Heterogeneity Effect of Central Bank Independence on Asset Prices: Evidence from Selected Developing Countries

(Kesan Heterogen Kebebasan Bank Pusat terhadap Harga Aset: Bukti dari Negara Membangun Terpilih)

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ABSTRACT

The study analyzes the response to financial asset prices and economic activity concerning central bank independence (CBI) shocks in selected developing countries. Financial asset prices were divided into the exchange rate, bond yield, and stock price, while the analysis was contingent on a panel Vector Autoregressive estimation. Furthermore, this study identifies heterogeneity across the countries in its sample through poolability tests. This is achieved through a mean-group estimation to the panel Vector Autoregressive by averaging the PVAR coefficients and impulse response function for all individual countries. Additionally, the sample countries are divided into two sub-groups. The results showed that central bank independence reduces bond yield and increases stock price in the first two quarters. However, it takes a year to cause an appreciation in the exchange rate. Moreover, financial asset prices have an essential role in monetary policy transmission to the extent that a change in CBI affects the exchange rate, bond yield, stock price, thereby influencing private consumption and investment.

Keywords: Central bank independence; exchange rate; stock price; bond yield; panel VAR
JEL: E31; E58; E61

ABSTRAK

Kajian ini bertujuan untuk menganalisis tindak balas kepada harga aset kewangan dan aktiviti ekonomi yang berkaitan dengan kejutan kebebasan Bank Pusat di negara-negara membangun terpilih. Harga aset kewangan terdiri daripada tiga kategori iaitu kadar pertukarah asing, hasil bon, dan harga saham. Analisis panel vektor auto regresif (panel VAR) telah digunakan untuk penganggaran model. Dengan menggunakan ujian poolability, hasil kajian menunjukkan berlakunya keheterogenan di seluruh negara dalam sampel kajian. Salah satu kaedah untuk menyelesaikan masalah keheterogenan ini adalah dengan menggunakan penganggaran model mean-group dalam model panel VAR dengan mempuratakan koefisien PVAR dan fungsi tindak balas bagi setiap negara. Selain itu, sampel kajian telah dibahagikan kepada dua sub-kumpulan. Hasil kajian mengesahkan bahawa kebebasan bank pusat mempunyai pengaruh yang kuat dalam menurunkan hasil bon dan meningkatkan harga saham pada dua suku pertama. Walau bagaimanapun, kejutan kebebasan bank pusat tersebut memerlukan tempoh setahun untuk menaikkan nilai kadar pertukaran. Tambahan lagi, harga aset kewangan mempunyai peranan penting dalam transmisi dasar monetari yang mana perubahan dalam CBI dapat mempengaruhi kadar pertukaran, hasil bon dan harga saham, yang mana seterusnya dapat mempengaruhi penggunaan dan pelaburan swasta.

Kata kunci: Kebebasan bank pusat; nilai tukar; harga saham; imbal hasil obligasi; panel VAR

INTRODUCTION

Studies show that central bank independence (CBI) has reduced inflation in developing countries by influencing the domestic outcome, including exchange rate, stock price, and bond yield. According to de Haan et al. (2018), the legal CBI index attracts investors through regular legislation, while independence risk originates from implicit or explicit pressure to revise the law. A change to an independent central bank suggests that new information regarding future monetary policy influences asset prices, such as exchange rate, bond yield, and stock price.

This paper is motivated by three principal reasons. First, central banks attained asset price stabilization in their policy implementation. The asymmetric issues

asset price shocks and the adverse effect from the fall in the prices are significantly greater than the corresponding positive impact. Significant drops in asset prices make lenders reduce credit supply, compromising asset prices and real economic activity. Second, asset prices are essentially forward-looking, comprising information about future inflation. This information is potentially significant for policy development, implying that asset prices are a source of data regarding future inflationary pressure. Third, the signaling effect channel highlights the potential role of current asset prices over future economic activities. Concerning economic aggregate demand, this is impacted by people's future income and profit expectations. The growth of real asset prices, which directly correspond to economic activities, influences such beliefs by indicating the economic outlook and future income. Consequently, it affects household consumption expenditure and the current economic investment of companies.

CBI's concept in developing countries differs from that in industrial nations (de Haan et al. 2018). For instance, the law and actual practice in the central banks in developed and developing countries are different. Developing countries have a lower rule of law than developed countries, with a possible difference between the institutional arrangement and adherence to the law. Agoba et al. (2017) stated that CBI requires strong political support to pursue price stability.

The CBI's effect on asset prices can be explained as follows. Central bank reform (change in CBI) alters the public's expectation concerning inflation and changes the asset price. This suggests that asset prices contain future inflation information for two critical reasons. First, aggregate demand change is directly due to a change in asset price. Second, asset prices depend on future return expectations, such as economic activity, inflation, and monetary policy. These changes highlight the importance of investigating the relationship between CBI and asset prices.

Claessens and Kose (2017) categorized asset prices into house price, equity price, exchange rate, and interest rate. Since house price is a non-tradeable product, this study only focuses on three other assets. Very few papers have focused on central bank reform over asset prices, such as Mishra and Reshef (2019) and Ozili (2020). They documented changes to central bank governors and their relationship to asset prices. Additionally, Eichler and Littke (2018) explored the impact of CBI on exchange rate volatility. Papadamou et al. (2017), Daraei (2018), and Garcia and Costa (2019) investigated the relationship between CBI and stock price volatility, while Masciandaro and Passarelli (2019), and Anwar and Suhendra (2020) analyzed the effect of CBI on bond yield. This study considers the impact of three different asset prices on private consumption and investment. It examines CBI's impact on investment and consumption through the exchange rate, bond yield, and stock price.

Central banks should analyze the influence of asset price fluctuation concerned with price and financial stability. Bernanke and Gertler (1999) asserted that financial and price stability are complimentary, implying that the central bank may stabilize asset prices. Low and stable inflation enables the central bank to react to the financial crisis. Nizamani et al. (2017), Ma et al. (2018), Roh et al. (2019), Sun et al. (2019), and Paul (2020) stated that asset prices predict future consumer price index movement. Moreover, Dima et al. (2017) and Li et al. (2017) showed that asset price development affects inflation and economic activity. The literature on asset price and monetary policy focuses on three key arguments. The first is that it is possible to measure the change in the price level (inflation) due to asset price changes (Karim & Zaidi 2015). Second, asset prices forecast inflation, and there are structural relations concerning asset price, investment, and consumption (Fenig et al. 2018; Miao et al. 2019; Alessi & Kerssenfischer 2019).

Economic theory suggests that asset price directly influences economic activity because it is forward-looking (Allesi & Kerssenfischer 2019). In this research, the correlation between asset prices and real activity highlights consumption and investment. Tobin's *q* theory explains asset prices' influence on household consumption and saving through wealth and substitution channels. Decisions relating to public consumption depend on current and future income and physical and financial assets. Moreover, changes in asset prices affect current consumption because of changes in real wealth and household finance. Hence, changes in consumption allocation influence household saving behavior.

This work contributes to the empirical research by linking CBI's relationship, three asset prices, including exchange rate, bond yield, stock price, and economic activity in developing countries. Additionally, it explores the interaction between CBI, exchange rate, bond yield, stock price, and economic activity. This is achieved by fitting a panel VAR estimation on quarterly data between 1991Q1 and 2016Q4 in seven countries determined by data availability. Subsequently, the study tests the pooling assumption of the model by applying the Chow and Roy-Zellner tests. It establishes that the models contain heterogeneity among the samples and applies a mean-group estimation for the panel VAR by averaging all individual coefficients. Furthermore, it divides the samples into subgroups to make a poolable group and compares the subsamples and the full sample regarding the link between CBI, exchange rate, bond yield, stock price, consumption, and investment.

