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EFFECTS OF CENTRAL BANK INDEPENDENCE IN DEVELOPING COUNTRIES

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Abstract

This thesis is composed of three empirical studies on the effect of central bank independence in developing countries. The first empirical study in Chapter 2 investigates the relationship between CBI and inflation in developing countries. After estimating a panel regression model, using pooled least square on the assumption of coefficient homogeneity; the result reveals that there is no significant negative relationship between CBI and inflation. The poolability of the panel is checked by applying the Chow test and Roy-Zellner test. The results show that the model is not poolable. Furthermore, by performing a panel heterogeneity model with pooled mean group (PMG) estimator and show that there exists a reverse relationship between CBI and inflation.

Chapter 3 presents the responses to financial asset prices, consumption and investment in relation to CBI shocks in developing countries. The financial asset prices are divided into three categories: exchange rate, stock index and bond yield. The analysis is based on a panel Vector Autoregressive (Panel VAR) estimation. By applying poolability tests, heterogeneity across the countries in our sample is identified. One possible solution to this problem is to apply a mean-group estimation to the panel VAR. Additionally, the sample countries are divided to make the sub-group poolable.

Chapter 4 examines whether CBI and macroprudential policy can contribute to enhancing financial stability in terms of credit per GDP. This chapter proposes a new index concerning macroprudential policy for 20 developing economies over the period 2000 to 2017. This chapter shows that the effect of CBI and macro-prudential policy on credit per GDP depends on the non-linearity of the CBI degree. The more independent the central bank, the more stable its financial system, with a stronger effect when CBI is below its trend. When the sample is separated into two groups based on the poolability test, the result reveals that countries with a higher average CBI index maintain better financial stability.

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Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Leicester or any other institution.

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List of Abbreviations

AIC	Akaike Information Criterion
ARDL	Autoregressive Distributive Lag
BRIC	Brazil, Russia, India and China
CBI	Central Bank Independence
CBIG	Central Bank Independence and Governance
CPI	Consumer Price Index
CWN	Cukierman, Webb and Neyapti
DFM	Dynamic Factor Model
ECB	European Central Bank
ECT	Error Correction Term
EEC	European Economic Community
EMS	European Monetary System
EMU	European Monetary Union
ESS	Error Sum of Square
FDI	Foreign Direct Investment
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GMM	Generalized Method of Movement
GMPI	Global Macroprudential Policy Instrument
GMT	Grilli, Masciandaro and Tabellini
HLM	Hierarchical Linear Modelling

IFS	International Financial Statistic
IMF	International Monetary Fund
IPS	Im, Pesaran and Shin
IRF	Impulse Response Function
LM	Lagrange Multiplier
LAC	Latin America and the Caribbean
LVAW	Legal Variable Aggregate Weighted
LLC	Levin, Lin and Chu
LR	Likelihood Ratio
MG	Mean Group
ML	Maximum Likelihood
MSCI	Morgan Stanley Capital International
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
PMG	Pool Mean Group
POLS	Panel Ordinary Least Square
PSTR	Panel Smooth Transition Regression
PVAR	Panel Vector Auto Regressive
RCM	Random Coefficient Model
RRSS	Restricted Residual Sum of the Square
TOR	Turn Over Rate
URSS	Unrestricted Residual Sum of the Square
VAR	Vector Auto Regressive
2SLS	2 Stage Least Square

Chapter 1

Introduction

1.1 Background and Motivation

There is a growing consensus among policymakers and economic researchers that monetary policy instruments are the most effective tools for controlling inflation because of their influence on aggregate demand to achieve price stability. According to Phillips (1958), there is a short-run trade-off between inflation and unemployment; thus, stabilising inflation has a direct effect on unemployment. However, central banks are constrained from having an effective monetary policy due to the dynamic time-inconsistency problem. The latter arise due to pressure from the government or politicians on the central bank to stimulate economic activity, which may have negative consequences for price stability.

Kydland and Prescott (1977) stressed the importance of the relationship between rational expectation and time inconsistency in monetary policy. They stated that monetary policymakers face a trade-off between inflation and unemployment while choosing the optimal monetary policy action in each period, and public behaviour under rational expectation is represented by Phillips curve. Since policymakers might lack credibility if they fail to convince the public that the inflation target will be achieved in the next period having missed their forecast in the past. Then if the actual inflation outturn is higher than expected it leads to lower real wage, which increases labour demand and thus, reduces unemployment. However, if the central bank is more concerned about inflation stabilization, then it will end up with lower inflation but at the cost of higher unemployment.

The time-inconsistency problem arises as a consequence of monetary policy that is no longer optimal in response to the original plan (Kydland and Prescott, 1977; Barro and Gordon, 1983; Rogoff, 1985). The time-inconsistency problem generates inflation bias, which occurs when a government interferes with a central bank's operation. In this situation, if the central bank knows a public inflation expectation, it tends to create inflation surprise, increasing seigniorage and raises employment levels. Consequently, the central bank may lose credibility is which render its role in managing inflation challenging. Therefore, delegating monetary policy to an independent central bank is anticipated to promote the economic agent's trust in future macroeconomic stability. An independent central bank is believed to be better positioned to eliminate the time-inconsistency problem of monetary policy (Rogoff, 1985; Bernanke, 2010).

Central bank independence (hereafter, CBI) signifies that the central bank is free from political interference to pursue a monetary policy goal focused on inflation control (Berger et al., 2001). CBI can be classified into three aspects; personnel, financial and policy independence. Personnel independence refers to the fact that the government has restricted its influence over the central bank's boards. Neumann (1991) argues that the public might view the government's influence as encouraging the central bank to pursue the kinds of policies that are in the government's interests. Financial independence is related to the bank's ability to determine its budget so that it cannot be forced into printing money to finance budget deficits (Sargent and Wallace, 1981; Eijffinger et al., 1998). Finally, policy independence reflects the central bank's freedom to set and implement its monetary policy without any political interference.

An independent central bank that has a mandate to control the monetary policy has two keys dimensions of independence: goal independence and instrument independence (Fischer, 1995). Goal independence implies that the central bank has the ability to set the goal of monetary policy without the direct impact of the fiscal authority. Goal independence evaluates the role of central banks in determining the main goal of their monetary policy. Instrument independence means that the central bank has the freedom to adjust its monetary policy tools in achieving monetary policy goals without any interference from the government (Walsh, 2010). An independent central bank may have only goal independence, only instrument independence, or has both. For example, Banco central do Brazil has only instrument independence. Banco central de Chile only has goal independence. While, central bank of Indonesia has both goal independence and instrument independence.

According to Cukierman (1998), the reasons why countries strive to increase their level of CBI is to achieve low and stable inflation. First, the failure of international institutions designed to maintain low and stable inflation for example, the Bretton Wood System and European Monetary System (EMS), has led some countries to find an alternative institution. Second, the experience of the highly autonomy Bundesbank has revealed that an independent central bank can be an effective institution to deliver low and stable inflation. Third, based on the Maastricht Treaty, which created by the European Economic Community (EEC), countries that are members of this community have to increase the autonomy of the central bank as a prerequisite for membership of the European Monetary Union (EMU), with low and stable inflation being the main objective of this community. Fourth, in some Latin American countries, having successfully stabilised inflation, the policymakers are looking for an instrument that can reduce the likelihood of high and persistent inflation. Fifth, the improvement of the level of legal CBI degree in some former socialist countries as part of the more general effort to upgrade their institutional framework which were required to enhance the efficacy of the free market economy. Empirical evidence from advanced countries reveals that a negative relationship between CBI and inflation encouraged governments to improve the independence of their central banks.

CBI has become one of the main concepts in monetary theory required for inflation stabilisation. Furthermore, the application of the idea of an independent central bank should be implemented. Since the theory of CBI is a qualitative concept, it is hard to quantify such a concept to make it applicable (Cukierman, 1992). Thus, several measurements of the degree of CBI have been developed. However, the validity of CBI indices remains debated, particularly with regards to developing countries. Cukierman et al. (1992) and de Haan and Kooi (2000) used the turnover rate of central bank governors as a proxy for the CBI index. They found that the turnover rate has a significant inverse effect on inflation in developing countries. However, there is a downside to using the turnover rate of the governor as a proxy for CBI, since the rate depends solely on the changing of the central bank governor, which might be a result of adherence to political leaders (Brumm, 2000). This thesis uses the index of legal CBI constructed by Garriga (2016), which reflects the degree of independence from the government based on 16 instruments. The characteristics of CBI depend on the legal aspect of autonomy (Bade and Parkin, 1988; Alesina, 1988; Grilli et al., 1991). Legal autonomy is a more appropriate proxy than the turnover rate of governors for three significant reasons. Firstly, the legal index avoids subjective bias as it is gained from the central bank's law and statutes (Hermes and Lensink, 2000). Secondly, economists argue that implementation of the legal statute of CBI mitigates the inflationary expectation in the economy. Thirdly, the legitimate indicator reflects the country's political and institutional capacity to follow the rules and ensure credibility of its monetary commitment (Polillo and Guillen, 2005).

The concept of CBI has developed in importance as regard to inflation stabilisation since the 1980s. Therefore, CBI has been applied not only to developed but also to developing countries. Some developing countries have reformed their central bank's statute to make their central bank more independent; hence, the central bank's focus is to pursue low and stable inflation (Acemoglu et al., 2008). The degree of the CBI index for developing countries has increased significantly in the last four decades. According to Garriga's (2016) CBI dataset, in 1980, the average CBI index for developing countries was 0.4134, and by 1990 it had increased to 0.4401. After the implementation of successful central bank reforms in developed countries, some developing countries began to reform their central banks in the 1990s to enhance their credibility. As a result, the average index of CBI improved to 0.4928 in 1995. The Asian financial crisis of 1997 that hit Asian and Pacific countries was one reason why some Asian developing countries, such as Indonesia, Thailand and Malaysia, gave their central bank more independence to rectify macroeconomic instability. This has had a positive impact on the average CBI degree in these countries, increasing it to 0.5401 in 2000. After the global financial crisis of 2008 - 2009, their average CBI improved to 0.5714. Finally, in 2012 their CBI index averaged at 0.5841.

On the other hand, inflation has become a major issue since the 1970s, particularly in developing countries. During the 1970s, following the end of the Bretton Woods agreement and the collapse of its exchange rate arrangements, an episode of high inflation had an undesirable effect on macroeconomic performance, including economic growth and unemployment. For instance, in 1980 the global inflation averaged approximately 17.5 percent. While average inflation in developed countries approximately 12.4 percent, the average inflation in developing countries was 26.7 percent. Furthermore, the financial crisis at the end of the 1980s and early 1990s in Latin America led to the highest world average inflation, of about 40.6 percent, while for developing countries averaged 120.6 percent. The inflation rate for emerging markets decreased significantly to approximately 8.5 percent in 2000. After the global financial crisis of 2009, the inflation rate in developing countries declined and stabilised at around 5 percent.

Empirical evidence regarding the relationship between CBI and inflation using a panel data model is inconclusive. Alesina and Summers (1993), Grilli et al. (1991), Cukierman et al. (1992), Brumm (2002), Ahsan et al. (2008), Maslowska (2011), Jonsson (1995) and Acemoglu et al. (2008) conclude that there is a negative relationship between CBI and inflation. According to King and Ma (2001) and Temple (1998), the negative effect of CBI on inflation exist only if high inflation countries are removed from the sample. However, Campillo and Miron (1997), Daunfeldt and De Luna (2008), Jácome and Vázquez (2008), Posso and Tawadros (2013), Dumiter et al. (2015) and Agoba et al. (2017) find no significant association between CBI and inflation. According to Brumm (2002) and Andriani et al. (2013), the absence of a negative relationship between CBI and inflation could be attributed to an inappropriate econometrics methodology. The first empirical study in Chapter 2 examines the heterogeneity effect of CBI on inflation in developing countries. The impact of CBI on inflation varies widely across countries. This diversity reflects the different characteristics of the central bank with respect to pursuing its monetary policy goal and heterogeneity in the structure of macroeconomic variables. Various reasons have been proposed to explain the cross-country heterogeneity of the effect of CBI, such as the financial structure, macroeconomic performance, and exchange rate regime.

Bodea and Hicks (2014) state that a higher degree of the legal CBI index is a signal that attracts investors given that CBI is granted via regular legislation and the risk of independence comes from implicit or explicit threats to amend the law. A change to an independent central bank means that new information about future monetary policy is delivered, thereby influencing financial asset prices, such as exchange rate, stock index and bond yield. Unlike the studies of Kuttner and Posen (2010) and Moser and Dreher (2010), who investigate the effect of a change in central bank governor, as a proxy of actual CBI, on the international financial market, our second empirical study in Chapter 3 investigates the interrelationship of CBI, financial asset prices, consumption and investment. This chapter is motivated by three principal reasons. First, most central banks have recently placed greater importance on achieving asset price stabilisation when setting their policy. The asymmetric issues related to asset price shocks and, the degree of the negative effect arising from the collapse in financial asset prices after bubble booms and busts are much greater than the positive effect caused by rising financial asset prices. Large falls in financial asset prices lead lenders to reduce credit supply. Subsequently, the demand for financial assets decreases and financial asset prices falls. These changes can place financial asset prices at risk, thereby causing severe harm to real economic activity. Second, financial asset prices are fundamentally forward-looking. As a result, they contain information concerning expectations regarding future inflation. This information is potentially significant for policymakers. This implies that financial asset prices can be effectively used as a source of information regarding future inflationary pressure. Third, the signalling effect channel emphasises the potential role of current financial asset prices over the level of future economic activities. Aggregate demand in the economy can be affected by people's expectations with regard to their future incomes. The development of real financial asset prices, which are closely related to real economic activities, has an effect on such expectations by signalling the economic outlook, including the growth of real income in the future. Consequently, this signal may affect the current investment of companies and household consumption expenditure in the economy.

The global financial crisis of 2007 to 2008 changed the role of most central banks and they are now focused more on financial stability, owing to the argument that financial stability is an essential key to macroeconomic stability. This new responsibility of the central banks creates new challenges for CBI. Financial instability can be described as excessive credit growth. The last empirical study in Chapter 4 investigates the effect of CBI and macroprudential policy on the share of credit in GDP using a panel threshold model. Our main findings are as follows. First, a linearity test is performed on our model using the Likelihood Ratio (LR) test, which shows that the non-linear model is significantly better than the linear model, thus confirming the presence of a non-linear relationship between CBI and credit per GDP. Second, after performing a panel threshold non-linear least square, the homogeneous assumption is checked for the threshold and coefficients of the explanatory variables using the dummy variable approach. The results reveal that the coefficients in our model are heterogeneous. Thus, this chapter applies the idea of mean group estimation as a solution for the heterogeneity established earlier. This chapter also divide the sample into two groups, poolable and not poolable groups, based on the result of the poolability test.

1.2 Contribution of the Thesis

Most empirical studies perform a panel data estimation to examine the relationship between CBI and inflation. However, those studies implement a conventional panel data approach (pooled least square or fixed effect estimations), which has some limitations. Pooled least square estimation treats the homogeneity coefficients for all cross-sections, thus neglecting individual heterogeneity (Samargandi et al., 2015). The fixed effect model has a drawback in that it does not take into consideration the unobservable individual-specific effect, thus yielding a biased and inconsistent estimation (Baltagi, 2008). In the light of the ongoing debate on the relationship between CBI and inflation, Chapter 2 seeks to contribute an empirical perspective in the following ways. First, the parameter homogeneity assumption of the pooled least square estimation is tested using the Chow test and Roy-Zellner test, and then test for individual fixed effect following the approach of Baltagi (2008). This chapter then model the CBI and inflation relationship in a dynamic model; which distinguish between the short and long-run effects. Such a distinction is crucial since CBI need not necessarily lead to lower inflation in the short-run because there is a trade-off between inflation and growth in the short term, and the government prefers high output to low inflation. Econometrics testing of the theory uncovers the proper equilibrium of the long-run parameter for the relationship between those variables. Thus, this chapter performs the MG and PMG estimators. According to Pesaran et al. (1999), both the MG and PMG methods capture the dynamics and parameter heterogeneity.

Chapter 3 seeks to contribute to the empirical research by linking the relationship between CBI, three different financial asset prices (i.e. exchange rate, stock index and bond yield), consumption and investment in developing countries. This chapter develops four different models based on three different financial asset prices in order to investigate the interaction between CBI, financial asset prices, consumption and investment. The first model studies the interaction between CBI, exchange rate, consumption and investment by fitting a panel VAR estimation on quarterly data spanning the periods 1991Q1 and 2016Q4. Subsequently, this model is used to test the poolability assumption using the Chow and Roy-Zellner tests. The result establish that the models contain heterogeneity among the samples; thus, this model applies a mean-group estimation for the panel VAR by averaging all the individual VAR coefficients. This model also divides the samples into subgroups to make a poolable group. Subsequently, the model is employed compare the subsamples and the full sample to establish the link between CBI, exchange rate, consumption and investment. The same processes are repeated for the model with stock index and bond yield, for the second and third models. Finally, the three financial asset prices are included in model four to investigate the effect of CBI on financial asset prices, consumption and investment.

Chapter 4 contributes to expanding the empirical studies on the interaction between CBI (independent monetary policy) and macroprudential policy and their effect on financial stability. This chapter constructs an index of macroprudential policy based on a survey of the IMF by Cerutti et al. (2017). Using 12 Global Macroprudential Policy Instruments (GMPI) created by Cerutti et al.

(2017), the chapter uses a new index based on the methodology of the coincident indicator model developed by Stock and Watson (1989) and Garratt and Hall (1996). To investigate the relationship between CBI and credit growth, and macroprudential policy and credit growth, this chapter constructs a non-linear methodology that captures the possible time-varying effect of CBI and macroprudential index on credit growth. The expected effect of CBI and macroprudential policy on credit per GDP should be different when the degree of CBI is high and low. Thus, by performing a panel threshold non-linear model, the result indicates the level of CBI that is considered to be high and slow credit growth. This chapter also checks the homogeneity assumption of the threshold and coefficients of the parameters by performing a non-standard poolability test using the dummy variable approach.

1.3 Structure of the Thesis

The rest of this study is organised as follows. Chapter 2 is the first empirical study, entitled *"Central Bank Independence and Inflation"*. This chapter empirically investigates the effect of CBI on inflation in 37 developing countries over the period 1972 to 2016 using a pool mean group estimation. Chapter 3 is the second empirical study, entitled *"Central Bank Independence, Financial Asset Prices, Consumption and Investment"*. This chapter investigates the interrelationship among CBI, three different financial asset prices (exchange rate, stock index and bond yield), consumption and investment using a panel vector autoregressive model. Chapter 4 is the last empirical study, entitled *"Central Bank Independence, Macroprudential Policy and Credit Growth"*. This chapter examines the non-linear effect of CBI and macroprudential policy on credit growth using a panel threshold model. Finally, Chapter 5 concludes the study with some policy implications and recommendations.

Chapter 2

Central Bank Independence and Inflation

2.1 Introduction

Central bank independence has an essential role in achieving macroeconomic stability, particularly in influencing the level of inflation. CBI is a solution to inflation bias due to time-inconsistency in monetary policy (Kydland and Prescott, 1977; Barro and Gordon, 1983; Rogoff, 1985). The hypothesis that a higher degree of CBI is negatively related to inflation has been proven by Alesina and Summers (1993), Grilli et al. (1991), Jonsson (1995), Brumm (2002), Ahsan et al. (2008), Acemoglu et al. (2008), and Maslowska (2011). This previous empirical research on the relationship between CBI and inflation focuses on advanced countries, specifically the Organisation for Economic Co-operation and Development (OECD) countries. According to Agoba et al. (2017), the existence of a negative effect of CBI on inflation in developed countries is due to them having financial systems and institutional of high quality.

Cukierman et al. (1992) examine the relationship between CBI and inflation in developed and developing countries. Their results show that the negative relationship only exists in developed countries, and fail to find the same result for developing countries. The main characteristics of developing countries include an unstable political situation, a hyperinflation period, and strong political interference in central bank matters; some developing countries also experience disinflation. According to Cukierman et al. (1992); Arnone et al. (2009) and Klomp and De Haan (2010), the concept of CBI in developing countries differs from that in industrial nations. For example, the law and actual practice in the central banks in developed and developing countries are different. Developing countries have a lower-level rule of law rather than developed countries, there might be a difference between the institutional arrangement and its adherence to the law. Campillo and Miron (1997) argue that in terms of pursuing price stability, CBI requires strong political support.

Having considered this evidence in developing countries, this study focuses on the analysis of the effect of CBI on inflation among developing countries. In most developing countries, high inflation remains one of the leading challenges to macroeconomic management and requires policy intervention. Moreover, among developing countries, a few have also experienced hyperinflation that has lasted for decades. To address this problem, many of these countries have had to reform their central bank legislation and change the central bank's objective to achieve low inflation. These reforms have been expected to create a higher level of independence to efficiently manage inflation. Dimakou (2015) evaluated the central bank reform in 77 countries (23 developed and 54 developing countries) based on the geo-economic group, from the 1990s to the beginning of the 2000s. It was found that institutional change in central banks had increased the level of independence. Some countries had also implemented an inflation targeting framework, in which an inflation target had been set as the nominal anchor and regularly communicated to the public.

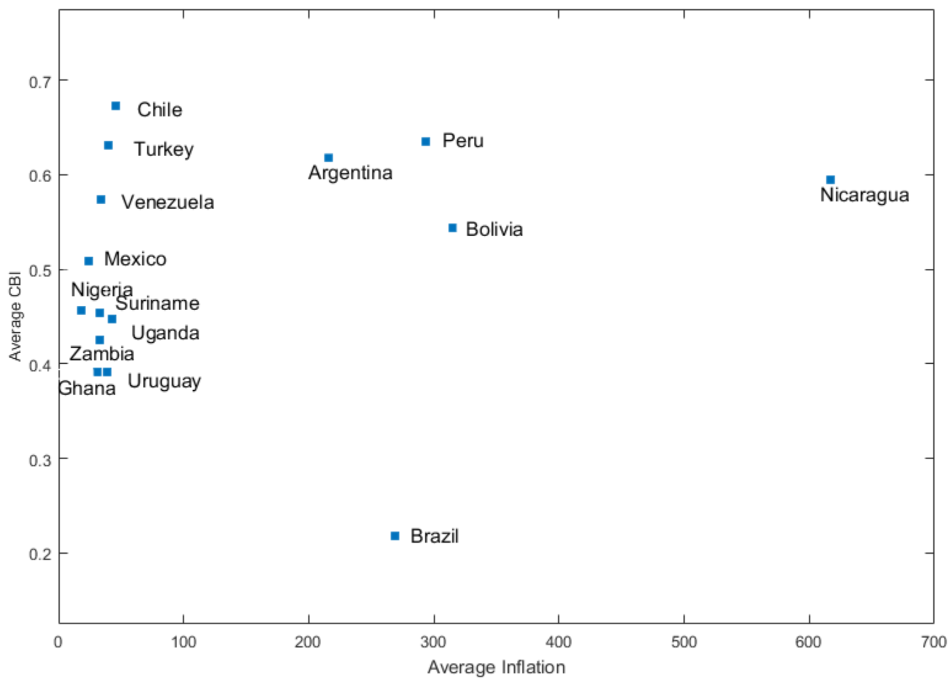


Figure 2.1: Average CBI and Average Inflation in High Inflation Countries

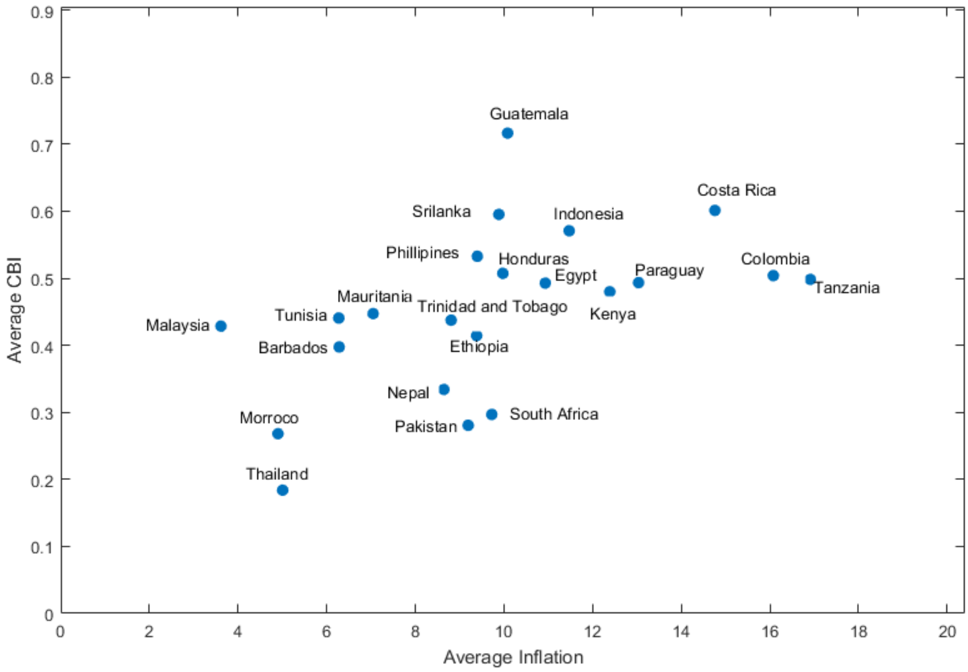


Figure 2.2: Average CBI and Average Inflation in Moderate Inflation Countries

Alesina and Summers (1993) examined the relationship between CBI and inflation in 16 developed countries for the period 1955-1988. Using a simple plot to capture inflation and CBI, they found a negative correlation between CBI and inflation. Their result is in line with the theoretical view that CBI creates lower inflation. Figure 2.1 and Figure 2.2 display the bivariate relationship between average CBI rate and average inflation for 15 high inflation economies and 22 moderate inflation economies during the period between 1972 and 2016. Some countries such as Peru, Argentina, and Nicaragua had high average inflation and a high average CBI. On the other hand, some countries with lower average inflation experienced a lower CBI index, for example, Thailand, Morocco and Pakistan. However, from this picture, it is difficult to draw conclusions regarding the existence of a negative relationship between CBI and inflation in developing countries.

The relationship between CBI and inflation varies widely in developing countries, reflecting differences in the institutional structure of the central banks and policy responses, and heterogeneity in the macroeconomic structures. This chapter analyses the effect of CBI on inflation in 37 developing countries over the period 1972 to 2016 using panel data estimation. First, the author perform pooled least square and fixed effect estimations for four models. Second, the author check a homogeneity assumption for the pooled least square estimation, applying Chow and Roy-Zellner tests. Third, the author employ panel heterogeneous estimators, mean group (MG) and pool mean group (PMG) regressions.

The result confirms the presence of heterogeneity parameters across cross-sections in the relationship between CBI and inflation. The results of the Chow and Roy-Zellner tests reject the homogeneous assumption for the coefficients in the pooled least square estimation. This chapter employs the Hausman test to check the long-run homogeneity restriction across the country for the MG and PMG estimators. The test shows that the PMG estimator is more consistent and efficient in our models. According to the PMG estimation, the result shows that in the long-run, CBI has a negative effect on inflation with coefficients ranging from -4.2971 to -33.987. This finding is robust, since the sample is divided into two groups, moderate and high inflation countries; the negative relationship between those variables still exists. Regarding the structural break test, our result shows that 20 countries experienced a break before their degree of CBI improved and 17 countries experienced a break after their CBI changed. This structural break finding is in line with the causality test result, which shows that there is bidirectional causality between CBI and inflation. This implies that the causality can run from CBI to inflation and from inflation to CBI.

The rest of this chapter is organised as follows. Section 2.2 introduces the literature review on central bank independence and inflation. Section 2.3 presents the data-set and construction of the methodology. Section 2.4 explores the empirical results. Section 2.5 concludes.

2.2 Literature Review on Central Bank Independence and Inflation

2.2.1 Theoretical Background

The theoretical view of CBI is related to time inconsistency in monetary policy based on the original paper of Kydland and Prescott (1977), Barro and Gordon (1983) and Rogoff (1985). Kydland and Prescott (1977) analyse the benefit of carrying out plans based on rules versus discretion. Barro and Gordon (1983) introduce inflation bias. They argue that policymakers have planned their objectives to reach a zero inflation rate, high growth, and employment. Policymaker had the incentive to trigger inflation surprises in order to bring about an increase in output and greater employment opportunities. Since Barro and Gordon (1983) assumed that the public is aware of policymaker's objective, then the expected inflation will equal to actual inflation. Inflation bias occurs under the discretionary monetary policy, where the government controls the central bank. Within this condition, if the central bank knows the public expectation, then it will have the ability to create inflation surprises to increase seigniorage income and achieve high employment and output. This result will affect people's trust in the central bank and will set a higher expectation in the following period. As inflation is a function of expected inflation, it will consequently be higher than it should have been. In the end, the central bank will find it challenging to manage inflation.

Barro and Gordon (1983) analysed inflation under discretionary monetary policy using the Lucas-Island supply function

$$y_t = y_n + a(\pi_t - \pi_t^e) + \varepsilon_t \tag{2.1}$$

where y_t is output; y_n is the natural rate of output; π_t is inflation; π_t^e is expected inflation; and ε_t is a real shock.

In this model, the output is a function of labour and capital (Cobb Douglas model). If actual inflation is greater than expected inflation, it leads to a real wage drop, as the expected real wage is lower than before, and the firm will absorb more labour. On the other hand, when expected inflation is higher than actual inflation, then real wage will rise, and the firm will reduce its number of employees.

Social loss function will be minimised by the central bank under the discretionary policy:

$$L = \frac{1}{2}\pi_t^2 + \frac{\lambda}{2}(y_t - y_n - k_t)^2 \tag{2.2}$$

where λ is society's preference for output, and k is constant. Under the discretionary monetary policy, on stabilising output and price, the output will be set by the monetary authority around $y_n + k$, while inflation will fluctuate around zero.

A simple relationship between inflation and the actual policy instrument adopted by policymaker gives:

$$\pi_t = \Delta m_t + v_t \tag{2.3}$$

where Δm is the growth rate of money supply (first difference of the log nominal supply of money), and v denotes the velocity shock. In setting Δm, this model assumes that expected inflation is given, supply shock (ε_t) is observable by the central bank but not velocity shock (ν_t), and also ε_t and ν_t are uncorrelated.

Firms use expected inflation to determine the wage. Meanwhile, the private agent has to carry out to the nominal wage contract before the central bank sets the nominal money supply growth rate. Under the discretionary policy, the central bank cares about output and attempts to decrease output variation through inflation. The central bank has the ability to make actual inflation different from the private agent's expectation.

By substituting Equations (2.1) and (2.3) into central bank loss function Equation (2.2), the effect of discretionary policy on inflation rate can be achieved, then take the first-order condition with respect to money growth:

$$\begin{aligned} V &= \frac{1}{2}\lambda\big[a(\Delta m + v - \pi)^2 + e - k\big]^2 + \frac{1}{2}(\Delta m + v)^2 \\ 0 &= \lambda\big[a(\Delta m - \pi) + e - k\big] + (\Delta m)^2 \\ \Delta m &= \frac{a^2\lambda\pi_t^e + a\lambda(k-e)}{(1+a)^2\lambda} \end{aligned} \tag{2.4}$$

Equation (2.4) shows that aggregate supply shock occurs since the central bank wants to minimise output variability (λ) around its target, which results in high inflation. There is a trade-off between inflation and output variability. The private sector uses this model as their expectation, and thereafter, the optimal policy depends on private agents' expected inflation. The expected inflation is generated from observing the aggregate supply shock (ε) as follows:

$$\pi^2 = E[\Delta m] = \frac{a^2\lambda\pi^e + a\lambda k}{1 + a^2\lambda} \tag{2.5}$$

where $\pi^e = a\lambda k > 0$, substitute this into Equation (2.3) and use Equation (2.4) to get equilibrium rate of inflation under the discretionary policy:

$$\pi^d = \Delta m + v = a\lambda k - \left(\frac{a\lambda}{1 + a^2\lambda}\right)e + v \tag{2.6}$$

Equation (2.6) shows that positive inflation rate equals to $a\lambda k$. Inflation bias is determined by the effect of money supply on output (a), the weight which the central bank puts on an output objective (λ), and distortion (k). When private agents are able to fully anticipate this rate, it has no effect on output. If monetary policy is delegated to an independent and conservative central bank, the central bank puts weight on inflation, meaning that it will be:

$$\pi^d(\delta) = \Delta m + v = \frac{a\lambda k}{1 + \delta} a\lambda k - \left(\frac{a\lambda}{1 + \delta + a^2\lambda}\right)e + v \tag{2.7}$$

The equation above implies that inflation bias will be lower since $1 + \delta > 1$ *or* $\delta > 0$ and this tends to reduce the loss function. However, the coefficient of aggregate supply shock (ε) is also lower, implying the central bank does not respond sufficiently to it. If it is more concerned with inflation than output stabilisation, inflation bias will be lower. However, this will also reduce output stabilisation. Thus, many researchers argue that lower average inflation can be reached by delegating monetary policy to a conservative and independent central bank. However, this is at the cost of lower output stabilisation. Thus, the trade-off between lower average inflation and higher output variability is expected to occur.

Rogoff (1985) proposed the solution for time-inconsistency problem by delegated monetary policy to an independent and conservative central bank which is more inflation averse than the government. A conservative and independent central bank would be able to reduce the average inflation, although the variability of output would increase. A conservative central bank can lower inflation bias caused by time-inconsistency monetary policy, but the central bank is less concerned in stabilising the output. Rogoff (1985) stated that there are two options to achieve price stability. The first is by a mandate to the government, and the second is by delegating monetary policy to a conservative central bank to achieve price stability.

If price stability is achieved by the government, society's loss function will be minimised:

$$\min\ L = b(y_t - y^*)^2 + (\pi_t - \pi^*)^2 \tag{2.8}$$

subject to

$$\text{Phillips curve} : y_t - y^p = (\pi_t - \pi^e) + \varepsilon_t \tag{2.9}$$

Assuming that $\pi^* = 0$ and $y^p = 0$. The loss function will become

$$L_G = b(y_t - y^*)^2 + \pi_t^2 \tag{2.10}$$

By substituting the constraint function to the objective function, and carrying out optimisation, the optimal inflation rate is obtained

$$L_G = b(a(\pi_t - \pi^e) + \varepsilon_t - y^*)^2 + \pi_t^2 \tag{2.11}$$

The first-order condition with respect to π_t is

$$\frac{\partial L_G}{\partial \pi_t} = 2ab[a(\pi_t - \pi^e) + \varepsilon_t - y^*] + 2\pi_t = 0 \tag{2.12}$$

$$2a^2b\pi_t - 2a^2b\pi^e + 2ab\varepsilon_t - 2aby^* + 2\pi_t = 0 \tag{2.13}$$

$$\pi_t(1+a^2b) - a^2b\pi^e + ab\varepsilon_t - aby^* = 0 \tag{2.14}$$

Since inflation expectation is formed before the government takes the policy, the equation becomes:

$$\pi_t^e = E_{t-1}(\pi_t) = aby^* \tag{2.15}$$

Then the inflation and output are:

$$\pi_t^{**} = aby^* - \frac{ab}{1+a^2b}\varepsilon_t \tag{2.16}$$

$$y_t^{**} = \frac{1}{1+a^2b}\varepsilon_t \tag{2.17}$$

The author conclude that if the monetary policy mandate is given to the government:

1. There will be inflation bias, since $\pi_t^e > 0$
2. The higher the preference for output stabilisation (b), the higher inflation will be, which is

$$\frac{\partial E_{t-1}(\pi_t)}{\partial b} = ay^* > 0, \text{ and } \frac{\partial var\ \pi_t^{**}}{\partial b} > 0 \tag{2.18}$$

3. Delegating monetary policy mandate to the government which is pro-growth will not increase average output, since $y^p = 0$, so that $E(y^{**}) = 0$, $\frac{\partial E(y^{**})}{\partial b} = 0$, but will only reduce output volatility, where $\frac{\partial vary_t^{**}}{\partial b} < 0$.

Rogoff (1985) argues that in order to achieve price stability in the sense of low inflation, one must choose a conservative central bank that is more inflation averse. If monetary policy is delegated to a conservative central bank, the rate of inflation and output will be:

$$\pi_t^{**} = a\hat{b}y^* - \frac{a\hat{b}}{1+a^2\hat{b}}\varepsilon_t \tag{2.19}$$

$$y_t^{**} = \frac{1}{1+a^2\hat{b}}\varepsilon_t \tag{2.20}$$

where $\hat{b}$ is a conservative central bank preference for output stabilisation, the value of $\hat{b}$ is lower than the government's choice to stabilise output (b). A more conservative central bank is inflation-averse, while the government is more pro-growth, so $0 < \hat{b} < b$. Thus, delegating monetary policy to a conservative central bank will lead to a lower inflation rate than if the government mandated the monetary policy.

King (1997) illustrates the trade-off between rules and discretion in a simple and standard model. The output is described by the reduced form of the supply function

$$y = y^* + b(\pi - \hat{\pi}) + \varepsilon \tag{2.21}$$

where $\hat{\pi}$ is the private sector's expected rate of inflation, and the $b > 0$, shock ε is white noise with zero mean and variance σ^2. The output is denoted by y, and potential output is denoted by y^*. The inflation rate is denoted by π. If a constant velocity of circulation is assumed, and the previous period's price level to unity is normalized, the money stock, m, is given by

$$m = \pi + y \tag{2.22}$$

The representative agent's preferences are given by a loss function defined over quadratic terms in inflation and output. The desired level of inflation is zero, and the target level of output, ky^*, exceeds the natural rate of output.

$$L = aE\pi^2 + E(y - ky^*)^2 \tag{2.23}$$

where $a > 0$, $k > 1$, and $E(\cdot)$ is the expectation operator.

Monetary policy reaction function is:

$$m = \lambda_1 + \lambda_2\varepsilon \tag{2.24}$$

The inflation target is denoted by π^*, while inflation and output are indicated as a function of private-sector expectation, the shock, the model parameter, and the policy reaction function, which itself comprises the inflation target and a response to the shock. In general:

$$y = y^* + b(\pi^* - \hat{\pi}) + \beta\varepsilon \tag{2.25}$$

$$\pi = \pi^* + \left(\frac{\beta - 1}{b}\right)\varepsilon \tag{2.26}$$

where $\beta = 1 + \{b(\lambda_2 - 1)\}\{1 + b\}$.

The first best monetary policy reaction function is the state-contingent rule. The optimal output is reached by minimising the expected loss L, subject to rational expectations in the private sector.

$$y_0 = y^* + \frac{a}{a + b^2}\varepsilon \tag{2.27}$$

$$\pi_0 = -\frac{a}{a + b^2}\varepsilon \tag{2.28}$$

The optimal value of loss function can be achieved by putting zero in inflation target and there is no inflation bias.

$$L_0 = z^2 + \frac{1}{1+\theta}\sigma^2 \tag{2.29}$$

where $z = (h-1)y^*$, $\theta = b^2/a$. The left-hand side of the loss function shows that output equals y^* rather than ky^* on average, and the right-hand side shows the loss from shocks. The value of L_0 is a benchmark against which other policy reaction functions may be judged.

If a state-contingent rule is not credible, then the optimal policy rule is determined with the contingent rule, except that λ_2 is constrained to zero.

$$y_R = y^* + \frac{1}{1+b}\varepsilon \tag{2.30}$$

$$\pi_R = -\frac{1}{1+b}\varepsilon \tag{2.31}$$

The inflation target is zero. The loss under the fixed rule is

$$L_R = z^2 + \frac{1+a}{(1+b)^2}\sigma^2 \tag{2.32}$$

Under discretion, there is a problem of dynamic inconsistency that creates inflation bias. The central bank chooses π^* and β to minimise loss function by assuming the expected inflation rate as predetermined. In a rational expectations equilibrium, this expected rate must be equal to the unconditional expected inflation rate generated by the optimal discretionary policy. Output and inflation are given by

$$y_D = y^* + \left(\frac{a}{(a+b)^2}\right)\varepsilon \tag{2.33}$$

$$\pi_D = \frac{b}{a}z - \left(\frac{a}{(a+b)^2}\right)\varepsilon \tag{2.34}$$

The loss function under pure discretion is

$$L_D = (1+\theta)z^2 + \frac{1}{(1+\theta)}\sigma^2 \tag{2.35}$$

In the recent generation of New Keynesian models of the business cycle, discretionary monetary policy results in inflation causing stabilisation the bias of monetary policy. This bias gives a rational reason for delegation of monetary policy to a conservative central banker. Tillmann (2008) proves that the welfare loss resulting from appointing a central banker with the suboptimal output weight is asymmetrical. According to a standard New Keynesian model, inflation is described by a forward-looking Phillips curve:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + e_t \tag{2.36}$$

where π_t is the inflation rate, x_t is the percentage of the output gap, E_t is the expectation operator, the discount factor is denoted by $\beta < 1$, and κ is the slope coefficient of the Phillips curve.

The cost-push shock e_t shows some degree of persistence described by the AR(1) coefficient $0 \leq \rho < 1$.

$$e_t = \rho e_{t-1} + \varepsilon_t \quad \text{with } \varepsilon_t \sim N(0,1) \tag{2.37}$$

The objective of monetary policy is to minimise the welfare loss L, which is described in term of inflation volatility and output gap volatility weighted by the parameter $\lambda^{CB} > 0$.

$$\min_{\pi_t, x_t} L = \min_{\pi_t, x_t} \left\{\pi_t^2, \lambda^{CB} x_t^2\right\} \tag{2.38}$$

$$\kappa\pi_t + \lambda^{CB} x_t = 0 \tag{2.39}$$

The target values for output and inflation are set to zero. Under the discretionary policy, expectations are taken as given and the first-order conditions for maximising Equation (2.38) subject to Equation (2.39) imply

Equilibrium inflation and output are given by

$$\pi_t = \frac{\lambda^{CB}}{\lambda^{CB}(1-\beta\rho)+\kappa^2} e_t \tag{2.40}$$

$$x_t = \frac{-\kappa}{\lambda^{CB}(1-\beta\rho)+\kappa^2} e_t \tag{2.41}$$

Both inflation and output gap fluctuations are stabilised less if shocks become more persistence.

Suppose the central bank credibly commit to a rule of the form $x_t^{rule} = b_x e_t$ and $\pi_t^{rule} = b_\pi e_t$, where b_x and b_π are coefficients to be determined. Then the equilibrium inflation is given by

$$\pi_t^{rule} = \frac{\lambda(1-\beta\rho)}{\lambda(1-\beta\rho)^2+\kappa^2} e_t \tag{2.42}$$

By comparing Equations (2.42) and (2.40), inflation is inefficiently stabilised under discretion because var $\left(\pi_t^{rule}\right) <$ var (π_t) for $\rho > 0$. This bias becomes larger if ρ increases. For white noise shocks, the stabilisation bias disappears.

The solution for stabilisation bias is to delegate policy to a central bank that has a different objective from the social planner. The social planner weights fluctuations in the output gap with a weight λ^p, which is not restricted to coincide with the weight of the central bank. The social planner then chooses λ^{CB} to minimise the welfare loss resulting from the equilibrium outcome for a given λ^{CB}

$$\min_{\lambda^{CB}} \frac{1}{1-\rho} \left\{ \left[\frac{\lambda^{CB}}{\lambda^{CB}(1-\beta\rho)+\kappa^2} \right]^2 + \lambda^p \left[\frac{-\kappa}{\lambda^{CB}(1-\beta\rho)+\kappa^2} \right]^2 \right\} \tag{2.43}$$

As a result, the following condition is obtained

$$\lambda^{CB} = \lambda^p(1-\beta\rho) \tag{2.44}$$

Since $\beta\rho < 1$, the optimal output weight of the central bank lies below the weight of the social planner attaches to output gap fluctuations.

2.2.2 Empirical Literature

The first empirical study to investigate the relationship between CBI and inflation was Grilli et al. (1991). They used their own CBI index to examine the effect of CBI on inflation in 18 OECD countries from 1950 to 1989, and found a significant negative relationship between these variables. However, when the sample periods were divided into four decades, they still proved that there exists a negative relationship between CBI and inflation. Cukierman et al. (1992) measured the legal CBI index for 72 countries and divided the sample into developing and developed countries for the period between 1950 and 1989. They found a negative relationship between legal CBI and inflation only for advanced economies, but not for developing economies.

Jonsson (1995) studied 18 countries from 1961 to 1989 to examine the effect of CBI on inflation. He employed a pooled least square to test the assumption of exogeneity in his study. Using Cukierman et al.'s (1992) CBI index, he found a negative relationship between CBI and inflation. After the period was separated into three different decades, CBI became the most critical aspect in reducing inflation during a high inflation period (1972-1979). Ahsan et al. (2008) constructed an index of central bank independence and governance (CBIG) in the Asia Pacific for 36 countries for the period 1991 to 2005 and examined its effects on inflation. By using pooled least square and applying a dummy variable for the Asian financial crisis of 1997, they concluded that there was a strong negative correlation between CBIG and inflation, particularly in the post-crisis period, since CBIG improved in their sample countries after the Asian financial crisis. But after separating the sample countries into low income and high-income countries, the result showed that CBIG was not efficient to reduce inflation for low-income economies.

Bogoev et al. (2012) employed fixed effect panel data for 17 transition countries in Central and Eastern Europe from 1990 to 2009. They used Cukierman et al.'s (1992) index for legal CBI and found that CBI was an essential factor behind disinflation after controlling for the effect of some macroeconomic and institutional variables. Bodea and Hicks (2015) expanded Cukierman et al.'s (1992) index of CBI for 78 countries from 1973 to 2008. They used this information to conclude that CBI is linked to lower inflation and is also dependent on the country's level of democracy. This study shows that countries that have undergone central bank reform have a higher degree of independence, and thus have lower inflation compared to countries that have not experienced such a reform.

Some empirical studies show that the negative effect of CBI on inflation exists only when high inflation countries are removed from the sample. King and Ma (2001) found various results of the impact of CBI on inflation in advanced, middle and low-income economies. By including the degree of tax centralisation and using panel data for 42 countries for the period 1965 to 1990, they found a positive relationship between CBI and inflation for all of the countries in their sample. However, after excluding sample countries with inflation of over 20%, they found that the relationship between CBI and inflation had a negative sign. Temple (1998), used Cukierman et al.'s (1992) legal index to investigate the effect of CBI on inflation. By including high inflation countries in his sample of OECD and developing economies, the reverse relationship disappeared. However, when the outlier countries were removed from his regression, a strong correlation between CBI and inflation was found at a 1% level of significance. He concluded that the existence of a reverse relationship between CBI and inflation profoundly influenced the presence of high inflation economies.

However, some research has concluded that in fact, there exists no such negative relationship between CBI and inflation. Campillo and Miron (1997) examined the relationship between CBI and average inflation for 49 countries from 1973 to 1994. Without any control variable in their model, they found no significant effect of CBI on inflation. Even after omitting high inflation countries (exceeded 50% inflation), the result was still inconsistent with the theory. Daunfeldt and De Luna (2008) looked at the data from 1975 to 2000 from 29 OECD countries and applied a non-parametric regression method to compare the long-term inflation data with an increase in the CBI index. They claimed that there is no correlation between CBI and inflation. They stated that price stability might have been achieved by an exchange rate agreement rather than central bank reforms. In their study, Jácome and Vázquez (2008) explored the effect of CBI on inflation in 24 Latin American and Caribbean countries from 1985 to 2002. By using an instrumental variable method with panel data, they uncovered a negative relationship between CBI and inflation. More recently, Posso and Tawadros (2013) estimated the effect of CBI on inflation for the periods 1987 to 1991 and 2002 to 2006 for 96 countries. They suggest that CBI has no significant impact on inflation, and claim that CBI is not an important aspect in lowering inflation.

Some recent studies have also failed to find a negative relationship between CBI and inflation. Dumiter et al. (2015) analysed the relationship between CBI and inflation for developed and developing countries in a different group from 2005 to 2014. Using a pooled least square and two-stage least square panel data model, they did not find a significant negative effect of CBI on inflation for either group. The lack of a relationship between those variables was due to the quality and quantity of the data, the time period, and the econometrical tools. Agoba et al. (2017) investigated the role of the financial system and quality of political institutions on the effectiveness of CBI in reducing inflation. They applied a 2SLS instrumental variable estimator for a sample of 48 African countries during the period 1970 to 2012. They introduced inflation targeting as an additional explanatory variable, using interaction terms between financial development and institutional quality, and comparing the relative effectiveness of banking sector development. However, they failed to find a negative relationship between CBI and inflation in African countries because those countries lacked high-level financial systems and political institutions.

2.3 Data and Econometric Methodology

2.3.1 Data

The panel data used in this study covers 37 developing countries[1] determined by data availability[2]. Our dataset consists of seven variables: inflation, CBI, output gap, openness, fiscal deficit, US inflation and the unemployment rate in the period from 1972 to 2016. Inflation is defined as the percentage change in the consumer price index over the corresponding period from the previous year, and is provided by International Financial Statistics from the IMF.

[1] The classification of developing countries based on IMF's World Economic Outlook

[2] List of countries is in Table A.1 in Appendix A

For the measure of CBI, the author follow the CBI index constructed by Cukierman et al. (1992). This index is based on a legal aspect of independence. The index is between 0 and 1, with higher values denoting greater CBI for the legal index. The data for the CBI index is a legal variable aggregate weighted taken from Garriga's (2016) data set.

The output gap is measured as the difference between the actual output (y) and the potential output (y*). The Hodrick-Prescott-filter is employed to compute the potential output (Hodrick and Prescott, 1997) since it is the most commonly accepted methodology for doing so. The gap is then calculated as the percentage deviation of output from its potential.

Following Catao and Terrones (2005), this chapter includes trade openness, calculated by the sum of export and import as a share of GDP. The author collected the data for trade openness from the IFS database. This chapter includes trade openness because several studies have found that openness has a significant effect on inflation (Terra, 1998; Jácome and Vázquez, 2008).

Another control variable is the fiscal deficit. The fiscal deficit is measured as the difference between government revenue and government expenditure, as a percentage of GDP following the approach of Bodea and Hicks (2015), Griffin (2011) and Bogoev et al. (2012). A negative sign denotes a deficit. The data is provided by the IFS.

US inflation is also included because the United States is the largest trading partner for developing countries. Given that around 50% of US trade is with developing countries, inflation in the US can spread to developing countries.

The unemployment rate is added, calculated as the percentage of those who are unemployment out of the total labour force. The data come from the World Economic Indicator from the World Bank database. Since data on the unemployment rate are only available from 1991 to 2016, the author follow the model of Kitov and Kitov (2011), who used Okun's law to predict the unemployment rate from 1972 to 1990.

2.3.2 Econometric Methodology

This study investigates the relationship between CBI and inflation. The author follows Cukierman et al. (1992); Eijffinger et al. (1998) models:

$$INF_{it} = \beta_0 + \beta_1 CBI_{it} + \varepsilon_{it} \tag{2.45}$$

The author extends the model by adding control variables. The first model is:

$$INF_{it} = \beta_0 + \beta_1 CBI_{it} + \beta_2 GAP_{it} + \beta_3 OPEN_{it} + \beta_4 FD_{it} + \varepsilon_{it} \tag{2.46}$$

In addition, by following Crowder (1996) that domestic inflation can be influenced by other countries inflation as an external shock. This chapter adds United States inflation since the United States is the large economy thus given its most influential role for small open economies (Cheung and Yuen, 2002). Therefore, the author extends Equation (2.46) to include United States inflation in order to examine their influence on inflation. Thus, the second model follows:

$$INF_{it} = \beta_0 + \beta_1 CBI_{it} + \beta_2 GAP_{it} + \beta_3 OPEN_{it} + \beta_4 FD_{it} + \beta_5 USINF_t + \varepsilon_{it} \tag{2.47}$$

The unemployment rate is one of the possible influence on inflation. A higher unemployment rate might increase the incentive for the government to drive economic expansion; as a result, increase the time-consistent inflation rate (Walsh, 1995). Phillips (1958) reported the negative relationship between inflation and unemployment rate. He described the trade-off between inflation and unemployment then become known as the Phillips curve. After the unemployment rate is added on Equation (2.46), our third model as:

$$INF_{it} = \beta_0 + \beta_1 CBI_{it} + \beta_2 GAP_{it} + \beta_3 OPEN_{it} + \beta_4 FD_{it} + \beta_5 UNP_{it} + \varepsilon_{it} \tag{2.48}$$

In the fourth model, both US inflation and unemployment rate are added on our basic model in Equation (2.46). Then model 4 is:

$$INF_{it} = \beta_0 + \beta_1 CBI_{it} + \beta_2 GAP_{it} + \beta_3 OPEN_{it} + \beta_4 FD_{it} + \beta_5 USINF_t + \beta_6 UNP_{it} + \varepsilon_{it} \tag{2.49}$$

where INF is inflation, CBI is legal CBI index, GAP is output gap, $OPEN$ is openness trade, FD is a fiscal deficit, $USINF$ is US inflation, and UNP is the unemployment rate. GAP $OPEN$, FD, $USINF$, and UNP are control variables. i= *1,2,...,N* sections and t=*1,2,...,T* time periods.

2.3.3 Panel unit root tests

In this study, the stationary properties for all variables will be checked using some different panel unit root tests. Levin et al. (2002) introduced the LLC test for panel data which allow individual intercepts and time trends, and heterogenous autocorrelation for the error terms. The main model in Levin et al. (2002) is:

$$\Delta y_{it} = \delta y_{it-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it}, \quad m = 1, 2, 3 \tag{2.50}$$

The null hypothesis is

$$H_0 : \delta = 0 \quad \text{against} \quad H_1 : \delta \neq 0 \tag{2.51}$$

LLC test is based on a three-step procedure. The first step is applying ADF regressions for every individual cross-section, and obtain two orthogonalized residuals. Then estimating the ratio of long-run to the short-run standard deviation for each cross-section is conducted in the second step. The final step is to regress the pooled estimation.

$$\tilde{e}^*_{i,t} = \delta \tilde{v}^*_{it-1} + \tilde{\varepsilon}^*_{it}, \tag{2.52}$$

Breitung (2005) shows that bias adjustment in Levin et al. (2002) the test may cause severe power loss. Then he proposed a test which does not require bias correction. The test contains three steps: the first is to obtain standardised residuals, $\tilde{e}_{i,t} = \frac{\hat{e}_{i,t}}{\hat{\sigma}_{\epsilon,i}}$; $\tilde{v}_{i,t-1} = \frac{\hat{v}_{i,t-1}}{\hat{\sigma}_{\epsilon,i}}$, thus $\tilde{e}_{i,t}$ and $\tilde{v}_{i,t-1}$; excluding the deterministic terms, the regression of $\Delta y_{i,t}$ and $y_{i,t-1}$ on $\Delta y_{i,t-L}$; $L = 1, 2, ..., p_i$ are performed. The second step is to transform $\tilde{e}_{i,t}$ and $\tilde{v}_{i,t-1}$ using forward orthogonalisation to obtain $\tilde{e}^*_{i,t}$ and $\tilde{v}^*_{i,t-1}$. The final step is to gain a test statistic for $H_0 : \rho = 0$ by following pooled regression of $\tilde{e}^*_{i,t}$ and $\tilde{v}^*_{i,t-1}$;

$$e^*_{i,t} = \rho v^*_{it-1} + \varepsilon^*_{it}, \tag{2.53}$$

Breitung (2005) shows that under the null hypothesis, t-statistic follows an asymptotic standard normal distribution.

The IPS tests constructed by Im et al. (2003) will be employed. Im et al. (2003) developed a panel unit root testing for dynamic heterogeneous panels under cross-sectional independence assumption. The model heterogeneous T periods and N cross-sections with errors in serially correlated is:

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{i,j} \Delta Y_{i,t-j} + \varepsilon_{i,t} \tag{2.54}$$

where Δ is the first different, $i = 1, \cdots, N$ and $t = 1, \cdots, T$. ε_{it} is identical and independently distributed.

The null hypothesis that contains a unit root is

$\mathrm{H}_0 : \beta_i = 0$ for all $i = 1, \cdots, N$

The alternative hypothesis of stationary is

$\mathrm{H}_1 : \beta_i < 0$ for all $i = N_1 + 1, \cdots, N$, with $0 < N_1 < N$.

The t-statistic of IPS test is:

$$Z_{IPS} = \frac{\sqrt{N}\left(\bar{t}_{NT} - N^{-1}\sum_{i=1}^{N} E\left[\tilde{t}_{Ti}\right]\right)}{\sqrt{N^{-1}\sum_{i=1}^{N} Var\left[\tilde{t}_{Ti}\right]}} \Longrightarrow N(0,1) \tag{2.55}$$

where N denotes the number of cross-section units, β_i is autoregressive root, $E\left[\tilde{t}_{Ti}\right]$and $Var\left[\tilde{t}_{Ti}\right]$ are the moment of mean and variance attained from Im et al. (2003) simulation and $\bar{t}_{NT}$ denotes the average computed ADF statistic defined as follow

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iTi} \tag{2.56}$$

2.3.4 Pooled Least Square and Fixed Effect Estimation

A. Pooled Least Square Estimation

Assume that a panel data of N cross-section units and T observation time series. Following Asteriou and Hall (2016) simple linear model with one explanatory variable:

$$Y_{it} = \alpha + \beta X_{it} + u_{it} \tag{2.57}$$

where Y and X have both i and t for $i= 1,2,\ldots,N$ sections and $t=1,2,\ldots,T$ time periods. $u_{it} \sim N(0, \sigma^2)$ *for all i and t.* X_{it} is assumed to be uncorrelated with u_{it}. Pooled least square model is assuming that all the coefficients in the model are the same across cross-sectional and time series observations.

B. Fixed Effect Estimation

In the pooled least square estimation in Equation (2.57), the disturbance term u_{it} capture the unobservable heterogeneity which consists of unobservable specific effect and remainders disturbance.

$$u_{it} = \mu_i + \nu_{it} \tag{2.58}$$

where μ_i denotes the unobservable country-specific effect and ν_{it} represents the remainder disturbance. The country-specific effect such as cultural, political, and institutional factors which are not constant over time are not included in the model. For one-way error component model, Baltagi (2008) reveals that these unobservable country-specific effects can be accounted into the model. The equation for the fixed effect is given:

$$y_{it} = \alpha + \beta x_{it} + \mu_i + \nu_{it} \tag{2.59}$$

For each country observation i, averaging equation

$$\bar{y}_{it} = \alpha + \beta \bar{x}_{it} + \mu_i + \bar{\nu}_{it} \tag{2.60}$$

Then subtracting Equation (2.59) from Equation (2.60) gives:

$$y_{it} - \bar{y}_{it} = \beta(x_{it} - \bar{x}_{it}) + (\nu_{it} - \bar{\nu}_{it}) \tag{2.61}$$

Note that the unobservable country-specific effect,μ_i, has disappeared. The transformation process in Equation (2.61) is known by within transformation.

