AGARCH model is superior to the CC and DCC variations, the results obtained in Table 2 were evaluated. The VARMA–BEKK–AGARCH model was estimated for the entire sample and the subsample by dividing the whole sample according to the structural break date as found in Table 1.

Within this empirical framework, the mean equation of model 1 showed that past changes in the shadow interest rate of the U.S. have a little immediate impact on the FXERI. However, the coefficient of υ_{12} is negative, and it can be said that the tight monetary policy in the U.S. reduces the net capital inflows to emerging countries and, consequently, decreases the FXERI. Similar findings have been obtained for the CRASERI in the context of model 2. The argument is that the high interest rate environment in the U.S. may lower the asset prices of emerging market countries, but this effect may be limited. Since this study uses the VARMA–BEKK–AGARCH model, the short-run effects of the FXERI on the shadow interest rate of the U.S. can also be examined. Considering the coefficient symbolized by υ_{21}, it became apparent that the increase in the FXERI causes the shadow interest rate to increase in the U.S. The detected return spillover may be attributed to the fact that the capital inflows into the financial markets of emerging countries cause excessive returns in the foreign exchange market and, as a result of this, the FED, which wants to reverse the direction of capital movements, may start to implement a high-interest policy. However, following the evaluation of the relationship between the shadow interest rate of the U.S. and the CRASERI, it can be claimed that the excess returns in the multiple-asset class of emerging markets do not have immediate effects on the shadow interest rate in the U.S. due to a statistically

insignificant coefficient. In other words, it can be asserted that the effects of the returns of various financial instruments on U.S. interest rates may occur in the longer term.

At this point, the fact that the monetary policy implementation is subject to a rule emerges as an influential factor for the dynamics of the financial markets of emerging countries and the expectations of economic agents. More specifically, the coefficient expressed by γ_{12} of the VARMA–BEKK–AGARCH model showed the shock spillovers among the variables in the short-run, parallel to Sugimoto and Matsuki (2019). Accordingly, it can be argued that shocks in the shadow interest rate of the U.S., in other words, unexpected developments that were not in line with the monetary policy rule, deteriorated the expectations related to the financial markets of the emerging markets and reduced the value of the FXERI and the CRASERI in line with Ammer et al. (2019), Caraiani and Călin (2018), Inoue and Rossi (2019), and Lee (2019). Since the reduction in excess returns can be considered as a factor reducing the likelihood of a financial bubble and thus the likelihood of a financial crisis, it can be argued that monetary policy shocks/contractionary monetary policy in the U.S., in terms of the shadow interest rate, contribute to the financial stability of emerging countries. On the other hand, it was revealed by the γ_{21} coefficients of the relevant model that the shocks in the FXERI will raise the interest rates in the U.S. Thus, the VARMA–BEKK–AGARCH model showed that the shocks in the FXERI are taken into consideration by the FED, while the shocks in the CRASERI do not create immediate short-term effects on the shadow interest rate of the U.S.

When the results of the model estimated for the entire sample were evaluated within the context of the conditional variance equation discussing the shock, volatility, and asymmetric spillovers in the long run, there was a significant interaction between the shadow interest rate of the U.S. and the FXERI and the shadow interest rate of the U.S. and the CRASERI. In terms of a_{12}^2, it was indicated that shocks in the shadow interest rate of the U.S. reduce the FXERI, in line with Caraiani and Călin (2018). Similar findings were obtained for the increase in the shadow interest rate for the CRASERI, and it can be suggested that contractionary monetary policy shocks in the U.S. can reduce the excess returns in the multiple-asset class in the long run. Considering the entire sample framework, it was also found that there are long-term asymmetric shock spillovers between the shadow interest rate of the U.S. and the FXERI and between the shadow interest rate of the U.S. and the CRASERI over the positive statistically significant c_{12} and c_{22} coefficients, in line with Ames et al. (2017) and Sugimoto and Matsuki (2019). In the light of these findings, it can be suggested that high shock and asymmetric information shocks in the shadow interest rate of the U.S. will have crucial effects on both variables. In other words, unexpected bad news about the shadow interest rate of the U.S. and unconventional monetary policy in the U.S. are exposed to higher rates of an impact than good news.

This study determined the break dates for all the variables used in our empirical models in line with the structural break unit root tests shown in Table 1. The break dates determined for each variable coincided with the GFC period; therefore, this study evaluated the effects of shadow interest rates on emerging countries' financial markets in the presence of quantitative easing and macro-prudential policies implemented by major central banks. The subsample models did not also include dummy variables, which were generated depending on the structural break dates of each variable. In this context, the coefficients obtained for the after-break model differ from those obtained for the entire sample with respect to the size, direction, and statistical significance levels. In terms of υ_{12}, it was shown that the increase in the shadow interest rate in the U.S. adversely affects the excess returns in the multiple-asset class of emerging countries. Within this framework, it was confirmed that the contractionary monetary policy implemented in the U.S. reduces the capital inflows to emerging markets and that investors even started to leave emerging countries due to the rising interest rates in the U.S. Despite the argument that there may be immediate interaction between the shadow interest rate of the U.S. and the CRASERI in the context of model 4, the statistically insignificant coefficient of the υ_{12} in model 3 showed that the effects of the monetary policy changes in the U.S. on the FXERI do not occur immediately. Although this finding is not parallel to the entire sample model, the negative and statistically significant values of the γ_{12} coefficients of both models suggested that the excess returns on the assets of emerging countries decrease, since the shocks in the shadow interest rate of the U.S. are perceived as a high interest rate environment in the U.S.

Table 2. Estimation results for the VARMA–BEKK–AGARCH model

	Full sample		After break	
Mean equation	Model 1: $(gfxeri_t^f, gsh_t^f)'$	Model 2: $(gcraseri_t^f, gsh_t^f)'$	Model 3: $(gfxeri_t^{ab}, gsh_t^{ab})'$	Model 4: $(gcraseri_t^{ab}, gsh_t^{ab})'$
ϕ_{10}	0.036***	0.032***	0.039***	0.035***
	(0.000)	(0.000)	(0.000)	(0.000)
υ_{11}	0.094***	0.132***	0.114***	0.112***
	(0.000)	(0.000)	(0.000)	(0.000)
υ_{12}	-0.000	-0.000	-0.000	-0.008
	(0.205)	(0.000)	(0.815)	(0.034)
γ_{11}	0.063***	-0.025***	0.001***	0.032***
	(0.000)	(0.000)	(0.000)	(0.000)
γ_{12}	-0.082***	-0.118***	-0.007***	-0.017***
	(0.000)	(0.000)	(0.000)	(0.000)
φ_{11}	-0.331**	0.619**	–	–
	(0.036)	(0.035)		
φ_{12}	-0.522	-0.949**	–	–
	(0.180)	(0.047)		
ϕ_{20}	-0.101***	-0.107***	0.032**	0.025*
	(0.000)	(0.000)	(0.025)	(0.066)
υ_{21}	0.034***	-0.011	0.032	0.018
	(0.000)	(0.592)	(0.453)	(0.422)
υ_{22}	0.644***	0.664***	0.396***	0.404***
	(0.000)	(0.000)	(0.000)	(0.000)
γ_{21}	0.044***	-0.038***	0.029***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
γ_{22}	-0.001***	-0.013***	0.006***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
ω_{22}	-0.699**	0.468**	–	–
	(0.038)	(0.0449)		
ω_{21}	0.272*	-0.384**	–	–
	(0.088)	(0.0491)		
Variance equation	Model 1: $(gfxeri_t^f, gsh_t^f)'$	Model 2: $(gcraseri_t^f, gsh_t^f)'$	Model 3: $(gfxeri_t^{ab}, gsh_t^{ab})'$	Model 4: $(gcraseri_t^{ab}, gsh_t^{ab})'$
ς_{11}	-0.058***	-0.081***	0.088***	0.087***
	(0.000)	(0.000)	(0.000)	(0.000)
ς_{21}	0.024	-0.001	0.011	0.017
	(0.579)	(0.952)	(0.592)	(0.112)
ς_{22}	-0.173***	-0.192***	0.000	-0.000
	(0.000)	(0.000)	(0.999)	(0.999)
a_{11}	0.308***	0.441***	0.381***	0.490***
	(0.000)	(0.000)	(0.000)	(0.000)
a_{12}	-0.151	-0.119***	-0.043	-0.060***
	(0.001)	(0.003)	(0.447)	(0.000)
a_{21}	0.000	0.000	0.003	0.016***
	(0.020)	(0.062)	(0.152)	(0.000)
a_{22}	0.537***	0.494***	0.089	0.088***
	(0.000)	(0.000)	(0.001)	(0.000)
b_{11}	0.939***	0.886***	0.885***	0.866***
	(0.000)	(0.000)	(0.000)	(0.000)
b_{12}	-0.045	-0.065***	-0.020	-0.028***
	(0.072)	(0.002)	(0.597)	(0.000)
b_{21}	0.000	0.000	0.002**	0.003***
	(0.031)	(0.010)	(0.014)	(0.001)
b_{22}	0.688***	0.695***	0.973***	0.973***
	(0.000)	(0.000)	(0.000)	(0.000)
c_{11}	-0.098	-0.148***	-0.039	-0.147**
	(0.000)	(0.000)	(0.660)	(0.041)
c_{12}	0.660***	0.494***	0.244***	-0.011
	(0.000)	(0.000)	(0.000)	(0.721)
c_{21}	-0.000	-0.000	0.004	0.009
	(0.100)	(0.011)	(0.298)	(0.139)
c_{22}	2.438***	2.421***	0.324***	0.309***
	(0.000)	(0.000)	(0.000)	(0.000)

Note: The values in parentheses refer to the p-values.
***, **, * denote significance at 1%, 5%, and 10% repectivelly.

Regarding the maintenance of global financial stability, it was revealed that the FED does not give an immediate reaction to shocks in the FXERI and the CRASERI since the υ_{21} in both models is statistically insignificant. Within the after-break models, the finding that the υ_{21} of both models was statistically insignificant suggests that the Fed does not immediately respond to changes in extreme returns on financial assets of emerging countries. Nevertheless, the γ_{21} of both models showed that excess return shocks are perceived as an increase in the risk of a financial crisis in emerging countries in the short run and thus have an increasing effect on the shadow interest rate of the U.S.

Long-term interactions were assessed through variance equations; more precisely, it can be said all the models are stationary due to the satisfaction of the $(a_{11}^2 + b_{11}^2) < 1$ and $(a_{22}^2 + b_{22}^2) < 1$ condition and the statistical significance. Thus, it was indicated that the volatility among the model variables exhibits weak mean reversion. It was also revealed that, except for model 3, the volatility of the model variables is significantly influenced by lagged own conditional variance (b_{11}^2, b_{22}^2), lagged own shocks (a_{11}^2, a_{22}^2), and own asymmetric shocks (c_{11}^2, c_{22}^2). In terms of the c_{12}^2 and $c_{22}c_{12}$ of the relevant models, it was indicated that asymmetric shock spillovers exist between the shadow interest rate of the U.S. and the FXERI. However, the finding that a_{12} and b_{12} were statistically insignificant in the relevant model does not confirm a long-term relationship between the shadow interest rate and the FXERI for the post-GFC period in terms of shock and volatility spillovers. The VARMA–BEKK–AGARCH estimations showed that there might be long-term impacts of the shadow interest rate of the U.S. on the CRASERI in terms of a_{12} and b_{12}, whereas the asymmetric shock spillover did not persist. These findings may be interpreted as the effects of the FED's interest rate policy on emerging markets being mitigated by the country-specific macroeconomic vulnerabilities of emerging countries after the GFC.

On the other hand, the relevant empirical models determined that bad news about the shadow interest rate of the U.S. does not tend to influence the excess returns in the multiple-asset class of emerging countries more than good news. In terms of a_{21}, b_{11}, and b_{21}, the model results also implied the long-term effect of excess returns in the financial markets of emerging countries on the shadow interest rate of the U.S. and the volatility transition between variables both in the post-GFC period and in the entire sample. Accordingly, the long-term effect of the change in the value of financial assets of emerging countries on U.S. financial markets and the FED interest rate policy was confirmed, in line with Ammer et al. (2019). Since the results obtained for c_{21} and c_{11} for all the models did not strongly support asymmetric effects, it can be said that the developments in the financial markets of emerging countries have a very weak probability of triggering a financial crisis in the U.S. economy.

In this study, the robustness of the estimated VARMA–BEKK–AGARCH-type models was also tested with the Ljung–Box, and McLeod–Li tests. Of all the models, the Ljung–Box test results generally revealed that the null hypothesis of no serial correlation could not be rejected. The McLeod–Li statistics also supported the adequacy of the ARCH and GARCH terms in the model. On the other hand, the slope-based Mork test was conducted to evaluate the presence of asymmetric relationships between the variables of the models within the scope of the non-linear VAR model (Kilian & Vigfusson, 2011). The Mork test was chi-square based, and p-values greater than 0.05 indicated the validity of the non-asymmetric relationship. This study estimated the non-linear VAR model for the full sample and the subsample in accordance with the vectors indicated in Table 3. At the confidence level of 95%, it can be accepted that there can be asymmetric effects in the impacts of gsh_t^f on $gfxeri_t^f$, while gsh_t^{ab} also has asymmetric effects on $gcraseri_t^{ab}$. Similarly, this study used Mork tests to investigate whether FXERI and CRASERI have asymmetric effects on the U.S. shadow interest rate, and it was strongly confirmed that shocks in the FXERI have asymmetric effects on the shadow interest rate of the U.S. Thus, it can be suggested that the positive and negative shocks in the FXERI will not be weighted with the same importance by the FED. On the other hand, since I found that the CRASERI does not have an asymmetric effect on the shadow interest rate of the U.S., it can be argued that the monetary policy in the United States gives significant responses to positive and negative shocks in the multiple-asset class.

Table 3. Residual diagnostics for the model variables and Mork test results

	$(gfxeri_t^f, gsh_t^f)'$		$(gcraseri_t^f, gsh_t^f)'$		$(gfxeri_t^{ab}, gsh_t^{ab})'$		$(gcraseri_t^{ab}, gsh_t^{ab})'$	
	$gfxeri_t^f$	gsh_t^f	$gcraseri_t^f$	gsh_t^f	$gfxeri_t^{ab}$	gsh_t^{ab}	$gcraseri_t^{ab}$	gsh_t^{ab}
Ljung–Box Q(20)	14.526	21.399	11.280	14.359	12.377	15.480	47.335***	23.856
	(0.796)	(0.374)	(0.871)	(0.811)	(0.871)	(0.748)	(0.000)	(0.248)
Ljung–Box Q(40)	33.080	40.864	15.665	27.207	15.344	32.566	97.542***	39.109
	(0.524)	(0.432)	(0.974)	(0.938)	(0.912)	(0.791)	(0.000)	(0.510)
McLeod–Li(20)	25.289	33.155**	11.265	14.475	10.536	19.820	11.368	10.661
	(0.145)	0.032	(0.915)	(0.805)	(0.957)	(0.469)	(0.936)	(0.954)
McLeod–Li(40)	47.400	55.036*	21.383	29.162	22.693	43.673	21.252	27.298
	(0.157)	0.057	(0.951)	(0.897)	(0.987)	(0.318)	(0.993)	(0.936)
	$gsh_t^f \rightarrow gfxeri_t^f$		$gsh_t^f \rightarrow gcraseri_t^f$		$gsh_t^{ab} \rightarrow gfxeri_t^{ab}$		$gsh_t^{ab} \rightarrow gcraseri_t^{ab}$	
Mork's test of symmetric coefficients and p-values	3.993** (0.045)		2.725* (0.098)		3.683** (0.054)		18.383*** (0.000)	
	$gfxeri_t^f \rightarrow gsh_t^f$		$gcraseri_t^f \rightarrow gsh_t^f$		$gfxeri_t^{ab} \rightarrow gsh_t^{ab}$		$gcraseri_t^{ab} \rightarrow gsh_t^{ab}$	
Mork's test of symmetric coefficients and p-values	9.139*** (0.002)		0.325 (0.568)		14.128*** (0.000)		0.084 (0.770)	

Note: The values in parentheses refer to the p-values.
***, **, * denote significance at 1%, 5%, and 10% repectivelly.

Conclusion

In this study, the VARMA–BEKK–AGARCH models were divided into two segments. More specifically, the mean equation reflects the short-run interactions between model variables, and the variance equation provides the opportunity to examine the shock, volatility, and asymmetric spillovers in the long run. The estimated for the entire sample revealed the relationship between the shadow interest rate and the FXERI, and shadow interest rates do not have immediate effects on the FXERI. It was also found that the changing economic conditions and the economic structure after the GFC do not change the transition of U.S. interest rates to emerging countries' exchange rates. In addition, the increases in the shadow interest rates in the U.S. will reduce the CRASERI. Therefore, it can be said that the level of integration between the changes in the U.S. money market conditions and the financial markets of emerging countries has increased. In this study, short-term shock spillovers were also evaluated among the variables of the models, and it was revealed that the shocks in shadow interest rates will decrease the value of the FXERI and CRASERI. In other words, it was determined that monetary policy changes that do not comply with the monetary policy framework pursued by the FED may cause capital flows to shift from emerging countries to the U.S. financial markets. Therefore, it can be argued that shocks in U.S. shadow interest rates are perceived by economic agents as the FED's interest rate increase and the tightening of money market conditions. Although the FED's policy rate cut is a sign of the strong performance of the U.S. economy, it is suggested by the models' results that the high interest rate environment in the U.S. can prevent excessive returns on the financial markets of emerging countries and can contribute to meeting the global financial stability target.

The results of VARMA–BEKK–AGARCH model showed that changes/shocks in shadow interest rates will reduce the excess returns in the financial markets of emerging countries in the long term. Additionally, the country-specific macroeconomic developments have gained weight in emerging countries' exchange rates in the post-GFC period and the relationship between the foreign exchange market the U.S. shadow interest has weakened. At this point, it can be argued that issues such as a high debt level and level of foreign exchange reserves, which cause macroeconomic and financial vulnerabilities in these countries, dominate the FXERI by affecting the country risk. The long-term response of the money and capital markets of emerging markets is negative and statistically significant to the country-specific macroeconomic and financial fragilities as well as the foreign interest rates. Moreover, there exposes the long-term relationship between the U.S. shadow interest rate and the CRASERI. The asymmetric impact of shadow interest rates

on the FXERI and the CRASERI were implied. Accordingly, it can be suggested that bad news about the shadow interest rate of the U.S. has a greater impact than good news.

The long-term effect of excess returns in the financial markets of emerging countries on the U.S. shadow interest rate was also analyzed with the VARMA–BEKK–AGARCH models. The shocks in the FXERI and the CRASERI can cause the interest rates to rise in the U.S. in the short term. In other words, due to excessive returns in emerging countries, it can be argued that the FED may soon pursue policies that reduce the abundance of global liquidity. As a result of the estimated values, it can also be assumed that these inferences are partially valid for the long term.

Furthermore, the excess returns in emerging countries have volatility spillovers to the U.S. shadow interest rates in the post-GFC period. However, it was suggested that bad news in the FXERI and the CRASERI does not influence the shadow interest rates in the U.S. more than good news. Although excess returns in the emerging countries did not have asymmetric effects on the shadow interest rate in the U.S., the results of the slope-based Mork test performed under the non-linear VAR model emphasized that the FED will give asymmetric responses to shocks in the FXERI.

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The potential growth impact of fiscal consolidations

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Abstract

Purpose — This paper analyzes the feasibility of fiscal consolidation implementation in the case of Indonesia. The main question to be investigated is whether fiscal consolidation will deteriorate economic growth or not.

Methods — This research uses various probabilistic models to assess the success of fiscal adjustments. Probit and logit models are used as a preliminary estimate, and the robustness checks are conducted by binary extreme value and Tobit models.

Findings — The results indicate that the magnitude of government revenue is less than that of government spending. They seem that increasing government revenue (taxes, for instance) is less harmful than reducing expenditures, which empirically denies what Keynesian economists approve of.

Implication — The results highlight that Indonesia's fiscal authority should immediately reform the economic, regulatory, and institutional environments in adopting fiscal austerity policies. The reforms are strongly required to realize fiscal health as well as to promote economic growth.

Originality — This paper contributes to the literature on fiscal policy in developing countries. Unlike other empirical studies, this research compares the actual output over the potential output, instead of the actual past output to evaluate the successfulness of fiscal consolidations.

Keywords — government revenue, government spending, fiscal consolidation, output gap, economic growth.

Introduction

Following the Coronavirus disease (Covid-19) outbreak around the world in late 2019, fiscal policy has received much attention. Many developed countries adopt the fiscal stimulus packages, compared to monetary policy, to survive the adverse impacts emerging from Covid-19. For instance, as of October 2020, member countries of G-20 announced that the fiscal stimulus packages ranged from 7 percent of GDP in China to 13 percent of GDP in the U.S. and more than 21 percent of GDP in Japan (Szmigiera, 2020).

The high fiscal stimulus packages and, at the same time, government revenue dropped induce budget deficits. Many developed and emerging economies financed them by issuing debts. According to the Institute of International Finance (2020), in the third quarter of 2020, global debt stocks reached record levels of $272 trillion. In response to the Covid-19 crisis, the global debt-to-GDP ratio has jumped by more than ten percentage points to 365 percent of GDP by the end of 2020. The high deficit and debts create some particular fiscal risks in the future. Accordingly, many countries

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suffer from long-run fiscal sustainability problems which require substantial fiscal consolidation[1] (Molnar, 2012).

From an academic perspective, the above phenomena are interesting to investigate, particularly from three main economic paradigms. On the one hand, according to the traditional Keynesian view, fiscal consolidations are projected to repress economic growth. On the other hand, the Neoclassical school of thought argues fiscal consolidations must not necessarily hamper economic growth but may boost the economy, at least in the short run. Meanwhile, following the Ricardian equivalence hypothesis believed that fiscal consolidation does not affect economic growth (Bilicka, Devereux, & Fuest, 2012).

For policymakers, understanding fiscal consolidation is also crucial to know its effectiveness. Concerning the expansionary effects, if the present tax increases imply that consumers' originally perceived future tax increases will be smaller than expected, the current private consumption can increase. Regarding the intertemporal substitution effect, if fiscal adjustments are perceived as permanent and successful, real interest rates of government bonds should decrease (Alesina & Ardagna, 1998). In turn, households will tend to bring consumption forward to the current period (Alesina & Ardagna, 1998).

Since the government officially announced Covid-19 for the first time on March 2, 2020, Indonesia launched the first two fiscal packages amounting to IDR 33.2 trillion (0.2 percent of GDP), the government announced an additional package of IDR 405 trillion (2.6 percent of GDP) on March 31, 2020. They were further expanded to IDR 677.2 trillion (4.2 percent of GDP) on June 4, 2020, as part of a national economic recovery program. The national economic recovery program has been continuously refined and stands at IDR 695.2 trillion (UNDRR, 2020).

As a result, the budget deficit widened up to more than 6 percent of GDP. Also, Indonesia's debt increased significantly in 2020 as the government has ramped up spending to rescue an economy battered by the Covid-19 pandemic amid falling state revenue collection. The country's debt-to-GDP ratio was increased to 34.53 percent as of August 2020, a jump from 29.8 percent recorded in the same month in the previous year, adding that the debt ratio might reach 37.6 percent by the end of 2020. The increasing debt-to-GDP ratio is the consequence of a lower interest rate and weakening domestic currency, and the rising issuance of sovereign debt papers to cover financing needs.

The Emergency Law No. 2/2020 indeed allows the state budget deficit to widen more than 3 percent of GDP only until 2022. In 2023 Indonesia has to return to the discipline of the fiscal rule, most notably capping fiscal deficit ratio to 3 percent of GDP and debt ratio maximum of 60 percent of GDP. Our question in mind is whether, in 2023, Indonesia will implement fiscal Austerity. Indonesia is, in fact, interested in growth to recover its domestic economy from the recent recession. At the same time, the vision of becoming an advanced country in 2045 (the 100th anniversary of the independence of the Republic of Indonesia) requires an economic growth rate of at least 7 percent per annum.

Even though fiscal consolidations need not necessarily be recessionary (Khoja & Khan, 2020), Indonesia does not allow too much fiscal contraction since most government outlay is obligatory spending in nature. On the contrary, as far as economic growth is the primary concern, implementing sustainable and inclusive growth fiscal measures is likely to require an increase in government revenue, or even sovereign debts, to cover interest payments. In this case, every attempt to reduce debt ratios via fiscal consolidation has very likely resulted in a higher debt to GDP ratio through their long-term negative impact on output (Fatás & Summers, 2018). This brings us back to the ideas of fiscal Austerity.

However, different theoretical perspectives are present in the literature regarding the impact of fiscal deficit on economic growth. On the one hand, the Keynesian view suggests that an increase in government spending would positively affect the output level in an economy. According to this view, during economic recessions, the government should engage in inactive fiscal policy and conduct a budget deficit to stimulate aggregate demand (Alberto Alesina, Barbiero, Favero, Giavazzi, & Paradisi, 2017).

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[1] The term 'fiscal consolidation' throughout this paper is interchangeable to 'fiscal austerity' and 'fiscal adjustment'.

On the other hand, the neoclassical perspective considers fiscal deficits bad for the economy because an increase in government spending leads to borrowing, which puts pressure on the interest rate (Bernheim, 1989). As a result of the hike in interest rate, private investment is crowded out by public borrowing. Furthermore, the effectiveness of the fiscal policy is dependent on the time lag. The longer lagged response makes it difficult for the fiscal policy to be effective.

The Ricardian equivalence hypothesis posits that individuals anticipate that the increase in government expenditures through borrowing in the current period would lead to higher taxes in the future. The individuals respond to this phenomenon by decreasing demand, and therefore the net impact of fiscal expansion may be neutral (Barro, 1974). The rational expectation models also suggest similar responses to the fiscal policy.

Moreover, a variety of methodologies have been proposed to test the validity of the three theories. However, after the initial contribution by Giavazzi and Pagano (1990), several studies have found empirical evidence supporting the importance of the composition of the fiscal adjustment for the macroeconomic outcomes, particularly those addressing the issue of potential non-Keynesian effects of fiscal consolidations.

The probability of expansionary effects of fiscal consolidations was found in the literature to be higher for expenditure-based than for revenue-based consolidations. Nevertheless, the recent empirical works on the link between fiscal consolidation and economic growth can be further divided into two groups with diverging results. The first group uses cross-country panel data to study the long-term relationship between fiscal consolidation and growth. The second uses time-series data within a single country to study the short-term relationship between the two variables.

In the first group, Afonso, Nickel, and Rother (2005) assessed the determinants of the success of a fiscal adjustment. Their results suggest that expenditure-based consolidations have tended to be more successful for the Central and Eastern European countries. In contrast, revenue-based consolidations tend to be less successful. Jadhav, Neelankavil, and Andrews (2013) suggest the feasibility of attaining growth through various programs, including Austerity in the industrialized countries.

Arizala, Gonzalez-Garcia, Tsangarides, and Yenice (2021) found that fiscal consolidations based on reducing public investment have the most significant effect on output in sub-Saharan Africa, while fiscal consolidations are based on revenue mobilization are less harmful. These findings suggest that the negative impact on growth can be mitigated through the design of fiscal adjustment. More recently, Nie (2020) obtained empirical evidence supporting the expansionary fiscal contraction hypothesis for OECD countries: results for output are driven by changes in tax rates and are robust to how one defines a high-debt regime and how one measures Austerity.

Most of the empirical evidence tends to confirm that expenditure-based strategy than revenue-based in fiscal adjustments. However, Wildowicz-Giegiel (2019) confirmed that fiscal Austerity in the Eurozone countries initiated to reduce the public debt to GDP ratio does not contribute to macroeconomic stabilization and adversely affects the potential output. Contrary to widely held opinion, this allows the claim that Austerity is not a good remedy for economies suffering from a recession.