This study compares which asset price has greater sensitivity to changes in CBI. The results show that CBI's shock on exchange rate appreciation is delayed, taking roughly a year, while stock price increases in two quarters after the shock. However, the effect becomes negative after period 3. Moreover, CBI has

significantly reduced bond yield in all periods. In conclusion, the greatest impact regarding CBI on asset prices concerns bond yield. Asset prices play a crucial role in monetary policy transmission since a CBI change affects the exchange rate, bond yield, stock price, private consumption, and investment. Greater CBI produces lower private consumption in all 3 channels. CBI requires 3 quarters to increase investment through the exchange rate and stock price, though it directly increases investment through the bond yield channel.

Section 2 of this research empirically analyzes central bank independence and asset prices. On the other hand, section 3 explores the data set, construction methodology applied, and models, section 4 examines the results, while section 5 is the conclusion.

LITERATURE REVIEW

The impact of monetary policy on financial asset prices is exciting research for the last two decades. Changes to the central bank governor trigger variations in monetary policy. Kuttner and Posen (2010) analyzed the influence of a change in central bank governor on asset prices. They assessed the impact of changing the central bank's governor on the exchange rate and bond yield in 15 industrialized countries from 1974 to 2006. To calculate the bond yield and volatility of the exchange rate, they used bootstrapped critical values in preference to those resulting from the normal distribution. They determined that changes to the bond yield and exchange rate are not distributed normally but are skewed and leptokurtotic. Furthermore, they suggested that central bank appointments transform the markets by impacting the interest rate and expected inflation. Their results showed that the exchange rate significantly reacts to the statement that there could be a new governor in the central bank. However, they failed to establish a consistently significant response concerning the bond yield of a new governor's announcement because of the limited availability of daily bond yield data.

Moser and Dreher (2010) examined the impact of changing the central bank's governor on foreign exchange and domestic stock markets, as well as sovereign bond spreads. This is in line with a data set employed for 20 emerging countries from 1992 to 2006. They suggested that financial markets respond positively to a new governor at the central bank, delivering crucial new information on future monetary policy. As CBI determines inflation bias, the public's perception of inflation expectation is affected. Consequently, the asset price should change due to their sensitivity to inflation. The results confirmed that changing the central bank's governor harms the financial market. Investors respond negatively because the new governor experiences a systemic credibility problem.

Förch and Sunde (2012) examined the effect of CBI on stock market return. Using monthly observations from 1988 to 2007 in 27 emerging economies, they calculated stock market returns as the percentage month-to-month change in the price stock market index. Their initial analysis examined CBI's influence on stock market returns by applying the non-parametric test of equality before and after CBI changes. Their results showed that CBI adjustments positively correlate with stock market returns over one month after the changes. However, they determined that CBI has no significant effect on stock market returns. Their second analysis employed fixed effect panel data estimation and established CBI's positive and significant effect on stock market returns. This implies that CBI is advantageous concerning market performance.

Papadamou et al. (2017) explored the impact of CBI on stock market volatility. They employed annual data from 1998 to 2005 and sampled 29 developed and developing countries applying panel data estimation. The study confirmed the positive and significant effect of CBI on conditional and historical stock market volatility. This implies that CBI increases stock market volatility and contributes to financial instability. Furthermore, they stated a trade-off between price and financial stability and that the monetary authorities prefer price stability. Garcia and Costa (2019) examined the relationship between CBI and stock market return from 21 developed countries from 1988 to 2007. They used a panel GMM estimation to relax the endogeneity problem and did not find a significant negative effect of CBI on stock price volatility.

de Haan et al. (2018) assessed the CBI index's effect on 10-year domestic bond yield for 78 OECD and non-OECD nations from 1974 to 2007. They stated that the CBI index attracts investors because it is awarded by regular legislation. Using fixed effect estimation for panel data, they determined that CBI has a negative relationship with 10-year bond rates in non-OECD countries but has no significant effect for full sample countries. Also, they stated that non-OECD countries might be expecting lower bond yields from greater CBI.

Eichler and Littke (2018) studied CBI's impact on exchange rate volatility using panel data for 62 economies from 1998 to 2010. They reported that an independent and conservative central bank reduces the public's uncertainty regarding the policy objective and inflation expectation volatility. Consequently, a reduction in the exchange rate volatility enables agents and the public to estimate its long-run equilibrium value and assess its valuation in the short-term. Furthermore, they showed that exchange rate volatility is subject to price flexibility in the goods market, interest rate sensitivity related to the demand for money, and central bank preferences concerning price stability. Strong empirical evidence show that independent central banks reduce exchange rate volatility. Additionally, more independent and conservative central banks produce lower uncertainty concerning inflation expectation, affecting exchange rate volatility.

This study fills the literature gap on the relationship between CBI and asset prices since the previous research used the change in the central bank's governor as a CBI proxy. While other studies examine the relationship between monetary policy and asset prices, this paper emphasized interrelationship CBI, asset prices, investment, and consumption.

ECONOMETRIC METHODOLOGY

This study observes the impact of CBI shock on financial asset prices in developing countries by applying a panel VAR proposed by Suhaibu et al. (2017). All variables are endogenous and interdependent, though a cross-sectional dimension is included in the representation. The panel VAR model is:

$$G_0 y_{it} = \sum_{j=1}^{p} G_j y_{it-j} + \mu_{it} \tag{1}$$

where G_0 is 6 x 6 contemporaneous matrix of coefficients, y_{it} is 6 x 1 vector of endogenous variables, i.e. $y_{it} = [ER_{it}, Stock_{it}, Bond_{it}, CBI_{it}, Cons_{it}, Inv_{it}]$. G_j is 6 x 6 autoregressive coefficient matrices for the j_{th} lag, y_{it-j} is 6 x 1 vector of the lags of the endogenous variables for an individual country I, and μ_{it} is 6 x 1 vector of error disturbance with assumed zero covariance and correlated across cross country. The contemporaneous covariance matrix of the disturbance follows the formulation:

$$E[\varepsilon_t \varepsilon_t'] = D \times I \tag{2}$$

where I is an identity matrix of order 6 x 6,

$$D = \begin{bmatrix} \sigma_1^2 & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma_2^2 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_3^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma_4^2 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_5^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma_6^2 \end{bmatrix} \tag{3}$$

$$\text{and } \varepsilon_{it} = G_0^{-1} \times \mu_{it} \tag{4}$$

Then the reduce form eq (4) is generated by multiplying both sides by G_0^{-1}.

$$y_{it} = \sum_{j=1}^{p} X_j y_{it-j} + \mu_{it} \tag{5}$$

where $X_j = G_0^{-1} \times G_j$ and $\varepsilon_{it} = G_0^{-1} \times \mu_{it}$

A panel VAR has three characteristic features. First, lags of all endogenous variables of all units enter unit i, known by dynamic interdependencies. Second, it is correlated across i, called static interdependencies. The third characteristic is cross-section heterogeneity, where the intercept, the slope, and the variance of the shocks u_{1it} are unit specific.

The panel VAR models in Equations (1) are estimated in pooled least squared (POLS). The POLS estimator is biased in a dynamic panel setting when the coefficients

on the endogenous variables differ across countries. This model represents a behavioral equation with the same parameters over time and across groups. On the other hand, the unrestricted model has the same behavioral but different parameters across time and groups (Baltagi, 2008). The restricted model for each group is:

$$y_{it} = Z_i \delta_i + u_i \text{ where i= 1,2,…,N} \tag{6}$$

Where $y_i' = (y_{i1},...,y_{iT})$, $Z_i = [lT, X_i]$ and X_i is $T \times K$. δ_i' is $1 \times (K+1)$, u_i is $Tx1$. δ_i' is vary for every individual equation.
The restricted model is given by:

$$y = Z \delta + u \tag{7}$$

where $Z' = (Z_1', Z_2', ..., Z_N')$, $u' = (u_1', u_2', ..., u_N')$
The null hypothesis of the probability test is:

$$H_0 : \delta_i = \delta \quad against \, H_1 : \delta_i \neq \delta \tag{8}$$

This paper runs the Chow and Roy-Zellner tests proposed by Baltagi (2008) to investigate the model's heterogeneity coefficients.