2.3.5 Diagnostic test for POLS and Fixed Effect

A. Poolability Test

This chapter applies poolability test to check whether the parameter of our equation varies from one country to the other. Pooled least square model represents a behavioural equation with the same parameters over time and across groups. On the other hand, the unrestricted model has the same behavioural but different parameters across time and across groups (Baltagi, 2008). The restricted model for each group is:

$$y_{it} = Z_i \delta_i + u_i \quad i = 1, 2, ..., N \tag{2.62}$$

where $y_i^{'} = (y_{i1}, ..., y_{iT})$, $Z_i = [\iota T, X_i]$ and X_i is T x K. $\delta_i^{'}$ is 1 x $(K{+}1)$, and u_i is (T x 1). $\delta_i^{'}$ is vary for every individual equation.

The restricted model is given by:

$$y = Z\delta + u \tag{2.63}$$

where $Z' = (Z_1', Z_2', ..., Z_N')$, $u' = (u_1', u_2', ..., u_N')$.

The null hypothesis is the poolability test is

$$H_0 : \delta_i = \delta \quad \text{against} \quad H_1 : \delta_i \neq \delta \tag{2.64}$$

Chow Test

Chow (1960) constructed a poolability test under the assumption that $u \sim N(0, \sigma^2 I_{NT})$ by using the F-test to test the hypothesis.

$$F_{Chow} = \frac{(RRSS - URSS)}{URSS} \frac{(N-1)}{(NT - N - K)} \tag{2.65}$$

RRSS is the restricted residual sum of the square of pooled least square, URSS denotes the unrestricted residuals sum of the square of all individual regressions. Under the H_0, the statistic of F_{obs} is distributed as F with $N-1, N(T-1)-K$ degree of freedom.

Roy Zellner Test

Roy-Zellner test is a generalisation of the Chow test for the N linear regression case, under the assumption of heteroskedastic variances (Roy, 1957; Zellner, 1962). The F statistic of Roy Zellner test can be achieved as

$$F_{RZ} = \frac{(ess_c - (ess_1 + ess_2 + ... + ess_N)}{(ess_1 + ess_2 + ... + ess_N)} \frac{(N-1)(K+1)}{N(T-K+1)} \tag{2.66}$$

where ess_c denotes the error sum of square the pooled regression, and $ess_1 + ess_2 + ... + ess_N$ are the error sum of square from the N separate time series regressions.

In this test, all regressions are transformed to have homoskedastic variances. The null hypothesis is $H_0 : \delta_i = \delta$ for every $i = 1, 2, ..., N$.

B. Test for The Presence of Fixed Effect

The fixed effect model in Equation (2.61) will yield bias estimates because the individual effect dummies are omitted by OLS estimation. Baltagi (2008) demonstrates how the joint significance of these dummies can be checked by applying an

F-test. The author tests the hypothesis that the individual effects assuming there is no time effect. The null hypothesis is $H_0 : \mu_i = 0$ for every $i = 1, 2, ..., N - 1$.

In this case:

$$F_{1-way} = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT - N - K)} \overset{H0}{\sim} F_{N-1,N(T-1)-K} \tag{2.67}$$

RRSS is the restricted residual sum of the square of pooled least square, URSS denotes the unrestricted residuals sum of the square of the LSDV regressions. Under the H_0, the statistic of F_{obs} is distributed as F with $N - 1, N(T - 1) - K$ degree of freedom.

2.3.6 Heterogeneous Panel Data Estimation

In the case that pooled least square estimator is not poolable because the assumption of homogeneity is not held. This chapter, therefore, adopts mean group estimator developed by Pesaran and Smith (1995) and pooled mean group estimator constructed by Pesaran et al. (1999). MG estimator assumes that the short-run and long-run coefficients are different across countries. Pesaran and Smith (1995) start the model with a simple heterogeneous dynamic model:

$$y_{it} = \lambda_i y_{i,t-1} + \beta_i^{'} \mathbf{x}_{it} + \varepsilon_{it}, \qquad i = 1, 2, ..., N, \quad t = 1, 2, ..., T, \tag{2.68}$$

where coefficients λ_i and β_i varying across groups according to the random coefficient model:

$$H_a : \lambda_i = \lambda + \eta_{1i}, \quad \beta_i = \beta + \eta_{2i}, \tag{2.69}$$

Assume that η_{1i} and η_{2i} have zero mean and constant covariances. It is also assume that higher-order moments of η_{1i} and η_{2i} and their cross moments exist and are finite. The short-run coefficients are β_i and λ_i, they are gained from the standard formulation of the random coefficient model. While, the long-run effects, $\theta_i = \beta_i/(1 - \lambda_i)$, and the mean lags, $\psi_i = \lambda_i/(1 - \lambda_i)$, vary randomly across groups:

$$H_b : \psi_i = \psi + \zeta_{1i}, \quad \theta_i = \theta + \zeta_{2i}, \tag{2.70}$$

ζ_{1i} and ζ_{2i} are assumed to have zero mean and constant covariances. The mean group estimator of $\mathbf{x}$ on y can be obtained from the average short-run coefficient or the average of long-run equilibrium:

$$\hat{\beta}_{MG} = N^{-1} \sum_{i=1}^{N} \beta_i \tag{2.71}$$

where $\hat{\beta}_i$ is the OLS estimator of β_i.

Pesaran et al. (1999) developed the pooled mean group estimation which incorporates both long-run and short-run effects by adopting an Autoregressive Distributive Lag structure (ARDL), and estimating ARDL method as an Error Correction Model. PMG estimator allows the intercepts, short-run coefficients, and error variances vary for every cross-sections, but the constraint of long-run coefficients are the same. Pesaran et al. (1999) showed that the effect of explanatory variable on the dependent variables can be tracked by taking sufficient lags in ARDL structure to solve the spurious regression. Meanwhile, the error correction model integrates the short-run dynamics and the long-run equilibrium without losing information of the long-run. PMG model is based on ARDL $(p, q, q, ..., q)$ model,

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}^{'} \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it} \tag{2.72}$$

where $\mathbf{x}_{it}$ $(kx1)$ is the vector of exogenous variables for group i. μ_i represents the fixed effects; λ_{ij} are the scalar which are the coefficients of the lagged dependent variables, and δ_{ij} are $(kx1)$ coefficient vectors. In PMG model T must be large in order to estimate the model for every cross-section. By re-parametrization, the equation become:

$$\Delta y_{it} = \phi i y_{i,t-1} + \beta_i^{'} \mathbf{x}_{it} + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*} \Delta \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it} \tag{2.73}$$

for $i = 1, 2, ..., N$, and $t = 1, 2, ..., T$, where

$$\phi_i = \left(\sum_{j=1}^{p} \lambda_{ij}^{*} \lambda_{ij} - 1 \right) = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}^{*} \lambda_{ij} \right), \quad \beta_i = \sum_{j=0}^{q} \delta_{ij}, \quad \lambda_{ij} = - \sum_{m=j+1}^{p} \lambda_{im},$$
$$\delta_{ij} = - \sum_{m=j+1}^{q} \delta_{im} \tag{2.74}$$

The error correction parametrization can be written as:

$$\Delta y_{it} = \phi i \mathbf{y}_{i,t-1} + \mathbf{x}_i \beta_i + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,-j} + \sum_{j=0}^{q-1} \Delta \mathbf{x}_{i,-j} \delta_{ij}^{*} + \mu_i \iota + \varepsilon_i \tag{2.75}$$

$i = 1, 2, ..., N$, where $\mathbf{y}_i = (y_{i1}, ..., y_{iT})'$ is a $Tx1$ vector of the observations on the dependent variable of the i th group, $\mathbf{X}_i = (x_{i1}, ..., x_{iT})'$ is a $Tx1$ matrix of observations on the regressors that vary both across groups and time veriods. $\iota = (1, ..., 1)'$ is a $Tx1$ vector of 1s, $\mathbf{y}_{i,-j}$ and $\mathbf{X}_{i,-j}$ are j period lagged values of y_i and X_i, and $\Delta \mathbf{y}_i = \mathbf{y}_i - \mathbf{y}_{i-1}$, $\Delta \mathbf{X}_i = \mathbf{X}_i - \mathbf{X}_{i-1}$, $\Delta \mathbf{y}_{i,-j}$ and $\Delta \mathbf{X}_{i,-j}$ are j period lagged values of $\Delta \mathbf{y}_i$ and $\Delta \mathbf{X}_i$, and $\varepsilon_i = (\varepsilon_{i1}, ..., \varepsilon_{iT})'$.

This chapter also employ the Hausman test to check the long-run homogeneity hypothesis of pooled mean group estimator. The null hypothesis in this test is pooled mean group estimator is consistent and more efficient than mean group estimator (Pesaran et al., 1999). If the null hypothesis is rejected, then it cannot be assumed the same long-run coefficients for all panels and the restriction imposed by pooled mean group estimator is not valid. In other words, mean group estimator is preferred.

2.3.7 Summary Statistics

According to Landström (2013), CBI can lower inflation only in high inflation countries. Furthermore, Jácome and Vázquez (2008) claim that Latin American and Caribbean nations were successful in reducing inflation from about 50% in 1985 [3] to 7% in 2002. Then, our panel is divided into two groups on the basis of the level of inflation: high inflation countries (which experienced inflation higher than 90%) and moderate inflation countries with inflation lower than 90%. Other studies consider high and moderate inflation countries as a relevant subgroup in their own right; it seems necessary to consider such a breakdown of the panel.

Summary statistics for the whole sample, moderate inflation countries, and high inflation countries are provided in Table 2.1. There are 37 countries; 22 are moderate inflation economies, and 15 are high inflation countries[4].

Table 2.1: Summary Statistics

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
Full Sample countries				
Inflation	62.05714	515.9544	-9.808765	11,749.64
CBI	0.473521	0.188055	0.134500	0.951250
Output Gap	-0.000458	0.389526	-3.441898	4.590886
Openness	60.55755	31.27921	6.320343	220.4074
Fiscal Deficit	-3.470327	4.583374	-49.86610	20.15989
US Inflation	3.668309	2.237536	-0.3420615	10.55824
Unemployment Rate	7.976403	4.763053	0.400000	28.11000
Moderate Inflation countries				
Inflation	9.915486	8.573471	-9.808765	72.83550

Continued on next page

[3] Excluding Bolivia and Argentina, 11.750% and 672% respectively

[4] The summary statistic for each country is presented in Appendix

Table 2.1 – *Continued*

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
CBI	0.4445453	0.175059	0.134500	0.951250
Output Gap	0.002690	0.080297	-0.313903	0.522191
Openness	66.41406	33.45444	13.57894	220.4074
Fiscal Deficit	-3.367946	4.377520	-49.86610	18.45845
US Inflation	3.657496	2.221573	-0.3420615	10.55824
Unemployment Rate	7.960447	5.301742	0.400000	28.11000
High Inflation countries				
Inflation	137.4512	801.2337	-1.166895	11,749.64
CBI	0.514106	0.198631	0.149618	0.899000
Output Gap	-0.005009	0.601741	-3.441898	4.590886
Openness	52.08936	25.58662	6.320343	148.5350
Fiscal Deficit	-3.618365	4.865209	-38.20499	20.15989
US Inflation	3.682165	2.243204	-0.3420615	10.55824
Unemployment Rate	7.999474	3.857024	0.900000	22.45000

Computed from sample data (1972-2016)
Based on author calculation

The descriptive statistics in Table 2.1 show that during the period 1972 to 2016, the average inflation for the whole sample was 62.05714%. In the 22 moderate inflation countries the average inflation was 9.915486% and in the 15 high inflation economies the average inflation was 137.4512%. The lowest degree of independence is 0.1345 points, and the maximum score is 0.951250 points; the average for the full sample is 0.473521. Meanwhile, the averages for the two groups are quite close, 0.4445453 and 0.514106 for the moderate and high inflation countries, respectively. Interestingly, the average output gap in the moderate inflation group is positive (0.002690), in contrast to the high inflation countries, where it is -0.005009. The moderate inflation countries have a higher degree of trade openness, 66.41406%, as compared to 52.08936% for the high inflation countries. The fiscal deficit ratio is around -3.3% for both groups. The mean US inflation is 3.668309, with the maximum being 10.55824 and the minimum being -0.3420615%. Finally, for the unemployment rate, the mean is around 8%, with a range of 0.400 to 28.11 for all countries.

2.4 Empirical Results

2.4.1 Panel Unit Root Tests

This chapter uses the panel unit root tests proposed by Levin et al. (2002), in conjunction Im et al. (2003) and Breitung (2005) panel unit root tests to check the stationary series of the CBI, inflation, output gap, openness, fiscal deficit, US inflation and unemployment rate. Regarding the LLC, IPS and Breitung tests, the null hypothesis is non-stationary. LLC and Breitung tests assume a common autoregressive parameter for all panel; each individual series is stationary. IPS test assumes individual unit root (some of the individual series are stationary). The optimal lag length is automatically selected by means of Schwarz Info Criterion. This chapter uses individual intercept and trend in panel unit root tests.

Table 2.2: Panel Unit Root Tests

Series	**LLC**	**Breitung**	**IPS**
	Full Sample (37 Countries)		
Inflation	-11.0165***	-7.30148***	-13.3492***
CBI	0.77725	-4.19532***	0.30105
Output Gap	-4.42720***	-9.38384***	-12.1038***
Openness	-3.12023***	0.09438	-3.06704***
Fiscal Deficit	-7.02122***	-7.85203***	-6.43398***
US Inflation	-18.5833***	-10.9621***	-14.4713***
Unemployment	-5.21693***	-6.41433***	-6.41433***

Continued on next page

Table 2.2 – *Continued*

Series	LLC	Breitung	IPS
Moderate inflation (22 Countries)			
Inflation	-9.81723***	-8.27090***	-11.3536***
CBI	0.01875	-3.44989***	-0.69460
Output Gap	-5.64369***	-5.994053***	-9.69640***
Openness	-2.51497***	1.11234	-2.30954**
Fiscal Deficit	-4.77947***	-7.32956***	-4.49673***
US Inflation	-14.3296***	-8.45104***	-11.1588***
Unemployment	-3.75188***	-4.81594***	-4.72698***
High inflation (15 Countries)			
Inflation	-5.74159***	-2.27281**	-7.22827***
CBI	1.15007	-2.43955***	1.26193
Output Gap	-0.83477	-7.43313***	-7.27470***
Openness	-1.85025**	-1.67874**	-1.80560**
Fiscal Deficit	-5.21297***	-4.06553***	-4.66133***
US Inflation	-11.8323***	-6.97649***	-9.21409***
Unemployment	-3.63743***	-5.12397***	-4.34915***

Note: The table reports panel unit root tests. The symbols * is p $\leq$ 10%, ** is p $\leq$ 5%, and *** is p $\leq$ 10%. H_0: Panels contain unit roots. H_1: Panels are stationary. Critical values: 1%: -2.33; 5%: -1.65; 10%: -1.28.

Table 2.2 represents the result of the panel unit root test at level. The result illustrated that the null hypothesis is rejected for all variables at the 1% level of significance. Rejecting the null hypothesis means that those variables are I(0).

2.4.2 Estimation result of Pooled Least Square and Fixed Effect

A. Estimation result of Pooled Least Square

First, the author estimates four models in Equations (2.46) - (2.49) on three different groups: full sample, moderate inflation countries and high inflation countries by performing pooled least square estimation. The results are presented in Table A.3.

Columns 1-3 of Table A.3 examine model 1 of Equation (2.46). The results indicate that the negative effect of CBI on inflation is insignificant for all sample countries, moderate inflation countries and high inflation countries. Cukierman et al. (1992), Campillo and Miron (1997) and Daunfeldt and De Luna (2008) use the conventional panel data model to examine the effect of CBI on inflation. These studies find that there is no significant negative relationship between CBI and inflation. Our results support their finding that the negative impact of CBI on inflation is not significant in three groups of sample countries. These results confirm that assuming a homogeneity coefficient across countries, CBI does not explain inflation in developing countries.

In contrast, the output gap has a strong effect on inflation that has a positive sign and is significant at the 1% level. This result is consistent with our expected outcome since the excess output from its potential will lead to a higher price. The coefficient of the output gap for the full sample of countries is 404.06; this denotes that an increase (decrease) of 0.01 point (1 percentage point) in the output gap will increase (reduce) inflation by 4.0406%. The coefficient for the high inflation countries is quite close to that of the full sample of countries; in contrast, the coefficient for the moderate inflation countries is 11.863. This coefficient indicates that the output gap is very sensitive and is an inflationary variable in the high inflation countries.

Looking at another control variable, trade openness, our result shows that an increase in the ratio of trade openness is associated with lower inflation. However, the negative significance only appears in the moderate inflation group, and it is insignificant for the whole sample and the high inflation countries. The coefficient for moderate inflation is -0.0616 and it is significant at 1%. This coefficient implies that an increase of 1% in the trade openness will lead to a 0.0616% reduction in inflation. These results show that trade openness only plays a significant factor in reducing inflation in low inflation countries.

For the last variable, the author find a significant negative relationship between a fiscal deficit and inflation for the full sample countries with a coefficient of -17.904. This coefficient suggests that inflation will increase by about 18% for every increase of 1% in the fiscal deficit for the full sample of countries. However, when the sample is split based on the average inflation rate, the fiscal deficit becomes an unnecessary factor to reduce inflation.

Next, model 2 in Equation (2.47) is examined and the results are presented in columns 4-6 of Table A.3. Generally, the author find similar results to the previous findings after adding US inflation into model 1. The author does not find the presence of a negative significant relationship between CBI and inflation. The only difference is that a fiscal deficit in high inflation countries has a negative effect on inflation that has a coefficient of -38.142 and is significant at 1%. US inflation itself has an effect on inflation in the moderate inflation countries group; the effect has a coefficient of 1.0817 and is significant at 1%. However, in the full sample and high inflation group, the author does not find a significant relationship between US inflation and inflation. Columns 7-9 of Table A.3 reveal the results of model 3 in Equation (2.48). After adding the unemployment rate on model 1 in Equation (2.46). Interestingly, a negative significant relationship between CBI and inflation is showed in the moderate inflation group of countries. The coefficient of this relationship is -2.6262 and it is significant at 10%. The author also finds the same result, in terms of both sign and level of significance, regarding the effect of the output gap, openness and fiscal deficit on inflation with model 2. The unemployment rate has a negative and significant effect on inflation in the moderate inflation group of countries that has a coefficient -0.1222 and is significant at the 5% level. This implies that an increase of 1% in unemployment leads to approximately 0.12% lower inflation.

Finally, the author regress the level of the inflation rate with all of the economic variables in Equation (2.49), apart from CBI, output gap, openness, fiscal deficit, US inflation and unemployment. The aim of this test is to examine the effect of CBI on inflation if many other independent variables concerning inflation are added into the model. The results reveal that there is not a negative significant relationship between CBI and inflation. Output gap has a positive and significant effect on inflation at the 1% level. Openness has a significant effect on inflation only in the moderate inflation countries with a negative sign. The fiscal deficit only works to reduce inflation in the full sample and the high inflation group of countries. The effect of US inflation is only significant in the moderate inflation group of countries and has a positive sign. The unemployment rate has a negative and significant effect on inflation in the moderate inflation countries but has a positive and significant effect in the full sample and high inflation countries.

Overall, if the author compares the result in the three different group samples using a pooled least square estimation for four models, the significant negative effect of CBI on inflation does not exist except in the moderate inflation countries in model 3. The output gap, in contrast, has a significant positive impact on inflation for three different groups in all of the models. Meanwhile, trade openness only works efficiently in the moderate inflation countries for all models. In contrast, a fiscal deficit can reduce inflation in the full sample and in high inflation countries. After adding US inflation, the effect of CBI, output gap, openness and fiscal deficit on inflation is similar to model 1. The only difference is that the fiscal deficit has a negative and significant effect on inflation in the high inflation group of countries. US inflation itself only affects inflation in the moderate inflation countries, where it has a negative sign and is significant at the 1% level. However, if the unemployment rate is added instead of US inflation in model 3, the author find a negative and significant effect of CBI on inflation. The author also finds a significant and positive effect of unemployment rate on inflation in the full sample and the high inflation group in this model. Meanwhile, the relationship between the unemployment rate and inflation in the moderate inflation group is significant and has a negative sign. Finally, after adding US inflation and unemployment into model 1, the effect of US inflation on inflation only works in the moderate inflation group but the author still finds a significant effect of unemployment on inflation.

B. Estimation result of Fixed Effect

Table A.4 presents the result of the fixed effect estimation for the four models in Equations (2.46) - (2.49) on three different groups: the full sample, the moderate inflation countries and the high inflation countries. The author find a negative and significant effect of CBI on inflation in all four models for the full sample, the moderate inflation group and the high inflation group. The sign of the coefficients is in line with the theoretical expectation. For the full sample group, the author find a statistically significant negative relationship between CBI and inflation, with the coefficient ranging from -385.73 to -470.08. The relationship between CBI and inflation in the moderate inflation countries is negative and significant with the coefficient ranging between -13.130 and -19.028. For the high inflation countries, CBI has a significant negative effect on inflation with the coefficient ranging from -655.22 to -842.26.

This finding is consistent with Eijffinger et al. (1998) who report a negative and significant relationship between CBI and inflation using a fixed effect estimator. However, the within transformation process in the fixed effect estimation has a major drawback, which is that this model wipes out all time-invariant explanatory variables (unobservable individual specific effect, μ_i) such as cultural, political and institutional factors. If $\mu_i \neq 0$ the fixed effect estimation will be biased and give inconsistent estimates.

2.4.3 Diagnostic test for POLS and Fixed Effect

A. Poolability Tests Across Cross-Sectional Countries

The assumption in the pooled least square model is that all of the coefficients must be the same across country. Having estimated the pooled least square method, this chapter performs a poolability test under the assumptions of homoskedastic, and normally distributed errors. The test results are given below:

Table 2.3: Poolability Test

Test	**Full Sample**	**Moderate Inflation**	**High Inflation**
Model 1			
Chow	3.13***	6.67***	2.56***
	(0.0000)	(0.0000)	(0.0000)
	[144,1480]	[84,874]	[56,605]
Roy-Zellner[a]	451.15***	560.46***	143.59***
	(0.0000)	(0.0000)	(0.0000)
	[144]	[84]	[56]
No. of cross sections	37	22	15
No. of observations	1585	937	648
Model 2			
Chow	2.65***	5.03***	2.21***
	(0.0000)	(0.0000)	(0.0000)
	[180,1443]	[105,852]	[70,590]
Roy-Zellner[a]	477.68***	528.46***	154.42***

Continued on next page

Table 2.3 – *Continued*

Test	Full Sample	Moderate Inflation	High Inflation
	(0.0000)	(0.0000)	(0.0000)
	[180]	[105]	[70]
No. of cross sections	37	22	15
No. of observations	1585	937	648
<u>Model 3</u>			
Chow	2.91***	6.22***	2.39***
	(0.0000)	(0.0000)	(0.0000)
	[180,1443]	[105,852]	[70,590]
Roy-Zellner[a]	522.95***	653.34***	166.99***
	(0.0000)	(0.0000)	(0.0000)
	[180]	[105]	[70]
No. of cross sections	37	22	15
No. of observations	1585	937	648
<u>Model 4</u>			
Chow	3.60***	5.03***	2.22***
	(0.0000)	(0.0000)	(0.0000)
	[216,1406]	[126,830]	[84,575]
Roy-Zellner[a]	572.58***	634.00***	183.75***
	(0.0000)	(0.0000)	(0.0000)
	[216]	[126]	[84]
No. of cross sections	37	22	15
No. of observations	1585	937	648

Note: [a] using Viona (2008) code
Symbols *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. Probabilities are in parentheses. F-Distributions for Chow test and Chi square for Roy-Zellner test are in the bracket.

First, a Chow test on model 1 is applied, under $H_0; \beta_i = \beta$ for $i = 1,....N$. For the full sample of countries, the F-statistic is 3.13 and distribute as F(144,1480).

Meanwhile, for the moderate inflation countries, with F (84,874), with an F-statistic of 6.67, and for the high inflation countries, F(56,605), and an F-statistic of 2.56. The probability for all groups is 0.000. The author then conclude that poolability across countries is rejected. Secondly, the Roy-Zellner poolability test is performed following Baltagi (2008) for Equation (2.46). the author checks the null hypothesis that the cross-section units can be pooled against the alternative hypothesis that the cross-section cannot be pooled. The test statistics follow an F- distribution with ((N-1)K', N(T-K')) degrees of freedom, where N is the number of cross-sections, T represents the number of time series, K denotes the number of explanatory variables, and K' = K+1. The test statistics are 11.930, 7,7847 and 27.738 for the full sample, moderate inflation countries, and high inflation countries respectively, and the p-value for all tests is 0.00. From the results, the hypothesis of slope homogeneity is rejected. The author finds the same results for model 2, model 3 and model 4, in that we reject the hypothesis of slope homogeneity. The author concludes that the panel data are not poolable with respect to cross-sectional countries.

B. Test for The Presence of Fixed Effect

The fixed effect estimator assumes that time-invariants to be fixed. The null hypothesis is $H_0 : \mu_i = 0$ for every $i = 1, 2, ..., N - 1$. Table 2.4 presents the results of the Chow test, which suggests that the null hypothesis is rejected for all models. The author concludes that individual effects are significant in our model. These results imply that the fixed effect estimation could lead to biased results.

Table 2.4: Test for The Presence of Fixed Effect

Test	**Full Sample**	**Moderate Inflation**	**High Inflation**
<u>Model 1</u>			
Cross-Section F	3.74***	13.13***	3.30***
Probability	(0.0000)	(0.0000)	(0.0000)
d.f.	[36,1588]	[21,937]	[14,647]
<u>Model 2</u>			
Cross-Section F	3.81***	11.99***	3.42***

Continued on next page

Table 2.4 – *Continued*

Test	Full Sample	Moderate Inflation	High Inflation
Probability	(0.0000)	(0.0000)	(0.0000)
d.f.	[36,1587]	[21,936]	[14,646]
Model 3			
Cross-Section F	4.05***	12.90***	3.46***
Probability	(0.0000)	(0.0000)	(0.0000)
d.f.	[36,1587]	[21,936]	[14,646]
Model 4			
Cross-Section F	4.10***	11.81***	3.552***
Probability	(0.0000)	(0.0000)	(0.0000)
d.f.	[36,1586]	[21,935]	[14,645]

Note: Symbols *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. Probabilities are in parentheses. F-Distributions are in the bracket.

2.4.4 Estimation result of Heterogeneous Panel Data

Given that our data is not poolable, in this case, the coefficients in the pooled least square model are different, with an individual coefficient for every explanatory variable. To address this problem, this chapter apply a heterogeneous panel data estimation. Pesaran and Smith (1995) developed a mean group estimator that relies on estimating T time series regressions and averaging country-specific and time series parameter estimations, which are the unweighted means of the individual coefficients. The mean group estimator allows the intercepts, slope coefficients, and error variances vary across cross-sections. This estimator is consistent with the heterogeneity of slope coefficients because it considers complete parameter heterogeneity across groups. The pooled mean group estimator constructed by Pesaran et al. (1999) produces an efficient estimation since this estimator considers the common economic features across the cross-sections. The PMG estimator allows the intercept, speed of convergence, short-run coefficients, and error variances to differ freely across groups. The long-run coefficients are a nonlinear function of its short-run parameter. The PMG estimator combines pooling and averaging and recognises the diversity within each cross-section.

Following Pesaran et al. (1999) to estimate a dynamic panel heterogeneous based on ARDL $(p_i, q_i, k_i, l_i, m_i)$ model, Equation (2.46) becomes:

$$INF_{it} = \alpha_i + \sum_{j=1}^{p_i} \beta_{ij} INF_{i,t-j} + \sum_{j=0}^{q_i} \delta_{ij} CBI_{i,t-j} + \sum_{j=0}^{k_i} \theta_{ij} GAP_{i,t-j} + \sum_{j=0}^{l_i} \gamma_{ij} OPEN_{i,t-j} + \sum_{j=0}^{m_i} \lambda_{ij} FD_{i,t-j} + \varepsilon_{it} \tag{2.76}$$

By re-parametrization, the error correction model becomes:

$$\begin{aligned}\Delta INF_{it} = {} & \phi i(INF_{i,t-1} - \alpha_i^* - \delta_i^* CBI_{it} - \theta_i^* GAP_i - \gamma_i^* OPEN_{it} - \lambda_i^* FD_{it}) \\ & + \sum_{j=1}^{p_i-1} \beta_{ij}^{**} INF_{i,t-j} + \sum_{j=0}^{q_i-1} \delta_{ij}^{**} CBI_{i,t-j} + \sum_{j=0}^{k_i-1} \theta_{ij}^{**} GAP_{i,t-j} + \sum_{j=0}^{l_i-1} \gamma_{ij}^{**} OPEN_{i,t-j} \\ & + \sum_{j=0}^{m_i-1} \lambda_{ij}^{**} FD_{i,t-j} + \varepsilon_{it}\end{aligned} \tag{2.77}$$

where $\phi_i = -(1 - \sum_{j=1}^{p_i} \beta_{ij})$; $\alpha_i^* = -\alpha_i/\phi_i$; $\delta_i^* = \sum_{j=0}^{qi} \delta_{ij}/\phi_i$; $\theta_i^* = \sum_{j=0}^{ki} \theta_{ij}/\phi_i$;
$\gamma_i^* = \sum_{j=0}^{li} \gamma_{ij}/\phi_i$; $\delta_i^* = \sum_{j=0}^{mi} \delta_{ij}/\phi_i$; i=1,2,...,37, t=1,2,...,45. ε_{it} is *iid*. ϕ_i is the coefficient of error correction term, which determines the speed of adjustment to the equilibrium. $\beta_{ij}^{**}, \delta_{ij}^{**}, \theta_{ij}^{**}, \gamma_{ij}^{**}, \lambda^{**}$ are short-run coefficient, while $\delta_{ij}^*, \theta_{ij}^*, \gamma_{ij}^*, \lambda^*$ are long-run coefficient, and α_i is the fixed effect.

A. Full Sample Model

This section examines the effect of CBI and other control variables on inflation. this section presents the estimation results of four models in three different groups by performing PMG and MG estimations for 37 developing economies during the period 1972 to 2016 in Table 2.5.

To choose the optimal lags for each variable in the long-run and the short-run, Akaike Info Criterion (AIC) is applied. The ARDL (1,1,1,1,1) is preferred in this model based on AIC results. The Hausman test is performed to test for the long-run homogeneity of the coefficient of all of the independent variables, with the null hypothesis as homogeneity in the long-run coefficient. If the null hypothesis is rejected, that means that the MG estimator is preferred to the PMG estimator. On the other hand, the PMG estimator is more consistent and efficient if the null hypothesis can not be rejected.

The error correction term is statistically significant and has a negative sign, so there exists a long-run relationship between inflation and its essential determinants. This negative and significant coefficient implies that in response to a shock, inflation adjust to the long-run equilibrium, the explanatory variables in the model bring about a correction in the opposite direction. In the PMG estimator, the coefficients of ECT are in the range -0.4840 to -0.4983 and significant at 1%. This implies that the disequilibrium in the short-run will be corrected annually by between 48.40% and 49.83% and a long-run equilibrium exists after around 2 years for the PMG estimator. On the other hand, for the MG estimator, the coefficients of ECT are between -0.6909 and -0.7311 and significant at 1%. The ECT coefficients of the MG estimator are higher than those for the PMG estimator. This implies that a long-run equilibrium exists earlier for the MG estimator, at around 1.36 to 1.44 years.

The PMG parameter constrains the long-run parameters such that they are the same across the country. The author tests the null hypothesis of homogeneity and the validity of the long-run homogeneity restriction across the country. If the null hypothesis is not rejected, that implies that the long-run parameter is homogeneous. As a result, the PMG estimator is consistent. The MG estimator is always consistent; however, under the homogeneity condition, it is inefficient. The Hausman statistic value for model 1 is 4.22 (p-value is 0.3376). The author also find that the p-values are 0.7833, 0.8236, and 0.9596 for model 2, model 3, and model 4, respectively. These results show that the null hypothesis is not rejected, which indicates that the PMG is consistent and more efficient than the MG estimator for the four different models. These Hausman test results imply that in the long-run, the relationship between inflation and the explanatory variables is the same across the countries.

The long-run parameter estimates can be explained as follows. The result shows a statistically significant negative long-run relationship between CBI and inflation with coefficients ranging from -4.2971 to -33.987 for the four models. This finding is supported by the theoretical view of CBI[5], whereby delegating monetary policy to an independent central bank will reduce inflation. Our finding is supported by Grilli et al. (1991), Cukierman et al. (1992), Jonsson (1995), Brumm (2002), Ahsan et al. (2008), Acemoglu et al. (2008) and Maslowska (2011),

[5] Kydland and Prescott (1977); Barro and Gordon (1983); Rogoff (1985)

who found a negative and significant effect of legal CBI on inflation. Hayo and Hefeker (2001) stated that most economists agree that CBI helps to reach the long-term goal of price stability.

Next turn the attention towards the relationship between the output gap and inflation. The result reveals that in the long-run, the relationship between the output gap and inflation is negative and significant with a coefficient ranging between -30.290 and -34.103 for the four models. These results reveal that in the long-run, a 1 percentage point increase in output gap leads to around 0.30 to 0.34% lower inflation. This corresponds to a finding reported by Kydland and Prescott (1990), that is, that the reverse relationship is due to supply shocks. Once the economy is overheating, higher productivity drives the firms to raise output. The extra level of output results in adequate income, which in turn produces an equivalent level of demand. Firms then reduce their labour, causing disinflationary pressure in a cycle, which is the opposite to that described for a demand shock.

The author now analyses the effect of trade openness on inflation. Trade openness affects inflation negatively at the 1% level of significance, as the author would expect, for models 1 and 2. The coefficients of this relationship are -0.0615 and -0.0558, which means that an increase of 1% in trade openness will reduce inflation to between 0.0558% and 0.0615%. This result corresponds with the theory that inflation is lower in an open economy, since a deterioration in the terms of trade increases the cost of the expansionary monetary policy. This result is also in line with the empirical finding of Romer (1993) regarding the negative relationship between trade openness and inflation in developing countries. He argued that the benefit of an expansionary monetary policy tends to be smaller in an economy with a larger share of trade to GDP because firstly, the weight of the home goods sector will be smaller, implying that the impact of monetary expansion on domestic employment will be reduced, and secondly, the currency depreciation resulting from monetary expansion will raise domestic inflation by more than it would in a closed economy. However, when the unemployment rate is included in the model, the negative and significant effect of openness on inflation disappears.

Table 2.5: Heterogeneous Panel Estimation

Variable	Model 1		Model 2		Model 3		Model 4	
	PMG	MG	PMG	MG	PMG	MG	PMG	MG
				Long Run Coefficients				
CBI	-11.082***	-5.7258	-4.2971*	-31.887	-33.987***	4.2539	-7.2125***	26.080
	(2.8408)	(107.28)	(2.3185)	(91.077)	(3.7033)	(167.47)	(2.4097)	(227.84)
Output Gap	-30.290***	-3.2776	-30.553***	4.8620	-34.103***	-15.910*	-32.428***	-8.7109
	(4.8273)	(11.930)	(4.4259)	(16.432)	(4.9602)	(8.2835)	(4.4340)	(9.2148)
Openness	-0.0615***	-3.1526*	-0.0558***	-2.9333*	0.0288	-3.3651	-0.0263	-2.8424
	(0.0220)	(1.7145)	(0.0204)	(1.6261)	(0.0216)	(2.3727)	(0.0176)	(2.2098)
FD	-0.4920***	-4.4522	-0.3855***	-4.3457	-0.3876***	0.4707	-0.2678***	0.4358
	(0.1052)	(4.4843)	(0.0942)	(4.4753)	(0.1108)	(4.6249)	(0.0921)	(4.9945))
US Inflation			0.7542***	-1.2780			0.8427***	0.7886
			(0.1500)	(4.9048)			(0.1458)	(4.7381)
Unemployment					-0.4393***	12.136	-0.3415***	3.305*
					(0.1195)	(6.2917)	(0.1189)	(6.9894)
				Short Run Coefficients				
Error Corrections	-0.4860***	-0.6909***	-0.4910***	-0.6961***	-0.4840***	-0.7311***	-0.4983***	-0.7309***
	(0.0398)	(0.0376)	(0.0401)	(0.0387)	(0.0383)	(0.0391)	(0.0368)	(0.0390)
Δ CBI	367.51	330.11	380.84	298.46	377.52	338.21	384.93	310.96
	(243.14)	(385.11)	(248.56)	(378.48)	(243.18)	(356.40)	(245.69)	(346.29)
Δ Output Gap	283.34***	294.35***	281.40***	289.46***	285.36***	312.25***	283.29***	307.00***
	(95.483)	(101.75)	(95.955)	(100.08)	(95.318)	(111.00)	(95.680)	(108.87)

Continued on next page

Table 2.5 – *Continued*

Variable	Model 1		Model 2		Model 3		Model 4	
	PMG	MG	PMG	MG	PMG	MG	PMG	MG
Δ Openness	-1.6518	-0.3071	-1.6346	0.5083	-1.8001*	-0.1791	-1.8087*	0.2769
	(1.1521)	(1.2369)	(1.1327)	(1.4909)	(1.0777)	(1.1422)	1.0635)	(1.5375)
Δ FD	1.0568	4.9690	1.2293	4.3881	1.1072	2.4070	1.2209	1.9408
	(3.9619)	(4.2613)	(3.9532)	(4.3491)	(4.1496)	(3.8131)	(4.1266)	(4.7164)
Δ US Inflation			-0.4754	-2.7364			0.5059	-2.1185
			(0.2434)	(1.3896)			(1.4162)	(3.2452)
Δ Unemployment					4.0367*	-3.7785	4.4083*	-4.3601
					(2.3401)	(4.7203)	(2.4409)	(5.0584)
Constant	49.547***	114.83	46.964**	157.40	54.841***	-33.480	48.052***	-74.401
	(18.415)	(88.278)	(18.308)	(98.953)	(18.803)	(245.49)	(18.398)	(321.04)
Joint Hausman Test	4.22 [0.3376]		2.45 [0.7833]		2.18 [0.8236]		1.50 [0.9596]	
No. of cross sections	37	37	37	37	37	37	37	37
No. of observations	1585	1585	1585	1585	1585	1585	1585	1585

Note: The table reports coefficients from PMG and MG estimation for four different models. The dependent variable is inflation. The symbols *, **, and *** denote statistical significance at the 10%, 5% and 1% respectively. Standard errors are in parentheses, p-value in brackets. Critical values: 1%: 2.576; 5%: 1.960; 10%: 1.645.

Fiscal deficit has a significant negative effect on inflation with a coefficient ranging from -0.2678 to -0.4920 for the four models. This indicates that a higher fiscal surplus (deficit) leads to lower (higher) inflation in the long-run. The more negative the fiscal deficit, the higher inflation will be, which means that fiscal deficit leads to inflation. This implies that a 1% reduction (increase) in the ratio of fiscal deficit on GDP is estimated to lower (higher) inflation by about 0.26% to 0.49%. This finding is supported by Bodea and Hicks (2015), Bogoev et al. (2012) and Garriga (2016), who found a negative relationship between fiscal deficit and inflation.

After the United States inflation is added into the model, the result shows that US inflation has a significant and positive effect on inflation, with a coefficient of between 0.7542 and 0.8427. This implies that if inflation in the United States increases by 1% that will lead to about 0.8% higher inflation in developing countries. These results are consistent with Kollmann (2001), who argues that inflation in a foreign country will lead to an increase firm's marginal costs, and thus, domestic price will higher. Cheung and Yuen (2002) state that US inflation has a positive and strong effect on a small open economy.

Finally, by adding the unemployment rate into the model, our results show that the unemployment rate has a negative significant effect on inflation. The coefficient of the unemployment rate for model 3 is -0.4393 and it is significant at the 1% level. This means that a reduction (rise) in the unemployment rate will increase (decrease) the inflation rate by 0.44%. The coefficient of the unemployment rate is lower when US inflation is included in the model (model 4), -0.3415, but it is still significant at 1%.

On the other hand, in the short-run, the coefficients of the PMG estimator reveals a different pattern. This is because, in the short-run, the coefficients are not restricted to being the same across countries. Hence, there will be no single common estimate for any coefficient. The average short-run effect can be estimated by considering the mean of the corresponding coefficients across countries. The author cannot establish a significant impact of CBI on inflation in all of the sample countries, or in the moderate and high inflation countries. This shows that there is a delayed effect of CBI that can reduce inflation in all four models. The reason why there is no significant effect of CBI on inflation in the short-run is that there is a trade-off between inflation and output. According to Debelle and Fischer (1994) and Walsh (1995), CBI strengthens the effect of monetary policy on real activity, and the trade-off between output and inflation is more significant in countries with a more independent central bank. This implies that countries with a more independent central bank have a larger short-run effect on real output and employment. This suggests that in the short-run, monetary policy seeks to pursue high output and employment rather than inflation. Another reason is that in the short-run prices are sticky and expected inflation is unchanged; therefore the monetary policy will not affect inflation in the short-run.

Output gap has a significant effect on inflation in the short-run, with a positive sign. The coefficients of the output gap are in the range of 281.40 and 285.36. These results imply that in the short-run, a 1 percentage point increase in the output gap leads to around 2.81 to 2.85% higher inflation. This result corresponds with the Phillips curve, in which the actual output is higher than the potential output; this will have an impact in terms of increasing wages in the labour market because higher wages enhance production costs. As a result, prices will rise. The previous study by Farvaque et al. (2010) supports this positive relationship between the output gap and inflation.

Trade openness only has a significant effect on inflation in model 3 and model 4, with coefficients of -1.8001 and -1.8087; both results are significant at 10%. US inflation does not have a significant effect on inflation in model 2 and model 4. Lastly, the unemployment rate has a positive and significant effect on inflation, with coefficients of 4.0367 and 4.4083, this effect is significant at 10%.

B. Split Sample Estimates

The results of the pooled mean group estimator for the moderate and high inflation countries are reported in Table 2.6. Focusing first on the moderate inflation economies, the adjustment coefficient for the PMG estimator is negative and significant at 1%. The speed of the adjustments are -0.4740, -0.4759, -0.4839 and -0.4833 for model 1, model 2, model 3 and model 4, respectively. These coefficients indicate that around 47% to 49% of the disequilibrium in the short-run is corrected in the long-run for the moderate inflation countries. These adjustments suggest that any deviation in inflation from the long-run equilibrium relationship will be corrected in the opposite direction in 2.1 to 2 years. Our finding for the high inflation group reveals that the long-run coefficient of convergence is negative and significant at the 1% level, with coefficients of -0.6095, -0.6128, -0.6206 and -0.6198 for model 1, model 2, model 3 and model 4, respectively. These coefficients indicate that around 60% to 62% of the disequilibrium in the short-run is corrected in the long-run for the high inflation group of countries. The adjustment time for inflation to achieve long-run equilibrium is approximately 1.6 years.

Based on the result attained from the error correction term coefficient, it can be inferred that inflation in the high inflation countries achieves long-run equilibrium faster than in the moderate inflation countries. Therefore, the impact of CBI on reducing inflation in high inflation countries is more efficient and faster than in the moderate inflation countries. According to Loungani and Sheets (1997), high inflation countries experience hyperinflation; this creates a high degree of aversion to inflation, which may establish a high degree CBI index and also result in lower inflation than in moderate inflation countries.

The author now analyse the long-run relationship between inflation and CBI for the moderate inflation group of countries. In model 1, CBI has a negative and significant effect on inflation with a coefficient of -7.4139; this effect is significant at 1%. This result implies that the index of legal CBI increases by 0.1 points, and inflation is therefore reduced by 0.74%. The estimated coefficient is quite close to the long-run coefficient reported by Eijffinger et al. (1998)[6]. If US inflation is added into the model, it reduces the coefficient to -3.8242. However, if the unemployment rate is added into the first model, then the effect of CBI on inflation is stronger (-10.631) than in the first model. Meanwhile, when both US inflation and unemployment are added into the model, the coefficient of the effect of CBI on inflation is -4.8142 and the effect is significant at 5%. Similarly, the coefficients of the relationship between CBI and inflation in high inflation countries are - 88.030, -86.435, -92.139 and -91.518 for model 1, model 2, model 3 and model 4, respectively and those relationships are significant at 1%. This implies that every 0.1 increase in the legal CBI index will reduce inflation by about 9%.

This finding implies that CBI could be helpful for countries facing a high level of inflation. Our result shows that the coefficient of the relationship between CBI and inflation is high, particularly in the high inflation group of countries. This high coefficient is due to the fact that this chapter uses the level of inflation that is calculated by the difference in consumer price divided by the previous consumer price. Previous studies have transformed inflation or used the logarithm of average inflation [7]. Other studies treat high inflation as an outlier and remove it from the sample data. The coefficients associated with the high inflation countries (from -86.435 to -92.135) are roughly ten times larger than those of the moderate inflation countries (-3.8242 to -10.631); this is due to the fact that the decrease in inflation is larger in high inflation countries. This finding is supported by

[6] Using legal CBI index constructed by Cukierman et al. (1992), Eijffinger et al. (1998) find the coefficient between legal CBI and inflation is -8.83

[7] Cukierman et al. (1992); Jácome and Vázquez (2008)

Jonsson (1995), who argued that CBI is the most crucial variable during a high inflation period. The more independent the central bank, the more freedom central bank has to set and implement monetary policy to reduce inflation. Our finding contrasts with that of Landström (2013), who argues that CBI is not an important factor in reducing inflation in low and moderate inflation countries.

The author now consider the relationship between the output gap and inflation. The result of the PMG estimator shows the adverse effect of the output gap on inflation in the long-run; this effect is significant at 1%. For the moderate inflation countries, the coefficients are -15.663, -17.447, -17.286 and -19.573 for model 1, model 2, model 3 and model 4, respectively. Meanwhile, for the high inflation countries, the coefficients are -45.657, -45.716, -40.950 and -42.023 for model 1, model 2, model 3 and model 4, respectively. This means that in the long-run, every 1 percentage point that actual GDP is higher than it's potential will reduce inflation by 0.15 to 0.2% in moderate inflation countries and 0.4 to 0.45% in high inflation countries. Kydland and Prescott (1990), Ball and Mankiw (1994), Judd and Trehan (1995), den Haan (2000) and Berument et al. (2008) also found the same result regarding the negative relationship between inflation and output gap. The negative correlation between those variables is due to the supply shock effect. The longer-run implications are entirely different as a supply-side shock can have a permanent impact on non-inflationary output levels. This finding denotes that the supply side is dominant in the long-run in developing countries. Hoffmaister and Roldós (1997, 2001) report that the principal factor in output fluctuation in Asian and Latin American countries is supply shock. Hoffmaister et al. (1998) find the same results for Sub-Saharan African countries. They conclude that supply shocks (productivity and labour supply) play a substantial role in explaining output movement.

This chapter can also see that the long-run effect of trade openness on inflation is negative and significant at 1% for moderate and high inflation countries. The coefficients for the moderate inflation group are -0.0403, -0.0304, -0.0243 and -0.0151 for model 1, model 2, model 3 and model 4, respectively. This means that the ratio of export and import to GDP increases (decreases) by 1% and then it will lower (higher) inflation by 0.015 to 0.04%. Meanwhile, the result shows a higher coefficient in the high inflation countries than in the moderate inflation countries: -0.3527, -0.3428, -0.3373 and -0.3256 for model 1, model 2, model 3 and model 4, respectively. Trade openness can affect inflation through import prices and the competitive effect, as a result, will increase efficiency, which will reduce the cost of production inputs. This result concur with the findings of Romer (1993), Temple (2002), Ashra (2002) and Lin (2010). This negative relationship can be explained by two main reasons. First, trade openness creates competitiveness and hence, reduces inflation. Second, trade openness leads to diversification, which may lower the aggregate inflation by lowering the price shock. The theoretical understanding as to why more open economies tends to result in less inflation follows from Rogoff's (1985) model, which shows that open economies gain less from surprise inflation and pay the price of monetary expansion more quickly, especially if the exchange rate is floating. Triffin and Grubel (1962) found that openness leads to the availability of cheaper goods, and confirmed that more open economies tend to have lower inflation. Alfaro (2005) indicated that in the short-run, there is no influence of trade openness on inflation; however that negative relationship exists in the long-run.

As a final check, the relationship between fiscal deficit and inflation is analysed. There, the result reveals that both the moderate and high inflation groups, fiscal deficit and inflation have a negative association at the 1% level of significance. The coefficients for the moderate inflation group are -0.3750, -0.2979, -0.2490, -0.2023 for model 1, model 2, model 3 and model 4, respectively. This means that a reduction in fiscal deficit of 1% leads to an increase in the inflation rate of 0.2023 to 0.3750%. In the sub-sample of high inflation countries, the impact of a 1% reduction in the fiscal deficit leads to an increase in the inflation rate of 2.5368%, 2.3760%, 2.2689%, 2.1174% for model 1, model 2, model 3 and model 4, respectively. This result coincides with the perspective that countries that have a high inflation rate typically lack good institutions and it is difficult to find external debt to finance their deficit. Thus use seigniorage revenues as a source to cover the deficit (Dornbusch et al., 1990). This finding is consistent with the study of Fischer et al. (2002), who state that fiscal deficit is an essential factor in influencing inflation, particularly in high inflation countries.

After controlling for US inflation, in the long-run, our finding for the moderate inflation group of countries is consistent with the prior expectation that US inflation positively influence domestic inflation. The coefficients of the effect of US inflation on domestic inflation are 0.7092 and 0.7927 for model 2 and 4, respectively and significant at the 1% level. This implies that an increase (reduction) of 1% in inflation in the US will lead to an increase (reduction) of around 0.71% and 0.8% in the moderate inflation group of countries. On the other hand, for the high inflation countries, the results show that US inflation has a positive but insignificant effect on inflation.

Then the unemployment rate is added into the basic model. In the moderate inflation group, the result shows that the unemployment rate has a negative effect on inflation in the long-run with coefficients of -0.4051 and -0.2946 for model 3 and model 4 respectively, which are significant at 1%. However, in the high inflation group of countries, the author does not find a significant effect of unemployment rate on inflation. These results imply that in the long-run, the unemployment rate in moderate inflation countries is larger and has more impact on inflation than the unemployment rate in high inflation countries.

Focusing on the short-run model, the output gap has a significant effect on inflation with a positive sign for both the moderate and high inflation countries in four different models. For the moderate inflation countries, the coefficients are 47.759, 43.073, 49.144, 44.302 for model 1, model 2, model 3 and model 4, respectively, while for high inflation countries, the coefficients are 631.30, 634.38, 633.40, and 636.87 for model 1, model 2, model 3 and model 4, respectively. These coefficients denote that a 1% (0.01 unit) increasing in output gap leads to an increase in inflation by 0.4 to 0.5 % for moderate inflation countries; and around 6.3% for high inflation countries. This finding concurs with Gerlach and Smets (1999) empirical finding that 1% increase in output gap raises inflation by 0.2%. This implies that in the short-run demand shocks are dominant in developing countries. Openness has a negative effect on inflation in high inflation countries in models 3 and 4 with a coefficient of around -4.4; this effect is significant at 10%. Finally, the unemployment in model 3 for the moderate inflation group has a positive effect at 5% with a coefficient of 0.4247.

Table 2.6: Pool Mean Group Estimation

Variable	Model 1		Model 2		Model 3		Model 4	
	Moderate	High	Moderate	High	Moderate	High	Moderate	High
Long Run Coefficients								
CBI	-7.4139***	-88.030***	-3.8242*	-86.435***	-10.631**	-92.139***	-4.8142**	-91.518***
	(2.2496)	(8.7718)	(2.0043)	(9.7235)	(2.3277)	(7.8694)	(2.0843)	(8.8479)
Output Gap	-15.663***	-45.657***	-17.477***	-45.716***	-17.286***	-40.950***	-19.573***	-42.023***
	(4.3588)	(0.513)	(4.1936)	(10.424)	(4.4220)	(9.7640)	(4.2158)	(9.8336)
Openness	-0.0403**	-0.3527***	-0.0304*	-0.3428***	-0.0243*	-0.3373***	-0.0151	-0.3256***
	(0.1736)	(0.0730)	(0.0160)	(0.0736)	(0.0147)	(0.0694)	(0.0139)	(0.0700)
FD	-0.3750***	-2.5368***	-0.2979***	-2.3760***	-0.2490***	-2.2689***	-0.2023**	-2.1174***
	(0.0875)	(0.5038)	(0.0805)	(0.4922)	(0.0880)	(0.4865)	0.0809)	(0.4759)
US Inflation			0.7092***	0.2337			0.7927***	0.2225
			(0.1379)	(0.7352)			(0.1351)	(0.6927)
Unemployment					-0.4051***	0.2236	-0.2946***	-0.1426
					(0.1339)	(0.6455)	(0.1129)	(0.6391)
Short Run Coefficients								
Error Corrections	-0.4740***	-0.6095***	-0.4759***	-0.6128***	-0.4839***	-0.6206***	-0.4833***	-0.6198***
	(0.0491)	(0.0638)	(0.0478)	(0.0641)	(0.0437)	(0.0649)	(0.0413)	(0.0657)
Δ CBI	-8.7095	981.76	-2.1903	1010.6	-1.5008	976.61	5.0592	1006.85
	(18.059)	(625.00)	(18.166)	(639.95)	(13.721)	(614.01)	(15.369)	(626.38)
Δ Output Gap	47.759***	631.30***	43.079***	634.38***	49.144***	633.40***	44.302***	636.87***
	(7.0725)	(209.51)	(7.2271)	(210.09)	(6.9402)	(208.58)	(7.1029)	(208.97)

Continued on next page

Table 2.6 – *Continued*

Variable	Model 1		Model 2		Model 3		Model 4	
	Moderate	High	Moderate	High	Moderate	High	Moderate	High
Δ Openness	0.0959	-4.1422	0.0404	-3.9706	0.0904	-4.4300*	0.0395	-4.4102*
	(0.0583)	(2.7872)	(0.0551)	(2.7494)	(0.0573)	(2.5592)	(0.0539)	(2.5208)
Δ FD	0.0193	3.9188	0.0359	4.3720	-0.0063	3.8718	0.0325	4.2571
	(0.0825)	(10.1316)	(0.0868)	(10.101)	(0.0863)	(10.5351)	(0.0932)	(10.496)
Δ US Inflation			0.1851	-1.7774			0.1260	0.6861
			(0.1749)	(2.8601)			(0.1742)	(3.6892)
Δ Unemployment					0.4247**	8.4956	0.5675	9.1491
					(0.1902)	(5.5330)	(0.3561)	(5.7016)
Constant	6.7164***	142.65***	4.4632***	142.09***	8.7422***	146.58***	5.4299***	145.39***
	(0.7406)	(43.940)	(0.5246)	(44.054)	(0.8108)	(44.213)	(0.5299)	(44.301)
No. of cross sections	37	37	37	37	37	37	37	37
No. of observations	1585	1585	1585	1585	1585	1585	1585	1585

Note: The table reports coefficients from pooled mean group estimation for four different models. Moderate is moderate inflation countries group, High is high inflation countries group. The dependent variable is inflation. The symbols *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. Standard errors are in parentheses. Critical values: 1%: 2.576; 5%: 1.960; 10%: 1.645.

2.5 Conclusion

This chapter provides new evidence of the effect of CBI and some control variables on inflation from the perspective of both long-run equilibrium and short-run dynamics. In this study, the author argue that the typical assumption of parameter homogeneity in panel data that has been used in previous empirical studies on the relationship between CBI and inflation does not hold. Since the previous works did not meet the validity of the parameter homogeneity, this implies that their results were biased. As a result, the findings regarding the existence of a negative relationship between CBI and inflation are not conclusive. This result is supported by Brumm (2002) and Andriani et al. (2013) who state that the absence of a negative relationship between CBI and inflation is due to an inappropriate econometrics methodology.

Given that our panel consists of heterogeneity across countries, this chapter performed the MG and PMG estimations in a panel of 37 developing economies. The sample was also divided into two groups, moderate and high inflation countries, to gain an insight into the nature of this heterogeneity. The results reveal that the error correction term for both the MG and PMG estimators is statistically significant and has a negative sign, suggesting that a long-run relationship exists between these variables. However, the Hausman test indicates that the PMG estimator is more consistent and efficient, so the MG estimator is omitted from the discussion. The speed of adjustment of inflation from the long-run equilibrium is corrected in the opposite direction. It takes around 1.6 years in the high inflation group and 2.1 years in the moderate inflation group.

Some further implications follow from these findings. The result confirms that there is a long-run negative relationship between CBI and inflation. If the author distinguishes between moderate and high inflation countries, the result shows that CBI has a higher impact in high inflation countries. This suggests that the role of central bank reforms is more efficient in reducing inflation in countries with a high inflation rate. The result of the PMG estimator provides evidence that output gap, trade openness, and fiscal deficit have a significant negative relationship with inflation in the long-run. The reverse relationship between output gap and inflation, in the long-run, reveals that in developing countries the effect of supply shocks is dominant. This finding is in line with the earlier work of Kydland and Prescott (1990), who argue that there exists a negative relationship between the output gap and inflation due to supply shocks. The open economy can lead to efficiency and reduce the cost of production due to the competitive effect among other countries. This view is in line with our result that trade openness has a negative and significant effect on inflation. Earlier studies such as those of Romer (1993), Temple (2002), Ashra (2002) and Lin (2010) support our result. The relationship between fiscal deficit and inflation is negative and significant. The more negative the fiscal deficit, the higher the inflation. This can be caused by the limited access of developing economies to external finance sources due to low government credibility. Thus they sometimes rely on seigniorage revenue to finance the deficit. After adding US inflation and unemployment rate, the author still find a negative and significant relationship between CBI and inflation. Regarding the short-run effect, CBI, trade openness, and fiscal deficit, they have an insignificant influence on inflation. Only the output gap has a significant effect on inflation, with a positive sign. This positive sign may be attributed to the dominance of demand shocks in developing countries.

Chapter 3

Central Bank Independence, Financial Asset Prices, Consumption and Investment

3.1 Introduction

The previous chapter reveals that CBI succeeds to reduce inflation in developing countries. Seeing as the objective of central bank independence is solely price stability, various countries which opted for the independent central bank have enjoyed low and stable inflation. However, after 2007, the financial crisis changed the central bank's concern, which is the apparent increase in financial instability (Bernanke and Gertler, 1999). Associated with financial instability, Shiratsuka (2001), argue that financial instability is closely interconnected with asset price fluctuation. He cited Japan's experience as an example, since the 1980's asset price bubble played a crucial part in economic fluctuation even though the inflation rate remained stable in that period. In addition, the low interest rate was exacerbating the asset price bubble resulting in financial instability and a prolonged recession. Borio et al. (1994) reported the fluctuation in financial asset prices in various developed countries since the early 1980s has been the role of financial instability.

The role of CBI to affect financial asset prices can be explained as follow: central bank reform (change in the degree of CBI) will alter the public's expectation of inflation. Then, if the public perception of inflation change, the asset price should also change due to the sensitivity related to inflation. This means that financial asset prices contain information pertaining to future inflation. Smets (1997) explained two key reasons concerning the relationship between financial asset prices and expected inflation. First, aggregate demand change is directly due to a change in asset price, whilst second, financial asset prices depend on future return expectation, such as future economic activity, inflation and monetary policy. These changes highlight the importance of investigating the relationship between CBI and financial asset prices. Claessens and Kose (2017) categorise asset price into equity prices, house prices, exchange rate, and interest rate. Seeing as house price is a non-tradeable product, the author therefore only focus on three other assets. A few papers have focused on central bank reform over the financial asset prices. Kuttner and Posen (2010) and Moser and Dreher (2010) documented the changes of central bank's governor and their relationship to the financial asset prices. Eichler and Littke (2018) examined the effect of CBI on exchange rate volatility. Forch and Sunde (2012) and Papadamou et al. (2017) investigated the relationship between CBI and stock index volatility, whilst Bodea and Hicks (2014) analysed the effect of CBI on bond yield. This chapter also examines the impact of three different financial asset prices on private consumption and investment. Finally, this chapter studies the effect of CBI on consumption and investment via the exchange rate, stock index and bond yield.