Ardanaz, Hallerberg, and Scartascini (2020) corroborated macro results with micro evidence from an original survey experiment that measures voter's fiscal policy preferences over the business cycle in seven countries across Latin America. They paid more attention to how fiscal adjustments episodes are implemented, both in terms of their design and timing. Their experimental evidence shows that respondents preferred expenditure cuts to tax increases during downturns, the opposite of the type of consolidations that countries typically pursue.

Departing from the supply-side economy, Bardaka, Bournakis, and Kaplanoglou (2021) presented evidence of both short-run and long-run negative effects of fiscal consolidation on total factor productivity (TFP). The short-run impact is disproportionately more damaging for the TFP of low debt countries. Contrary to the expansionary austerity thesis, their empirical results would advise against spending-driven fiscal consolidation since such consolidation undermines capacity due to the importance of government spending in shaping productive capital.

In the second group, Boulila and Benbouziane (2018) found that neither increasing taxes cuts nor reducing expenditures is a solution for the crisis for Algeria that confirms empirically what Keynesian economists approve of. Papaioannou (2019) investigated the influence of public expenditure on economic growth using Markov Switching regression and quarterly data for Greece. The results showed that the effects of government spending on economic growth are asymmetric over the business cycle.

Acocella, Beqiraj, Di Bartolomeo, Di Pietro, and Felici (2020) concluded that plans to reduce the public debt in Italy based on tax increases are more effective than expenditure reductions. Tang, Liu, and Cheung (2010) investigate the effectiveness of fiscal policy in five Southeast Asian countries of Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Through a structural vector autoregression model, government spending is found to have a weak and largely insignificant impact on output. In contrast, taxes are found to have outcomes contrary to conventional theory.

In the case of Indonesia, Surjaningsih, Utari, dan Trisnanto (2012) indicated the absence of discretionary fiscal policy. Their study also concluded that in the short-term adjustment, an increase in government spending positively affects output, while a tax increase has a negative effect. Therefore, government spending is more effective in stimulating economic growth, especially in times of recessions. In contrast, Kuncoro dan Pambudi (2014) showed that a decrease in government expenditure would positively impact real private investment and export volume.

In other avenues, the widening fiscal deficits induced by government spending in the last decade encourage some scholars' concern about fiscal sustainability. Basri and Rahardja (2011) suggest improving the quality of spending to control the fiscal deficits. To contribute to a greater economic stabilization, fiscal space can be maintained by converting unproductive spending into productive spending. Kuncoro (2014) indicated that the relative efficiency scores of taxes revenue is lower compared to nontaxes revenue. In his subsequent paper, he alternatively recommends tax counterbalancing as a strategic way not only to manage fiscal deficits but also to enlarge fiscal space (Kuncoro, 2019).

A brief review of macroeconomic theory and empirical evidence above suggests that the impact of fiscal consolidation programs on short-term economic growth is ambiguous. While there seems to be consensus on the larger role for expenditure cuts, the results are less homogenous at the more disaggregated level. The mixed empirical results of the implementation of fiscal consolidation in various countries encourage this study to reexamine them. Even though the successful fiscal consolidation is determined by some important factors (initial fiscal condition, duration, magnitude, composition, and credibility), how it will be carried out without jeopardizing economic growth remains the major issue.

Methods

In order to understand the long-run effects of fiscal consolidation on economic growth, one strategy is to compare growth in several consolidation episodes with growth in those episodes without consolidation (Kleis & Moessinger, 2016). This investigation, however, would not produce credible insights since the approach could suffer from a selection and/or reverse causality bias. To cope with these problems, it is important to identify what has been happening in a consolidating country in the absence of fiscal consolidation. In this setting, the endogenous decision to consolidate is of minor importance.

Meanwhile, this comparison is not possible using standard estimators without relying on strong, and in most cases, implausible assumptions, a variety of methodologies have been proposed to identify different aspects in the literature. In the light of this, we now turn to design empirical research on the conditions under which fiscal consolidations have not been expansionary yet. In this setting, the expansionary fiscal consolidations can be well investigated.

This study is interested in the impact of fiscal Austerity (expenditure-based and revenue-based) on the economic activities represented by gross domestic product. Therefore, this investigation uses three macroeconomic variables: gross domestic product (*GDP*), government

expenditures (*G.E.*), and government revenues (*G.R.*) as employed by Boulila and Benbouziane (2018):

$$Log\ GDP_t = \alpha + \beta\ Log\ GE_t + \gamma\ Log\ GR_t + \varepsilon_t \quad (1)$$

Transforming into growth rate, (1) would be:

$$\Delta\ Log\ GDP_t \equiv\ Growth_t = \alpha + \beta\ \Delta\ Log\ GE_t + \gamma\ \Delta\ Log\ GR_t + \varepsilon_t \quad (2)$$

where Δ is the first difference operator and β and γ are the fiscal multiplier, respectively.

Equation (2) is understood that higher real GDP growth is of crucial importance for the success of consolidation efforts, notably given also the denominator effect in this context. This is particularly critical because the impacts of austerity measures are not the same in all stages of the economic cycle (Auerbach & Gorodnichenko, 2013).

For our econometric analysis in this context, we assume that a fiscal adjustment is successful if there is an improvement in real or actual GDP so that it is greater than the potential one, instead of referring to the past real or actual GDP.

Since we concern with the success of economic growth instead of its magnitude, the corresponding variable is then transformed into a binary variable:

$$Growth_t^* = \{^{GDP > GDPp;\ 1}_{GDP < GDPp;\ 0} \quad (3)$$

where *GDPp* is the potential GDP.

Having determined the nature of the fiscal consolidation episodes as either successful or unsuccessful, we can also assess their potential determinants. Therefore, the estimate is as follows:

$$Growth_t^*\ = \alpha + \beta\ \Delta\ Log\ GR_t + \gamma\ \Delta\ Log\ GE_t + \varepsilon_t \quad (4)$$

Our model allows not only to send a signal of fiscal adjustment but also to evaluate the feasibility of which measure is more effective. Based on formula (4), it can be observed that fiscal consolidations tend to bring reductions in debt ratios only if economic growth is strong and the output gap increases. If the output gap falls, fiscal consolidations have an associated lower drop in the debt ratio.

To identify potential output, this study adopts Hodrick-Prescott (H.P.) filtering method. This method is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. The method was first used in a working paper (circulated in the early 1980's and published in 1997) by Hodrick and Prescott (1997) to analyze postwar U.S. business cycles.

Technically, the H.P. filter is a two-sided linear filter that computes the smoothed series τ of y by minimizing the variance y of around τ, subject to a penalty that constrains the second difference of τ. The H.P. filter then chooses s to minimize:

$$\sum_1^T (y_t - \tau_t)^2 + \lambda \sum_2^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \quad (5)$$

The penalty parameter λ controls the smoothness of the series τ. The larger the λ, the smoother the τ. As $\lambda = \infty$, τ approaches a linear trend. The default value of λ in Eviews is set to be 1,600 for quarterly data.

The binary response regression model as (4) will be estimated by the logit model. The logit model uses the logistic probability distribution to estimate the parameters of the model. Although seemingly nonlinear, the log of the odds ratio, called the logit, makes the logit model linear in the parameters. The marginal effect of a regressor in the logit model depends not only on the coefficient of that regressor but also on the values of all regressors in the model.

$$\pi =\ \emptyset\ (\alpha + \beta\ \Delta\ Log\ GR_t + \gamma\ \Delta\ Log\ GE_t) \quad (6)$$

An alternative to the logit model is the probit model. The underlying probability distribution of probit is the normal distribution (independent variables in the model). The difference lies in the fact that logistic function has harder "fat tails". The parameters of the probit

model are usually estimated by the method of maximum likelihood. Similar to the logit model, the marginal effect of a regressor in the probit model involves all the regressors in the model.

$$\pi = \frac{1}{1+ e^{-(\alpha+\beta \Delta Log\, GR_t+\gamma \Delta Log\, GE_t)}} \quad (7)$$

The logit and probit coefficients cannot be compared directly because the logarithmic distribution has a variance equal $\pi^2/3$. Multiplying the probit coefficients by 1.81 makes them then comparable with the logit coefficients. In practice, the logit and probit models give similar results. There are no significant differences in practice, only in the case that the sample contains numerous observations with extreme values. The choice between them depends on the availability of software and the ease of interpretation (Gujarati, 2014).

For this study, the variable of interest is specified as follows. The government revenue covers taxes and nontaxes received, including grants. The term 'government expenditure' used in this study is central government outlay comprising general consumption or recurrent expenditure realization (mostly allocated onto wage/salary and goods/services purchase) and capital expenditure, excluding interest payment. Inclusively, we also assess the spending of transfer to regions. The primary balance budget is the difference between total government spending (excluding interest payment) and government revenues. Overall balance budget deficit is the difference between total government spending and government revenues. The fiscal data are taken from the Ministry of Finance.

The selected key macroeconomic variable is GDP. The GDP is used as the main factor for the government to set the state budget projection for the next year. The GDP data is available on a quarter-basis. Those variables are presented at a 2010 constant price. The GDP data are taken from the Central Board of Statistics. Price levels are derived from the GDP in current price divided by GDP in constant prices (2010=1). The deflator index is also used to convert all variables into the real values. The sample periods were chosen for this study extend from 1983(1) to 2019(4). The year 1983 is set as the starting observation merely related to the data availability. The total observation is 148 sample points.

Results and Discussion

Table 1 provides descriptive statistics for each variable of interest. The mean values of government expenditure and government revenue ratios are not far from each other. This makes sense. In the state budget preparation, the government expenditure is determined first based on the projects list proposed by ministries and governmental institutions, followed by estimating the government revenue. Then, the government in the current fiscal year collects tax/nontax revenue to fulfill the government expenditure. If the government expenditure is greater than government revenue, the government will experience budget deficits that will be financed by domestic and foreign debts.

Table 1. Descriptive Statistics of Fiscal Variables to GDP Ratio

	GR	GE	PB	DEF
Mean	0.204	0.193	0.011	-0.015
Median	0.154	0.142	0.010	-0.013
Std. Dev.	0.134	0.132	0.056	0.059
Skewness	1.529	1.879	2.014	1.992
Kurtosis	4.659	6.041	12.092	11.562
Jarque-Bera	74.646	144.149	609.855	549.932
Probability	0.000	0.000	0.000	0.000

Source: data analysis

A consequence of debt financing generates interest payments. When interest payment is excluded from government expenditure, a primary balanced budget will be achieved. The mean value of the primary balance ratio is about 1 percent of GDP while the overall balance budget is -1,5 percent on average. Along with the current increases in deficit and debt, the interest payment

will also be increasing. As a result, the primary balance will be minus as occurs in recent years, implying the government uses debt to cover interest payment.

The tight fiscal space which is represented by the increase in primary balance deficits strongly suggests mobilizing government revenues. The lower skewness, kurtosis, and greater standard of deviation compared to government expenditure indicate that government revenue has a big potential to be the main source in financing government expenditure. While most central government outlays are mandatory spending in nature, fiscal consolidation through revenue-based, at this point, is more reasonable. This will be described further in the next section.

Figure 1 presents overall balanced budget deficits in more detail. The overall balance budget ranges from (deficit) -12 percent to (surplus) 0.6 percent of GDP. The worst deficit ratio took place in 1998 in accordance with the Asian monetary crisis. The highest surplus ratio occurred in the mid-1980s when the new tax law was implemented. More recently, the largest surplus ratio was enjoyed in 2012 when the commodity boom began. It seems that the government budget deficit is heavily dependent on some external factors.

The above results implicitly offer some fundamental implications. The government can use the overall balanced budget of plus/minus 10 percent as the preliminary reference for carrying out the active fiscal policy. The active fiscal policy might be conducted by fiscal adjustment through either revenue-based or expenditure-based. Each of these policies will be described further in the next section. However, implementing pro-growth, pro-job, and pro-poor fiscal measures is likely to require an increase in government revenues rather than spending cuts.

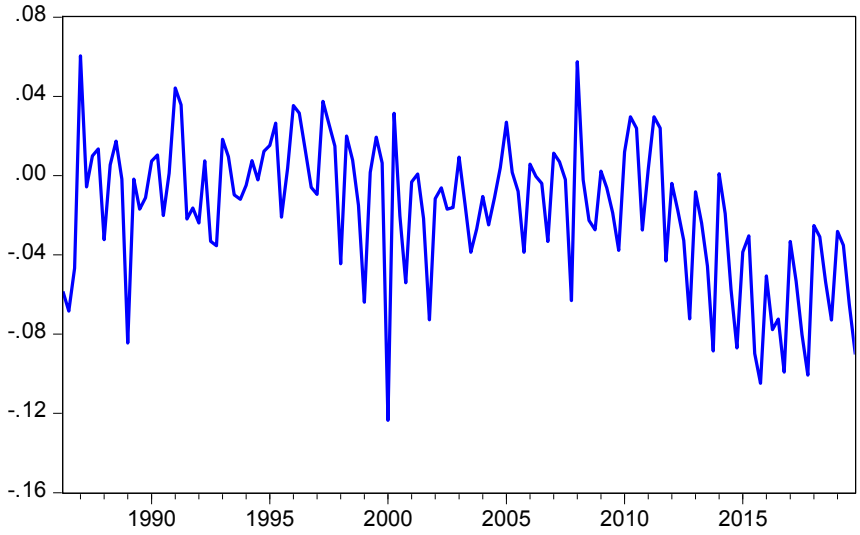

Figure 1. Overall Balance Deficit Ratio (%)

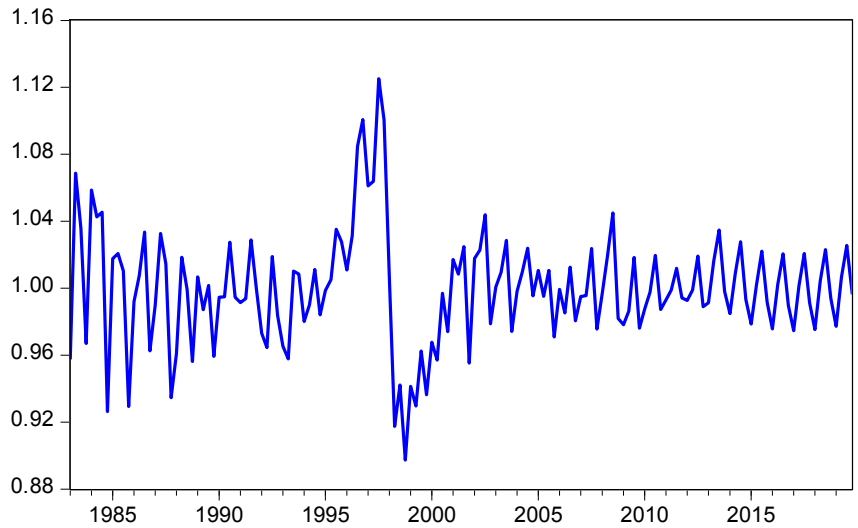

Figure 2. Actual Output to Potential Output Ratio

Figure 2 displays the dynamics of the actual output to potential output ratio. The output gap was low in the early 2000s, associated with the economic recovery process from the impacts of the 1997/1998 Asian monetary crisis. The output gap tended to be high, approximately 4 percent ahead of the 2009 global financial crisis. In such a case, promoting actual output above or at least equal to the potential output would be an appropriate goal for fiscal consolidation.

A brief visual inspection of both Figure 1 and 2 combinations overall concludes that fiscal policy in Indonesia during the sample observation periods is typically a-cyclical or even pro-cyclical, as found by Akitoby, Clements, Gupta, dan Inchauste (2006), and Baldacci (2009). The pro-cyclicality induced deficit bias, and further, the stabilization goal of fiscal policy would become destabilizing, demanding fiscal Austerity. It will be checked again more deeply by using statistical methods.

According to Şen and Kaya (2013), Granger causality can be explored to test the ability of revenue to be a stabilizer instrument. Table 2 reports the standard Granger causality test results for the revenue to actual output and potential output. Since the Granger causality test is very sensitive to the selection of lag lengths, the leg lengths are determined by Akaike Information Criteria (AIC). The standard Granger causality test results show a unidirectional causality running from government revenue to potential output instead of actual output. It means that government revenue prospectively could be a fiscal stabilizer instrument in the future, as suggested by (Kuncoro, 2019).

Slightly different results are found in the context of government spending. There is a unidirectional Granger causality running from government expenditure to both actual output and potential output. The larger spending exerted by the government, the higher the output. However, the higher output does not necessarily require the government to spend more to facilitate economic activities. Hence, we can say that government spending is independent of economic conditions.

They imply further that the expenditure-based fiscal consolidation can be conducted anytime regardless of the economic conditions, either in recessions or in the economic booms. Our analysis seems to disagree with the conventional wisdom that longer consolidations are initiated when public debt is high, fiscal deficits are large, the heavy interest burden, and long-term sovereign bond yields are elevated (Lodge & Rodriguez-Vives, 2013).

Table 2. Causality Tests of Revenue and Expenditure to GDP

Null Hypothesis:	Obs	F-Stat	Prob.
Δ (log((GE)) does not Granger Cause Δ (log(GDP))	144	3.512	0.017**
Δ (log(GDP)) does not Granger Cause Δ (log((GE))		1.784	0.153
Δ (log(GR)) does not Granger Cause Δ (log(GDP))	144	0.976	0.406
Δ (log(GDP)) does not Granger Cause Δ (log(GR))		2.933	0.036**
Δ (log(GR)) does not Granger Cause Δ (log(GDPp))	143	2.533	0.043**
Δ (log(GDPp)) does not Granger Cause Δ (log(GR))		0.667	0.616
Δ (log((GE)) does not Granger Cause Δ (log(GDPp))	143	3.658	0.007***
Δ (log(GDPp)) does not Granger Cause Δ (log((GE))		0.465	0.761

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

So far, we have discussed the feasibility of fiscal consolidation in Indonesia partially using narrative approaches. In the preceding section, we examine the growth impact of fiscal consolidation. Table 3 summarizes the estimation result of probit and logit models. On the one hand, the likelihood of an output gap decreases with higher government revenues. This means that the tax or nontax intensification and extensification that cause government revenue growth tend to hasten the necessary fiscal consolidation.

On the other hand, the increase in government spending exerts a positive and significant effect on the likelihood of fiscal consolidations. Thus, higher government spending appears to act as a fine-tuning stabilizer, as it reduces the need for any reform-driven change in domestic demand. This finding is consistent with the result of most empirical studies outlined in the previous section.

However, the size of spending cuts seems to matter more than those of tax increases. This suggests that policy shift towards a more efficient collection, progressive tax rate, and less distortionary tax system. Fiscal consolidations do not necessarily increase the tax rate. Broadening the tax base by fighting tax avoidance and tax evasion plays a vital role in fiscal adjustments. Additionally, structural reforms reduce the deadweight loss of the tax system for the economy by eliminating rents and inefficiencies. In this way, the increase in government revenues can significantly reduce the deficit and debt ratios.

Table 3. Estimation Result of Probit and Logit Models

Models	Probit		Logit	
	Coeff.	Prob.	Coeff.	Prob.
C	-0.117	0.272	-0.190	0.272
Δ log (GR)	-0.459	0.066*	-0.776	0.069
Δ log (GE)	0.852	0.002***	1.402	0.004***
McFadden R^2	0.053	-	0.053**	-
S.D. Dep. Var.	0.500	-	0.500	-
LR statistic	10.754	0.004***	10.758	0.004***
Obs with Dep = 0	79		79	
Obs with Dep = 1	68		68	
% Correct	53.74		53.74	
% Incorrect	46.26		46.26	

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

We re-estimate the same set of specifications using traditional binary extreme value and Tobit models as a robustness check. The results of which are presented in Table 4 seem to approximate those of probit and logit models. The sign and magnitude of the corresponding coefficients are close to each other. This is supported by a scale parameter that is close to unity (0.93). The scale parameter is identified in censored and truncated regression models and is estimated along with the regression coefficient.

In general, there are no qualitatively major changes in the results and conclusions. Tax-driven reforms increase the probability of successful fiscal consolidations by assuming other things are constant. The size of composition matters significantly for revenue-based rather than spending-based. All in all, our conclusions are robust, independently of the econometric model used.

Table 4. Estimation Result of Binary Extreme Value and Tobit Models

Models	Binary Extreme Value		Tobit	
	Coeff.	Prob.	Coeff.	Prob.
C	0.255	0.030**	0.044	0.666
Δ Log (GR)	-0.424	0.073*	-0.358	0.059*
Δ Log (GE)	0.892	0.002***	0.717	0.002***
Scale	-	-	0.927	0.000***
McFadden R^2	0.054	-	-	-
S.D. Dep. Var.	0.500	-	-	-
LR statistic	11.057	0.004***	-	-
Obs with Dep = 0	79		79	
Obs with Dep = 1	68		68	
% Correct	53.74		-	
% Incorrect	46.26		-	

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

The above findings offer some important implications for reforming public finances. At present, Indonesia only has the automatic stabilizers in its taxation through progressive income tax. However, the corporate income tax is no longer progressive since 2020, with a single rate of 22 percent. The personal income tax has already been progressive, but its contribution to tax revenue

is very low. Hence, reforming the tax system will boost fiscal health without sacrificing economic growth too much.

On the spending side, the country does not have automatic stabilizers yet, as is typically the case in developing economies. Inadequate fiscal space, relatively small population, and a high share of public spending as a share of GDP needs more time to implement in Indonesia, at least within the medium term. The local governments are still heavily reliant on central government fiscal transfer that covers around two-thirds of their budget. Their current aggregate own-source revenue stands at only 2.4 percent of GDP. In short, better spending is the key solution.

Under those circumstances, the post-Covid-19 pandemic seems the perfect time for Indonesia to run fiscal adjustments. All in all, for the time being, Indonesia's fiscal stabilizers still rely on discretionary fiscal measures due to the automatic fiscal stabilizers being limited. Accordingly, it is not surprising that countries with weak automatic stabilizers have enacted larger fiscal stimulus programs (Dolls, Fuest, & Peichl, 2012).

Conclusion

Fiscal policy has received much attention in recent years. The use of large fiscal stimulus packages to dampen the adverse impact of the Covid-19 pandemic recently has raised concerns about the long-run fiscal sustainability. The high budget deficit and debt ratios inevitably need to restructure into manageable levels, which require substantial fiscal consolidation measures.

This paper aims at analyzing the feasibility of fiscal austerity implementation to mitigate future economic consequences in the case of Indonesia. We explore various probabilistic models to assess the success of fiscal adjustment subject to expenditure-based and revenue-based. Our models not only generate a signal of fiscal adjustment success but also evaluate the feasibility of which measure is more effective.

By applying probit and logit models for the quarterly data, we found that increasing taxes is less harmful than reducing expenditures, which empirically denies what Keynesian economists approve of. Our findings are robust when we recheck using the extreme binary value and Tobit models. Hence, we empirically deny what Keynesian economists approve of. Fiscal consolidations must not necessarily hamper economic growth. In contrast, fiscal adjustments may boost the actual output greater than the potential output, at least in the short run. However, Indonesia's fiscal authority has quickly reformed economic, regulatory, and institutional tax ecosystems in adopting fiscal austerity policies to achieve fiscal health without jeopardizing economic growth.

This paper focused only on fiscal variables. The analysis of fiscal consolidation here isolates the effects of other factors affecting the economy: the exchange rate, monetary policy, health of public finances, availability of bank lending, and so on. Further research might control these factors, so the analysis of fiscal Austerity in Indonesia can provide deeper insights into this empirical question.

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Does economic freedom affect entrepreneurship? Insights from Africa

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Abstract

Purpose — Literature suggests that entrepreneurship can serve as a veritable tool for providing decent employment and improving economic prosperity. Therefore, the objective of this study is to examine the impact of economic freedom on entrepreneurship in Africa.

Design/methodology/approach — The study employs data of 18 African countries covering a period of 2007-2018. The analysis is based on the following techniques: Panel-Corrected Standard Errors (PCSE), generalized method of moments, Hausman–Taylor IV estimator and Driscoll-Kraay standard errors.

Findings — Finding based on Panel-Corrected Standard Errors (PCSE) technique reveals that economic freedom and its dimensions improve the level of entrepreneurship in Africa. This finding is robust to other alternative estimation techniques. Secured property right, relaxed tax burden, monetary freedom, trade freedom, freedom from corruption, investment freedom, financial freedom, business freedom and labor freedom have positive impact on African entrepreneurship.

Practical implications — The study, hence, suggests that policy should be implemented to maximize the level of economic and fundamental freedom of citizens to encourage indigenous entrepreneurs in Africa. Quality of infrastructure should be improved as well as simplification of firms' registration procedures. African government also needs to build effective and efficient institutional framework to maintain government integrity in Africa.

Originality/value — The position of African countries in the nexus between economic freedom and entrepreneurship is rarely discussed in the literature. Hence, this study contributes in this respect and showcases how economic freedom influence the decision to engage in entrepreneurial venture in African perspectives.

Keywords — economic institutions, startups, Hausman–Taylor IV estimator, Africa

Introduction

Many recent studies trace the level of economic freedom as a measure of conditions for economic prosperity and one of the determinants of entrepreneurship. However, the existing studies supporting this preposition are few and mostly dominated in developed countries (Lihn & Bjørnskov, 2017; Saunoris & Sajny, 2017; Shakya & Plemmons, 2021). The position of Africa is rarely discussed in the literature. Investigating the relationship between economic freedom and entrepreneurship in Africa is very essential and crucial for policy makers and researchers.

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Theoretically, the issue of economic freedom is commonly discussed within the framework of economic institution (Baumol, 1990; North, 1991; Schumpeter, 1934). Higher level of economic freedom may improve the level of entrepreneurial decision of economic actors and serves as a motivator for innovative activities. It mobilizes the apparatus for new knowledge creation, technology spillovers, competition and further guarantees efficient allocations of factors in the economy for formation of new entrepreneurial firms (Ajide, Ajisafe, & Olofin, 2019). Notwithstanding these prepositions, few scholars document conflicting findings on the impact of economic freedom on entrepreneurship (Bjørnskov & Foss, 2008, 2016; Chowdhury, Terjesen, & Audretsch, 2015; Saunoris & Sajny, 2017; Shakya & Plemmons, 2021). They also explain that the findings may have something to do with the government regional policy and peculiarity of different institutional conditions in the society. This suggests an empirical question to be answered in the context of African perspectives. Therefore, the objective of the current study is to examine the impact of economic freedom on entrepreneurship in African nations.

The motivation behind this research lies on: (1) the non-availability of data to consider the case of Africa by the previous studies. (2) The empirical assumptions of the nature of entrepreneurship that make findings to be different in developing countries compared to developed economies due to institutional and political environment context. (3) The need for sustainability of African economies as defined in UN sustainable development goals (Dvouletý, Gordievskaya, & Procházka, 2018). (4) And, lastly the ability to achieve the objectives of African union (AU) and Economic Community of West African States (ECOWAS). For instance, economic freedom dimensions such as labour freedom, financial freedom, trade freedom, investment freedom among others are appropriate for the aim of African union and other regional agreements in Africa where goods, services skilled labour and investment can move freely among African nations. Most importantly, free movement of capitals, labour and trade activities are crucial for sustainable development of African countries and enhance the integration of African markets (Miller & Holmes, 2010). Free movement of resources and relaxations of capital control policy can increase the level of African development (Ajide et al., 2019).