The impulse response functions are computed (IRFs) once all the panel VAR coefficients are estimated. Impulse response functions describe an endogenous variable's response over time to a shock in another variable. The Cholesky decomposition is used in computing the IRFs. The Cholesky decomposition assumption is that the earlier VAR order series impact the other variables contemporaneously, while the later series impact those listed earlier only with a lag. Consequently, variables listed earlier in the VAR order are considered more exogenous.

These models contain heterogeneity among country samples. Therefore, one way to solve the heterogeneity problem is to perform the mean-group estimation procedure proposed by Pesaran and Smith (1995). It has been used in previous studies, such as Assenmacher-Wesche and Gerlach (2008), to obtain cross-sectional average responses. In particular, let $\gamma_{kl}^{(i)}$ be a h × 1 vector containing the responses of variable l to an impulse in variable k over periods for country i. The MG responses of variable l to an impulse in variable k over h periods are calculated by averaging the individual country's coefficients.

$$MG_{kl} = \frac{1}{N} \sum_{1}^{N} \gamma_{kl}^{(i)} \tag{9}$$

The same processes are conducted for impulse response function by averaging an individual country's impulse response function in every period.
This study has the following analysis:

1. CBI influences other variables.
2. CBI only influences the exchange rate, but it only influences consumption and investment.
3. CBI only influences the stock price, but it only influences consumption and investment.

4. CBI only influences bond yield, but it only influences consumption and investment.
5. Consumption is influenced by all variables except investment.
6. Investment is influenced by all variables except consumption.

DATA

The panel data employed in this estimation covers 7 developing countries[1] having changes in CBI and data availability. The dataset comprises 6 quarterly variables from 1991 quarter 1 to 2016 quarter 4. They include CBI, exchange rate, stock price, bond yield, household consumption, and investment. The legal aspect of independence regarding CBI was used. The index is between 0 and 1, with greater values indicating a bigger CBI legal index. The data relating to the CBI index is legal variable aggregate weighted from Garriga's (2016) data set.

The role of asset prices is represented by the exchange rate, bond yield, and stock price. This study employed the exchange rate and stock price in terms of logarithm natural. The exchange rate is the bilateral currency of each nation's sample against the U.S. dollar (USD). The bilateral exchange rate is selected since it represents the exchange rate activity in the financial market. Data were acquired from the International Financial Statistics. The stock price is local market indices measured in the local currency, obtained from Bloomberg. Furthermore, the study used the government securities interest rate as a proxy for bond yield, and the data were retrieved from the IFS of the IMF. It employed household consumption and investment as a real economic activity following Claessens and Kose (2017). The natural logarithm data were obtained from the IFS of the IMF.

EMPIRICAL FINDING

FULL SAMPLE COUNTRIES PANEL VAR

This study estimated the model to examine the interrelationship between CBI, exchange rate, bond yield, stock price, and economic activity panel VAR application. It tested the pooling assumption of the models by applying the Chow and Roy-Zellner tests. Moreover, it established that the model contains heterogeneity among the country samples and applied the MG estimation procedure by averaging all the individual VAR coefficients. It analyzed the impulse response function using the MG estimation procedure by averaging the individual country's impulse response function in every period. Figure 1 displays the impulse response function over 20 quarters for a one standard innovation shock implied by the panel VAR regression

using the mean-group estimator. This study focused on a CBI shock to 3 different asset prices. The exchange rate response to one standard innovation shock of CBI is positive, with the highest effect being approximately 0.84% in period 17. This indicates that the CBI shock depreciates the exchange rate, consistent with Kabundi and Mlachila (2019). It confirms the exchange rate puzzle, where the effect of monetary policy results in exchange rate depreciation. According to Drakos et al. (2018), there is an exchange rate puzzle in countries with strongly restricted capital mobility, meaning that monetary policy change may not influence the exchange rate. Furthermore, the stock price response to one standard innovation shock to CBI is negative after the shock. This suggests that the greater CBI shock reduces the stock price in the short-run. Following the CBI shock, it requires 13 quarters for the stock price to increase, reaching a peak of 1.8% in period 20. This adverse reaction of the stock price to increasing CBI is known as the "paradox of monetary credibility" (Best 2018). These authors stated that this negative relationship is attributable to the high asymmetric information, which affects the stock market's ability to transfer information and lowers the monetary policy transmission mechanism's efficiency. Li et al. (2010), and Hashim et al. (2017) stated that international financial factors have a greater impact than domestic monetary policy on developing countries' stock prices. A unit positive innovation to CBI on bond yield is significant with a negative coefficient. In reaction to one positive innovation to CBI, bond yield decreases by 16% in period 4, while from quarter 4 onwards, the negative response reduces gradually. This suggests that investors reward a credible independent central bank because a higher CBI reflects good governance, which reduces the investment risk. Lower government bond yields are recognized by investors to improve public finances. de Haan et al. (2018) suggested that investors are willing to be involved in democratizing countries and that legal CBI slashes borrowing costs for such nations.

A one-standard innovation shock to the exchange rate produces lower consumption, to a minimum of 1.8% approximately in quarter 2, while the effect is positive after period 9. This implies that the depreciation in the domestic currency decreases consumption. It confirms the Backus-Smith puzzle of a negative relationship between exchange rate and consumption (Lambrias 2020). According to Jiang (2017), the consumption-real exchange rate anomaly is triggered by international financial markets' underdevelopment. In line with this, Majid and Rahmanda (2018), Iyke and Ho (2020) determined a negative relationship between exchange rate and consumption. In response to one positive innovation of the stock price, consumption increases to its peak at period 10 to 3.24%. These results are supported by Adam et al. (2017) and Di Maggio et al. (2020), which stated that consumer spending increases

due to a rise in stock market return. This finding is in line with the life-cycle effect, in which consumer expenditure improves in response to greater wealth. Hence, an increase in stock price increases investors' wealth, encouraging further consumption. The influence of a one-unit innovation to bond yield increases consumption by 1.2% in period 2. Subsequently, from the fourth quarter onwards, the response of consumption to the bond yield shock is negative, meaning that it generates higher consumption in the short-run. This finding is in line with the theoretical relationship between

the real interest rate and consumption (Di Maggio et al. 2017) since higher bond yield increases disposable income, generating higher consumption. However, the negative relationship between consumption and bond yield, shown after quarter 4, is caused by high inflation in the sample countries. This higher inflation rate lowers private assets, interpreted as negative income by consumers, and reduces consumption (Li et al. 2017; Mawardi et al. 2019). Finally, the response of consumption to one standard innovation shock concerning CBI is negative, attaining its lowest level
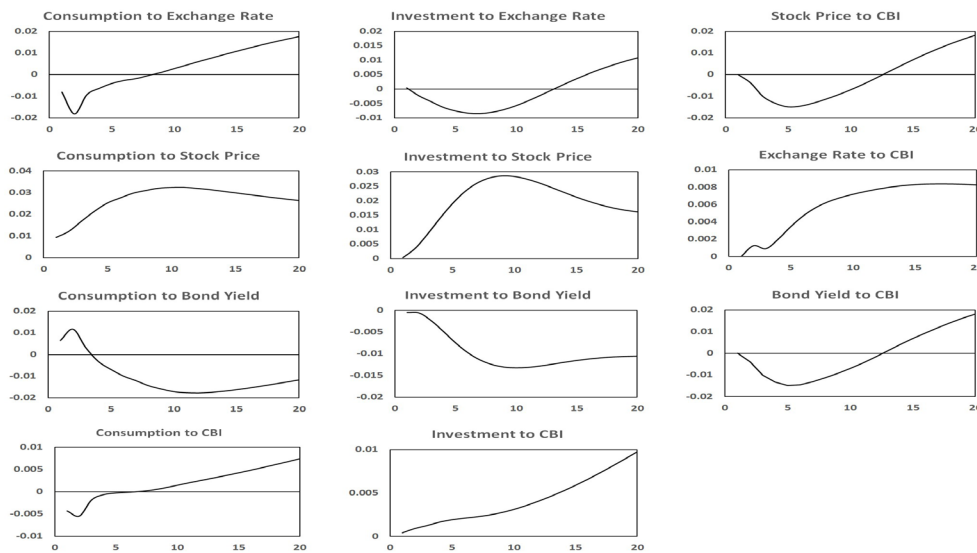