It is vital for central banks to examine the effect of asset price fluctuation related to two of the central bank's objectives: price and financial stability. Bernanke and Gertler (1999) stated that price stability and financial stability are complementary, which implies that by stabilising price, the central bank may stabilise financial asset prices. Low and stable inflation provide the central bank with room to react to the financial crisis. Certain studies, such as Stock and Watson (1999), Goodhart and Hofmann (2000) and Bordo and Jeanne (2002) agreed that financial asset prices can predict future movement in the CPI. Cecchetti et al. (2000) state that development of financial asset prices have a significant impact on inflation and economic activity. The literature on financial asset prices and monetary policy tends to focus on three arguments: the first is that the change in price level (inflation) can be measured by the asset price changing; second, financial asset prices forecast inflation and third, there are structural links between asset price and consumption and investment (Gilchrist and Leahy, 2002).

Economic theory suggests that asset price has a direct effect on consumption and investment for the reason that it is forward-looking. In this study, the relationship between financial asset prices and real activity focus on consumption and investment. Tobin's q theory explains the influence of financial asset prices on household consumption and saving decisions via wealth and substitution channels. Public consumption decisions are based on current and future income, as well as current financial and physical assets. Changes in financial asset prices can affect current consumption because of changes in household financial and real wealth. Thus, changes in consumption allocation can influence household saving behaviour.

Furthermore, this chapter compares which asset price has greater sensitivity due to CBI changing. Our results show that the shock of CBI on exchange rate appreciation is delayed. In fact, it takes roughly a year for CBI to appreciate the exchange rate. Stock index will rise in two quarters after the shock of CBI, though after period three the effect becomes negative. Finally, this chapter establishes that CBI has a significant role in reducing bond yield in all periods. Therefore, this chapter can concludes that the greatest effect of CBI on financial asset prices is on bond yield. In this paper, financial asset prices have an essential role in monetary policy transmission, to the extent that change in CBI affects the exchange rate, stock index and bond yield, thereby influencing private consumption and investment. Greater CBI produces lower private consumption for all three channels. CBI needs three quarters to increase investment via the exchange rate and stock index, but CBI directly increases investment via the bond yield channel.

The remainder of the chapter is organised as follows. Section 3.2 describes a theoretical and empirical review on CBI and financial asset prices. Section 3.3 explores the data set, CBI construction methodology used and models. Section 3.4 discusses the empirical results. In particular, this chapter emphasises analysing structural shock produced by the impulse response function. Section 3.5 is the concluding session.

3.2 Literature Review on Central Bank Independence and Financial Asset Prices

3.2.1 Theoretical Review on Central Bank Independence and Financial Asset Prices

A. Foreign Exchange Markets

This chapter follows a model similar to Sanchez (2008) in order to investigate the relationship between CBI and exchange rate. In this context, the behaviour of the private sector can be described as follows:

$$\pi_t = E_{t-1}\pi_t + \alpha(y_t - \varepsilon_t^s) - \gamma(e_t - E_{t-1}e_t) \tag{3.1}$$

$$y_t = -\beta r_t - \delta e_t + \varepsilon_t^d \tag{3.2}$$

$$r_t = -E_t e_{t+1} + e_t + \varepsilon_t^f \tag{3.3}$$

$$r_t = R_t + E_t\pi_{t+1} \tag{3.4}$$

where all variables (except the interest rates) are in term of logarithms and constants have been normalised to zero. All parameters are assumed to be positive, except δ which can apply for any real value. The negative δ denotes a contractionary depreciation, while the positive means an expansionary depreciation. Equation (3.1) is augmented Phillips curve, where inflation rate (π) is determined by expectation of inflation ($E_{t-1}\pi$), output gap (y) and exchange rate (e) pass through term. A higher e denotes an appreciation. Expression (3.2) denotes that output depends on the real interest rate (r), real exchange rate and demand shock (ε_t^d). Equation (3.3) states an uncovered interest parity condition. Equation (3.4) is the Fisher equation. ε_t^s and ε_t^d are i.i.d. white noise shock with mean zero, whilst ε_t^f denotes an autocorrelated disturbance.

According to Rogoff (1985), the central bank minimises the following loss function:

$$L = \frac{1}{2}E[\chi(\pi_t - \tilde{\pi}_t)^2 + \alpha(y_t - \varepsilon_t^s)^2] \tag{3.5}$$

It is also assumed that the public knows α, β, δ and the distribution of disturbances (ε_t^s, ε_t^d and ε_t^f) and that it observes the nominal interest rate and nominal exchange rate. The central bank concerns about the deviation of inflation from its target, $\pi_t - \tilde{\pi}_t$, and the output gap, $y_t - \varepsilon_t^s$.

From Equation (3.1):

$$\alpha(y_t - \varepsilon_t^s) = (\pi_t - E_{t-1}\pi_t) + \gamma(e_t - E_{t-1}e_t) \tag{3.6}$$

Substituting Equation (3.6) to (3.5):

$$L = \frac{1}{2}E[\chi(\pi_t - \tilde{\pi}_t)^2 + (\pi_t - E_{t-1}\pi_t) + \gamma(e_t - E_{t-1}e_t)^2] \tag{3.7}$$

Differentiating Equation (3.7), with respect to π, then:

$$\begin{aligned}
&\chi\pi_t - \chi\tilde{\pi}_t + \pi_t - E_{t-1}\pi_t + \gamma(e_t - E_{t-1}e_t) = 0 \\
&(1+\chi)\pi_t = E_{t-1}\pi_t - \gamma(e_t - E_{t-1}e_t) + \chi\tilde{\pi}_t \\
&\pi_t = \frac{1}{(1+\chi)}[E_{t-1}\pi_t - \gamma(e_t - E_{t-1}e_t)] + \frac{\chi}{(1+\chi)}\tilde{\pi}_t
\end{aligned} \tag{3.8}$$

Thus, an optimal policy of inflation under discretion is:

$$\pi_t = \left(1 - \frac{\chi}{(1+\chi)}\right)[E_{t-1}\pi_t - \gamma(e_t - E_{t-1}e_t)] + \frac{\chi}{(1+\chi)}\tilde{\pi}_t \tag{3.9}$$

Assuming rational expectation which expected inflation equals expected targeted inflation:

$$E_{t-1}\pi_t = E_{t-1}\tilde{\pi}_t \tag{3.10}$$

Substituting Equation (3.10) to Equation (3.9), to get the optimal inflation rate, π_t^{opt}:

$$\pi_t^{opt} = -\left(1 - \frac{\chi}{(1+\chi)}\right)\gamma(e_t - E_{t-1}e_t) + \frac{\chi}{(1+\chi)}\tilde{\pi}_t + \left(1 - \frac{\chi}{(1+\chi)}\right)E_{t-1}\pi_t \tag{3.11}$$

The optimal inflation rate captures the effect of unexpected exchange rate fluctuation on prices and the weighted expectation of the inflation target and the actual inflation target.

After getting an optimal inflation rate, the optimal interest rate can be found.

First, combining Equations (3.1) and (3.2):

$$r_t = \frac{1}{\alpha\beta}E_{t-1}\pi_t - \frac{\delta}{\beta}e_t + \frac{1}{\beta}\varepsilon_t^{xd} - \frac{\gamma}{\alpha\beta}(e_t - E_{t-1}e_t) - \frac{1}{\alpha\beta}\pi_t \tag{3.12}$$

Second, substituting Equation (3.12) to Equation (3.11), to get the optimal interest rate, r_t^{opt}:

$$r_t^{opt} = \frac{1}{\beta}\varepsilon_t^{xd} - \frac{\chi}{\alpha\beta(1+\chi)}(\tilde{\pi}_t - E_{t-1}\tilde{\pi}_t) - \frac{\chi\gamma}{\alpha\beta(1+\chi)}(e_t - E_{t-1}e_t) - \frac{\delta}{\beta}e_t \tag{3.13}$$

where $\varepsilon_t^{xd} \equiv \varepsilon_t^d - \varepsilon_t^s$. The optimal central bank reaction function in Equation (3.10) implies that the interest rate should be increased to balance positive unexpected excess demand pressure, while that it should be reduced if the inflation target is relaxed or the exchange rate appreciated.

By assuming that the inflation target applies a fixed and credible value of $\tilde{\pi}_t$). From Equation (3.3):

$$e_t = r_t + E_t e_{t+1} e_t - \varepsilon_t^f \tag{3.14}$$

Combining Equations (3.13) and (3.14):

$$\begin{aligned} e_t = {} & \frac{1}{\beta}\varepsilon_t^{xd} - \frac{\chi}{\alpha\beta(1+\chi)}(\tilde{\pi}_t - E_{t-1}\tilde{\pi}_t) - \frac{\chi\gamma}{\alpha\beta(1+\chi)}(e_t - E_{t-1}e_t) - \frac{\delta}{\beta}e_t \\ & + E_t e_{t+1} e_t - \varepsilon_t^f \end{aligned} \tag{3.15}$$

$$\begin{aligned} e_t(1 + \frac{\delta}{\beta}) = {} & \frac{1}{\beta}\varepsilon_t^{xd} - \frac{\chi}{\alpha\beta(1+\chi)}(\tilde{\pi}_t - E_{t-1}\tilde{\pi}_t) - \frac{\chi\gamma}{\alpha\beta(1+\chi)}(e_t - E_{t-1}e_t) \\ & + E_t e_{t+1} e_t - \varepsilon_t^f \end{aligned} \tag{3.16}$$

$$e_t(\frac{\beta+\delta}{\beta}) = \frac{1}{\beta}\varepsilon_t^{xd} - \frac{\chi}{\alpha\beta(1+\chi)}(\tilde{\pi}_t - E_{t-1}\tilde{\pi}_t) - \frac{\chi\gamma}{\alpha\beta(1+\chi)}(e_t - E_{t-1}e_t) + E_t e_{t+1} - \varepsilon_t^f \tag{3.17}$$

$$e_t = \frac{1}{\beta+\delta}\varepsilon_t^{xd} - \frac{\chi\gamma}{(\beta+\delta)(1+\chi)\alpha}(e_t - E_{t-1}e_t) + \frac{\beta}{\beta+\delta}E_t e_{t+1} - \frac{\beta}{\beta+\delta}\varepsilon_t^f \tag{3.18}$$

Taking the first derivative of e_t with respect to χ:

$$\frac{\partial e_t}{\partial \chi} = -\frac{\gamma}{\alpha(\beta+\delta)}\frac{1}{(1+\chi)^2}(e_t - E_{t-1}e_t) < 0 \tag{3.19}$$

The higher CBI, χ, generates a higher exchange rate. In other words, more independent central banks are more likely to appreciate the exchange rate.

B. Domestic Stock Markets

Following Papadamou et al. (2017) for analysing the impact of CBI on stock index volatility where the economy has characterised the equations:

$$\pi_t = \pi_t^e + \gamma y_t - \varepsilon_t^\pi, \quad \gamma > 0 \tag{3.20}$$
$$y_t = -\theta r_t + \delta q_t + \varepsilon_t^d, \quad \theta, \delta > 0 \tag{3.21}$$
$$q_t = \rho E_t q_{t+1} + (1-\rho)E_t d_{t+1} - r_t + \varepsilon_t^q \tag{3.22}$$

where (π_t) is the inflation rate, y_t is the output, ε^π is a supply shock, r_t is the real interest rate, q_t is stock index, ε^d is a demand shock. All variables are in logarithm, except the interest rate, and constants have been normalised to zero.

Equation (3.20) is a simple Phillips curve. Aggregate demand, in Equation (3.21), depends negatively on the real interest rate (r_t) and positively on stock index (q_t). Equation (3.22) denotes that real stock index is measured by the expected capital gain ($E_t q_{t+1}$), the expected dividend ($E_t d_{t+1}$), real interest rate, and a time-varying risk premium (ε_t^q). Assume that the expected dividend is proportional to output, $d_{t+1} = y_t$, and consider that the expected value of the future stock index is $E_t q_{t+1} = \beta q_t$.

According to Rogoff (1985), the central bank minimises the following loss function:

$$L = \frac{1}{2} E[\pi^2 + b(y - k)^2] \tag{3.23}$$

where E denotes the expectation operator, b and k denote the weight associated with output objective, and inflation objective (which is supposed to be zero). Finally, by assuming that the agents form its inflationary expectation π^e, shocks (ε_π, ε^d, and ε_t^q) occur, the central bank sets its monetary policy, and firms determine their level of production and price (y and p).

The value of b shows the conservativeness of the central bank, the less conservative means the more independent central bank. By assuming that the central bank anticipates the public think, the optimal condition can be achieved by minimising the central bank loss function. From Equation (3.20):

$$y_t = \frac{\pi_t - \pi_t^e + \varepsilon_t^\pi}{\gamma} \tag{3.24}$$

Substituting Equation (3.24) into Equation (3.23) and minimising the loss function with respect to π gives:

$$\frac{\partial L}{\partial \pi} = 2\pi + \frac{2b}{\gamma}\left(\frac{\pi_t - \pi_t^e + \varepsilon_t^\pi}{\gamma} - k\right) = 0 \tag{3.25}$$

hence

$$\pi = -\frac{b}{\gamma}(y - k) \tag{3.26}$$

Combine Equations (3.20) and (3.26):

$$y = \frac{-\pi_t^e + \varepsilon_t^\pi + \frac{bk}{\gamma}}{(\frac{b}{\gamma} + \gamma)} \tag{3.27}$$

The real interest rate can be derived by combining Equations (3.21) and (3.27):

$$r = \frac{1}{\theta}\frac{\gamma}{b+\gamma^2}\pi^e + \frac{\delta}{\theta}q + \frac{1}{\theta}\varepsilon^d - \frac{1}{\theta}\frac{\gamma}{b+\gamma^2}\varepsilon_\pi - \frac{1}{\theta}\frac{\gamma}{b+\gamma^2}k \tag{3.28}$$

The public knows the policymakers' minimisation problem and uses Equation (3.26) to form its inflation expectation:

$$\pi^e = \frac{b}{\gamma}k \tag{3.29}$$

Substituting inflation expectation in Equation (3.29) into Equation (3.27) to get equilibrium output:

$$y = \frac{\gamma}{b+\gamma^2}\varepsilon_\pi \tag{3.30}$$

Finally, combine Equations (3.20), (3.29) and (3.30) into Equation (3.26) to get expected inflation to get equilibrium inflation:

$$\pi = \frac{b}{\gamma}k - \frac{b}{b+\gamma^2}\varepsilon_\pi \tag{3.31}$$

Combine Equations (3.28), (3.29), (3.30) and (3.31) into Equation (3.22) then get the stock index:

$$q = \frac{\gamma}{\beta + \gamma^2}\left[\frac{(1-\rho)\theta\alpha + 1}{(1-\rho\beta)\theta + \delta}\right]\varepsilon_\pi + \frac{1}{(1-\rho\beta)\theta + \delta}(\theta\varepsilon^q - \varepsilon^d) \tag{3.32}$$

Since CBI has a negative relationship with the weight attached to the output objective, b, as a result, the positive relationship between CBI and stock index is proven. Differentiating the stock index in Equation (3.32) with respect to inverse of CBI, b:

$$\frac{\partial \text{ q}}{\partial b} = -\frac{1}{(b + \gamma^2)^2}\Big)^2 \left[\frac{(1-\rho)\theta + 1}{(1-\rho\beta)\theta + \delta}\right]^2 \varepsilon^\pi < 0 \tag{3.33}$$

Since the value of b has a negative effect on stock index, this means that if central bank weight more on output objective lead to lower stock index. In other words, the more independent central bank (lower b) are more likely to increase the stock index.

C. Bond Markets

This section starts the analysis of the interaction between CBI and bond price using a simple macroeconomic model developed by Ellingsen and Soderstrom (2001). In the model, a relationship between the inflation rate (π) as a function of the output gap (y_t) is determined by a Phillips curve.

$$\pi_{t+1} = \pi_t + \alpha y_t + \varepsilon_{t+1} \tag{3.34}$$

where $\alpha > 0$ and ε_t is supply shock with independently and identically distributed. The output gap in term of real interest rate is determined by an aggregate demand equation:

$$y_{t+1} = \beta y_t - \gamma(i_t - \pi_t) + \eta_{t+1} \tag{3.35}$$

where $0 < \beta < 1$; $\gamma > 0$; and η is demand shock with independently and identical distributed. The central bank's objective is to minimise the loss function, which is quadratic in deviations of inflation from its target and the output gap:

$$L_t = \frac{1}{2}[\pi_t^2 + \lambda y_t^2] \tag{3.36}$$

where $\lambda \geq 0$ is the central bank's conservative and independent degree which is the preference for output stability relative to inflation stability. The lower λ implies the central bank more conservative and more independent. To solve the central bank's optimisation problem, this section follows Svensson (1997) and Ball (1999) thus leading to a policy rule for the nominal interest rate in terms of inflation and output:

$$i_t = (1 + A)\pi_t + By_t \tag{3.37}$$

where

$$A = \frac{\alpha\delta k}{\gamma(\lambda + \alpha^2\delta k} > 0$$

$$B = \frac{\beta}{\gamma} + \alpha A > 0$$

A and B are convolutions of the parameters α, β, γ, and λ. Higher λ leads to lower both A and B, and this implies that the more conservative and independent central bank (CB's preferences for inflation stability) leads to larger monetary policy responses to both inflation and output. Long-term interest rates are assumed to be determined via the expectation hypothesis. The nominal interest rate on a pure discount bond maturity n is given by:

$$i_t^n = \frac{1}{n}\sum_{s=0}^{n-1} E_t i_{t+s} + \xi_t^n \tag{3.38}$$

where E_t denotes an expectation operation, ξ_t^n denotes the term premium at time t for maturity n, assumed to be independent of monetary policy.

Using the interest rate rule in Equation (3.38) for the short rate, the interest rate of maturity n will follow:

$$i_t^n = \frac{1}{n}(1+A)\pi_t + By_t + [1 + A(1-\gamma B)]X_n[\pi_t + \alpha y_t] + \xi_t^n \tag{3.39}$$

where

$$X_n = \frac{1-(1-\alpha\gamma A)^{n-1}}{\alpha\gamma A} \tag{3.40}$$

In this model, the changes in the nominal interest rate i_t are due to two factors. First, the development of inflation and output which is called endogenous policy. Second, shifts in the central bank's conservative and independent which captured by parameter λ, it is called exogenous policy. This model implies that the market interest rate responds differently depending on the policy changes is seen as endogenous or exogenous policy. The interest rate responds positively to the changing of inflation or output. However, interest rate moves in the opposite direction with the change of the central bank preference. This means that the more independent central bank (higher parameter λ) the lower interest rate.

The ideas behind this result are quite straightforward. First, if the central bank knows about inflation and output shocks, the public will draw inference about the underlying fundamentals when observing the central bank's policy actions. An unexpected tightening, increase in interest rate, reflects that the central bank's response to the unobservable shock, with persistence in the economy, will cause a period of tight monetary policy. As a result, the interest rate of all maturities increases as financial markets adjust their expectations of the future path of policy. Second, when inflation and output are observable but the central bank's preference is not, an unexpected tightening is interpreted that the central bank is more inflation averse and independence (higher λ). The central bank then responds aggressively to any given shock, cancel out the effects of the shock faster, and finally return to a neutral policy stance earlier. Thus, short rates increase with the central bank rate, but long rates fall because the tight policy will be expected to last for a shorter period.

3.2.2 Empirical Literature

The effect of monetary policy on financial asset prices has become one of the most interesting research in macroeconomic policy since the last two decades. Rigobon and Sack (2004) estimated the response of financial asset prices to changes in monetary policy in the US using daily data from January 3, 1994, to November 26, 2001. They performed identification by means of the heteroskedasticity method which relies on examining changes in the co-movement of interest rates and financial asset prices when the variance of one of the shocks in the system is recognised as shifting. As a result, the response of financial asset prices to the interest rate can be measured. They claimed that stock index has a significant negative reaction to monetary policy. However, the increase in the short-term interest rate has a positive and significant effect on the Eurodollar rate and bond yield.

Changes in monetary policy could be caused by changes central bank governor, thereby influencing on financial asset prices has been investigated by Kuttner and Posen (2010). They assessed the impact of changing the governor of the central bank on exchange rate and bond yield in 15 industrialised countries covering the years 1974 to 2006. To calculate the volatility of the exchange rate and bond yield, they used bootstrapped critical values instead of those derived from the normal distribution, seeing as they found that changes to the exchange rate and bond yield are not distributed normally and both skewed and leptokurtotic. They suggest that central bank appointments should change the markets through their effect on expected inflation and the interest rate. Their findings revealed that the exchange rate has a statistically significant response to the announcement of a new governor. However, they failed to establish a consistently significant response with respect to bond yield to the announcement of a new governor. One probable reason regarding that failure is due to the limited availability of daily bond yield data.

Moser and Dreher (2010) examined the effect of changing the governor of the central bank on the foreign exchange market, domestic stock market and sovereign bond spreads based on a data set for 20 emerging countries over the period 1992 to 2006. They suggest that financial markets react positively to a new central bank governor of the central bank, such changes convey new information on the subject of future monetary policy. As inflation bias is determined by the degree of CBI, the public's perception of inflation expectation will be affected. Consequently, asset price should change to the extent of their sensitivity to inflation. Their results show that changing the governor of the central bank has a negative effect on the financial market. The reasons why investors respond negatively is because the new governor of the central bank apparently suffers from a systemic credibility problem.

The effect of CBI on stock market return has been analysed by Forch and Sunde (2012). Using monthly observations from 1988 to 2007 in 27 emerging economies, they calculate stock market returns as the percentage month-to-month change in the price stock market index obtained from Morgan Stanley Capital International (MSCI) emerging market index. Additionally, they use the legal CBI index constructed by Cukierman et al. (1992). Their first investigation examined the impact of CBI on stock market returns applying the non-parametric test of equality of stock market returns prior to and after changes in CBI. Their results reveal that changes in CBI have a positive relationship with stock market returns over one month after the changes. However, they determine that CBI has no significant effect on stock market returns for the periods of three, six and 12 months after the CBI changes. Their second analysis uses fixed effect panel data estimation. They find a positive and significant effect of CBI on stock market returns, which implies that CBI appears to be beneficial concerning market performance. Papadamou et al. (2017) investigated the effect of CBI on stock market volatility. In their study, they use annual data for the period 1998 to 2005 and sample 29 developed and developing countries using panel data estimation. They divided stock market volatility into conditional stock market volatility that is obtained from the standard deviation of quarterly stock index and historical stock market volatility which can be measured using GARCH based stock return volatility. Using pooled OLS and the Prais-Winsten method with PCSEs, they confirm the positive and significant effect of CBI on both conditional and historical stock market volatility. This implies that a greater level of CBI can increase stock market volatility, which means that a high level of CBI can contribute to financial instability. They argue that there is a trade-off between price stability and financial stability and moreover, that the monetary authorities prefer price stability.

Bodea and Hicks (2014) examined the effect of the CBI index on 10-year domestic bond yield for a sample of 78 OECD and non-OECD countries during the period 1974 to 2007. They used Cukierman et al.'s (1992) index for CBI, as they were able to recognise the central bank's reforms for every country. They argue that a higher degree of legal CBI index is a signal to attract investors seeing as CBI is granted via regular legislation and the risk of independence comes from implicit or explicit threats to amend the law. Using fixed effect estimation for panel data since the fixed effects control time-invariant country specifics, while the time trend helps control the overtime increase of bonds. They determined that CBI has a negative relationship with 10-year bond rates in non-OECD countries, but CBI has no significant effect on 10-year bond rates for full sample countries. They argue that non-OECD countries may expect lower bond yield from greater CBI, when compared to other economies and moreover, that CBI can act as a separating signal.

Eichler and Littke (2018) investigated the effect of CBI on exchange rate volatility using panel data for 62 economies from 1998 to 2010. They reported that a conservative and independent central bank will reduce the public's uncertainty about the central bank's policy objective, thus reduce the volatility of inflation expectation. Consequently, agents are easier to estimate the long-run equilibrium value of the exchange rate and to assess the degree of exchange rate valuation in the short-run. They also revealed that exchange rate volatility depends on price flexibility in the goods market, central bank preferences for price stability and the interest rate sensitivity related to money demand. They established strong empirical evidence that an increase in independent central banks decreases exchange rate volatility. They argued that more conservative and independent central banks produce lower uncertainty concerning inflation expectation, thus creating a pronounced stabilising effect on exchange rate volatility.

The relationship between asset price and consumption and investment is vary depending on financial structure. Assenmacher-Wesche et al. (2008) studied the response of asset prices (property price and equity price), inflation and real activity to interest rate policy shocks for a panel of 17 OECD countries using quarterly data for the period 1986 to 2006. By way of performed individual VAR, they discovered that inflation and output growth respond better to interest rate shock than property and equity shock. Furthermore, their study applies a mean group estimator for panel VAR, which split the sample into two groups based on financial structure. They concluded that the interest rate shock has a positive effect on housing price and increase consumption and investment. However, for equity price, monetary policy shock reduces the equity price. Panel VAR analysis of different subgroups of countries reveals that the effect of interest rate on housing price seems influenced by financial structure.

3.3 Methodology and Data

3.3.1 Panel unit root tests

It is important to specify the order of integration for all variables before using a panel VAR technique. In this study, the stationary properties for all variables will be checked using some different panel unit root tests. This chapter performs panel unit root tests constructed by Levin et al. (2002), Breitung (2005) and Im et al. (2003)[1].

3.3.2 Panel Vector Autoregressive

The primary goal of this study is to observe the impact of CBI shock on financial asset prices in developing countries. To solve this problem, this chapter applies a panel VAR proposed by Canova and Ciccarelli (2013). In the panel VAR model, all variables are considered as endogenous and interdependent but a cross-sectional dimension is included in the representation. Let, Y_t as the stacked model of y_{it}, the vector of G variables for each unit i=1,...,N, i.e., $Y_t = (y\prime_{1t}, y\prime_{2t}, ..., y\prime_{Nt})'$ where i is generic and indicate countries. Then, a panel VAR is:

$$y_{it} = A_{0i}(t) + A_i(\ell)Y_{t-1} + u_{it} \quad i = 1, ..., N \quad t = 1, ..., T \tag{3.41}$$

where $A(\ell)$ is a polynomial in the lag operator and iid, A_0t is the deterministic components, u_{it} is a $G \times 1$ vector of random disturbances. Equation (3.41) may include constants, seasonal dummies and deterministic polynomial in time.

A typical variation of Equation (3.41) allows the G variables in Y_t to be linear function of a set of predetermined or exogenous variables, W_t. Then Equation (3.41) can be written as:

$$y_{it} = A_{0i}(t) + A_i(\ell)Y_{1t-1} + F_i(\ell)W_t + u_{it} \tag{3.42}$$

where $u_t = [u_{1t}, u_{2t}, ..., u_{Nt}]' \sim iid(0, \sum)$, $F_{i,j}$ are $G \times M$ matrices for each lag $j = 1, ..., q$, and W_t is a $M \times 1$ vector of predetermined or exogenous variables, common to all unit i.

A panel VAR has three characteristic features. First, lags of all endogenous variables of all units enter the model for unit i, it is known by dynamic in-

[1] All tests have been defined in detail in Chapter 2 Subsection 2.3.3.

terdependencies. Second, u_{it} is generally correlated across i, it is called static interdependencies. The third characteristic is cross-section heterogeneity where the intercept, the slope, and the variance of the shocks u_{1it} may be unit specific.

In carrying out a panel VAR model, the optimal lag has to be obtained through the lag selection criteria. The optimal lag is needed in order to find more efficient and unbiased results. The selection of lag lengths to the panel VAR is very crucial step to choose the optimal lag lengths that allow the panel VAR model to reflect a sufficiently rich dynamic structure in the model. The lag lengths in the panel VAR model is selected based on the Akaike Information Criteria (AIC).

A. Model 1: CBI, Exchange Rate, Consumption and Investment

Our Panel VAR model to analyse the interaction among CBI, exchange rate, consumption and investment includes four endogenous variables: exchange rate (ER), CBI, household's consumption (Cons), and investment (Inv). Turning now to the full panel VAR case, in our model G=4, thus our Panel VAR models are:

$$\begin{aligned} ER_{it} = \alpha_{1,i} + \sum_{j=1}^{k} a_{1,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{1,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{1,j} Cons_{i,t-j} \\ + \sum_{j=1}^{k} d_{1,j} Inv_{i,t-j} + u_{1,it} \end{aligned} \tag{3.43a}$$

$$\begin{aligned} CBI_{it} = \alpha_{2,i} + \sum_{j=1}^{k} a_{2,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{2,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{2,j} Cons_{i,t-j} \\ + \sum_{j=1}^{k} d_{2,j} Inv_{i,t-j} + u_{2,it} \end{aligned} \tag{3.43b}$$

$$\begin{aligned} Cons_{it} = \alpha_{3,i} + \sum_{j=1}^{k} a_{3,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{3,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{3,j} Cons_{i,t-j} \\ + \sum_{j=1}^{k} d_{3,j} Inv_{i,t-j} + u_{3,it} \end{aligned} \tag{3.43c}$$

$$\begin{aligned} Inv_{it} = \alpha_{4,i} + \sum_{j=1}^{k} a_{4,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{4,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{4,j} Cons_{i,t-j} \\ + \sum_{j=1}^{k} d_{4,j} Inv_{i,t-j} + u_{4,it} \end{aligned} \tag{3.43d}$$

B. Model 2: CBI, Stock Index, Consumption and Investment

Our Panel VAR model to analyse the interaction among CBI, stock exchange, consumption and investment include four endogenous variables: stock index (Stock), CBI, household's consumption (Cons), and investment (Inv). Turning now to the full panel VAR case, in our model G=4, thus our Panel VAR models are:

$$Stock_{it} = \alpha_{1,i} + \sum_{j=1}^{k} a_{1,j} Stock_{i,t-j} + \sum_{j=1}^{k} b_{1,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{1,j} Cons_{i,t-j} + \sum_{j=1}^{k} d_{1,j} Inv_{i,t-j} + u_{1,it} \tag{3.44a}$$

$$CBI_{it} = \alpha_{2,i} + \sum_{j=1}^{k} a_{2,j} Stock_{i,t-j} + \sum_{j=1}^{k} b_{2,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{2,j} Cons_{i,t-j} + \sum_{j=1}^{k} d_{2,j} Inv_{i,t-j} + u_{2,it} \tag{3.44b}$$

$$Cons_{it} = \alpha_{3,i} + \sum_{j=1}^{k} a_{3,j} Stock_{i,t-j} + \sum_{j=1}^{k} b_{3,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{3,j} Cons_{i,t-j} + \sum_{j=1}^{k} d_{3,j} Inv_{i,t-j} + u_{3,it} \tag{3.44c}$$

$$Inv_{it} = \alpha_{4,i} + \sum_{j=1}^{k} a_{4,j} Stock_{i,t-j} + \sum_{j=1}^{k} b_{4,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{4,j} Cons_{i,t-j} + \sum_{j=1}^{k} d_{4,j} Inv_{i,t-j} + u_{4,it} \tag{3.44d}$$

C. Model 3: CBI, Bond Yield, Consumption and Investment

Our Panel VAR model to analyse the interaction among CBI, bond yield, consumption and investment include four endogenous variables: bond yield (Bond), CBI, household's consumption (Cons), and investment (Inv). Turning now to the full panel VAR case, in our model G=4, thus our Panel VAR models are:

$$Bond_{it} = \alpha_{1,i} + \sum_{j=1}^{k} a_{1,j} Bond_{i,t-j} + \sum_{j=1}^{k} b_{1,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{1,j} Cons_{i,t-j} + \sum_{j=1}^{k} d_{1,j} Inv_{i,t-j} + u_{1,it} \tag{3.45a}$$

$$CBI_{it} = \alpha_{2,i} + \sum_{j=1}^{k} a_{2,j} Bond_{i,t-j} + \sum_{j=1}^{k} b_{2,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{2,j} Cons_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{2,j} Inv_{i,t-j} + u_{2,it} \tag{3.45b}$$

$$Cons_{it} = \alpha_{3,i} + \sum_{j=1}^{k} a_{3,j} Bond_{i,t-j} + \sum_{j=1}^{k} b_{3,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{3,j} Cons_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{3,j} Inv_{i,t-j} + u_{3,it} \tag{3.45c}$$

$$Inv_{it} = \alpha_{4,i} + \sum_{j=1}^{k} a_{4,j} Bond_{i,t-j} + \sum_{j=1}^{k} b_{4,j} CBI_{i,t-j} + \sum_{j=1}^{k} c_{4,j} Cons_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{4,j} Inv_{i,t-j} + u_{4,it} \tag{3.45d}$$

D. Model 4: CBI, Exchange Rate, Stock Index, Bond Yield, Consumption and Investment

Our Panel VAR model to analyse the interaction among CBI, financial asset prices, consumption and investment include six endogenous variables: exchange rate (ER), stock index (Stock), bond yield (Bond), CBI, household's consumption (Cons), and investment (Inv). Turning now to the full panel VAR case, in our model G=6, thus our Panel VAR models are:

$$ER_{it} = \alpha_{1,i} + \sum_{j=1}^{k} a_{1,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{1,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{1,j} Bond_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{1,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{1,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{1,j} Inv_{i,t-j} + u_{1,it} \tag{3.46a}$$

$$Stock_{it} = \alpha_{2,i} + \sum_{j=1}^{k} a_{2,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{2,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{2,j} Bond_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{2,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{2,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{2,j} Inv_{i,t-j} + u_{1,it} \tag{3.46b}$$

$$Bond_{it} = \alpha_{3,i} + \sum_{j=1}^{k} a_{3,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{3,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{3,j} Bond_{i,t-j}$$

$$+ \sum_{j=1}^{k} d_{3,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{3,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{3,j} Inv_{i,t-j} + u_{1,it} \tag{3.46c}$$

$$CBI_{it} = \alpha_{4,i} + \sum_{j=1}^{k} a_{4,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{4,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{4,j} Bond_{i,t-j}$$
$$+ \sum_{j=1}^{k} d_{4,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{4,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{4,j} Inv_{i,t-j} + u_{1,it} \quad (3.46d)$$

$$Cons_{it} = \alpha_{5,i} + \sum_{j=1}^{k} a_{5,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{5,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{5,j} Bond_{i,t-j}$$
$$+ \sum_{j=1}^{k} d_{5,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{5,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{5,j} Inv_{i,t-j} + u_{1,it} \quad (3.46e)$$

$$Inv_{it} = \alpha_{6,i} + \sum_{j=1}^{k} a_{6,j} ER_{i,t-j} + \sum_{j=1}^{k} b_{6,j} Stock_{i,t-j} + \sum_{j=1}^{k} c_{6,j} Bond_{i,t-j}$$
$$+ \sum_{j=1}^{k} d_{6,j} CBI_{i,t-j} + \sum_{j=1}^{k} e_{6,j} Cons_{i,t-j} + \sum_{j=1}^{k} f_{6,j} Inv_{i,t-j} + u_{1,it} \quad (3.46f)$$

3.3.3 Poolability tests

This chapter applies poolability test to check whether the coefficients in models 1 to 4 homogeneous across the cross-section by applying the Chow and Roy-Zellner tests[2].

3.3.4 Data

For the measure of CBI, this chapter follows the CBI index constructed by Cukierman et al. (1992). This index is based on the legal aspect of independence. The index is between 0 and 1, with higher values denoting greater CBI for the legal index. The data relating to the CBI index is legal variable aggregate weighted obtained from Garriga's (2016) data set.

The role of financial asset prices is represented by the exchange rate, stock index and bond yield. This chapter uses the exchange rate and stock index in terms of logarithm natural. Exchange rate is the bilateral currency of each country's sample against the U.S. dollar (USD). The data are retrieved from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The stock index is local market indices measured in local currency, which obtain from Bloomberg. This chapter uses the government securities interest rate as a proxy for government bond yield, whereby data are retrieved from the IFS of the IMF.

[2] The poolability tests have been explained in detail in Chapter 2 Subsection 2.3.5.

This chapter uses household consumption and investment following Claessens and Kose (2017). The reason why this chapter uses total consumption and investment is because consumption is the largest share of output, while investment is the most volatile component of output (Beaudry et al., 2015). Household consumption data is the private consumption expenditure. The data are retrieved from the IFS of the IMF. Investment is measured as gross fixed capital formation and it is taken from the IFS of the IMF. Consumption and investment are in terms of logarithm natural.

3.4 Empirical Results

3.4.1 Model 1: CBI, Exchange Rate, Consumption and Investment

A. Summary Statistics

The panel data used in this model covers 26 developing countries[3] determined by data availability. Our dataset consists of 4 variables: CBI, exchange rate, consumption and investment. Quarterly data from the years 1991 quarter 1 to 2016 quarter 4 are used.

Table 3.1: Summary Statistics

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
Ln Exchange Rate	2.3724	2.3086	-5.7386	9.5361
CBI	0.5405	0.1886	0.1345	0.9512
Ln Consumption	12.1945	2.7550	4.1735	21.3359
Ln Investment	11.5065	2.9870	3.0725	22.1196

Test Period: 1991.1-2016.4. All variables - with the exception of the CBI degree - in logs.

B. Panel Unit Root Tests

This chapter uses the panel unit root tests proposed by Levin et al. (2002), in conjunction with Im et al. (2003) and Breitung (2005) panel unit root tests to

[3] Argentina, Bolivia, Egypt, Ethiopia, Ghana, Guatemala, Honduras, Indonesia, Kenya, Malaysia, Mauritania, Mexico, Morocco, Nicaragua, Pakistan, Paraguay, Philippines, South Africa, Suriname, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay, Venezuela and Zambia

check the stationary series of the CBI, exchange rate, consumption and investment. Regarding the LLC, IPS and Breitung tests, the null hypothesis is non-stationary. LLC and Breitung tests assume a common autoregressive parameter for all panel; each individual series is stationary. IPS test assumes the individual unit root (some of the individual series are stationary). The optimal lag length is automatically selected by means of Schwarz Info Criterion. This chapter uses individual intercept and trend in panel unit root tests.

Table 3.2: Panel Unit Root Tests

Series	**LLC**	**Breitung**	**IPS**
ln Exchange Rate	-4.3490***	1.7727	-2.6921***
CBI	-2.9180***	-2.1609**	-2.0782**
Ln Consumption	-3.7550***	2.0605	-0.5044
Ln Investment	-3.4058***	2.0101	-1.6551**

Note: All variables - with the exception of the CBI degree - in logs. The symbols * is p $\leq$ 10%, ** is p $\leq$ 5%, and *** is p $\leq$ 1%. Critical values: 1%: -2.33; 5%: -1.65; 10%: -1.28.

Table 3.2 represents the result of the panel unit root test at level. The result illustrated that the null hypothesis is rejected for all variables at the 5% level of significance. Rejecting the null hypothesis means that those variables are I(0).

C. Full Sample Countries Panel VAR

First, model 1 is estimated to examine the interrelationship between CBI, exchange rate, consumption and investment by applying a panel VAR. Lag 2 is selected as the optimal lag based on the Akaike information criterion which reveal in Table B.1 in the Appendix. The results of panel VAR are presented in Table B.2 in the Appendix.

D. Poolability Test for Panel VAR

The panel VAR models in Equations (3.43a) - (3.43d) are estimated in pooled least squared (POLS). The POLS estimator is known to be potentially biased in a dynamic panel setting if the coefficients on the endogenous variables differ across-countries. The author runs the Chow and Roy-Zellner tests proposed by Baltagi (2008) to investigate the heterogeneity coefficients in the model.

Table 3.3: Poolability Test

	Exchange rate	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	2.77***	2.14***	2.86***	4.29***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[200, 2423]	[200, 2424]	[200, 2424]	[200, 2424]
Roy-Zellner Test				
F-Statistic	553.58***	428.22***	572.64***	857.45***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[200]	[200]	[200]	[200]

Note: *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively.

The result in Table 3.3 reveals the poolability test for the models. The null hypothesis confirms that the coefficients are the same for all countries sample. While the alternative hypothesis is the coefficients differ all cross-countries. The Chow and Roy-Zellner tests show that the null hypothesis is rejected. This result implies that coefficients in the panel VAR model contain cross country heterogeneity.

E. Mean Group Estimation for Panel VAR

One common way to solve the heterogeneity problem in the model is to perform the mean-group estimation proposed by Pesaran and Smith (1995), which has also been used in previous studies, such as those of Assenmacher-Wesche et al. (2008) and Sa et al. (2011). The results of the mean-group estimation for the panel VAR are presented in Table 3.4.

Table 3.4: MG Panel VAR Regression Model 1

	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.1844	-0.0229	-0.0223	-0.0325
Exchange Rate (-2)	-0.2673	0.0282	0.0829	0.0370
CBI (-1)	0.5998	0.8360	0.2580	0.1539

Continued on next page

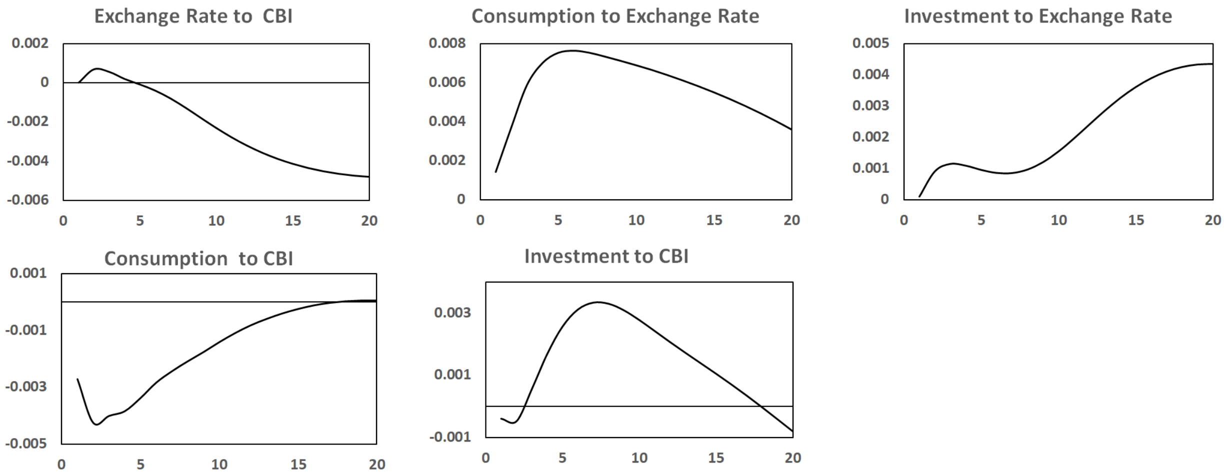
Table 3.4 – *Continued*

	Exchange Rate	**CBI**	**Consumption**	**Investment**
CBI (-2)	0.0165	-0.0265	-0.7388	-0.1061
Consumption (-1)	-0.0041	-0.0594	1.1520	0.0517
Consumption (-2)	0.0747	0.0631	-0.2829	-0.0030
Investment (-1)	0.0802	0.0062	0.2436	1.6404
Investment (-2)	-0.1053	-0.0038	-0.1611	-0.6951
C	-0.6292	0.0074	0.6649	0.0005

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.

The exchange rate is positively affected by its own first lag and negatively affected by its own second lag. The effect of CBI on the exchange rate is positive, with coefficients of around 0.6 and 0.01 for CBI lags 1 and 2, respectively. This implies that a higher CBI leads to a depreciation in the exchange rate. CBI lag one has a positive effect on CBI with a coefficient of 0.8360, but CBI lag 2 has a negative effect on CBI. Consumption is positively affected by its own first lag and negatively affected by its own second lag. CBI lag 1 has a positive effect on consumption with a coefficient of 0.2580, while an increase of 1% in CBI lag 2 leads to a decrease in consumption of around 0.74%. Investment is positively affected by its own first lag and negatively affected by its own second lag. An increase of 1% in CBI lag 1 increases investment by 0.1539%, but an increase of 1% in CBI lag 2 reduces investment by 0.15061%. Therefore, it can be concluded that CBI lag 1 has a positive effect on the exchange rate, consumption and investment, while, CBI lag 2 has a positive effect on the exchange rate, but a negative effect on consumption and investment.

Figure 3.1: Impulse Response Function Mean Group Estimation Model 1



It is difficult to interpret the coefficient of VAR; hence, the author focuses the analysis on Impulse Response Function (IRF) and variance decomposition. Figure 3.1 displays the impulse responses functions over 20 quarters for a one standard deviation shock implied by the panel VAR regression using the mean-group estimator. This section will focuses on the exchange rate response to CBI shock, consumption and investment responses to the exchange rate shocks, consumption and investment responses to CBI shocks. The response of the exchange rate to one standard deviation shock of CBI is positive in the beginning, 2 periods after the shock. This finding indicates that in the short-run, the CBI shock depreciates the exchange rate. After the central bank reform shock, it takes five quarters for the exchange rate to begin to appreciate, with the highest effect around 0.5% in period 20. This finding confirms the evidence of the delayed overshooting puzzle of the effect of monetary policy on the exchange rate, in which shock monetary policy requires time to appreciate the exchange rate, as prior studies such as Eichenbaum and Evans (1995) and Scholl and Uhlig (2008) demonstrated.

The response of consumption to one standard deviation shock of the exchange rate is positive and reaches the peak of about 0.77% at quarter 6 prior to falling in the following quarter. This implies that the depreciation exchange rate increases consumption which is consistent with the international real business cycle model Backus et al. (1992). Our finding is in line with Kandil (2015) who found a positive relationship between exchange rate and consumption in emerging economies. The positive response to exchange rate shock is also showed in investment, where shock one standard deviation exchange rate increases 0.1% investment at quarter three. This result denotes that depreciation of the exchange rate increases investment because it reduces investment cost and hence, attracts new investment.

Blonigen (1997) concludes that depreciation improves foreign direct investment. A one percentage point to the degree of CBI shock leads to a fall in consumption by 0.27% in the first quarter and reaches the minimum around 0.4% at quarter 2. From period 3 onwards, the impulse response turns back and reaches the initial value at quarter 17. This finding could possibly initiate greater CBI followed by the tightening of monetary policy, for instance, reducing the supply of money to decrease inflation, although it also reduces private consumption. Shock one standard deviation in CBI increases investment and reaches the peak of around 0.8% in quarter 8. Subsequently, the impact falls to the initial value at period 18. This result is in line with our expectation that a higher degree of CBI attracts investment.

Table 3.5: Forecast Error Variance Decompositions Model 1

Period	**Exchange rate**	**CBI**	**Consumption**	**Investment**
	Forecasting Exchange Rate			
4	95.5573	1.7704	1.1519	1.5202
8	86.1522	4.4440	3.7057	5.6979
12	79.2689	7.1358	5.4770	8.1182
16	74.5350	9.1775	7.0903	9.1970
20	71.0128	10.4824	8.6717	9.8329
	Forecasting CBI			
4	3.2491	93.9349	2.1445	0.6714
8	9.2098	83.2188	5.5808	1.9904
12	13.4531	76.5960	6.7544	3.1963
16	15.8101	72.6234	7.3386	4.2277
20	17.0955	70.0082	7.8597	5.0365
	Forecasting Consumption			
4	6.8046	4.8279	85.0986	3.2687
8	10.9290	6.3834	73.9580	8.7294
12	13.8712	7.7769	64.4866	13.8651
16	15.8802	9.1736	58.4469	16.4991
20	17.1744	10.4686	54.6726	17.6842
	Forecasting Investment			
4	5.7748	4.6715	13.8347	75.7188
8	9.5272	6.7563	18.4218	65.2945

Continued on next page

Table 3.5 – *Continued*

	Exchange rate	CBI	Consumption	Investment
12	13.0612	8.3453	21.6108	56.9826
16	16.0477	9.5483	23.5625	50.8414
20	17.9136	10.4947	24.8209	46.7707

Each row shows the percentage of the variance of the error in forecasting the the variable mentioned in the title of the table, at each forecasting horizon (in quarters) given in the first column.

This session discusses the forecast error variance decompositions which disclose the contributions of the variable's to the variation of one variable, as reported in Table 3.5. Panel 1 of Table 3.5 reveals that approximately 95.5% of the variance of the errors in forecasting the exchange rate comes from innovations to the exchange rate itself at the 4-quarter horizon; the contribution of innovations to the exchange rate drops to around 71% at a 20-quarter horizon. The second largest contribution comes from CBI and reaches over 10% at the 20-quarter horizon. Innovations to consumption and investment make a small contribution to variance in errors in forecasting the exchange rate.

In panel 3 in Table 3.5, it is evidence that consumption explains above 85% of the forecast error variance of the consumption at the 4-quarter horizon, though the contribution drops continuously to roughly 54% at the 20-quarter. The importance of innovations to the exchange rate contribute approximately 7% in the 4-quarter then increase to around 17% in period 20.

The last panel in Table 3.5 explains that the importance of investment decreases with the increase in the forecast horizon. The investment contributes approximately 76% of the variance of the error in forecasting the investment at the 4-quarter horizon; then falls to around 47% at the 20-quarter horizon. The contribution of the exchange rate innovations to forecast the increase in investment from just below 6% in quarter 4 to around 18% at quarter 20. The innovation of consumption makes a sizeable contribution to the forecast error variance of the investment, practically 25% at period 20.

F. Sub-sample analysis

The sample of countries the divided into three groups to make our subsamples poolable. The first group include Guatemala, Morocco, Paraguay, Thailand, Malaysia and Trinidad and Tobago. The second group covers 5 countries: Tunisia, Uruguay, Pakistan, the Philippines and Egypt. The third group consists of 15 countries: Mexico, Honduras, Mauritania, Suriname, Argentina, Ghana, Kenya, South Africa, Turkey, Zambia, Bolivia, Ethiopia, Nicaragua, Venezuela and Indonesia.

Table 3.6 reveals the Panel VAR regression for subsample group 1. Lag 3 is selected as the optimal lag based on the Akaike Information Criterion which reveal in Table B.1 in the Appendix.

Table 3.6: Panel VAR Regression Model 1 Group 1

	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.3420***	0.0143	-0.1322	-0.1128***
	(0.0410)	(0.0304)	(0.1250)	(0.0197)
Exchange Rate (-2)	-0.3791***	-0.0065	-0.0139	0.0980***
	(0.0672)	(0.0497)	(0.2046)	(0.0322)
Exchange Rate (-3)	0.0384	-0.0077	0.1549	0.0159
	(0.0422)	(0.0312)	(0.1286)	(0.0202)
CBI (-1)	-0.0669	0.9843***	0.0391	0.0053
	(0.0554)	(0.0410)	(0.1689)	(0.0266)
CBI (-2)	0.0789	0.0015	0.0022	-0.0081
	(0.0778)	(0.0576)	(0.2370)	(0.0373)
CBI (-3)	-0.0097	0.0029	-0.0253	0.0038
	(0.0554)	(0.0410)	(0.1687)	(0.0266)
Consumption (-1)	0.0003	0.0055	0.9422***	0.0067
	(0.0134)	(0.0099)	(0.0408)	(0.0064)
Consumption (-2)	-0.0160	-0.0005	-0.0393	-0.0040
	(0.0184)	(0.0136)	(0.0562)	(0.0088)
Consumption (-3)	0.0148	-0.0055	0.0764*	-0.0025
	(0.0133)	(0.0098)	(0.0406)	(0.0064)
Investment (-1)	0.1081	-0.0055	-0.0399	1.7998***
	(0.0857)	(0.0634)	(0.2609)	(0.0411)
Investment (-2)	-0.2007	-0.0009	0.0997	-0.8284***
	(0.1608)	(0.1190)	(0.4895)	(0.0771)
Investment (-3)	0.0927	-0.0173	-0.0512	0.0278
	(0.0841)	(0.0623)	(0.2563)	(0.0404)
C	0.0065	0.0068	0.1362***	0.0080

Continued on next page

Table 3.6 – *Continued*

	Exchange Rate	**CBI**	**Consumption**	**Investment**
	(0.0187)	(0.0138)	(0.0570)	(0.0089)

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

The exchange rate is positively affected by its own first lag and negatively affected by its own second lag at 1% significance. CBI lag one has a positive and significant effect on CBI with a coefficient of 0.9843. Consumption is positively affected by its own first lag and its own third lag at 1% and 10% levels of significance. Investment is positively affected by its own first lag and negatively affected by its own second lag at 1% significance. In conclusion, the author does not find a significant effect of CBI on the exchange rate, consumption and investment. While exchange rate lag one has a negative effect on investment, investment lag two has a positive effect on it.

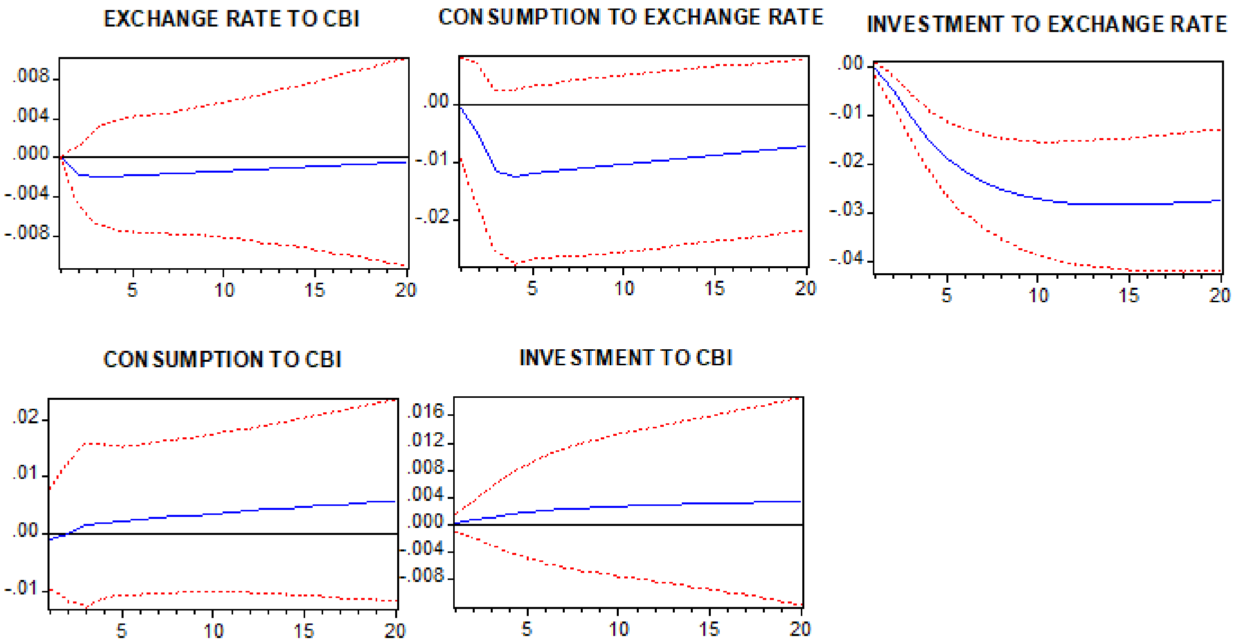
To check the presence of heterogeneity across countries, the author apply the Chow and Roy-Zellner tests for pooling assumption. The results of the poolability test in Table 3.7 show that the null hypothesis is not rejected. This signifies that the panel is poolable, and there is no heterogeneity among the countries sample.

Table 3.7: Poolability Test Model 1 Group 1

	Exchange rate	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	1.40	1.32	1.17	1.42
Probability	(0.0294)	(0.0610)	(0.1835)	(0.0249)
df	[60, 533]	[60, 533]	[60, 533]	[60, 533]
Roy-Zellner Test				
F-Statistic	84.21	79.22	70.45	85.27
Probability	(0.0213)	(0.0489)	(0.1675)	(0.0177)
df	[60]	[60]	[60]	[60]

Note: *** denote statistical significance at 1 per cent respectively.

Figure 3.2: Impulse Responses Function Model 1 Group 1



The impulse response function for group 1 based on Panel VAR in Table 3.6 is presented. Initially, it can be seen that the effect of central bank reform shock is negative in relation to the exchange rate. This result is in line with our expectation that higher CBI affects the appreciation of the exchange rate. In response to one positive standard deviation shock to the degree of CBI, the exchange rate level appreciates by 0.2% in the third quarter. From period four onwards, the response increases to reach the initial value. Shock one standard deviation exchange rate produces lower consumption and reaches the minimum at period four at 0.2%, while the direction changes the following quarter. The negative response is also shown by investment to the exchange rate shock. This result signifies that the depreciation exchange rate leads to lower investment. Finally, this finding can perceive that the effect of CBI shock increases both consumption and investment. Consumption responds positively to CBI shock after quarter two and increases over time. The investment response to CBI shock is positive and the coefficient is roughly 0.03% in the first period. The response is increasing gradually and reaches the peak, roughly 0.34% at period 20.

Next, move to the second group. The panel VAR regression result is shown in Table 3.8. Lag 3 is selected as the optimal lag based on the Akaike Information Criterion which reveal in Table B.1 in the Appendix.

Table 3.8: Panel VAR Regression Model 1 Group 2

	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.3788***	0.0116	-0.0489	-0.0482***
	(0.0516)	(0.0335)	(0.1248)	(0.0167)
Exchange Rate (-2)	-0.3401***	-0.0022	0.0173	0.0846***
	(0.0855)	(0.0555)	(0.2069)	(0.0276)
Exchange Rate (-3)	-0.0457	-0.0058	0.0354	-0.0342**
	(0.0510)	(0.0331)	(0.1234)	(0.0165)
CBI (-1)	0.0324	0.9651***	0.0159	-0.0035
	(0.0694)	(0.0450)	(0.1680)	(0.0224)
CBI (-2)	0.0098	-0.0001	-0.0086	-0.0018
	(0.0966)	(0.0626)	(0.2336)	(0.0312)
CBI (-3)	-0.0336	-0.0046	-0.0759	-0.0042
	(0.0689)	(0.0447)	(0.1667)	(0.0223)
Consumption (-1)	0.0174	0.0032	0.8424***	0.0032
	(0.0184)	(0.0119)	(0.0444)	(0.0059)
Consumption (-2)	-0.0142	-0.0039	0.2998***	-0.0023
	(0.0236)	(0.0153)	(0.0570)	(0.0076)
Consumption (-3)	0.0045	-0.0043	-0.1552	-0.0011
	(0.0184)	(0.0119)	(0.0444)	(0.0059)
Investment (-1)	0.1332	-0.0089	0.0035	1.8732***
	(0.1388)	(0.0900)	(0.3357)	(0.0448)
Investment (-2)	-0.0999	0.0105	0.3815	-0.9143***
	(0.2636)	(0.1710)	(0.6376)	(0.0852)
Investment (-3)	-0.0359	0.0001	-0.3755	0.0396
	(0.1345)	(0.0872)	(0.3253)	(0.0434)
C	-0.0512	0.0569***	0.0967	0.0221***
	(0.0323)	(0.0209)	(0.0782)	(0.0104)

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

The exchange rate is positively affected by its own first lag and negatively affected by its own second lag at 1% significance. CBI lag one has a positive and significant effect on CBI with a coefficient of 0.9651. Consumption is positively affected by its own first lag and its own second lag at 1% level of significance. Investment is positively affected by the exchange rate first lag and the exchange rate third lag at 1% significance, but negatively affected by the exchange rate second lag at 1% significance. Investment is positively affected by its own first lag but negatively affected by its own second lag at 1% significance. In conclusion, the author does not find a significant effect of CBI on the exchange rate, consumption and investment. While the exchange rate lag one has a negative effect on investment, investment lag two has a positive effect on investment.