Based on this, the novelties of this study are of two folds. First, it provides an empirical evidence into the relationship between economic freedom and entrepreneurship in African perspective, which has received little attention. This paper investigates the relationship by extending the panel-corrected standard errors (PCSE), generalized method of moments (GMM) and Hausman–Taylor/instrumental variable estimation techniques to entrepreneurship function to include economic freedom. Furthermore, to circumvent for omitted variables and regional specific variables, the study includes institutional and regulatory variables (like time required to start business, procedures to register business and quality of infrastructure). This is notable because government integrity and regulatory quality will create conducive business environment for African entrepreneurs towards achieving economic sustainability. In addition, the study not only addresses the issue of cross sectional dependence, but also focuses on the major determinants of entrepreneurship.

Economic freedom can be recognized as an important, institutional environment in growth processes, job creation, value creations and quality of life (Bennett, 2021; Okunlola & Akinlo, 2021). It can be conceptualized within the realm of economic institutions due to its ability to affect economic power, decision of economic actors through their engagement in entrepreneurial startups across different sectors. It involves individual liberties and rights to produce, distribute and consume goods and services. It provides absolute rights of ownership of property and freedom of labour including goods and capital. It involves absence of economic liberty coercion and constraints in the economy (Miller & Holmes, 2010). The role of economic freedom on entrepreneurial startup can be inferred from the Northian institutional theory. Because institution happens to be the rule of the game in the society, it influences individuals and entrepreneurial startups. Economic freedom plays a very important role in encouraging or discouraging risk taking behaviour entrepreneurs. A stable economic institutions lead to economic freedom and at the same time reduces the uncertainty levels in the economic transactions (Baumol, 1990; North, 1991). For instance, property right protection attracts entrepreneurial investment and creates high level of

credibility business environment (Bjørnskov & Foss, 2016). The property right which is one of the key aspect of economic institutions may serve as a motive for engaging entrepreneurial activities (Schumpeter, 1934). Economic institutions change the economic conditions, reduce economic uncertainties and coordinate the level of economic operations in a dynamic manner. It guides the existence of judicial system in protecting individual rights and reduce the level of expropriation in the economic system (Knight, 1921). Monetary freedom involves sound money, stability and predictability of prices. Instability in price system increases the level of monetary policy fluctuations in the future earnings of entrepreneurs (Bjørnskov & Foss, 2008). A society with higher level of economic freedom would favour rapid development in entrepreneurship and economic prosperity (Miller & Holmes, 2010). In a society where economic freedom exists, individual economic actors are free to choose any legitimate activities such as entrepreneurial venture, produce, consume and invest at their own freewill once protected and respected by the state (Díaz-Casero, Díaz-Aunión, Sánchez-Escobedo, Coduras, & Hernández-Mogollón, 2012)

The mixed findings of previous papers in entrepreneurship literature have created further interest to examine the nexus between economic freedom and entrepreneurial startups in African context (Bjørnskov & Foss, 2016; Chowdhury et al., 2015). Bjørnskov and Foss (2008) examine the impact of economic policy proxied as Economic Freedom Index on the supply of entrepreneurship. They find that government size reduces entrepreneurial development and sound money promotes entrepreneurship. Other aspects of economic freedom do not have significant impact on entrepreneurship. Díaz-Casero et al. (2012) document over a period of 2002-2009 that economic freedom is closely related to early stage entrepreneurship. In general, they suggest that entrepreneurship decreases as fiscal freedom and government size increase. But they conclude that entrepreneurship by opportunity increases in innovation-driven economies with small size of government. This is in line with the results of Lihn and Bjørnskov (2017). They establish within 30 OECD countries that political veto players and economic institutions jointly affect entrepreneurship. They discover that larger government spending increases the level of entrepreneurship at lower veto power.

In this vein, the study of Saunoris and Sajny (2017) classifies entrepreneurship into formal and informal entrepreneurship. This provides the opportunity to examine how economic freedom affects the two forms of entrepreneurship. Their results based on cross-country data show that economic freedom promotes formal entrepreneurship after correcting for the possibility of reverse causality among the variables while economic freedom reduces the level of informal entrepreneurial settings. Furthermore, Angulo-Guerrero, Pérez-Moreno, and Abad-Guerrero (2017) examine how economic freedom influences opportunity and necessity entrepreneurship within OECD countries over a period of 2001-2012. The analysis is based on system Generalized Method of Moments estimator. Findings reveal that economic freedom encourages opportunity entrepreneurship and reduces the level of necessity entrepreneurship. Opportunity entrepreneurship benefits from economic freedom due to improved judiciary system, property rights protection, credit regulations, labour freedom and business freedom. The recent study of Shakya and Plemmons (2021) in United States examines the nexus between entrepreneurial startups and economic freedom over a period of 2005 to 2015. Using a post-double–selection LASSO method, the results show that regulatory freedom improves the level of startups in USA while increase in government spending and taxes reduce the level of startups.

In a nutshell, it is very glaring that there few studies examining the nexus between entrepreneurship and economic freedom in advanced countries while the situation of developing countries still remain unknown. Our study intends to shed light on the position of African countries by proposing that there is a significant impact of economic freedom on entrepreneurship in Africa.

Methods

The main objective of this study is to examine the impact of economic freedom on entrepreneurship in Africa. Based on the theoretical prepositions and previous studies discussed in the previous section, we therefore specify the empirical model as:

$$ED_{i,t} = \beta_0 + \beta_1 ECI_{i,t} + \sum_{k=1}^{6} \delta_k X_{k,i,t} + e_{i,t} \quad (1)$$

ED is the entrepreneurship proxied by new business density and *ECI* is economic freedom. In addition, X represents vector of control variables, *i* is the index of countries, *t* is index of time (years) and e_{it} is the error term. The inclusion of control variables is inferred from the economic theory and existing literature. The control variables include: Inflation rate (*IN*), startup requirement (*SP*), Foreign Direct investment inflow (*FD*), GDP per capita growth (*GR*), Time required to register (*TE*) and Quality of Infrastructure (*QINF*). Inflation is used to measure macroeconomic stability. Instability in the economy reduces the rate of return on capital employed and discourages entrepreneurial development. It is expected that higher quality of infrastructure would have a positive impact on new startups in Africa (Abdullah & Chowdhury, 2020; Ajide et al., 2019). It is empirically agreed that economic growth proxied as GDP per capita influences entrepreneurial development in Africa (Adusei, 2016; Ajide et al., 2019). We used time required to register business and number of startup procedures to capture regulatory requirements for setting up business in Africa while FD is used to capture the activities of multinational corporations (Munemo, 2018).

Data of the study covers a period of 12 years (2007-2018) with the use of eighteen (18) African countries including Algeria, Botswana, Gabon, Mali, Mauritius, Morocco, Nigeria, Rwanda, Senegal, Sierra-Loane, South Africa, Tunisia, Uganda, Zambia, Zimbabwe, Tanzania, Lesotho and Namibia. These countries are selected on the basis of data availability. The sources of the data are World Bank development indicators and World Bank Entrepreneurship database. We source for data on economic freedom from The Heritage Foundation Index database and data on quality of infrastructure are sourced from the World Economic Forum Competitiveness Index. The Heritage Foundation index of economic freedom is used to capture fundamental economic rights and freedom of economic actors in an economy. It measures different dimensions of freedom which includes: property right (*PR*), Tax Burden (*TB),* monetary freedom (*MF*), trade freedom (*TF*), government size (*GS*), freedom from corruption also called government integrity (*GI*), investment freedom (*IF*), financial freedom (*FF*), business freedom (*BF*) and labour freedom (*LF*). Individual dimension is assigned a score within a range of 0 (no freedom) to100 (being most free). We calculate the aggregate economic freedom by taking the average score as shown in Equation (2).

$$ECI = \frac{1}{n}\sum_{i=1}^{n} EOI_{j,t} \quad (2)$$

ECI is the aggregate institutional index; n is the number of economic freedom indicator measures; *j* denotes each individual indicator; and t stands for time-series observations. Table 1 summarizes the variables structure and their measurements.

Table 2 presents the descriptive statistics of the variables. New business density is about 2.213 per 1000 adults with a maximum value of 20.09 and minimum value of 0.060. The recorded average value is a welcome development in African continent due to a relative improvement in doing business reforms. Every government in the continent now knows the importance of entrepreneurship and how a conducive environment may help in expanding the hub of African innovation. The inflation rate is 5.57 percent on average with a maximum value of 18.2. Furthermore, the GDP growth rate is approximately 4.41 per capita. This seems to be consistent overtime due to growth in sales of commodities and services in international market (ADB, 2017).

The quality of infrastructure is about 3.67 on a scale of 1-7 points. It has a minimum point of 1.94 but maximum value of 5.62. With this score, we can say most African governments are now investing in infrastructure more than before. This makes most countries in Africa to improve in growth performance. This also increases the total number of new business in the period of study. The aggregate index of economic freedom is 57.45 with a maximum value of 77 on a scale of 100 points. This means that there a reasonable level of freedom in the selected countries which seems to be encouraging entrepreneurial startup as confirmed by the positive association between the two variables in Table 3. The pairwise correlation in Table 3 signifies the potential associations between economic freedom and entrepreneurship which is positive and significance.

Table 1. Variables structure, measurements and sources of data

Variables	Measurements	Sources
Entrepreneurship (ED)	Number of new business registered per 1000 adult population	World Bank Entrepreneurship database.
Inflation rate (IN)	Inflation rate	World Bank Development Indicators
Startup requirement (SP)	Number of procedures to registered business	World Bank Entrepreneurship database/Doing Business
Foreign direct investment inflow (FD)	Foreign direct investment as a percentage of GDP	World Bank Development Indicators
GDP per capita growth (GR)	Growth of Gross domestic product per capita	World Bank Development Indicators
Time required to register (TE)	Number of days required to register business.	World Bank Entrepreneurship database/Doing Business
Quality of Infrastructure (QINF)	Quality of infrastructure index (ranged 1 to 7)	World Economic Forum Competitiveness Index
Economic freedom (ECI)	This is an annual average of Property right (PR), Tax Burden (TB), monetary freedom (MF), trade freedom (TF), government size (GS), freedom from corruption also called government integrity (GI), investment freedom (IF), financial freedom (FF), business freedom (BF) and labour freedom (LF). The aggregate economic freedom is calculated by taking the average score using equation (2)	The Heritage Foundation index

Table 2. Descriptive statistics

Variables	Mean	Std. Dev.	Min.	Max.	Obs
ED	2.213	3.378	0.060	20.090	210
IN	5.579	4.023	2.409	18.219	211
SP	8.333	2.820	4	17	216
FD	3.363	3.033	-0.324	32.301	216
GR	4.414	4.071	-20.598	20.715	216
TE	29.270	23.361	4	105	216
QINF	3.673	0.820	1.947	5.619	184
ECI	57.458	9.118	21.4	77	216
PR	37.674	15.257	5	75	216
GI	35.218	10.867	12.2	64	216
TB	73.605	8.871	44.1	92.5	216
GS	71.218	19.619	0	96.3	216
BF	60.788	12.715	30	83.3	216
LF	60.078	17.307	21.7	91.4	216
MF	72.716	14.105	0	86	216
TF	70.838	9.524	44.8	89	216
IF	49.513	17.390	0	90	216
FF	43.796	15.532	10	70	216

Table 3. Correlation

Variables	ED	IN	SP	FD	GR	TE	QINF	ECI	PR
ED	1.000								
IN	-0.046	1.000							
SP	-0.151*	0.189*	1.000						
FD	-0.150*	0.133	-0.056	1.000					
GR	-0.151*	0.087	0.036	0.159*	1.000				
TE	0.140*	-0.011	0.395*	-0.039	-0.375	1.000			
QINF	0.397*	-0.256*	-0.134	-0.029	-0.085	0.045	1.000		
ECI	0.504*	0.041	-0.137*	0.023	-0.078	-0.349*	0.476*	1.000	
PR	0.672*	-0.106	-0.215*	-0.231*	-0.156*	-0.132	0.449*	0.075*	1.000
GI	0.681*	-0.201*	-0.201*	-0.095	-0.134*	0.016	0.681*	0.681*	0.763*
TB	0.236*	0.287*	0.095	0.093	0.081	-0.376*	0.254*	0.480*	0.159*
GS	-0.049	0.107	-0.036	0.0211*	0.000	-0.375*	0.001	0.453*	0.037
BF	0.392*	-0.072	-0.152*	-0.023	-0.176*	-0.251*	0.659*	0.613*	0.586*
LF	0.163*	0.235*	0.329*	-0.012	0.022	0.070*	0.246*	0.495*	0.268*
MF	-0.002	-0.095	-0.152*	0.062	-0.108	-0.481*	0.147*	0.630*	0.384*
TF	0.345*	0.038	-0.185*	0.060	-0.035	-0.254*	0.439*	0.723*	0.547*
IF	0.408*	-0.055	-0.298*	0.096	-0.015	-0.416*	0.318*	0.820*	0.590*
FF	0.581*	0.085	-0.103	-0.077	-0.016	-0.122	0.374*	0.803*	0.699*
Variables	GI	TB	GS	BF	LF	MF	TF	IF	FF
GI	1.000								
TB	0.124	1.000							
GS	-0.170	0.482*	1.000						
BF	0.629*	0.209*	0.060	1.000					
LF	0.303*	0.258*	0.054	0.178*	1.000				
MF	0.254*	0.163*	0.401*	0.355*	0.171*	1.000			
TF	0.532*	0.243*	0.230*	0.415*	0.322*	0.388*	1.000		
IF	0.551*	0.360*	0.355*	0.369*	0.209*	0.491*	0.681*	1.000	
FF	0.586*	0.292*	0.189*	0.465*	0.322*	0.363*	0.635*	0.904*	1.000

* denotes significance at 5%.
Source: computed by author

This study first estimates pooled Ordinary least Square (POLS) and examines the autocorrelation and heteroscedasticity. The Wooldridge test for autocorrelation reveals the presence of first order autocorrelation in the panel setting. We also present the Likelihood-ratio test confirming the presence of heteroscedasticity in the panel. In addition, the Pesaran's test of cross sectional independence confirms the presence of cross sectional dependence.

Due to the presence of autocorrelation, heteroscedasticity and cross sectional dependence, we implement a Prais-Winsten regression with panel-corrected standard errors (PCSE) in the first instance. However, the main problem of this estimator is the failure to correct for endogeneity and the impact of time-invariant variables. In this study, some variables like the economic freedom, time required to register business and startup business procedures are time invariants. Variables like GDP per capita growth among others are endogenous. As a robustness check on this estimator, the study re-estimates the baseline model using GMM approach along the lines of Arellano and Bond (1991) and Hausman–Taylor/instrumental variable (HT-IV) estimator. The GMM approach is used to address reverse causality/endogeneity issues among the variables. HT-IV estimator has the benefit of capturing the time-invariant variables and also correct for endogeneity (Alhassan & Kilishi, 2019; Hausman & Taylor, 1981).This study takes a further step to examine the robustness of the baseline model via Regression with Driscoll-Kraay standard errors.

Results and Discussion

Empirical Results

In this section, we present the empirical results of the impact of economic freedom on entrepreneurial startups in Africa. Table 5 shows the results of PCSE where the first column presents the baseline results and other column shows the results of individual economic freedom dimension. Starting from the baseline estimate which reveals the aggregate index of economic

freedom (ECI), it could be observed that ECI has a strong and positive impact on African entrepreneurial startup. This suggests that economic freedom is necessary for entrepreneurial development in Africa. In other words, the economic freedom level in a country defines the extent of institutional conditions for entrepreneurial activity to thrive. The higher the degree of freedom in the economic society, the higher the level of economic prosperity and growth through entrepreneurship. This submission is in line with empirical findings of Díaz-Casero et al. (2012) and Lihn & Bjørnskov (2017) in innovation-driven economies.

In relation to the policy variables (that is, individual dimensions of economic freedom), Table 4 reveals that all the ten dimensions have positive impacts on entrepreneurial startups. This implies that trade freedom, financial freedom, labor freedom, investment freedom and others have the tendency to improve the level of entrepreneurial startups in Africa. These dimensions of economic freedom can create an African region where goods and services, skilled labor and investment may freely move for efficient utility within African countries. This supports the submission of Angulo-Guerrero et al. (2017) who explains that high level of capital inflow and trading activities can be assured where there is high level of labor and investment freedom with protection of property rights. In addition, Miller and Holmes (2010) assert that financial freedom improves the level of capital inflows by removing or reducing the level of financial constraints among the entrepreneurs. Furthermore, trade freedom guarantees flourishment of export-import entrepreneurship by removing all categories of capital controls including tariffs and non-tariffs in the international transactions. Economic freedom can improve the level of African entrepreneurship by eliminating unnecessary tax impositions and ensure labor and safety regulations.

Table 4. PCSE results (Dependent variable: ED)

Variables	Baseline	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IN	-0.025	0.036	0.026	0.002	0.100	0.071	0.067	0.102	0.027	0.083*	-0.050
	(0.485)	(0.195)	(0.210)	(0.930)	(0.145)	(0.342)	(0.370)	(0.140)	(0.675)	(0.077)	(0.244)
SP	-0.286***	-0.118***	-0.108***	-0.182***	-0.314***	-0.299***	-0.342***	-0.305***	-0.258***	-0.223***	-0.188***
	(0.000)	(0.000)	(0.007)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FD	-0.375***	0.005	-0.027	-0.068*	-0.280***	-0.260***	-0.266***	-0.260**	-0.353***	-0.396***	-0.244***
	(0.000)	(0.806)	(0.394)	(0.078)	(0.006)	(0.006)	(0.007)	(0.011)	(0.002)	(0.004)	(0.002)
GR	0.026	-0.026	-0.032	-0.033	-0.048	-0.016	-0.054	-0.052	-0.036	-0.043	-0.048
	(0.781)	(0.281)	(0.185)	(0.222)	(0.591)	(0.861)	(0.554)	(0.624)	(0.673)	(0.571)	(0.614)
TE	0.0693***	0.016	0.004	0.004	0.041**	0.047***	0.039***	0.038***	0.051***	0.066***	0.043***
	(0.000)	(0.147)	(0.662)	(0.505)	(0.012)	(0.003)	(0.011)	(0.026)	(0.001)	(0.001)	(0.001)
QINF	-0.006	0.797***	0.332*	0.734***	0.827***	0.207	0.671***	0.806***	-0.082	0.407*	0.320
	(0.975)	(0.000)	(0.060)	(0.002)	(0.006)	(0.523)	(0.025)	(0.006)	(0.832)	(0.099)	(0.240)
ECI	0.281***										
	(0.000)										
PR		0.077***									
		(0.000)									
GI			0.066***								
			(0.002)								
TB				0.071***							
				(0.001)							
GS					0.010***						
					(0.055)						
BF						0.071***					
						(0.000)					
LF							0.021***				
							(0.015)				
MF								0.001			
								(0.943)			
TF									0.129***		
									(0.000)		
IF										0.102***	
										(0.000)	
FF											0.136***
											(0.000)
Constant	-12.349***	-4.651***	-1.545**	-5.241***	-4.190**	-5.071***	-3.686*	-3.643	-10.654***	-6.287***	-4.958***
	(0.000)	(0.000)	(0.021)	(0.002)	(0.040)	(0.006)	(0.057)	(0.184)	(0.000)	(0.003)	(0.004)
R-sq.	0.537	0.231	0.118	0.242	0.310	0.334	0.314	0.307	0.384	0.470	0.535
Wald (χ^2)	395.90***	59.51***	35.72***	27.99***	240.33***	350.97***	299.61***	276.20***	655.75***	156.24***	340.97
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

*** denotes significance at 1%.

Large trade flows and investment freedom improve access to international price signals which allow African entrepreneurs to take advantages of international opportunities. Our results also demonstrate that well-defined and property rights' enforcements would help in reducing transaction costs which improves the motivation of entrepreneurial venturing in Africa. The results also confirm the study of Zhou (2018) in China. The author document that formal property rights' protection and deregulated market improve the level of entrepreneurial development positively. Among the control variables, only startup procedures (SP), foreign direct investment (FD) and quality of infrastructure are constantly significant in the model. Startup procedures capture the regulation requirement for setting up venture. The coefficient is negative and significant. This implies regulation requirements in most African countries demotivates potential entrepreneurs from taking up entrepreneurial businesses. The coefficients of FD is negative and significant implies that multinational firms discourage local entrepreneurial venturing. This could be due to higher wages offered to local, potential entrepreneurs (Ajide et al., 2019). The baseline model shows R-squared of 53.7 percent revealing the level of model's goodness of fit. This shows that the extent of variations in the exogenous variables are jointly and significantly explained by the model which is 53.7 percent of the aggregate variations in entrepreneurial startups. The Wald test also reveals that the estimated model is statistically significant and overall fitted for the entrepreneurial analysis at 1 percent level of significance.

Robustness Checks

Due to the limitations of our methodology employed, we are unable to address the causality issues among the variables. It is possible that entrepreneurship may influence economic institutional arrangement and further influence policy changes. In this case, economic freedom may be endogenous to entrepreneurial development. We address this issue by re-estimating our baseline model using Hausman-Taylor IV-estimator and first difference generalized methods of moments (GMM).

Table 5. Estimated results (Dependent variable: ED)

Variables	Hausman-Taylor IV-estimator	Difference GMM	Regression with Driscoll-Kraay standard errors
ED(-1)		1.152***	
		(0.000)	
IN	-0.069**	-0.021	-0.025
	(0.030)	(0.527)	(0.404)
SP	-0.010	0.046	-0.286***
	(0.932)	(0.603)	(0.000)
FD	-0.002	0.048***	-0.375***
	(0.965)	(0.000)	(0.001)
GR	0.008	-0.010	0.026
	(0.726)	(0.137)	(0.754)
TE	-0.058***	0.015***	0.069***
	(0.000)	(0.001)	(0.000)
QINF	-0.389*	-0.185***	-0.006
	(0.065)	(0.006)	(0.982)
ECI	0.070**	0.020***	0.281***
	(0.026)	(0.008)	(0.000)
Const.			-12.349***
			(0.000)
	Wald (χ^2)=41.46(0.000)	J-stat=11.798(0.989), AR(1) =-1.707(0.087),AR(2)=-1.081(0.279)	R-squared = 0.5379, Wald (χ^2)=99.10(0.000)

***, **, * denote significance at 1%, 5%, and 10% repectivelly.
Source: computed by author

In Table 5, we present Hausman-Taylor IV-estimator's results which address the problem of endogeneity and most appropriate when there is time-invariant variables in the model. For instance, the startup procedures (SP) and time required to commence business are time-invariant. We further employ first difference GMM estimator for robustness check. This technique also corrects for endogeneity and capture reverse causality among the variables. The Regression with Driscoll-Kraay standard errors is most employed where there is potential possibility of cross-sectional dependence. Nevertheless, these estimators still prove that economic freedom has positive and significant impact on entrepreneurial startup in Africa. That is, after controlling for reverse causality, the results show that economic freedom increases formal entrepreneurship (Saunoris & Sajny, 2017). This implies that economic freedom allows every entrepreneurs to engage productive resources and reduce the number of unproductive ones, thereby ensuring effective utilization of productive resources and improving economic prosperity (Schumpeter, 1942; Sobel, 2008).

It has been widely accepted that entrepreneurial mindset is necessary among the youth and the government incentives to encourage the spirit in our society is very important to achieve sustainable development goals. Entrepreneurship can reduce the level of African poverty, enhance growth and decent jobs for African women and youths. Innovation, infrastructure development and industrialization can be realized through the spirit of entrepreneurial development. However, an accelerated entrepreneurial development is workable where there is conducive business environment including strong institutions. Building a conducive environment for entrepreneurship may require higher level of economic freedom in all its dimensions as shown in this study. The findings of this study shows that economic freedom and its dimensions improve the level of entrepreneurial startups in the selected African countries. This implies that economic freedom can influence the possibility of achieving sustainable growth through entrepreneurship. Economic freedom improves the level of property rights security and choices for businesses including the opportunities therein. Our results show that financial, trade and labour freedom among others are useful in improving the level of African entrepreneurial startups. In this way, economic freedom increases the level of investor's confidence in Africa and paves ways for achieving sustainable growth and economic development. This is in line with the previous studies (Angulo-Guerrero et al., 2017; Saunoris & Sajny, 2017). It implies that policy makers that are interested in reducing unemployment rate, creation of new jobs and improve the level of sustainable development should take institutional framework and economic freedom as policy variables because they have long run implications for the economy (Shakya & Plemmons, 2021).

Conclusion

African policy on liberalization has made the region to be highly integrated. The process has improved the level of economic freedom across every sector of the economy. Despite the fact that there is an increase in the level of integration towards economic freedom, its impact of entrepreneurship is less discussed in the extant literature. In a more specific, the existing empirical findings in developed countries remained inconclusive on the topic. In this study, we examine the impact of economic freedom on entrepreneurial startups in selected countries in Africa over a period of 2007-2018. The study employs a battery of methodologies including PCSE, difference GMM, Hausman-Taylor IV- estimator and, Driscoll-Kraay standard errors' estimating techniques. The results show that economic freedom increases entrepreneurial startups in Africa. This means that economic freedom reduces the barriers in the process of creating new businesses (Bennett, 2021). This finding further motivates us to probe the subcomponents of economic freedom. The results of the subcomponents reveal that secured Property right, relaxed Tax Burden, monetary freedom, trade freedom, government size, freedom from corruption (government integrity), investment freedom, financial freedom, business freedom and labour freedom have positive impact on new business creation.

This study has many policy implications as follows. First, the findings suggest that the more the freedom of individuals in controlling their lives with less government intervention, the higher the entrepreneurial development in Africa. This means that government policy needs to be directed

towards increasing the level of economic freedom. With higher level of freedom, there will be an improvement in competitions, efficiency, technology transfer due to the presence of foreign entrepreneurs and labour quality in Africa. These are fundamentally important to improve the African nations' development. In addition, our findings from the individual economic freedom dimension reveals that labour is correlated with higher level of entrepreneurial development. That is, a relaxation of restrictions on hours worked, minimum wages and other stringent policies in labour market can improve the level of African entrepreneurship. This is based on the conventional belief that freedom in labour market can correct the discrepancy in the supply of labour and the demand of African entrepreneurs. It will also enable free movement of skilled labours across African countries, thereby ensuring efficient allocations of factors. It is also worth to mention that government integrity is very important. Accountability and transparency of policy to encourage civil, monetary, investment and financial freedom is important in Africa. This will improve the confidence of domestic and international investors. It will help in the achievement of African sustainable development.

In this study, we are able to provide insights on the nexus between economic freedom and entrepreneurship. However, it should be viewed in the light of its limitations. First, we unable to relate economic freedom to informal entrepreneurial startup. Second, we only consider eighteen African nations in the analysis due to data availability. We encourage the future studies to overcome this shortcoming.

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Education, skills, and labour market outcome in Indonesia: An instrumental variable approach

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Abstract

Purpose — This study examines the contribution of schooling and skills to earnings. Importantly, this study captures the importance of observing cognitive skills and non-cognitive skills associated with personality traits in determining earnings.

Methods — A revised Mincer Model serves as a theoretical framework to explain the contribution of schooling and skills to earnings. Using the Indonesian labour data from the 5th wave of Indonesian Family Life Survey (IFLS), the 2-Stage Least Squares is employed to measure the effects of schooling, cognitive and non-cognitive skills on earnings.

Findings — The results show that schooling and skills, both cognitive and personality traits determine the labour market outcomes. In addition, the relationship between education and earning is nonlinear, suggesting that the returns on education varied across education levels.

Implication — The policy should aim to enhance human capital by improving knowledge, cognitive and non-cognitive capacities to assist students in achieving their full potentials.

Originality — This study contributes to the literature by measuring the effects of unobservable cognitive skills and non-cognitive skills on earnings in developing countries absent in the previous studies. This study also utilizes the instrumental variable approach of 2-Stage Least Squares to deal with omitted variable bias and the endogeneity problem in the basic Mincer model.