FIGURE 1. Impulse response function mean group full sample countries
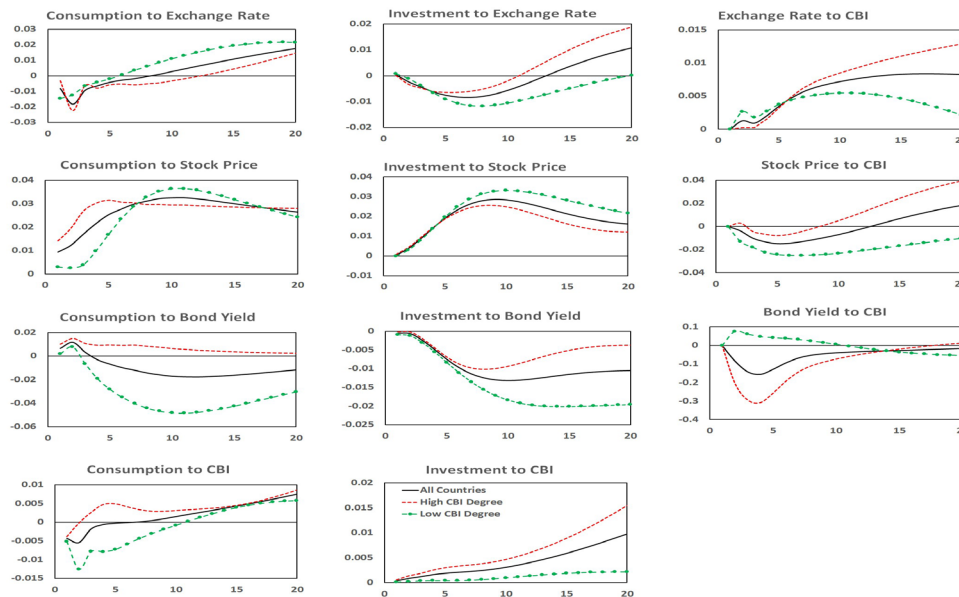*Note:* This estimation only averages the coefficient but not for confidence interval.

FIGURE 2. Impulse responses function split according to CBI degree
Note: This estimation only averages the coefficient but not for confidence interval.

at 0.55%. In quarter two, its response becomes positive after quarter 7. CBI's negative effect on consumption is caused by the optimistic expectation of improved future economic performance due to higher CBI. Consequently, a greater CBI encourages the public to purchase more assets, including foreign currency and stocks and bonds, reducing consumption. However, after several periods, a higher CBI increases asset prices, public disposable income, and consumption.

The impulse response of investment to a one-unit shock to the exchange rate is negative between periods 2 and 13, implying that depreciation reduces investment. Depreciation increases the price for imported capital, while input reduces profits and investment. Binding and Dibiasi (2017) and Avdjiev et al. (2019) showed that currency depreciations lower domestic investment. A one-standard innovation shock to stock price positively affects investment, with the effect reaching its peak in quarter 9, at 2.86%. From period 10 onwards, the effect of the stock price on investment is slightly lower. This result corresponds with Tobin's q theory, which suggested that a company's current fixed capital stock's market value is determined by asset price. Desfiandi et al. (2017), and Ming and Jais (2020) asserted that a 1% change in equity price creates a 1% increase in long-run investment. Concerning a positive change of one-standard innovation in bond yield, the investment decreases and reaches its lowest point in period 10, at approximately 1.32%. This denotes that an increase (decrease) in bond yield reduces (higher) investment. The investor perceives greater bond yield as a sign of a lower global sovereign and higher investment risk. A shock of one-standard innovation to CBI positively affects investment, reaching a peak of roughly 1% at period 20. A greater CBI provides more transparency and credibility to the central bank, attracting investment. Furthermore, increasing CBI is a signal for implementing structural economic reforms, promoting investment (Lavezzolo 2006; Hartwell 2019).

SUB-SAMPLE ANALYSIS

The countries' sample was divided into two groups (3 to 4 countries for each group) based on CBI, inflation rate, exchange rate arrangement, capital control, financial capitalization and sovereign risk. Surprisingly, none of the subsample groups is poolable after applying the Chow and Roy-Zellner tests. The mean group estimation was used for the panel VAR for both groups and the mean group for all the countries' samples.

GROUP SPLIT CONCERNING CBI DEGREE

The first criterion is the significance of CBI's degree, as this study distinguished between a high and low CBI index. The more independent the central bank, the better

the implementation of monetary policy. This means no government interference, and the monetary policy is predictable by the public. Consequently, when market participants are informed about the present and future monetary policy action, it affects asset prices. The first group with a high CBI index included Egypt, Kenya, Malaysia, and the Philippines, while the second group covers Pakistan, South Africa, and Thailand. The panel VAR regression and a poolability test were applied for the two subsamples. The Chow and Roy- Zellner tests show that the null hypothesis should be rejected. This signifies that the panels are not poolable, and there is heterogeneity in the coefficient of parameters among the country sample in both groups. Hence, a mean-group estimator was conducted for the panel VAR for each group.

The impulse response function was estimated to a unit innovation of CBI, exchange rate, bond yield, and stock price, whose results are illustrated in Figure 2. Hence, the right side of Figure 2 reveals the mean impulse responses of 3 asset prices to a CBI shock for a low and a high CBI compared to the average for all countries. For a high CBI, the positive response of the exchange rate to CBI shock begins in quarter 4. On the other hand, for group two, a shock of CBI's one-standard innovation depreciates the exchange rate, though the effect is smaller than for group one after period 6. This study established a difference between both groups for stock price response to a CBI shock after the eighth period. While the high CBI degree group illustrates its positive effect on stock price, the low CBI group exhibits the opposite response. A higher CBI reduces bond yield in group one, while a shock creates a higher bond yield until period 12. These results contradict Mishra and Reshef (2019), which showed that the financial markets in countries with high and low CBI do not experience different shocks responses. The response of investment to a shock to asset prices and CBI has the same trend for both groups and all countries. However, it is stronger in group two, except for the bond yield shock. A change in asset prices significantly affects consumption for group one than for group two. Furthermore, consumption reacts differently to a shock to CBI for periods 4 to 12, positively for group one but negatively for group two. Overall, the high CBI group reacts strongly and rapidly than the low CBI group.

GROUP SPLIT CONCERNING AVERAGE INFLATION

This study presented the second approach by separating the countries depending on inflation. There are two critical factors regarding the relationship between asset prices and expected inflation. First, an aggregate demand change is directly due to a change in asset price. Secondly, asset prices depend on future expected returns, such as economic activity, inflation, and monetary policy. This means that they contain information

related to future inflation. Therefore, when the public's perception of inflation changes, asset prices should change due to inflation sensitivity. Group one comprises low average inflation countries, including Malaysia, the Philippines, South Africa, and Thailand, while the other comprises Egypt, Kenya, and Pakistan, which are high average inflation countries. The Chow and Roy Zellner tests were conducted after estimating the model using a panel VAR. The results indicate that both groups are not poolable, necessitating the application of a mean group estimation.