To check the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption are applied. The results of the poolability tests are presented in Table 3.9. The results demonstrate that the null hypothesis is not rejected. This implies that the panel is poolable and there is no heterogeneity among the countries sample.

Table 3.9: Poolability Test Model 1 Group 2

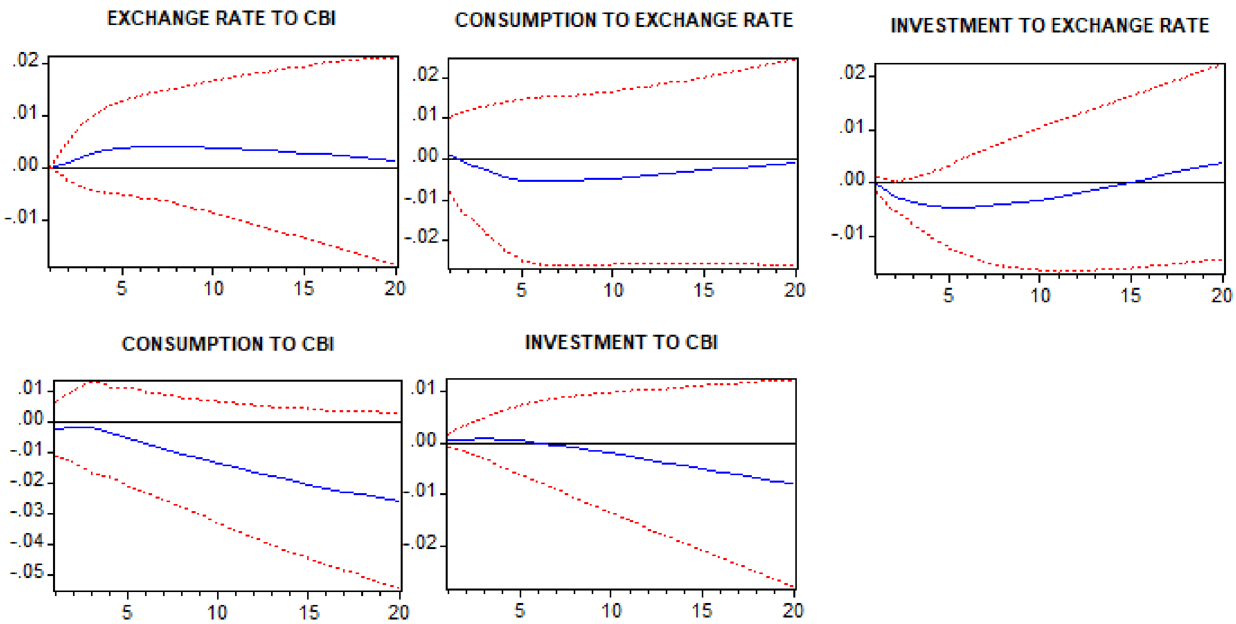
	Exchange rate	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	1.42	0.85	1.51	1.48
Probability	(0.0390)	(0.7461)	(0.0182)	(0.0249)
df	[48, 444]	[48, 444]	[48, 444]	[48, 444]
Roy-Zellner Test				
F-Statistic	68.13	40.97	72.63	70.83
Probability	(0.0295)	(0.7538)	(0.0124)	(0.0177)
df	[48]	[48]	[48]	[48]

Note: *** denote statistical significance at 1 per cent respectively.

Figure 3.3 describes that shock one standard deviation of CBI causes an increase in the exchange rate and reaches the peak, approximately 0.4% at period 8, after that the response fall to the original level. Our result reveals that greater CBI produces depreciation in the exchange rate. This confirms the existence of the exchange rate puzzle for this group. The negative response of consumption to one standard deviation shock of the exchange rate begins in period 2 and reaches the minimum at period 6, about 0.55%. From quarter 7 onwards, the response climbs to reach the initial value. In contrast, the investment response to one standard deviation shock of CBI is negative, from the first period and reaches the trough by 0.46% at period 5. Subsequently, the response rises and reaches the initial value. This evidence implies that the depreciation (appreciation) exchange rate leads to lower (higher) consumption and investment. Finally, the author analyses the effect of CBI on consumption and investment via the exchange rate.

In response to one-standard deviation shock of CBI, the consumption response is negative for all periods. This may well be caused by the strong effect of the depreciation exchange rate due to CBI and therefore, generates higher imported goods. Therefore, private consumption drops. Conversely, shock positive CBI leads to increased investment until period 6. This implies that higher CBI together with the depreciation exchange rate attracts investors in the short-run.

Figure 3.3: Impulse Responses Function Model 1 Group 2



Next, move to the last group. The Panel VAR regression result is shown in Table B.3. Lag 2 is selected as the optimal lag based on the Akaike Information Criterion which reveal in Table B.1 in the Appendix.

To verify the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption are applied. The results of the poolability tests in Table 3.10 show that the null hypothesis is not rejected. This result denotes that the panel is not poolable and there is heterogeneity among the countries sample.

Table 3.10: Poolability Test Model 1 Group 3

	Exchange rate	CBI	Consumption	Investment
Chow Test				

Continued on next page

Table 3.10 – *Continued*

	Exchange rate	**CBI**	**Consumption**	**Investment**
F-Statistic	2.82***	2.65***	3.86***	4.16***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[112, 1389]	[112, 1390]	[112, 1390]	[112, 1390]
Roy-Zellner Test				
F-Statistic	315.87***	297.14***	431.92***	466.01***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[112]	[112]	[112]	[112]

Note: *** denotes statistical significance at the 1.

In this part, the mean-group estimation is applied by averaging the coefficient for the 15 countries sample. The result is shown in Table 3.11.

Table 3.11: MG Panel VAR Regression Model 1 Group 3

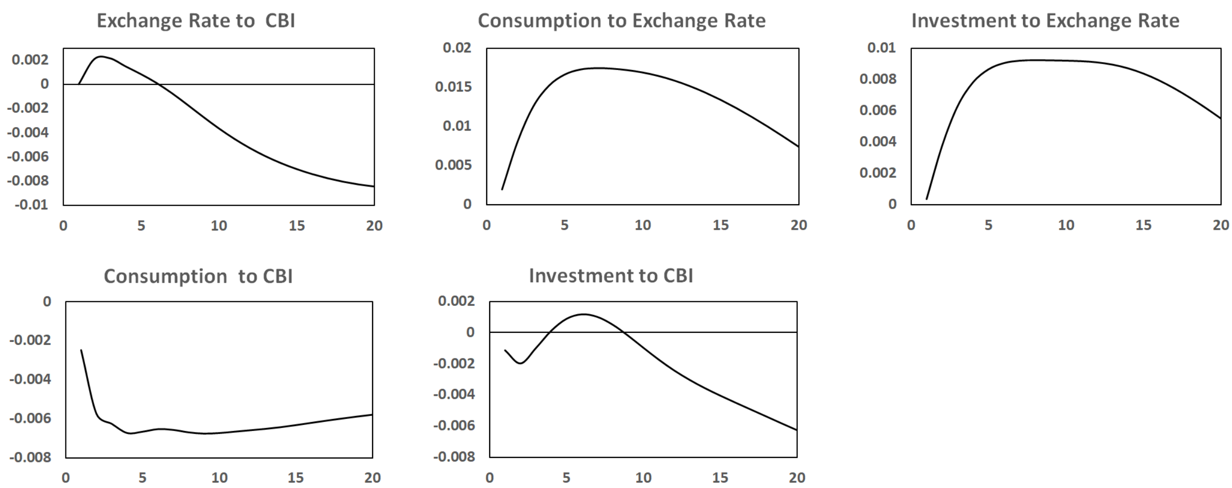
	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.1667	-0.0476	0.0828	0.0065
Exchange Rate (-2)	-0.2696	0.0680	0.0558	0.0049
CBI (-1)	0.2338	0.8281	-0.2631	-0.0001
CBI (-2)	-0.2060	-0.0307	0.2212	0.0145
Consumption (-1)	0.0159	-0.0506	1.1619	0.0711
Consumption (-2)	0.0844	0.0501	-0.3311	0.0016
Investment (-1)	0.1016	-0.0032	0.4256	1.5903
Investment (-2)	-0.1442	0.0036	-0.3386	-0.6680
C	-0.4259	0.0601	0.6457	-0.0384

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.

Table 3.11 describes the mean group estimation for sub sample group three. The exchange rate is positively affected by its own first lag but negatively affected by its own second lag. The effect of CBI lag 1 on the exchange rate is positive, with a coefficients of 0.2338. CBI lag 2 has a negative effect on the exchange rate with a coefficient of -0.2060. This finding implies that a higher CBI lag 1 leads to a depreciation in the exchange rate, but a higher CBI lag 2 leads to an appreciation in the exchange rate. CBI lag one has a positive effect on CBI with a coefficient of 0.8281, but CBI lag 2 has a negative effect on CBI. Consumption is positively affected by its own first lag but negatively affected by its own second lag. CBI lag 1 has a negative effect on consumption with a coefficient of -0.2631, while an increase of 1% in CBI lag 2 leads to an increase in consumption of around 0.33%. Investment is positively affected by its own first lag but negatively affected by its own second lag. An increase 1% in CBI lag 1 reduces investment 0.0001%, but an increase 1% in CBI lag 2 increases investment 0.0145%. In conclusion, CBI lag 1 has a positive effect on the exchange rate but a negative effect on consumption and investment. Meanwhile, CBI lag 2 has a negative effect on the exchange rate, but a positive effect on consumption and investment.

Figure 3.4 presents the result of IRF's using the mean-group estimation for 15 countries. Shock a one-unit innovation to the degree of CBI on the exchange rate is positive at the first 3-period and reaches the peak at 0.15% in period 3. Subsequently, the response falls to the initial value at period 6 and remains negative until the end of period 20. This finding signifies that CBI creates depreciation in the short-run but generates appreciation in the long-run. This group shows the delayed overshooting puzzle of the exchange rate due to changes in monetary policy. The shock a one-unit innovation exchange rate increases consumption and reaches the peak of about 1.8% at period 6. This group demonstrates that the depreciation exchange rate affects higher consumption and investment. These findings confirm the international business cycle model prediction of the positive relationship between the exchange rate and consumption. Shock a one-unit innovation exchange rate affects higher investment, roughly 0.9% at period 6. This indicates that the depreciation exchange rate generates lower cost for investment; thus, it increases the investment. The response of consumption to CBI shock is negative, reaching the minimum at period 4. After that, the response remains steady. This negative effect might be caused by the strong influence of the depreciation exchange rate. The negative investment response to CBI shock is shown in the first 4 periods. After periods 4 to 8, the investment response to CBI shock is positive. From period 9 onwards, the investment response is negative. The result shows that investment response fluctuation due to higher CBI.

Figure 3.4: Impulse Responses Function Model 1 Group 3



G. Comparison sub-sample group

This section analyses the interaction between CBI, exchange rate, consumption and investment in various sub-samples: full sample, group 1, group 2 and group 3. The results show how these relationships are influenced by a diversity of factors such as heterogeneity of economic sectors, degree of CBI, inflation, exchange rate regime and capital mobility (Lane, 2001).

Figure 3.5 reveals the impulse response of the exchange rate to the shock of CBI in three different groups samples and the average for the full sample. Interestingly, the response to the shock varies in each group. From the graph, it is apparent that a one-unit shock in CBI negatively affects the exchange rate in the first group. However, the positive effect is shown for groups two, three and also for the full sample countries, even though after a certain period the effect is negative. The magnitude of the maximum impact of one percentage point change in the degree of CBI on the exchange rate varies between -0.2% and 0.4%. The maximum impact is achieved at period 2 for the full sample, group 1 and group 3; however, for group 2 is in period 8.

This section discusses various economic features of developing countries to determine the main factors that can describe the different results among groups. First, the exchange rate classification measured by Reinhart and Rogoff (2004) which is presented in Table B.4 row 5 in the Appendix is applied. A higher number means a more flexible exchange rate arrangement. The three groups have different degrees of exchange rate flexibility. Group 1 has the lowest exchange rate flexibility; the average group members in group 1 are applying de facto crawling peg. Group 2 has moderate exchange rate flexibility; a number of countries are using the crawling band exchange rate arrangement. Group 3 is the highest degree; certain countries adopt the manage floating exchange rate. Theoretically, the peg exchange rate arrangement may result in exchange rate puzzling (Kim and Lim, 2016). In the 1990s, most developing countries applied the peg exchange rate system to limit speculation, provide a stable system for traders and investors, and prevent market adjustments when a currency undervalued. However, this system creates an unreal exchange rate or exchange rate manipulation. Therefore, there is a gap between the official and unofficial exchange rate. Independent central banks commonly followed by changing the exchange rate system from the peg to the floating exchange rate system. In the short-run, the exchange rate will adjust to the market value. Therefore, the exchange rate will be depreciated as it is undervalued. However, in the long-run, central bank reforms could lower the exchange rate depreciation. This implies that under CBI, monetary policy is predictable, generating lower exchange rate uncertainty. This finding is relevant with Cermeño et al. (2010), who concluded that central bank reforms are associated with reduced exchange rate uncertainty and lower average depreciation in the long-run.

According to Mundell (1963), the link between monetary policy and the exchange rate is based on perfect capital mobility. When capital mobility is highly controlled, the increase in CBI degree may not effect capital flows and the exchange rate. Table B.4 row 6 in the Appendix describes the capital control restriction developed by Fernández et al. (2016). This results establishes that the degree of capital control restrictions are different for the three subgroups, resulting in different monetary transmission effects on the exchange rate. The results for group 1, which is the lowest capital control restriction, are compatible with theoretical expectations that higher CBI leads to lower inflation expectation and hence, will appreciate the exchange rate. The "overshooting" theory developed by Dornbusch (1976) predicts that in the long-run, the exchange rate should initially overshoot to respond to monetary policy shock. Thus, an overshooting exchange rate occurred in this group. Previous empirical results support this finding, for instance, Kim and Roubini (2000), Faust and Rogers (2003) and BjÃžrnland (2009), who ascertained an appreciation exchange rate to monetary policy shocks. In contrast, the exchange rate puzzle is demonstrated by group 2, where monetary policy shock affects exchange rate depreciation. In this group, capital mobility restriction is high. The previous result presented by Grilli and Roubini (1995) strengthen this finding. According to Kim and Lim (2016), exchange rate puzzle occurs in countries with strong restricted capital mobility. Hence, the change in monetary policy may not influence the exchange rate. The result for group 3 and the full sample group add the existence of the "delayed overshooting" puzzle previously documented by Eichenbaum and Evans (1995) and Scholl and Uhlig (2008). Group 3 has moderate capital mobility restriction. Eichenbaum and Evans (1995) found that the exchange rate overshoots is the long-run effect of monetary policy shock, though it occurs one to three years after the shocks. These delays can be caused by "forward discount bias" puzzle, conditional on monetary policy shocks.

Figure 3.5: Impulse Response Function of Exchange Rate to CBI Shock

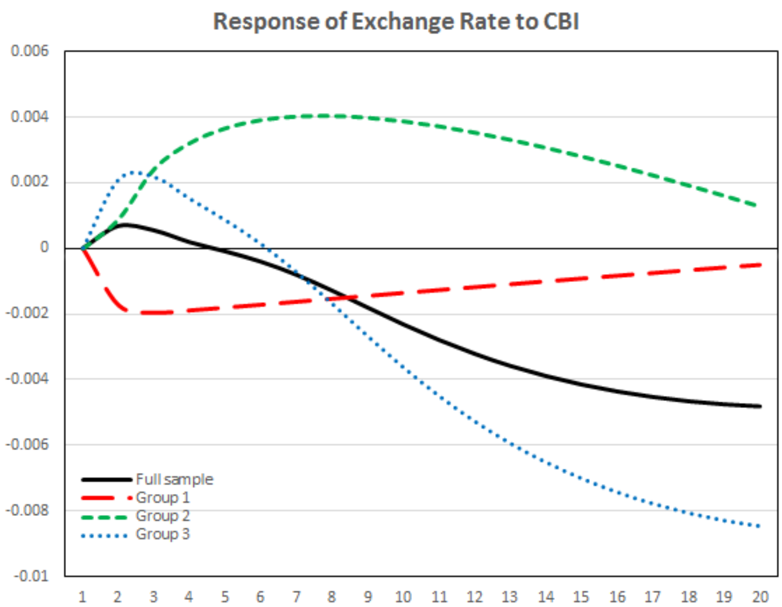
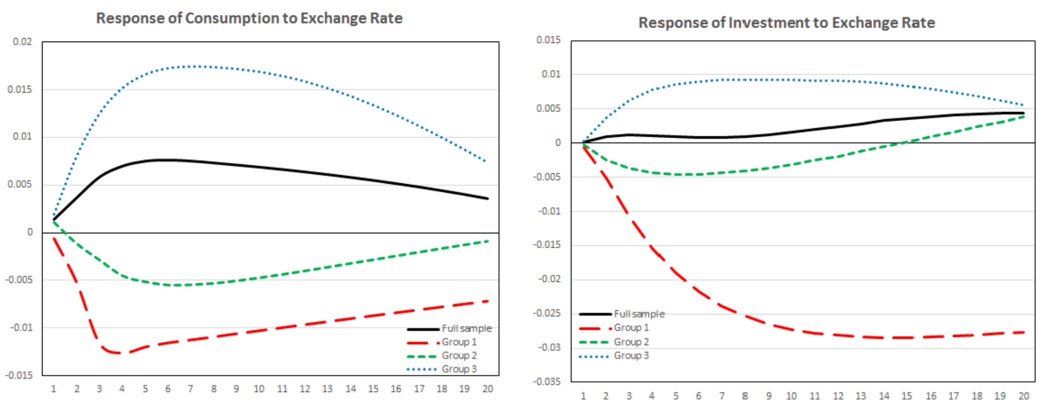


Figure 3.6: Impulse Response Function of Consumption and Investment to Exchange Rate Shock



The left side of Figure 3.6 shows the impulse responses of consumption to a one positive unit shock in the exchange rate. The effects of the exchange rate on consumption are positive in the full sample and group 3. This suggests that currency depreciation generates higher consumption which supports the international real business cycle model which predicts the positive relationship between domestic consumption and the depreciation exchange rate. The depreciation exchange rate generates less expensive exports, while imports are more expensive. Based on competitiveness, foreign demand for exports goods and services will increase and domestic demand for imports will decrease; thus, shifting consumption to domestic goods and services. As the net external demand increases, the increases in aggregate demand will have a positive effect on output and create jobs. Increasing income and employment generates increased consumption. Past empirical studies such as Kandil (2015), found that the depreciation exchange rate initiates increased consumption growth in developing countries, due to increases in the domestic prices of import goods and services. Conversely, for groups 1 and 2, consumption increases due to the appreciation exchange rate. Appreciation of the exchange rate decreases the cost of tradables and nontradables goods and, therefore, increases consumption growth. The combined effect will depend on the elasticity of consumers' substitution between tradables and non-tradables (Kandil and Mirzaie, 2006). This result confirms the Backus-Smith puzzle of a negative relationship between exchange rate and consumption (Backus and Smith, 1993). According to Kollmann (2012), the consumption-real exchange rate anomaly might be due to the underdevelopment of international financial markets. Additional empirical evidence such as Devereux et al. (2012), determined a negative relationship between exchange rate and consumption.

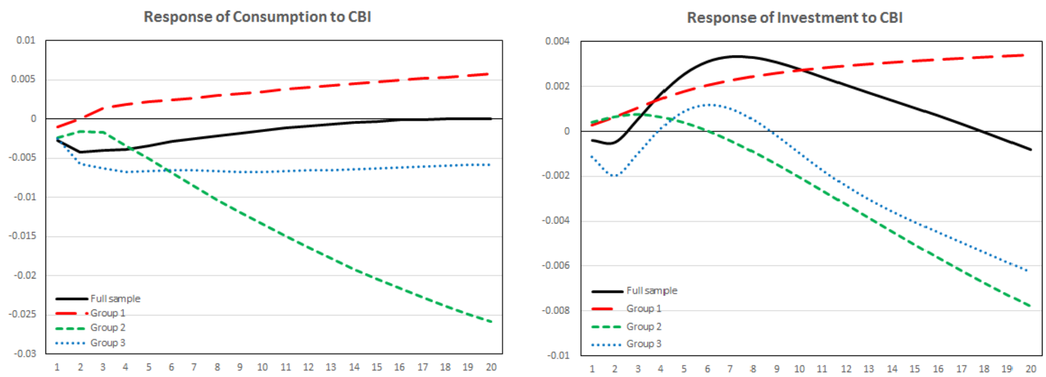
The right side of Figure 3.6 illustrates the impulse responses of the investment to a one-unit shock in the exchange rate depreciation can create an increase in investment as the marginal profit from an additional unit of capital is likely to increase as future foreign sales rise for group 3 and the average all countries. Conversely, for groups 1 and 2, the appreciation exchange rate leads to higher investment. Depreciation produces higher price for imported capital, whilst inputs can reduce profits and, in turn, lower investment. The overall impact of the exchange rate changes on investment hinges on which of these forces dominates (Landon and Smith, 2009). Depreciation of the exchange rate boosts investment, reducing the cost of investment in domestic countries. Increases in investment are also consistent with higher demand for goods and services because competition increases. This indicates the more dominant supply-side effect via the increase of competitiveness channel, particularly in the tradable sector.

Currency depreciation also has a positive implication for investment by means of relative wage channels. Depreciation reduces domestic's wages and production costs compared to those of its foreign counterparts. Therefore, it increases the overall rate of return on foreign investment in the domestic country. Previous studies, such as Blonigen (1997), argue that foreign exchange rate depreciation will lead to enhanced foreign direct investment (FDI) into the foreign economy. This result is also in lines with the Mundell-Fleming model for open economies which describes that the depreciation of domestic currency generates greater investment, seeing that it produces cheaper domestic goods and thus, more competitive in international markets. The principal factor related to a company's investment decisions are price competitiveness (Brito et al., 2018). In contrast, appreciation of domestic currency should stimulate investment for countries that depend on imported capital goods, as foreign capital goods are cheaper (Alejandro, 1963). Specific studies show that currency depreciations (appreciations) are associated with a contraction (expansion) in investment (Landon and Smith, 2009; Goldberg, 1993; Campa and Goldberg, 2005). Furthermore, there is also extensive theoretical literature looking at how linkages between exchange rate and output can depend on exchange rate regimes (Uribe, 1997; Mendoza and Uribe, 1997).

The different effect of the exchange rate on consumption and investment might be caused by average level of inflation. Regarding Table B.4 row 3 in Appendix B; Group 1 comprises a low average inflation rate, group 2 has a moderate inflation rate and group 3 consists of a high inflation rate, while the average for all countries is close to the average of group 3. For low and moderate inflation rate, the appreciation (depreciation) exchange rate leads to higher (lower) consumption and investment. The positive effect is higher for the low inflation group. Conversely, in countries with high inflation, depreciation (appreciation) causes higher (lower) consumption and investment.

Finally, the direct link from CBI to consumption and investment in Figure 3.7 is determined. The reaction of consumption due to changes in CBI is negative in the first quarter for all groups. Only after a lag of approximately 3 quarters for group 1 does the impact become positive, though for the other groups the response is negative until period 20. CBI has a positive effect on consumption only in countries with low inflation, given that a greater degree of CBI gives central banks freedom to set monetary policy, for instance lowering interest rates and increasing the money supply. Thus, these expansionary monetary policies create higher consumption. In contrast, in group 2 and group 3, which have high inflation rates, the central bank focuses more on lowering price by setting contractionary monetary policy such as, tight money policy. Tightening the supply of money lowers private consumption. Generally, the average for all countries sample is that higher CBI creates lower consumption, seeing as regularly, they have high inflation and the target of the central bank is to reduce prices.

Figure 3.7: Impulse Response Function of Consumption and Investment to CBI Shock



The reason for different consumption responses to CBI is the sensitivity of imported goods (Carriere-Swallow et al., 2017). One major problem in developing countries is high inflation owing to lack of supply. One possible solution is importing goods to lower the price because price in foreign countries is lower than domestically. For group 1, greater CBI causes an appreciation of the exchange rate, making imported goods cheaper. Hence households can consume more. In contrast, CBI affects the depreciation exchange rate in group 2, group 3 and in the full sample. This depreciation generates more expensive imported goods, therefore, reducing consumption.

Figure 3.7 also presents the investment responses to CBI shock in various groups. The result shows that the positive effect of CBI on investment, seeing that increasing the degree of CBI as a signal to combat inflation, display good governance institution and consequently, will attract investment. For group 2 and group 3, the responses become negative after 6 and 8 quarters. Here, the central bank could focus on reducing inflation by raising the interest rate and thus, discouraging investment. In group one, increasing the degree of CBI is also a signal for the implementation of structural economic reforms (Lavezzolo, 2006). This will create good opportunities for investors and moreover, promote investment.

Generally, the inverse relationship of CBI to consumption and investment can be explained by there the trade-off between inflation and output. Because the monetary authorities prefer price stability; thus, they less concern regarding the real activity. These findings are related to Barro and Gordon (1983) who stated that there is always a trade-off between credibility and flexibility, given that the difference between economic activity (growth and unemployment) and inflation can be viewed as the main difference between discretion and rules. Our findings are supported by previous studies, for example Alesina and Summers (1993), Cukierman et al. (1992), Froyen and Waud (1995) and Parkin (2014), who found no association between CBI and consumption, and CBI and investment.

3.4.2 Model 2: CBI, Stock Index, Consumption and Investment

A. Summary Statistics

This model investigates the interrelationship between CBI, stock index, consumption and investment. Unfortunately, due to the lack of data on stock index, the countries sample is reduced to only 16 developing countries[4]. Our dataset consists of four variables: CBI, stock index, household consumption and investment. Quarterly data over the period 1991 quarter 1 to 2016 quarter 4 are applied.

Table 3.12: Summary Statistics

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
Ln Stock Index	7.4195	3.1490	-6.9077	11.3609
CBI	0.5520	0.2104	0.1345	0.9512
Ln Consumption	13.5362	2.5519	4.3364	21.3359
Ln Investment	13.1128	2.6933	4.6535	22.1196

Test Period: 1991.1-2016.4. All variables - with the exception of the CBI degree - in logs. Based on author calculation

B. Panel Unit Root Tests

This model uses panel unit root tests proposed by Levin et al. (2002), in conjunction Im et al. (2003) and Breitung (2005) panel unit root tests to check the stationary of the variables (CBI, stock index, consumption and investment). The

[4]Argentina, Costa Rica, Egypt, Indonesia, Kenya, Malaysia, Morocco, Nigeria, Pakistan, Philippines, South Africa, Sri Lanka, Thailand, Tunisia, Turkey and Venezuela

null hypothesis of those tests is all series are non-stationary processes. The LLC and Breitung tests assume a common autoregressive parameter for all panels, whereby each individual series comprises stationary. The IPS test assumes individual unit root (some of the individual series comprise stationary). Additionally, the optimal lag length is automatically selected using the Schwarz Info Criterion.

Table 3.13: Panel Unit Root Tests

Series	**LLC**	**Breitung**	**IPS**
Ln Stock Index	0.8586	-2.5380***	0.9741
CBI	-0.6989	-1.7914**	-0.0133
Ln Consumption	-1.8451**	1.6430	0.5435
Ln Investment	-2.3431***	2.2043	-0.5657

Note: The table reports panel unit root tests. The symbols * is $p \leq 10\%$, ** is $p \leq 5\%$, and *** is $p \leq 1\%$. Critical values: 1%: -2.33; 5%: -1.65; 10%: -1.28.

Table 3.13 represents the result of the panel unit root test at the level. The result shows that the null hypothesis is rejected for all variables at the 5% level of significance. Rejecting the null hypothesis implies that those variables are I(0).

C. Full Sample Countries Panel VAR

First, the panel VAR estimation is applied to examine the interrelationship between CBI, stock index, consumption and investment. Lag 2 is selected as the optimal lag based on the Akaike information criterion which reveal in Table B.5 in the Appendix. The results of panel VAR for model 2 are presented in Table B.6 in the Appendix.

D. Poolability Test for Panel VAR

The panel VAR regression in Table B.6 is estimated in pooled least squared (POLS). The POLS estimator is known to be potentially biased in a dynamic panel setting if the coefficients on the endogenous variables differ across countries. The Chow test and Roy-Zellner test proposed by Baltagi (2008) is performed to investigate the heterogeneity coefficients in the model.

Table 3.14: Poolability Test Model 2

	Stock Index	CBI	Consumption	Investment
Chow Test				
F-Statistic	1.58***	1.85***	1.71***	3.42***
Probability	(0.0001)	(0.0000)	(0.0000)	(0.0001)
df	[120, 1341]	[120, 1341]	[120, 1341]	[120, 1341]
Roy-Zellner Test				
F-Statistic	189.31***	221.65***	205.75***	410.14***
Probability	(0.0001)	(0.0000)	(0.0028)	(0.0000)
df	[120]	[120]	[120]	[120]

Note: *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively.

The result in Table 3.14 reveals the poolability test for the models. The null hypothesis in this test is the coefficients are the same for all individual country, while the alternative hypothesis is the coefficients differ for all countries. The Chow and Roy-Zellner tests explain that the null hypothesis is rejected. This implies that coefficients in the panel VAR model contain heterogeneity.

E. Mean Group Estimation for Panel VAR

One common way to solve the heterogeneity problem in the model is to apply the mean-group estimation proposed by Pesaran and Smith (1995), which has also been used by previous studies, such as those of Assenmacher-Wesche et al. (2008) and Sa et al. (2011). Table 3.15 describes the mean-group estimation for the panel VAR in model 2.

Table 3.15: MG Panel VAR Regression Model 2

	Stock Index	CBI	Consumption	Investment
Stock Index (-1)	1.0021	0.0062	0.0322	0.0258
Stock Index (-2)	-0.1491	-0.0087	-0.0124	-0.0045
CBI (-1)	-1.1171	0.8424	0.6217	-0.0937
CBI (-2)	-4.0298	-0.0303	1.9191	0.0678
Consumption (-1)	0.0461	0.0437	1.0586	0.0448

Continued on next page

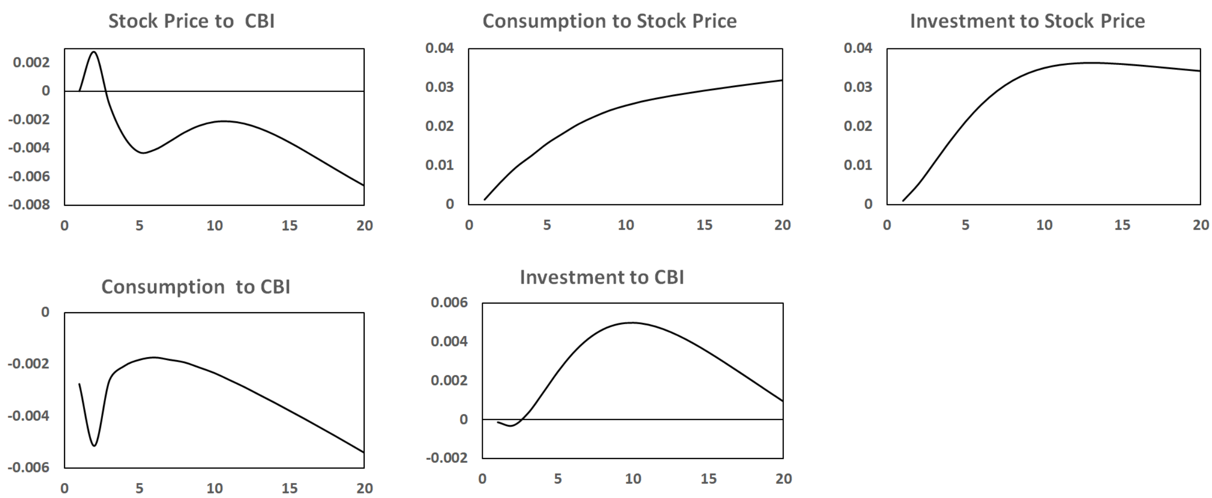
Table 3.15 – *Continued*

	Stock Index	**CBI**	**Consumption**	**Investment**
Consumption (-2)	0.0219	0.0606	-0.1276	0.0008
Investment (-1)	0.2908	0.0048	0.2339	1.6111
Investment (-2)	-0.2544	-0.0094	-0.1891	-0.6799
C	2.2044	-0.0571	-1.0918	0.1321

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.

Table 3.15 describes the mean group estimation for the panel VAR of the interaction among stock index, CBI, consumption and investment. The stock index is positively influenced by its own first lag with a coefficient of 1.0021. This implies that an increase of 1% in the stock index in the previous quarter leads to a rise in the stock index of around 1%. However, stock index lag 2 leads to a decrease in the current stock index with a coefficient of -0.1491. An increase of 1% in stock index lag 1 leads to an increase in consumption and investment of approximately 0.03%. In contrast, an increase of 1% in stock index lag 2 leads to a reduction in consumption and investment of approximately 0.01% and 0.04%, respectively. The result reveals that a negative relationship between CBI and stock index, with coefficients of -1.1171 and -4.0298 for CBI lag 1 and lag 2, respectively. The effects of CBI lag 1 and lag 2 on consumption are positive with coefficients of 0.6217 and 1.9191. CBI lag 1 has a negative effect on investment, but CBI lag 2 has a positive effect on it.

Figure 3.8: Impulse Response Function Mean Group Estimation Model 2



To analyse the interaction between CBI, stock index, consumption and investment, the author focuses more on the impulse response function. Figure 3.8 shows the interactions of CBI, stock index, consumption and investment implied by the mean group estimator. First, look at the impulse response of the stock index to CBI shock. Regarding the shock one standard deviation relating to CBI, the stock index responds positively until period two, though the response moves to the initial value in period three. From quarter three onwards, the response of the stock index to CBI shock is negative. This finding corresponds with our expectation that CBI improves stock market performance. The responses of consumption and investment to stock index shock are positive. Concerning consumption, an increase of 1% in the stock index enhances consumption by about 2% at quarter six and from the seventh quarter onwards, the consumption response to stock index shock slightly increases. This result supports the life-cycle effect's hypothesis that consumer spending rises due to the positive wealth effect. Shock one standard deviation of the stock index triggers higher investment around 2% at quarter four and reaches the peak approximately 3.6% at period 10. This result is in lines with Tobin's q theory which links financial asset prices and investment.

Next, turn to the response of consumption and investment to CBI shocks. Shock one standard deviation related to the degree of CBI reduces private consumption, roughly 0.5% in two quarters. This result might be caused by tight monetary policy to combat high inflation in developing countries, but it has the side effect of reducing public consumption. However, after the CBI shock, it takes three quarters before the investment starts to rise and reaches the peak at period 10. Subsequently, the response falls to the initial value. This result confirms that higher CBI is a good signal to attract investors.

Table 3.16: Forecast Error Variance Decompositions Model 2

Period	Stock Index	CBI	Consumption	Investment
	Forecasting Stock Index			
4	95.0296	2.1104	1.5954	1.2645
8	84.7496	6.8873	4.0024	4.3607
12	77.6759	9.7492	6.1491	6.4257
16	73.4812	11.4419	7.6908	7.3861
20	70.7712	12.4587	8.8314	7.9387
	Forecasting CBI			

Continued on next page

Table 3.16 – *Continued*

	Stock Index	CBI	Consumption	Investment
4	5.4103	92.4082	1.4689	0.7125
8	7.4028	86.2638	4.4898	1.8437
12	8.4830	82.4692	6.2648	2.7830
16	9.3230	79.5755	7.4922	3.6093
20	9.8956	77.3434	8.4330	4.3280
	Forecasting Consumption			
4	5.7197	5.2703	86.3977	2.6122
8	10.1974	4.7667	78.7523	6.2836
12	13.1097	4.9026	72.6212	9.3665
16	15.0429	5.4472	68.0454	11.4646
20	16.5726	6.1492	64.5730	12.7052
	Forecasting Investment			
4	15.0468	4.5368	9.0136	71.4028
8	28.9932	6.6920	15.2262	49.0886
12	34.4774	9.2348	19.0427	37.2452
16	35.9660	11.2218	21.2121	31.6002
20	35.9944	12.7660	22.7127	28.5269

Each row shows the percentage of the variance of the error in forecasting the variable mentioned in the title of the table, at each forecasting horizon (in quarters) given in the first column.

Subsequently, the results of the forecast error variance decompositions which reveals the contribution of the variable's to the variation of one variable are reported in Table 3.16 is presented. Panel 1 of Table 3.16 reveals that approximately 95% of the variance of the errors in forecasting the stock index comes from innovations to the stock index itself at the 4-quarter horizon. Moreover, the contribution of innovations to the stock index drops to around 70% at the 20-quarter horizon. The second largest contributions come from CBI and reaches approximately 12% at the 20-quarter horizon. Innovations related to consumption and investment contribute around 8% at the 20-quarter.

From panel 3 in Table 3.16, it is evident that consumption explains above 86% of the forecast error variance of the consumption at the 4-quarter horizon, even though the contribution declines continuously to around 64% at the 20-quarter. The importance of innovations to the stock index contributes approximately 6% in the 4-quarter then increases to roughly 16% in period 20. Additionally, CBI makes a small contribution to the forecast error variance of consumption, only 5 to 6%.

The last panel in Table 3.16 explains that the importance of investment decreases with the increase in forecast horizon. The investment contributes approximately 71% of the variance of the error in forecasting the investment at the 4-quarter horizon, then falls to around 28% at the 20-quarter horizon. The contribution of stock index innovations to forecast error variance decompositions of investment rise from just 15% in quarter 4 to around 36% at quarter 20. Additionally, CBI innovation makes the smallest contribution to the forecast error variance related to investment, less than 13% at period 20.

F. Sub-sample analysis

This section distinguishes the countries samples based on financial capitalisation, specifically low and moderate financial capitalisation[5]. The financial capitalisation data is retrieved from the World Bank, then divided by GDP. The first group is low financial capitalisation per GDP consists of Argentina, Kenya, Morocco, Nigeria, Sri Lanka and Tunisia. The second group is moderate financial capitalisation which covers Costa Rica, Pakistan, the Philippines, South Africa, Thailand, Indonesia, Malaysia, Turkey, Egypt and Venezuela. The author then estimates the panel VAR for each group and explore whether the impact of CBI on stock index, stock index on consumption and investment and CBI on consumption and investment differs between two groups. Our approach of grouping the countries sample in two groups and estimating Panel VAR for each group may be robust for the relationship between CBI on stock index, the stock index on consumption and investment and CBI on consumption and investment.

Table 3.17: Panel VAR Regression Model 2 Group 1

	Stock Index	**CBI**	**Consumption**	**Investment**
Stock Index (-1)	1.1231***	-0.0200**	0.0336	0.0204***
	(0.0437)	(0.0098)	(0.0390)	(0.0058)
Stock Index (-2)	-0.1312***	0.0196**	-0.0364	-0.0199***
	((0.0438)	(0.0099)	(0.0391)	(0.0058)
CBI (-1)	-0.1620	0.9775***	-0.209354	-0.033512
	(0.1956)	(0.0441)	(0.1743)	(0.0261)

Continued on next page

[5]List of countries' data is in Appendix

Table 3.17 – *Continued*

	Stock Index	**CBI**	**Consumption**	**Investment**
CBI (-2)	0.1464	-0.0018	0.2248	0.0351
	(0.1945)	(0.0439)	(0.1733)	(0.0259)
Consumption (-1)	0.0254	-0.0013	1.0192***	0.0021
	(0.0494)	(0.0111)	(0.0440)	(0.0066)
Consumption (-2)	-0.0260	0.0023	-0.0444	0.0032
	(0.0501)	(0.0113)	(0.0447)	(0.0067)
Investment (-1)	0.3617**	0.0501	0.3024*	1.7812***
	((0.1785)	(0.0403)	(0.1591)	(0.0238)
Investment (-2)	-0.3612**	-0.0516	-0.2746*	-0.7859***
	(0.1761)	(0.0397)	(0.1570)	(0.0235)
C	0.0838	0.0224	0.0284	-0.0142*
	(0.0617)	(0.0139)	(0.0550)	(0.0082)

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

Table 3.17 describes the panel VAR of the interaction among stock index, CBI, consumption and investment for group one. Lag 2 is selected as the optimal lag based on the Akaike Information Criterion which reveal in Table B.5 in the Appendix. The stock index is positively influenced by its own first lag and investment lag one with coefficients of 1.1231 and 0.3617; those variables are significant at 1%. However, stock index lag two and investment lag two have a significant and negative effect on stock index with coefficients of -0.1312 and -0.3612. Stock price lag one has a negative and significant effect on CBI with a coefficient of -0.0200, but stock index lag two has a positive and significant effect on CBI with a coefficient of 0.0196. CBI lag one has a positive and significant effect on CBI, with a coefficient of 0.9775. Consumption is positively influenced by consumption lag one and investment lag one with coefficients of 1.0586 and 0.3024. Meanwhile investment lag two has a negative effect on consumption with a coefficient of -0.2746 at 10% level of significance. Investment is positively influenced by stock price lag one and investment lag one at 1% significance with coefficients of 0.0204 and 1.7812, respectively. By contrast, investment lag two has a negative effect on investment with a coefficient of -0.7859.

Table 3.18: Poolability Test Model 2 Group 1

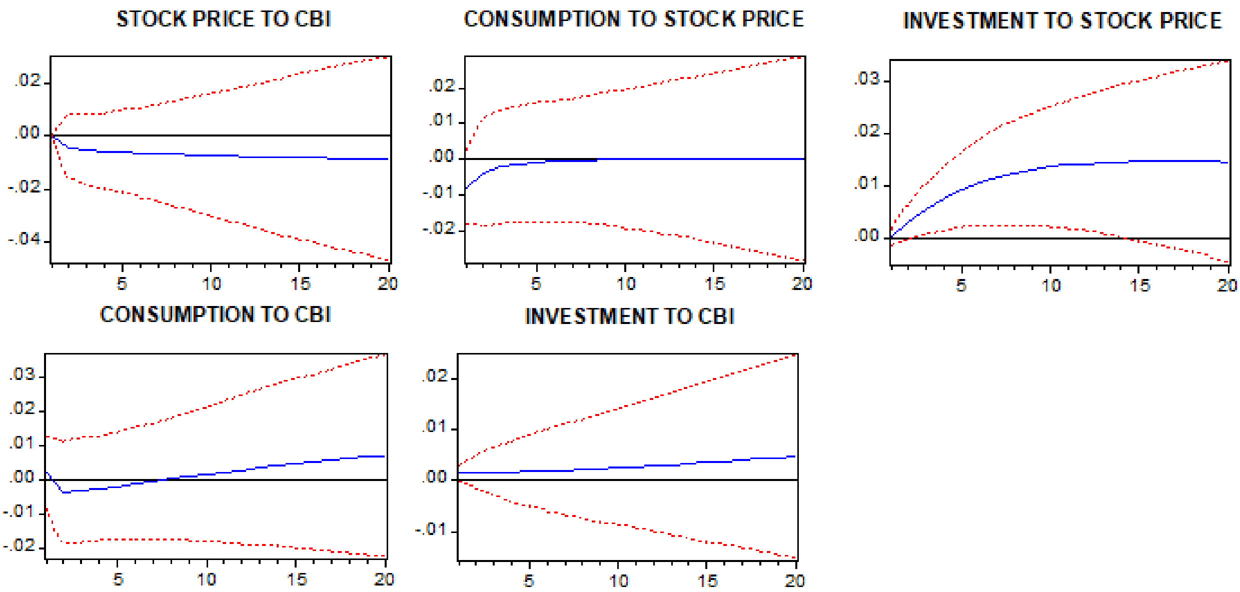
	Stock Index	CBI	Consumption	Investment
Chow Test				
F-Statistic	1.48	1.55	0.71	1.46
Probability	(0.0319)	(0.0199)	(0.9079)	(0.0374)
df	[40, 472]	[40, 472]	[40, 472]	[40, 472]
Roy-Zellner Test				
F-Statistic	59.35	61.90	28.44	58.46
Probability	(0.0250)	(0.0147)	(0.9141)	(0.0298)
df	[40]	[40]	[40]	[80]

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

To check the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption is applied. The results of the poolability test shown in Table 3.18 reveal that the null hypothesis is not rejected. This denotes that the panel is poolable and there is no heterogeneity among the countries sample. Table B.8 panel 1 column 5 in the Appendix illustrates that the financial capitalisation per GDP is between 13% to 17% with the average 15%. Thus, the result shows that group 1 is homogeneous.

The author can now present the results of impulse response function for the low market capitalisation countries. The results in Figure 3.9 show that stock index responds negatively in relation to shock one standard deviation regarding CBI degree. A one per cent increase in the degree of CBI will decrease the stock index about 0.4% in quarter two and the slight decline in stock index is continuous until period 20. This means that greater CBI will harm the stock index in countries with low market capitalisation. The negative reaction of the stock index to increasing CBI is also known as the "paradox of central bank credibility" (Ioannidis and Kontonikas, 2008). They argued that the negative relationship is due to the higher level of asymmetric information which may reduce the ability of the stock market to transfer information and lowering the efficiency of this monetary transmission mechanism. Another reason is stated by Li et al. (2010) who claimed that international financial factors have a larger impact than domestic monetary policy on stock index in developing countries.

Figure 3.9: Impulse Responses Function Model 2 Group 1



The negative response is also shown in consumption of stock index shock. One standard deviation of the stock index leads to a reduction in consumption of 0.8% in the first quarter. Subsequently, it takes 8 quarters for its effect on consumption to die out. This negative effect of stock index on consumption might be caused by the small number of people involved in stock market activity. Thus, public consumption is not dependent on their wealth asset. In contrast, shock one standard deviation of stock index increases investment by 10% at period 6 and from period 7 onwards the response slightly increases. This result is in line with Tobin's q theory which links financial asset prices and investment. The consumption response to one standard deviation CBI shock is positive approximately 0.2% in the first period. Nonetheless, in the second quarter, the consumption response is negative of around 0.4%. The effect becomes the initial value in period 8. Then after that period until period 20, the consumption response is positive. These findings demonstrate the effectiveness of monetary transmission via the wealth effect. The investment response to CBI shock is positive and relatively persistent for all periods. Shock one standard deviation CBI lead to increase investment by 0.2% at first quarter. This implies that CBI attracts investment via the stock market.

Next, move to the second group. Lag 2 is selected as the optimal lag based on the Akaike information criterion which reveal in Table B.5 in the Appendix. Table B.7 describes the panel VAR regression of stock index, CBI, consumption and investment for group 2.

Table 3.19: Poolability Test Model 2 Group 2

	Exchange rate	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	1.71***	2.06***	2.32***	4.26***
Probability	(0.0003)	(0.0000)	(0.0000)	(0.0000)
df	[72, 868]	[72, 868]	[72, 868]	[72, 868]
Roy-Zellner Test				
F-Statistic	123.27***	148.37***	167.28***	306.86***
Probability	(0.0002)	(0.0000)	(0.0000)	(0.0000)
df	[72]	[72]	[72]	[72]

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

To check the presence of heterogeneity across countries, the Chow and Roy-Zellner tests with regard to the pooling assumption is applied. The results of the poolability tests revealed in Table 3.19 suggest that the null hypothesis is rejected. This means that the panel is not poolable and there is heterogeneity among the countries sample. Table B.8 panel 2 column 5 in the Appendix shows the financial capitalisation per GDP is varies for all countries in group 2, with Venezuela the lowest, around 3%, whereas the highest is South Africa with approximately 200%. Consequently, the result shows that group 2 is heterogeneous. In this part, the mean group estimation by averaging the coefficient for the 10 countries sample is applied. The result is shown in Table 3.20.

Table 3.20: MG Panel VAR Regression Model 2 Group 2

	Stock Index	**CBI**	**Consumption**	**Investment**
Stock Index (-1)	0.9494	0.0049	0.0488	0.0281
Stock Index (-2)	-0.1007	-0.0088	-0.0197	-0.0027
CBI (-1)	-2.0427	0.8116	0.9856	-0.1654
CBI (-2)	-6.9401	-0.0281	2.9170	0.0503
Consumption (-1)	0.0260	-0.0053	0.9224	0.0206
Consumption (-2)	0.0357	0.0414	0.0009	0.0241
Investment (-1)	0.2352	-0.0178	0.3526	1.5948
Investment (-2)	-0.1868	-0.0025	-0.3059	-0.6685
C	4.0245	-0.1044	-1.7911	0.2698

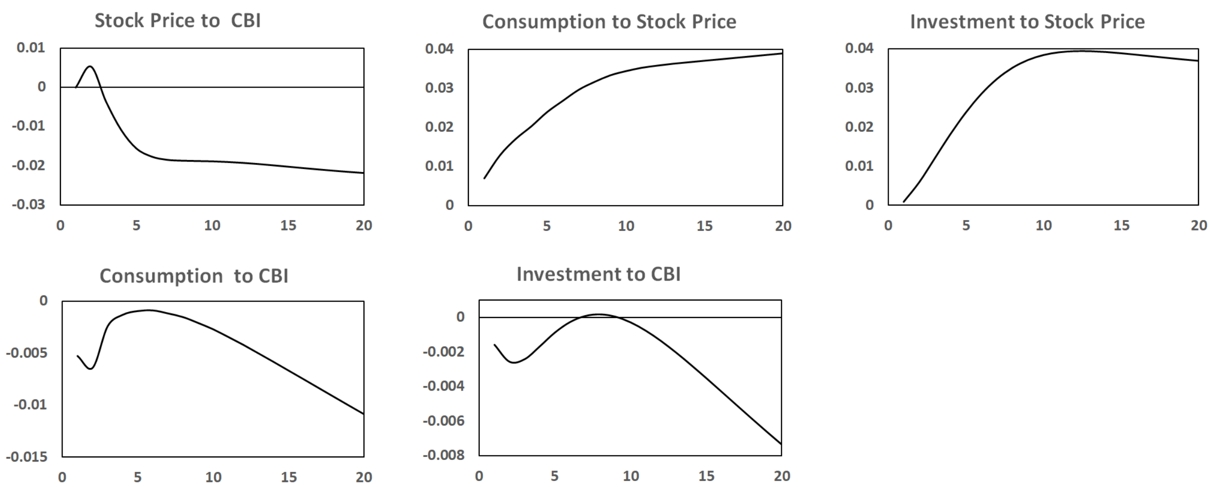
Note: The mean group estimation is the unweighted mean of coefficients of explanatory variables the individual country estimates. This estimation only averages the coefficient but not for standard error and t-statistic.

Table 3.20 describes the mean group estimation panel VAR for group two of the interaction among stock index, CBI, consumption and investment. The stock index is positively influenced by its own first lag with a coefficient of 0.9494. This implies that an increase of 1% in the stock index in the previous quarter leads to a rise in the stock index of around 1%. However, stock index lag 2 leads to a decrease in the current stock index with a coefficient of -0.1007. An increase of 1% in stock index lag 1 leads to an increase in consumption and investment of approximately 0.05% and 0.03%, respectively. In contrast, an increase of 1% in stock index lag 2 leads to a reduction in consumption and investment of approximately 0.02 and 0.003%, respectively. The result show that a negative relationship between CBI and stock index, with coefficients of -2.0427 and -6.9401 for CBI lag 1 and lag 2. The effects of CBI lag 1 and lag 2 on consumption are positive with coefficients of 0.9856 and 2.9170, respectively. CBI lag 1 has a negative effect on investment, but CBI lag 2 has a positive effect on it.

Figure 3.10 shows the interactions concerning CBI, stock index, consumption and investment implied by the mean group estimator for countries with moderate financial capitalisation. First, look at the impulse response of the stock index to CBI shock. The shock one standard deviation of CBI leads to an increase in stock index approximately 0.5% at period two but moves to the initial value in period three. This implies that higher legal CBI index is valuable in relation to financial market performance for countries with moderate financial capitalisation. Enhancing the degree of CBI is also a signal that good government establishes a strong commitment to fighting inflation for investors (Lavezzolo, 2006). Therefore, the investors will believe that national economic policy will be stable and consistent (Pastor and Maxfield, 1999). This evidence seems to support the work of Forch and Sunde (2012) who ascertained that changes in CBI are related to higher stock index returns over one month, although stock index do not respond significantly over a period of 12 months after the CBI shock.

The responses of consumption and investment to stock index shock are positive. For the impulse response of consumption to stock index shock, an increase of one standard deviation of stock index increases consumption approximately 1% in the first quarter and reaches its highest close to 4% at period 20. This result is in line with Friedman's permanent income hypothesis pertaining to the positive relationship between stock index and consumption. Shock one standard deviation of the stock index leads to higher investment, around 4% in quarter 12. From period 12 onwards, the effect of stock index on investment is steady. This result corresponds with Tobin's q theory developed by Tobin (1969), who argued that the market value of a company's existing fixed capital stock can be determined by asset price. q is defined as the ratio of the total market value of companies relative to the replacement cost of their existing capital stock at current prices. When q is high ($q > 1$) implies that a company's stock is more expensive than the replacement cost of its asset. Thus, the company can increase new equity to develop its capital and therefore, improve its value. Specifically, a company tends to invest more when its stock index increases. According to Fama (1990), stock index is a leading indicator for the economy overall. Hence, the investor will understand that an increase in stock index will assist the economy will grow quickly. Davis and Stone (2004) have shown that a 1% change in equity price creates a 1% change in long-run investment. Subsequently, turn to consumption and investment in relation to CBI shocks. After central bank reform shock, there will be a negative effect on consumption. This means that increasing CBI generates lower consumption. This might be caused by high inflation in the countries sample. The result shows that a negative effect of CBI shock with respect to investment.

Figure 3.10: Impulse Responses Function Model 2 Group 2

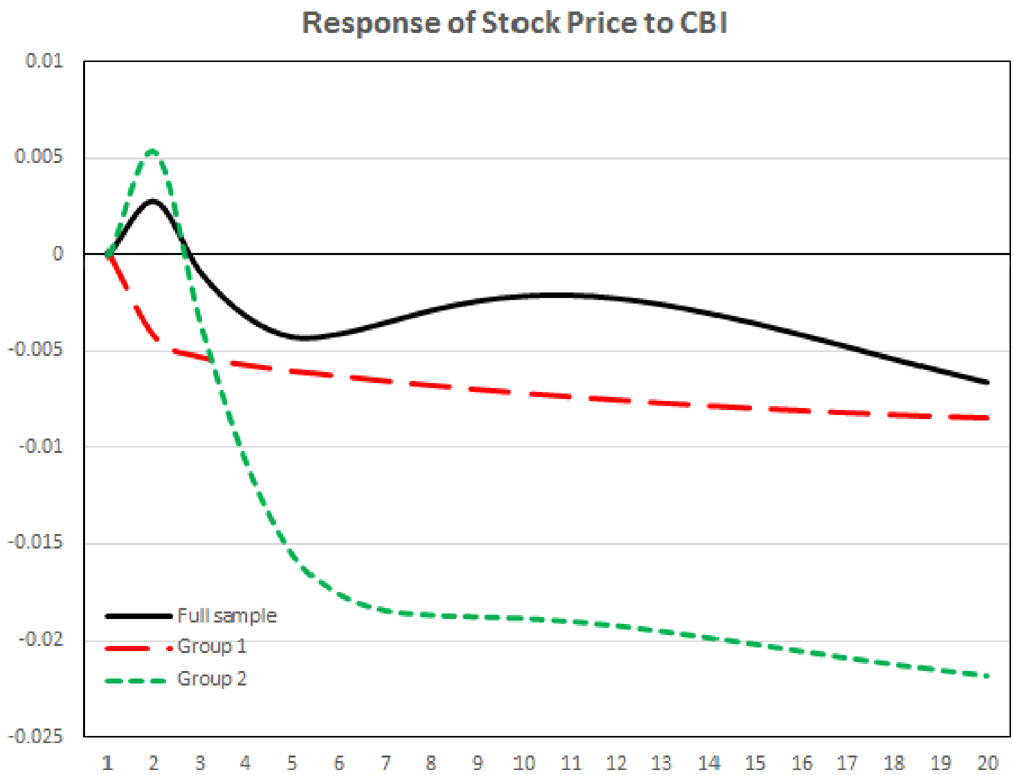


G. Comparison sub-sample group

Figure 3.11 indicates a fluctuating response of stock index to CBI shock for group 1, group 2 and the average for the all countries sample. For group 2 and the full sample, shock one standard deviation of CBI will respond positively by way of stock index with a magnitude of 0.5% and 0.25% in period 2, though it moves to the initial value in period 3. From period 4 onwards, the stock index response is negative. In general, CBI has a positive effect on stock index in the short term. This implies that higher legal CBI index is valuable with regard to financial market performance. Enhancing the degree of CBI is also a signal that good government establishes a strong commitment in fighting inflation for investors (Lavezzolo, 2006). Consequently, the investors will believe that national economic policy will be stable and consistent (Pastor and Maxfield, 1999). This evidence appears to support the work of Forch and Sunde (2012), who found that CBI changes are related to higher stock index returns over one month. Nonetheless, stock index does not respond significantly over a period of 12 months after the CBI shock.

A different response is shown by group 1 where the CBI shock influences stock index negatively for all periods. This means that higher CBI will harm the stock index in countries with low market capitalisation. The negative reaction of stock index to increasing CBI is also termed the "paradox of central bank credibility" (Ioannidis and Kontonikas, 2008). They argued that the negative relationship is due to the higher level of asymmetric information which may reduce the ability of the stock market to transfer information and as a result of lowering the efficiency of this monetary transmission mechanism. A further reason is stated by Li et al. (2010), who assert that international financial factors have a greater impact than domestic monetary policy on stock index in developing countries.

Figure 3.11: Impulse Response Function of Stock Index to CBI



The left side of Figure 3.12 is describing the consumption responses to stock index shock. A shock one-standard deviation related to stock index increases consumption for group 2 and the full sample. Thus, the result shows the existence of a wealth channel. This result is consistent with the life-cycle effect, in which consumer expenditure improves over time in response to greater wealth. Moreover, Friedman's permanent income hypothesis proposes that people smooth out consumption over their lifetime. Hence, an increase in stock index creates greater wealth, therefore, encouraging further consumption. This result supports previous empirical studies such as Starr-McCluer (2002), who established that consumer spending increase by about 3 - 7 cents for every dollar increase in stock market wealth. He and McGarrity (2005) suggest that a 1% increase in the stock market return resulted in an increase in consumption of consumer durables of 0.48% and 0.28% over the period 1946 to 1986 and 1987 to 2000, respectively. Ungerer (2003) determined that a one-dollar increase in stock market wealth produced a higher marginal propensity to consume of 0.01 cents. Conversely, the shock one standard deviation of stock index generates lower consumption in group 1, though the impact diminishes after 2 years of the shock. The negative effect of the stock index on consumption in countries with low market capitalisation could be because there is a small number of people involved in the financial market. Thus, public consumption is not dependent on their wealth asset.