Keywords — earnings, cognitive & non-cognitive skills, big five personality traits, Mincer equation

Introduction

Slower economic growth and middle-income trap are likely due to the lack of productivity in the Indonesian economy. A published document by Asian Development Bank (Asian Development Bank, 2018) shows that the slow transformation of Indonesia's economy and the labour market in the post-New Order Period is due to low productivity. Enhancing productivity is becoming the main strategy as Indonesia could not rely on commodities similar to the first decade of the 2000s that contributed to high economic growth. The data from the OECD reveals that labour productivity in Indonesia in 2018 is US$ 25,143 of GDP per person employed while the OECD countries on average have labour productivity of US$ 97,250 of GDP per person. Indonesian labour productivity is only a quarter of developed countries.

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Labour productivity is determined by workers' capacity that in turn depends on workers' knowledge and ability to perform the tasks. Despite the Indonesian high literacy rate of 99.67 percent (Nambiar, Karki, Rahardiani, Putri, & Singh, 2019), Indonesia's quality of human capital is low compared to developed countries and neighbouring Asian countries. The PISA (Programme for International Student Assessment) for students aged 15 years in 2019 shows that the Indonesian students' performance in three main skills of reading, numeracy, and science is ranked 72 out of 78 countries. On average, Indonesian students' reading score is 371, much lower than the score in the OECD countries, 487. In terms of numeracy skills, the average score is 379, more than 100 points lower than in the OECD countries, 489.

Further, the performance in science is also lower, 396 compared with 489. In addition, Indonesia has the second-highest youth unemployment rate in the Asia-Pacific region, 15 percent (International Labour Organization, 2018). Moreover, skills mismatch has persisted in Indonesia's labour market. ILO survey shows a mismatch between the education qualification and job requirements (International Labour Organization, 2018).

In order to improve labour productivity, it is essential to measure the role of human capital in the labour market outcome. In the labour economics literature, the basic Mincer model is frequently employed to understand the determinants of labour market outcome measured by earnings. The model stipulates that wages are determined by schooling measured by years of education. Generally, the model highlights the role of human capital in the labour market outcome. Specifically, the first model developed by Mincer (1958) focused on schooling as a representation of human capital and its effect on earnings. The model was further developed by incorporating training and working experiences to have more comprehensive measures of human capital (Mincer, 1958).

In addition to schooling, this study incorporates a direct measure of cognitive and non-cognitive (personality traits) skills in the Indonesian labour market. Referring to literature, the Mincer model should be improved by managing the problem of endogeneity and omitted variable bias (Humphreys, 2013). The endogeneity issue emerged as there is a relationship between individual characteristics, such as ability and residuals. Dickson (2009) argues that education measured by schooling was an endogenous variable since there was a possibility that unobserved characteristics influence the schooling choice that may correlate with earnings.

Further, Harmon (2011) mentioned the potential endogeneity problem of employing the basic Mincer model due to "ability bias." However, the bias can be explained by the contribution of hidden ability in earnings. The paper argues that students with greater hidden and unobservable abilities likely have higher education, allowing them to receive higher earnings. Thus, a simple relation failed to explain the causal relationship between schooling and earnings. Furthermore, Harmon, Oosterbeek, and Walker (2003) and Maluccio (1998) suggested including more variables capturing the natural ability, such as IQ test scores and school grades.

The recent literature examining the role of human capital in earnings argued that research in this area should include skill capacities as a direct measure of human capital. Skills consist of both cognitive and non-cognitive (i.e., personality traits). Blazquez, Herrarte, and Llorente-Heras (2018) showed that cognitive and non-cognitive skills influenced occupational status and earnings among European university graduates. Further, Gensowski (2018) provided evidence of a significant effect of personality traits on lifetime earnings, and the effect was the largest for workers between 40 and 60 years old. Additionally, Checchi and van de Werfhorst (2018) study suggested that both education inequality and skill inequality contribute to widening earning inequality.

In order to manage endogeneity issues, this study employs the Instrumental Variable approach (IV) as suggested by Lall and Sakellariou (2010). The study selects the instruments closely correlated with schooling, but it is not correlated with the ability (as unobserved characteristics) and earnings, which is the distance of schooling. Further, this study incorporates the nonlinear relationship between wages and education, referring to Maluccio (1998) as there may be a condition where different experience premiums arise for people with different levels of education.

By acknowledging the recent development of the Mincer model, this study aims to measure the role of human capital on labour market outcome by incorporating education (schooling) as an indirect measure of skills and direct measures of cognitive and non-cognitive (personality traits) skills in the Indonesian labour market. In addition, this study manages the endogeneity problem by utilizing an instrumental variable approach 2-Stage Least Squares (2-SLS) by using the distance to school as an instrument of schooling (Humphreys, 2013; Lall & Sakellariou, 2010). The previous studies on this topic in developing countries, especially Indonesia, have been absent. Therefore, this study is an attempt to fill in the literature gap. The rest of the paper presents the data and empirical methods, followed by results and discussion, and conclusion.

Methods

This study employs the 5th wave Indonesian Family Life Survey. There are more than 7,000 samples suitable for this study representing 83% of the population aged between 15 and 50 years. The samples are waged workers both in private and public institutions and as full-time and casual workers. The samples resided in 13 provinces in Indonesia, distributed in Java Island, Bali, Nusa Tenggara Barat, South Sulawesi, South Kalimantan, South Sumatera, Lampung, West Sumatera and North Sumatera.

To examine the role of schooling in earnings, the Mincer model is estimated to generate the rate of return on education. The basic empirical model (equation 3) regresses wage on education, year of experience, tenure, and the square of experience of training and tenure. The return on education is the value of the coefficient of β_1 that shows the percentage increase in wage as workers' education increases. Further, the coefficient of β_3 reflects the percentage increase in wage as workers have additional work experience.

The model also controls the demographic information, such as urban/rural, marital status, and parents' education. In addition, this study also estimates the model across gender to further examine whether there is a different influence between male and female workers. In order to investigate the determinants of schooling and abilities to earning, this study modifies the Mincerian earning equation by adding cognitive and personality traits information to capture the unobservable factors of individuals' capacities. Specifically, this study incorporates the individuals' unobservable characteristics of the cognitive test scores and personality traits information into the model. The cognitive skills are measured by four variables, namely episodic memory of immediate (EPI) and delay (EPR), the Woodcock-Johnson test, and the Raven's Progressive Matrices (RPM). Episodic memory test is proposed to assess conjointly semantic and episodic knowledge across multiple tasks: semantic matching, naming, free recall, and recognition (Tulving, 1993). The Woodcock-Johnson sets a new standard for evaluating individual strengths and weaknesses among contemporary, theory-based measures of academic achievement, oral language, and cognitive abilities (Schrank, 2014). The Raven's Progressive Matrices (RPM) test is a standardized intelligence test that consists of visually presented and geometric-analogy-like problems in which a matrix of geometric figures is presented with one entry missing, and the correct missing entry must be selected from a set of answer choices (Kunda, McGreggor, & Goel, 2009).

In addition, the non-cognitive capacities are represented by five factors of personality traits which were first surveyed in 2014. The data are collected using 15 specific questionnaires concerning the big five personality factors (Strauss, Witoelar, & Sikoki, 2016). The questions are adopted from the big five personality questions in John and Srivastava (1999). The respondents were questioned using statements that were more appropriate in representing their personality. Those five personalities are extraversion, conscientiousness, openness, agreeableness, and neuroticism. The literature suggests that the first three factors—extraversion, conscientiousness, and openness—positively influence labour market outcomes (Ravianto, 1985). Individuals with extraversion personalities are observed as persons with positive emotionality, greater social activity, and willingness to take the leadership role (Barrick & Mount, 1991). Persons with

conscientious personalities are hard-working, productive, punctual, organized, result-oriented, and responsible.

Meanwhile, individuals with an open personality are creative with many ideas, aesthetic, smart, thoughtful, curious, artistic, and concerned with values (John & Srivastava, 1999). Their excessive negative feelings would lead to psychological stress that is prone to lower productivity. In contrast, neuroticism is associated with low productivity because workers with such a personality tend to lack positive psychological adjustment and emotional stability, and this has a negative influence on both intrinsic and extrinsic career success accordingly (Ham, Junankar, & Wells, 2009).

Further, schooling contribution to earnings is examined by incorporating the potential endogeneity issue in the basic Mincer model (empirical model). Considering the development in the methodology aspect of the earnings model, this study employs both approaches suggested by Humphreys (2013) and Lall and Sakellariou (2010). The 2-Stage Least Squares (2-SLS) is employed to manage the endogeneity problem by including the distance to school as an Instrumental Variable (IV).

By construction, the Ordinary Least Squares (OLS) model ignores the underlying accumulation process for education, as the latter is assumed to be exogenous. One of the alternatives to avoid OLS inconsistency, proposed initially in the context of cross-section data, is the use of Instrumental Variable (IV) procedures, where education is treated as an endogenous regressor, in the econometric sense of being correlated with the residual (Caparrós Ruiz, Navarro Gómez, & Rueda Narváez, 2010). Another common approach is to use an Instrumental Variable (IV) that correlates closely with schooling but is not correlated with ability or wages. Possible confounding instrumental variables include ability, health, and family background characteristics. Then, any resultant correlation between education and the wage can no longer be reliably interpreted as a causal effect (that is, an economic return).

Dickson (2009) explained that instruments must be correlated with the endogenous variables but not with the random error (rank condition), legitimately excluded from the wage equation (exclusion restriction) and be more numerous than the endogenous regressors (order condition). Suppose that Z1 and Z2 are two possible instruments for a variable X. The empirical model adopted from Dickson (2009) is as follows:

$$Cov\,(Z_1, \mu) \;=\; 0 \;=\; Cov\,(Z_2, \mu) \tag{1}$$

$$Cov\,(Z_1, X) \neq\; 0\,, Cov\,(Z_2, X) \;\neq\; 0 \tag{2}$$

The IV used in this study is the distance to school, as Lall and Sakellariou (2010) suggested. This instrument affects education but does not independently enter into the earnings equation and is uncorrelated with the error term in the wage equation. Recalling the model from the start of this section, the moment conditions that we want to impose:

Empirical Model

$$\begin{aligned} Log(wage) = \; & \beta_0 + \beta_1 educ_i + \beta_2 educ_i^2 + \beta_3 expr_i + \beta_4 expr_i^2 + \beta_5\, tenure_i + \\ & \beta_6 tenure_i^2 + \beta_7 male_i + \beta_8 married_i \; + \beta_9\, urban_i + \beta_{10} father_i + \\ & \beta_{11}\, mother_i + \beta_{12}\, openess_i + \beta_{13}\, conscientiousness_i + \\ & \beta_{14}\, extraversion_i + \beta_{15}\, agreeableness_i + \beta_{16}\, neuroticism_i + \beta_{17}\, WJ_i + \\ & \beta_{18}\, RPM_i + \beta_{19}\, EPI_i + \beta_{20}\, EPR_i + \mu_i \end{aligned} \tag{3}$$

The dependent variable is the natural logarithm of the monthly earnings or wages (Log(wage)). The independent variables are number of years of schooling (Educ) as a proxy of education; two measures of experience of the number of working experiences ((potential) Expr) and the quadratic of working experiences ((potential) Expr^2); two measures of tenure: number of years of tenure (Tenure) and quadratic number of years of tenure (Tenure^2); dummy variable for male workers (1= male, 0= female); dummy variable for married (1= married, 0= single/ divorce/ widow/ others); dummy variable for urban (1= urban, 0= rural); parents' education background measured by number of years of schooling of father (Fathers) and for mothers (Mothers); measures of non-cognitive capacities of personality traits of five dummies of Openness (1=

openness, 0= others), Conscientiousness (1= conscientiousness, 0= others), Extraversion (1= extraversion, 0= others), Agreeableness (1= agreeableness, 0= others), Neuroticism (1= neuroticism, 0= others); four measures of cognitive capacities of The Woodcock-Johnson Battery Cognitive test scores (WJ), Standardized intelligence test (RPM), Immediate word recall memory (EPI) and Delayed word recall memory (EPR); and instrumental variable of distance to school measured by the time required to reach school in minutes (Distance).

Results and Discussion

The total number of individuals observed is 7,727 with age between 15 to 50 years old. The sample consists of individuals employed in the past one month and worked as full-time employees in public and private sectors. In addition, the average age was 25 years old, and most workers have at least 12 years of education or equivalent to high school. Concerning their monthly earnings, the average wage was IDR 1.87 million. Furthermore, on average, the observed workers had 12 years of experience and four years of tenure.

In terms of cognitive capacities, this study reports three test scores of Woodcock-Johnson (WJ) test, Raven test (RPM), and Episodic Memory test, both immediate and delayed word recall. Regarding individual strengths among academic achievement, oral language, and cognitive abilities measured by the Woodcock-Johnson test, the average score is 543. Considering the standardized intelligence score for visual measured by RPM, the means is 12.9. Finally, in terms of memory tests capturing the conjointly semantic and episodic knowledge, the average score for immediate memory (EPI) is 5.97, and the average score for delay memory (EPR) is 5.07 (Table 1).

Table 1. Summary Statistics of Main Variables

	Means	Standard deviation	Minimum	Maximum
Dependent Variables				
Wage	1,871,095	2,060,161	2,500	30,000,000
Log wage	13.98	1.08	7.82	17.22
Independent Variables				
Education	12.93	2.80	0	16
Education^2	175.15	68.06	0	256
(Potential) Expr	12.57	5.81	2	39
(Potential) Expr^2	191.78	201.45	4	1521
Tenure	4.29	5.02	0	37.17
Woodcock-Johnson (WJ)	543.04	54.74	299	635
Raven test (RPM)	12.90	3.09	0	17
Episodic Memory Immediate (EPI)	5.97	1.48	1	10
Episodic Memory Delay (EPR)	5.07	1.67	1	10
Fathers (education)	9.14	6.29	0	16
Mothers (education)	9.37	6.43	0	16
Instrument Variable (IV)				
Distance to school (Distance)	21.51	24.98	1	720

Source: IFLS Wave 5

Table 2 presents the results of the estimated seven variants of the Mincer model. The first variant (column1) presents the basic Mincer model by controlling demographic factors, non-cognitive skills, and cognitive skills. The estimation shows that schooling significantly influences workers' earnings with a coefficient of 0.079, implying that the increase in earnings is associated with an increase in education. Every additional one year of education increases earnings by 7.9 percent. The level of education has a positive and statistically significant effect on monthly wages for male and female workers. These findings support the human capital theory that investment in

education contributes to increased labour market outcomes. The findings correspond with a previous study by Purnastuti, Miller, and Salim (2013) that the returns on education in the Indonesian labour market are lower than the international average of 9.7 percent (Patrinos, 2016).

Table 2. The Estimation of Schooling, Cognitive and Personality Traits on Earning across Gender (OLS and 2-SLS)

Variables	All Respondents (OLS)	Male Workers (OLS)	Female Workers (OLS)	All Respondents (OLS)	Male Workers (OLS)	Female Workers (OLS)	All Respondents (2SLS)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Educ	0.079***	0.106***	0.041***	0.170***	0.029	0.290***	0.297*
	(0.007)	(0.009)	(0.011)	(0.041)	(0.049)	(0.072)	(0.161)
Educ^2				-0.004**	0.003	-0.010***	
				(0.002)	(0.002)	(0.003)	
Expr	0.305***	0.407***	0.245***	0.291***	0.421***	0.238***	0.315***
	(0.042)	(0.054)	(0.065)	(0.042)	(0.054)	(0.065)	(0.057)
Expr^2	-0.010***	-0.014***	-0.009**	-0.009***	-0.015***	-0.008**	-0.007
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)
Tenure	0.179***	0.193***	0.174***	0.179***	0.194***	0.177***	0.125*
	(0.017)	(0.021)	(0.027)	(0.017)	(0.021)	(0.027)	(0.071)
Tenure^2	-0.014***	-0.013***	-0.017***	-0.014***	-0.013***	-0.017***	-0.010**
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.005)
Male							0.117
							(0.104)
Married	-0.327***	0.070	-0.591***	-0.326***	0.067	-0.587***	-0.426***
	(0.045)	(0.062)	(0.064)	(0.045)	(0.062)	(0.064)	(0.121)
Urban	0.346***	0.224***	0.496***	0.344***	0.224***	0.486***	0.280***
	(0.036)	(0.046)	(0.054)	(0.036)	(0.046)	(0.054)	(0.055)
Father (education)							-0.019
							(0.014)
Mother (education)							-0.018*
							(0.010)
Openness	-0.156	-0.270	-0.357	-0.147	-0.254	-0.263	-0.198
	(0.167)	(0.226)	(0.236)	(0.167)	(0.226)	(0.237)	(0.243)
Consciousness	0.089***	0.132***	0.034	0.087***	0.134***	0.030	-0.027
	(0.033)	(0.043)	(0.049)	(0.033)	(0.043)	(0.049)	(0.077)
Extraversion	0.126***	0.109**	0.263***	0.127***	0.109**	0.261***	0.123***
	(0.036)	(0.049)	(0.051)	(0.036)	(0.049)	(0.050)	(0.047)
Agreeableness	0.003	0.017	0.037	0.009	0.012	0.046	-0.084
	(0.033)	(0.043)	(0.049)	(0.033)	(0.043)	(0.049)	(0.071)
Neuroticism	-0.076	0.313**	-0.232*	-0.083	0.323**	-0.236*	0.075
	(0.101)	(0.159)	(0.127)	(0.101)	(0.159)	(0.126)	(0.143)
Woodcock Johnson (WJ)	0.002***	0.001**	0.003***	0.002***	0.001**	0.003***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Raven Test (RPM)	0.014**	0.016**	0.005	0.013**	0.016**	0.004	-0.006
	(0.006)	(0.007)	(0.008)	(0.006)	(0.007)	(0.008)	(0.015)
Episodic Memory	-0.024	-0.051**	0.006	-0.023	-0.052**	0.004	-0.019
Immediate (EPI)	(0.016)	(0.021)	(0.025)	(0.016)	(0.021)	(0.024)	(0.023)
Episodic Memory Delay	0.001	0.051***	-0.054**	0.002	0.051***	-0.054**	-0.006
(EPR)	(0.015)	(0.019)	(0.021)	(0.015)	(0.019)	(0.021)	(0.019)
Constant	9.436***	8.902***	9.880***	8.962***	9.276***	8.410***	8.337***
	(0.258)	(0.337)	(0.388)	(0.332)	(0.410)	(0.573)	(0.960)
Observations	3,917	2,185	1,732	3,917	2,185	1,732	2,724
R-squared	0.183	0.270	0.195	0.184	0.271	0.201	0.048

Standard errors in parentheses; ***, **, * denote significance at 1%, 5%, and 10%, respectively.
Source: IFLS Wave 5 estimated by Ordinary Least Square (OLS) and Two Stages Least Square (2SLS) using STATA

The Mincer model also underlines the importance of skills accumulation through working experience. The coefficients of experience variables are positive in all seven models in table 2. Further, the contribution of skills accumulation through experience to earnings is higher than education. In the first model, an increase of working experience contributes to 30 percent of earnings. In addition to experience, this study also estimates the return on skill accumulation from the current jobs measured by tenure. The estimations show that tenure has a positive and

significant influence on earnings by 17.9 percent (column 1). These findings provide evidence of the importance of skills accumulation acquired from job experience in improving workers' competency.

As the workers get older, the ability to absorb new skills is lower, which may explain the declining return from additional years of experience. That is, the contribution of skills accumulation through experience becomes less as they work longer. This tendency is reflected in the estimated coefficients on the quadratic years of experience of both working and tenure, which are negative and statistically significant, -0.01 for experience (column 1) and -0.014 for tenure (column 1).

Further, demographic information is important to examine the determinants of earnings. The estimations in Table 2 show that marital status and residential areas influence earnings, and the coefficients are statistically significant. Being married is associated with lower earnings, particularly for female workers (columns 3 and 6). Female workers have double tasks both in working places and in the families, which may explain their lower productivity in the workplace. In contrast, the marital status of male workers has no significant effect on earnings because they can work as full-time workers after being married (columns 2 and 5). Furthermore, working in urban areas positively affects the workers' earnings both for males and females.

The fourth model variant (column 4) estimates the Mincer model by adding the quadratic of education to test the nonlinearity assumption of education and earnings relationship. The nonlinearity assumption test is conducted to capture the possible convex relationship between schooling and earnings (Lemieux, 2006). The estimation shows that after controlling for nonlinearity of schooling, education remains important, and the return on education becomes higher of 17 percent. However, the returns on education are nonlinear that the coefficient of squared of education is negative and statistically significant. The findings correspond with the study by Park (1999) that found the nonlinearities of schooling on earnings. The study shows that the wage returns from years of schooling between completing high school and completing college or university are varied. The marginal return on education is not constant. Instead, it has a slope between two points of transition.

Further, the estimation of nonlinearity of education is conducted separately for male and female workers. The results show that the coefficients of squared education are no longer significant for male workers, but it is significant for female workers. Thus, the nonlinearity is particularly relevant for female workers in that the relationship between education and earnings forms a concave curve, indicating that an increased year of education generates a lower premium after a certain point. This may be due to over-education, making the supply of labour have qualifications far exceeding the one required by the jobs, thereby likely reducing the premium enjoyed by higher educated workers.

The gender wage gap is confirmed by the difference of return on education between male and female workers. The return on education for male workers is 10.6 percent (column 2) and for female is 4.1 percent (column 3). Nevertheless, after controlling for the endogeneity issue, the gap is no longer statistically significant, as shown by the coefficient of the male dummy variable in model 7 (column 7). This finding is similar to Purnastuti et al. (2013) that the variation between male and female workers' returns on education may indicate the existence of gender wage gaps that favour male workers. They found that the changing return on education between males and females differs. In addition, their study shows that the return across different education levels was significantly different between male and female workers. Female workers generated higher returns after completing junior high school compared to male counterparts. In addition, the return for females with college and university education was also above male workers. Nonetheless, their study concluded that, on average, males received higher wages compared to female workers, which indicated a gender gap. However, the gap was shrinking for workers with higher education.

Finally, this study deals with omitted variable bias by directly measuring the unobserved individual characteristics using both cognitive and non-cognitive capacities and performing an instrumental variable approach (column 7). Including individual capacities improves the

estimation of earnings function as the model controls for the individual ability. Regarding the measures of personality traits, the estimation results indicate that consciousness and extraversion have positive effects on workers' earnings. Thus, in addition to schooling, good working attitudes contribute to the variation in workers' earnings. The workers' productivity is higher if they work hard, are punctual, well-organised, result-oriented, and responsible. These are the characteristics of individuals with consciousness characteristics. In addition, being positive emotionally, having greater social activities, and being willing to take the leadership role—all of which are the characteristics of extraversion personality—will boost the workers' productivity accordingly. Meanwhile, neuroticism personality negatively affects workers' earnings, particularly for females, because they lack positive psychological adjustment and stable emotion, leading to stress and lower productivity.

Further, Table 2 also shows that the inclusion of a direct measure of cognitive capacities is proven to be important. According to Woodcock-Johnson (WJ) measurement, individual strengths, such as academic achievement, oral language, and cognitive abilities, are positively and statistically significant, as they can explain earning variation across different specifications. Correspondingly, the measure of intelligence visual capacity of Raven test score also positively contributes to earnings. Individuals with higher visual intelligence earn higher than those with lower intelligence.

Finally, following the related literature, such as Lall and Sakellariou (2010), this study can deal with potential endogeneity problems in the basic Mincer model by employing the instrument variable approach. The instrument is estimated using the 2-Stage Least Square method and 'distance to school' as instrument to schooling (column 7). Moreover, the parents' educations are included in the explanatory variables to capture the socio-economic status. The schooling variable remains positive and statistically significant in explaining the earning variation. In addition, experience, tenure, demographic factors, such as marital status and urban, are still good predictors of earnings. In terms of individual capacities, only extraversion personality positively affects earnings.

Conclusion

This study aims to examine the determinants of workers' earnings in Indonesia by incorporating the direct measures of cognitive abilities and non-cognitive capacities and managing the endogeneity issue of schooling. The current literature in economics has acknowledged the role of non-cognitive capacities in determining workers' performance. The modified Mincer equation was estimated to examine the effect of schooling, working experience, tenure, demographic factors, personality traits, and cognitive capacities on monthly wages. The results show that schooling, cognitive and non-cognitive personality traits determine the labour market outcomes. The level of education has a positive and statistically significant influence on monthly wages. In addition, the relationship between education and earning is nonlinear, suggesting that the returns on education varied across education levels. The coefficient of squared education is negative, implying that the returns on education increase only up to a certain level of education and decline beyond that level.

Furthermore, including the direct measure of cognitive capacities and personality traits is important to deal with the issue of omitted variable bias. The individual strengths among academic achievements, such as oral language and cognitive abilities measured by the Woodcock-Johnson (WJ) test, are positive and statistically significant in explaining earning variation across different specifications. In addition, the visual capacity of an individual's intelligence as measured by the Raven test score is also a significant predictor of earnings. The findings also support the literature that personality traits contribute to explain the earning variation. Three characteristics are good predictors of the earnings model. Consciousness and extraversion have positive effects on workers' earnings, while neuroticism personality has a negative influence on workers' earnings.

The estimation using the instrument variable approach of two Stage Least Square (2SLS) reveals that schooling is affected by other individual characteristics such as access to education and the socio-economic status of parental education. This is consistent with a PISA 2018 from

the OECD that the academic performance is unequal and that more affluent students on average have better performance than disadvantaged groups. Finally, this study also reveals that the contribution of schooling to earnings varies across gender. The schooling coefficient is larger for male workers than female workers, indicating a possible gender wage gap. In addition, the nonlinearity of schooling and earnings is particularly observed among female workers.

There are some policy implications derived from this study. The policy should be directed to develop human capital by putting more investment in the education sector and improving allocation effectiveness. The policy intervention, for example, is targeted at socio-economically disadvantaged students. Further, education should develop knowledge, cognitive and non-cognitive capacities to assist students in achieving their full potentials. Additionally, access to education is made available not only for young people but also for adults by providing lifelong education. This current study relies on a cross-sectional dataset of the 2015 survey. Accordingly, the future study may utilize a longitudinal dataset to examine policy changes and their impact on labour market outcomes.

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Lingering effects of foreign resource dependency in Pakistan: Assessing gains from domestic resources

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Abstract

Purpose — This study explores the asymmetric effects of FDI (Foreign Direct Investment) on economic growth in Pakistan.

Methods — This paper uses an Asymmetric Effects ARDL (Autoregressive Distributed Lag) model.

Findings — The results show that the effects of increasing and decreasing FDI are not equal. The study concludes that reducing FDI is more beneficial for economic growth, particularly in the longer horizon. It mobilizes domestic investment and promotes financial freedom while reducing the reliance on pollution-intensive multinational corporations and taps indigenous knowledge gains.

Implications — This study proves that self-reliance is more beneficial for the case of Pakistan.

Originality — The researchers and policymakers are unclear about the merits and demerits of FDI as a substitute for domestic investment. Empirical studies are majorly convinced that an increase in FDI generally merits economic growth but weighs in the Pollution Haven Hypothesis and ignores the indigenous knowledge-based domestic resource.

Keywords — domestic investment, pollution haven hypothesis, multinational corporations

Introduction

Developing an economy with low purchasing power like Pakistan tends to lack the capability to save domestically. Further, the immature financial system does not motivate enough to engage people in investing activities. Because of this issue, the capital market equilibrium is stabilized using investment acquired from abroad with expectations that it will fill the domestic investment gap while transferring knowledge abroad. Several empirical studies have pointed at the growth potential of FDI (Asghar, Nasreen, & Rehman, 2011; Atique, Ahmad, Azhar, & Khan, 2004; Hunjra, Raza, & Asif, 2013; Rehman, 2016; Shahbaz, Nasreen, Abbas, & Anis, 2015).