The impulse response function indicates that the response of asset prices to a CBI shock is stronger in the high inflation group. A one-standard innovation shock to CBI depreciates the domestic currency by about 2% after period 12. CBI reduces the stock price for the first 13 periods and increases it from period 14 onwards. The response of bond yield to a CBI shock is negative and reaches the lowest level of 0.35. Conversely, in low-average inflation countries, CBI insignificantly influences the exchange rate, bond yield, and stock price. This is because the response of the 3 asset prices is near to the initial value. Investment reacts more to the shock to the 3 different asset prices in nations with low average inflation. Moreover, appreciation of the domestic currency generates higher investment for countries with low average inflation. On the other hand, in high inflation countries, depreciation contributes to higher investment. This study did not determine a significantly different effect of the stock price on investment for both groups. However, a 1% decrease (increase) in bond yield boosts (reduces) investment by roughly 2% and 0.5% for low and high inflation groups. The investment response to a CBI shock is similar for both groups until period 12, though at period 13 onwards, it increases in the high inflation group, while it is stable for the low inflation group. The consumption response to a change in the exchange rate and stock price is weaker for the low inflation group, though the trend is similar for both groups. The response of consumption to a bond yield shock varies for both groups, positive for the high inflation group and negative for the low inflation group. This implies that a decrease of 1% in bond yield increases consumption by approximately 4% in the low inflation group and a decrease in consumption by 2% in the high inflation group in period 12. A unit standard innovation shock to CBI generates 1% higher consumption in period 4 for the high average inflation group. It requires 15 periods for CBI to increase consumption for the low average inflation countries.

GROUP SPLIT CONCERNING EXCHANGE RATE ARRANGEMENT

The third feature is the significance of the exchange rate arrangement. Low flexibility in the exchange rate increases inflation, interest rate, money supply, and output (Charef & Ayachi 2018). The sample countries were divided into low and high flexibility exchange rate countries. The low flexibility exchange rate countries, which include Egypt, Malaysia and Pakistan, in addition to high flexibility exchange rate countries, which include Kenya, the Philippines, South Africa and Thailand. The Chow and Roy Zellner tests after estimation of the panel VAR estimation shows that the two groups are not poolable. As a result, a mean group estimation was applied for the panel VAR.

The economic exchange rate regime substantially affects asset market prices due to the risk premium's sensitivity on the interest rate. According to Sun and Zhao (2020), countries with high exchange rate flexibility have a higher risk premium on their interest rate, increasing uncertainty in the asset market. Dellas and Tavlas (2013) ascertained a different response regarding asset prices to monetary policy shocks inflexible and peg exchange rate countries. Moreover, the study showed that monetary expansion positively affects asset prices, significantly impacting a flexible exchange rate. Figure 4 shows the impulse response functions for two different groups. CBI's positive effect on asset prices for the high exchange rate flexibility group aligns with this study's expectations. For instance, a CBI shock generates appreciation in the exchange rate up to 14 quarters. Also, the shock to CBI reduces the bond yield by roughly 0.3% in period 4. The changes in bond yield affect consumption and investment, while CBI causes a depreciation in the exchange rate of approximately 2% in period 12. It also reduces the stock price until period 13 but increases it from period 14 onwards. CBI reduces bond yield only for 4 periods after the shock and increases after period 5. Additionally, appreciation of the exchange rate increases investment for all periods, but the increase in consumption in the high flexibility exchange rate group only continues until period 4. Conversely, depreciation increases investment and consumption after period 8 for the low flexibility exchange rate group. A shock positive innovation to stock price increases consumption and investment, with a higher effect in the low flexibility group. An increase (decrease) in bond yield generates lower (higher) investment and consumption in high flexibility exchange rate countries, while the other group's reverse responses are revealed. CBI increases investment and consumption in the low flexibility exchange rate group. However, for the high flexibility group, CBI negatively affects consumption up to period 13 and slightly impacts investment.

GROUP SPLIT CONCERNING CAPITAL CONTROL

International capital mobility reduces capital cost, increases foreign investment, and boosts economic growth. Moreover, low capital restriction reduces market uncertainty and increases international capital
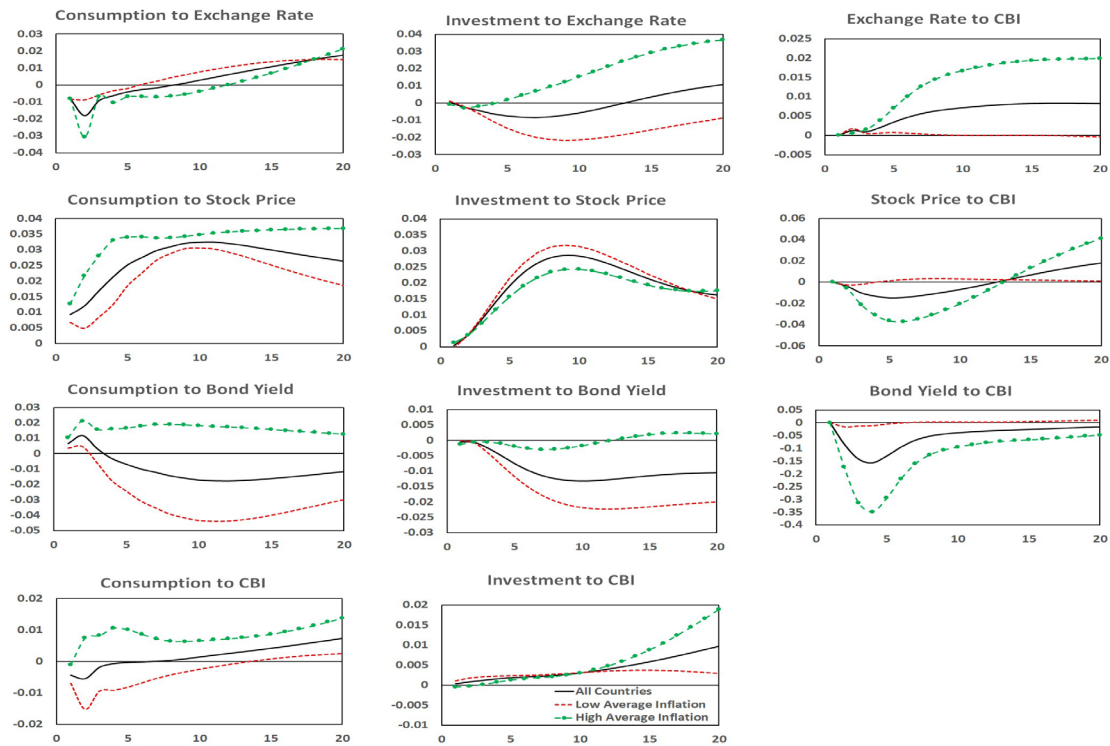
FIGURE 3. Impulse responses function split with respect to average inflation
Note: This estimation only averages the coefficient but not for confidence interval.
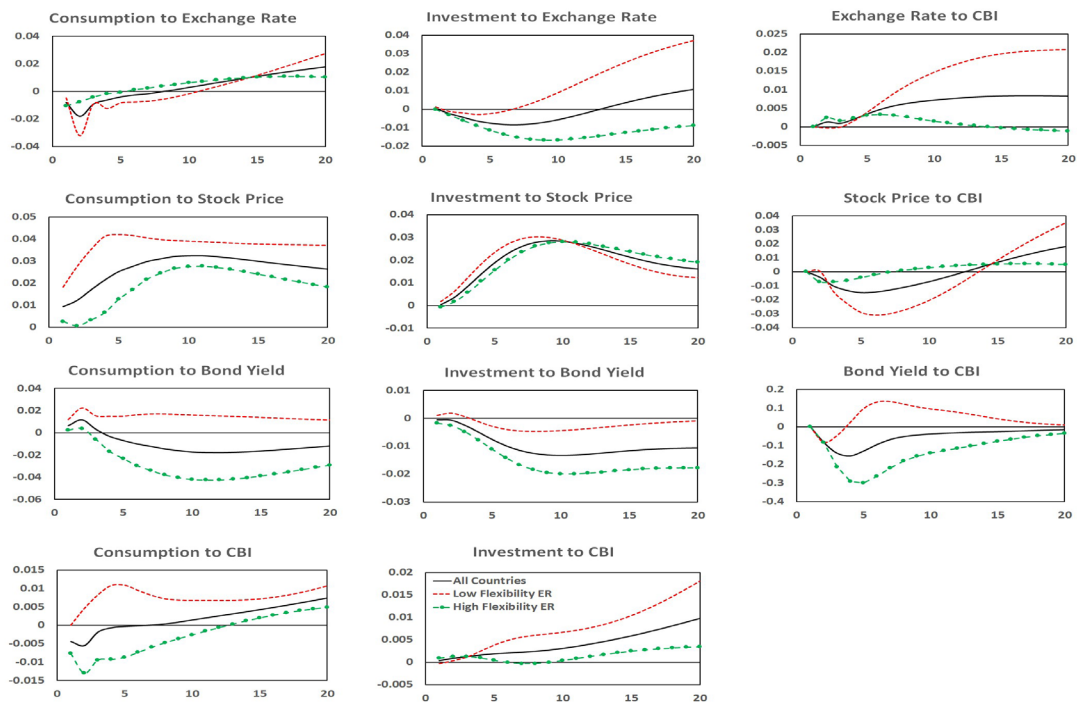