Figure 3.12: Impulse Response Function of Consumption and Investment to Stock Index

The right side of Figure 3.12 is describing the investment responses to stock index shock. Here, shock one standard deviation of the stock index affects investment positively for all three groups. The effect reaches the peak after 12 quarters at 1.5, 3.6 and 4.0% for group 1, full sample and group 2, respectively. From period 12 onwards, the effect of the stock index on investment is steady. This result corresponds with Tobin's q theory developed by Tobin (1969) who argued that the market value of a company's existing fixed capital stock can be determined by asset price. Davis and Stone (2004) have shown that a 1% change in equity price creates a 1% increase in long-run investment.

Figure 3.13: Impulse Response Function of Consumption and Investment to CBI

The effect one standard deviation degree of CBI on consumption and investment via stock index is presented in Figure 3.13. For group 1, the positive reaction of consumption to CBI shock is shown in quarter eighth onwards but the reaction is negative from quarter two to seven. However, for group 2 and the full sample, consumption responds negatively to CBI shock. The largest decline in consumption in response to CBI shock is group 2. The negative response could be caused by weak financial and institutional development. Moreover, there is low participation by domestic investor in stock markets in developing countries (Siokis, 2005). Pichette et al. (2003) and Kishor (2007) stated that wealthier households hold most financial wealth, but their consumption is not responsive to gains in financial wealth. As a result, the wealth effect (represented by stock index) channel is not the main factor in representing monetary policy on consumption.

The response of investment to CBI shock via stock index varies for three different groups. For countries with low market capitalisation and the full sample, the effect of CBI on investment is positive, but for moderate market capitalisation, the effect is negative. The negative response of the moderate group is due to the negative effect of CBI on stock index, while for countries with low financial capitalisation, the financial market makes a small contribution to consumption and investment. Thus, the positive effect of investment may well be because of increasing direct investment, given that a greater degree of CBI is a good signal to attract investment. Overall, these results suggest financial capitalisation per GDP plays a prominent role in the effect of CBI shocks on consumption and investment via stock index.

3.4.3 Model 3: CBI, Bond Yield, Consumption and Investment

A. Summary Statistics

The panel data used in this model covers 19 developing countries[6] determined by data availability. Our dataset consists of 4 variables: CBI, bond yield, household consumption and investment. Quarterly data over the period 1991 quarter 1 to 2016 quarter 4 are employed.

Table 3.21: Summary Statistics

Variable	Mean	Std.Deviation	Min.	Max

Continued on next page

[6] Barbados, Bolivia, Egypt, Ghana, Kenya, Malaysia, Mexico, Nepal, Nigeria, Pakistan, Philippines, South Africa, Sri Lanka, Tanzania, Thailand, Trinidad and Tobago, Uganda, Uruguay and Zambia

Table 3.21 – *Continued*

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
Bond Yield	11.9778	11.6251	0.0040	154.6500
CBI	0.4889	0.1478	0.1345	0.7970
Ln Consumption	12.7816	2.6732	4.3776	18.2547
Ln Investment	13.9489	2.7470	4.0755	17.0918

Computed from sample data (1991.1-2016.4)
Based on author calculation

B. Panel Unit Root Tests

This model uses the panel unit root tests proposed by Levin et al. (2002), in conjunction Im et al. (2003) and Breitung (2005) panel unit root tests to check the stationary series of the CBI, bond yield, consumption and investment. Regarding the LLC, IPS and Breitung tests, the null hypothesis is non-stationary. LLC and Breitung tests assume a common autoregressive parameter for all panel; each individual series is stationary. IPS test assumes individual unit root (some of the individual series are stationary). The optimal lag length is automatically selected by means of Schwarz Info Criterion. The unit root tests use individual intercept and trend in panel.

Table 3.22: Panel Unit Root Tests

Series	**LLC**	**Breitung**	**IPS**
Bond Yield	-5.6149***	-4.9940***	-7.5489***
CBI	-1.5458*	-1.6639**	-2.0851**
Ln Consumption	-3.4665***	0.8983	-2.2063**
Ln Investment	-1.8451**	3.3464	-0.4900

Note: The table reports panel unit root tests. The symbols * is p $\leq$ 10%, ** is p $\leq$ 5%, and *** is p $\leq$ 1%. Critical values: 1%: -2.33; 5%: -1.65; 10%: -1.28.

Table 3.22 represents the result of the panel unit root test at level. The result indicates that the null hypothesis is rejected for all variables at the 5% level of significance. Rejecting the null hypothesis means that those variables are I(0).

C. Full Sample Countries Panel VAR

First, model 3 is estimated to examine the interrelationship between CBI, bond yield, consumption and investment. Lag 2 is selected as the optimal lag based on Akaike information criterion which reveal in Table B.9 in the Appendix. The results of panel VAR for model 3 are presented in Table B.10.

D. Poolability Test for Panel VAR

The panel VAR models in Equations (3.45a)- (3.45d) are estimated in pooled least squared (POLS). The POLS estimator is known to be potentially biased in a dynamic panel setting if the coefficients on the endogenous variables differ across countries. The Chow test and Roy-Zellner test proposed by Baltagi (2008) are performed to investigate the heterogeneity coefficients in the model.

Table 3.23: Poolability Test Model 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	3.15***	2.47***	1.91***	2.64***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[144, 1720]	[144, 1721]	[144, 1721]	[144, 1721]
Roy-Zellner Test				
F-Statistic	453.18***	356.26***	274.67***	380.58***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[144]	[144]	[144]	[144]

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

The result in Table 3.23 reveals the poolability test for the models. The null hypothesis confirms that the coefficients are the same for all cross countries. While the alternative hypothesis is the coefficients differ all across countries. The Chow and Roy-Zellner tests show that the null hypothesis is rejected. This implies that coefficients in the panel VAR model contain cross country heterogeneity.

E. Mean Group Estimation for Panel VAR

One common way to solve the heterogeneity problem in the model is to perform the mean-group estimator proposed by Pesaran and Smith (1995) which is used by previous studies such as Assenmacher-Wesche et al. (2008); Sa et al. (2011). The results of the mean-group panel VAR are presented in Table 3.24.

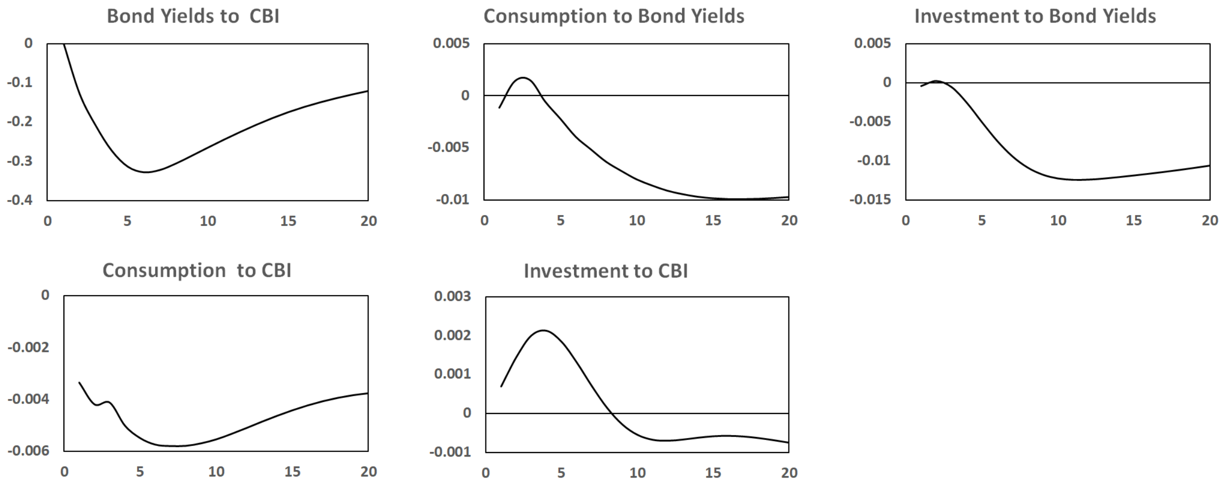
Table 3.24: MG Panel VAR Regression Model 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	1.0119	-0.0005	0.0027	-0.0001
Bond Yield (-2)	-0.2293	0.0003	-0.0057	-0.0007
CBI (-1)	-23.8524	0.8666	0.1950	0.0172
CBI (-2)	16.6708	0.0010	-0.6062	-0.2520
Consumption (-1)	16.2739	0.0035	1.2356	0.0205
Consumption (-2)	-16.5870	0.0090	-0.3218	0.0087
Investment (-1)	6.1728	0.0003	0.0960	1.6794
Investment (-2)	-6.2083	-0.0060	-0.0349	-0.7178
C	9.3374	-0.0234	0.5874	0.2016

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.

Table 3.24 describes the mean group estimation for the panel VAR of the interaction among bond yield, CBI, consumption and investment. Bond yield is positively influenced by its own first lag with a coefficient of 1.0119. This implies that an increase (decrease) of 1% in bond yield in the previous quarter leads to rise (decline) in bond yield of around 1.01%. Meanwhile, bond yield lag two has a negative effect on bond yield, with a coefficient of -0.2293. Bond yield lag 1 has a positive effect on consumption but a negative effect on investment. On the other hand, bond yield lag 2 has a negative effect on consumption and investment, with coefficients of -0.0057 and -0.0007, respectively. CBI lag one has a negative effect on bond yield with a coefficient of -23.8524, but a positive effect on consumption and investment. However, an increase of 1% CBI lag 2 leads to an increase of 16.6708% in bond yield, and reduces consumption by 0.6062% and investment by 0.2520%.

Figure 3.14: Impulse Response Function Mean Group Estimation Model 3



To analyse the effect of CBI on bond yield, the bond yield on consumption and investment, and CBI on consumption and investment will focus more on impulse response function and variance decomposition. The results in Figure 3.14 show that shock a one-unit positive innovation to the degree of CBI on bond yield is a negative sign. In reaction to one positive innovation to the degree of CBI, the level of bond yield declines by 32% in period six, where from quarter 8 onwards the negative response is getting lower. This reveals that a more independent central bank can reduce government borrowing cost. This occurs for the reason that higher CBI is a signal that a more credible central bank generates better future economic performance. In response to changes in one standard deviation of the bond yield, the consumption drops around 0.1% at quarter one but becomes positive at quarter two. Subsequently, from the fourth quarter onwards, the consumption response to bond yield is negative. This means that increased (decreased) bond yield generates lower (higher) consumption. Increased bond yield encourages the willingness to invest in government bond and therefore reduces current consumption. The influence of a one-unit innovation to the bond yield reduces investment significantly and reaches the lowest at period 10, around 1.2%. This implies that lower bond yield generates increased investment. Lower bond yield is a sign of a higher global sovereign rating signifying lower investment risk. Consequently, it attracts investors to increase investment. Shock one standard deviation of CBI reduces consumption around 0.6% from period 6 to 9. After period 9, the negative effect is smaller. This may be caused by the lower wealth of the consumer since higher CBI reduces bond yield leading to a lower disposable income. As a result, consumer spending decreases. In contrast, shock one standard deviation of CBI has a positive effect on investment and reaches the peak around 0.2% in period 4. Higher CBI provides more transparency and credibility for the central bank and therefore, attracts more investment.

Table 3.25: Forecast Error Variance Decompositions Model 3

Period	**Bond Yield**	**CBI**	**Consumption**	**Investment**
	Forecasting Bond Yield			
4	90.5109	5.1636	2.0575	2.2680
8	78.1703	10.3358	5.6837	5.8102
12	71.8910	13.0028	7.2678	7.8384
16	68.2698	13.7011	7.9474	10.0816
20	66.0768	13.8377	8.3673	11.7182
	Forecasting CBI			
4	7.5414	90.5987	0.7778	1.0821
8	9.0388	83.7922	2.5853	4.5838
12	9.6135	79.2090	3.9627	7.2148
16	9.9890	76.7129	4.8542	8.4439
20	10.3878	75.1477	5.4956	8.9690
	Forecasting Consumption			
4	2.9415	5.1385	90.6887	1.2312
8	6.1593	6.7164	80.6808	6.4436
12	8.5909	8.2607	72.5313	10.6171
16	10.1755	9.8192	66.8070	13.1984
20	11.1635	11.2522	62.4662	15.1181
	Forecasting Investment			
4	3.5864	5.1693	9.8358	81.4084
8	7.3090	8.8561	12.8531	70.9817
12	9.9460	12.0416	15.1469	62.8656
16	11.5574	14.5582	16.6415	57.2429
20	12.4910	16.4111	17.7171	53.3808

Each row shows the percentage of the variance of the error in forecasting the variable mentioned in the title of the table, at each forecasting horizon (in quarters) given in the first column.

This session discusses the forecast error variance decompositions which reveal the contributions of variables to the variation of one variable that are reported in Table 3.25. Panel 1 of Table 3.25 reveals that approximately 90% of the variance of the errors in forecasting the bond yield come from innovations to the bond yield itself at the 4-quarter horizon. The contribution of innovations to the bond yield drops to around 66% at the 20-quarter horizon. The second largest contribution comes from the degree of CBI which contributes growth from 5% in the 4-quarter to 14% at the 20-quarter.

It is evident from panel 2 of Table 3.25 that consumption explains above 90% of the forecast error variance of the consumption at the 4-quarter horizon; but the contribution declines continuously to roughly 62% at the 20-quarter. The importance of innovations to the bond yield contributes approximately 3% in the 4-quarter then increase slightly to around 11% in period 20. CBI makes a small contribution to the forecast error variance, only 5% in the 4-quarter horizon.

The last panel in Table 3.25 explains that the importance of investment decreases with the increase in the forecast horizon. The investment contributes approximately 81% of the variance of the error in forecasting the investment at the 4-quarter horizon; then falls to around 53% in the 20-quarter horizon. The contribution of bond yield innovations to forecast investment increase from just below 4% in quarter 4 to around 12.5% at quarter 20. The innovation of consumption has a larger contribution than bond yield to forecast error variance of investment, approximately 17% at period 20.

F. Sub-sample analysis

The sample of countries are divided into three groups to obtain poolable group estimation. The first group includes Ghana, Malaysia, Nigeria, South Africa, Sri Lanka, Thailand and Zambia. The second group covers Egypt, Mexico, Nepal, Barbados, Pakistan in addition to Trinidad and Tobago. The last group involves Tanzania, Bolivia, Kenya, Philippines, Uganda and Uruguay. The panel VAR is estimated for each group and explore whether the impact of CBI on bond yield, the bond yield on consumption and investment, CBI on consumption and investment differs among the three groups. This approaches of grouping the countries sample in three groups and estimating the panel VAR for each group may be robust regarding the result for the impact of CBI on bond yield, the bond yield on consumption and investment, CBI on consumption and investment. The result establishes the poolable model for groups one and two, but for group three, it is not poolable. The author then apply MG estimator for panel VAR on group three. The author differentiates for every group member using a degree of CBI, inflation, bond yield and sovereign risk. The author does not find different average sovereign risk indices amongst the group. However, the author finds that in group 1, the average CBI is low, but the bond yield is high. In group 2: the average CBI degree and bond yield is low, whereas, in group 3, the average CBI degree and bond yield are high.

This part analyses the effect of CBI on bond yield, bond yield on consumption and investment, and CBI on consumption and investment in three sub-samples. By doing so is to address the principal aim of the thesis, i.e. to deal with country heterogeneity, since by splitting based on average CBI and bond yield rate, the subsamples become more homogeneous groups than the entire countries sample.

Table 3.26: Panel VAR Regression Model 3 Group 1

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	0.8924***	0.0000001	0.0013***	0.0010***
	(0.0164)	(0.000006)	(0.0004)	(0.0002)
CBI (-1)	-0.8870	0.9890***	0.0554	-0.0007
	(1.3379)	(0.0049)	(0.0385)	(0.0160)
Consumption (-1)	0.2870	0.0004	0.9933***	0.0108***
	(0.2160)	(0.0007)	(0.0062)	(0.0025)
Investment (-1)	-0.5925***	-0.0004	0.0028	0.9876***
	(0.2108)	(0.0007)	(0.0060)	(0.0025)
C	5.3013***	0.0063	0.0427	0.0376***
	(1.2156)	(0.0044)	(0.0350)	(0.0146)

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

Table 3.26 reveals the Panel VAR regression for subsample group 1. Lag 1 is selected as the optimal lag based on the Akaike information criteria which reveal in Table B.9 in the Appendix. Bond yield is positively influenced by its own first lag with a coefficient of 0.8924 at 1% significance. However, investment lag two has a significant and negative effect on bond yield with a coefficient of -0.5925. CBI lag one has a positive and significant effect on CBI, with a coefficient of 0.9890. Consumption is influenced positively by bond yield lag one and consumption lag one with coefficients of 0.0013 and 0.9933, respectively, those two variables are significant at 1%. Investment is influenced positively by bond yield lag one, consumption lag one and investment lag one with the coefficients of 0.0010, 0.0108 and 0.9876, respectively at 1% significance.

Table 3.27: Poolability Test Model 3 Group 1

	Bond Yield	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	1.10	1.51	1.51	1.30
Probability	(0.3427)	(0.0563)	(0.0566)	(0.1561)
df	[24, 692]	[24, 692]	[24, 692]	[24, 692]
Roy-Zellner Test				
F-Statistic	26.29	36.25	36.22	31.12
Probability	(0.3387)	(0.0519)	(0.0522)	(0.1504)
df	[24]	[24]	[24]	[24]

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

To confirm the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption are applied. The results of the poolability test in Table 3.27 show that the null hypothesis is not rejected. This means that the panel is poolable and there is no heterogeneity among the countries sample.

Figure 3.15 reveals the IRF's of CBI, bond yield, consumption and investment for the first group. Shock a one-unit standard deviation of CBI will reduce the bond yield 4% four periods after the shock. The more independent the central bank, the lower the bond rate, which corresponds with our expectation. The effect of bond yield on consumption is positive. A change of 1% in bond yield increases consumption of 2.5% in one year. The consumption increase is due to bond yield which occurs throughout the period. This result is in line with the theory, given that higher bond yield will increase disposable income; thus, create higher consumption. The same response is also revealed by investment on bond yield shock. Investment increases 2.6% in period 4 for shock one standard deviation of bond yield and the response increases slightly for every period. This shows that higher bond yield attracts the public to invest more because they will receive higher returns. The effect of CBI shock on consumption is positive but it has a weak effect, as it takes 13 quarters for consumption to increase 1% from the CBI shock. However, the result shows that the response of investment to CBI shock is a very weak response. The small effect of CBI on consumption and investment considers the effect of monetary policy on consumption and investment via bond yield is weak.

Figure 3.15: Impulse Responses Function Model 3 Group 1

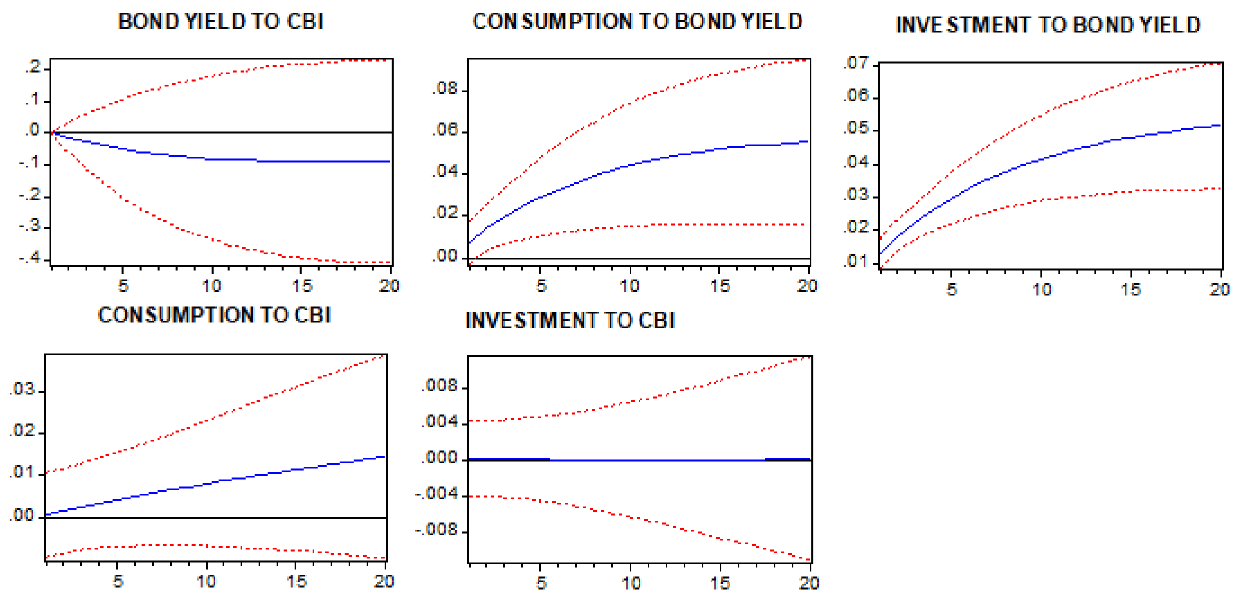


Table 3.28: Panel VAR Regression Model 3 Group 2

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	0.9771***	0.0002	0.0008	0.0004
	(0.0415)	(0.0004)	(0.0017)	(0.0003)
Bond Yield (-2)	-0.0748*	-0.0001	0.0002	0.00008
	(0.0415)	(0.0004)	(0.0017)	(0.0003)
CBI (-1)	-1.2939	0.9841***	-0.0339	-0.0008
	(4.1017)	(0.0415)	(0.1705)	(0.0312)
CBI (-2)	1.5680	-0.0012	-0.0049	0.0004
	(4.0920)	(0.0414)	(0.1701)	(0.0311)
Consumption (-1)	0.4577	0.0017	0.9182***	-0.0009
	(0.9984)	(0.0101)	(0.0415)	(0.0076)
Consumption (-2)	-0.6703	-0.0016	0.0612	0.0024
	(0.9975)	(0.0101)	(0.0414)	(0.0076)
Investment (-1)	6.3191***	0.0169	0.0740	1.8118***
	(3.2043)	(0.0324)	(0.1331)	(0.0244)
Investment (-2)	-6.0782*	-0.0168	-0.0514	-0.8130***

Continued on next page

Table 3.28 – *Continued*

	Bond Yield	**CBI**	**Consumption**	**Investment**
	(3.2279)	(0.0326)	(0.1341)	(0.0245)
C	0.4205	0.0051	0.0367	-0.0037
	(0.5860)	(0.0059)	(0.0243)	(0.0044)

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

Table 3.28 reveals the panel VAR regression for subsample group 2. Lag two is selected as the optimal lag based on the Akaike information criteria which reveal in Table B.9 in the Appendix. Bond yield is positively influenced by its own first lag and investment lag one with coefficients of 0.8924 and 6.3191; all variables are significant at 1%. However, bond yield lag one and investment lag two have a significant and negative effect on bond yield with coefficients of -0.0748 and -6.0782, respectively, at 10% level of significance. CBI lag one has a positive and significant effect on CBI, with a coefficient of 0.9841. Consumption is influenced positively by consumption lag one with a coefficient of 0.9182 at 1% level of significance. Investment is influenced positively by investment lag one with a coefficient of 1.8118, but influenced negatively by investment lag two with a coefficient of -0.8130, all variables are significant at 1%.

Table 3.29: Poolability Test Model 3 Group 2

	Bond Yield	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	1.33	1.25	0.89	1.56
Probability	(0.0886)	(0.1474)	(0.6694)	(0.0180)
df	[40, 539]	[40, 539]	[40, 539]	[40, 539]
Roy-Zellner Test				
F-Statistic	53.23	49.88	35.50	62.24
Probability	(0.0786)	(0.1362)	(0.6728)	(0.0137)
df	[48]	[48]	[48]	[48]

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

To verify the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption are applied. The results of the poolability test in Table 3.29 show that the null hypothesis is not rejected. This suggests that the panel is poolable and there is no heterogeneity among the countries sample.

Figure 3.16: Impulse Responses Function Model 3 Group 2

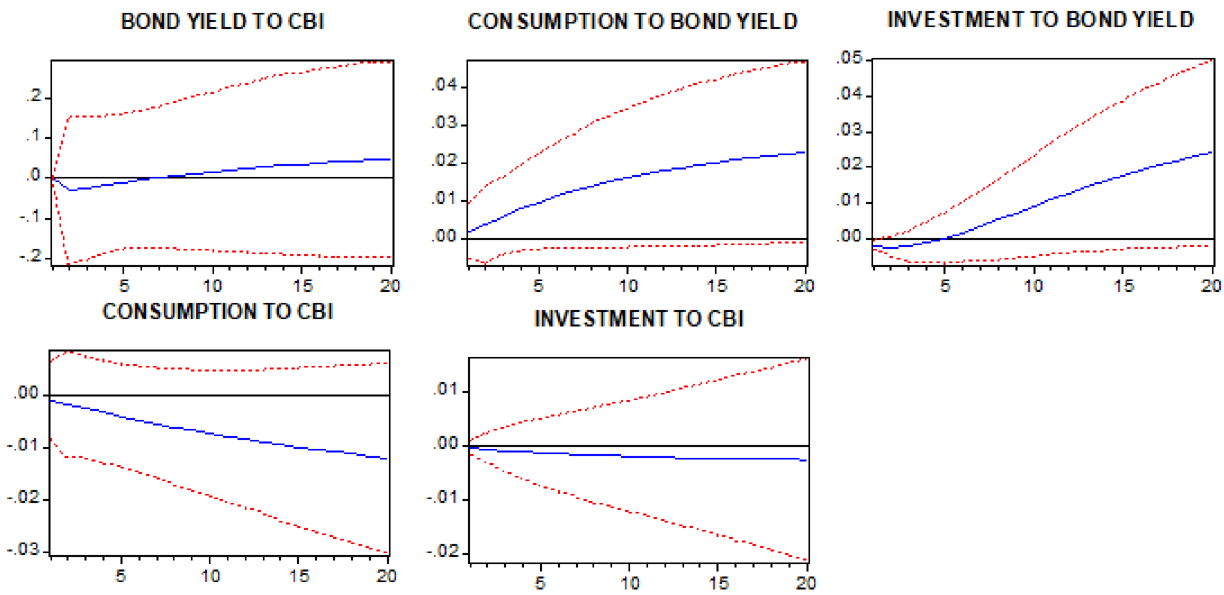


Figure 3.16 reveals the IRF's of CBI, bond yield, consumption and investment for the second group. Shock one-unit standard deviation of CBI generates lower bond yield by 3% in period 2. Subsequently, the impact is zero at quarter seven. From quarter eight onwards, the bond yield response to CBI shock is positive. Our finding shows that CBI is only effective in reducing bond yield in the short-run. Shock one standard deviation bond yield leads to an increase of 1 % in consumption in period five. The increase in consumption due to bond yield occurs throughout the period. The investment response to one percentage point relating to CBI shock is negative until period four, whereas the lowest is 0.2% in period 2. The effect of CBI on investment is zero in period 5; however, it has a positive effect from quarter six onwards. The effect of CBI shock on consumption is negative. Shock one standard deviation CBI degree leads to a decrease of 0.3% in consumption in period four. The negative is greater for the later period. The investment response to CBI shock is negative and constant over the 20 periods. Shock one standard deviation CBI degree produces a decrease of 0.1 to 0.2% in investment for all periods. The negative responses of consumption and investment to CBI shock reflect the weak effect of monetary policy on real activity via bond yield.

Table B.11 reveals the panel VAR regression for subsample group 3. Lag 1 is selected as the optimal lag based on the Akaike information criteria which reveal in Table B.9 in the Appendix.

Table 3.30: Poolability Test Model 3 Group 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Chow Test				
F-Statistic	4.17***	2.52***	6.12***	6.50***
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)
df	[20, 553]	[20, 553]	[20, 553]	[20, 553]
Roy-Zellner Test				
F-Statistic	83.46***	50.37***	122.42***	130.02***
Probability	(0.0000)	(0.0002)	(0.0000)	(0.0000)
df	[20]	[20]	[20]	[20]

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

To confirm the presence of heterogeneity across countries, the Chow and Roy-Zellner tests for pooling assumption are applied. The results of the poolability tests in Table 3.30 reveal that the null hypothesis is not rejected, which means that the panel is not poolable and there is heterogeneity among the countries sample.

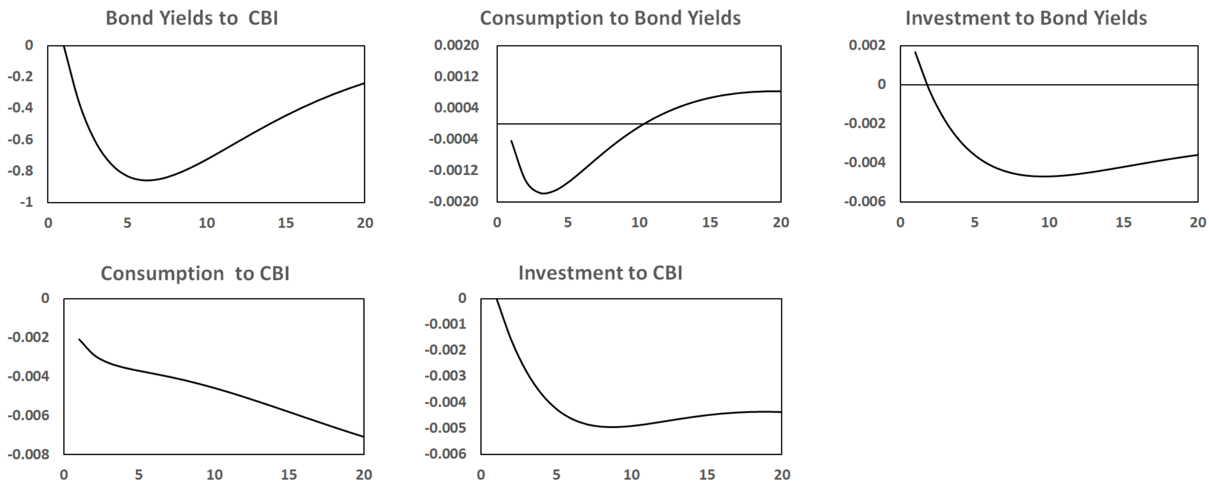
Table 3.31: MG Panel VAR Regression Model 3 Group 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	0.7598	0.0003	-0.0022	-0.0014
CBI (-1)	-25.6426	0.8643	-0.0760	-0.1237
Consumption (-1)	-2.1944	-0.0018	0.8294	-0.0087
Investment (-1)	1.1944	0.0048	0.1393	0.9980
C	29.0201	0.0693	0.4571	0.2568

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.

Table 3.31 describes the mean group estimation for panel VAR group 3 of the interaction among bond yield, CBI, consumption and investment. Bond yield is positively influenced by its own first lag with a coefficient of 0.7598. This implies that an increase (decrease) of 1% bond yield in the previous quarter leads to a rise (decline) in bond yield of around 0.76%. Bond yield lag 1 has a negative effect on consumption and investment, with coefficients of -0.0022 and -0.0014, respectively. CBI lag one has a negative effect on bond yield, consumption and investment with coefficients of -25.6426, -0.0760 and -0.1237, respectively.

Figure 3.17: Impulse Responses Function Model 3 Group 3



This group applies mean-group estimation by averaging the coefficient for the 6 countries sample for the IRF's of CBI, bond yield, consumption and investment. The result is shown in Figure 3.17. Shock a one-unit positive innovation to the degree of CBI on bond yield is negative. In reaction to one positive innovation to the degree of CBI, the level of bond yield declines by 8.6% in period six, from quarter 8 onwards the response toward the initial value. This result correspondences with our expectation that CBI is an essential factor for reducing bond yield. In response to change a-1 percent of the bond yield, the fall in consumption starts in the first quarter and reaches the lowest at quarter 3, around 0.18%; the response towards the initial value at period 10. Then, from the eleventh quarter onwards, the consumption response to bond yield is positive. This means that when bond yield increases, the public will spend more to buy bonds; thus, reduce consumption in the short-run. However, after 10 quarters, public spending begins to rise because they have more income from the bond returns. The influence of a one-unit innovation to the bond yield increases investment 0.18% in the first quarter, although starting from the third quarter, the investment response is negative and reaches its lowest point in period 9, around 0.5%. This shows that investors will respond directly to increasing bond yield. Shock one standard deviation of CBI reduces consumption by around 0.2% in period one. After that, the negative effect is greater. Shock one standard deviation of CBI has a negative effect on investment and reaches the lowest point, around 0.5% in period 8. Subsequently, the effect remains stable. The negative effect of CBI on consumption and investment via bond yield may be caused by the strong negative effect of bond yield on consumption and investment.

G. Comparison sub-sample group

Figure 3.18: Impulse Response Function of Bond Yield to CBI

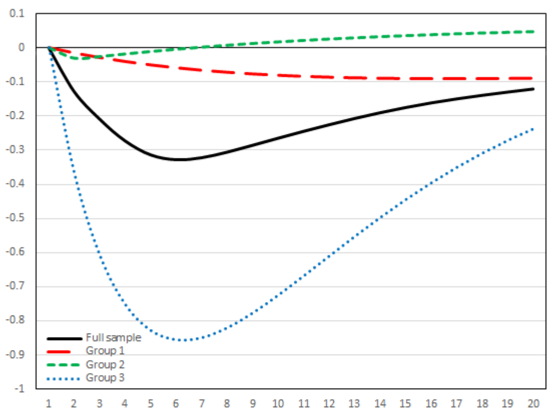


Figure 3.18 describes shock a one-unit positive innovation to the degree of CBI on bond yield for four different groups. In response to one positive innovation to the degree of CBI, the level of bond yield declines with the highest for group 3, followed by the full sample and group 1, while for group 2 the response is zero. This evidence suggests that investors reward a credible independent central bank as higher CBI reflects good governance; thus reduces investment risk. Lower government bond yields are perceived by investors as signalling an improvement in public finances. Bodea and Hicks (2014) indicated that investors are eager to enter countries that appear to be democratising early and that legal CBI can reduce borrowing costs even for such countries. Pastor and Maxfield (1999) stated that CBI as a signal of more credible economic policies for international investors. They arrived at the conclusion that higher levels of CBI have a positive and significant effect on investment in developing countries. Now, comparing the effect of CBI on the bond yield on three different groups. The negative effect of CBI on bond yield is strong for the group with a high CBI degree but high bond yield. The negative relationship between both variables is weak for group

countries with a low degree of CBI and high bond yield. For group countries with a low degree of CBI and low bond yield, CBI reduces bond yield only in the short-run.

Figure 3.19: Impulse Response Function of Economy Activity to Bond Yield

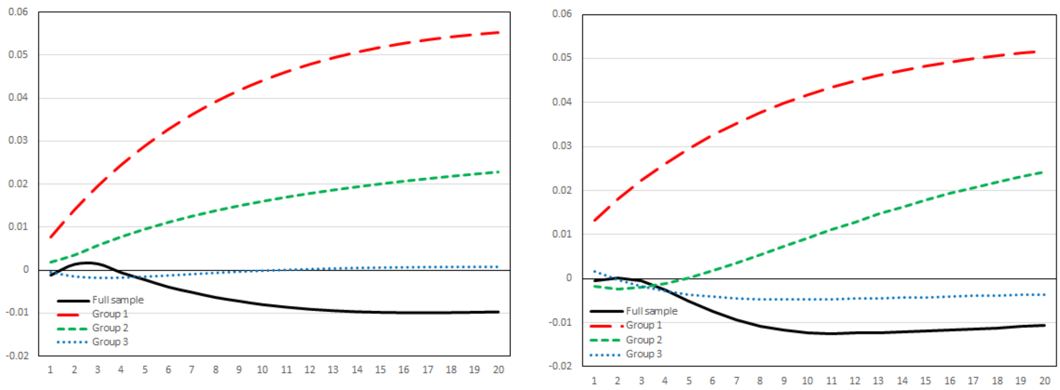
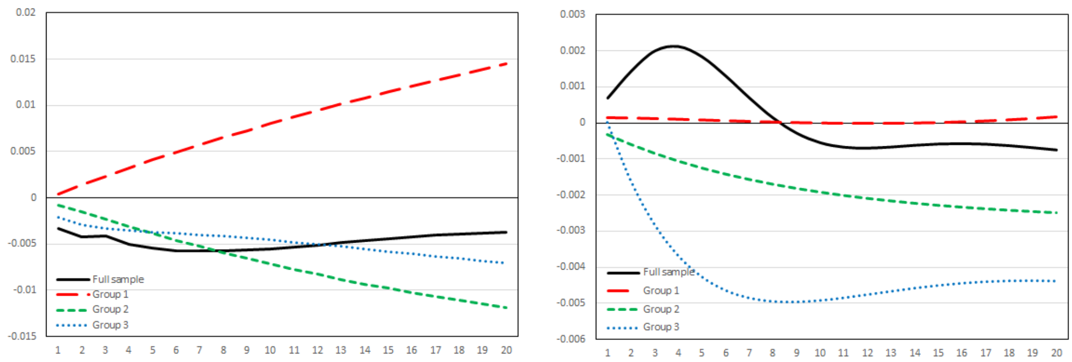


Figure 3.19 reveals the impacts of a one-unit positive innovation to the bond yield on consumption and investment. For consumption, in response to change a-1 percentage point of the bond yield, consumption rises rapidly for groups 1 and 2, where the magnitude for group 1 is around double group 2. An increase in the interest rates on government bonds generates higher disposable income; hence, increases public consumption. The consumption response on bond yield is around zero for group 3 for all period. However, for the full sample, the author can find the negative effect of bond yield on consumption after 4 quarters. The negative effect might be caused by high inflation in the countries sample. The higher inflation rate will lower private assets which is interpreted as negative income by consumers and reduces consumption (Hansen, 1996). The different responses of consumption to bond yield shock could be caused by the level of inflation in the countries sample.

The influence of a one-unit innovation to the bond yield raises investment significantly in group 1 and group 2 but is negative for group 3 and the full sample. The increase in investment as a higher interest rate on government bonds would be required in order for investors to hold the additional bonds. Government bond yield can be seen by investors from two perspectives. First, if bonds are seen as a component of asset wealth, then increasing or reducing bond yield, investors have a similar reaction. Second, if the reduction in bond returns is perceived as a signal of improvement in public finance, then investors will allow investment to increase above its equilibrium because the risk is lower.

Figure 3.20: Impulse Response Function of Economy Activity to CBI



The left side of Figure 3.20 describes the effect of CBI on consumption via bond yield. The consumption response to CBI shock is negative for all groups except on group 1. For group 1, which comprises high bond yield countries, the positive effect of CBI on consumption as the impact of high disposable income due to high bond yield. Higher bond yield produces greater returns for consumer and therefore, will encourage the public to spend on consumption. Conversely, the negative effect of CBI on consumption for group 2 is caused by the positive view of better future economic performance due to a higher CBI. As a result, a higher degree of CBI will encourage the public to buy government bond; thus, reduce consumption. For group 3 and the full sample, higher CBI causes lower bond yield thus reduce public disposable income. Lower disposable income results in a drop in consumption.

The right side of Figure 3.20 presents the response of investment to CBI shock. Investment response to CBI shock is neutral for group 1, this means that CBI is not significantly affecting investment. This finding is in line with (Claessens and Kose, 2017) who stated that the indirect effect of monetary policy on consumption and investment via the interest rate channel is weak in an undercapitalised financial system. The negative response of investment to CBI shock is shown by group 2 and group 3. However, the impact on group 3 is almost twice that of group 2. This might be caused by more financial friction in group 3 than group 2. As stated by Bernanke and Gertler (1995) the indirect effect of monetary policy on investment via the interest rate is large in countries with market imperfection and financial friction. In the full sample countries, the positive response of investment to CBI shock appears until the beginning of quarter eight but is negative from period eight onwards. This implies that increasing CBI successfully attracts investors at the beginning. However, CBI losses the effectiveness to enhance investment because it has diminishing marginal returns (Bodea and Hicks, 2014).

3.4.4 Model 4: CBI, Exchange Rate, Stock Index, Bond Yield, Consumption and Investment

A. Summary Statistics

The panel data used in this estimation covers 7 developing countries[7] that were determined by data availability. The dataset comprises of six quarterly variables covering the period 1991 quarter 1 to 2016 quarter 4, namely CBI, exchange rate, stock index, bond yield, household consumption and investment. The moments of the variables are provided in Table Table 3.32

Table 3.32: Summary Statistics

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
Ln Exchange Rate	2.3293	2.3776	-6.3283	9.5361
Ln Stock Index	7.4195	3.1490	-6.9077	11.3609
Bond Yield	11.9389	11.9083	0.0040	154.65
CBI	0.5381	0.1786	0.1345	0.9512
Ln Consumption	12.5592	2.8250	4.1735	21.3359
Ln Investment	11.8010	3.0298	3.0725	22.1196

Test Period: 1991.1-2016.4. All variables - with the exception of the bond yield and CBI degree - in logs.
Based on author calculation

B. Panel Unit Root Tests

This model uses the panel unit root tests proposed by Levin et al. (2002), in conjunction Im et al. (2003) and Breitung (2005) to check the stationarity series of the six variables. Regarding the LLC, IPS and Breitung tests, the null hypothesis is for non-stationary of the variables. LLC and Breitung tests assume a common autoregressive parameter for all panel; each individual series is stationary. Whereas, IPS test assumes individual unit root (some of the individual series are stationary). These tests use individual intercept and trend in panel unit root tests.

[7] Egypt, Kenya, Malaysia, Pakistan, Philippines, South Africa and Thailand

Table 3.33: Panel Unit Root Tests

Series	LLC	Breitung	IPS
ln Exchange Rate	-4.3490***	1.7727	-2.6921***
Ln Stock Index	-0.1040	-1.8012**	0.3093
Bond Yield	-5.7186***	-4.5914***	-7.4191***
CBI	-2.6207***	-2.2462**	-2.6334***
Ln Consumption	-2.7710***	2.3050	-0.0462
Ln Investment	-3.6577***	3.7652	-1.1086

Note: All variables - with the exception of the CBI degree - in logs. The table reports panel unit root tests. The symbols * is p ≤ 10%, ** is p ≤ 5%, and *** is p ≤ 1%. Critical values: 1%: -2.33; 5%: -1.65; 10%: -1.28.

Table 3.33 presents the result of the panel unit root test at the level. The result illustrates that the null hypothesis is rejected for all variables at 5% level of significance. Rejecting the null hypothesis means that those variables are I(0).

C. Full Sample Countries Panel VAR

First, the author estimate the model to examine the interrelationship between CBI, exchange rate, stock index, bond yield, consumption and investment by applying panel VAR. The optimal lag based on the Akaike information criterion is two lags which reveal in Table B.13 in the Appendix. The results of panel VAR for model 4 are presented in Table B.14.

D. Poolability Test for Panel VAR

The panel VAR models in Equations (3.46a)- (3.46f) are estimated in pooled least squared (POLS). The POLS estimator is known to be potentially biased in a dynamic panel setting if the coefficients on the endogenous variables differ across countries. To address this, the Chow and Roy-Zellner tests proposed by Baltagi (2008) to investigate the heterogeneity coefficients in the models are applied.

Table 3.34: Poolability Test Model 4

	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***

Continued on next page

Table 3.34 – *Continued*

	Exchange Rate	Stock Index	Bond Yield	CBI	Consumption	Investment
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 3.34 reveals the poolability test for model 4. The null hypothesis confirms that the coefficients are the same for all cross countries, while the alternative hypothesis is that the coefficients differ across countries. The results indicate that both tests reject the null hypothesis at the 1% level of significance. This implies that the coefficients in the panel VAR model contain cross country heterogeneity of the parameter coefficient.

E. Mean Group Estimation for Panel VAR

One common way to solve the heterogeneity coefficient problem in the panel data model is to perform a mean-group estimator following the approach by Pesaran and Smith (1995), which has been employed in other empirical studies, such as those of Assenmacher-Wesche et al. (2008) and Sa et al. (2011). To conduct a mean group estimation for the panel VAR, the VARs for each country separately is estimated and then compute the average of the coefficients across the countries (Canova and Ciccarelli, 2013). The results of the mean group estimation for the panel VAR are presented in Table 3.35.

Table 3.35: MG Panel VAR Regression Model 4

	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

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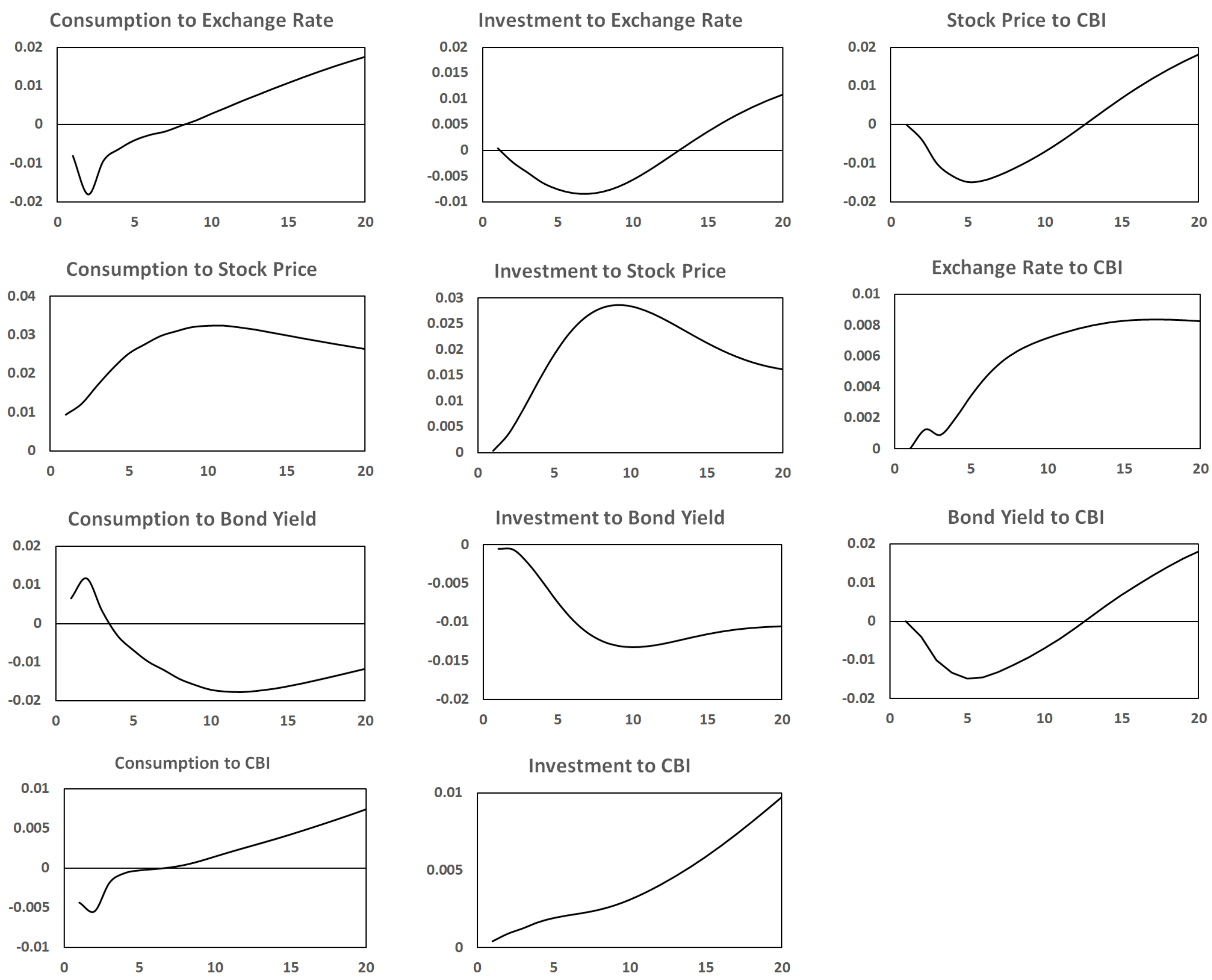
Table 3.35 – *Continued*

	Exchange Rate	Stock Index	Bond Yield	CBI	Consumption	Investment
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.

Table 3.35 shows that exchange rate lag 1 has a positive relationship with the exchange rate with a coefficient of 1.0146, which implies that the exchange rate in the previous quarter leads to a depreciation in the exchange rate of around 1.0146%. However, exchange rate lag 1 has a negative relationship with consumption and investment with coefficients of -0.3031 and -0.0567, respectively. Exchange rate lag 2 has a negative effect on the exchange rate with a coefficient of -0.1536, but a positive effect on consumption and investment with coefficients of 0.4154 and 0.0621. An increase of 1% in stock index lag 1 leads to an increase of 0.8885%, 0.055% and 0.025% in stock index, consumption and investment, respectively. In contrast, stock index lag 2 has a negative effect on stock index, consumption and investment. Bond yield lag 1 has a positive effect on bond yield, consumption and investment with coefficients of 0.9696, 0.0078 and 0.0002, respectively. Meanwhile, bond yield lag 2 has a negative effect on bond yield, consumption and investment. The effects of the lags in CBI on financial asset prices are various. CBI lag 1 has a positive effect on the exchange rate and stock index, but a negative effect on bond yield. Meanwhile, CBI lag 2 has a positive effect on the exchange rate and bond yield, but a negative effect on stock index. Meanwhile, CBI lag 1 has a positive effect on consumption and investment. CBI lag 2 has a positive effect on consumption, but a negative effect on investment.

Figure 3.21: Impulse Response Function Mean Group Estimation Model 4



Furthermore, focus the analysis on IRF and variance decomposition based on a mean group estimation for the panel VAR. Figure 3.21 displays the impulse response function over 20 quarters for a one standard deviation shock implied by the panel VAR regression using the mean-group estimator. First, focus on a CBI shock to three different financial asset prices. The response of the exchange rate to one standard deviation shock of CBI is positive, with the highest effect being around 0.84% in period 17. This indicates that the CBI shock depreciates the exchange rate, which is in line with the previous result presented by Grilli and Roubini (1995). This result confirms the evidence of the exchange rate puzzle, where the effect of monetary policy leads to the depreciation of the exchange rate. According to Kim and Lim (2016), the exchange rate puzzle occurs in countries with strongly restricted capital mobility. Hence, the change in monetary policy may not influence the exchange rate. The response of stock index to one standard deviation shock to CBI is negative in the beginning after the shock. This reflects that the higher CBI shock leads to a reduction in the stock index in the short-run. After the CBI shock, it takes 13 quarters for the stock index to begin to increase, and it reaches the peak of around 1.8% in period 20. This negative reaction of the stock index to increasing CBI is also known as the "paradox of central bank credibility" (Ioannidis and Kontonikas, 2008). These authors argued that this negative relationship is due to the higher level of asymmetric information, which may reduce the ability of the stock market to transfer information and thus lower the efficiency of the monetary policy transmission mechanism. Another reason is given by Li et al. (2010); they claimed that international financial factors have a larger impact than domestic monetary policy on the stock index in developing countries. A unit positive innovation to the degree of CBI on bond yield is significant with a negative coefficient. In reaction to one positive innovation to the degree of CBI, the level of bond yield declines by 16% in period four, where from quarter 4 onwards the negative response reduces gradually. This evidence suggests that investors reward a credible independent central bank as higher CBI reflects good governance, which reduces the investment risk. Lower government bond yield are perceived by investors as signalling an improvement in public finances. Bodea and Hicks (2014) indicated that investors are eager to enter countries that appear to be democratising early and that legal CBI can reduce borrowing costs even for such countries.

A one-standard deviation shock to the exchange rate produces lower consumption, reaching a minimum of about 1.8% in quarter 2, while the effect is positive after period nine. This implies that the depreciation (appreciation) in the exchange rate decreases (increases) consumption. This result confirms the Backus-Smith puzzle of a negative relationship between exchange rate and consumption (Backus and Smith, 1993). According to Kollmann (2012), the consumption-real exchange rate anomaly might be caused by the underdevelopment of international financial markets. There is additional empirical evidence for this, such as that of Devereux et al. (2012), who determined a negative relationship between exchange rate and consumption. In response to one positive innovation of the stock index, the level of consumption increases, reaching a peak at period 10, of around 3.24%. Previous empirical results support this finding. For instance, Starr-McCluer (2002), He and McGarrity (2005) and Ungerer (2003) show that an increase in consumer spending leads to a rise in the stock market return. This result is consistent with the life-cycle effect, in which consumer expenditure improves over time in response to greater wealth. Hence, an increase in stock index increases investors' wealth, thereby, encouraging further consumption. The influence of a one-unit innovation to bond yield increases consumption by around 1.2% in period 2. Subsequently, from the fourth quarter onwards, the response of consumption to the bond yield shock is negative. This means that, in the short-run, an increase in bond yield generates higher consumption. This finding is in line with the theoretical relationship between real interest rate and consumption (Taylor, 1999), given that higher bond yield will increase disposable income, thus generating higher consumption. However, the existence of a negative relationship between consumption and bond yield, which is shown after quarter 4, might be caused by high inflation in the sample of countries. This higher inflation rate will lower private assets, which is interpreted as negative income by consumers and reduces consumption (Hansen, 1996). Finally, the response of consumption to one standard deviation shock to CBI is negative and it reaches its lowest level, at 0.55%; in quarter two, its response becomes positive after quarter seven. The negative effect of CBI on consumption might be caused by the optimistic expectation of improved future economic performance due to higher CBI. As a result, a higher degree of CBI will encourage the public to buy more assets (foreign currency, stocks and bonds), thus reducing consumption. However, after some periods, a higher CBI generates higher financial asset prices, thus increasing public disposable income. Higher disposable income results in a rise in consumption.

The impulse response of investment to a one-unit shock to the exchange rate is negative between periods two and thirteen. This implies that depreciation generates lower investment. Depreciation produces a higher price for imported capital, whilst input can reduce profits and, in turn, lower investment. Prior studies such as those of Landon and Smith (2009), Goldberg (1993) and Campa and Goldberg (2005) show that currency depreciations are associated with a contraction in domestic investment. A one standard deviation shock to stock index positively affects investment. The effect reaches its peak in quarter nine, at 2.86%. From period 10 onwards, the effect of the stock index on investment is slightly lower. This result corresponds with Tobin's q theory developed by Tobin (1969), who argued that the market value of a company's existing fixed capital stock can be determined by asset price. Davis and Stone (2004) have shown that a 1% change in equity price creates a 1% increase in long-run investment. In response to a positive change of one-standard deviation in bond yield, the investment drops and reaches its lowest point in period 10, at approximately 1.32%. This means that an increase (decrease) in bond yield generates lower (higher) investment. Higher bond yield can be viewed by the investor as a sign of a lower global sovereign rating, signifying higher investment risk. Consequently, this leads investors to reduce their investment. A shock of one-standard deviation to CBI has a positive effect on investment and it reaches the peak of about 1% at period 20. A higher CBI provides more transparency and credibility to the central bank, and therefore, attracts investment. Furthermore, increasing the degree of CBI is also a signal for the implementation of structural economic reforms (Lavezzolo, 2006). This will create good opportunities for investors, and as a result, promote investment.

Table 3.36: Forecast Error Variance Decompositions Model 4

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Forecasting Exchange Rate						
4	82.3640	7.5827	3.5917	2.5483	0.6409	3.2721
8	64.5896	12.3612	5.0531	6.6711	3.4457	7.87901
12	53.3634	15.0827	5.4897	9.9451	6.4660	9.6531
16	47.4382	16.2280	5.6288	11.5561	9.0536	10.0953
20	44.1987	16.9810	5.8364	12.0223	11.1047	9.8569
Forecasting Stock Index						
4	13.7231	80.5433	2.2767	1.9175	1.2349	0.3044
8	20.2829	65.9710	4.7111	5.6488	2.1029	1.2832
12	24.4569	56.5773	5.4188	7.8205	2.7180	3.0084
16	24.9129	51.6395	5.7715	9.6907	3.3236	4.6618
20	23.7091	48.7401	6.2634	11.2531	4.4162	5.6181
Forecasting Bond Yield						
4	7.6420	7.8227	79.1953	3.9028	0.9475	0.4897
8	10.1371	8.5340	70.3958	7.2242	2.7270	0.9819
12	12.8356	10.5436	63.7150	8.1100	3.3386	1.4572
16	14.1027	12.5256	59.1960	8.4212	3.6017	2.1526
20	14.6528	13.8425	56.3024	8.4805	3.8558	2.8659
Forecasting CBI						
4	5.4075	1.7097	9.5503	80.7130	1.1552	1.4643
8	9.9023	2.0667	11.3811	72.4135	2.4792	1.7571
12	12.0346	2.7805	11.1708	68.2994	2.8282	2.8866
16	12.1250	3.1259	11.0020	66.3878	3.1056	4.2537
20	11.1735	3.2208	11.1126	65.4315	3.9691	5.0924

Continued on next page

Table 3.36 – *Continued*

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Forecasting Consumption						
4	1.7511	5.6439	1.7903	5.9915	83.5267	1.2966
8	2.3757	12.5046	5.8380	4.3852	71.7023	3.1942
12	3.1767	17.4477	9.8223	3.4370	61.4356	4.6807
16	3.8556	20.2561	12.0217	3.5485	54.9988	5.3193
20	4.6709	21.9225	12.8908	4.2165	50.7602	5.5390
Forecasting Investment						
4	4.7272	13.9301	5.7816	1.4310	4.3312	69.7990
8	12.1170	30.8357	9.9077	2.3913	8.5654	36.1828
12	17.5189	33.5749	11.1921	4.2171	11.0826	22.4145
16	19.5184	31.8712	11.9087	6.3244	12.9189	17.4583
20	19.0446	30.2089	12.5010	8.2251	14.5408	15.4796

Each row shows the percentage of the variance of the error in forecasting the variable mentioned in the title of the table, at each forecasting horizon (in quarters) given in the first column.

The forecast error variance decompositions reveal the contributions of the variables to the variation in one variable and the estimates are reported in Table 3.36. Panel 1 of Table 3.36 reveals that approximately 82% of the variance in the errors in forecasting the exchange rate comes from innovations to the exchange rate itself at the 4th quarter horizon; the contribution of innovations to the exchange rate drops to around 44% at a 20-quarter horizon. The second largest contribution comes from stock index, which reaches just under 17% at the 20-quarter horizon. Innovations to CBI, bond yield, consumption and investment make a small contribution to the forecast error variance of the exchange rate.

In panel 2 of Table 3.36, there is evidence that stock index explains above 80% of the forecast error variance of the stock index at the 4th quarter horizon, though this contribution drops gradually to roughly 47% at the 20th quarter. The importance of innovations in exchange rate contributes approximately 14% to the stock index in the 4th quarter, increasing to around 24% in period 20.

Panel 3 of Table 3.36 reveals that bond yield explains above 79% of the forecast error variance in bond yield at the 4th quarter horizon, though the contribution drops continuously to roughly 50% in the 20th quarter. The importance of innovations in stock index contributes approximately 8% to the bond yield in the 4th quarter, increasing to around 14% in period 20. Innovations to CBI, consumption and investment make a small contribution to the variance in the errors in forecasting the exchange rate.