Foreign direct investment plays an essential role in a country's economic growth. However, it is even more critical in developing countries. Foreign direct investment in one country demonstrates the interest and confidence of other countries and investors in the host country, positively related to economic growth and GDP. The country's economic, political, and social

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situation is also essential to increase foreign direct investment (Pusterla & Resmini, 2007). The empirical investigation pointed out that FDI is a favorable variable that positively impacts the economy in the short and long run (Iram & Nishat, 2009; Samantha & Haiyun, 2017). Theoretically, it was expected that foreign firms might not invest because of high investment costs and unfamiliar institutional and political regimes. FDI looks for any of the three conditions proposed by Dunning (1981). Anyone of these, ownership, internalization, or location conditions, enables them to decide to engage in investment (Asghar et al., 2011).

Considering the presence of theoretical benefits of FDI on growth, still, literature provides mixed or inconclusive empirical results on the effects of FDI on growth (Carkovic & Levine, 2005). Furthermore, not much emphasis has been given to whether the foreign resources are flowing at or being pulled inward by the country. Indeed, attracting FDI will accompany some costs, which country like Pakistan has to pay to sustain to attract external resources. These external resources are generically risk-averse, which means that the developing countries have to offer interest premiums to attract them. This high interest rate will harm the economy in two ways. Firstly, it will crowd out domestic investment which has indigenous knowledge. Secondly, it will increase inflation via the fisher equation.

Hence under this premise, the foreign investment must provide extraordinary returns to negate the fall in domestic investment-based production and sustain the purchasing power where the domestic investment could have used the advantage of indigenous knowledge tapping the abundant labor resource. The second argument is that pollution-intensive industries find it heaven for countries with immature institutions like Pakistan, leading to a high inflow of FDI and increased exports. However, these industries will exploit the institutions in the longer horizon, evade tax liabilities, and unrestrictedly pollute. As a result, in the longer run, the national standard of living of the people may deteriorate, affecting growth via a fall in labor productivity (Forte & Moura, 2013). The last argument is that if the foreign investment is capital or technology-intensive, it might not create enough jobs compared to the domestic variant of business/investment venture (Jenkins, 2006; Mucuk & Demirsel, 2013).

Based on the arguments mentioned above, the present study postulates that the increase and decrease in FDI may not have an equal and opposite effect on Pakistan's economic growth. The literature available on FDI through light on its positive role in raising the pace of economic development. Not much literature is available which considers both positive and negative aspects of FDI in developing countries. The present study is an attempt to explore the asymmetric effect of FDI on the economic growth of Pakistan using the data from 1970 to 2019. This study will adhere to several implications: whether the foreign investments are dirty industries based or crowding out domestic investment.

Several studies have explored the link between FDI and GDP. Few of the significant studies are mentioned here. Awan, Khan, and uz Zaman (2011) advocated the growth effects of FDI, but the time taken by the FDI to create an impact depends on the economic conditions and national policies. First, an essential factor is the premium returns which the investor enjoys, and the second factor is that the investor retains managerial/administrative control over the venture.

While discussing the positive effects of FDI on growth, we can find several studies that have provided a causal relationship between FDI and growth (Asghar et al., 2011). However, few studies are available that advocate the insignificant effects of FDI on economic growth (Georgantopoulos & Tsamis, 2012). There is additional evidence for adverse effects in the literature. The results show that there is no strong reason between FDI and economic growth in the case of Pakistan. Pakistan's economic growth attracts foreign direct investment, which confirms the market size hypothesis. It suggests that production and its growth are the determining factors of foreign direct investment. The fact that FDI did not have an apparent positive effect on Pakistani economic development means that previous studies had reduced the positive impact of FDI on economic growth (Ashraf et al., 2019).

A study by Mencinger (2003) for European countries between 1994 – 2001 showed that an increase in FDI harmed GDP. A similar case is evident for 17 Arab countries between 1990 – 2000 (Omran & Bolbol, 2003) and 67 low developed economies (Hermes & Lensink, 2003). Further, a

time-series study related to Pakistan showed adverse effects for data taken between 1980 – 2009. A similar result is evident in the USA (Ford, Rork, & Elmslie, 2008).

The first possible reason for the adverse effects of increasing FDI is the immature institutions in developing countries like Pakistan, which lead to the pollution haven hypothesis. Several studies have confirmed the positive impact of increased FDI on environmental quality deterioration (Asghari, 2013; Shahbaz et al., 2015). Secondly, FDI inflow motivated by premium returns leads to a crowd-out effect. A sector-wise study for Uganda showed that FDI creates crowd-out in several sub-sectors (Ahmed, Ghani, Mohamad, & Derus, 2015). There are other reasons for crowd-out, like superior technology and competitiveness (Agosin & Machado, 2005; De Backer & Sleuwaegen, 2003; Wang, 2010). Lastly, Bao-shuai's (2009) study showed that FDI inflow increases inflation in the short run because of the interest premium. Lastly, Mucuk and Demirsel (2013) study use the FMOLS and DOLS model in seven developing countries. The results show that, for Argentina and Turkey, an increase in FDI increases unemployment.

A country needs FDI because it cannot generate domestic investment. Many factors coin low domestic investment, but literature is convinced that domestic investment positively affects economic growth, as suggested by the Solow Growth Model (Solow, 1956). Several empirical studies have advocated its positive effect (Afridi, 2016; Amjad & Awais, 2016). It creates the multiplier effect as per the Keynesian school of thought. In comparison, there are no leakages of surplus gained from this domestic investment going out of the country.

This study has selected banking sector development as a controlling factor in the model of FDI. This is because a supporting banking sector will promote and mobilize the saving and investment in the economy. It may remove hurdles that discourage domestic or foreign investment by creating ease and security in transactions. There is ample literature advocating the positive supply leading effect of banking sector development on economic growth (Abubakar & Gani, 2013; Hassan & Kalim, 2017).

Empirical studies are available in the debate of the positive or negative effects of FDI on economic growth. Still, most of them believe that the negative impact is because of the wrong specification of the model. This study has proposed a few theories that may explain that FDI increase could be harmful to the case of Pakistan. We are opting for the asymmetric effects ARDL model to see the impact of increasing and decreasing the portion of FDI on GDP. Hence the question set by this study is to investigate if there is an asymmetric effect of FDI on GDP in the short-run and long run.

Methods

Variables and Data Sources

Table 1 presents the variables used in this study with their units, transformation, and sources. The sample ranges from 1975 to 2019. The data has been collected for the reputed data repository of World Development Indicators (WDI). All the variables are transformed to a natural log to smoothen the data series while estimating the coefficients' elasticities (relative slope) (Benoit, 2011).

Table 1. Variables and sources

Variable (Symbol)	Units (Transformation)	Source
Gross Domestic Product (LGDP)	Per capita (Constant USD) (Natural Log)	WDI
Foreign Direct Investment (LFDI)	Inflow % of GDP (Natural Log)	WDI
Gross Capital Formation (LINV)	% of GDP (Natural Log)	WDI
Banking Sector Development (LBS)	Domestic credit to private sector % of GDP (Natural Log)	WDI

Estimation Equation and Approach

The following equation represents the stochastic equation used by this study. Here, it is assumed that the independent variable changes are proportional to changes in the dependent variable. This proportionality is converted to equality using the constant of proportionality (slope coefficients α_i). For the data sets of more than two observations, the constant of proportionality is measured using

regression analysis. However, since the data is long while there is only one cross-section, it is expected that the data might not be fixed in repeated sampling, making variables non-stationary. This study will deploy ADF unit root tests (Dickey & Fuller, 1981) to assess the nature of non-stationarity if all variables are non-stationary at the first difference I(1). In this case, we can use the basic ECM (Engle & Granger, 1987). If they are of mixed order in nature, we will use the ARDL cointegrating bounds-based approach (Pesaran, Shin, & Smith, 2001). Lastly, this study has hypothesized that increasing and decreasing FDI could positively affect a country like Pakistan; hence, this variable is asymmetric. This study has used the asymmetric effects ARDL model (Shin, Yu, & Greenwood-Nimmo, 2014).

$$LGDP_t = \alpha_0 + \alpha_1 LFDI_t^+ + \alpha_2 LFDI_t^- + \alpha_3 LINV_t + \alpha_4 LBS_t + \varepsilon_t \quad (1)$$

Previously, several studies have used this asymmetric ARDL model using FDI and GDP separately (Kalim, Faiz, & Arshed, 2019; Ullah, Apergis, Usman, & Chishti, 2020; Yilanci, Ozgur, & Gorus, 2019). But none of them had assessed the asymmetric effects of FDI on GDP.

Results and Discussion

Table 2 shows the descriptive statistics of the variables. Other than FDI, all variables have a mean value more significant than the standard deviation, which is under dispersed. Further, the Jarque and Bera (1987) test show that FDI is not normal. This means that for the case of Pakistan, the inflow of FDI is not stable within the selected period.

Table 2. Descriptive statistics

	LGDP	LINV	LFDI	LBS
Mean	6.628	2.847	-0.727	3.121
Median	6.686	2.866	-0.550	3.179
Maximum	7.088	3.030	1.299	3.394
Minimum	6.110	2.578	-4.669	2.733
Std. Dev.	0.286	0.103	1.092	0.173
Skewness	-0.312	-0.576	-1.049	-0.708
Kurtosis	2.006	2.652	5.342	2.561
Jarque-Bera	2.810	2.959	20.196	4.486
Probability	0.245	0.227	0.000	0.106
Observations	44	44	44	44

The correlation matrix presented in Table 3 reveals that gross capital formation and banking sector development negatively correlate with GDP while FDI is positively correlated with GDP. Figure 1 shows the line charts of increasing and decreasing components of FDI and GDP.

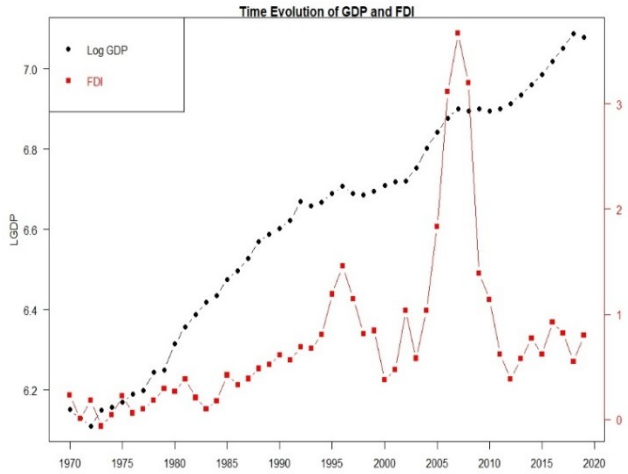
Table 3. Correlation matrix

	LGDP	LINV	LFDI	LBS
LGDP	1	-0.036	0.758	-0.449
LINV	-0.036	1	0.267	0.561
LFDI	0.758	0.267	1	0.001
LBS	-0.449	0.561	0.001	1

Figures 1 to 4 provide the pairwise line plots between GDP and independent variables used in the study. Figure 1 finds the time association between GDP and FDI here. We can see that every peak in FDI is associated with an increase in the GDP value as expected in theory. However, for the years after 2010, there is a fall in FDI, but still, GDP is rising. This points to the notion that in recent years FDI is more harmful to Pakistan.

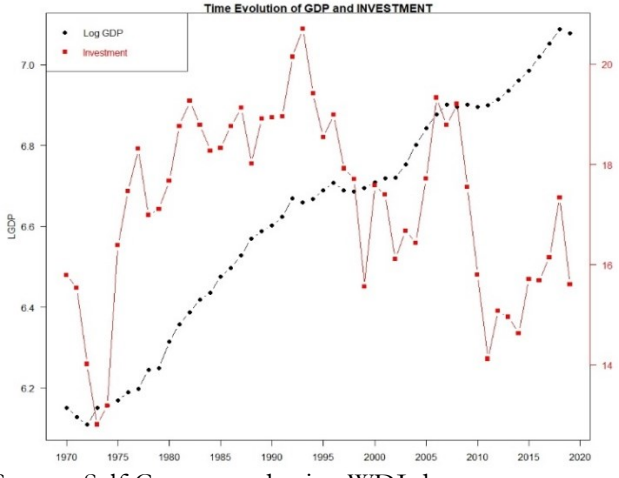
Figure 2 provides a time association between GDP and Domestic Investment. Here we could see positive association till the year 1995 beyond there are mixed patterns. Figure 3 shows a positive association between labor resources and GDP for the case of Pakistan. In Figure 4, we

can observe that the increase in the money supply indicates that banking sector development is coined with an increase in GDP while a decrease in the money supply is matched with the slowing of GDP.



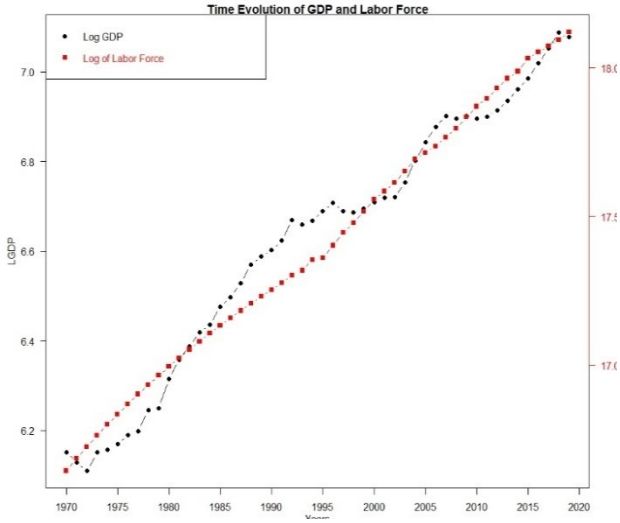
Source: Self Constructed using WDI data

Figure 1. GDP and FDI Line Chart



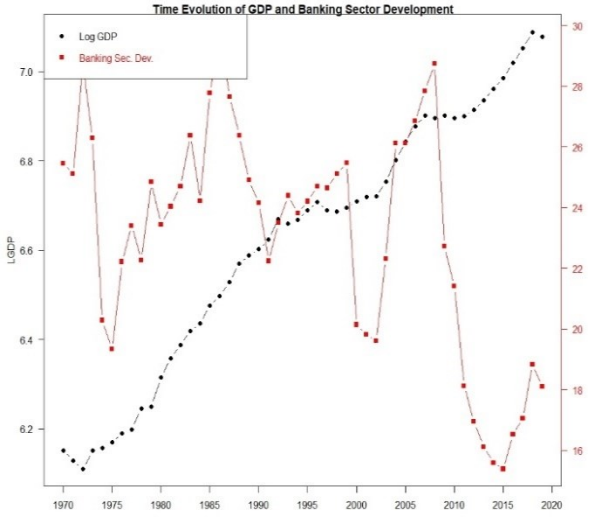
Source: Self Constructed using WDI data

Figure 2. GDP and Domestic Investment Line Chart



Source: Self Constructed using WDI data

Figure 3. GDP and Labor Force Line Chart



Source: Self Constructed using WDI data

Figure 4. GDP and Banking Development Line Chart

Table 4. Time-series: ADF Unit Root Tests

	In-Level		At-First difference	
	Test	Prob	Test	Prob
LGDP	-1.043	0.730	-5.502	0.000
LFDI	-3.241	0.024	-13.027	0.000
LINV	-2.185	0.214	-6.068	0.000
LBS	-1.709	0.421	-5.884	0.000

Table 4 provides the unit root test results. The specification of the unit root tests is determined using the line chart of the series. It can be seen that other than the FDI, all variables are non-stationary in-level, making them I(1), while the series of FDI is I(0). This ADF test confirms that the variables are in a mixed order of integration, for which estimation ARDL cointegrating bounds is necessary. In the overall unrestricted ARDL model, the proposed variables

explain 99% of the variation in the dependent variable. Further, the lag specification for LGDP, LFDI_POS, LFDI_NEG, LINV, and LBS are 3, 0, 4, 3, and 1, respectively.

Table 5. ARDL Bound Test

F Bounds Statistic	6.957	
Upper bound critical values		
	5%	4.01
	2.5%	4.49
	1%	5.06

Table 5 reports the ARDL bounds test. The test value is 6.957, higher than the upper bound critical value of 5.06 at a 1% level. This confirms a significant level of Cointegration between the dependent and independent variables in which FDI is asymmetric.

Table 6 reports the long-run and short-run coefficients of the model. Firstly, the Cointegration(-1) is negative and significant, which means that the model is converging (Banerjee et al., 1998). If there is a 1% deviation in the long-run equilibrium, the model's dependent variable will adjust to 0.37% each period.

Thus, restoring to a new equilibrium takes 2.7 years. This confirms that we can use this model for policy intervention. Further, in the short run, banking sector development, increasing FDI, and domestic investment have a positive effect on GDP. Since the increasing FDI is significant in the short run while decreasing FDI is insignificant, there is a hint of asymmetry in the short run.

Table 6. Short Run Model Estimation
(Dependent Variables: ΔLGDP; Lag order: 3, 0, 4, 3, 1; Observations 45)

Variable	Coefficient	Prob.
ΔLGDP -1	-0.204	0.198
ΔLGDP -2	-0.237	0.134
ΔLFDI_POS	0.014*	0.082
ΔLFDI_NEG	-0.006	0.448
ΔLFDI_NEG -1	0.025**	0.024
ΔLFDI_NEG -2	-0.027**	0.023
ΔLFDI_NEG-3	0.031***	0.002
ΔINV	0.200***	0.001
ΔINV -1	0.042	0.377
ΔINV -2	-0.099***	0.009
ΔLBS	0.063*	0.067
Cointegration Eq. -1	-0.375***	0.000

Table 7. Long-Run Model Estimation
(Dependent Variables: LGDP)

Variable	Coefficient	Prob.
LFDI_POS	0.038**	0.030
LFDI_NEG	-0.080***	0.002
LINV	0.497***	0.000
LBS	0.029	0.733
Constant	4.313***	0.000

***, **, * denote significance at 1%, 5%, and 10%, respectively.

In the long-run estimation result, shown in Table 7, if there is a 1% increase in domestic investment, there is a 0.497% increase in GDP on average. In comparison, the effect of banking sector development is insignificant. For the case of increased FDI, a 1% increase will lead to a 0.037% increase in GDP. For decreasing FDI, a 1% increase will lead to a 0.08% decrease in GDP. The coefficients are not opposed to each other, which hints long run asymmetry.

Table 8 provides the diagnostic tests. Since all tests are insignificant, it confirms that the model is normally distributed, independent, homoscedastic, linear, and stable. Figures 5 and 6 demonstrate that the coefficients generated from this specification are robust to any known or unknown structural break within the selected period.

Table 8. ARDL Diagnostic Tests

Diagnostic Tests	Test Statistic	Probability
Jarque-Bera	0.898	0.638
Breusch-Godfrey Serial Correlation	0.337	0.716
Breusch-Pegan-Godfrey Heteroscedasticity	0.680	0.782
Ramsey RESET	5.625	0.524

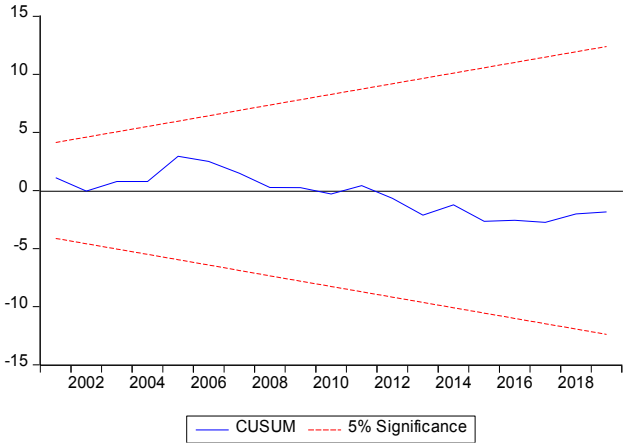


Figure 5. CUSUM

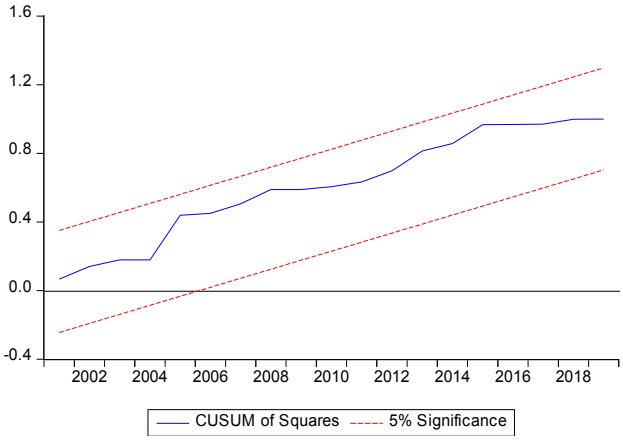


Figure 6. CUSUM Squared

Figure 7 reports the degree of asymmetry in the model. It shows that there is an increase in GDP for the case 1% shock from increasing FDI. However, that positive effect does not increase more than 0.03%. For 1% shock from decreasing FDI, there is an increase in GDP. This effect grows over time to about 0.07% of GDP. The red line shows the degree of asymmetry. Here we can see that with time lags, the asymmetry is increasing. This chart confirms the hypothesis proposed by this study that both the increasing and decreasing FDI have a positive effect on the case of Pakistan. And since FDI exploits the Pakistani economy, reducing FDI, although volatile initially, tend to have a higher positive effect on the economy.

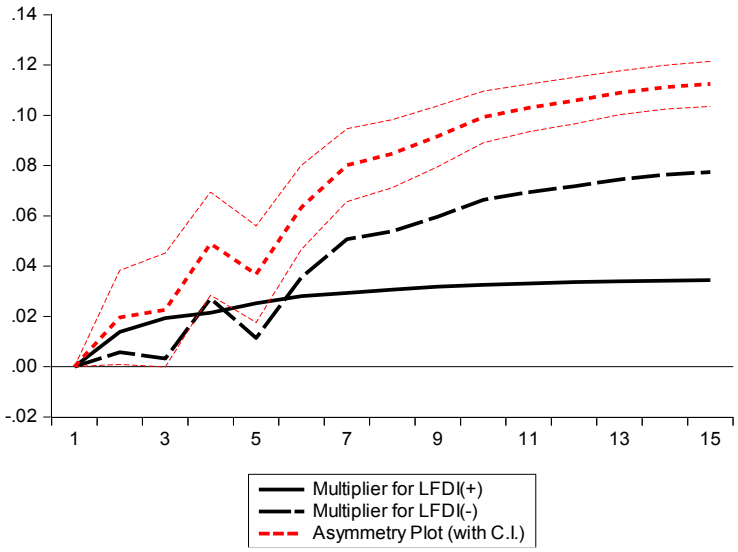


Figure 7. Asymmetric Effects Graph

Conclusion

The inflow of foreign capital in the form of FDI can be a friend or a foe. Most of the studies related the FDI inflow to an increase in technology, skills, and growth. Still, they are referring to standard macroeconomic theories that are related to developed economies. This study postulated that although FDI increases can be beneficial, the positive effect's size depends on many factors. Countries like Pakistan must ensure that these factors are in their favor; otherwise, decreasing FDI may benefit them.

According to this study, some countries conveniently resort to debt or foreign resources rather than raising their domestic resources from savings. Further, their immature institutions and unstable economy pave the way for FDI tagged with high premium and exploiting the pollution haven hypothesis. This, in return, concludes that the surplus from FDI in the form of better technology, employment, and exports is reduced because of the crowding-out effect, inflation, and deteriorated environment quality. Now the net positive effect depends on how clean, efficient, and cost-effective the FDI venture is.

This study has used the asymmetric effects ARDL model to assess the differences in the effect of increasing and decreasing FDI on GDP for the case of Pakistan. The data was collected from 1970 to 2019. The post regression diagnostics and the CUSUM/CUSUMsq graphs show that the model is stable in response to unknown structural shocks and free of any assumption violation-related issues for this time frame. The estimates showed undoubtedly a positive effect of increasing FDI, but this positive effect stops rising after seven years. While for the case of decreasing FDI, we have a volatile/cyclic movement of positive effects till seven years where the economy is by force resorting to national resources. After seven years, we can see an increasingly positive impact which is more than the increasing FDI. This asymmetry points out that for a developing economy like Pakistan, FDI inflow was because of the higher interest premium and the loopholes in the regulations they can exploit. We must develop indigenous resources to increase our financial freedom and reap a higher surplus from the national investment ventures.

Other developing economies can use this model to assess if the current inflow of FDI is beneficial or a burden for their economy. Policymakers must find new insights via this model to align their policies in managing exploitive foreign resources.

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Export diversification and economic growth: A threshold regression approach for emerging markets and developing countries

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Abstract

Purpose — This study investigates the nonlinear relationship between export diversification and economic growth in 44 emerging markets and developing countries.

Methods — The threshold regression methodology is employed to analyze data for the period between 1995 and 2015. Export diversifications in terms of both geography and product are measured by the Herfindahl-Hirschman market concentration index and overall Theil index, respectively.

Findings — The results demonstrate a nonlinear relationship between export diversification and economic growth. Above the threshold, diversified export markets and products boost economic growth. Below the threshold, the positive relationship between diversification in both markets and products and growth is insignificant.

Implications — The research implies that export diversification strategy in emerging markets and developing countries should be considered carefully when the level of export diversification is higher than the threshold, which usually occurs in the later stage of diversification.

Originality — The study investigates nonlinearity in terms of degrees of diversification instead of degrees of development. With this approach, the threshold is identified to show how economic growth is affected under different regimes.

Keywords — export diversification, economic growth, threshold regression, emerging markets, and developing countries

Introduction

Export-led growth strategy has become dominant in many countries, especially emerging markets and developing countries (EMDCs). To follow this strategy, exports in EMDCs have gone through structural transformations in terms of products and markets. In other words, the process of export growth goes hand in hand with export diversification. Is there any causal relationship between export diversification and economic growth? Insights into this question will help EMDCs design better their export strategy. In general terms, export diversification refers to a diversified export structure (Al-Marhubi, 2000). Export diversification is discussed as product diversification from a product point of view and product diversification from a geographic perspective (Ali, Alwang, & Siegel, 1991). Similarly, Osakwe and Kilolo (2018) define export diversification as the spread of exports over various products and trading partners.

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In the product space, export diversification refers to the change in export structures by widening the export basket; increasing export earnings by adding technology and innovation (Osakwe & Kilolo, 2018). Vertical product diversification involves a structural transformation from primary commodities to manufactured products due to technological innovations (Agosin, 2009; Chenery, 1979; Syrquin, 1989). Horizontal export diversification employs new areas of primary exports (Herzer & Nowak-Lehnmann, 2006) to minimize the economic disadvantages and political risks. Amurgo-Pacheco & Pierola (2008) investigate product and geographic patterns of export diversification by disentangling trade with intensive and extensive margins. The intensive trade margin refers to the growth of exports in old goods, while trade in extensive margin involves an increasing number of varieties traded. Extensive margin diversification is essential if export diversification involves a shift in export composition from primary commodities to manufactured goods (Dennis & Shepherd, 2011). Geographic export diversification means widening the range of destinations for exports (Hill, Hitt, & Hoskisson, 1992).