FIGURE 4. Impulse responses function split with respect to exchange rate arrangement
Note: This estimation only averages the coefficient but not for confidence interval.

inflow. Therefore, less restriction allows countries to generate higher asset prices. The study sample countries were divided into low and high capital restriction countries. The low capital restriction countries, for example Egypt, Kenya and South Africa and high capital restriction countries, in particular Malaysia, Pakistan, the Philippines and Thailand.The Chow and Roy Zellner tests were conducted after estimating the panel VAR model. The results show that both groups are not poolable, necessitating applying a mean group estimation for the panel VAR.

Figure 5 reveals the impulse response functions for two different groups distinguished by capital control. First, the impact of CBI on asset prices was examined. A positive innovation about CBI causes exchange rate depreciation, though the response is higher for low capital restriction countries. CBI generates a higher stock price from period 8 after the low capital control group's shock and a negative response in the high capital control group. A shock of one-unit of CBI's standard innovation reduces bond yield, reaching 0.6, at period 4 for the low capital restriction group. CBI has a small positive effect on bond yield for the high capital control group. The exchange rate's appreciation increases investment for all periods, although higher consumption exists up to period 8 for the high capital restriction group. However, for the low capital restriction group, depreciation increases investment from the 4th quarter after the shock and increases consumption after period 13. There is no significantly different effect of the stock price on investment for both groups. The positive response of consumption to the stock price is higher in the low capital restriction group. A decrease (increase) in bond yield leads to higher (lower) investment and consumption for the high capital restriction group. The opposite results are revealed for the low capital restriction countries. A higher CBI increases consumption and investment in the low capital restriction countries. Furthermore, CBI's effect on asset prices is larger in the low capital restriction group due to expansive monetary policy. The low capital restriction influences exchange rate movement and asset price fluctuation. Similarly, the effect of CBI on consumption and investment is greater for the low capital restriction countries. Conversely, a positive shock to asset prices significantly affects investment and consumption in the high capital restriction group. This is caused by high capital restriction, where countries prevent volatility in the financial asset market.

GROUP SPLIT CONCERNING FINANCIAL CAPITALIZATION

The monetary policy transmission mechanism on asset prices may not work well in low financial capitalization countries. For instance, a rise in the interest rate may not induce capital inflow in the bond market and have a small effect on the domestic currency in low capitalization countries. The low financial capitalisation countries covering Egypt, Kenya, Pakistan and the Philippines and high financial capitalisation countries, comprising Malaysia, South Africa and Thailand. The sample countries were divided into low and high financial capitalization countries. The Chow and Roy Zellner tests were conducted after a panel VAR estimation. The results indicate that both groups are not poolable, necessitating applying a mean group estimation for the panel VAR.

For the high financial capitalization countries, a one-standard innovation shock to CBI increases the exchange rate by 0.5% in period 4 and the stock price by 1.5% 8 periods after the shock. CBI increases bond yield by 5% in period 3 before the shock is shut down in period 4. Moreover, there is a 2%, 3.5%, 2.5%, and 1% increase in investment due to a 1% appreciation in the exchange rate, a 1% increase in stock price, a 1% reduction in bond yield, and a 1% higher CBI. The same responses are revealed for consumption to asset price changes. A shock of one-standard innovation to the exchange rate improves consumption by roughly 1.5%. Additionally, consumption increases by 4% and 5% in response to a rise of 1% in the stock price, which reduces bond yield by 1%. The response of investment to a CBI shock is positive, though consumption reacts negatively.

A 1% increase in CBI leads in low financial capitalization countries reduces the exchange rate by 1.5% in period 8. The stock price decreased by 3% in 5 periods after the CBI shock, and bond yield reduces by 25% in the 4th quarter after the CBI shock. There is a slight increase in investment due to the appreciation of period two's exchange rate, while consumption doubles for every increase in the exchange rate. A shock of one-standard innovation to stock price increases consumption and investment by nearly 3%. One-standard innovation to bond yield generates 0.5% less investment but 1% higher consumption. The response of investment to a CBI shock is positive from period 12 onwards following the shock, while the positive response of consumption to a CBI shock becomes faster from period 4.