Likewise, panel 5 of Table 3.36 shows that consumption explains more than 83% of the forecast error variance in consumption at the 4th quarter horizon, though this contribution drops continuously to roughly 56% at the 20th quarter. The second largest contribution comes from stock index, and reaches just under 22% at the 20th quarter horizon. Innovations to CBI, consumption and investment make a small contribution to the variance in the errors in forecasting the exchange rate, of around 5%.

The last panel in Table 3.36 explains that the importance of investment decreases with the increase in the forecast horizon. Investment contributes approximately 70% in the variance in the error in forecasting the investment at the 4th quarter horizon; this then falls to around 15% in the 20th quarter horizon. The contribution of stock index innovations to forecasting an increase in investment goes from just below 14% in quarter 4 to around 30% in quarter 20. Innovation in the exchange rate makes a sizeable contribution to the forecast error variance in investment, of almost 19% in period 20.

F. Sub-sample analysis

The sample of countries are divided into two groups based on CBI degree, inflation rate, exchange rate arrangement, capital control, financial capitalisation and sovereign risk. Surprisingly, non of the subsample groups is poolable after applying the Chow and Roy-Zellner tests. Then the author use a mean group estimation for the panel VAR for the two groups, and compare this with the mean group for the sample of all of the countries.

Group Split with Respect to CBI Degree

The first criterion considered is the importance of degree of CBI. The author distinguished between a high CBI index and a low CBI index. The more independent the central bank, the better the implementation of monetary policy by the central bank, since there is no government interference; thus the monetary policy will be more predictable by the public. As a result, if market participants are informed about the present and future monetary policy action, then the monetary policy can affect financial asset prices. The first group with a high CBI index included Egypt, Kenya, Malaysia and the Philippines. The second group covers 3 countries, namely, Pakistan, South Africa and Thailand. The author applied a Panel VAR regression for the two subsamples, and then ran poolability test for each group. The Chow and Roy-Zellner tests show that the null hypothesis is rejected. This signifies that the panels are not poolable and that there is heterogeneity on the coefficient of parameters among the country sample on both groups. Thus, the author performed a mean-group estimator for the panel VAR for each group.

Table 3.37: MG Panel VAR Regression Split According to CBI Degree

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
High CBI Degree Group						
Exchange Rate (-1)	0.9391	-0.2515	6.4346	0.0257	-0.4770	-0.0652
Exchange Rate (-2)	-0.0497	0.1856	-6.0608	-0.0363	0.5816	0.0839
Stock Index (-1)	-0.0719	0.9264	-0.8765	0.0017	0.0667	0.0262
Stock Index (-2)	0.0333	-0.1091	0.9790	0.0002	0.0093	-0.0025
Bond Yield (-1)	0.0022	-0.0093	0.9760	-0.0011	0.0053	0.0002
Bond Yield (-2)	-0.0037	0.0118	-0.2525	-0.0005	-0.0058	-0.0016
CBI (-1)	2.9709	3.8682	-158.9952	0.8018	12.5670	1.1408
CBI (-2)	1.4739	-16.6515	113.5021	-0.0534	9.9727	-0.3511
Consumption (-1)	-0.0812	0.2276	4.5995	0.0310	0.7763	0.1043
Consumption (-2)	0.1097	-0.1036	-6.9436	-0.0277	0.1271	-0.0520
Investment (-1)	0.2224	0.1461	3.0545	-0.0322	-0.3710	1.5200
Investment (-2)	-0.1738	-0.2437	-1.6584	0.0293	0.4295	-0.5976
C	-2.4639	7.6594	37.4075	0.1478	-11.3637	-0.3395
Low CBI Degree Group						
Exchange Rate (-1)	1.1152	-0.4698	-0.3893	0.0239	-0.0714	-0.0453
Exchange Rate (-2)	-0.2922	0.5657	-1.0102	-0.0353	0.1937	0.0330
Stock Index (-1)	-0.0755	0.8380	-0.0442	0.0011	0.0390	0.0227
Stock Index (-2)	0.0627	0.0316	0.1114	-0.0043	-0.0759	-0.0004
Bond Yield (-1)	-0.0094	-0.0275	0.9611	-0.0005	0.0110	0.0003
Bond Yield (-2)	0.0045	0.0059	-0.0896	-0.0006	-0.0279	-0.0029
CBI (-1)	0.5348	-1.7329	11.2575	0.7612	-1.5187	-0.0340
CBI (-2)	-0.2234	0.0800	-7.0712	-0.0089	0.7692	0.0618
Consumption (-1)	-0.0077	0.7372	1.9808	0.0078	1.0736	0.0652
Consumption (-2)	0.0095	-0.8753	-1.6270	-0.0103	-0.1954	-0.0555
Investment (-1)	0.3124	-0.1994	0.2991	-0.0433	1.4793	1.5885
Investment (-2)	-0.3023	0.3540	-0.8209	0.0557	-1.4649	-0.6459
C	0.3836	1.3296	5.5932	0.0122	1.9150	0.4798

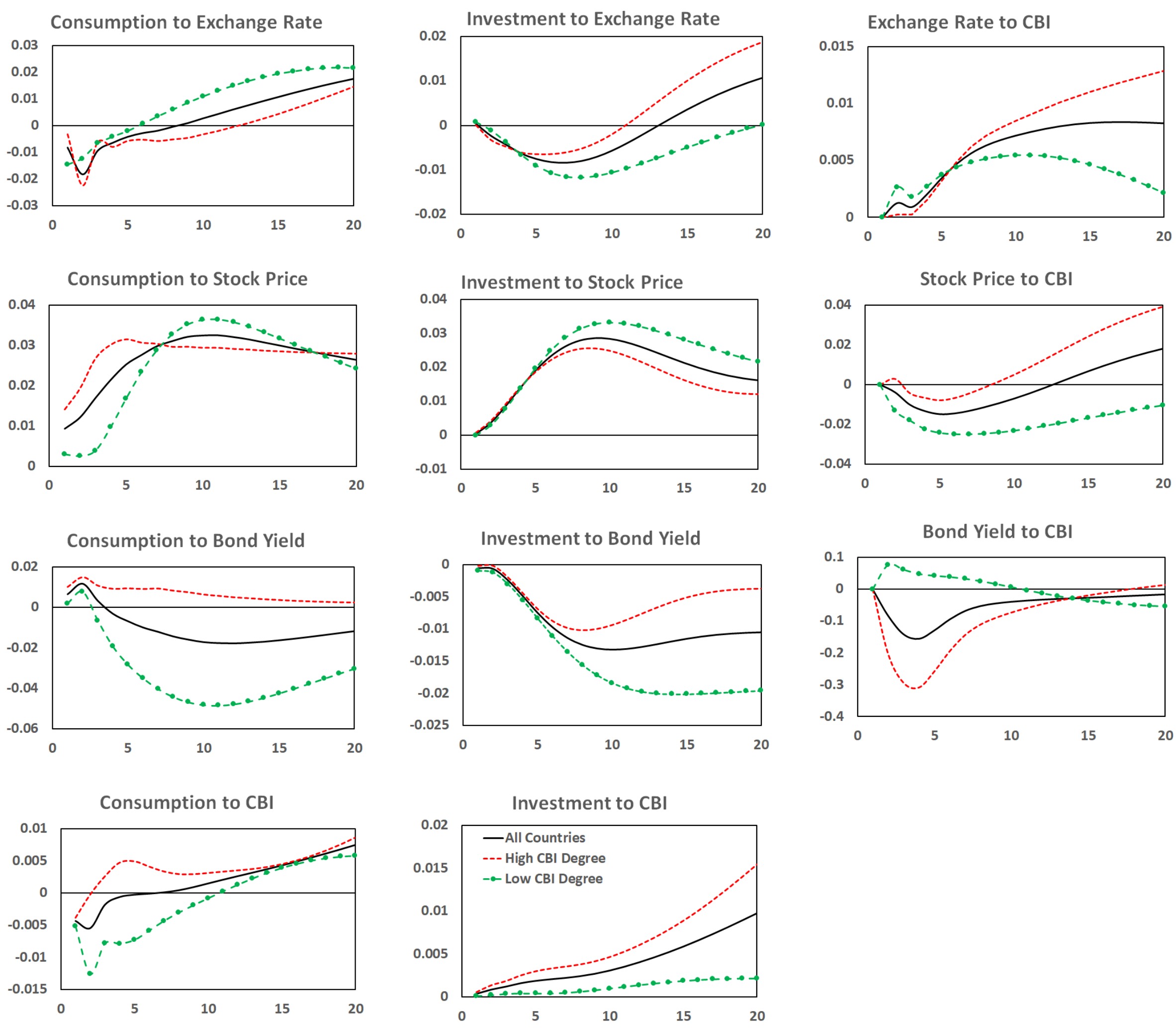
Note: The mean group estimation is the unweighted mean of coefficients of explanatory variables the individual country estimates. This estimation only averages the coefficient but not for standard error and t-statistic.

Table 3.37 describes the result of the mean group estimation for the panel

VAR for two different groups, with a high and a low CBI degree. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on three financial asset prices are different depending on the degree of CBI. In the high CBI degree group, CBI lag 1 has a positive effect on stock index but a negative effect on exchange rate and bond yield. In contrast, for the low CBI degree group, CBI lag 1 has a negative effect on stock index but a positive effect on exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. CBI lag 1 has a positive effect on consumption and investment in the high CBI degree group, while the effect of CBI lag 1 on consumption and investment is negative in the low CBI degree group. Overall, by splitting our sample based on CBI degree, the result shows that different effects of CBI on financial asset prices and consumption and investment.

Furthermore, by estimating the impulse response function to a unit innovation of CBI, exchange rate, stock index and bond yield. The results are illustrated in Figure 3.22. The right side of Figure 3.22 shows the mean impulse responses of three financial asset prices to a CBI shock for a low and a high CBI degree compared to the average for all countries. For a high CBI degree, the positive response of the exchange rate to CBI shock begins in quarter four. For group two, a shock of one standard deviation of CBI generates a depreciation in the exchange rate, but the effect is smaller than for group one only after period six. The result shows that a significant difference between the two groups for the response of stock index to a CBI shock after the eighth period. While the high CBI degree group shows a positive effect of CBI on stock index, the low CBI group show the opposite response. A higher CBI reduces bond yield in group one, whilst, a shock to CBI leads to higher bond yield until period 12. Our findings contradict those of Moser and Dreher (2010), who argues that the financial markets in countries with high and low CBI degrees do not have different responses to CBI shocks. The response of investment to a shock to financial asset prices and CBI has the same trend for both groups as well as for all countries. However, the response of investment is stronger in group two, except for the bond yield shock. A change in financial asset prices has a larger effect on consumption for group one than for group two. Consumption reacts differently to a shock to CBI for periods four to twelve: positively for group one but negatively for group two. Overall, the high CBI degree group reacts more strongly and more quickly than the low CBI degree group.

Figure 3.22: Impulse Responses Function Model 4 Split According to CBI Degree



Group Split with Respect to Average Inflation

Similarly, the author presents the second approach by splitting the countries depending on the level of inflation. According to Smets (1997), there are two key factors regarding the relationship between financial asset prices and expected inflation. First, an aggregate demand change is directly due to a change in asset price, and second, financial asset prices depend on future expected return, such as future economic activity, inflation and monetary policy. This means that financial asset prices contain information related to future inflation. Therefore, if the public's perception of inflation changes, financial asset prices should also change due to the sensitivity related to inflation. Group one comprises low average inflation countries, including Malaysia, the Philippines, South Africa and Thailand. The other group covers Egypt, Kenya and Pakistan, which are high average inflation countries. The Chow and Roy Zellner tests are ran after estimating the model using a panel VAR. The results indicate that the two groups are not poolable. As a result, the author apply a mean group estimation for the Panel VAR.

Table 3.38 presents the results of the mean group estimation for the panel VAR after the sample is split with respect to average inflation. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on three financial asset prices are different depending on the inflation rate. In the low inflation group, CBI lag 2 has a negative effect on stock index but a positive effect on the exchange rate and bond yield. In contrast, for the high average inflation group, CBI lag 2 has a negative effect on stock index but a positive effect on the exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. CBI lag 1 has a negative effect on consumption and investment in the low average inflation group, while the effect of CBI lag 1 on consumption and investment is positive in the high average inflation group. Overall, by grouping the sample based on average inflation, the effects of CBI on financial asset prices, consumption and investment can be seen to be different.

Table 3.38: MG Panel VAR Regression Split with Respect to Average Inflation

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Low Average Inflation Group						
Exchange Rate (-1)	1.1231	-0.3389	2.3962	0.0162	-0.0709	-0.0695
Exchange Rate (-2)	-0.2541	0.0948	-3.0347	-0.0370	0.1906	0.0485
Stock Index (-1)	-0.1013	0.8154	-0.4890	0.0001	0.0221	0.0325
Stock Index (-2)	0.0719	-0.0046	0.5337	0.0008	-0.0291	-0.0035
Bond Yield (-1)	-0.0082	-0.0264	0.8457	-0.0015	0.0011	-0.0006
Bond Yield (-2)	0.0018	0.0180	-0.0541	-0.0008	-0.0179	-0.0023
CBI (-1)	0.2984	-0.3693	3.6346	0.7608	-1.5155	-0.0052
CBI (-2)	-0.1934	0.1840	-3.5981	-0.0176	0.8469	0.0090
Consumption (-1)	-0.0021	0.1110	-0.5212	0.0062	0.5728	0.0189
Consumption (-2)	-0.0487	0.0021	-0.4686	-0.0014	0.2570	-0.0082
Investment (-1)	0.3018	0.0486	0.9920	-0.0663	1.0818	1.5377
Investment (-2)	-0.2246	-0.0976	-0.6886	0.0693	-1.0116	-0.5948
C	0.2392	1.4948	11.8619	0.0661	1.4983	0.4690
High Average Inflation Group						
Exchange Rate (-1)	0.8699	-0.3532	4.9953	0.0365	-0.6128	-0.0395
Exchange Rate (-2)	-0.0196	0.6869	-5.0450	-0.0343	0.7152	0.0802
Stock Index (-1)	-0.0363	0.9859	-0.5608	0.0033	0.0986	0.0144
Stock Index (-2)	0.0111	-0.1077	0.7051	-0.0050	-0.0247	0.0009
Bond Yield (-1)	0.0044	-0.0046	1.1348	0.0000	0.0167	0.0013

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Table 3.38 – *Continued*

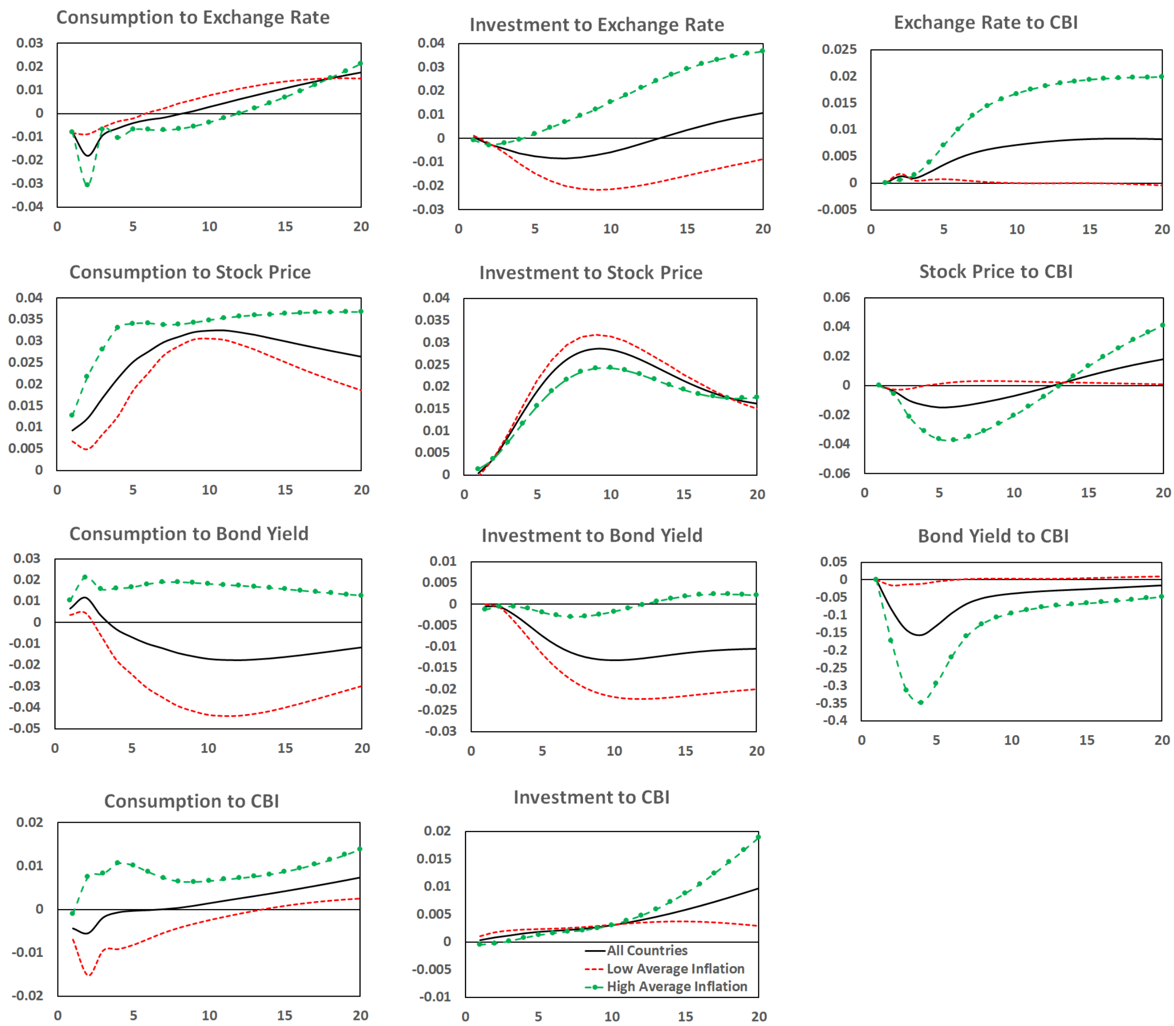
	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Bond Yield (-2)	0.0018	0.0180	-0.0541	-0.0008	-0.0179	-0.0023
CBI (-1)	4.0982	3.9170	-205.5823	0.8159	17.2579	1.4940
CBI (-2)	1.9996	-22.3673	149.0624	-0.0566	12.9369	-0.4184
Consumption (-1)	-0.1131	0.8927	8.8085	0.0409	1.3448	0.1791
Consumption (-2)	0.2206	-1.0162	-10.2604	-0.0454	-0.3686	-0.1138
Investment (-1)	0.2065	-0.0693	3.0491	0.0022	-0.4577	1.5649
Investment (-2)	-0.2345	0.1591	-2.1140	0.0023	0.4566	-0.6497
C	-3.2205	9.5490	39.6539	0.1213	-15.2343	-0.5982

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.

The impulse responses function indicates that the response of financial asset prices to a CBI shock is stronger in the high inflation group. A one-standard deviation shock to CBI leads to a depreciation in the exchange rate of about 2% after period 12. CBI reduces the stock index for the first 13 periods, and then increases the stock index at 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 has a small effect on the exchange rate, stock index and bond yield, since the response of the three financial asset prices is near to the initial value. Investment reacts more to the shock to the three different financial asset prices in countries with low average inflation. Appreciation of the exchange rate generates higher investment for countries with low average inflation; meanwhile, in high inflation countries, depreciation leads to higher inflation. The author does not find a significantly different effect of stock index on investment for the two groups. However, a 1% decrease (increase) in bond yield raises (reduces) investment by around 2% and 0.5% for the low and high inflation groups, respectively. The response of investment to a CBI shock is similar for the two groups until period 12, but at period 13 onwards investment increases in the high inflation group, while for the low inflation group it remains stable. The response of consumption to a change in the exchange rate and stock index 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 the two groups; it is positive for the high inflation group and negative for the low inflation group. This implies that a decrease of 1% in bond yield leads to an increase in consumption of around 4% in the low inflation group, but a decrease in consumption of 2% in the high inflation group in period 12. A unit standard deviation shock to

CBI generates around 1% higher consumption in period 4 for the high average inflation group, while it takes 15 periods for CBI to increase consumption for the low average inflation countries.

Figure 3.23: Impulse Responses Function Model 4 Split with Respect to Average Inflation



Group Split with Respect to Exchange Rate Arrangement

The third feature to consider is the importance of the exchange rate arrangement. Low flexibility in the exchange rate causes high volatility in inflation, interest rate, money supply and output (Bodart and Reding, 1999). The author divides the sample countries into low flexibility exchange rate countries, which include Egypt, Malaysia and Pakistan, and 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 reveals that the two groups are not poolable. As a result, a mean group estimation for the panel VAR is applied.

The results of the mean group estimation for the panel VAR for two different groups based on the exchange rate arrangement is presented in Table 3.39. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on the three financial asset prices are different depending on the exchange rate regime. In the low flexibility exchange rate group, CBI lag 2 has a negative effect on stock index but a positive effect on the exchange rate and bond yield. In contrast, for the high flexibility exchange rate group, CBI lag 2 has a positive effect on stock index but a negative effect on the exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. In the low flexibility exchange rate group, CBI lag 1 has a positive effect on consumption, while CBI lag 2 has a negative effect on investment. Meanwhile in the high flexibility exchange rate group, CBI lag 1 has a negative effect on consumption, and CBI lag 2 has a positive effect on investment. Overall, dividing the sample into two groups based on the exchange rate regime, the result shows that the effects of CBI on financial asset prices and consumption and investment are different.

Table 3.39: MG Panel VAR Regression Split with Respect to Exchange Rate Arrangement

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Low Flexibility Exchange Rate Group						
Exchange Rate (-1)	0.9944	-0.3392	-2.4446	0.0524	-0.7137	-0.0611
Exchange Rate (-2)	-0.0530	0.6425	1.4743	-0.0601	0.8065	0.0859
Stock Index (-1)	-0.0309	0.8013	0.4216	0.0087	0.0970	0.0263
Stock Index (-2)	-0.0007	0.0041	-0.4308	-0.0077	-0.0028	0.0023
Bond Yield (-1)	0.0050	-0.0139	1.0663	-0.0013	0.0102	0.0007
Bond Yield (-2)	-0.0053	0.0132	-0.2533	-0.0004	-0.0085	-0.0017
CBI (-1)	4.4631	4.7840	-181.0354	0.7586	16.9182	1.4714
CBI (-2)	2.1112	-22.6293	163.1939	-0.0335	13.1891	-0.5916
Consumption (-1)	-0.0117	0.9399	1.6362	0.0043	1.0411	0.0795
Consumption (-2)	0.0215	-1.0067	-1.1780	-0.0076	-0.0720	-0.0580
Investment (-1)	0.3134	0.0664	0.6339	-0.0264	-0.5424	1.5301
Investment (-2)	-0.2313	-0.0204	-0.5973	0.0368	0.5326	-0.5954
C	-3.9435	9.4493	7.2927	0.0523	-15.1086	-0.1556
High Flexibility Exchange Rate Group						
Exchange Rate (-1)	1.0297	-0.3494	7.9761	0.0043	0.0048	-0.0533
Exchange Rate (-2)	-0.2291	0.1281	-7.9242	-0.0177	0.1221	0.0442

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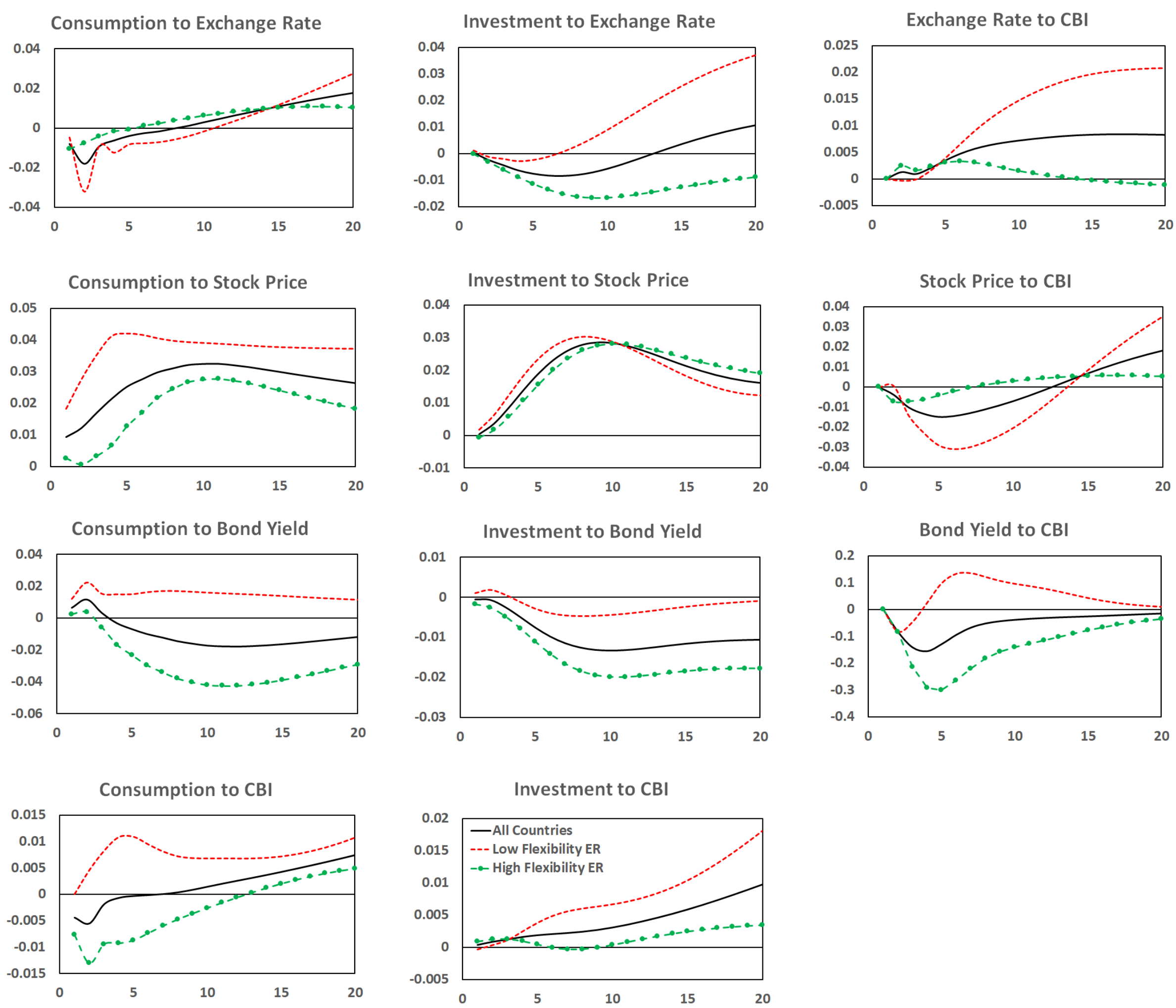
Table 3.39 – *Continued*

	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
Stock Index (-1)	-0.1054	0.9538	-1.2258	-0.0040	0.0233	0.0236
Stock Index (-2)	0.0808	-0.0885	1.3856	0.0028	-0.0454	-0.0045
Bond Yield (-1)	-0.0086	-0.0195	0.8971	-0.0005	0.0059	-0.0001
Bond Yield (-2)	0.0036	0.0063	-0.1297	-0.0006	-0.0203	-0.0025
CBI (-1)	0.0247	-1.0195	-14.7756	0.8038	-1.2607	0.0117
CBI (-2)	-0.2771	0.3805	-14.1967	-0.0349	0.6577	0.1389
Consumption (-1)	-0.0782	0.0756	4.8581	0.0336	0.8006	0.0936
Consumption (-2)	0.1006	-0.0051	-7.2804	-0.0297	0.0345	-0.0501
Investment (-1)	0.2216	-0.0532	2.8034	-0.0448	1.1453	1.5638
Investment (-2)	-0.2270	0.0371	-1.8261	0.0434	-1.0686	-0.6355
C	0.7815	1.5696	36.1329	0.1178	1.4040	0.1370

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.

It is believed that in economies, the exchange rate regime has a significant effect on asset market prices due to the sensitivity of the risk premium on the interest rate. According to Schnabl (2008), countries with high exchange rate flexibility have a higher risk premium on their interest rate and thus rising uncertainty in the asset market. Dellas and Tavlas (2013) found a different response of financial asset prices to monetary policy shocks in flexible and peg exchange rate countries; monetary expansion has a positive effect on financial asset prices, and the impact is higher under a flexible exchange rate. Figure 3.24 shows the impulse response functions for two different groups. For the high exchange rate flexibility group, a positive effect of CBI on financial asset prices exists, which is in line with our expectations. For instance, a CBI shock generates appreciation in the exchange rate, even though it takes up to 14 quarters following the shock. The result shows that the shock to CBI reduces the bond yield by around 0.3% in period 4. Furthermore, the changes in bond yield create large impacts on consumption and investment. By contrast, for the low exchange rate flexibility group, CBI causes a depreciation in the exchange rate of approximately 2% in period 12. CBI also reduces the stock index until period 13 but increases it in period 14 onwards. CBI reduces bond yield only for four periods after the shock, while after period 5, the bond yield increase. Appreciation of the exchange rate increases investment for all periods, but the increases in consumption in the high flexibility exchange rate group only continue until period 4. By contrast, depreciation leads to higher investment and consumption after period eight for the low flexibility exchange rate group. A shock positive innovation to stock index increases in consumption and investment, the effect is higher in the low flexibility group than in the high flexibility group. An increase (decrease) in bond yield generates lower (higher) investment and consumption in high flexibility exchange rate countries, while the reverse responses are revealed for the other group. CBI has a positive effect by increasing investment and consumption in the low flexibility exchange rate group. However, for the high flexibility group, CBI has a negative effect on consumption up to period 13 and CBI has a small impact on investment.

Figure 3.24: Impulse Responses Function Model 4 Split with Respect to Exchange Rate Arrangement



Group Split with Respect to Capital Control

International capital mobility has some advantages in that it reduces capital cost, increases foreign investment and boosts economic growth. Low capital restriction reduces market uncertainty and increases international capital inflow. Therefore, less restriction allows countries to generate higher financial asset prices. The author divides our sample countries into low capital restriction countries, namely Egypt and Kenya, and high capital restriction countries, namely Malaysia, Pakistan, the Philippines, South Africa and Thailand. The author run the Chow and Roy Zellner tests after estimating the panel VAR model. The results indicate that the two groups are not poolable. As a result, the author applies a mean group estimation for the panel VAR.

The results of the mean group estimation for the panel VAR for the two different groups based on capital control are presented in Table 3.40. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on the three financial asset prices are different depending on the capital restriction. In the low capital restriction group, CBI lag 2 has a negative effect on stock index but a positive effect on the exchange rate and bond yield. In contrast, for the high capital restriction group, CBI lag 2 has a positive effect on stock index but a negative effect on the exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. In the low capital restriction group, CBI lag 1 has a positive effect on consumption and investment, while in the high capital restriction group, CBI lag 1 has a negative effect on consumption and investment. Overall, dividing the sample into two groups based on capital restriction, the result shows that the effects of CBI on financial asset prices, consumption and investment are different.

Table 3.40: MG Panel VAR Regression Split with Respect to Capital Control

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Low Capital Restriction Group						
Exchange Rate (-1)	0.7438	-0.2923	9.7066	0.0043	-0.9338	-0.0573
Exchange Rate (-2)	0.1195	0.4472	-8.6722	-0.0070	1.0832	0.1065
Stock Index (-1)	-0.0445	1.0639	-1.2565	0.0014	0.1451	0.0161
Stock Index (-2)	0.0192	-0.1954	1.3527	-0.0027	-0.0377	-0.0004
Bond Yield (-1)	0.0054	-0.0054	1.0874	-0.0000	0.0247	0.0012
Bond Yield (-2)	-0.0036	0.0052	-0.3981	0.0000	-0.0177	-0.0024
CBI (-1)	6.1297	7.3087	-310.9403	0.7916	25.8887	2.2631
CBI (-2)	2.8574	-33.3075	220.6016	-0.0919	19.3954	-0.6673
Consumption (-1)	-0.1501	0.1854	10.2506	0.0525	1.1718	0.1716

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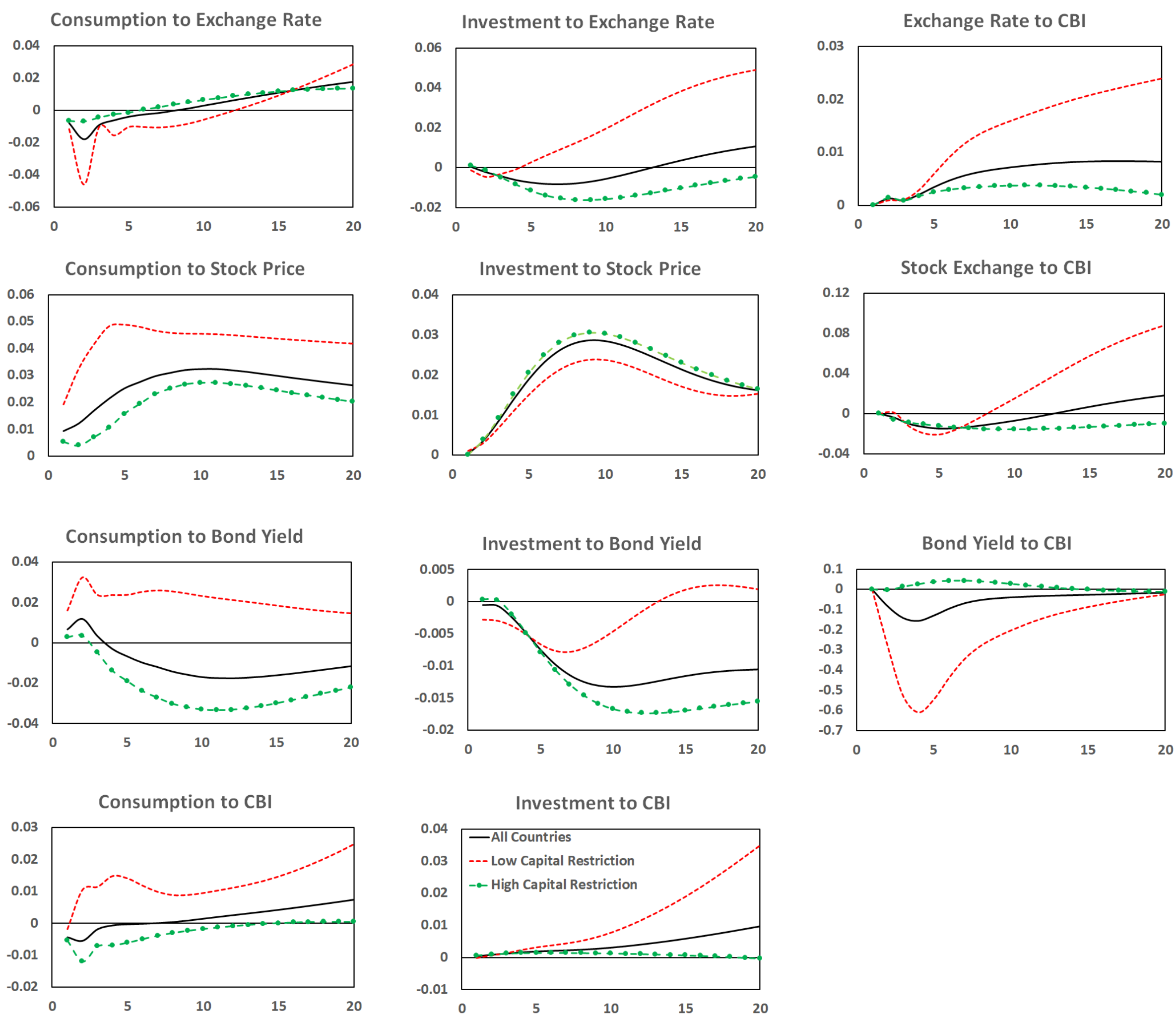
Table 3.40 – *Continued*

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Consumption (-2)	0.2743	-0.1818	-13.0984	-0.0531	-0.1990	-0.0906
Investment (-1)	0.1661	-0.1105	2.9246	-0.0011	-0.6533	1.5338
Investment (-2)	-0.2203	0.0681	-0.9750	0.0009	0.6500	-0.6252
C	-4.5028	14.2167	60.5568	0.1773	-22.9129	-1.0154
High Capital Restriction Group						
Exchange Rate (-1)	1.1229	-0.3661	1.0315	0.0332	-0.0509	-0.0564
Exchange Rate (-2)	-0.2629	0.3091	-1.9859	-0.0474	0.1483	0.0443
Stock Index (-1)	-0.0850	0.8183	-0.2251	0.0015	0.0188	0.0282
Stock Index (-2)	0.0565	0.0099	0.3089	-0.0013	-0.0230	-0.0021
Bond Yield (-1)	-0.0061	-0.0218	0.9225	-0.0012	0.0010	-0.0001
Bond Yield (-2)	0.0012	0.0109	-0.0965	-0.0007	-0.0143	-0.0021
CBI (-1)	0.2457	-0.8687	3.9344	0.7815	-1.2131	-0.0130
CBI (-2)	-0.0979	0.0498	-1.6817	-0.0113	0.6815	0.0231
Consumption (-1)	-0.0096	0.5503	0.7679	0.0085	0.7964	0.0539
Consumption (-2)	-0.0163	-0.5353	-1.2917	-0.0071	0.0640	-0.0386
Investment (-1)	0.2989	0.0415	1.4532	-0.0513	0.8521	1.5556
Investment (-2)	-0.2323	-0.0098	-1.4293	0.0565	-0.7953	-0.6156
C	0.0602	1.2386	9.0592	0.0547	1.2232	0.4224

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.

Figure 3.25 reveals the impulse response functions for two different groups that are distinguished by capital control. First, look at the effect of CBI on financial asset prices. A positive innovation to CBI causes exchange rate depreciation, though the response is higher for low capital restriction countries. CBI generates a higher stock index starting in period 8 after the shock for the low capital control group, but a negative response is revealed in the high capital control group. A shock of one-unit of standard deviation of CBI leads to a reduce in bond yield, it reaches the lowest around 0.6 at period 4 for the low capital restriction group. Meanwhile, CBI has a small positive effect on bond yield for the high capital control group. The appreciation of the exchange rate generates higher investment for all periods, but higher consumption exists up to period 8 for the high capital restriction group. However, for the low capital restriction group, depreciation increases investment starting in the 4th quarter after the shock and increases consumption after period 13. The author does not find a significantly different effect of the stock index on investment for the two groups. Whilst the positive response of consumption to the stock index 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 only in the low capital restriction countries. Overall, the effect of CBI on financial asset prices is larger in the low capital restriction group. This is caused by expansive monetary policy and the fact that low capital restriction can influence exchange rate movement, thus affect asset price fluctuation (Lane and Shambaugh, 2010). Likewise, the effect of CBI on consumption and investment is higher for the low capital restriction countries. On the other hand, a positive shock to financial asset prices has a greater effect on investment and consumption in the high capital restriction group. This may be caused by high capital restriction, where countries can prevent volatility in the financial asset market (Amin and Annamalah, 2013).

Figure 3.25: Impulse Responses Function Model 4 Split with Respect to Capital Control



Split with Respect to financial capitalisation

The effect of the monetary policy transmission mechanism on financial asset prices may not work well in low financial capitalisation countries. For example, an increase in the interest rate may not induce capital inflow in the bond market and also have a small effect on the exchange rate in low financial capitalisation countries. The sample countries are divided into low financial capitalisation countries covering Egypt, Kenya, Pakistan and the Philippines, and high financial capitalisation countries, comprising Malaysia, South Africa and Thailand. The Chow and Roy Zellner tests after a panel VAR estimation are ran. The results indicate that the two groups are not poolable. As a result, a mean group estimation for the Panel VAR is performed.

The results of the mean group estimation for the panel VAR for the two different groups based on financial capitalisation are presented in Table 3.41. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on the three financial asset prices are different depending on the financial capitalisation. In the low financial capitalisation group, CBI lag 2 has a negative effect on stock index but a positive effect on the exchange rate and bond yield. In contrast, for the high financial capitalisation group, CBI lag 2 has a positive effect on stock index but a negative effect on the exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. In the low financial capitalisation group, CBI lag 1 has a positive effect on consumption and investment, while in the high financial capitalisation group, CBI lag 1 has a negative effect on consumption and investment. Overall, dividing the sample into two groups based on financial capitalisation, the result shows that the effects of CBI on financial asset prices and consumption and investment are different.

Table 3.41: MG Panel VAR Regression Split with Respect to Financial Capitalisation

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
Low Financial Capitalisation Group						
Exchange Rate (-1)	0.9229	-0.2185	4.6149	0.0378	-0.3955	-0.0352
Exchange Rate (-2)	-0.0591	0.3919	-4.5844	-0.0373	0.5084	0.0650
Stock Index (-1)	-0.0581	0.9773	-0.8421	-0.0013	0.0676	0.0142
Stock Index (-2)	0.0226	-0.1052	0.9171	0.0010	-0.0067	0.0002
Bond Yield (-1)	0.0035	-0.0027	1.0595	-0.0001	0.0102	0.0007
Bond Yield (-2)	-0.0025	-0.0035	-0.3040	-0.0005	-0.0080	-0.0018

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Table 3.41 – *Continued*

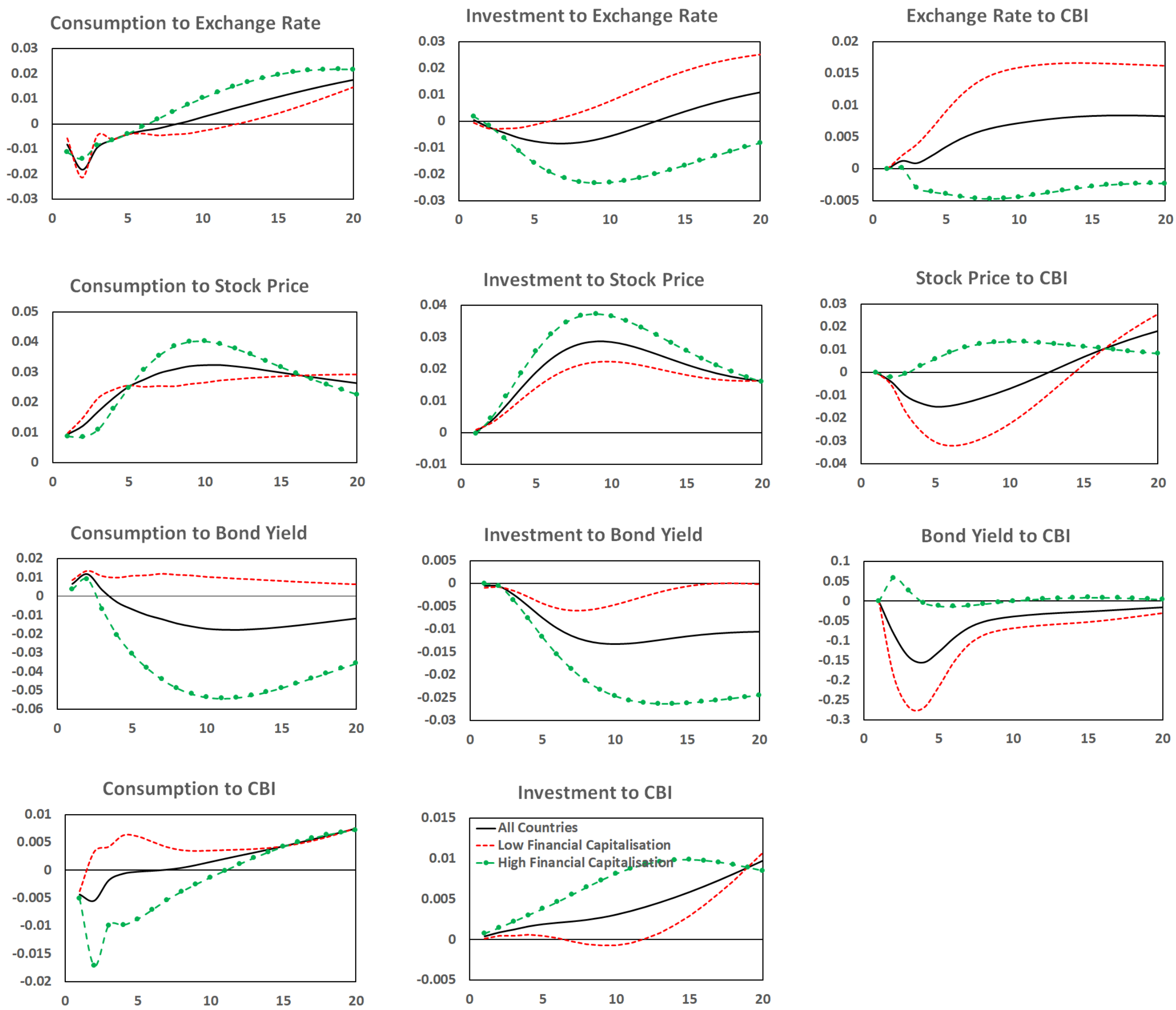
	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
CBI (-1)	3.1421	2.8892	-157.4384	0.8239	12.8394	1.1172
CBI (-2)	1.4635	-16.7270	114.3943	-0.0479	9.7346	-0.3265
Consumption (-1)	-0.0890	0.6725	6.3976	0.0367	1.0294	0.1401
Consumption (-2)	0.1480	-0.6904	-8.3241	-0.0369	-0.1254	-0.0858
Investment (-1)	0.2687	0.0167	4.0402	-0.0064	-0.3240	1.5658
Investment (-2)	-0.2490	0.0036	-2.9015	0.0029	0.3895	-0.6413
C	-2.4835	7.3737	36.1353	0.1715	-11.3835	-0.3606
High Financial Capitalisation Group						
Exchange Rate (-1)	1.1367	-0.5138	2.0370	0.0077	-0.1801	-0.0852
Exchange Rate (-2)	-0.2796	0.2907	-2.9787	-0.0340	0.2914	0.0581
Stock Index (-1)	-0.0939	0.7701	-0.0900	0.0051	0.0379	0.0387
Stock Index (-2)	0.0770	0.0264	0.1939	-0.0053	-0.0544	-0.0039
Bond Yield (-1)	-0.0112	-0.0363	0.8497	-0.0018	0.0045	-0.0003
Bond Yield (-2)	0.0028	0.0262	-0.0210	-0.0006	-0.0249	-0.0026
CBI (-1)	0.3065	-0.4275	9.1817	0.7317	-1.8819	-0.0026
CBI (-2)	-0.2096	0.1806	-8.2608	-0.0162	1.0865	0.0289
Consumption (-1)	0.0027	0.1440	-0.4166	0.0003	0.7360	0.0175
Consumption (-2)	-0.0416	-0.0928	0.2136	0.0020	0.1413	-0.0104
Investment (-1)	0.2506	-0.0268	-1.0152	-0.0776	1.4166	1.5275
Investment (-2)	-0.2020	0.0243	0.8364	0.0908	-1.4116	-0.5877
C	0.4098	1.7104	7.2894	-0.0193	1.9414	0.5080

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.

For the high financial capitalisation countries, a one standard deviation shock to CBI creates an appreciation in the exchange rate of 0.5% in period 4, and also increases the stock index by 1.5% just 8 periods after the shock; CBI increases higher bond yield by 5% in period 3 before the shock is shut down in period 4 onwards. The result shows that 2%, 3.5%, 2.5% and 1% increase in investment due to a 1% appreciation in the exchange rate, a 1% increase in stock index, a 1% reduction in bond yield and a 1% higher CBI. The same responses are also revealed for consumption to asset price changes. A shock of one standard deviation to the exchange rate raises consumption by around 1.5%. Consumption also increases by 4% and 5% in response to an increase of 1% in the stock index, which also reduces bond yield by 1%. The response of investment to a CBI shock is positive, but consumption reacts negatively to it.

On the other hand, in low financial capitalisation countries, a 1% increase in CBI leads to a depreciation in the exchange rate of 1.5% in period 8; while the stock index decreases by 3% in 5 periods after the CBI shock, bond yield reduces by 25% in the 4th quarter after the CBI shock. There is a slight increase in investment due to appreciation of the exchange rate in period two, whilst consumption doubles for every appreciation in the exchange rate. A shock of one standard deviation to stock index rises consumption and investment by around 3%. Meanwhile, a one standard deviation 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 rises faster from period 4.

Figure 3.26: Impulse Responses Function Model 4 Split with Respect to Financial Capitalisation



Group Split with Respect to sovereign risk

According to Claessens and Kose (2017), financial asset prices are determined by the country's economic fundamentals and investor risk aversion. The level of sovereign risk is influenced by macro fundamental factors; and thus affects financial asset prices. High sovereign risk implies a high probability of defaults for investment. Therefore, a country with high sovereign risk will offer a high interest rate to attract foreign investors. The author divides our sample countries into high sovereign risk countries which include Egypt, Kenya, Pakistan, the Philippines and South Africa. The other group consists of Malaysia and Thailand, which are considered to have a low sovereign risk. The Chow and Roy Zellner tests after estimating the panel VAR model are ran. The results reveal that the two groups are not poolable. As a result, a mean group estimation for the Panel VAR is applied.

Table 3.42: MG Panel VAR Regression Split with Respect to Sovereign Risk Group

	Exchange Rate	**Stock Price**	**Bond Yield**	**CBI**	**Consumption**	**Investment**
High Sovereign Risk Group						
Exchange Rate (-1)	0.9511	-0.1774	4.0612	0.0298	-0.3423	-0.0355
Exchange Rate (-2)	-0.0737	0.3092	-4.0863	-0.0298	0.5132	0.0578
Stock Index (-1)	-0.0624	0.9539	-0.7296	-0.0011	0.0796	0.0159
Stock Index (-2)	0.0424	-0.0839	0.7753	0.0015	-0.0479	0.0040
Bond Yield (-1)	-0.0018	-0.0038	1.0104	-0.0003	0.0158	0.0007
Bond Yield (-2)	0.0021	-0.0065	-0.2481	-0.0004	-0.0216	-0.0021
CBI (-1)	2.8323	1.9276	-120.2850	0.7594	9.3170	0.8757
CBI (-2)	0.9895	-13.3250	86.5283	-0.0397	8.2577	-0.2359
Consumption (-1)	-0.0703	0.5245	5.1366	0.0289	0.9622	0.1123
Consumption (-2)	0.1096	-0.5442	-6.7161	-0.0296	-0.0724	-0.0684
Investment (-1)	0.3997	-0.1856	2.6514	-0.0199	0.6027	1.5625
Investment (-2)	-0.3836	0.2193	-1.8090	0.0174	-0.5582	-0.6341
C	-1.9905	6.2119	30.6822	0.1728	-8.3392	-0.2255
Low Sovereign Risk Group						
Exchange Rate (-1)	1.1731	-0.7642	2.1322	0.0129	-0.2052	-0.1096
Exchange Rate (-2)	-0.3533	0.4470	-3.4212	-0.0510	0.1710	0.0728
Stock Index (-1)	-0.1011	0.7249	0.0048	0.0079	-0.0070	0.0469
Stock Index (-2)	0.0545	0.0389	0.1868	-0.0098	0.0246	-0.0156
Bond Yield (-1)	-0.0054	-0.0503	0.8676	-0.0023	-0.0124	-0.0009
Bond Yield (-2)	-0.0059	0.0488	-0.0191	-0.0010	0.0006	-0.0024
CBI (-1)	-0.3369	0.3180	-0.3918	0.8468	-0.4367	0.0414
CBI (-2)	0.1390	0.1295	0.0768	-0.0210	0.4548	-0.0199

Continued on next page

Table 3.42 – *Continued*

	Exchange Rate	Stock Price	Bond Yield	CBI	Consumption	Investment
Consumption (-1)	0.0017	0.2497	-0.6712	0.0014	0.7572	0.0258
Consumption (-2)	-0.0405	-0.1596	0.4626	0.0033	0.1420	-0.0161
Investment (-1)	-0.0861	0.4572	-0.0709	-0.0794	-0.0298	1.5165
Investment (-2)	0.1580	-0.5048	-0.0257	0.0984	0.0573	-0.5788
C	0.6240	1.7835	6.4993	-0.1179	0.9931	0.6044

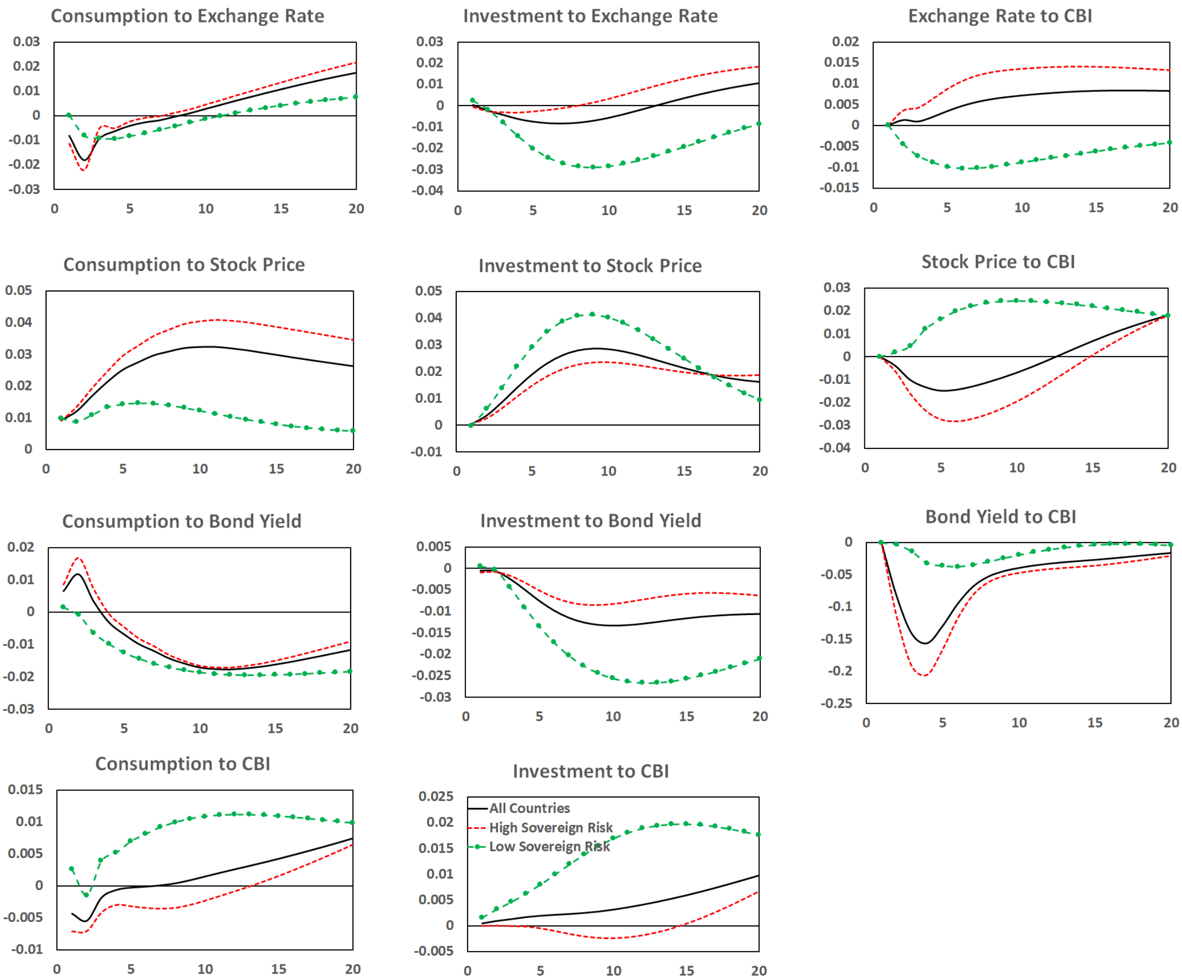
Note: The mean group estimation is the unweighted mean of coefficients of explanatory variables the individual country estimates. This estimation only averages the coefficient but not for standard error and t-statistic.

The results of the mean group estimation for the panel VAR for the two different groups based on sovereign risk are presented in Table 3.42. The optimal lag based on the Schwarz information criterion is two lags. The result shows that the effects of CBI on the three financial asset prices are different depending on the sovereign risk. In the high sovereign risk group, CBI lag 1 has a negative effect on bond yield but a positive effect on the exchange rate and stock index. In contrast, for the low sovereign risk group, CBI lag 1 has a positive effect on stock index but a negative effect on the exchange rate and bond yield. The effects of CBI on consumption and investment are different for the two groups. In the high sovereign risk group, CBI lag 1 has a positive effect on consumption and investment, while in the low sovereign risk group, CBI lag 2 has a negative effect on consumption but a positive effect on investment. Overall, dividing the sample into two groups based on sovereign risk, the result shows that the effects of CBI on financial asset prices, consumption and investment are different.

Figure 3.27 reveals the impulse response functions for two different groups that are distinguished by Sovereign Risk. The positive responses of financial asset prices to a CBI shock are largely higher in the low sovereign risk group. A shock of one standard deviation to CBI generates appreciation in the exchange rate, which gradually grows to around 1% by period 6. A 1% higher in CBI leads to a 2% higher stock index from period 6 onwards, while a 1% increase in CBI reduces bond yield by 5.1%. In contrast, in high sovereign countries, a one standard deviation shock to CBI is significant and reduces bond yield by 20% in period 4. However, a 1% higher CBI generates depreciation in the exchange rate of 1.5% and lowers the stock index by 3%. These results show that a low sovereign risk provides good expectations regarding future consumption and investment. Since financial asset prices depend on future expectations, they react positively to CBI changes, thus generating higher consumption and investment.

Appreciation of the exchange rate increases investment by 3% and 0.5% for low and high sovereign risk countries, respectively. However, there is a quite similar response of consumption to an appreciation in the exchange rate. The reaction of investment is larger to a CBI shock, but the responses of consumption are lower to a CBI shock in the low sovereign risk than the high sovereign risk group. A decrease (increase) in bond yield leads to a rise (reduction) in consumption and investment with a higher impact on low sovereign risk countries. A positive response of consumption and investment to a CBI shock occurs in low sovereign countries, whilst in high sovereign risk countries the response is negative.

Figure 3.27: Impulse Responses Function Model 4 Split with Respect to Sovereign Risk



3.5 Conclusion

This chapter provides empirical analysis of CBI, consumption and investment via three different financial asset prices: exchange rate, stock index and bond yield. It begins with the methodological design of our empirical analysis. Initially, the panel VAR is applied for four different models. Panel VAR is selected for the reason that it is the most appropriate method and it has the ability to treat all variables as endogenous. The author suspects the appearance of heterogeneity among cross-sections; hence, the author verifies the pooling assumption of the panel. The result shows that the heterogeneity of the sample; therefore, mean-group estimation developed by Pesaran and Smith (1995) for panel VAR is applied. The author also splits our sample into two and three groups so our subsamples are poolable.