Traditional literature identifies specialization according to comparative advantage and realization of economies of scale as sources of gains from trade, suggests only level effects of trade on income because open economy enjoys a high level of income than the closed economy, but no rate effects or open economy will not necessarily grow faster (Grossman & Helpman, 1990). However, some more research has shed more light on the channel through which export may cause effects on growth, focusing more on the growth effects of export diversification. A positive link between growth and export diversification relates to export earnings instability. Adding new products to the existing export basket can reduce revenue dependence on a limited number of commodity goods that are mostly exposed to price ups and downs. Shepherd (2009) also argues that high concentration in terms of products and markets creates high short-run volatility in national income; developing countries obtain more stable export revenue through a wide range of export products and export markets. Thus, countries with a high level of export diversification can compensate for income losses from high profitable or more stable sectors. Similarly, by adding a new market to the current portfolio, a country can decrease the reliance of export earnings on the conditions of a less diversified export market. Various studies indicate the positive association between the level of product concentration and the severity of trade collapse in the case of crisis (see Karahan, 2017; Romeu & Costa Neto, 2011). Observations from World Bank (1987) show that countries with high export concentration have a more volatile real exchange rate to the detriment of investment in production and services. To sum up, export diversification has a positive association with income growth.

Immisserizing growth theory indicates that economic growth offset with deteriorating trade terms could worsen a country. Developing countries get stuck in this situation if they concentrate on exporting primary commodities at a price disadvantage compared to manufactured goods. Sustained growth entails export diversification in developing countries to shift exports from primary goods to manufactured goods, as indicated by "vertical diversification". Similarly, the "natural resource curse" hypothesis also implies that a large share of natural resource exports in GDP could deteriorate terms of trade, excess volatility, and low productivity growth (Prebisch, 1950; Sachs & Waner, 1995). Cadot, Carrère, and Strauss-Kahn (2013) summarize three supportive arguments for the notion of this hypothesis. First, as the relative price of primary products has a downward trend, countries with high dependency on commodity goods suffer from decreased exports. Second, the dominance of primary products in the export basket is a factor of growth-inhibiting volatility because of the volatility of the terms of trade. Finally, concentration on primary commodities hampers productivity as primary products are typical laggards.

The comparison between specialization and export diversification attracts much attention in the literature. Chenery (1979) discussed the conflicts between trade theory focusing on the comparative advantage and growth theory ignoring comparative advantage. Grossman and Helpman (1990), also looking into the comparative advantage and long-run growth, emphasize acquiring comparative advantage. Agosin (2009) considered widening comparative advantage as the main force behind economic growth.

Endogenous growth theory refers to the product variety for export as one of the sources of growth. Diversification contributes to sustained growth by knowledge spillover effects like "learning by doing" and "learning by exporting". Export diversification entails using new technology. "Learning by doing" relates to the spillover from the export sectors to other sectors in the economy. Business skills acquiring by diversified exports will spread to other areas. All of these contribute to capital accumulating and become sources of growth. "Learning by exporting" means that the export sector is acquiring knowledge from abroad while foreign importers transfer their technological information for higher productivity Herzer and Nowak-Lehnmann (2006). Product cycle theory explains the spillover as mentioned above effects (Vernon, 1966). A product in its life cycle brings opportunities for an importing country to become an exporter of this product. This product would not be new to the world, but it could get knowledgeable spillover effects described above for this country.

To sum up, the literature mentioned earlier implies the positive effects of export diversification on growth. From our perspective, benefits from diversification cannot be obtained without considering comparative advantage (Cadot et al., 2013). Early stages of diversification need to be associated with the most effective products, leading to economic growth. A greater degree of diversification, to some extent, will involve less effective products which have no comparative advantage or new markets where existing products have no competitive advantage. Different from the early stages, export diversification at this stage brings no source for economic growth.

Several empirical investigations into the link between export diversification and growth have shown a linear relationship, implying greater export diversification associated with faster growth (Agosin, 2009; Al-Marhubi, 2000; Hodey, Oduro, & Senadza, 2015). Al-Marhubi (2000) uses three indicators (number of products exported, diversification index, and concentration index) measuring export diversification to estimate the growth effects of 91 economies for the period from 1961 to 1988. Employing ordinary least square (OLS) estimation, the research proves that export diversification is associated with higher economic growth. Agosin (2009) investigates the growth effects of export diversification from the data of 27 emerging economies in Latin America and Asia for the period 1980-2003. Estimation results derived by OLS methodology also show that export diversification is a source for economic growth. More importantly, the research indicates spillover effects of export sectors to other economic areas. It is also evidenced that an economy will obtain more significant economic growth when exporting to higher-income markets. Hodey et al. (2015) analyze the effects of export diversification on growth by employing the system GMM estimation techniques. The findings show a positive monotonic relationship between export diversification and growth in 42 Sub–Saharan African economies.

By contraries, findings from Ferreira and Harrison (2012) using the autoregressive distributed lags (ARDL) model and dynamic OLS for the period 1965-2006 indicate that horizontally and vertically diversified exports are not positively associated with growth in Costa Rica. The study implies that export diversification cannot lead to growth without spillover effects like "learning by doing" and "learning by exporting" from the export sectors to other economic sectors. Hinlo and Arranguez (2017) analyze data from ASEAN countries for the period 1980-2014 but focus on geographically diversified exports. They find no causal relationship between geographical diversification and growth in Indonesia, Singapore, and Thailand. Nevertheless, the research has found bidirectional causality in Malaysia and uni-directional causality in the Philippines.

Some studies employing nonlinear estimation methods have recently challenged the linear positive effect of export diversification on growth. Cadot et al. (2011) analyze HS6 classification data from 159 economies for the period 1988-2006 and obtain a conclusion of a hump-shaped relation with a turning point around $25,000 per-capita income at PPP. Diversification is found at an income level below $25,000, and re-concentration tends to happen with per capita income over the turning point. It is inferred that export diversification should be a key element of the development process. Munir and Javed (2018) analyze the impacts of horizontal and vertical export diversification on the economic growth of 4 South Asian countries for the period 1990-2013. Using regression analysis of panel data with a squared term of export diversification as a regressor

represents a reversed U-shaped (hump-shaped) relationship between vertical diversification and growth and a U-shaped relationship for horizontal diversification. Vertical diversification is insignificantly positively associated with growth because early stages of diversification lead to higher growth, but after some critical points, specialization drives economic growth. On the contrary, horizontal diversification is negatively related to growth in that initial degrees of diversification give no benefits for growth up to a threshold after which diversification may become a driver for growth. However, the thresholds mentioned have not been defined in detail in the study.

Aditya and Acharyya (2013) findings are in parallel with Munir and Javed (2018). Using non-linear estimation techniques with a dynamic panel model – GMM for 65 countries in the period between 1965 and 2005, the study indicates the U-shaped relationship between export concentration and economic growth that implies a reversed U-shaped relationship between export diversification and growth. Export diversification fosters economic growth until it reaches a critical value of diversification. After this threshold, re-concentration with existing products takes place. The thresholds (degrees of concentration derived by the first-order condition of optimization for the logarithm of GDP) are found to vary from one group of countries to another. Hesse (2009) also examines the dataset of 99 countries in the period between 1965 and 2000 by GMM methodology. The study finds a nonlinear relationship but in a manner that developing countries obtain higher income with more significant diversified export while developed countries benefit from specialization.

This paper follows the strand of the nonlinear relationship between export diversification and growth with some modifications. We investigate nonlinearity in terms of degrees of diversification instead of degrees of development, as indicated in Cadot et al. (2011). Unlike Aditya and Acharyya (2011), Hesse (2009), and Munir and Javed (2018), referring to nonlinearity by using a squared term of diversification, we analyze nonlinearity via threshold regression methodology for panel data. With this approach, the threshold is identified in an attempt to show how economic growth is affected under different regimes, and there are before and after the threshold. Besides, both geography and product areas of export diversification are involved in this study, while previous studies focus on either of them.

The rest of the paper is organized as follows. Section 2 discusses the application of threshold regression methodology to the research model constructed based on endogenous growth theory. Data for estimation and robustness tests are also elaborated in this section. The last two sections analyze results and conclude the main findings, respectively.

Methods

We use a panel dataset of 44 EMDCs in the period between 1995 and 2015. While the selection of EMDCs involved in the study relies mainly on the availability of macroeconomic data in EMDCs, the selection of the research period depends on the availability of export diversification data. We use two measures of export diversification, including the Herfindahl-Hirschman market concentration index (HHI) and the overall Theil Index (THE). HHI can reflect export diversification relative to geography as it measures the dispersion of trade value across an exporter's partners. Meanwhile, THE developed by Theil (1976) reflects export diversification in terms of products. The overall Theil index is the sum of two components: intensive margin refers to the diversification of export values among active product lines, and extensive margin shows diversification by adding new products (Cadot et al., 2011). As both indices measure export concentration, an increase in the index implies higher export concentration or lower export diversification, and a decrease in the index indicates lower export concentration or higher export diversification. Although the two measures are popularly used in previous studies, no study uses both of them to reflect different aspects of export diversification. The estimation using HHI as export diversification variable is conducted in the period between 1995 and 2015; the other using THE as export diversification variable is conducted from 1995 to 2014.

Table 1. EMDCs in The Study

ID	Country	ID	Country	ID	Country	ID	Country
1	Algeria	12	Croatia	23	Lithuania	34	Poland
2	Argentina	13	Ecuador	24	Malaysia	35	Romania
3	Bolivia	14	Egypt	25	Mauritius	36	Russian Federation
4	Brazil	15	El Salvador	26	Mexico	37	Senegal
5	Bulgaria	16	Georgia	27	Moldova	38	Tanzania
6	Burkina Faso	17	Guatemala	28	Morocco	39	Thailand
7	Cameroon	18	Guyana	29	Mozambique	40	Tunisia
8	Chile	19	Hungary	30	Panama	41	Turkey
9	China	20	India	31	Paraguay	42	Uganda
10	Colombia	21	Indonesia	32	Peru	43	Uruguay
11	Costa Rica	22	Jamaica	33	Philippines	44	Vietnam

Source: Authors.

The research model to examine the impact of export diversification on economic growth in EMDCs is constructed based on the endogenous growth theory as follows:

$$GDPG_{i,t} = \alpha_i + \beta_1 EDI_{i,t} + \beta_2 CAP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 GOV + \beta_5 LAB_{i,t} + \beta_6 AFCi,t + \beta_7 GFCi,t + u_{i,t} \quad (1)$$

Where the subscript *i* indexes the individual (country) and the subscript *t* indexes time, error $u_{i,t}$ is assumed to be independent and identically distributed with mean zero and nite variance.

In model (1), the dependent variable on the left-hand side is real economic growth (GDPG) measured by the annual growth of GDP per capita. Independent variables on the right-hand side involve export diversification (EDI) measured by the HHI and THE as mentioned above, physical capital (CAP) measured by the ratio of gross capital formation to GDP, foreign direct investment (FDI) measured as the ratio of net foreign direct investment inflow to GDP, the labor force (LAB) measured by the growth of total labor and government expenditure (GOV) is measured by the ratio of government consumption to GDP. The growth model also captures structural breaks in the economic growth series of EMDCs generated by two financial crises involving dummy variables of AFC (Asian Financial Crisis 1997) and GFC (Global Financial Crisis 2008). All variables data are taken from World Bank Open Data, except for the Theil index from International Monetary Fund (2020).

To examine the non-linear relationship between export diversification and economic growth in EMDCs, we employ the methodology of the threshold autoregressive model (TAR) introduced by Tong (1978) and Hansen (1999). TAR model specifies that individual observations can fall into discrete classes based on the value of an observed variable (threshold variable). In other words, TAR methodology classifies the influence of regressors on dependent variables into different regimes relative to varying levels of threshold variables. In this study, the threshold variable is export diversification (EDI) to investigate its various impact on economic growth relative to the level of export diversification. As indicated in Hansen (1999), model (1) in the form of two-regime could be written as follows:

$$GDPG_{i,t} = \alpha_1 + \beta_1' X_{i,t} I[EDI_{i,t} \leq \gamma] + \beta_2' X_{i,t} I[EDI_{i,t} > \gamma] + \beta_3 Z_{i,t} + u_{i,t} \quad (2)$$

In model (2) γ is the threshold value, $X_{i,t}$ includes EDI, CAP, FDI, GOV, and LAB, which cause various impacts on economic growth under different regimes of the threshold variable (export diversification); $Z_{i,t}$ includes AFC and GFC having unchanged influences on economic growth regardless of different regimes. Export diversification is expected to significantly foster economic growth in the early stages when the export diversification level is above the threshold level. The positive influence will diminish when the export diversification process reaches a greater degree, which means that the export diversification level is lower than the threshold level. The number of threshold values and tests are identified using the Threshold Test methodology developed by (Bai & Perron, 1998, 2003).

The robustness test and comparison with previous studies (Aditya & Acharyya, 2013; Hesse, 2009; Munir & Javed, 2018) use the methodology employed in previous studies. The non-linear relationship between export diversification and economic growth is examined by adding the squared term of export diversification into the model (1).

$$GDPG_{i,t} = \alpha_i + \beta_1 EDI_{i,t} + \beta_2 EDI^2{}_{i,t} + \beta_3 CAP_{i,t} + \beta_4 FDI_{i,t} + \beta_5 GOV + \beta_6 LAB_{i,t} + \beta_7 AFC + \beta_8 GFC + u_{i,t} \quad (3)$$

In model (3), we expect β_1 is positive (>0) and β_2 is negative (<0) simultaneously, reflecting an inverted U-shape relationship between export diversification and economic growth as in previous studies. This expectation implies that higher economic growth is driven by greater export diversification when export diversification is lower at a certain level. However, when export diversification is greater than that specific level, it is no longer significantly associated with higher economic growth. Adversely, when β_1 is negative and β_2 is positive simultaneously, export diversification and economic growth have a U-shaped relationship. Estimation of the model (3) is generated by panel model methodology, including pooled OLS, fixed effect model (FEM), and random effect model (REM).

Results and Discussion

Descriptive statistics of the variables are presented in Table 2. The diversity of data reflects different levels of growth as well as export diversification across EMDCs. The GDP growth rate of all countries ranges from -14.351% to 23.053% with a sample mean of 3.050% and a high standard deviation of 3.517. The average export diversification measured by HHI is about 0.125, with the minimum and maximum values at 0 and 0.710, respectively. This figure indicates that most EMDCs keep low diversification in terms of the export market. The export diversification measured THE ranges from 1.597 to 5.592 with a sample mean of 2.938. Diversity in the level of export diversification predicts different effects on economic growth in EMDCs. Descriptive statistics of other dependent variables also show the diversity of the sample in terms of the ratio of capital formation to GDP, the ratio of net FDI inflow to GDP, the ratio of government consumption to GDP, and the growth of the labor force.

Table 2. Descriptive Statistics

	GDPG	HHI	THE	CAP	FDI	GOV	LAB
Mean	3.050	0.124	2.938	22.737	3.742	14.368	1.527
Median	3.240	0.090	2.847	21.836	2.812	13.813	1.778
Maximum	23.053	0.710	5.592	45.690	50.505	28.806	11.261
Minimum	-14.351	0.000	1.597	4.493	-15.989	4.997	-9.900
Standard deviation	3.517	0.103	0.853	5.779	4.365	4.196	1.837
Skewness	-0.376	3.140	0.699	1.162	4.735	0.465	-0.414
Kurtosis	6.146	14.980	3.075	5.234	41.951	3.082	6.177

Source: Authors.

Threshold Test

Threshold test using Bai-Perron test used to identify the threshold and number of regimes. Table 3 shows the results of the test for the model using HHI and THE. The hypothesis of no threshold is rejected in both models, while the hypothesis of 1 threshold could not be rejected. These results imply a non-linear relationship between economic growth and export diversification in the form of two regimes. The threshold values of export diversification measured by HHI and THE are 0.060 and 2.069, respectively. As these thresholds are below average HHI and THE of EMDCs, most EMDCs belong to the first export diversification regime in terms of geography and product.

Table 4 summarizes the main estimation results of the threshold model in the model (2) using HHI and THE as highly consistent threshold variables. The result shows estimated coefficients of independent variables at the top panel in the first regime and the second regime of

the HHI and THE variables. The middle panel of the result represents estimated coefficients of constant and two dummy variables of crises which are unchanged in two regimes. The bottom panel is some statistics that indicate both estimated models are well-behaved.

Table 3. Threshold Test Results

Hypothesis	HHI	THE
0 vs 1 (F-stat)	6.471***	4.782**
1 vs 2 (F-stat)	2.422	2.592
Threshold value	0.060	2.069

Source: Authors' estimation

Table 4. Threshold Regression Estimation Results

Variables	Dependent Variable: GDPG			
	First Regime		Second Regime	
	HHI < 0.060	HHI ≥ 0.060	THE < 2.069	THE ≥ 2.069
HHI	-4.642	-5.273**		
THE			-1.339	-1.585***
CAP	0.106***	0.108***	0.185***	0.160***
FDI	0.199***	0.031	0.211**	0.094**
GOV	-0.465***	-0.337***	-0.166	-0.372***
LAB	0.463**	0.172***	0.065***	0.051*
C	4.222***		-2.123	
C97	-0.786**		-0.845***	
C08	-2.290***		-2.372***	
R^2	0.332		0.371	
Adj. R^2	0.288		0.316	
F-stat (Prob)	7.525 (0.000)		6.766 (0.000)	
DW	1.947		1.896	
LM(2)	1.208 (0.211)		1.852 (0.131)	
LM(4)	1.659 (0.157)		1.475 (0.158)	

Notes: ***, **, * indicate significant level at 1%, 5%, and 10%, respectively.
Source: Authors' estimation.

Regarding estimation with export diversification measured by HHI, the estimated coefficient of HHI is insignificantly negative in the first regime when HHI is below the threshold value. However, the negative influence of HHI on economic growth is significant at a 5 percent level in the second regime when HHI is higher than the threshold value. This result implies a more diversified portfolio of the export market leads to an increase in economic growth when the degree of diversification is lower than a certain degree (i.e., the threshold), reflecting more benefits associated with comparative advantages as well as earning stability of existing products on the entrance to new markets. However, when market diversification reaches a certain degree (i.e., the threshold), existing products could not maintain comparative advantages in additional markets. As a result, greater export diversification would no longer be a positive driver for economic growth. Besides, adding a new market to the current portfolio would fail to obtain more stable earnings when macroeconomic conditions of the new market are correlated with other markets in the portfolio.

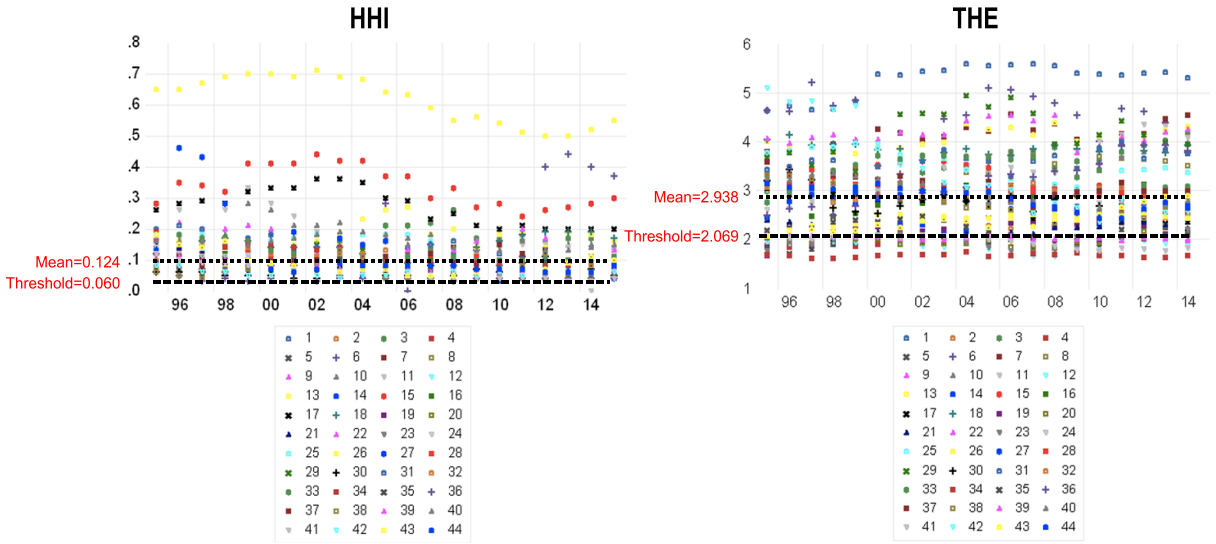
Regarding estimation results of the model in equation 2 with THE as the measure of export diversification, the coefficient of THE is also insignificantly negative in the first regime but significantly negative in the second regime. This result also indicates a nonlinear relationship between economic growth and export diversification in terms of product. Adding a new product to current export baskets can promote economic growth when the degree of product diversification is below the threshold. In the early stages, exports relied heavily on commodity goods. Thus, in terms of the horizontal aspect, a more diversified product portfolio can reduce the reliance on a

limited number of commodity goods whose prices are highly volatile. In terms of the vertical aspect, the addition of higher value-added products can increase productivity and output growth through knowledge spillover effects. These positive influences of more diversification in terms of horizontal and vertical aspects occur because product diversification at early stages usually concentrates on the most effective products with a strong comparative advantage. When the export basket becomes diversified at a certain high level, a new export product is hardly the particularly effective one, thus benefits to economic growth are hardly obtained.

The estimation results in this study partly support the findings by Aditya and Acharyya (2013) and Munir and Javed (2018), confirming the contribution of export diversification in terms of both geography and product to economic growth in the early stages. However, while previous studies indicate the negative influence of export diversification on economic growth when export diversification is at a high level, this study shows other evidence. Keeping diversifying export markets or products could not promote economic growth when the degree of diversification meets its threshold. This result is consistent with theoretical arguments. As macroeconomic conditions of markets are correlated regionally or globally, benefits of export earning stability indicated in portfolio investment theory could not grow unlimitedly. Romeu & Costa Neto (2011) and Karahan (2017) also indicate that more market diversification does not guarantee a more stable export revenue in crisis when countries' macroeconomic conditions are highly positively correlated.

Similarly, spillovers from export sectors to other sectors in the economy following endogenous growth theory would gradually diminish. Bao, Ye, and Song (2016) indicate a negative spillover of export production among Chinese firms in the later stage of export growth. The entry of more exporters will increase export crowding, as a result, raising the costs for exporting and depressing the export prices due to more competitive pressure. Moreover, an over-diversified export portfolio in terms of products will involve products with a less comparative advantage, while an over-diversified export portfolio in terms of the market will involve markets where existing products have a less competitive advantage. Cadot et al. (2011) also document a hump-shape relationship between export diversification and the level of income and find that "countries on the right of the turning point close lines that are typical, in terms of factor intensities, far from their endowments-outliers in their export portfolios".

Figure 1 indicates that most EMDCs experience export diversification in terms of geography lower than the threshold value. Thus, EMDCs significantly growth benefit from diversification during the study period. The export diversification in terms of products on average is much lower than the threshold, while the export diversification in terms of geography on average is relatively close to the threshold. This implies a great room for the addition of more products and more narrow room for increasing export markets.



Source: WB (2020), IMF (2020) and authors' calculation.

Figure 1. HHI and THE of EMDCs compared to threshold values

According to estimation results, other variables also cause consistent influences on economic growth in both models using HHI and THE as measures of export diversification. Economic growth is significantly driven by capital formation, FDI, and the labor force. Contrarily, an increase in government consumption is detrimental for growth which can be explained by higher external debt to finance public consumption in EMDCs. External debt burden leads to more deficit fiscal balance, worsens the balance of payment, lowers sovereign credit rating, and undeniably damages economic growth.

Robustness Test

Table 5 summarizes estimation results of model (3) by FEM based on the results of likelihood ratio and Hausman tests which are also presented at the bottom of the table. The coefficients of export diversification and its squared terms are consistently and significantly negative in both HHI and THE models. This result supports Aditya and Acharyya (2013) and Munir and Javed (2018), indicating a U-shape relationship between export concentration and economic growth or an inverted U-shape relationship between export diversification economic growth. Thus, benefits to economic growth could be obtained in the early stages of export diversification, while disadvantages to economic growth are the influence of export diversification at a high level. Besides, the effects of capital formation, FDI, and government consumption on economic growth are consistent with threshold estimation results. These consistencies confirm the robustness of our estimation results.

Table 5. Robustness Estimation Results by Fixed Effect Model

Variables	Dependent Variable: GDPG	
	HHI	THE
(1)	(2)	(3)
THE		-6.334***
THE^2		-0.690**
HHI	-5.010*	
HHI^2	-1.524**	
CAP	0.141***	0.223***
FDI	0.065**	0.111***
GOV	-0.349***	-0.381**
LAB	-0.079	-0.100
C97	-0.612*	-0.846**
C08	-2.066***	-2.215***
C	5.595***	-8.497**
R^2	0.297	0.344
Adj. R^2	0.255	0.292
F-stat (Prob)	7.075 (0.000)	6.655 (0.000)
DW stat	1.629	1.694
Poolability test (F-stat)	3.785 (0.000)	4.294 (0.000)
Hausman test (Chi-sq stat)	33.541 (0.000)	15.102 (0.019)

Notes: ***, **, * indicate significant level at 1%, 5%, and 10%, respectively.

Conclusion

There has been growing consensus that export diversification can solve the weakness of the high dependence of exports on commodity goods in EMDCs. However, whether this strategy associated with general economic growth? This study investigates the nonlinear relationship between export diversification and economic growth by employing the threshold regression methodology introduced by Tong (1978) and Hansen (1999). The Herfindahl-Hirschman market concentration index measures geographical and product diversification, and the overall Theil index is involved. The following result of this study uses data from 44 EMDCs in the period between 1995 and 2015. First, the threshold values of export diversification measured by HHI and THE are found to be significant, implying the nonlinear relationship between export diversification and economic

growth across EMDCs. Second, below the threshold, export diversification in terms of geography and products is associated with economic growth. This result implies the role of an export diversification strategy in growth. However, when the level of export diversification is higher than the threshold, economic growth fails to get benefits from an increase in export diversification in either geography or product aspects.

Our results support previous studies that document the positive influence of export diversification on economic growth in the early stage. However, different from previous studies which conclude the negative effect of export diversification above the threshold on economic growth, we indicate no benefit for economic growth following an increase in export diversification.

The results evidence of this study is the appropriation of export diversification to stimulate growth in EMDCs. As the degree of export diversification of most EMDCs is currently lower than the threshold values, it seems that these countries would keep increasing the level of export diversification in terms of the geography or product aspect. Since the effects of export diversification on growth are sensitive to its levels, EMDCs need to track the degree of export diversification of the economy to have an appropriate assessment. When the level of export diversification is greater, EMDCs should revise their export diversification strategy because an expansion of markets or the addition of export products would not be beneficial to growth. In essence, the positive effect of export diversification on economic growth occurs only when adding a new product or market to the existing portfolio is accompanied by the benefit of stabilizing export revenue or the spillover effects of export activities, most importantly, the comparative advantage. Therefore, the assessment of export diversification of each economy should be considered in these aspects.

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Exchange rates and oil price under uncertainty and regime switching: A Markov-switching VAR approach

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Abstract

Purpose — This paper analyses the effects of the US economic policy uncertainty index and oil price changes on the dollar exchange rate over a monthly period from January 2006 to August 2020.

Methods — This paper uses the Markov-switching Vector Auto-Regressive (VAR) model.

Findings — The results show that the sharp decline regime in the exchange rate is the most stable. In addition, the impact of the oil price on the exchange rate of the concerned currencies is stronger than the effect of EPU on the exchange rate of these currencies. We also find that most of the effects of oil prices were negative, while positive for the Canadian dollar and the Japanese yen exchange rate.

Implications — Addressing this investigation contributes to many of the areas covered in recent macroeconomic and finance research. Moreover, such research can help predict changes in currency and oil prices better and create profitable investment and hedging strategies for currencies and oil.