GROUP SPLIT CONCERNING SOVEREIGN RISK

According to Claessens and Kose (2017), asset prices are determined by a nation's economic fundamentals and investor risk aversion. The sovereign risk is influenced by fundamental macro factors and affects asset prices. High sovereign risk implies a high probability of defaults for investment. Therefore, a country with high sovereign risk offers a high-interest rate to attract foreign investors. The sample countries were divided into high sovereign risk countries, including Egypt, Kenya, Pakistan, and South Africa. The other group consists of the Philippines, Malaysia and Thailand, considered to have a low sovereign risk. The Chow and
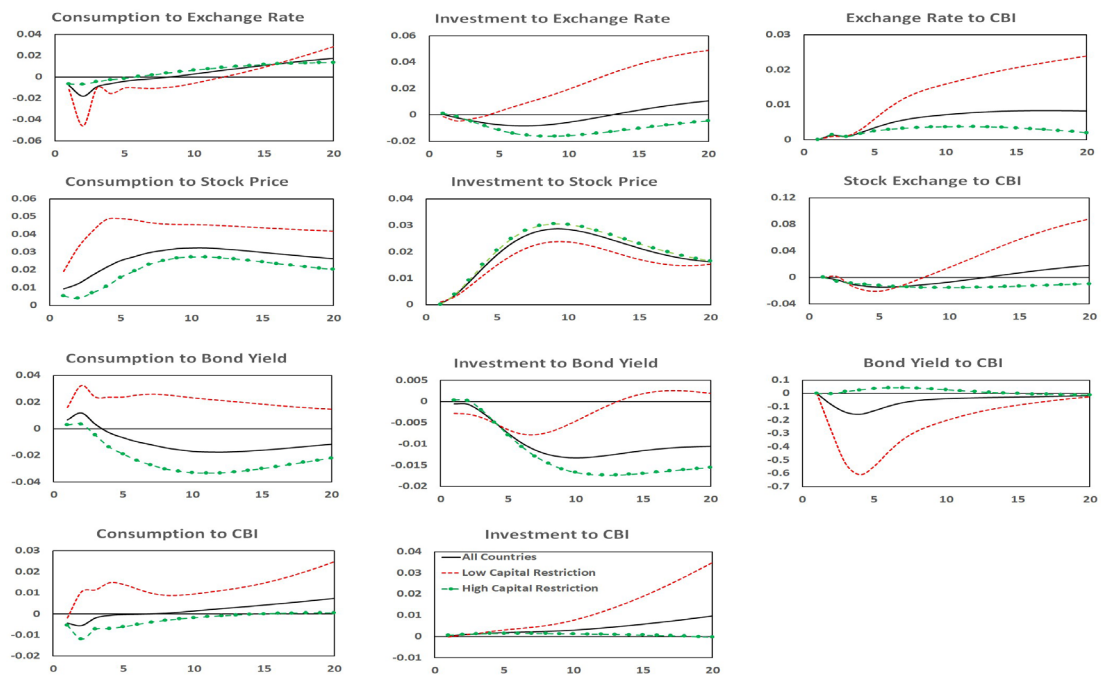
FIGURE 5. Impulse responses function split with respect to capital control
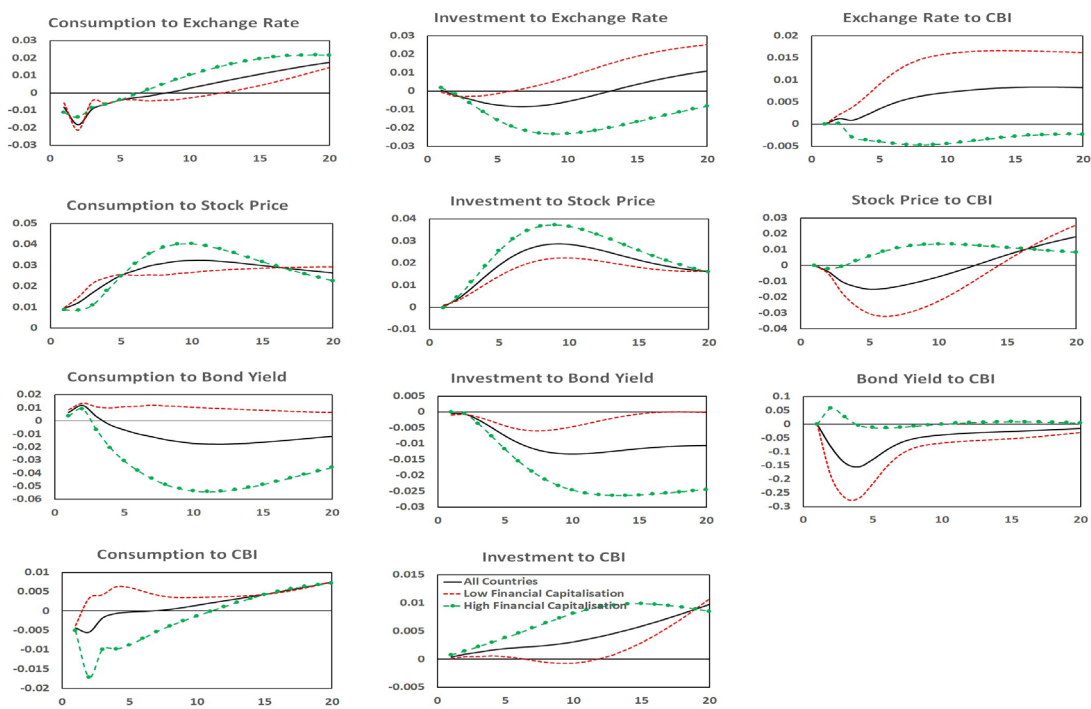*Note:* This estimation only averages the coefficient but not for confidence interval.

FIGURE 6. Impulse responses function split with respect to financial capitalisation
Note: This estimation only averages the coefficient but not for confidence interval.
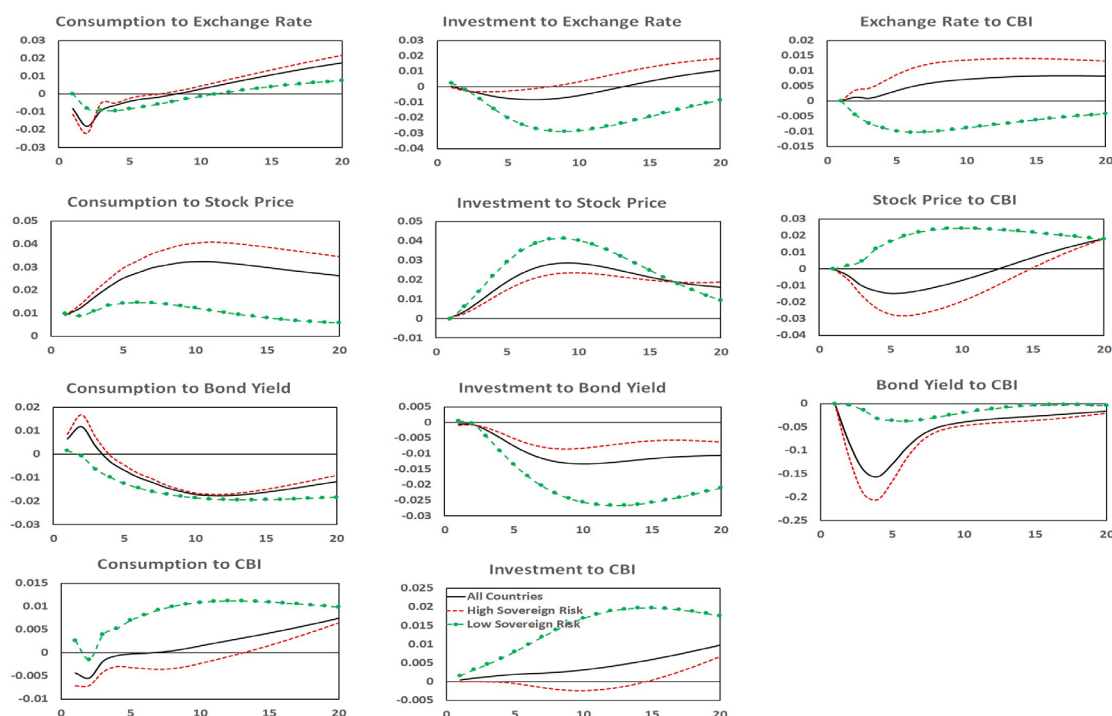
FIGURE 7. Impulse responses function split with respect to sovereign risk
Note: This estimation only averages the coefficient but not for confidence interval.

Roy Zellner tests were conducted after estimating the panel VAR model. The results show that both groups are not poolable, necessitating applying a mean group estimation for the panel VAR.