First, the author examine the interaction between CBI, exchange rate, consumption and investment. Our results using panel VAR indicate the model contains heterogeneity across countries. The mean-group panel VAR by averaging the individual VAR for all samples is applied. The result establishes that the negative response of the exchange rate to CBI shock is delayed; it takes around 5 quarters to appreciate exchange rate. The effect of the exchange rate on both consumption and investment is positive, which implies that depreciation in the exchange rate creates higher consumption and investment. The result determines that CBI has a contradictory effect on real activity, a negative effect on consumption but a positive effect on investment. The author then split our sample into three groups to create homogeneous subsample. Results show that CBI produces appreciation of the exchange rate for group 1 but depreciation of the exchange rate for group 2. For group 3, CBI strengthens the exchange rate after 6 quarters of the shock. Meanwhile, the response of consumption and investment to the exchange rate also vary for all three groups. The result shows that a negative response for both consumption and investment to the exchange rate for groups 1 and 2. This means that appreciation of the exchange rate generates higher consumption and investment. However, for group 3 the author finds the opposite result, which is depreciation will increase both consumption and investment. Finally, the CBI link to real activity via the exchange rate channel can be explained as follows. Higher CBI degree increases consumption and investment only occurs in countries with low inflation (group 1). In contrast, CBI causes lower consumption and investment for countries with moderate and high inflation (groups 2 and 3).

The second model analyses the interaction between CBI, stock index, consumption and investment. Our results using panel VAR indicate that the model contains heterogeneity across countries. The mean-group panel VAR by averaging the individual VAR for all samples is applied. The result shows that the stock index increases due to CBI changing at the beginning, two periods after the shock. This demonstrates that CBI strengthens the financial market. The effect of the stock index on both consumption and investment is positive. This signifies that higher stock index initiates higher consumption and investment. The result ascertains that CBI has a negative influence on consumption but a positive effect on investment. The author then divide our sample to be two groups to make the homogeneous subsample. The results show that CBI creates a higher stock index for group 2 which contains countries with high market capitalisation, though for countries with low market capitalisation CBI will lower the stock index. Meanwhile, the consumption response to stock index shock is different for both groups. The result shows that the response of consumption to the stock index is positive for group 2. Additionally, the consumption response to stock index shock is negative for group 1 but then diminishes 2 years after the shock. The result establishes a positive effect of stock index on investment in both groups and the magnitude in countries with high market capitalisation is virtually threefold in comparison to the countries with low market capitalisation. Finally, the connection of CBI to real activity via the stock index channel can be explained as follows. A greater degree of CBI increases consumption and investment only in countries with high market capitalisation (group 2). In contrast, CBI lessens consumption and investment for countries with low market capitalisation (group 2).

The third model investigates the link between CBI, bond yield, consumption and investment. From the results, which use a panel VAR, specify that the model contains heterogeneity across countries. The author then applies a mean-group panel VAR by averaging the individual VAR for all of the samples. The results reveal that CBI is effective in reducing bond yield with the maximum effect at period 6 after the shock. Shock one standard deviation bond yield has a negative effect on consumption and investment. The result determines that CBI has a contradictory effect on real activity; a negative effect on consumption but a positive influence on investment for the first two years after the shock. The author then divides our sample to be three groups to make the homogeneous subsample. The results illustrate that CBI lowers bond yield for all groups; however, for group 2 the positive response occurs after period eight. Meanwhile, the response of consumption and investment to bond yield also varies for all three groups. The result shows that a positive response for both consumption and investment for groups 1 and 2. This means that higher bond yield leads to higher consumption and investment. However, for group 3, the shock on bond yield will reduce both consumption and investment; nevertheless, the effect is extremely small. Finally, the CBI link to real activity via the interest rate channel can be explained as follows. A higher degree of CBI increases consumption only in low bond yield countries (group 1) but does not provide the same investment response in group 1. In contrast, CBI lowers consumption and investment in moderate and high bond yield countries (groups 2 and 3).

The link between CBI and three different financial asset prices shows the optimal monetary policies. The CBI shock on exchange rate appreciation is delayed and it takes roughly a year for CBI to appreciate the exchange rate, with a maximum magnitude of 0.5% at quarter 20. The stock index will rise, by a magnitude of approximately 0.25% in quarter two after the CBI shock, though after period 3 the effect becomes negative. CBI has a huge impact on reducing bond yield with a magnitude of 30% a year after the shock. It can be concluded that CBI's greatest influence is on bond yield.

The result can also compares the effect of CBI on consumption and investment via three different channels, the exchange rate, wealth and interest rate channels. A higher CBI produces lower private consumption with a magnitude of between 0.4% to 0.5% for all three channels. CBI requires three quarters to increase investment via the exchange rate and wealth channel, but CBI directly increases investment via the interest rate channel.

Chapter 4

Central Bank Independence, Macroprudential Policy and Credit per GDP

4.1 Introduction

Since 1990, central bank independence has held a crucial role in achieving macroeconomic stability, particularly in influencing the level of inflation. Our result in Chapter 2 reveals that CBI success to reduce inflation in developing countries. However, the 2007 to 2008 global financial crisis has changed the role of the central bank is to focus more on financial stability, for the reason that financial stability is an essential key concerning macroeconomic stability. Jeanneau (2014), reviewed the laws and statutes of 114 central banks and determined that 82% has an explicit financial stability goal. The new responsibility of the central banks creates new challenges for central bank independence. Table 4.1 reveals the average CBI degree before, during and after the financial crisis for six groups of developing countries based on different regions. From the table, it can seen that there is an increase in the degree of CBI both during the crisis and after the financial crisis in all groups except in emerging and developing Europe.

Table 4.1: Legal CBI Index before, during and after GFC

Country group:	**2000-2007**	**2008-2009**	**2010-2017**
Commonwealth of Independent State	0.61	0.64	0.65
Emerging and Developing Asia	0.44	0.46	0.50

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Table 4.1 – *Continued*

Country group:	2000-2007	2008-2009	2010-2017
Emerging and Developing Europe	0.83	0.83	0.83
Latin America and the Caribbean	0.60	0.61	0.61
Middle East and North Africa	0.44	0.49	0.50
Sub-Saharan Africa	0.56	0.58	0.59

Source: Own calculations using data of Garriga (2016).
Group of countries based on IMF classifications.

According to Berger and Kißmer (2013), CBI may foster financial stability seeing as a high degree of CBI indicates that it is more likely that the central bank refrain from implementing pre-emptive monetary tightening to maintain financial stability. Prior empirical studies such as Herrero and Del Rio (2003), Klomp and de Haan (2009) and Doumpos et al. (2015) investigate the effect of CBI on financial stability in various indicator such as likelihood banking crisis and bank soundness. They conclude that higher CBI is associated with better financial stability. According to the European Central Bank (ECB), financial stability is defined as a condition in which the financial system, consisting of financial intermediaries, and market infrastructure are stable (ECB, 2009).

The most important feature of developing and emerging countries is that the financial system is centred on banks (Cottarelli et al., 2005); thus banking credit is the most important factor of internal financing to a firm in developing countries. A further reason is that the bank has the most significant contribution in the financial system and is directly affected by central bank policy. In the analysis of Cihak (2007) and Doumpos et al. (2015), financial stability is proxied by the probability of banking crises. There are various issues in using banking crises as an indicator of financial stability. First, banking crises identify crises only when they are severe enough to trigger market events (Klomp and de Haan, 2009). Second, the identification of the exact timing of crises is somewhat subjective, whilst its accuracy has been questioned (Caprio and Klingebiel, 1999). Third, it only takes banking crises into account, therefore neglecting instability in another part of the financial system. Alternatively, this chapter uses credit growth as a proxy of financial stability given that credit growth is the best predictor of financial crises (Kaminsky and Reinhart, 1999; Borio et al., 2002; Reinhart and Rogoff, 2009; Schularick and Taylor, 2012). Kim and Mehrotra (2018) use credit as an indicator of financial stability because excessive credit growth is a leading contributor to banking crises. Recent studies such as Jordà et al. (2013) and

Taylor (2015), investigate this argument further and conclude that past credit growth can forecast future financial instability.

Table 4.2 presents the average credit per GDP and the number of banking crisis before, during and after global financial crises for our sample of countries. The credit growth increases significantly until the financial crisis period and an increasing number of banking crises follows it.

Table 4.2: Credit per GDP and Financial Crises

	2000-2007	**2008-2009**	**2010-2017**
Average Credit per GDP	24.12	31.42	32.18
Number of Banking Crises	7	23	4

Source: Own calculations using data of Laeven and Valencia (2018) for banking crises and World Economic Indicator for Credit per GDP.

One set of policies which has an essential effect on financial stability is macroprudential policy. Macroprudential policy is a policy that is applied to reduce systemic risk, increase financial stability and build a safer financial system that could reduce the probability of future crises. The objective of macroprudential policy is to limit the financial risk that affects the financial system. A few studies investigate the effectiveness of macroprudential policy in reducing credit growth using panel data regression with macro-level datasets. Cerutti et al. (2017), Dell'Ariccia et al. (2012) and Lim et al. (2011) using cross country data to examine the use of macroprudential policy on credit growth. In their study, they conclude that macroprudential policy is associated with reduced excessive credit growth.

Excessive credit growth is one of the main factors associated with banking or financial crises in developing countries. Even though an increase in credit can positively contribute to economic growth in the long run, in the short run it might lead to poor credit allocation creating economic imbalance. Credit growth can lead to financial crises via three channels: the first is by generating external macroeconomic imbalances; second, by inflating asset price resulting in bubbles and busts; third, by leading to inefficient use of resources (Bahadir and Valev, 2006). The literatures differentiate credit to the private sector between household credit (consumption credit) and firm credit (productive credit). Household credit growth increases demand for consumption goods, which leads to an increase in consumption of goods and services. Since most developing countries have low national saving rate, relaxation of the credit constraints creates an increase in household indebtedness without a similar rise in their future income, resulting in an increase in default risks (Copelman et al., 1996). Another consequence of a low saving rate is that credit growth is funded by international capital inflows which potentially increase financial crises (McKinnon and Pill, 1998). On the other hand, an excessive growth in firm credit possibly causes banking crises via asset price bubbles. According to Borio and Lowe (2002), growth in corporate credit results in higher leverage which can result in defaults if the firm or the economy experiences a major shock. This can create systemic defaults leading to banking crisis.

This chapter is different from the existing literature from three perspectives. First, this study contributes to expanding empirical studies of the interaction between CBI (independent monetary policy) and macroprudential policy and their effectiveness on financial stability. The existing literature debate the interaction effect of monetary and macroprudential policies on credit growth. According to Ueda and Valencia (2014), the central bank conducts monetary policy and macroprudential regulation to achieve price and financial stability. The central bank does not deliver the social optimum of price and financial stability because of a time-inconsistency problem. However, separation price and financial stability to an independent institution can achieve the social optimum. Masciandaro and Volpicella (2016) suggest that there are certain benefits when the central bank involves macroprudential regulation, mainly related to the increase in information that the central bank can accumulate to make policy decisions.

Second, this chapter constructs an index of macroprudential policy based on a survey of the IMF by Cerutti et al. (2017). Using the 12 GMPI variables created by Cerutti et al. (2017), this chapter constructs a new index based on the methodology of the coincident indicator model developed by Stock and Watson (1989) and Garratt and Hall (1996). The advantages of this model are that the 12 GMPI instruments are driven by a common component that can be captured by an unobserved variable (Hall et al., 2003). According to Garratt and Hall (1996), to do this, first, the author performs a state space form in which Kalman filter is used to obtain an optimal estimate based on a maximisation algorithm to find the minimum model size. Second, by applying a model averaging technique to reduce model uncertainty. The new index is applied in our empirical analysis.

Third, prior empirical studies which investigate the relationship between CBI and credit growth, macroprudential policy and credit growth are performing the linear regression model and ignoring the possibility of a non-linear relationship.

To conduct a more comprehensive analysis, This chapter constructs a non-linear methodology which captures the possibly time varying nature of CBI and macroprudential index on credit growth. The author expects that the effect of CBI and macroprudential policy on credit per GDP is different when the degree of CBI is high and low. Thus, by performing a panel threshold non-linear regression, the author can indicates what level of CBI is considered to be high and slow credit growth. To the best of our knowledge, this paper is the first empirical study which investigates the role of CBI and macroprudential policy on credit growth using the non-linear model. Fourth, the model Panel Smooth Transition Regression (PSTR) developed by Gonzalez et al. (2017), assumes that the threshold and coefficients of parameters that are homogeneous across units. However, those parameters may be different across countries. To check the homogeneity assumption, this chapter performs a non-standard poolability test using the dummy variable approach.

The findings of this chapter are fourfold. First, by performing a linearity test on our model. The result of the LR test shows that the non-linear model is significantly better than the linear model, thus confirming the presence of a non-linear relationship between CBI and credit per GDP. Second, after performing panel threshold non-linear least square, the homogeneous assumption for the threshold and coefficients of explanatory variables are checked using the dummy variable approach. Our results reveal that the coefficients in our model are heterogeneous. Thus, this chapter applies the idea of mean group estimation as a solution for heterogeneity cases. The author also divides the sample into two groups based on the result of the poolability test, as well as groups that are poolable and not poolable. Third, our empirical result signifies that the threshold level for the full sample is 0.4564; the low regime regarding the degree of CBI is less than or equal 0.4564, while the high regime in relation to the degree of CBI is above 0.4564. Fourth, the result demonstrates the existence of synergies of price and financial stability due to CBI. The result shows that CBI is significant in reducing credit per GDP both in the low and high regime. This result is robust after the sample is separated into two groups as still find the negative relationship between two variables. However, a tighter macroprudential policy with higher CBI leads to a trade-off between price and financial stability.

The remainder of the chapter is organised as follows. Section 4.2 provides a theoretical and empirical review on central bank independence and financial stability. Section 4.3 explores the data set, construction methodology used and models. Section 4.4 discusses the empirical results, whilst Section 4.5 is the concluding session.

4.2 Literature Review on Central Bank Independence and Financial Stability

4.2.1 The Concept of Financial Stability

Financial stability can be defined as a condition in which all components of the financial system are functioning well. The financial system includes financial institution, market and payment, besides settlement and clearing system.

There are two principal reasons that CBI is essential for financial stability. The first, an independent central bank is free from political pressure, which implies that the central bank is less restricted in preventing financial crisis, which should allow the central bank to create specific policies before the crisis erupts (Cihak, 2007). If the central bank is not independent, politicians seek to interfere with the central bank, which causes delays in preventing the financial crisis due to conflicts of interest. Moreover, if politicians are uncertain of the costs of a crisis, they prefer to postpone actions to reduce the cost of adjustment. For example, in practically every financial crisis in the 1990s, political interference on policymakers was the leading cause of weakening banks in the run-up to the crisis (Klomp and de Haan, 2009). An independent central bank is also better at maintaining financial stability, given that the central bank can identify problems in the financial sector and warn financial markets with the aim of preventing financial crisis.

Second, there is a time-inconsistency problem as regards financial stability policy, which is similar to the time-inconsistency problem in monetary policy. According to Cihak (2007), the time-inconsistency problem in financial stability policy can be explained as follows. There are two possible responses that can be taken by the policymaker in a deal with financial instability; specifically tough and lenient. If the agents believe that the policymaker will take tough action, the policymaker will benefit if a lenient policy is created, because in the short term, the cost will be lower for lenient policy than tough policy. Following rational expectation, agents are familiar with the policymaker's incentive; therefore, the agents expect that the policymaker will take the lenient policy. To solve this problem, the policymaker necessities a solution that delegates responsibility to maintain financial stability to an independent central bank with a strong aversion to financial instability.

The banking system plays a significant role in financial intermediaries by bridging excess funds from depositors to households and investors as debtors (Koong et al., 2017). Credit has a prominent function in supporting investment and economic growth via a credit channel. However, if credit expansion is too fast it may lead to financial instability through excessive leverage and asset price bubble. According to Reinhart and Rogoff (2009), rapid credit growth or credit booms are often related to a banking crisis and also have a crucial impact on macrofinancial stability[1]

Among the different aspect of financial instability, the focus on credit per GDP as an indicator of financial instability, particularly in developing countries, is supported by prior studies of (Kaminsky and Reinhart, 1999; Borio et al., 2002; Reinhart and Rogoff, 2009; Schularick and Taylor, 2012; Jordà et al., 2013; Taylor, 2015; Dell'Ariccia et al., 2016; Koong et al., 2017; Kim and Mehrotra, 2018), which find that fast-growing private credit is the main predictor of banking crises, whilst a high credit to GDP is an indicator of financial instability. Alessi and Detken (2018) state that credit per GDP is valuable in assessing the vulnerability of a country.

4.2.2 Theoretical Review on Central Bank Independence, Macroprudential Policy and Financial Stability

This chapter follows a model developed by Ueda and Valencia (2014) and Smets et al. (2014), so as to examine the relationship between CBI, macroprudential policy and financial stability. Assume that a loss function has three elements: inflation (π), output (y) and leverage (ϕ). The objective of the policymaker is to minimise the loss function (L).

$$L = \frac{a}{2}(\pi - \pi^*)^2 + \frac{b}{2}(y - y^*)^2 + \frac{c}{2}(\phi - \phi^*)^2 \tag{4.1}$$

$a, b, c > 0$ are the weights relating to each objective and the starred variables are the optimal targets.

Assume that the economy is the following equations:

[1]Macrofinancial stability refers to the strong macro-financial linkange and resulting interdependence between macroeconomic and financial stability. See Reinhart and Rogoff (2009)

$$y = \hat{y} + \alpha(\pi - \pi^e) + \beta\delta \tag{4.2}$$

$$\delta = \delta_0 + \epsilon \tag{4.3}$$

$$\pi = \pi_0 + \gamma\delta \tag{4.4}$$

$$\phi = \hat{\phi} - (\pi - \pi^e) + \delta \tag{4.5}$$

Equation (4.2) is the standard Lucas supply curve, where the output (y) is determined by potential output ($\hat{y}$), expected inflation (π^e) and change in credit (δ). This implies that output is positively influenced by unexpected inflation and loosening macroprudential policy. In Equation (4.3), δ_0 denotes macroprudential policy, such as capital requirements and loan to value ratios, which have a positive effect of credit growth, whilst ϵ is a credit shock. Total inflation (π) in Equation (4.4) is determined by a component of inflation, (π_0), that can be controlled by the central bank. Equation (4.5) is ex-post leverage, which is influenced by inflation surprise, output surprise, credit growth and predetermined level of leverage,$\hat{\phi}$. Following a standard assumption of Barro-Gordon literature, $\hat{y} < y^*$. which implies that potential output is lower than its efficient level; thus, give the incentive to boost output. Another assumption is $\hat{\phi} > \phi^*$, stating the assumption that there is a tendency to over-accumulate debt in the financial sector.

This static model can be used to illustrate the interaction between monetary and macroprudential policies (π and δ) into two different cases. In the first case, monetary authority concern only on price stability but rule out financial stability. In this case, it can be set $\pi^e = \pi$ in Equations (4.2) and (4.5). The first-order condition of the loss function in Equation (4.1) with respect to monetary policy (π) and macroprudential policy (δ) :

$$\frac{d(L)}{d\pi} = \pi = 0 \tag{4.6}$$

$$\frac{d(L)}{d\delta} = \frac{d[\frac{a}{2}(\pi - \pi^*)^2 + \frac{b}{2}[(\hat{y} + \alpha(\pi - \pi^e) + \beta\delta) - y^*]^2 + \frac{c}{2}[(\hat{\phi} - (\pi - \pi^e) + \delta) - \phi^*]^2]}{d\delta} = 0 \tag{4.7}$$

$$\frac{d(L)}{d\delta} = \frac{d[\frac{b}{2}[(\hat{y} + \beta\delta) - y^*]^2 + \frac{c}{2}[(\hat{\phi} + \delta) - \phi^*]^2]}{d\delta} = 0 \tag{4.8}$$

$$\frac{d(L)}{d\delta} = \frac{b}{2} * 2[(\beta\hat{y} + \beta^2\delta) - \beta y^*] + \frac{c}{2} * 2[(\hat{\phi} + \delta) - \phi^*] = 0 \tag{4.9}$$

$$\frac{d(L)}{d\delta} = b[(\beta\hat{y} + \beta^2\delta) - \beta y^*] + c[(\hat{\phi} + \delta) - \phi^*] = 0 \tag{4.10}$$

$$\frac{d(L)}{d\delta} = (b\beta^2 + c)\delta + b\beta(\hat{y} - y^*) + c(\hat{\phi} - \phi^*) = 0 \tag{4.11}$$

$$\delta = \frac{b\beta}{b\beta^2 + c}(y^* - \hat{y}) + \frac{b}{b\beta^2 + c}(\hat{\phi} - \phi^*) \tag{4.12}$$

Monetary policy sets the inflation target is zero in Equation (4.6). Macroprudential policy is set so as to optimally trade-off the benefit of higher output and the cost of higher debt overhang in Equation (4.12). A higher gap of output from it steady-state produces looser macroprudential policy. In contrast, a higher over accumulate debt leads to tighter macroprudential policy. When debt overhang appears, monetary policy will be the last one changing. Thus, it is reasonable to assume that the macroprudential authorities will set their policy while taking monetary policy reaction as given. The monetary policymaker set inflation target is zero because the only one objective is price stability. Then, the macroprudential authority will aware of this and therefore will have no incentive loosen up macroprudential policy in order to have higher output because monetary policy will not accommodate a part of debt overhang. The macroprudential policy will be set as in Equation (4.12) which will be independence on whether the macroprudential policymakers pay attention to inflation or not.

The second case is monetary policymaker also conduct both price and financial stability objective, then monetary authority's reaction function will be given as:

$$\pi = c(\phi - \phi^*) - c(\pi - \pi^e) + c\delta \tag{4.13}$$

Equation (4.13) confirms that monetary policymaker set inflation higher, the higher the debt overhang and the easier the macroprudential policy. In this case, the macroprudential policymaker will have an incentive to set a looser macroprudential policy favouring output and allowing for a larger debt accumulation because it makes use of the fact that the monetary authority will inflate away a part of the debt overhang.

To proof this, this chapter will determine that macroprudential policy (δ) taking into consideration the monetary policy reaction function (π). Under rational expectations, the macroprudential policy becomes:

$$\delta = \frac{b(\beta(1+c)+\alpha c)}{c+\alpha\beta(\beta(1+c)+\alpha c)}(y^* - \hat{y}) - \frac{c}{c+\alpha\beta(\beta(1+c)+\alpha c)}(\hat{\phi} - \phi^*) \tag{4.14}$$

The reaction coefficient to the output gap is higher in Equation (4.14) than Equation (4.12); while, the reaction coefficient of the leverage gap is smaller. The end result is not only higher output, but also higher debt accumulation and an inflation bias.

4.2.3 Empirical Literature

The impact of monetary policy on financial stability is a question pertaining to the relationship between price stability and financial stability. The literature shows that there are either synergies or a trade-off between price and financial stability. The first strand argues that the synergies between price and financial stability contend that monetary policy design (narrow central bank objective and central bank independence) achieves price stability and also fosters financial stability. An alternative strand claims that if the trade-off existed, it would be difficult to find an inline impact on price and financial stability.

The argument for the synergies effect of CBI on both objectives is based on the view that CBI generates low and stable inflation, creating an economy with a predictable interest rate and producing a lower risk of interest rate mismatches, leading to a minimum inflation risk premium in the long-term interest rate, affecting financial stability. According to Issing (2003), price stability is a necessary condition for financial stability.

There are particular empirical studies which support the synergies effect. In their study, Klomp and de Haan (2009), examine the effectiveness of CBI on financial instability by performing a dynamic panel model for 60 countries over the period 1985 to 2005. They construct a financial instability index, which consists of three sets of variables that refer to the banking system, financial risk and balance sheet of the monetary authority. The index is obtained by applying factor analysis for the three sets of indicators. They used the generalized method of moments (GMM) estimator to estimate the relationship between CBI and financial instability. They confirm that CBI has a negative and significant effect on financial instability. They also divided the CBI into economic and political independence and established that political independence is essential to reduce financial instability. To avoid the possibility of heterogeneity in the sample, they divided the sample into two groups, developed and developing countries. They conclude that CBI has a stronger impact on financial instability in developing countries than in advanced countries.

Conversely, Mishkin (1997), supports the argument for a trade-off between price and financial stability. He argued that an increase in interest rate could control inflation, but it has a negative impact on the bank's balance sheets and firms' financial worth. The same opinion is voiced by Cukierman (1992), who states that a rapid and substantial increase in interest rate is required to control the inflation rate. The rise in interest rate produces a different effect on banks' assets and liabilities, contributing to market risk. Another reason for trade-off arises from deflation or inflation that is too low; it reduces the profit margin of banks and also increases non-performing loans in the bank's balance sheet due to default borrower.

Many of the existing studies suggest that CBI fosters financial stability (Klomp and de Haan, 2009; Cihak, 2010; Doumpos et al., 2015). Specifically, Cihak (2010), investigates the relationship between CBI and financial stability. He uses the CBI index developed by Arnone et al. (2009) and uses a dummy variable relating to the occurrence of a banking crisis for the measure of financial instability.

By performing a pairwise correlation coefficient, he finds a negative relationship between both variables and furthermore, that countries with a high CBI index have a lower probability of banking crisis. He also applies a logit model to estimate the probability of a crisis in a specific country and period, as a function of CBI. He concludes that CBI is significant concerning financial stability.

A prominent study by Doumpos et al. (2015) who examine the impact of CBI on bank soundness as a proxy of financial stability. The soundness of banks is measured by the Z score, and the CBI index is taken from Bodea and Hicks (2015). Their sample includes 1756 commercial banks from 94 countries for the period 2000 to 2011. They employ a Hierarchical Linear Modelling (HLM) for simultaneous regression at both bank and country level. They establish that CBI has a positive effect on bank soundness; this implies that the higher the CBI index, the healthier the bank. Herrero and Del Rio (2003) evaluate the effect of CBI on the probability of banking crises for the sample of 79 countries from 1970 to 1999. They perform a logistic distribution model to estimate how CBI affects the occurrence of the banking crisis. They conclude with evidence, that CBI significantly reduces the likelihood of banking crises.

An alternative empirical study using country-level data conducted by Cerutti et al. (2017), analyses the effectiveness of macroprudential policy on credit growth for a sample of 119 countries over the period 2000 to 2013. They developed a macroprudential policy index based on GMPI data obtained from an IMF survey covering 12 instruments. They determine that tightening macroprudential policy is related to lower bank credit growth. After separating the country sample into developed, emerging and developing countries, they discover the substantial effect of macroprudential policy to slow credit growth in emerging and developing countries. This signifies that emerging and developing countries use macroprudential policy more effectively in reducing credit development. Lee et al. (2016) present an empirical framework to analyse how effectively macroprudential policy is at controlling the credit growth of ten developing Asian countries using quarterly data from 2000 to 2013. They perform qualitative vector autoregressive model to generate the dynamic impulse response of credit growth due to changes in the macroprudential policy for every sample country. Overall, they claim that macroprudential policy effectively dampens credit growth.

Akinci and Olmstead-Rumsey (2018) evaluate the role of macroprudential policy using quarterly data from 2000 to 2013 for 57 developed and emerging countries. They establish that a higher macroprudential policy index reduces overall credit growth, housing credit growth and house price inflation. Kim and

Mehrotra (2018) examine the effect of monetary and macroprudential policy on the macroeconomic variable for four inflation targeting countries in the Asia-Pacific area; specifically Australia, Indonesia, Korea and Thailand for the period 2000 Q1 to 2014 Q4. The main finding of their study is that monetary and macroprudential policies significantly reduce both credit growth and inflation.

This study also relates to the determinants associated with credit growth. Stepanyan and Guo (2011) examine factors affecting credit growth in 38 emerging market economies from 2001 Q1 to 2010 Q2. They find that inflation dampens credit growth, while GDP growth increases credit growth. Saito et al. (2014) study factors determining credit growth using annual data for 45 countries from 2004 to 2010. They ascertain that inflation impairs credit growth, while financial crisis and market capitalisation have a positive impact on credit for all the sample countries. When they divided the sample into three groups: OECD, BRIC (Brazil, Russia, India and China), in addition to LAC (Latin America and the Caribbean), they find that the factors which influence credit growth positively in OECD countries are private consumption, international trade and market capitalisation. Regarding the BRIC group, investment, international trade and market capitalisation positively influence credit growth. However, current account balance and GDP growth have a negative impact on credit growth. For the LAC countries, current account, consumption, inflation, investment and economic growth have a negative effect on credit growth.

4.3 Data and Methodology

4.3.1 Construction of a Macroprudential Policy Index

To document the importance of macroprudential policy, this chapter uses the index developed by Cerutti et al. (2017), who examine the GMPI index. In their study, 12 macroprudential policy instruments: loan-to-value ratio caps (LTV_CAP), debt to income ratio (DTI), dynamic loan loss provisioning (DP), general countercyclical capital buffer or requirement (CTC), leverage ratio (LEV), capital surcharges on SIFIs (SIFI), limits on interbank exposure (INFER), concentration limits (CONC), limits on foreign currency loans (FC), countercyclical reserve requirement (RR_REV), limits on domestic currency loans (CG) and levy or tax on financial institutions (TAX) are measured for every country. For each instrument, they assign 1 if it is implemented and 0 otherwise. The GMPI index is the sum of the score for all 12 tools. There are, however, several disadvantages in just aggregating all 12 instruments. First, this approach is unweighed given that all instruments have the same scale. Thus, it is a rather mechanical method, while the econometric approach is not clear.

In this paper, using the 12 GMPI developed by Cerutti et al. (2017), this chapter constructs a new index based on the methodology of the dynamic factor model (DFM) developed by Stock and Watson (1989) and Garratt and Hall (1996).

In general form, the dynamic factor model can be specified as:

$$X_t = \alpha S_t + \varepsilon_t \tag{4.15}$$

$$S_t = \beta_1 S_{t-1} + \beta_2 S_{t-2} + \cdots + \beta_k S_{t-k} + \mu_t \tag{4.16}$$

$$\varepsilon_t = \gamma_1 \varepsilon_{t-1} + \gamma_2 \varepsilon_{t-2} + \cdots + \gamma_k \varepsilon_{t-k} + \epsilon_t \tag{4.17}$$

where X_t denotes an n x 1 vector of macroprudential policy, S_t is a vector of unobservable variable, ε_t represents an n x 1 vector of disturbances. α, β and γ are the coefficients of a parameter. μ_t and ϵ_t $i.i.d$ with a zero mean and given covariance matrix.

In particular, by following the methods developed by Stock and Watson (1989) and Garratt and Hall (1996), a range of 12 GMPI are written as a dynamic factor model. Then, a Maximum Likelihood (ML) method is used to estimate the parameters (factor loading). The macroprudential policy index is subsequently obtained using the Kalman filter. The state space form of the dynamic factor model is:

$$\begin{bmatrix} LTV \\ DTI \\ DP \\ CTC \\ LEV \\ SIFI \\ INFER \\ CONC \\ FC \\ RR \\ CG \\ TAX \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \\ \lambda_6 \\ \lambda_7 \\ \lambda_8 \\ \lambda_9 \\ \lambda_{10} \\ \lambda_{11} \\ \lambda_{12} \end{bmatrix} S_t + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \\ \varepsilon_7 \\ \varepsilon_8 \\ \varepsilon_9 \\ \varepsilon_{10} \\ \varepsilon_{11} \\ \varepsilon_{12} \end{bmatrix} \tag{4.18}$$

$$S_t = \alpha S_{t-1} + \mu_t \tag{4.19}$$

Equations (4.18) and (4.19) correspond to Equations (4.15) and (4.17).

4.3.2 Data

For the measure of CBI, this chapter follows the CBI index constructed by Cukierman et al. (1992). This index is based on the legal aspect of independence. The index is between 0 and 1, with higher values denoting greater CBI for the legal index. The data relating to the CBI index is legal variable aggregate weighted obtained from Garriga's (2016) data set.

This chapter uses private credit per GDP, which is the total debt of households and domestic non-financial sectors in relation to the financial institution, relative to GDP. Data is taken from the World Bank's Global Financial Development Database. Extensive literature has documented that high credit growth has been shown to be a good crisis predictor (Demirguc Kunt and Detragiache, 1997).

Figure 4.1: CBI Index

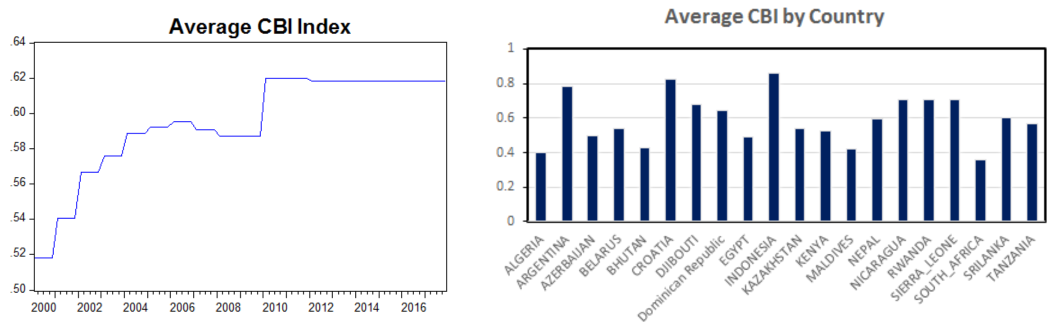
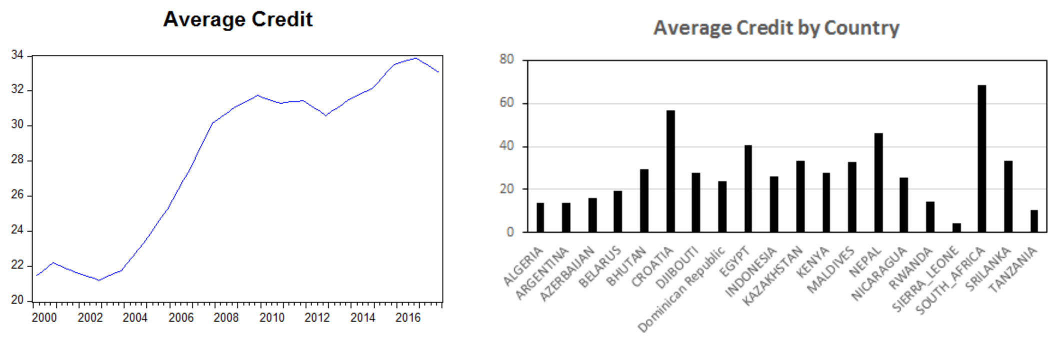


Figure 4.1 illustrates the average CBI index for all samples and by country. The left panel shows that the degree of CBI increased from 0.52 to 0.59 in the period 2000 to 2008. While, after 2012, the degree is relatively constant at around 0.62. In the diagram on the right, it can be seen the average CBI index is in the range 0.37 to 0.85, with the lowest in South Africa and the highest in Indonesia.

Figure 4.2: Credit Growth



Credit in emerging countries has been growing during the past two decades. On average, banking credit accounted for roughly 33% of GDP at the end of 2017 (Figure 4.2). Credit growth changed significantly throughout the period. The period 2004 to 2008 is characterised by high credit growth, from around 22% in 2004 to approximately 32% in 2008. After the global financial crisis, credit per GDP decreased to 30% in 2012. In the more recent sub-period, 2013 to 2016, credit per GDP rose again, approximately 34% in 2016. In Figure 4.2, in the diagram on the right, it can be seen the heterogeneous credit per GDP for the sample of countries. The lowest credit per GDP is Sierra Leone, with around 5%, whilst the highest is South Africa, with approximately 70%.

Figure 4.3: Macroprudential Policy Index

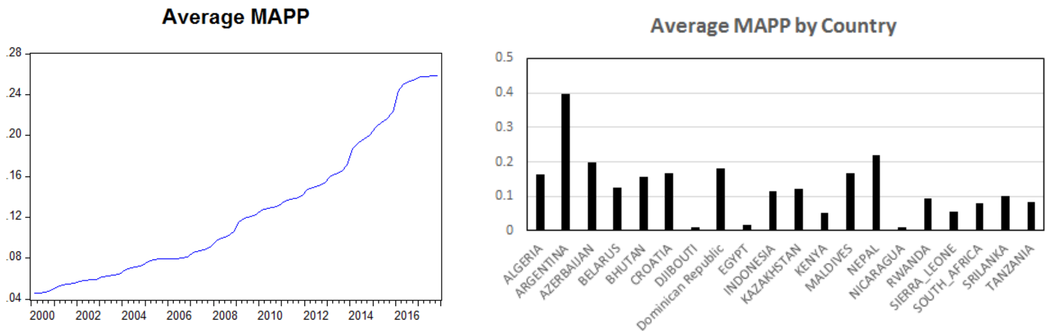
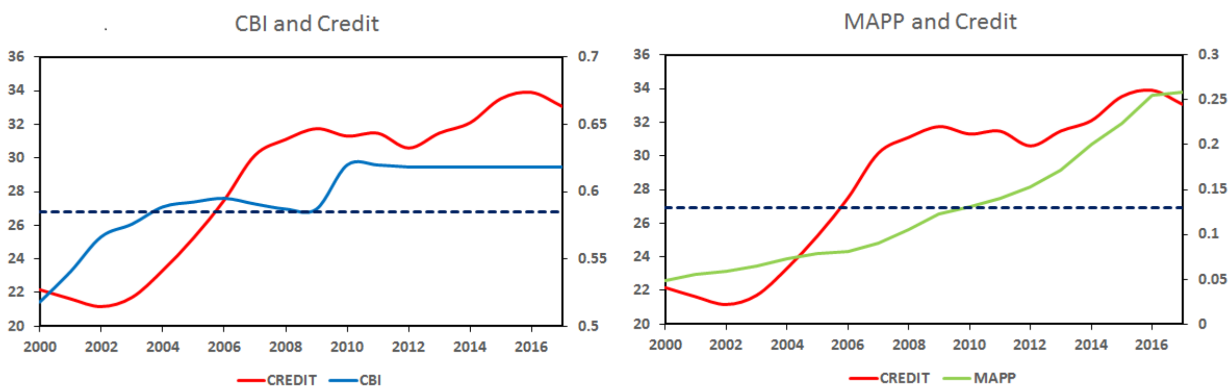


Figure 4.3, the diagram on the left describes the development of macroprudential policy index. The index is between 0 and 1. The average index for our sample increased over time, starting at 0.05 in 2000 to around 0.26 in 2017. The diagram on the right in Figure 4.3 suggests that there are considerable cross-country variations in macroprudential policy index. Nicaragua and Djibouti have the lowest average index with approximately 0.02. Those countries only applied one instrument of macroprudential policy (leverage ratio for Nicaragua and concentration limit for Djibouti) since 2016. Conversely, Argentina has the highest average index, 0.4 (Argentina performed limits on domestic current loans, concentration limit and limit for interbank exposure since 2000; countercyclical reserve requirement since 2001 and limit for foreign currency loans since 2003)[2].

Figure 4.4: CBI, Credit and Macroprudential Policy Index



In Figure 4.4, the diagram on the left indicates that credit per GDP relates differently to CBI when the degree of CBI is high and low. From the period 2000 to 2008, when the degree of CBI is low, increasing CBI is seen to directly increase credit per GDP ratio. This implies that an independent central bank triggers

[2]For more detail, see Figure C.2 in the Appendix

accelerated credit expansion. However, after 2009, when the CBI degree is high, credit per GDP appears to increase slightly. From the graph, it can be concluded that the low degree of CBI associated with high credit growth and a high degree of CBI relates to low credit growth.

However, the diagram on the right side of Figure 4.4 shows the relationship between macroprudential policy index and credit per GDP. Macroprudential policy index is seen to be lower when credit per GDP increased significantly in the period 2000 to 2008. When the macroprudential policy index is high, it appears that credit per GDP is reduced. From both graphs in Figure 4.4, it can be seen that when the degree of CBI is low, the macroprudential policy index is also low. Hence, there is a sharp increase in credit per GDP. When the degree of CBI is high, this is followed by a high macroprudential policy index, which leads to slow expansion in credit per GDP. It can be concluded that there is a non-linear relationship between CBI and macroprudential policy index and credit per GDP.

This chapter adds the following control variables: inflation, economic growth, interest rate and exchange rate. Following Stepanyan and Guo (2011) for the effect of inflation on credit per GDP. Inflation is defined as the percentage change of the consumer price index over the corresponding period. The priori sign of inflation on credit per GDP is positive, which suggests that inflation hinders financial stability for the reason that it increases the uncertainty. Economic growth is included as the main factor for credit per GDP. Economic growth is the rate of annual growth of GDP. According to Herrero and Del Rio (2003), higher economic growth should reduce credit per GDP because public income is high. Thus, they do not need to borrow money from the bank. Interest rate is measured as central bank policy rate and it is taken from the IFS of the IMF. As for interest rate, a high interest rate leads to reduced demand for bank credit. The last control variable is exchange rate. Exchange rate is bilateral rate between US Dollar and domestic currency. As suggested by Bruno and Shin (2014), the exchange rate is the main factor as regards credit per GDP. The data of exchange rate are retrieved from the IFS of the IMF.

4.3.3 Empirical Methodology

The aim of this study is to investigate the non-linearity effect of CBI on credit growth. Therefore, this chapter estimates the threshold level of CBI and explore the effect of CBI, macroprudential policy and some control variables on credit per GDP when CBI is above and below its threshold. Following Panel Smooth Transition Regression (PSTR) created by Gonzalez et al. (2017), to obtain the threshold level for CBI, speed of transition between the regime, besides the effect of explanatory variables on credit per GDP for low and high regimes. However, there are several drawbacks to performing the PSTR approach in our model. First, the author cannot finds a heterogeneous effect of CBI on credit per GDP for all countries, since the original model of PSTR is a non-dynamic fixed effect model where heterogeneity in the model is removed by its average. The second, the transition function (γ, c) may differ across countries. In this context, the author performs the PSTR model in terms of panel non-linear least square with the assumption that parameters and threshold are the same across countries. To check the pooling assumption of coefficients explanatory variables and threshold, a non-standard poolability test using a dummy variable approach is applied. To support the non-linearity hypothesis, this chapter employs a linearity test using the LR test to confirm whether the non-linear model is better than the linear model.

A. Panel Threshold Non-Linear Model

Gonzalez et al. (2017) define the PSTR estimation is a model of panel fixed effect with exogenous regressors. Accordingly, the author modified the PSTR model of Gonzalez et al. (2017), in a panel least square model. A simple panel transition model with two regimes is defined as follows:

$$y_{it} = \beta_0' x_{i,t} + [\beta_1' x_{i,t}] G(Z_{i,t;\gamma,c}) + \varepsilon_{it} \tag{4.20}$$

y_{it} is credit per GDP as a dependent variable; $x_{i,t}$ is a vector of time-varying exogenous variables; $G(Z_{i,t;\gamma,c})$ is the transition function and ε_{it} is the error term.

Gonzalez et al. (2017) define that $G(Z_{i,t}; \gamma, c)$ as the transition function. $Z_{i,t}$ is the threshold variable; γ defines the smoothness of the transition from low regime to high regime, c is the threshold parameter, whilst $G(Z_{i,t}; \gamma, c)$ is a continuous function of the observable variable $Z_{i,t}$ and is normalised to be bounded between 0 and 1. The regression coefficients for the low regime is β_0' and $\beta_0' + \beta_1'$ is for the high regime. The coefficient of the transition variable,$Z_{i,t}$, determines the coefficient of $G(Z_{i,t}; \gamma, c)$ and thus, the regression coefficients $\beta_0' + \beta_1' G(Z_{i,t}; \gamma, c)$ for country i at time t. Gonzalez et al. (2017) suggest that the transition function follows the logistic specification function:

$$G(Z_{i,t;\gamma,c}) = (1 + exp(-\gamma \prod_{j=1}^{m} (Z_{i,t} - c_j)))^{-1}$$
$$\text{with} \quad \gamma > 0 \quad \text{and} \quad c_1 < c_2 < ... < c_m \tag{4.21}$$

where $c = (c_1...c_m)'$ is an m-dimensional vector of location parameter and the parameter γ is the slope of smoothness between the low and high regimes.

In the model, assume that there is only one transition function and also one location parameter for the threshold variable. Thus, our model including two different regimes separating the low and high value of $Z_{i,t}$ with a single monotonic transition of the coefficient as β_0 and $\beta_0 + \beta_1$ is an increase of $Z_{i,t}$. If γ is the high value, the logistic transition, $G(Z_{i,t}; \gamma, c)$, becomes the indicator function $G(Z_{i,t}, c)$. For $\gamma \to \infty$, indicator function $G(Z_{i,t}, c) = 1$ if event if $Z_{i,t} > c$ occurs and indicator function $G(Z_{i,t}, c) = 0$ otherwise. If $\gamma \to 0$, the transition function $G(Z_{i,t}; \gamma, c)$ is constant. In which case, Equation (4.20) becomes a linear model.

B. Testing for a non-linear regression against a general alternative

In order to avoid an unidentified model, this chapter should test the non-linear model against a general alternative (linear model). The test follows the null hypothesis $H_0 = 0$ or $H_0 = \beta_0 = \beta_1$. The test is non-standard since under H_0 the non-linear model contains unidentified nuisance parameters. To solve this problem, Gonzalez et al. (2017), followed Luukkonen et al. (1988) by replacing $G(Z_{i,t}; \gamma, c)$ in Equation (4.20) with its first-order Taylor expansion round $\gamma = 0$. Following the auxiliary regression, Equation (4.20) becomes:

$$y_{it} = \beta_0' x_{i,t} + \beta_1' x_{i,t} Z_{i,t} + ... + \beta_m' x_{i,t} Z_{i,t}^m + \varepsilon_{it} \tag{4.22}$$

The test can be conducted using the likelihood ratio test where the test is distributed $\chi^2(df)$ under the null hypothesis. The likelihood ratio test is as follows:

$$LR \;\; Test = 2 * [l_U - l_R] \tag{4.23}$$

where l_R denotes the log-likelihood under H_0, i.e. linear model. However, l_U represents the log-likelihood under H_1 (non-linear model).

The LR test for testing linear restriction involves the following steps:

1. The null hypothesis is that the linear is valid.
2. Estimate both linear and nonlinear model and derive l_R and l_U.
3. Calculate the LR statistic based on Equation (4.23).
4. Find χ^2 distribution with degrees of freedom of restrictions.
5. If LR statistics $> \chi^2$ distribution, reject the null hypothesis.

C. Poolability Test

This chapter applies a non-standard poolability test to check whether or not the model is poolable. To do so, two models will be compared; specifically, the restricted and unrestricted models. The unrestricted model is our general model in Equation (4.20). This chapter used a dummy variable approach where D=0, except for country i where D=1 in the restricted model. By multiplying the dummy variable for each of the dependent variables. Thus, the slope is allowed to vary because of the two conditions (0 and 1) associated with the dummy variable.

$$y_{it} = \beta_0' x_{i,t} + [\beta_1' x_{i,t}] G(Z_{i,t;\gamma,c}) + [\beta_0' x_{i,t} + [\beta_1' x_{i,t}] G(Z_{i,t;\gamma,c})] * Dummy + \varepsilon_{it} \tag{4.24}$$

To test the statistical significance between restricted and unrestricted model, this chapter applies the LR test.

$$LR \;\; Test = 2 * [l_U - l_R] \tag{4.25}$$

where l_R denotes the log-likelihood under H_0, i.e. the restricted model. However, l_U represents the log-likelihood under H_1 (unrestricted model).

The poolability test for testing heterogeneity involves the following steps:

1. The null hypothesis is that the restriction is valid.
2. Estimate both restricted and unrestricted models and derive l_R and l_U.
3. Calculate the LR statistic based on Equation (4.25).
4. Find χ^2 distribution with degrees of freedom of restrictions.

5. If LR statistics > χ^2 distribution, reject the null hypothesis.
6. If the null hypothesis is rejected, the model is not poolable.

Repeat the procedures for all countries.

4.4 Empirical Results

4.4.1 Summary Statistics

The panel data used in this model covers 20 developing countries[3] determined by data availability. Our dataset consists of seven variables: CBI, macroprudential index, credit per GDP, economic growth, inflation, exchange rate and interest rate. Quarterly data from the years 2000 to 2017 are used.

Table 4.3: Summary Statistics

Variable	**Mean**	**Std.Deviation**	**Min.**	**Max**
CBI	0.5940	0.1575	0.1791	0.9040
MaPP	0.1255	0.1229	0.0000	0.4167
Ln Credit per GDP	3.0830	0.9330	-7.1115	4.3944
Inflation	7.7015	8.9601	-18.1100	118.5881
Growth	5.1668	4.0672	-20.5988	34.5000
Interest Rate	10.2140	7.9054	1.2500	80.0000
Ln Exchange Rate	3.9171	2.5500	-3.1350	9.5927

Table 4.3 summarises the descriptive statistics of the dependent variable and explanatory variables in our model for 20 developing countries. During the period 2000 to 2017, the average index of the independent central bank for an individual country is 0.594, with the minimum index 0.1791 and the maximum index 0.9040. The average macroprudential policy index reflected by MaPP is approximately 0.125. With a standard deviation of around 0.123, the minimum Mapp index is 0 while the maximum is 0.4167. Regarding credit per GDP in terms of a logarithm, the average bank credit to GDP ratio is 3.0830 with a large variation across the country from -7.1 to 4.4. For control variables, average inflation is 7.70%, average

[3] Algeria, Argentina, Azerbaijan, Belarus, Bhutan, Croatia, Djibouti, Dominican Republic, Egypt, Indonesia, Kazakhstan, Kenya, Maldives, Nepal, Nicaragua, Nigeria, Rwanda, Sierra Leone, South Africa, Sri Lanka, Tanzania, Thailand, Tonga, Turkey, Uruguay

economic growth is 5.17%, average interest rate is 10.21%, whilst the average ln exchange rate is 3.92.

4.4.2 Panel threshold Non Linear Model

A. Testing for a non linear regression against a general alternative

Following Gonzalez et al. (2017), in the case of two extreme regimes and one transition function, our model is:

$$y_{it} = \beta_0' x_{i,t} + \beta_1' x_{i,t} G(Z_{i,t;\gamma,c}) + \varepsilon_{it} \tag{4.26}$$

Summarising the factors influencing credit growth, this paper regards credit growth as a function of CBI, macroprudential policy index, inflation, economic growth, interest rate and exchange rate. Moreover, the transition variable is CBI. Thus, the threshold non-linear model for credit growth with two regimes is

$$\begin{aligned} Credit_{it} = {} & \beta_0 + \beta_{01} CBI_{i,t} + \beta_{02} MaPP_{i,t} + \beta_{03} Inflation_{i,t} + \beta_{04} Growth_{i,t} \\ & + \beta_{05} IR_{i,t} + \beta_{06} ER_{i,t} + (\beta_{11} MaPP_{i,t} + \beta_{12} CBI_{i,t} + \beta_{13} Growth_{i,t} \\ & + \beta_{14} Inflation_{i,t} + \beta_{15} IR_{i,t} + \beta_{16} ER_{i,t}) G(CBI_{i,t}; \gamma_j, c_j) + \varepsilon_{it} \end{aligned} \tag{4.27}$$

By replacing $G(Z_{i,t}; \gamma, c)$ in Equation (4.27) with its first-order Taylor expansion round $\gamma = 0$. Following the auxiliary regression, Equation (4.27) becomes a linear model:

$$\begin{aligned} Credit_{it} = {} & \beta_0 + \beta_{01} CBI_{i,t} + \beta_{02} MaPP_{i,t} + \beta_{03} Inflation_{i,t} + \beta_{04} Growth_{i,t} \\ & + \beta_{05} IR_{i,t} + \beta_{06} ER_{i,t} + \varepsilon_{it} \end{aligned} \tag{4.28}$$

This chapter runs a log-likelihood ratio test to confirm whether the non-linear model is better than the linear model.

$$LR\ \ Test = 2 * [l_U - l_R] \tag{4.29}$$

The l_U of -1669.410 is obtained from the non-linear model, whereas the l_R of -1726.617 is obtained from the linear model.

The LR ratio with the value 114.414 is obtained, while the $\chi^2(10)$ with 5% significance is 18.31. Seeing as the LR ratio is higher than χ^2 statistic, therefore the null hypothesis is rejected at the 5% level. This result indicates that the non-linear model is significantly better than the linear model, therefore confirming the presence of a non-linear relationship between CBI and credit growth.

B. Estimation Result of Non Linear Model

Table C.3 presents the result of the non-linear model with a threshold level of CBI. The result reveals that the estimated threshold level of CBI is 0.1299. This implies that there is a low regime if the degree of CBI is less than or equal 0.1299 and a high regime if the CBI index is above 0.1299. However, the slope of transition between regimes is 8.5924.

The result shows that CBI slows the credit growth significantly in the high regime, though it is insignificant in the low regime. This implies that when CBI is high, it can retard credit growth significantly. However, the author cannot finds a significant effect as regards macroprudential policy on credit growth both in the low and high regime. For the control variable in the low regime, inflation and exchange rate have a positive and significant effect on credit growth. However, economic growth and interest rate reduce credit growth significantly. In the high regime, economic growth and exchange rate cause a decrease in credit growth, nonetheless, the interest rate significantly increases the credit growth.

C. Poolability Test

The preceding results show that CBI has a negative and significant effect on credit growth only in the high regime and moreover, that macroprudential policy has no significant impact on credit growth both in the low and high regime. Those results assume that the coefficients for all explanatory variables are homogeneous for all countries and ignore the possibility of heterogeneity in the sample. Therefore, this chapter tests the pooling assumption in the model to check whether or not the coefficients for explanatory variables are poolable.

This chapter runs a non-standard poolability test to verify whether or not the model is poolable by using a dummy variable approach. To do so, the author will compares two models, namely the restricted and unrestricted models. The Unrestricted model is the general model in Equation (4.27), while this test uses a dummy variable approach where D=0, except for country i where D=1 for the restricted model. This model multiplies the dummy variable for each of the dependent variables. Consequently, the slope is allowed to vary because of both conditions (0 and 1) associated with the dummy variable.

$$\begin{aligned} Credit_{it} = \beta_0 + [&\beta_{01}CBI_{i,t} + \beta_{02}MaPP_{i,t} + \beta_{03}Inflation_{i,t} + \beta_{04}Growth_{i,t} \\ &+ \beta_{05}IR_{i,t} + \beta_{06}ER_{i,t} + (\beta_{11}MaPP_{i,t} + \beta_{12}CBI_{i,t} + \beta_{13}Growth_{i,t} \\ &+ \beta_{14}Inflation_{i,t} + \beta_{15}IR_{i,t} + \beta_{16}ER_{i,t})G(CBI_{i,t};\gamma_j, c_j)] + [\beta_{21}CBI_{i,t} \\ &+ \beta_{22}MaPP_{i,t} + \beta_{23}Inflation_{i,t} + \beta_{24}Growth_{i,t} + \beta_{25}IR_{i,t} + \beta_{26}ER_{i,t} \\ &+ (\beta_{31}MaPP_{i,t} + \beta_{32}CBI_{i,t} + \beta_{33}Growth_{i,t} + \beta_{34}Inflation_{i,t} + \beta_{35}IR_{i,t} \\ &+ \beta_{36}ER_{i,t})G(CBI_{i,t};\gamma_j, c_j)] * Dummy + \varepsilon_{it} \end{aligned} \tag{4.30}$$

Table 4.4: Poolability Test

Country	l_U	l_R	**LR Statistic**	χ^2	**Summary**
Algeria	-1577.515	-1669.41	183.79	21.03	Not Poolable
Argentina	-1752.673	-1669.41	-166.52	21.03	Poolable
Azerbaijan	-1655.518	-1669.41	27.784	21.03	Not Poolable
Belarus	-1439.179	-1669.41	460.46	21.03	Not Poolable
Bhutan	-1660.129	-1669.41	18.562	21.03	Poolable
Croatia	-1650.917	-1669.41	36.986	21.03	Not Poolable
Djibouti	-1660.144	-1669.41	18.532	21.03	Poolable
Dominican Rep	-1661.651	-1669.41	15.518	21.03	Poolable
Egypt	-1651.861	-1669.41	35.098	21.03	Not Poolable
Indonesia	-1627.827	-1669.41	83.166	21.03	Not Poolable
Kazakhstan	-1653.65	-1669.41	31.52	21.03	Not Poolable
Kenya	-1670.521	-1669.41	-2.222	21.03	Poolable
Maldives	-1666.711	-1669.41	5.398	21.03	Poolable
Nepal	-1626.832	-1669.41	85.156	21.03	Not Poolable
Nicaragua	-1662.592	-1669.41	13.636	21.03	Poolable
Rwanda	-1669.842	-1669.41	-0.864	21.03	Poolable
Sierra Leone	-1560.513	-1669.41	217.79	21.03	Not Poolable
South Africa	-1558.747	-1669.41	221.32	21.03	Not Poolable
Sri Lanka	-1656.03	-1669.41	26.76	21.03	Not Poolable

Continued on next page

Table 4.4 – *Continued*

Country	l_U	l_R	**LR Statistic**	χ^2	**Summary**
Tanzania	-1656.321	-1669.41	26.178	21.03	Not Poolable

Table 4.4 shows the result of the poolability test using the dummy variable approach. From 20 countries in the sample, the result shows that eight countries are poolable, while 12 countries are not. This result implies that the homogeneity assumption for full sample does not hold. This signifies that the coefficients are not the same for every country. Thus, the result concludes the existence of heterogeneity in the model and that the result in Table C.3 is biased. Based on the result of the poolability test, then the sample is divided into two groups: Group 1 consists of poolable countries, while Group 2 covers countries that are not poolable.

D. Split Sample

The results in Table 4.5 and Table 4.7 consider two-subsamples, that of Group 1 is poolable countries and Group 2 that are not poolable countries based on the result of the poolability test. The first group consists of Argentina, Bhutan, Djibouti, Dominican Republic, Kenya, Maldives, Nicaragua and Rwanda, whereas the other group covers Algeria, Azerbaijan, Belarus, Croatia, Egypt, Indonesia, Kazakhstan, Nepal, Sierra Leone, South Africa, Sri Lanka and Tanzania.

Poolable group

Table 4.5: Estimation Result of Group 1 (Poolable group)

Variable	**High Regime**	**Low Regime**
CBI	-8.5891	-41.132
	(-9.589570)***	(-3.3259)***
MaPP	-0.9206	12.500
	(-7.4638)***	(3.4009)***
Inflation	-0.0075	0.0832
	(-4.1040)***	(2.8586)***
Growth	-0.0011	0.0323

Continued on next page

Table 4.5 – *Continued*

Variable	**High Regime**	**Low Regime**
	(-0.2650)	(0.8449)
Interest Rate	0.6415	-0.6281
	(4.4467)***	(-4.2845)***
Exchange Rate	-0.1231	0.2906
	(-10.1775)***	(0.9828)
Threshold (c)	0.2672***	
Slope (γ)	9.6490***	

The dependent variable is credit per GDP. *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. t-statistics are in parentheses. Critical values: 1% : 2.576; 5% : 1.960; 10% : 1.645.

Table 4.5 reports the parameter estimates of the panel threshold model for Group 1. The threshold value and the transition parameter are 0.2672 and 9.6490, respectively. The effect of CBI on credit per GDP is negative and significant at 1% with the values -41.132 and -8.5891 for low and high regimes. This result is in line with our expectation, as an increase in CBI reflects a monetary improvement condition that dampens the ratio of credit per GDP and hence, reduces the probability of financial instability.