Originality — We consider the effect of economic policy uncertainty (EPU) and oil price changes on the relationships between those markets and study these relationships under different market conditions.

Keywords — oil price, exchange rate, Markov switching.

Introduction

The coronavirus (COVID-19) pandemic has created an unprecedented economic and financial crisis. In contrast, the measures necessary to contain the virus have led to an economic downturn and sharp fluctuations in oil prices; it has become a general economic crisis (Liu, Sun, & Zhang, 2020). Notably, the COVID-19 crisis has proven that global economies are fragile and can be affected by crises (Corbet, Larkin, & Lucey, 2020), similar to the 2008 global financial crisis that negatively affected financial markets. Some researchers, such as Baker et al. (2020), found that the current COVID-19 pandemic has a more significant impact on stock market performance than any previous health crisis. Furthermore, there is a great degree of uncertainty at present about how severe and long they are. The latest global financial stability report shows that the financial regime is already severely affected, and the intensification of the crisis could impact global financial stability (Padhan & Prabheesh, 2021). A recent study by Chkir, Guesmi, Brayek, and Naoui (2020) shows that the impact of oil price changes on the exchange rate markets varies in size, and its importance is based on the distribution of exchange rate returns. They also found that the response of currency

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markets to oil price movements changes between countries and oil price regimes and is more severe during highly volatile regimes.

The oil price shock is the main source of movement in the real exchange rate of the USD (Albulescu & Ajmi, 2021). When analyzing the relationship between oil prices and currency exchange rates, the problem is the possibility of two-way mutual causality of indicators. The first channel is based on trading conditions. For oil-importing countries, the latest price increase leads to a deterioration in the trade balance and subsequent depreciation of the national currency. The second channel finds its embodiment through the effect of wealth. An increase in oil prices leads to a shift in welfare from importers to exporters, which entails a change in the exchange rate of importing countries due to current account deficits and investment outflows (Walid, Chaker, Masood, & Fry, 2011).

The exchange rate is one of the key channels through which the oil price in dollars is transferred to the real economy (see Nouira, Amor, & Rault, 2019). Therefore, the US dollar movements are considered a predictive power in the international energy market. Zhang (2013) regimes that the dollar price of oil gives the impression of rising with the depreciation of the U.S. dollar. Some studies have found a relationship between the price of oil and the dollar's exchange rate (Turhan, Hacihasanoglu, & Soytas (2013); Aimer (2016, 2017, 2019a, 2019b)).

Since the US currency is the reference currency on the oil market, the question of possible links between oil prices and the dollar price seems particularly crucial. This question is particularly acute because of recent fluctuations in the oil price, especially since the early 2000s. Since 2002, and if we ignored the downward correction in July 2008, the oil price has been on an overall upward trend. At the same time, the dollar has depreciated (see Figure 1); it seems that crude prices and the dollar evolve in a similar way in relatively "calm" periods. When dollar movements are more pronounced, the direction of the relationship appears to be reversed. An inverse relationship is also observed over the period 2002-July 2008, the price of oil increases, while the dollar tends to depreciate. Therefore, it indicates that the relationship between the two variables is not unequivocal and depends on the period considered. On the other hand, visual observation suggests that the price of crude tends to be ahead of the dollar. In other words, if a causality between the two variables exists, it seems to operate from the price of oil towards the dollar.

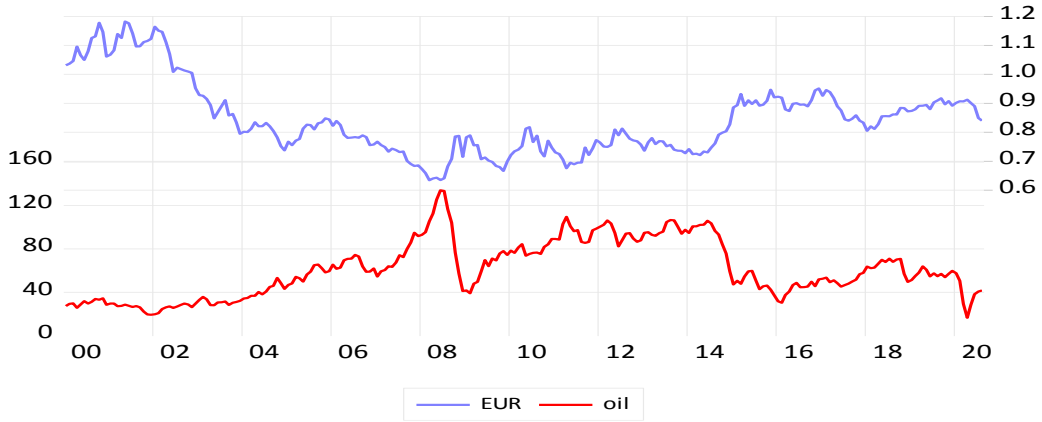

Figure 1. WIT crude oil prices and the exchange rate of the USD/EUR.

The purpose of this study is to analyze the effects of oil price movements and economic policy uncertainty on exchange rates using an MS-VAR model. Since the MS-VAR model includes information on the probability density function of variables, it has the advantage of analyzing the properties of the dependence structure between variables in consideration of extreme events. Meanwhile, the problem is that uncertainty is a variable that is difficult to capture directly. Moreover, Bollen, Gray, and Whaley (2000) study's study indicates that the regime-switching model captures exchange rate dynamics better than the alternative time-series models. Most of the current studies analyzed crude oil prices only, and they did not include oil prices in EPU and changes in market conditions on the relationships between these variables. Most researchers find somewhat

conflicting results that do not allow the researchers to conclude. Aloui, Aïssaa, and Nguyen (2013) and Ding and Vo (2012) show that increases in oil prices are correlated with the appreciation of the US dollar, but Narayan, Narayan, and Prasad (2008) and Zhang, Fan, Tsai, and Wei (2008) report a negative correlation between US dollar exchange rates and oil prices.

However, this study includes crude oil prices, US EPU, and exchange rates for five currencies. Our study contributes to the literature by examining the relationships between global oil prices (WTI) and the exchange rate of the U.S. dollar against foreign currencies (EX) by considering the effects of the U.S. EUP. We believe our findings contribute to several areas covered by modern economic research. More specifically, this study contributes to a better understanding of how changes in international oil prices are transmitted to the dollar's exchange rates. According to Arouri, Jouini, and Nguyen (2011), these findings contribute to an understanding of forecasting changes in oil prices and exchange rates, profitable oil and currency hedging, and the creation of investment strategies. Al-Abri (2013) examines whether real exchange rate responses differ according to the exchange rate regimes of some OECD (oil importers) and that the flexible exchange rate regime shows a relatively faster adjustment to its long-term equilibrium.

Methods

Our data consist of monthly statistics on WTI crude oil prices (OILP) dollars per barrel and the USD exchange rate against five currencies Canadian Dollar (CAD), Euro (EUR), British Pound (GBP), Japanese Yen (JPY), and Libyan Dinar (LYD), and the U.S. economic policy uncertainty (EPU) index proposed byBaker et al. (2016). The data covers the monthly period from January 2006 to August 2020. All the variables: oil prices, uncertainty index, and exchange rates for the five currencies were obtained from the Federal Reserve Bank of St. Louis database (FRED): https://fred.stlouisfed.org/. We chose this period to study the relationships between variables over different periods of stability and instability. Moreover, the US EPU index is based on newspapers in the US (see Baker et al., 2016). All monthly variables are expressed in natural logarithms after taking the first differences to remove heterogeneity. Table 1 shows the descriptive statistics and standard tests for these variables.

Table 1. Descriptive Statistics

	CAD	EUR	GBP	JPY	LYD	OILP	EPU
Mean	0.001	0.000	0.001	-0.001	0.000	-0.002	0.009
Std. Dev.	0.028	0.028	0.026	0.026	0.016	0.116	0.270
Skewness	0.477	0.436	0.418	0.277	2.564	-0.935	0.776
Kurtosis	5.867	4.957	4.860	4.073	21.254	10.653	5.263
J-B	66.97[a]	33.68[a]	30.54[a]	10.71[a]	2636.6[a]	455.2[a]	55.26[a]
ADF	-14.57[a]	-13.72[a]	-12.33[a]	-12.21[a]	-14.19[a]	-9.71[a]	-11.53[a]
PP	-14.55[a]	-13.71[a]	-12.45[a]	-12.21[a]	-14.19[a]	-9.28[a]	-17.17[a]
Corr. WTI	-0.30[a]	-0.23[a]	-0.31[a]	0.08	-0.24[a]	1.00	-0.31[a]
Corr. EPU	0.09	0.08	0.0.11	-0.24[a]	0.06	-0.31[a]	1.00

Notes: [a] indicate the rejection of the null hypothesis of associated statistical tests at the 1% level. Unit root tests are at constant, linear trend based on AIC. All the variables are in logarithm after taking the first differences form that we previously calculated. J-B is Jarque-Bera. Corr. refers to the correlation coefficients.

According to descriptive statistics in Table 1, the value of the standard deviation "indicator of volatility" of the EPU experienced relatively higher volatility than that of crude oil price and exchange rates during the study period. We note that the CAD and EUR are similar in terms of volatility (0.005%), and the LYD is the lowest rate of fluctuation among the exchange rates of the rest of the concerned currencies. Additionally, we note that the skewness coefficients are negative for CAD, EUR, and JPY while positive for the GBP, LYD, OILP, and EPU. Kurtosis coefficients for all variables are more significant than three. However, the Jarque–Bera test statistics, the departure from the normality test was confirmed. Finally, unit root tests by the Dickey and Fuller (1979) and Phillips and Perron (1988) tests show that all variables are stationary at their levels I(0) and significant

at 1%. In addition, we found the unconditional correlation between the economic policy uncertainty index and crude oil prices. It varies significantly across the exchange rates: from -0.30 (CAD) to 0.18 (JPY) for oil prices, as shown in the penultimate row of Table 1. While the relationship between the EPU and other indicators ranges from -0.03 LYD to 0.04 (GBP) as indicated in the last row of Table 1, however, on average, the values are weak between positive and negative.

Markov Switching -VAR model

In this study, we focus on the famous Markov regime-switching approach based on Hamilton (1989, 1990) applied to exchange rates, which many economists have used to model the nonlinear behavior of economic variables such as time series jump/break (Chen, Zhu, & Zhong, 2019; Fallahi, 2011; Krolzig, 2013). Hansen (2001) and Perron (2006) also emphasized the need to consider structural and regime changes in the time-series models of the macroeconomic. Hamilton (1989) and Krolzig (2013) overcome the shortcomings of linear models dealing with asymmetry by combining MS and VAR. Therefore, our study employs the MS-VAR approach to characterize the nonlinear relationships between the respective time series. Our study aims to describe the effects of oil prices on the exchange rate of the USD against five currencies by looking at the effects of the EPU.

Equation (1) describes the autoregressive model that is the basis for time series analysis.

$$y_t = v_t(s_t) + A_1(s_t)y_{t-1} + \cdots + A_p(s_t)y_{t-p} + u_t(s_t) \quad (1)$$

Where $y_t = (y_{1t}, y_{2t}, y_{3t})'$, $t = 1, \dots, T$, s_t denotes the regime variable, with $u_t \sim NID(0, \sum(s_t))$; $v_t(s_t), A_1(s_t), \dots, A_p(s_t)$ are mean parameters related to the state variable; describe the dependence of the parameters on the realized regime s_t. $s_t = \{1, \dots, m\}$ is specified by the transition probabilities.

$$\text{Prod}(s_{t+1} = j | s_t = i) = P_{ij}, \sum_{j=1}^{m} P_{ij} = 1 \; were \; i, j = 1, \dots, m \; ; 0 \le P_{ij} \le 1 \quad (2)$$

Each parameter of the model depends on the regime in which the regime is at date t. Therefore, each regime features its own shock diffusion regime.
The transition matrix P defines the transition probabilities.

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ P_{21} & P_{22} & \dots & P_{2m} \\ \vdots & \dots & \ddots & \vdots \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix} \quad (3)$$

In addition, probabilities of transition on important information about the expected duration (D_j) and that the regime will stay in a certain regime (j) as in the Equation 4:

$$E(D_j) = \frac{1}{1 - P_{ij}} \; ,j = 1,2, \dots, m \quad (4)$$

We compute impulse response functions (IRFs) for both regime switching, oil price shock, and uncertainty occurring in a given regime based on the MS-VAR model. Koop et al. (1996) introduced regime-dependent IRFs, which can measure the responses of the regime to shocks to the variables in period h as follows:

$$IR_{\nabla u}(h) = E[y_{t+h} | \xi_t, u_t + \nabla_u; \; Y_{t-1}] - E[y_{t+h} | \xi_t, u_t; \; Y_{t-1}] \quad 5)$$

where ∇_u is the shock at time t and the responses to shocks, as in the linear VAR process:

$$IR_{uk}(h) = \frac{\partial E[y_{t+h} | \xi_t, u_t; \; Y_{t-1}]}{\partial u_{kt}} \quad (6)$$

The responses to a regime switching are defined in the spirit of the IRF concept:

$$IR_{\nabla u}(h) = E[y_{t+h} | \xi_t + \nabla \xi, u_t; \; Y_{t-1}] - E[y_{t+h} | \xi_t, u_t; \; Y_{t-1}] \quad (7)$$

where $\nabla \xi$ is the switching in regime at time t.

Results and Discussion

Nonlinearity Test

The Brock–Dechert–Scheinkman (BDS) test suggested by Broock, Scheinkman, Dechert, and LeBaron (1996) is used to test the null hypothesis of linearity and has high power against numerous nonlinear alternatives. The results of the BDS tests, as in Table 2, show the linear dependencies in the VAR residual, and the majority of the statistics are significant nonlinear dependencies. Therefore, we reject the null hypothesis of linearity. Specifically, linear dependencies occur in all variables at the 1% significance level.

Table 2. BDS Test Results.

Dimension of Embedding (m)	BDS Statistic				
	m=2	m=3	m=4	m=5	m=6
OIL	0.049***	0.078***	0.088***	0.085***	0.076***
USD/CAD	0.016***	0.021**	0.021*	0.022*	0.021*
USD/EUR	0.007	0.025**	0.034***	0.040***	0.044***
USD/GBP	0.002**	0.000	0.000***	0.000***	0.000***
USD/JPY	0.004	0.020**	0.028**	0.031**	0.028**
USD/LYD	0.002*	0.001**	0.000**	0.000	0.000
EPU	0.007	0.025**	0.034***	0.040***	0.044***

Note: ***, **, and * denote the significance of nonlinear dependency at 1%, 5% and 10% levels, respectively.

Within the scope of the study, firstly, we define the appropriate model to create a suitable MS-VAR model. In the linear VAR (p) model, the p degree was determined using the Akaike Information Criterion (AIC), Schwarz Criterion (S.C.), and Hannan-Quinn Criterion (H.Q.). Moreover, MS-VAR determination differs according to regime numbers (q) and variance matrix definition. In this regard, the appropriate model is the MS(3)-VAR(1) model. In this regard, Stillwagon and Sullivan (2020) confirmed that it is advisable to allow and test for greater than two regimes in characterizing exchange rates. After we determined the MS-VAR model, the model used Likelihood-ratio (L.R.) statistics to test the MS(3)-VAR(1) model. To test the stability of the VAR model, we determine the lag number of the VAR models using the information criteria (AIC, SC, H.Q.). The best lag number of these models is one lag.

Regime-Switching Analysis

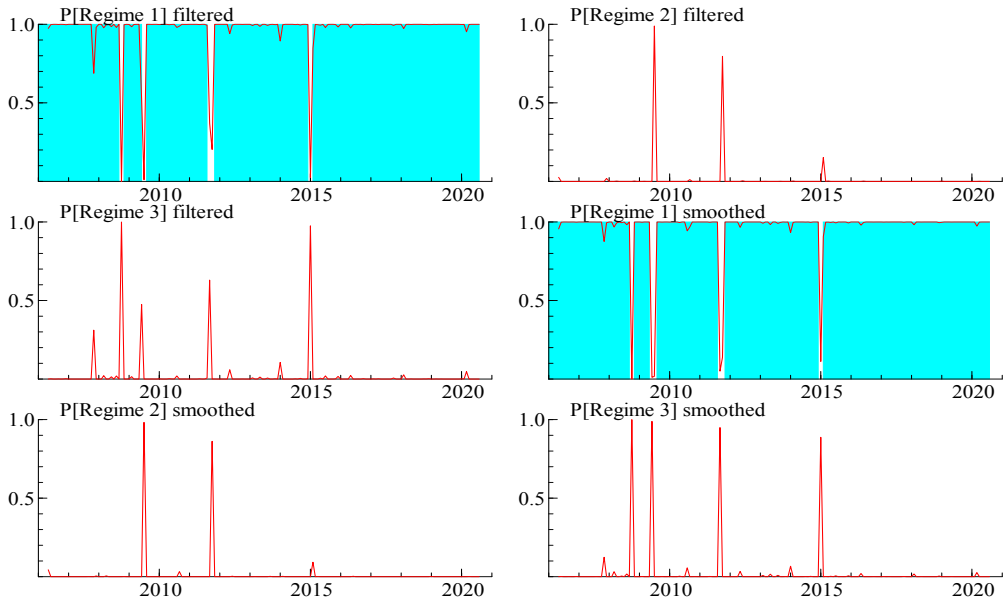

Figure 2. Filtered and smoothed probabilities for USD/CAD

According to Calvet and Fisher (2008), filtered probabilities are useful for prediction, while smoothed probabilities allow most information after data analysis. In particular, as in Figures 2 to 6, the results of the filtered and smoothed probabilities show the characteristics of the regime-switching associated with fluctuations in the exchange rates of five currencies from January 2006 to August 2020. In this context, it shows that the changes in exchange rates show a dynamic exchange regime that can be described in regime 1 "sharp decline", in regime 2 "small drop" and in regime 3 "steady rise".

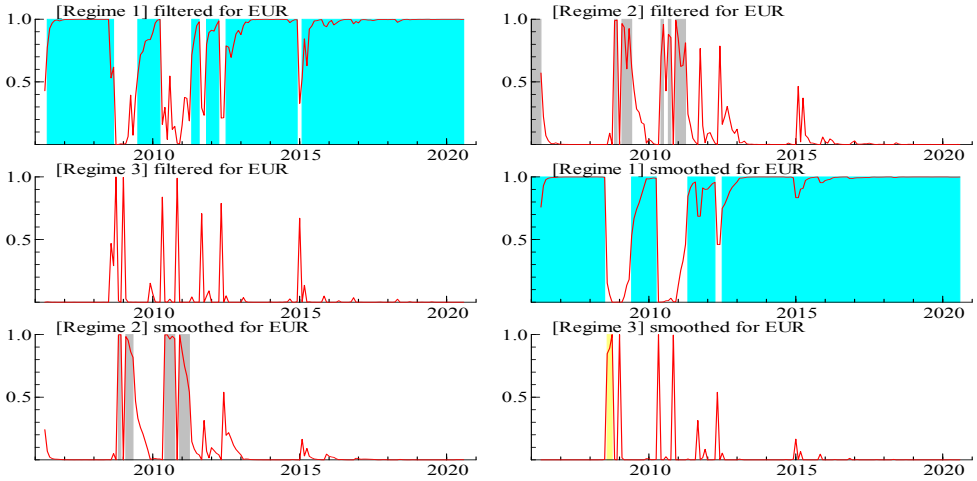

Figure 3. Filtered and smoothed probabilities for USD/EUR.

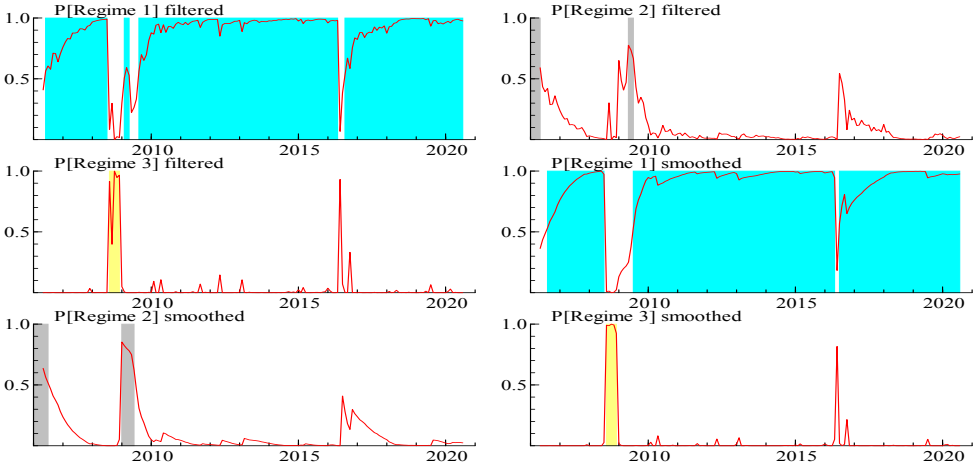

Figure 4. Filtered and smoothed probabilities for USD/GBP

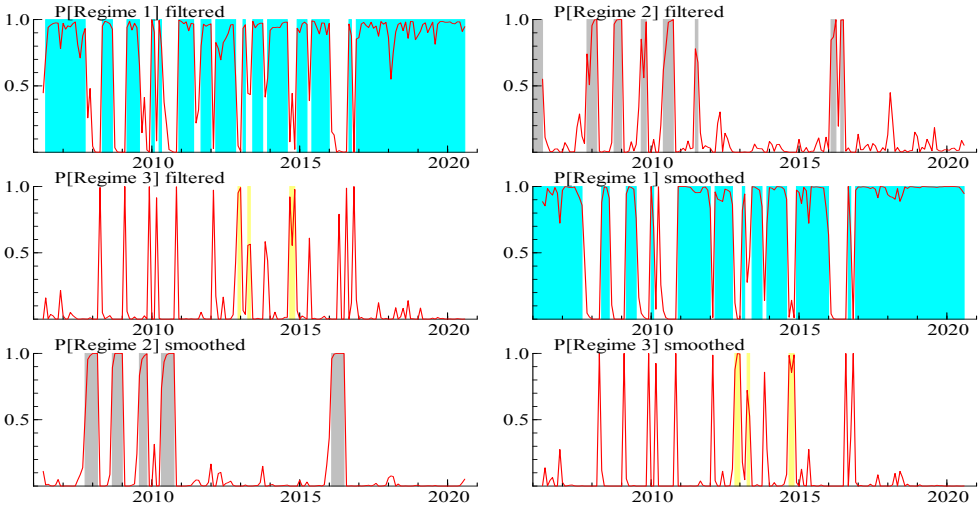

Figure 5. Filtered and smoothed probabilities for USD/JPY

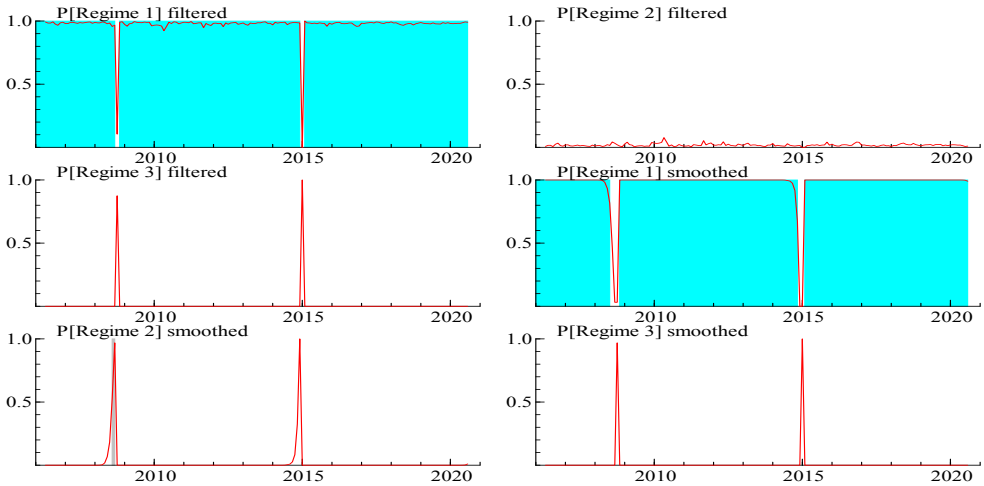

Figure 6. Filtered and smoothed probabilities for USD/LYD

Table 3 shows the transition probabilities between the three different regimes in the CAD, ERU, GBP, JPY, and LYD cases. The probability of staying in a sharp decline is 0.973, 0.978, 0.983, 0.891, 0.988, respectively; the probability of a transition from a sharp decline to a small drop regime is 0.000 in the CAD, EPU, GBP, (0.050 in case of JPY) and (0.011in case of LYD) and to a steady rise regime is 0.026, 0.021, 0.016, 0.058 and 0.000, respectively. In addition, the probability of remaining in a small drop regime is 0.000, 0.704, 0.856, 0.782 and 0.387 respectively; the probability of a transition from a small drop regime to a sharp decline regime is 1.000, 0.177, 0.143, 0.217 and 0.000, respectively and to a steady rise regime is 0.000, 0.119, 0.000 and 0.612, respectively. The probability of remaining in a steady rise regime is 0.000, 0.239, 0.608, 0.275, and 0.000, respectively. Moreover, the probability of the steady rise regime transitioning to a sharp decline regime and a small drop regime is (0.560 to 0.439), (0.000 to.0.239), (0.103 to 0.287), (0.724 to 0.000), and (1.000 to 0.000), respectively.

These findings imply that a small drop regime in the CAD and a sharp decline regime in ERU, GBP, and JPY have the highest continuous probability and, therefore, the most substantial stability. In the case of the LYD, These results indicate that the steady rise regime in LYD has the higher continuous probability and, accordingly, the strongest stability.

Table 3. Regime Transition Probabilities.

	Regime 1	Regime 2	Regime 3
Model 1(USD/CAD)			
Regime 1	0.974	0.000	0.026
Regime 2	1.000	0.000	0.000
Regime 3	0.560	0.440	0.000
Model 2(USD/EUR)			
Regime 1	0.979	0.000	0.021
Regime 2	0.177	0.704	0.119
Regime 3	0.000	0.761	0.239
Model 3(USD/GBP)			
Regime 1	0.983	0.000	0.017
Regime 2	0.143	0.857	0.000
Regime 3	0.104	0.288	0.609
Model 4(USD/JPY)			
Regime 1	0.892	0.050	0.058
Regime 2	0.000	0.782	0.218
Regime 3	0.724	0.000	0.276
Model 5(USD/LYD)			
Regime 1	0.988	0.012	0.000
Regime 2	0.000	0.388	0.612
Regime 3	1.000	0.000	0.000

After briefly explaining the characteristics of the three regimes, the study calculates regime transition probabilities to have information about the transitions between regimes. The results are shown in Table 4. First, regarding the CAD regimes, the result shows that a small drop regime and a steady rise regime tend to last for one month for both regimes on average, representing 1.16% and 2.33% of the sample, respectively. However, regime 1 is also the most stable, representing 96.51% of the sample and an average of 33.20 months. Second, concerning the EUR regimes, Table 4 shows that a small drop regime and a steady rise regime tend to last for 3.40 months and 1.40 months on average, representing 9.88% and 4.07% of the sample, respectively. We also find that a sharp decline regime is also the most stable, representing 86.05% of the sample and an average of 37 months.