Figure 7 shows the impulse response functions for two different groups distinguished by sovereign risk. The positive responses of asset prices to a CBI shock are essentially higher in the low sovereign risk group. A shock of one-standard innovation to CBI gradually increases the exchange rate by 1% by period 6. A 1% increase in CBI produces a 2% rise in stock price from period 6 onwards, while a 1% increase reduces bond yield by 5.1%. In contrast, in high sovereign countries, a one-standard innovation shock to CBI significantly reduces bond yield by 20% in period 4. However, a 1% higher CBI increases the exchange rate by 1.5% and lowers the stock price by 3%. These results show that low sovereign risk provides reasonable expectations regarding the future economic activity. Additionally, as asset prices depend on future expectations, they react to positive CBI changes, increasing consumption and investment. The exchange rate appreciation boosts investment by 3% and 0.5% for low and high sovereign risk countries, respectively. However, there is a reasonably similar response regarding consumption concerning an appreciation in the exchange rate. The investment reaction is larger about a CBI shock, though the consumption responses are lower in the low than the high sovereign risk group. A decrease (increase) in bond yield increases (reduction) in consumption and

investment with a higher impact on low sovereign risk countries. There are positive and negative responses of consumption and investment to a CBI shock in low and high sovereign countries.

CONCLUSION

This paper provides empirical analysis of CBI and economic activity through three asset prices, including exchange rate, bond yield, and stock price. It begins with the methodological design of empirical analysis. Initially, we applies the panel VAR because it is the most appropriate method that treats all variables as endogenous. There is heterogeneity among cross-sections, verifying the pooling assumption of the panel. Furthermore, there is heterogeneity of the sample, necessitating the application of mean-group estimation for panel VAR. The sample was separated into two subsample groups.

The association between CBI and three asset prices illustrates the optimal monetary policies. The results support the positive impact of CBI on financial stability. The CBI shock on exchange rate appreciation is delayed and requires a year to appreciate the exchange rate, with a maximum of 0.5% at quarter 20. The stock price increases by approximately 0.25% in quarter two after the CBI shock, though the effect is negative after period 3. CBI significantly reduces bond yield by 30% per annum after the shock. The effect of CBI on economic activity

is compared through wealth, exchange, and interest rates. A greater CBI reduces private consumption by 0.4% to 0.5% for all 3 channels. CBI requires 3 quarters to increase investment through the exchange rate and wealth channels, but CBI directly increases investment through the interest rate.

The policy implication of this study is the importance of financial capitalization in developing countries. The effects of CBI on three financial asset prices in developing countries differ based on financial capitalization. For countries with high financial capitalization, an increase in the degree of CBI's has increased the exchange rate, stock index and reduces bond yield. This study recommends that governments in developing countries increase financial capitalization by introducing public companies to the stock exchange. To encourage companies to introduce their capital into the stock exchange, policymakers in developing countries should remove difficulties in the stock exchange, such as tax and regulatory and legal barriers.

NOTE

[1]   Egypt, Kenya, Malaysia, Pakistan, the Philippines, South Africa and Thailand.

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APPENDIX

TABLE 1. Panel VAR regression full sample countries

	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
Exchange Rate (-1)	1.2877***	-0.1391	3.9053***	0.0080	0.0134	-0.0767***
	(0.0418)	(0.1365)	(1.0693)	(0.0145)	(0.1274)	(0.0146)
Exchange Rate (-2)	-0.2969***	0.138696	-3.8526***	-0.0079	0.0160	0.0785***
	(0.0418)	(0.1365)	(1.0694)	(0.0145)	(0.1275)	(0.0146)
Stock Index (-1)	-0.0498***	1.0397***	-0.3627	0.0021	0.0288	0.0236***
	(0.0124)	(0.0406)	(0.3183)	(0.0043)	(0.0379)	(0.0043)
Stock Index (-2)	0.0484***	-0.0403	0.4752	-0.0026	-0.0105	-0.0223***
	(0.0126)	(0.0413)	(0.3240)	(0.0044)	(0.0386)	(0.0044)
Bond Yield (-1)	-0.0014	-0.0047	1.1628***	-0.0002	0.0026	0.0009*
	(0.0014)	(0.0048)	(0.0376)	(0.0005)	(0.0044)	(0.0005)
Bond Yield (-2)	0.0024*	0.0029	-0.2504***	0.0003	-0.0032	-0.0012**
	(0.0014)	(0.0046)	(0.0364)	(0.0004)	(0.0043)	(0.0005)
CBI (-1)	0.0335	0.0624	-1.4165	0.9795***	-0.1461	0.0175
	(0.1155)	(0.3768)	(2.9500)	(0.0400)	(0.3517)	(0.0405)
CBI (-2)	-0.0250	-0.0745	0.9879	0.0120	0.1313	-0.0194
	(0.1153)	(0.3760)	(2.9443)	(0.0399)	(0.3510)	(0.0404)
Consumption (-1)	0.0202	-0.0464	0.3183	0.0030	0.8671***	0.0010
	(0.0130)	(0.0426)	(0.3335)	(0.0045)	(0.0397)	(0.0045)
Consumption (-2)	-0.0147	0.0557	-0.3254	-0.0038	0.1067***	-0.0004
	(0.0130)	(0.0425)	(0.3329)	(0.0045)	(0.0397)	(0.0045)
Investment (-1)	0.1284*	-0.0453	1.9883	0.0137	0.1484	1.7718***
	(0.0671)	(0.2189)	(1.7144)	(0.0232)	(0.2044)	(0.0235)
Investment (-2)	-0.1269*	0.0325	-2.0920	-0.0131	-0.1496	-0.7749***
	(0.0666)	(0.2172)	(1.7011)	(0.0230)	(0.2028)	(0.0233)
C	-0.0624*	0.0908	1.1336	0.0101	0.1657	0.0258**
	(0.0345)	(0.1125)	(0.8810)	(0.0119)	(0.1050)	(0.0121)

Note: *, **, and *** denote statistical significance at the 10%, 5% and 1% respectively. Standard errors are in parentheses. Critical values: 1% : 2.576; 5% : 1.960; 10% : 1.645.

TABLE 2. Poolability test full sample countries

	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
Chow Test						
F-Statistic	2.17***	1.81***	3.23***	1.11	1.83***	2.57***
Probability	(0.0000)	(0.0001)	(0.0000)	(0.2617)	(0.0001)	(0.0000
df	[72, 554]	[72, 554]	[72, 554]	[72, 554]	[72, 554]	[72, 554]
Roy-Zellner Test						
F-Statistic	156.14***	130.52***	232.23***	79.87	131.61***	184.99***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.2456)	(0.0000)	(0.0000)
df	[72]	[72]	[72]	[72]	[72]	[72]

Note: *** denotes statistical significance at 1 per cent.

TABLE 3. Mean group panel VAR regression full sample countries

	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
Exchange Rate (-1)	1.0146	-0.3450	3.5101	0.0249	-0.3031	-0.0567
Exchange Rate (-2)	-0.1536	0.3485	-3.8963	-0.0359	0.4154	0.0621
Stock Index (-1)	-0.0735	0.8885	-0.5198	0.0014	0.0549	0.0247
Stock Index (-2)	0.0459	-0.0488	0.6072	-0.0017	-0.0272	-0.0016
Bond Yield (-1)	-0.0028	-0.0171	0.9696	-0.0008	0.0078	0.0002
Bond Yield (-2)	-0.0002	0.0093	-0.1827	-0.0005	-0.0153	-0.0022
CBI (-1)	1.9268	1.4677	-86.0298	0.7844	6.5303	0.6373
CBI (-2)	0.7465	-9.4809	61.8278	-0.0343	6.0283	-0.1742
Consumption (-1)	-0.0497	0.4460	3.4772	0.0211	0.9037	0.0875
Consumption (-2)	0.0667	-0.4343	-4.6651	-0.0202	-0.0111	-0.0535
Investment (-1)	0.2609	-0.0019	1.8736	-0.0369	0.4220	1.5494
Investment (-2)	-0.2289	0.0125	-1.2995	0.0406	-0.3824	-0.6183
C	-1.2435	4.9466	23.7728	0.0897	-5.6728	0.0116

Note: The mean group estimation is the unweighted mean of coefficients of explanatory variables the individual country estimates. This estimation only averages the coefficient but not for standard error and t-statistic.