Third, Table 4 related to the GBP regimes shows that a case of small decline regime and steady rise regime tends to last for 4.50 months and 3.00 months on average, representing 5.23% and 3.49% of the sample, respectively. The sharp decline regime is the most stable, accounting for 91.28% of the sample, with an average of 52.33 months. Fourth, in the aspect related to the JPY regimes, it appears that the case of small decline regime and steady rise regime tends to last for 5.40 months and 1.42 months on average, representing 15.70% and 9.88% of the sample, respectively. The sharp decline regime is the most stable, accounting for 74.42% of the sample, with an average of 9.85 months. Fifth, Table 4, related to the LYD regimes, shows that a case of small decline regime and steady rise regime tends to last for 1.50 months and 1.00 months on average, representing 1.74% and 1.16% of the sample, respectively. Furthermore, the sharp decline regime is the most stable, accounting for 97.09% of the sample, with an average of 55.67 months. In addition, the volatility is higher for regime 1 than for regimes 2 and 3. In general, the sharp decline regime is the most stable, representing between 74.42% and 97.09% of the sample.

Table 4. Information on Regime Structure.

	Number of samples	Probability	Duration
Model 1(USD/CAD)			
Regime 1	166	0.965	33.20
Regime 2	2	0.012	1.00
Regime 3	4	0.023	1.00
Model 2(USD/EUR)			
Regime 1	148	0.861	37.00
Regime 2	17	0.099	3.40
Regime 3	7	0.041	1.40
Model 3(USD/GBP)			
Regime 1	157	0.913	52.33
Regime 2	9	0.052	4.50
Regime 3	6	0.035	3.00
Model 4(USD/JPY)			
Regime 1	128	0.744	9.85
Regime 2	27	0.157	5.40
Regime 3	17	0.099	1.42
Model 5(USD/LYD)			
Regime 1	167	0.971	55.67
Regime 2	3	0.017	1.50
Regime 3	2	0.012	1.00

Effects of Oil Shocks

Table 5 shows the effect of oil prices and EPU on exchange rates. In the first system, the sharp decline regime, we found a statistically significant negative impact of oil prices and EPU on the CAD. Thus, CAD and EPU can be helpful in forecasting changes in oil prices during periods of high volatility ((Roubaud & Arouri, 2018). There is a negative effect of EPU on the CAD in the third system, i.e., a 1% increase in EPU leads to a 0.14% increase in CAD. This result means that the foreign exchange market experiences tremendous pressure during periods of high uncertainty and remains relatively calm when uncertainty is low. This negative effect of uncertainty on

exchange rates is consistent with Krol (2014) and Kido (2016), which showed that high EPU leads to higher exchange rate volatility.

In addition, concerning the impact of oil prices and EPU on the EUR, we find a positive effect of the oil price on the EUR in the sharp decline regime. Specifically, a 1% increase in oil prices causes the EUR to rise by 0.27%. This finding is consistent with Juhro and Phan (2018), where they found that EPU positively and statistically predicts the exchange rates of six out of ten ASEAN currencies. Moreover, this is consistent with Roubaud and Arouri (2018) findings that EPU depends on previous changes in oil prices. EPU dynamics seemingly persist to a degree, and this persistence is stronger during high volatility periods. In contrast, there is a statistically significant negative effect of oil price on the USD/EUR in the third regime, where an increase in the oil price by 1% leads to a decrease in the EUR by 0.8%. This finding is consistent with Roubaud and Arouri's (2018) findings that the exchange rate, stock markets and EPU are not correlated with oil prices in a low volatility regime. However, there was no statistically significant effect in the second regime - the small drop regime. On the one hand, the impact of the oil price and the EPU on the GBP, in the case of the sharp decline regime, we find that there is a negative effect of the oil price on the GBP. In addition, an increase in the oil price by one unit leads to a decrease in the GBP by 0.5%, while there is no statistically significant effect of the EPU on the GBP.

Moreover, Table 4 show a statistically significant effect of the EPU on JPY in the third regime, as an increase in EPU by one unit will lead to a rise in the exchange rate by 0.13%. However, there is a negative impact of the oil price on JPY for both the second and third regimes, but its influence in the small drop regime is more than its influence in the third regime. In the case of Libya, there is no statistically significant effect of the oil price and the EPU on the LYD. Our results are consistent with, Lizardo and Mollick's (2010) study which find that an increase in the real oil price leads to a depreciation of the U.S. dollar against the currencies of oil exporters.

Generally, the impact of the oil price is more significant than the effect of EPU on the exchange rate of these currencies, which is in line with a study of Aimer (2021). We also find that most of the effects of the oil price were negative, while most of the impact of the EPU on the exchange rate were positive. In addition, there is no effect of the EPU on the EUR, GBP, and LYD.

Table 5. Regression Coefficients of Regime Transition.

	Regime 1	Regime 2	Regime 3
Model1	CAD_t	CAD_t	CAD_t
EPU_{t-1}	-0.006**	-0.010	0.136***
OIL_{t-1}	-0.054*	-0.046	-0.138
Model2	EUR_t	EUR_t	EUR_t
EPU_{t-1}	-0.017	0.019	-0.008
OIL_{t-1}	0.272***	0.004	-0.081*
Model3	GBP_t	GBP_t	GBP_t
EPU_{t-1}	0.013	0.020	-0.054
OIL_{t-1}	-0.052*	-0.004	0.083
Model4	JPY_t	JPY_t	JPY_t
EPU_{t-1}	-0.014	-0.012	0.131***
OIL_{t-1}	-0.039	-0.068*	-0.018
Model5	LYD_t	LYD_t	LYD_t
EPU_{t-1}	-0.007	0.001	0.074
OIL_{t-1}	0.003	-0.017	-0.434

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level of significance, respectively.

Impulse-Response Functions

For further analysis, we use the cumulative impulse response by MS (3)-VAR (1) to investigate the direction and duration of the effects of oil prices on exchange rates by considering the effects of EPU. We observe the cumulative response to the exchange rates of the three regimes over a 10-month horizon, as shown in Figures from 7 to 11.

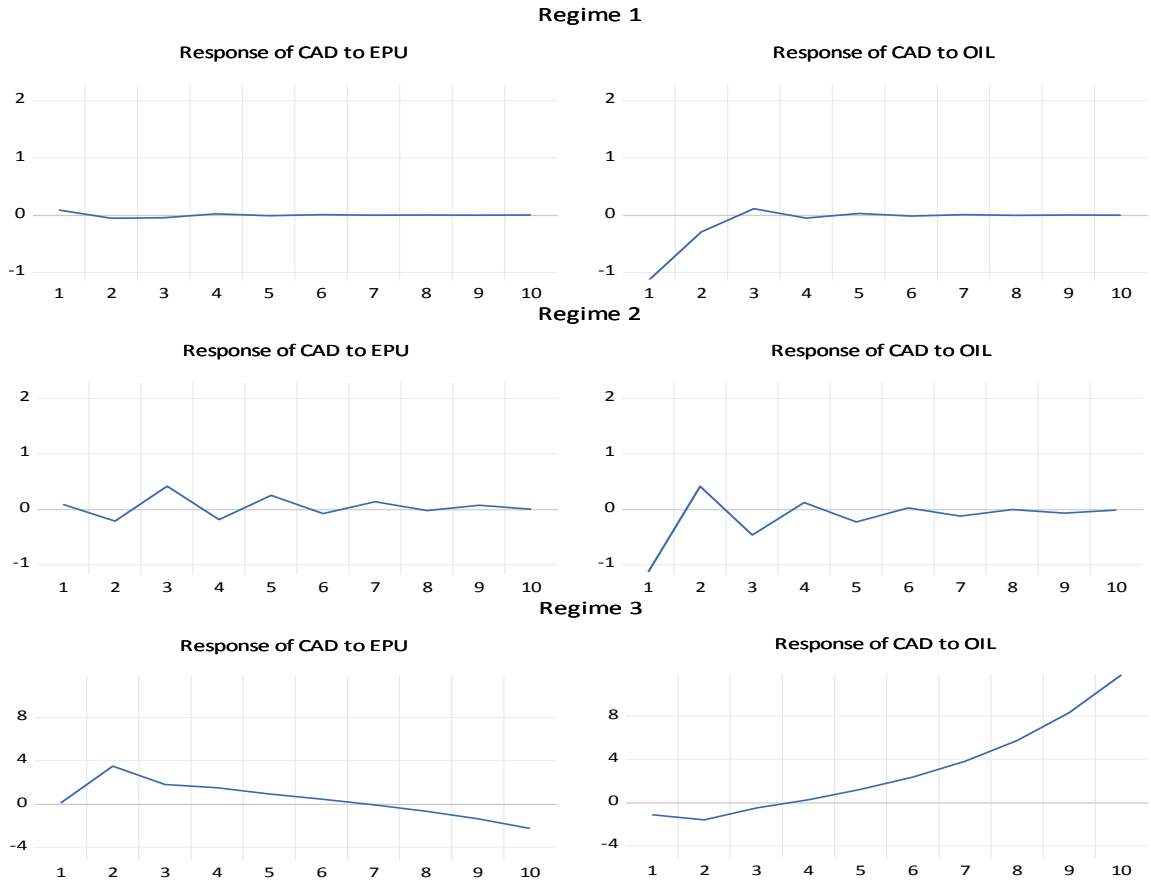

Figure 7. Impulse response of USD/CAD

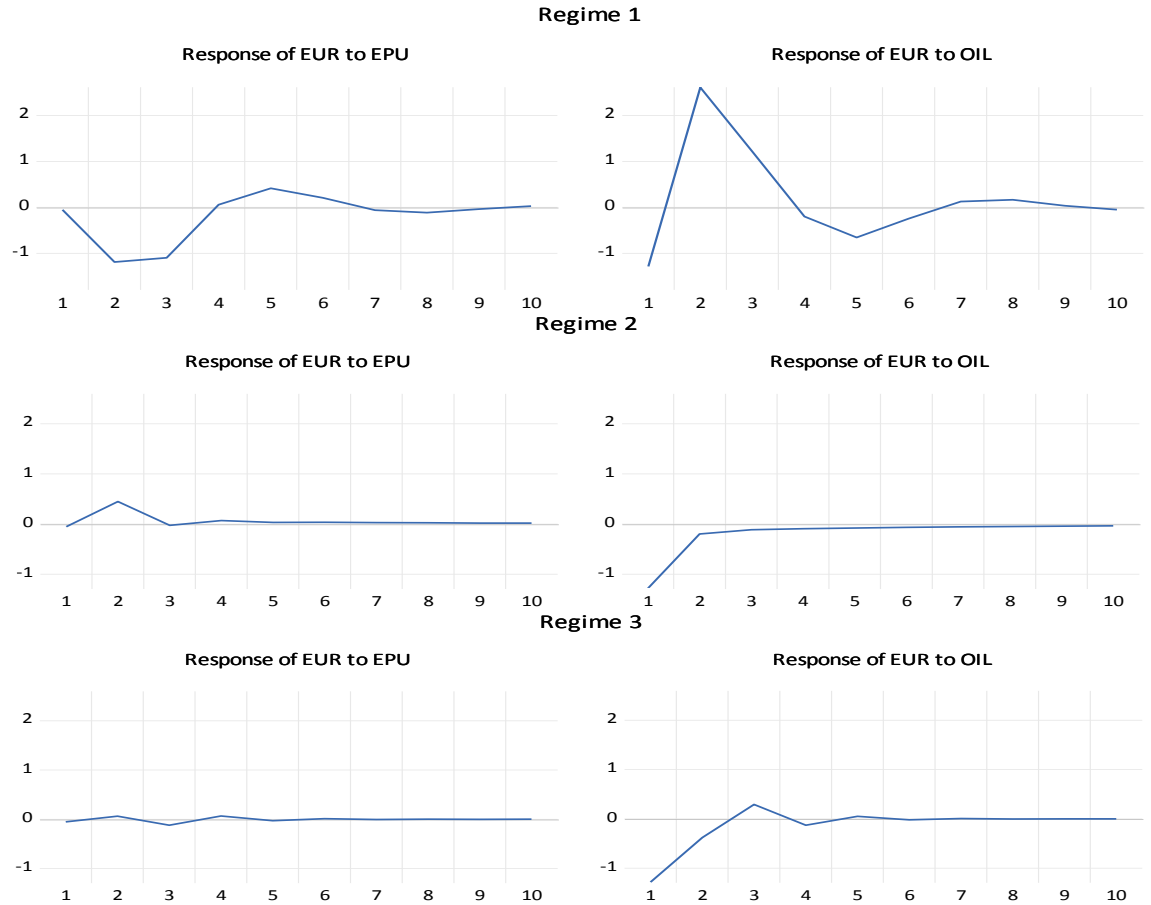

Figure 8. Impulse response of USD/EUR

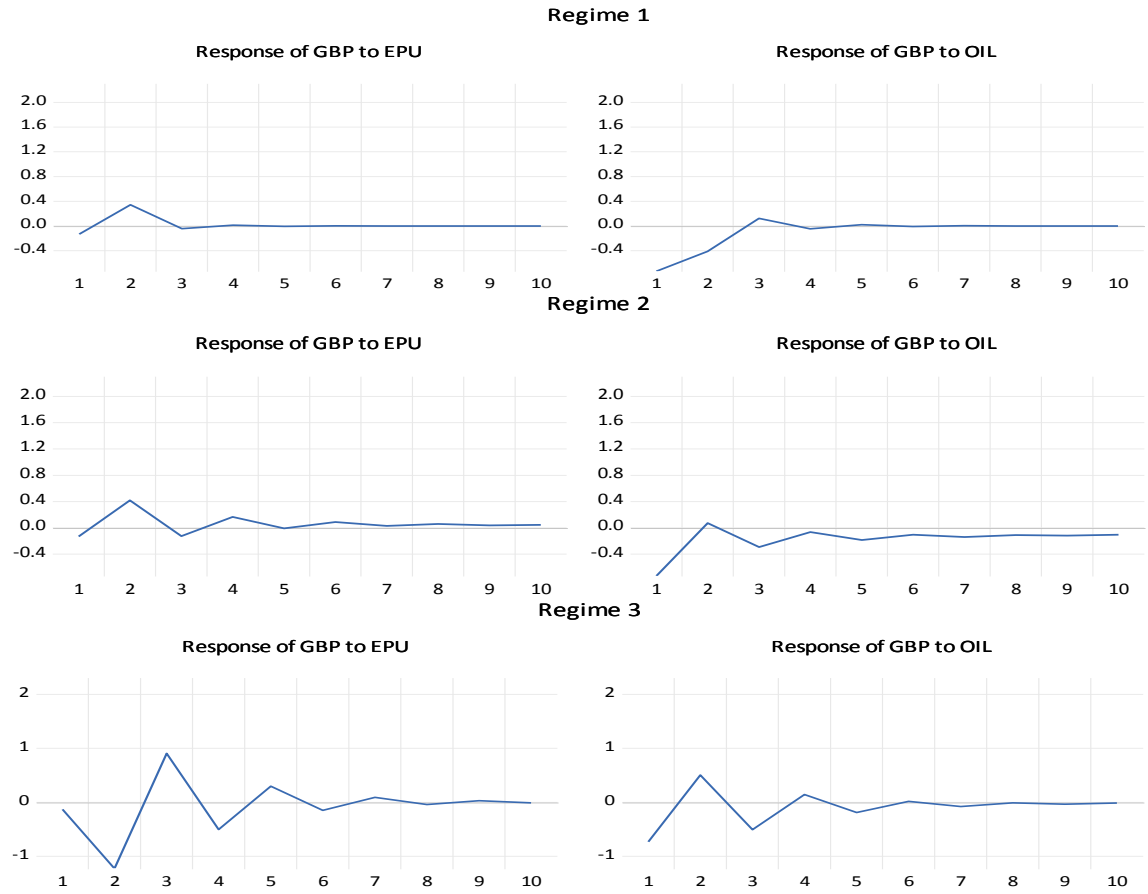

Figure 9. Impulse response of USD/GBP

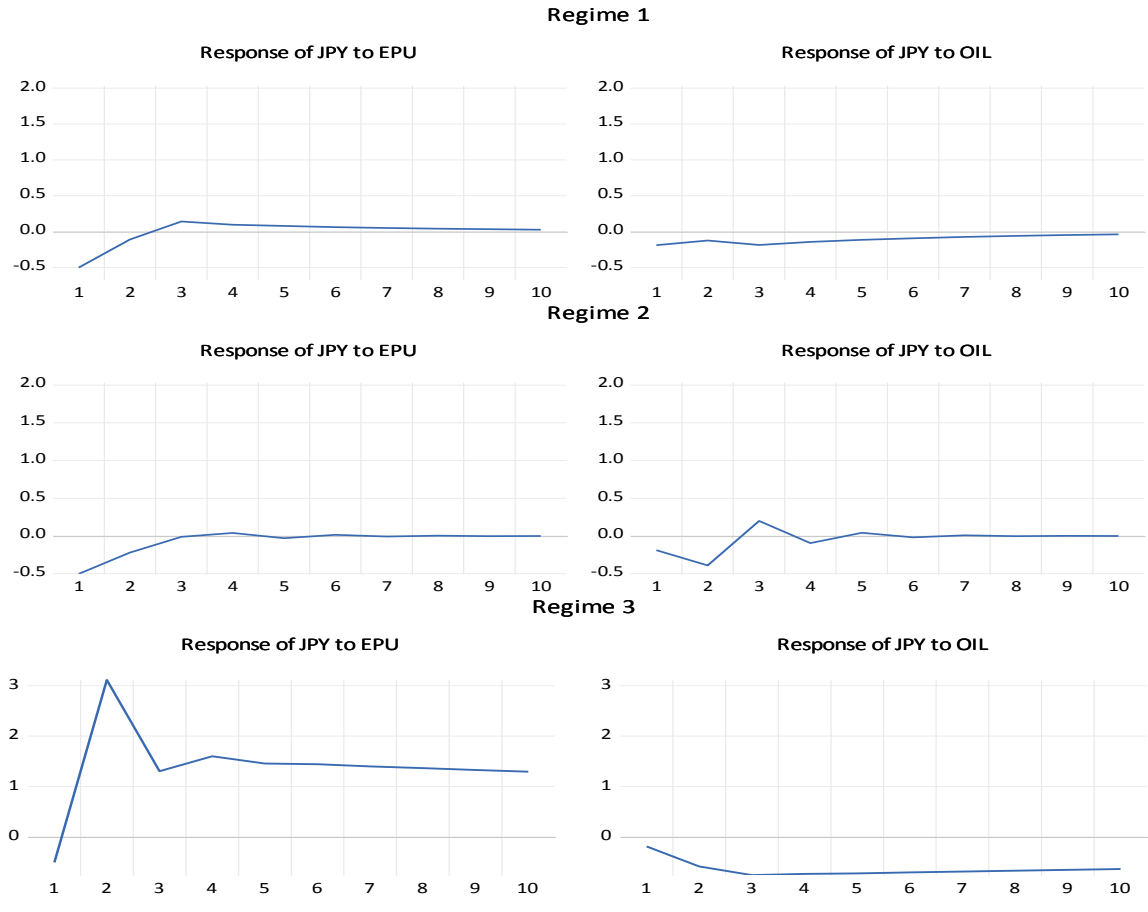

Figure 10. Impulse response of USD/JPY

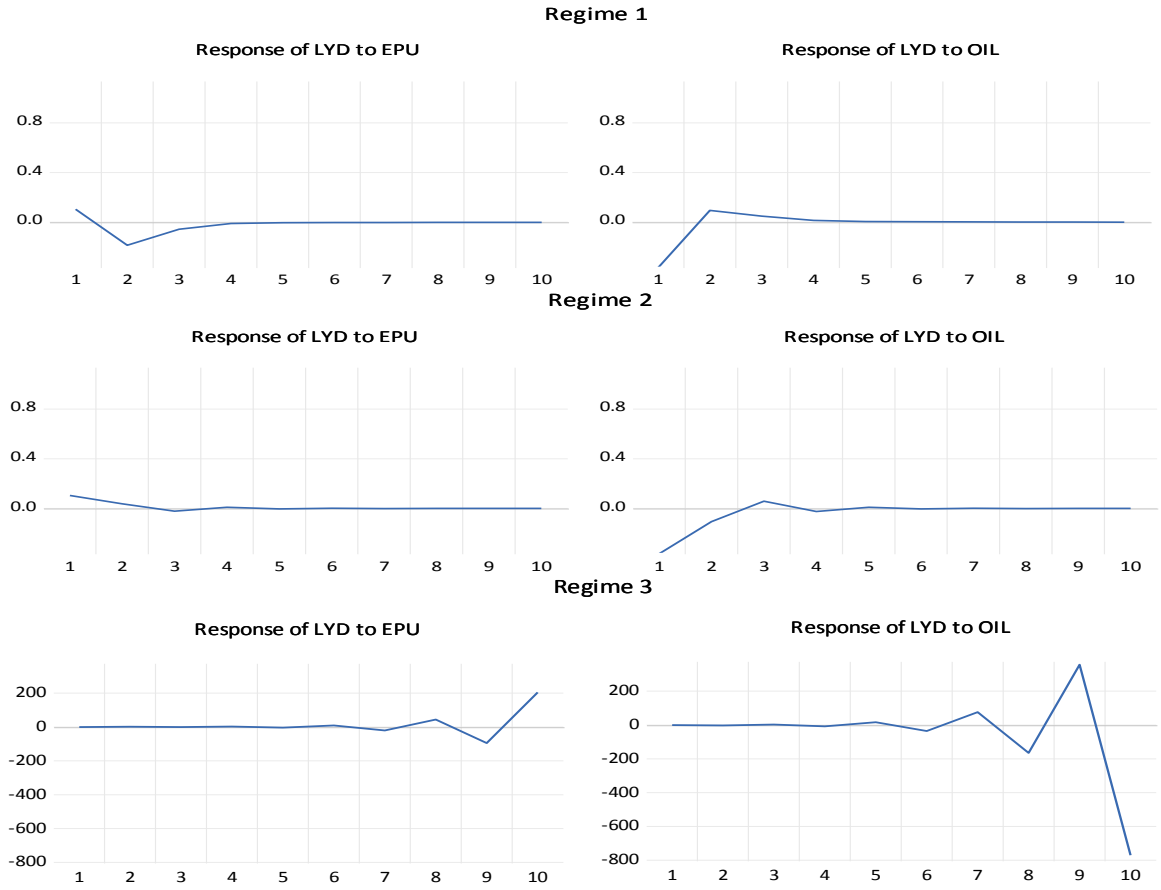

Figure 11. Impulse response of USD/LYD

As shown in Figure 7, the EPU shock causes a slight response between positive and negative for the CAD in the first system. In the first and second regimes, the shock effect is minor, fluctuating between positive and negative without an obvious pattern until the end of the period. In the third regime, the EPU shock had positive and negative effects until the middle of the sixth month and peaked at (3.48) in the second month, after which its effect faded.

Concerning the impact of the oil price shock on the CAD, in the first regime, the effect of the shock is negative during the first trimester, and its effect disappears after the third month. In the second regime, the impact of the shock fluctuates between negative and positive until the middle of the seventh month, after which it is minimal. In the case of the steady rise regime, the impact of the shock is negative until the third month, and then the effect becomes increasingly positive, reaching a peak of 11.79 at the end of the period. In particular, the impact of the shock of EPU and the oil price shock on the CAD differs between the three regimes.

Second, the dynamic effect of the EUR response from the uncertainty shock is shown in Figure 8. In the first regime, the results show that the oil price variable appears to have significant impacts during the first four months. However, the shock to the EPU led to an increasingly negative response in the euro exchange rate during the first and second months. Then the response changes to positive during the fourth month until its effect stabilizes after the fourth month. While in regime 2, the response is positive during the first three months; after that, its effect fades away until the end of the period.

In the case of the steady rise regime, the impact of the shock is slight, between negative and positive, until its effect fades after the sixth month. There is a sudden negative to positive euro exchange rate response in the first four months in the first regime. It is negative, peaking at -1.28 in the first month, and its positive peak at (2.60) in the second month, after which its effect becomes minor. In the second and third regimes, there is a diminishing negative effect over the length of the period.

Third, the dynamic effect of the GBP response to the EPU shock, as shown in Figure 9. In regimes 1 and 2, the EPU shock and the oil price shock lead to a negative exchange rate response during the first month and then change to positive during the first three months to that their effect fades. While in the third regime, there is a surprising fluctuating effect between negative and positive of the shock of EPU on GBP during the first seven months. We find that the impact of a shock in the first and second regimes is different from the third. In addition, the effect of the oil price shock on the exchange rate is similar between the three regimes, as the effect fluctuates during the first six months, and after that, the effect fades.

Fourth is the perspective of the dynamic impact of the JPY with response to the EPU shock (Figure 10). In regimes 1 and 2, there is a sudden effect of negative to positive due to the shock of EPU during the first three months and after the third month; it becomes a long-lasting positive effect of EPU shock. Regarding the exchange rate response to the oil price shock, there is a negative and diminishing effect in the first regime, which fades away at the end of the period. While in the second regime, there is a fluctuating effect between negative and positive until the first six months, and then their effect fades. Finally, in the third regime, there is a negative impact of trauma over the period.

Fifth is the dynamic effect of the LYD response (Figure 11). In the case of the first regime, the impact of the EPU shock leads to a positive response in the LYD during the first month and then turns negative in the second and third months. After that, its effect wanes until the tenth month. In the second regime, the impact of the shock is positive during the first three months, and after that, its effect diminishes until the tenth month. In the case of the third regime, there is no effect of the shock during the first seven months, after which the effect fluctuates between positive and negative without an obvious pattern. Likewise, in the first and second regimes, the shock in oil price leads to a negative response during the first two months, after which its effect diminishes. While in the third regime, the oil price shock has no effect on the exchange rate during the first six months, its impact becomes surprising between positive and negative.

In the short term, we found that the effect of the crude oil price on most exchange rates is negative, but the degrees of response between them vary. Likewise, in the long term, the impulse responses of most exchange rates converge to zero, except for the response of the CAD and LYD in the case of the third regime. On the other hand, there is no evidence to classify the impact of EPU shocks on exchange rates in the short and long term. This result confirms that the importance of lagged exchange rates varies by the regime ((Basher, Haug, & Sadorsky, 2016).

In comparison with previous studies related to our research, our results differ from earlier studies due to the different exchange rate regimes and the diversity of countries' economies in terms of whether they are exporters or importers of oil. Our findings are of great importance to policymakers and investors regarding managing exchange rate fluctuations and preventing potential risks that may arise due to heavy reliance between different markets.

Conclusion

This paper contributes to previous studies on the interactions between oil prices and exchange rates by considering the effects of EPU. Based on the M.S. -VAR model. The transition probabilities between the three different regimes show that the small drop regime in the CAD has the highest continuous probability and, accordingly, the strongest stability. While the sharp decline regime in the EUR, the GBP, and JPY have the highest continuous probability, so these currencies have the strongest stability. Otherwise, the steady rise in the LYD has the higher continuous probability, and accordingly, the strongest stability. Overall, a sharp decline regime is the most stable, representing between 74.42% and 97.09% of the sample.

In terms of the effect of exchange rates and EPU on the relevant exchange rates, we find that the impact of the oil price on the exchange rate of the concerned currencies is more significant than the effect of economic policy uncertainty on the exchange rate of these currencies. We also find that most of the effects of oil prices were negative, while the effects of EPU on the exchange

rate were positive for the CAD and JPY. However, there is no effect of EPU in the EUR, GBP, and LYD.

Moreover, the results of the IRFs also showed that the effect of the oil price on most exchange rates is negative in the short term, but the degrees of response between them vary. Likewise, in the long term, the driving responses of most exchange rates converge to zero, except for the CAD and LYD in the steady rise regime.

Several future research methods are possible. First, further empirical investigations should examine whether including EPU and exchange rate changes improves oil price forecasts. Second, this study should be extended to other developed and emerging oil-exporting and importing countries to observe how exchange rates respond to oil prices and economic policy shocks.

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