Regarding the macroprudential policy index, it reveals a significant negative effect on credit per GDP when CBI is above the threshold value. As expected, when the central bank is highly independent, tightening macroprudential policy is successful in reducing credit growth. However, in the case of CBI that is below the threshold level, the macroprudential policy has a positive and significant effect on credit per GDP with a coefficient of 12.500. This demonstrates that an increase of one percentage point in relation to macroprudential policy index produces higher credit per GDP of 0.125%. In the case of the low regime, it may well have happened before the credit boom occurred. Hence, an increase in credit per GDP was necessary to raise investment.

The impact of inflation on credit per GDP is significant at the 1% level. In two extreme regimes, the effects are -0.0075 and 0.0832 for high and low regimes, respectively. In the low regime, an increase (decrease) in inflation leads to increasing (drop) credit per GDP. This signifies that there are synergies between price and financial stability when CBI is below the threshold. However, in the case of a high-level CBI index, higher inflation reduces credit per GDP. This result is consistent with the theory that high inflation limits the amount of external financing available to borrowers, where during high inflation periods, banks become less willing to engage in long-running financial projects and tend to maintain more liquid portfolios. As a result, our finding confirms the existence of a trade-off between price and financial stability when CBI is above the threshold.

The result does not show a significant effect of economic growth on credit per GDP both in the low and high regime. This may possibly be because the economic growth fluctuated and is low in our sample period. Hence, it does not affect credit per GDP significantly. The interest rate has a negative effect on credit per GDP and is significant at 1% when CBI is below its threshold with coefficient -0.6281. This result is consistent with economic theory that a higher interest rate leads to lower demand for credit. In contrast, the higher interest rate produces higher credit per GDP in the high regime. The effect of exchange rate on credit per GDP is negative and significant only in the high regime with a coefficient of -0.1231. This means that depreciation (appreciation) of 1% domestic currency leads to a decrease (increase) credit per GDP.

Not Poolable group Result of panel threshold non-linear model for the group that is not poolable is presented in Table C.4. The estimated slope parameter that refers to the velocity of transition from the low to high regime is estimated as 4.6298. Meanwhile, the estimated location parameter for CBI is 0.1704.

Our results suggest that CBI matters reduce credit per GDP, although the effect is only significant for the high regime. This implies that higher CBI is effective at reducing credit per GDP when the CBI index is above a certain level. However, when CBI is below its threshold, an increase in CBI does not have a significant effect on reducing credit per GDP. The effect of macroprudential policy on credit per GDP is negative and significant at 10% with a coefficient of -29.9449 for the low regime. In contrast, the higher macroprudential policy increases credit per GDP significantly at 1% in the high regime.

Regarding control variables, the result shows a positive relationship between inflation and credit per GDP. Those relationships are only significant at 5% in the low regime but insignificant in the high regime. Economic growth has a negative and significant effect at 5% on credit per GDP in the low regime with a coefficient of -0.4252. When CBI is above the threshold, economic growth has a positive impact on credit per GDP but is insignificant. The result determines a significant relationship between the interest rate and credit per GDP at a 1% level, while the relationship is opposite for the two regimes. Economic growth has a negative effect on credit per GDP with a coefficient of -0.2808 in the low regime, but a positive effect with a 0.1931 value in the high regime. Exchange rate only significantly influences credit per GDP in the high regime with a coefficient of -0.1518.

Poolability Test for Group 2 (Not Poolable Group)

After test the pooling assumption for the not poolable group, the result in Table 4.6 shows that heterogeneity coefficients among explanatory variables exist in this group. Thus, this chapter performs mean group estimation by performing individual regression for every country then averaging the coefficients. However, the author only obtains a result that indicates individual regression for six countries (Algeria, Azerbaijan, Croatia, Egypt, Nepal and Sri Lanka). This means that the author cannot obtain regression results for another six countries. The possible reason for this failure is data for individual country lack variation. Hence, the author grouping Kazakhstan and Tanzania because those countries are poolable. The author include Belarus, Indonesia, Sierra Leone and South Africa in a group. After performed regression for four countries and subsequently check the assumption of homogeneity. The pooling assumption for the group of four countries is held; hence, the coefficients of parameters are homogeneous. To obtain mean group estimation for the not poolable group, this chapter applies a weighted average based on the number of countries in the group.

Table 4.6: Poolability Test for Group 2 (Not Poolable Group)

Country	l_U	l_R	**LR Statistic**	χ^2	**Summary**
Algeria	-1018.224	-1669.41	183.79	21.03	Not Poolable
Azerbaijan	-1071.182	-1669.41	-166.526	21.03	Poolable
Belarus	-945.2873	-1669.41	27.784	21.03	Not Poolable
Croatia	-1096.432	-1669.41	460.462	21.03	Not Poolable
Egypt	-1087.9	-1669.41	18.562	21.03	Poolable
Indonesia	-1082.734	-1669.41	36.986	21.03	Not Poolable
Kazakhstan	-1094.852	-1669.41	18.532	21.03	Poolable
Nepal	-1087.937	-1669.41	15.518	21.03	Poolable
Sierra Leone	-1028.154	-1669.41	35.098	21.03	Not Poolable
South Africa	-993.4054	-1669.41	83.166	21.03	Not Poolable
Sri Lanka	-1079.275	-1669.41	31.52	21.03	Not Poolable
Tanzania	-1095.018	-1669.41	-2.222	21.03	Poolable

The dependent variable is credit per GDP. *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. t-statistics are in parentheses.

Mean Group Estimator for Group 2 (Not Poolable Group)

Table 4.7: Mean Group Estimation for Group 2 (Not Poolable Group)

Variable	**High Regime**	**Low Regime**
CBI	-7.4586	-28.8683
MaPP	2.3303	-9.6167
Inflation	0.0003	0.0306
Growth	-0.0501	0.1052
Interest Rate	0.0981	-0.0758
Exchange Rate	-0.2630	0.8220
Threshold (c)	0.5941	
Slope (γ)	45.2908	

The dependent variable is credit per GDP. 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.

Table 4.7 reveals a panel threshold model for the not poolable group using mean group estimator. The threshold level of CBI (c) is 0.5941, while the slope of transition parameter γ is 45.2908. Based on the result, the mean group estimation for this group, the impact of CBI on credit per GDP is negative in two regimes, with coefficients -28.8683 and -7.4586 for the low and high regimes, respectively. This negative relationship implies that CBI is a significant factor to reduce financial instability or foster financial stability. The intensity of this negative impact on the low regime is more prominent than the high regime and may possibly be caused by a small change in CBI at the low regime. Thus, the effect on credit per GDP change is significant.

Result for the effect of macroprudential policy on credit per GDP is negative when CBI is below its threshold with a coefficient of -9.6167. This implies that the effect of a one percentage point increase in the macroprudential policy index lowers credit per GDP for the low regime by 0.097%. However, an increase of one percentage point in relation to macroprudential policy index produces an increase in credit per GDP of 0.023% when CBI is above its threshold.

The relationship between inflation and credit per GDP is positive. The coefficients are 0.0306 and 0.0003 for the low and high regimes, respectively. This result corresponds with our expectation that inflation boosts demand for credit and consistent with the work of Stepanyan and Guo (2011). Economic growth has a positive relationship with credit per GDP in the low regime, while the relationship in the high regime is negative. 1% increase in economic growth rises credit per GDP 0.1052% in the low regime. However, when CBI is high, GDP growth that is 1% lower (higher) leads to a 0.05% increase (decrease) in credit per GDP. The higher interest rate leads to lower credit per GDP in the low regime but leads to higher credit per GDP in the high regime. In the low regime, the relationship between the interest rate and credit per GDP is negative, an increase of 1% interest rate drops 0.07% credit per GDP. However, the result shows a puzzle effect on the interest rate in the high regime, an increase of 1% in the interest rate increases credit per GDP of roughly 0.099%. Lastly, depreciation of 1% in domestic currency increases credit per GDP of 0.8220% in the low regime but reduces credit per GDP in the high regime by 0.2630%. This implies that depreciation of 1% in the exchange rate increases credit per GDP by about 0.82%, when CBI is below its threshold.

E. Mean Group Estimator of Full Sample

After performed mean group estimation for full sample countries. This section uses weighted average for the coefficients of group 1 (poolable countries group) and group 2 (countries that are not poolable) based on the number of countries in each group.

Table 4.8: Mean Group Estimation of Full Sample

Variable	**High Regime**	**Low Regime**
CBI	-7.9108	-33.7741
MaPP	1.0299	-0.7697
Inflation	-0.0028	0.0517
Growth	-0.0305	0.0761
Interest Rate	0.3155	-0.2967
Exchange Rate	-0.2070	0.6095
Threshold (c)	0.4564	
Slope (γ)	31.0341	

The dependent variable is credit per GDP. 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.

Table 4.8 reveals that the threshold level of CBI is 0.4564. Furthermore, the smoothness of the transition between the low and high regimes is 31.0341. Our result confirms that CBI has a negative impact on credit per GDP above and below the threshold level. The negative effect of CBI on credit per GDP is stronger in the low regime than the high regime. An increase of one percentage point in relation to CBI reduces credit per GDP in the low regime and high regime, by approximately 0.34% and 0.08%, respectively. This negative relationship implies that CBI succeeds in reducing financial instability or foster financial stability which is in line with prior empirical studies conducted by Klomp and de Haan (2009); Berger and Kißmer (2013); Doumpos et al. (2015). Our result also supports the argument for a synergistic relationship between price and financial stability, as stated by Issing (2003), who claims that financial stability can be attained after price stability is achieved. This suggests that CBI has a significant mitigating effect on the growth of credit.

The effect of macroprudential policy on credit per GDP is diverse for both regimes; negative in the low regime but positive in the high regime. In the low regime, an increase of 1% in macroprudential policy index reduces credit per GDP by approximately 0.77%. This finding is supported by the studies completed by Cerutti et al. (2017), Dell'Ariccia et al. (2012) and Lim et al. (2011), who show evidence of a negative relationship between macroprudential policy and credit per GDP. However, the result shows a positive effect of macroprudential policy on credit per GDP when the CBI index is above the threshold level with a coefficient of 1.0299. This suggests that when CBI is high, an increase of 1% in the macroprudential policy index increases credit per GDP by 1.0299%. Our result is supported by Kim and Mehrotra (2018), who claim that CBI and macroprudential policy could be synergies to obtain price and financial stability during normal time. However, under low and stable inflation and buoyant credit growth, the monetary authority faces a dilemma due to the appearance of a trade-off between price and financial stability. Higher CBI and more tightening macroprudential policy would stabilise only one objective, whereas using both in the opposite direction could result in both policies working for different purposes.

Now move to the effect of control variables on credit growth. The first is inflation. The result shows an opposite effect in relation to inflation on credit growth on both regimes, with coefficients of -0.0028 and 0.0517 for both the high and low regimes. The result in the low regime corresponds with our expectation that inflation boosts demand for credit and is in line with the work of Stepanyan and Guo (2011). This is because a higher inflation rate leads to a lower real interest rate, the effect of reducing the cost of credit, which then finally boosts demand for bank credit. Another reason is an increase in inflation reflects the higher price of goods and services, suggesting that households need more money to fulfil their consumption, thus increasing demand for credit and consequently increasing credit per GDP. However, in the high regime, the increase in inflation produces low credit per GDP. This result is consistent with the theory that high inflation limits the amount of external financing available to borrowers, where during high inflation periods, banks become less willing to engage in long-running financial projects and tend to maintain more liquid portfolios. Another reason is higher inflation increases uncertainty regarding future return. As a result, banks are less willing to supply credit.

The second control variable is economic growth. The impact of economic growth on credit per GDP differs for the low and high regimes. It shows a positive effect in the low regime but is negative in the high regimes. When CBI lowers its threshold, an increase of 1% in economic development boosts credit per GDP by around 0.08%, which is in agreement with Cottarelli et al. (2005). An increase in economic growth demonstrates development of real activity, which encourages investors to borrow credit to expand their business. This result supports the theory of a pro-cyclical relationship between economic growth and bank credit, where bank lending is high during the expansion of consumption and investment because during an economic boom financing is required for new investments and higher consumption of goods and services. Thus, bank willingness to lend increases since the private sector balance sheet is improving (Gómez et al., 2019). However, when the CBI is high, 1% lower in GDP growth leads to a 0.03% increase credit per GDP. The negative relationship between GDP growth and credit per GDP might be caused that there are incentive policies for credit expansion when the economy is in recession as a strategy to avoid endogenous shock such as increase in money supply (Stiglitz and Greenwald, 2003). Another reason for this negative relationship is an increase in productivity (GDP growth) creates a higher profit thus more internal fund available, as a result, decrease in credit demand (Kiss et al., 2006).

It is interesting to note that the impact of interest rate on credit per GDP differs when CBI is above and below the threshold. In the low regime, the relationship between the interest rate and credit per GDP is negative, an increase of 1% interest rate drops credit per GDP by 0.3%. This result parallels with our expectation, as an increase in the interest rate means the increased cost of borrowing reduces demand for credit and consequently, lower credit per GDP. Monetary tightening, indicated by a rise in the interest rate, may also produce a lower credit supply, hence, lower credit per GDP. However, the result shows a puzzle effect in relation to the interest rate in the high regime, a rise in interest rate increases credit per GDP. This result tends to support the argument that the higher the interest rate, the higher the yield for banks. Thus, there is a greater incentive to supply credit (Akinlo and Oni, 2015).

The last control variable is the exchange rate. This result finds a contrast effect of exchange rate on credit per GDP for two different regimes. In the low regime, an increase in the exchange rate increases credit per GDP. This implies that depreciation of 1% in the exchange rate increases credit per GDP by about 0.61%. This finding is in line with Stepanyan and Guo (2011) who state that credit growth in terms of domestic currency reflects the exchange rate movements rather than originally credit growth. However, in the high regime, depreciation (appreciation) of 1% in the exchange rate reduces (increases) credit growth by roughly 0.21%. These findings are in agreement with the "risk-taking channel" of appreciation exchange rate and financial stability (Bruno and Shin, 2014). They claim that currency appreciation leads to a stronger balance sheet for local borrowers, lower credit risk. Hence, bank lending capacity increases, which as a result increases credit per GDP.

F. Comparison Sub-Sample Group

Table 4.9: Comparison Sub-Sample Group

Variable	Full Sample		Group 1		Group 2	
	High Regime	Low Regime	High Regime	Low Regime	High Regime	Low Regime
CBI	-7.9108	-33.7741	-8.5891	-41.132	-7.4586	-28.8683
MaPP	1.0299	-0.7697	-0.9206	12.500	2.3303	-9.6167
Inflation	-0.0028	0.0517	-0.0075	0.0832	0.0003	0.0306
Growth	-0.0305	0.0761	-0.0011	0.0323	-0.0501	0.1052
Interest Rate	0.3155	-0.2967	0.6415	-0.6281	0.0981	-0.0758
Exchange Rate	-0.2070	0.6095	-0.1231	0.2906	-0.2630	0.8220
Threshold (c)	0.4564		0.2672		0.5941	
Slope (γ)	31.0341		9.6490		45.2908	

Note: The table reports coefficients from panel threshold non-linear least square estimation. The dependent variable is inflation. The symbols *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively.

This section analyses the effect of CBI, macroprudential policy, inflation, economic growth, interest rate and exchange rate on credit per GDP for the high and low regimes in two different groups: Group 1 and Group 2. The full sample results are shown because it is the average of both groups, so the coefficients are continuously between two groups. Our results reveal how the model is influenced by a diversity of factors such as exchange rate regime, degree of CBI, and monetary policy tightening.

Table 4.9 describes panel threshold non-linear regression for two different groups and the average for the full sample. Interestingly, the threshold and speed of transition are significantly different for both groups 1 and 2. The threshold level of CBI is 0.2672 and 0.5941 for Group 1 and Group 2, respectively, while the average threshold level of CBI for all samples is 0.4564. The speed of transition between low and high regimes is 9.6490 for Group 1, 45.2908 for Group 2, whilst the average slope for the full sample is 31.0341. The result finds that the threshold and slope for Group 1 are lower than Group 2; this might be caused by the different levels of degree of CBI for each group. Group 1 observes that the average degree of CBI for all countries is above the threshold. However, for Group 2, only four countries (Croatia, Indonesia, Sierra Leone and Sri Lanka) are beyond the estimated threshold level. In the remaining eight countries for Group 2, the average level of CBI is lower than its threshold.

The result finds a negative relationship between CBI and credit per GDP for all groups, in both the low and high regimes. This implies that CBI fosters financial stability when the degree of CBI is below the threshold and above the threshold. In the low regime, the coefficients are -28.8683, -41.132 and -33.7741 for Group 2, Group 1 and the average of the full sample, respectively. While in the high regime, the coefficients are -7.4586, -8.5891 and -7.9108 for Group 2, Group 1 and the average of the full sample. The negative effect of CBI on credit per GDP is higher in Group 1 compared to Group 2. This higher effect may well be caused by a higher degree of CBI in Group 1, in which the CBI index in Group 1 is above the average but in Group 2 it is below the average. This result is in agreement with the findings of Cihak (2010) who states that countries with an above-average degree of CBI have better financial stability compare in contrast with countries with below-average degree of CBI.

Next, move to the effect of macroprudential policy on financial stability. The result finds significantly different results in the low and high regimes for Group 1 and Group 2. In Group 1, the effect of macroprudential policy on credit per GDP is positive in the low regime but negative in the high regime. In contrast, the relationship both variables is negative in the low regime but positive in the high regime for Group 2. Table C.1 in the Appendix does not see a significant difference in macroprudential policy index between groups 1 and 2. However, in terms of credit per GDP, there is a huge gap between the two groups, where Group 1 (24.6671) is lower than Group 2 (31.0756). According to Dell'Ariccia et al. (2016), who used credit boom as a proxy of financial stability, they stated that the average credit per GDP at the start of credit boom was 31%, which is similar to the average credit per GDP for Group 2. In this group, even though the degree of CBI is low, tighter macroprudential policy leads to lower credit per GDP. One possible reason is since policymakers know they face financial instability, they use macroprudential instruments to reduce credit per GDP. However, the interaction between higher CBI and tighter macroprudential policy produces financial instability. This might occur because when the central bank has two policy objectives (price and financial stability), it uses inappropriate instruments to achieve each goal (Masciandaro and Volpicella, 2016). For Group 1, in case of a high CBI index, tighter macroprudential regulation dampens credit per GDP. This supports the idea that, particularly in a central bank which is highly independent, a higher macroprudential policy index can improve the stability of the financial system.

Now look at the effect of control variables on credit per GDP. The first variable is inflation. The result finds that the effect of inflation on credit per GDP in the low regime in Group 1 is higher than Group 2 (0.0832 and 0.0306 for groups 1 and 2, respectively). This implies that when the degree of CBI is below the threshold, an increase (decrease) in inflation leads to higher (lower) financial instability in Group 1 that has a stronger effect than Group 2. This result support synergies between price and financial stability because a decrease in inflation produces lower financial instability or higher financial stability. One difference that characterises both groups is the inflation rate; the average inflation in Group 1 (7.4%) is lower than Group 2 (7.9%). Since low and stable inflation produces predictable interest rate. Thus, countries in Group 1 have a lower long-term interest rate since the inflation risk is lower. As a result, Group 1 has a stronger effect of inflation on credit per GDP. Conversely, if CBI is above the threshold, our result shows that there is a trade-off between price and financial stability due to the negative effect of inflation on credit per GDP for Group 1. This finding in Group 1 for the high regime means that lower inflation leads to higher credit per GDP and hence, reduces financial stability. According to Herrero and Del Rio (2003), low inflation leads to a decrease in bank profit margin and therefore influences the bank to increase credit supply and increase bank risk-taking.

The next control variable is GDP growth. In the low regime, the effect of economic growth on credit per GDP is positive, whilst Group 2 has a higher coefficient than group 1. The reason for the positive effect is that higher economic growth produces an increase in expected income and profit, enhancing the public's financial condition and finally allowing a higher level of credit. However, in the high regime, economic growth has a negative impact on credit per GDP, with a stronger impact in Group 2 than Group 1. This signifies that the higher the economic growth, the more stable the financial system when the degree of CBI is above the threshold. Table C.1 in the Appendix shows that the average economic growth in Group 2 is higher than Group 1. Economic growth has a positive correlation with the financial development index (Levine, 1999; Detragiache and Kenichi, 2004; Kiss et al., 2006); the index for Group 2 is 0.21 and for Group 1 is 0.17. The higher financial development index means a more efficient financial intermediation sector, producing a stronger effect on financial stability.

The interest rate has a negative effect on credit per GDP in the low regime, but a positive impact on the high regime. Those effects are the same for groups 1 and 2. This means that when CBI is below its threshold, an increase in the interest rate is associated with higher financial stability. However, when CBI is above the threshold, a tighter monetary policy could lead to greater financial stability. Those effects are higher in Group 1 compared to Group 2. One possible reason for the stronger influence in Group 1 is because the average interest rate in Group 1 (8.5%) is lower than Group 2 (11.3%). A higher interest rate reflects tighter monetary policy conditions. This finding in line with Stepanyan and Guo (2011), who state that a tighter (looser) monetary stance causes lower (higher) credit per GDP. Monetary policy affects bank credit via two channels: bank lending and bank balance sheet. Tighter monetary policy produces lower supply bank credit (bank lending channel) and also leads to a lower firm balance sheet then reduces their ability to borrow money from the bank (balance sheet channel).

The last control variable is the exchange rate. It can be seen that an increase in exchange rate leads to a rise in credit per GDP in the low regime but reduces credit per GDP in the high regime for both groups. This implies that the depreciation exchange rate increases financial instability when CBI is below the threshold, but fosters financial stability if CBI is above its threshold. The magnitude effect of exchange rate on credit per GDP is higher in Group 2 than Group 1. This might be caused by different exchange rate arrangements for both groups. By following the exchange rate classification measured by Reinhart and Rogoff (2004), which is presented in Table C.1 in Appendix. A higher number denotes a more flexible exchange rate arrangement. The average for Group 1 is 5 which is the facto crawling page, while for Group 2 it is crawling band exchange rate arrangement. This means that countries in Group 1 are applying a relatively fixed exchange rate regime. This result agrees with the findings of Herrero and Del Rio (2003) and Domac and Peria (2003), which claims that countries with a fixed exchange rate regime have a lower probability of a banking crisis and hence, promote financial stability.

4.5 Conclusion

This chapter used a novel econometric model and a new data set to examine the effect of CBI and macroprudential policy on credit per GDP. By applying the PSTR model in terms of the panel non-linear least square method to find a threshold level for CBI. This chapter also performed a poolability test to check whether our threshold level and coefficients of parameters are homogeneous. This chapter used a dummy approach to check this pooling assumption. Our result shows that the model is not poolable; thus, this chapter applies the mean group approach. With a sample of quarterly data for 20 developing countries for the period 2000 to 2017, the result finds the presence of the threshold level of CBI at around 0.4564. When the sample was divided into two groups, the CBI threshold level is 0.2672 and 0.5941 for the groups that are poolable and not poolable, respectively.

The result finds the evidence of existence synergies between price and financial stability due to CBI. Our results show that the more independent central bank is beneficial in reducing credit per GDP, thus dampens financial instability. This result is in line with Fratzscher et al. (2016). Likewise, these results confirm the result obtained in Klomp and de Haan (2009), who claimed that CBI is effective in reducing financial instability. This finding is robust. Moreover, when the sample is split into two groups based on the poolability test, the result still finds a negative relationship between CBI and the credit to GDP ratio. However, the magnitude of the effect is more prominent for the poolable group due to the higher than average degree of CBI for this group compared to the group that is not poolable. The effect of CBI on credit per GDP is more significant in the low regime than in the high regime. This may possibly be because there is a small change in CBI in the low regime, which produces a higher marginal effect.

Macroprudential policy has a different effect on credit per GDP when the degree of CBI is below and above its threshold. For the low regime, macroprudential policy succeeds in promoting financial stability. However, when the degree of CBI is high, our result illustrates a trade-off between price and financial stability. Higher CBI and tighter macroprudential policy would stabilise only one objective.

When CBI is below its threshold, the relationship between inflation and credit growth is positive. The result finds that price stability is a sufficient condition for financial stability because when the policymaker achieves low and stable inflation, financial stability is obtained. This also reveals that there is a synergy between price and financial stability. However, in a high CBI regime, inflation has a negative effect on credit growth. This implies higher inflation promotes financial stability. Economic growth has a positive effect on improving financial stability in the high regime. The result finds similar results for the groups that are poolable and not poolable, but the magnitude effect is stronger for the group that is not poolable. Tightening monetary policy by increasing the interest rate leads to a more stable financial system when CBI is below its threshold for the full sample, the groups that are poolable and not poolable. The effect of the interest rate on credit per GDP is higher in the poolable group because the average interest rate for this group is lower than the other group. Finally, the depreciation exchange rate leads to more financial stability when CBI is below the threshold, but appreciation promotes financial stability if CBI is above its threshold.

Chapter 5

Conclusion

This chapter presents the highlights of the findings and the policy implications of the three empirical studies, as well as limitations of the study and recommendations for future research.

5.1 Review and Summary of the Results

The main idea of this thesis was to investigate the heterogeneity effect of CBI on inflation, financial asset prices and credit per GDP in developing countries.

The relationship between CBI and inflation has created a controversial debate in the empirical literature. It is generally admitted that CBI is an essential factor inflation stabilisation. Nevertheless, empirical evidence in this field indicates differing and inconclusive results. Chapter 2 investigated the effect of CBI on inflation in a panel of 37 developing economies for the period 1972 to 2016. The study applies poolability tests to check the homogeneity assumption in the panel models. The Chow and Roy-Zellner tests proved that the homogeneity assumption in the models does not hold; as a consequence, our models consist of heterogeneous parameters across countries. Chapter 2 employed a panel heterogeneity model (MG and PMG estimations) to verify the short-run and long-run effect of CBI on inflation. The results confirmed that there is a negative and significant relationship between CBI and inflation. After splitting the sample into two groups based on the rate of inflation to create high and moderate inflation groups. The result provides evidence that CBI reduces inflation in both groups.

Chapter 3 provided an empirical analysis of CBI, consumption and investment via three different financial asset prices: exchange rate, stock index and bond yield. In this chapter, the panel VAR proposed by Canova and Ciccarelli (2013) was applied to four different models. The author verified the poolability assumption of the panel VAR by performing Chow and Roy-Zellner poolability tests. The result found heterogeneity in the sample; therefore, an MG estimation for the panel VAR was applied by running individual VAR for each country and averaging the coefficients. The author also split the sample into two and three groups such that our subsamples were poolable. The first model studied the responses of the exchange rate, consumption and investment due to a shock to CBI. Our results show that after a central bank reform shock, it takes five quarters for the exchange rate to begin to appreciate. A shock of one percentage point to the degree of CBI leads to a fall in consumption but increases investment. Moreover, a shock of one standard deviation of the exchange rate leads to increased consumption and investment. The sample is the split into three groups to make the subsamples poolable. The results for each of the three groups differ. This shows how results can be influenced by different factors, such as: heterogeneity of economic sectors, degree of CBI, inflation, exchange rate regime and capital mobility.

The second model examined the interrelationship between CBI, stock index, consumption and investment. The MG estimation for the panel VAR shows that a shock of one standard deviation relating to CBI causes the stock index to respond positively until period two; then the response gradually returns to the initial value in period three. A shock of one standard deviation related to the degree of CBI reduces private consumption. However, after the CBI shock, it takes three quarters before the investment starts to rise. Furthermore, the responses of consumption and investment to a stock index shock are positive. Model three analysed the effect of CBI on bond yield, the effect of bond yield on consumption and investment, and the effect of CBI on consumption and investment. The MG for the panel VAR reveals that an increase of one positive innovation to the degree of CBI leads to a decline bond yield. Similarly, a shock of one standard deviation to CBI reduces consumption but increases investment.

Model four combined three financial asset prices into one model; thus aimed to investigate the interrelationship among CBI, those three financial asset prices, consumption and investment. By performing an MG estimation for the panel VAR, our results show that the response of the exchange rate to a one standard deviation shock to CBI is positive, but the responses of stock index and bond yield are negative. Consumption responds negatively due to a shock of a one-standard deviation to the exchange rate; however, it responds positively to a one-unit innovation to the stock index and bond yield. The impulse response of investment to a one-unit shock to the exchange rate and bond yield is negative; meanwhile, the response of investment is positive to a one-unit shock in the stock index.

Chapter 4 applied a PSTR model in terms of the panel non-linear least square method to find a threshold level for CBI on credit growth. This chapter also performed a poolability test to check whether our threshold level and the coefficients of the parameters were homogeneous. This chapter used a dummy approach to check this pooling assumption. Our result shows that the model is not poolable; thus, this chapter applied the mean group approach. The result provides evidence of the existence of synergies between price and financial stability due to CBI. The results show that a more independent central bank is beneficial in reducing the credit to GDP ratio, thus dampening financial instability. This finding is robust. Moreover, when the sample is split into two groups based on the poolability test, the result still show a negative relationship between CBI and the credit to GDP ratio. However, the magnitude of the effect is more prominent for the poolable group due to the higher than average degree of CBI for this group compared to the group that is not poolable. The effect of CBI on credit per GDP is more significant in the low regime than in the high regime. This may be because there is a small change in CBI in the low regime, which produces a higher marginal effect. The macroprudential policy has different effects on credit per GDP when the degree of CBI is below and above its threshold. For the low regime, the macroprudential policy succeeds in promoting financial stability. However, when the degree of CBI is high, our result illustrates a trade-off between price and financial stability. A higher CBI and tighter macroprudential policy would stabilise only one objective.

5.2 Policy Recommendations

The findings of this study provide a basis for some sound policy recommendations. Based on Chapter 2, developing countries have the challenge of considering CBI an essential factor in reducing inflation. However, for some central banks, the legal independence index is low. These include Thailand (0.1839), Brazil (0.2174), Morocco (0.2680), Pakistan (0.2806) and Nepal (0.3341). Most developing countries still need to reform their central bank legislation in order to deliver the price stability objective. Some central banks' laws and statutes need further revision because their Acts are considerably out of date. For example, according to Garriga (2016), Banco Central do Brazil is still guided by the 1988 Act, which grants it a low degree of CBI.

The findings from Chapter 3 show that policymakers in developing countries need to pay more attention to improve their credibility in the international financial market in order to attract capital; a higher degree of CBI reflects more transparency and credibility, thus attracting more investment. However, the effect of CBI on attracting capital depends on global financial factors, such as capital restriction. Lower capital restriction reduces capital costs, increases investment and boosts economic growth, thereby, generating higher financial asset prices. Our results show that for countries with low capital control, a higher CBI has a positive impact on financial asset prices; appreciate the exchange rate, raise the stock index and reduce the bond yield. Our findings suggest that developing countries have gradually removed restrictions on capital inflow such as taxes.

Another policy implication based on the result of Chapter 3 is the importance of financial capitalisation in developing countries. The effects of CBI on three financial asset prices in developing countries differ based on financial capitalisation. For countries with high financial capitalisation, an increase in the degree of CBI creates an appreciation in the exchange rate, increases stock index and reduces bond yield. This chapter recommends that governments in developing countries increases financial capitalisation gradually by introducing public companies to the stock exchange. To encourage companies to introduce their capital into the stock exchange, the author suggest that policymakers in developing countries remove difficulties in the stock exchange such as tax, and regulatory and legal barriers.

Chapter 4 points to the fact that CBI may foster financial stability and lower inflation as a necessary condition to achieve financial stability. A higher CBI and tighter macroprudential policy reduce credit per GDP for countries with poor financial institutions. In contrast, a lower CBI and tighter macroprudential policy produce low credit per GDP for countries with a higher quality financial institutions. Overall, the results further highlight the fact that CBI and macroprudential policy substitute rather than complement each other. This finding has important policy implications, especially for developing countries with a low financial development index, which need to strengthen their central bank and where tightening the macroprudential policy would reduce financial instability.

5.3 Limitations and Suggestions for Further Study

This thesis has made efforts to make the findings as reliable as possible; however, there are a number of limitations concerning the data. First, the data for the CBI index developed by Garriga (2016) are limited until 2012; however, the author extend the data until 2017 with the assumption that there was no change in central banks' laws and statutes in any of the countries in our sample. Consequently, the degree of CBI from 2013 to 2017 is constant.

Chapter 2 only checks the poolability assumption along the cross-section. However, according to Baltagi (2008), heterogeneity might come from both the cross-section and time dimension. This chapter only considers heterogeneity on the cross country and ignore the possibility of heterogeneity along the time dimension.

In Chapter 3, there are two main limitations. First, there is a limitation regarding the number of countries in the sample in the four models. Model 1 covers 26 countries, model 2 includes 16 countries and model 3 comprises 19 countries. However, the country samples are different in the 3 models. Consequently, when all the samples are combined in model 4, there are only 7 countries that are included in those 3 models.

Second, the author divided the sample into two or three groups to make our subsample poolable; however, the author could not identify specific characteristics for each group. The author averaged some factors to make one group different from the others. Another limitation of these chapters is regarding the mean group estimation as an averaging of the individual country estimations. In this estimation, the author only averaged the coefficients of the explanatory variables without averaging the t-statistic and standard error; as a consequence, the author could not conclude whether or not the effect of the explanatory variable was significant.

Chapter 4 has some limitations too. First, this chapter assumes that there is only one transition function and one location parameter of the CBI threshold. This assumption might be appropriate for a country that only has one change to the CBI degree along the sample period. Second, this chapter assumes that group 1 is a poolable group, and that the homogeneity assumption is held in this group.

This thesis can be extended in several ways. One possible extension to Chapter 2 is a study that divides the sample based on the level of inflation. It is recommended that future research should split the sample based on the exchange rate regime or whether those countries apply an inflation targeting framework. It would also be interesting if the sample were split based on the time dimension, for example from 1972 to 1990 and from 1991 to 2016. Then one could examine whether the effect of a change to CBI is still significant in reducing inflation. Future empirical work might also differentiate the CBI index between the political and economic independence index. Thus, this chapter could be extended to investigate those two indices on inflation separately to find the primary cause in reducing inflation.

Chapter 3 only take into account three financial asset prices: exchange rate, stock index and bond yield. This thesis could not look at the issue of house prices. The reason this chapter lefts house prices out is due to the lack of sufficient data on house prices in the sampled developing countries. Future empirical study could investigate the effect of CBI on house prices in developing countries since house prices typically constitute a larger share of the total assets in developing countries (Claessens and Kose, 2017).

In Chapter 4, to make our analysis robust. Future research may examine the implications of alternative measures of financial stability based on bank credit, for example, credit per GDP gap, the level of a bank's Non Performing Loans (NPL) and bank soundness. This would provide more insightful analysis and empirical evidence on the effect of CBI on financial stability. This is because there is no perfect financial stability measure since each measure has specific advantages. A further study could also estimate the threshold effect on the macroprudential policy index. It would be interesting to evaluate whether there is an optimal level of macroprudential policy index that changes the effect of macroprudential policy on credit growth.

Appendices

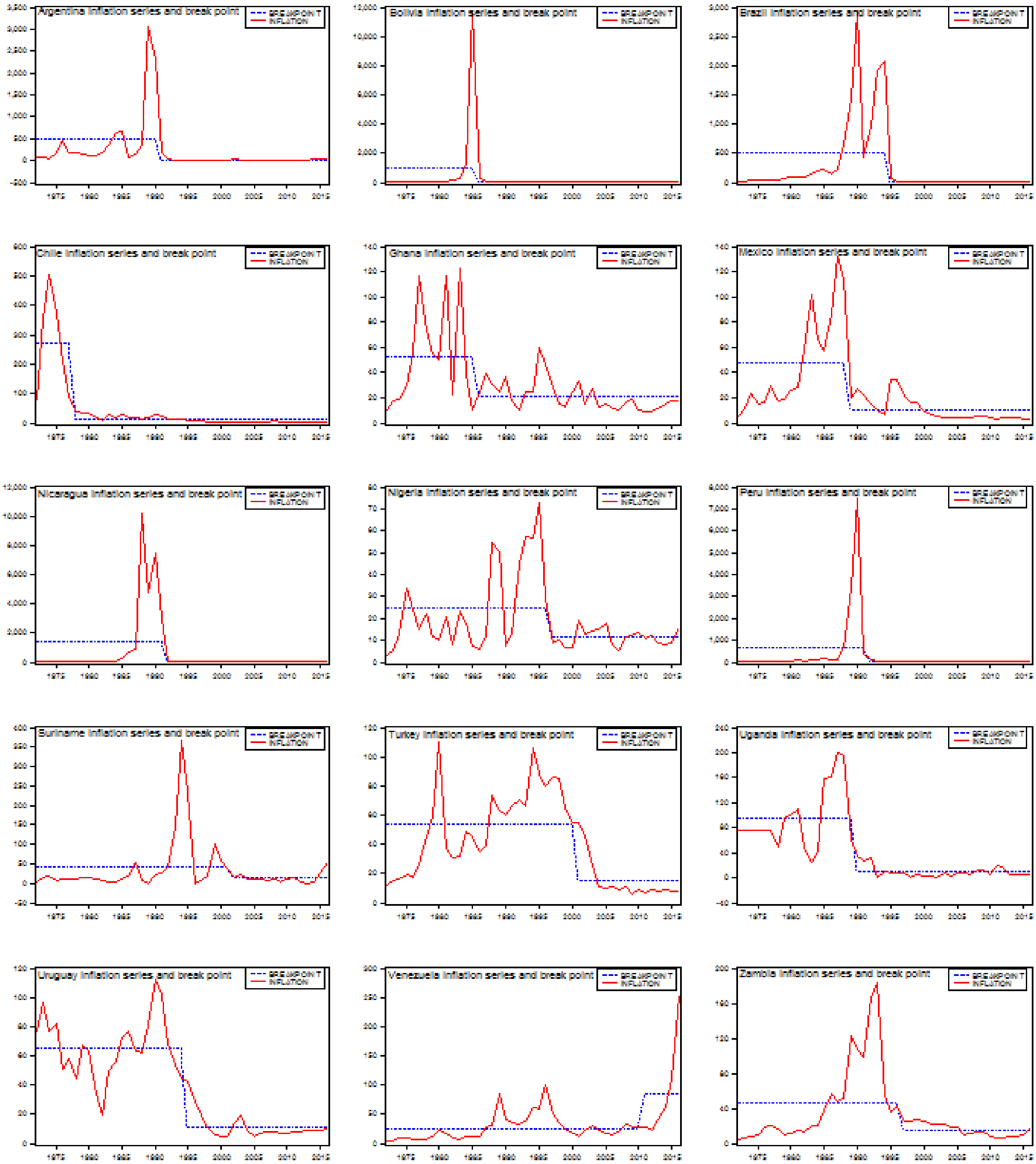
Appendix A

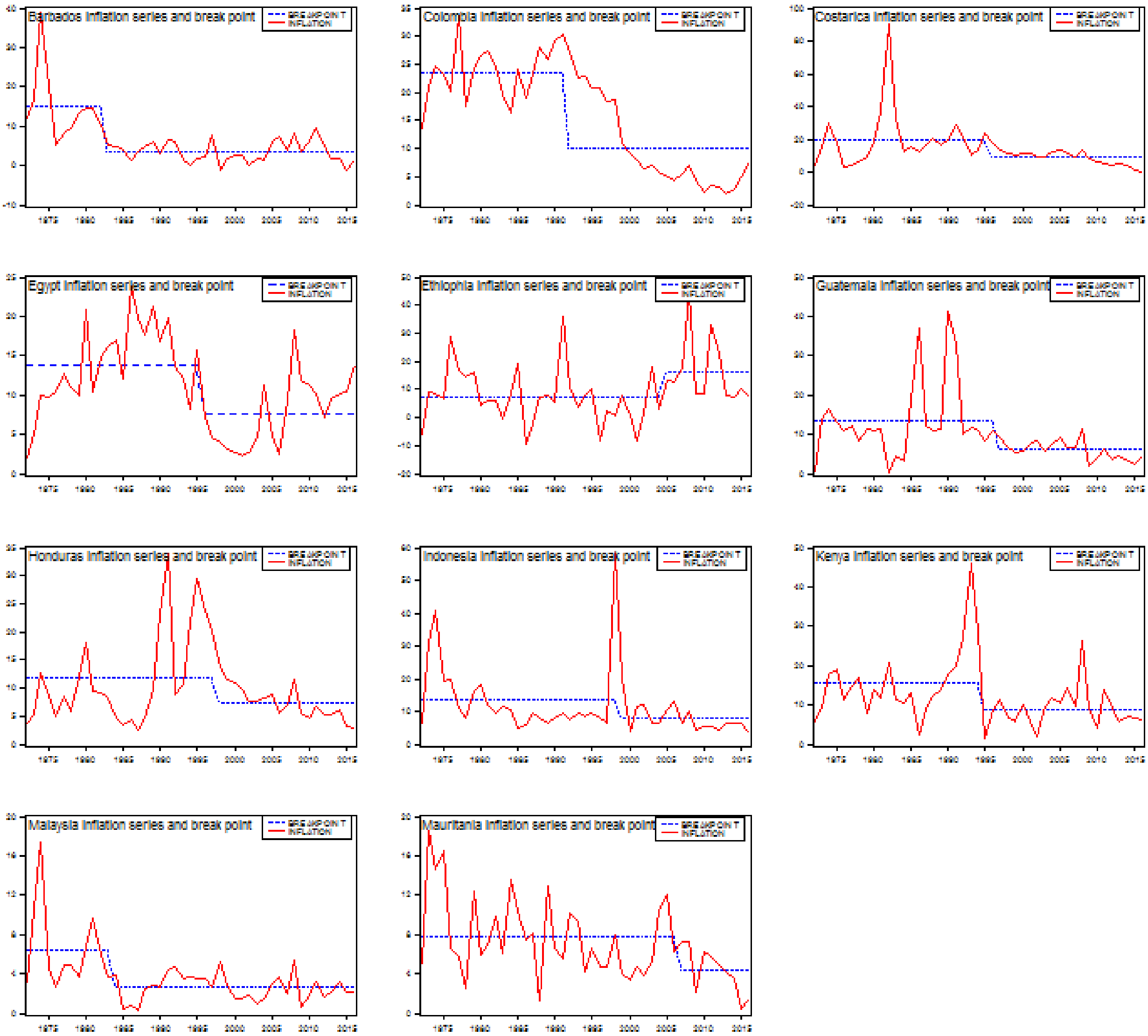
Appendix to Chapter 2

Table A.1: List of Countries

Moderate Inflation Countries	**High Inflation Countries**
Barbados	Argentina
Colombia	Bolivia
Egypt	Brazil
Ethiopia	Chile
Guatemala	Costarica
Honduras	Ghana
Indonesia	Mexico
Kenya	Nicaragua
Malaysia	peru
Mauritania	Suriname
Morocco	Turkey
Nepal	Uganda
Nigeria	Uruguay
Pakistan	Venezuela
Paraguay	Zambia
Philippines	
South Africa	
Sri Lanka	
Tanzania	
Thailand	
Trinidad and Tobago	
Tunisia	

Figure A.1: Diagram showing the breakpoint for the annual inflation rate

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Colombia inflation series and break point
Costarica inflation series and break point
Egypt inflation series and break point
Ethiophia inflation series and break point
Guatemala inflation series and break point
Honduras inflation series and break point
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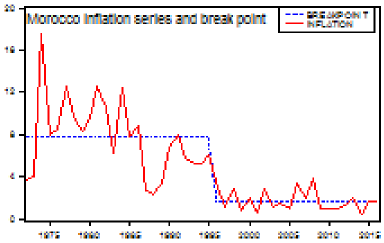
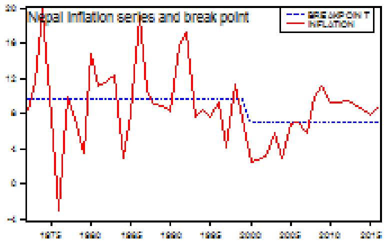
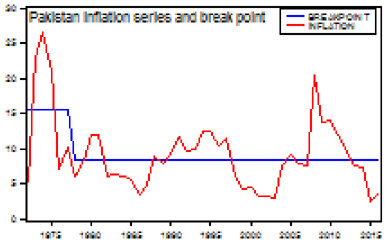
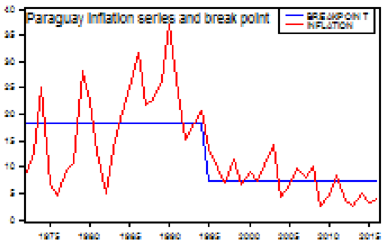
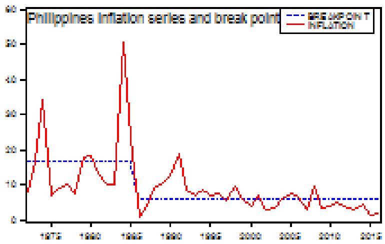
Malaysia inflation series and break point
Mauritania inflation series and break point

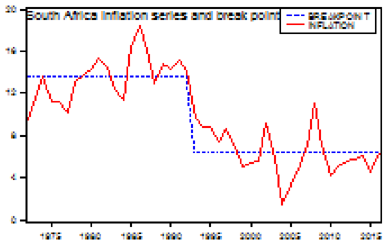

Morocco inflation series and break point

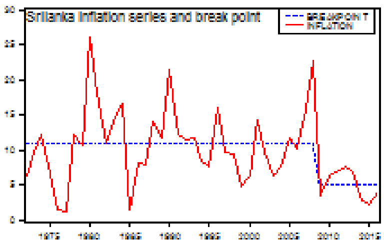

Nepal inflation series and break point

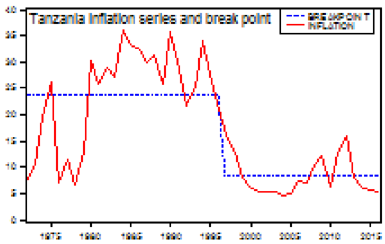

Pakistan inflation series and break point

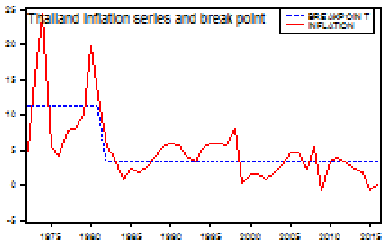

Paraguay inflation series and break point

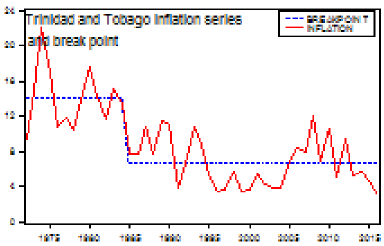

Philippines inflation series and break point


South Africa inflation series and break point


Srilanka inflation series and break point


Tanzania inflation series and break point


Trailand inflation series and break point


Trinidad and Tobago inflation series
and break point

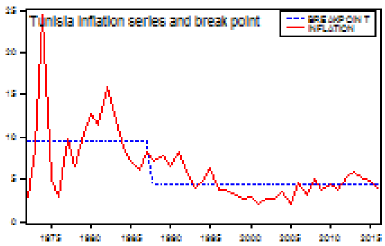

Tunisia inflation series and break point

Table A.2: Descriptive Statistic Chapter 2

Country	Inflation			CBI			Output Gap			Openness			Fiscal Deficit			Unemployment Rate		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Argentina	215.72	3079.81	-1.1668	0.6183	0.8025	0.4001	-0.0252	2.4449	-1.3693	22.7163	41.7527	11.5456	-2.9717	3.549	-12.7379	9.1493	22.450	2.0000
Barbados	6.2823	38.922	-1.2688	0.3975	0.4133	0.3859	-1.49E-13	0.1413	-0.1517	108.51	145.911	83.163	-4.4431	-0.062	-10.979	13.401	24.410	6.280
Bolivia	314.97	11749	0.9282	0.5442	0.7970	0.3023	7.58E-15	2.9428	-2.2734	56.7453	85.264	41.892	-4.2775	4.4698	-25.4	7.564	20.300	2.7000
Brazil	268.73	2947.4	3.1985	0.2174	0.2548	0.1496	4.33E-14	3.1661	-1.8417	20.613	29.678	14.390	-3.9727	0.5395	-16.061	6.5946	12.32	1.80
Chile	46.093	504.73	0.0717	0.6724	0.819	0.2572	-7E-14	0.9047	-1.5806	56.017	80.789	22.721	0.2836	7.9281	-15	9.60	21.00	3.30
Colombia	16.077	33.713	2.0227	0.5039	0.6932	0.2672	-0.0019	0.0901	-0.0831	33.083	38.668	23.672	-1.4369	0.8463	-5.333	9.6737	15.58	4.91
Costa Rica	14.759	90.122	-0.0041	0.6012	0.7342	0.474	-2.08E-13	0.1516	-0.221	73.581	92.489	53.980	-3.2900	0.31	-7.3953	6.2655	9.48	3.77
Egypt	10.932	23.864	2.1023	0.4927	0.5173	0.4875	-1.72E-13	0.1124	-0.1056	51.791	82.176	29.956	-9.139	1.7043	-49.866	8.8324	13.37	1.50
Ethiopia	9.3832	44.391	-9.8087	0.4144	0.4287	0.3995	0.0001	0.1885	-0.1908	33.507	50.579	15.198	-3.7377	-0.7889	-8.88	5.6417	8.2	5.0
Ghana	31.325	122.87	8.7268	0.3906	0.5606	0.3056	-6.44E-14	0.2501	-0.3452	58.479	116.04	6.3203	-5.9202	-1.324	-14.157	6.4753	10.40	3.60
Guatemala	10.082	41.221	0.3073	0.7165	0.7825	0.6835	0.0275	0.3284	-0.2746	47.727	69.544	24.932	-1.9067	0.7539	-7.1214	2.7055	4.10	3.60
Honduras	9.9739	33.972	2.4871	0.5073	0.671	0.3641	-1.57E-13	0.1350	-0.1478	90.707	136.489	48.789	-2.8945	2.893	-10.501	4.6542	8.10	2.90
Indonesia	11.470	58.387	3.5258	0.5708	0.9512	0.3171	-0.0018	0.1726	-0.1891	51.990	196.186	35.411	-2.136	0.962	-6.595	5.5580	11.24	1.3
Kenya	12.387	45.978	1.5543	0.4798	0.5373	0.4365	-1.01E-13	0.2089	-0.1106	57.290	74.573	37.929	-3.8826	0.256	-11.615	10.6784	12.20	8.10
Malaysia	3.6141	17.329	0.2900	0.42825	0.5765	0.3442	-1.2E-15	0.1087	-0.1650	146.80	220.40	73.668	-4.4859	3.702	-16.652	3.8124	8.30	2.45
Mauritania	7.0476	18.55	0.4845	0.4472	0.636	0.3933	-1.36E-13	0.1871	-0.2581	100.39	140.69	57.117	-2.5176	7.5917	-10.169	10.1393	10.50	9.40
Mexico	24.624	131.82	2.7206	0.5085	0.6382	0.3403	-0.0075	0.5400	-0.3127	41.588	78.145	16.513	-4.230	0.157	-14.196	4.1546	8.00	0.90
Morocco	4.9005	7.556	0.4354	0.2680	0.6518	0.1439	-2.28E-13	0.0872	-0.0843	59.231	85.6721	37.796	-4.8807	3.469	-17.729	12.265	17.30	8.91
Nepal	8.6436	19.806	-3.1132	0.3341	0.6442	0.1790	0.0209	0.2513	-0.1351	39.983	64.035	13.578	-3.2056	3.6540	-8.9768	3.0184	4.5	1.8
Nicaragua	616.57	10205	2.8090	0.5940	0.7217	0.454	8.26E-14	4.5908	-3.4418	84.752	115.17	39.081	-5.4888	4.2237	-31.297	10.272	17.1	5.19
Nigeria	18.773	72.835	3.457	0.4565	0.6262	0.3636	-1.66E-13	0.5221	-0.3083	48.848	81.812	21.124	-1.342	18.458	-15.368	6.3937	7.60	4.30
Pakistan	9.1926	26.663	2.5395	0.2806	0.3396	0.2234	-1.25E-13	0.1025	-1.1019	33.1962	38.909	24.515	-5.946	-0.148	-10.212	4.8188	8.27	1.70
Paraguay	13.036	37.259	2.591	0.4935	0.6171	0.3752	-3.67E-14	0.2449	-0.1777	76.962	124.47	25.828	1.7772	13.976	-2.4666	6.0808	10.80	3.30
Peru	293.17	7481.6	0.1931	0.6350	0.7977	0.4316	-6.69E-15	2.5766	-2.2395	38.894	58.433	22.536	-1.9771	3.2167	-8.9347	7.2311	9.90	4.00
Philippines	9.3983	50.339	0.7515	0.5327	0.634	0.4171	-5.27E-14	0.1297	-0.1209	68.127	108.25	39.149	-1.5607	0.6475	-4.9833	7.5517	11.83	3.20

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Table A.2 – *Continued*

Country	Inflation			CBI			Output Gap			Openness			Fiscal Deficit			Unemployment Rate		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
South Africa	9.7251	18.41	1.425	0.2968	0.3651	0.2186	-0.0004	0.0649	-0.0774	52.669	72.865	37.487	-3.3042	1.3992	-9.0302	21.644	28.11	9.24
Sri Lanka	9.8843	26.145	1.2248	0.5952	0.642	0.4295	-1.08E-13	0.1488	-0.1180	67.090	88.636	46.225	-8.1833	-4.3666	-22.204	8.1053	14.67	4.00
Suriname	32.801	368.47	-0.701	0.453	0.5138	0.4171	-2.5E-14	1.2389	-0.9536	89.760	148.53	42.655	-4.2194	5.687	-24.894	10.250	19.50	4.80
Tanzania	16.913	36.145	4.7358	0.4983	0.5872	0.4393	-1.73E-14	0.2697	-0.3139	46.230	66.401	22.108	-4.3460	2.333	-24.894	3.2451	5.1	2.00
Thailand	5.0064	24.313	-0.895	0.1839	0.3815	0.1345	-246E-13	0.1312	-0.1302	87.506	140.437	37.373	-1.1887	4.8436	-9.017	1.7795	5.8	0.40
Trinidad and Tobago	8.8074	22.024	3.0604	0.4374	0.4438	0.4313	-6.57E-14	0.3290	-0.2147	88.857	127.87	60.821	-1.3268	10.296	-12.692	11.444	22.10	3.30
Tunisia	6.2730	24.394	1.983	0.4406	0.6216	0.3146	-8.78E-14	0.0825	-0.0812	84.775	115.396	50.088	-3.7390	-0.65	-8.3463	15.088	18.89	12.40
Turkey	39.726	110.17	6.2509	0.6311	0.899	0.4678	0.0019	0.4419	-0.5294	36.078	54.970	9.0997	-3.6801	1.8612	-12.01	8.404	13.05	5.62
Uganda	43.242	200.026	-0.2875	0.4468	0.5418	0.3425	-1.83E-13	0.7086	-0.6340	34.857	56.258	16.951	-3.0993	0.444	-9.5625	2.4002	3.5	0.9
Uruguay	39.138	112.52	4.3593	0.3913	0.7117	0.1817	6.8E-15	0.3047	-0.4224	43.284	65.208	19.923	-2.2305	0.9296	-9.2514	10.1226	17.15	6.32
Venezuela	33.745	254.94	2.8212	0.5736	0.7870	0.2107	-1.2E-13	0.8782	-0.3786	49.502	60.127	30.716	-3.2318	7.94	-17.846	9.3811	16.80	5.00
Zambia	33.024	183.31	5.06	0.4218	0.494	0.3256	-3.94E-14	0.6940	-0.3929	73.868	92.130	56.121	-6.9609	20.159	-38.204	12.356	19.70	7.60
United State	3.6683	10.582	-0.3420															

This table presents summary statistics by country. The sample covers 1972-2016.

Table A.3: Pooled Least Square Estimation

Variable	Model 1			Model 2			Model 3			Model 4		
	Full	Moderate	High	Full	Moderate	High	Full	Moderate	High	Full	Moderate	High
CBI	-74.435	-2.2851	-207.47	-76.487	1.7901	-217.09	-70.972	-2.6262*	-233.564	-70.504	1.4598	-238.69
	(66.004)	(1.5396)	(158.87)	(70.071)	(1.5542)	(173.67)	(65.959)	(1.5422)	(158.60)	(70.061)	(1.5598)	(173.22)
Output Gap	404.06***	11.863***	463.70***	404.19***	6.5082***	463.87***	401.12***	11.231***	449.20***	401.09***	6.0512*	449.31***
	(31.927)	(3.3420)	(50.628)	(31.972)	(3.2760)	(50.680)	(31.927)	(3.3439)	(50.769)	(31.975)	(3.2779)	(50.827)
Openness	-0.3821	-0.0616***	-0.0338	-0.3844	-0.0558***	-0.0312	-0.4441	-0.0606***	-0.5040	-0.4436	-0.0551***	-0.5023
	(0.3913)	(0.0080)	(1.1812)	(0.3923)	(0.0077)	(1.1822)	(0.3921)	(0.0080)	(1.1918)	(0.3930)	(0.0077)	(1.1929)
FD	-17.904***	-0.0232	-38.224	-17.897***	-0.0226	-38.142***	-17.553***	-0.0282	-36.377***	-17.554***	-0.0268	-36.335***
	(2.7535)	(0.0616)	(6.5893)	(2.7558)	(0.0593)	(6.66211)	(2.7560)	(0.0615)	(6.6059)	(2.7580)	(0.0593)	(6.6358)
US Inflation				-0.5089	1.0817***	-1.9579				0.1155	1.0687***	-1.0488
				(5.8220)	(0.1238)	(14.220)				(5.8241)	(0.1238)	(14.170)
Unemployment							5.2871**	-0.1222**	19.096**	5.2898**	-0.1008**	19.081**
							(2.5614)	(0.0506)	(7.7018)	(2.5657)	(0.0488)	(7.7102)
Constant	58.493	14.916***	109.88	61.501	8.7777***	122.20	19.653	15.964***	1.6397	18.950	9.7156***	8.3240
	(41.360)	(0.9053)	(99.424)	(53.810)	(1.1199)	(133.82)	(45.402)	(1.0018)	(108.23)	(57.582)	(1.2068)	(141.02)
R^2	0.1002	0.0737	0.1347	0.1002	0.1420	0.1348	0.1026	0.0793	0.1427	0.1026	0.1458	0.1427
Adjusted R^2	0.0925	0.0698	0.1295	0.0975	0.1375	0.1282	0.0998	0.0745	0.1362	0.0993	0.1405	0.1349
No. of cross sections	37	22	15	37	22	15	37	22	15	37	22	15
No. of observations	1629	963	666	1629	963	666	1629	963	666	1629	963	666

Note: The table reports coefficients from pooled least square estimation. The dependent variable is inflation. The symbols *, **, 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 A.4: Fixed Effect Estimation

Variable	Model 1			Model 2			Model 3			Model 4		
	Full	Moderate	High	Full	Moderate	High	Full	Moderate	High	Full	Moderate	High
CBI	-385.73***	-19.028***	-655.22***	-451.65***	-13.293***	-807.16***	-416.16***	-18.767***	-712.76***	-470.08***	-13.130***	-842.26***
	(91.493)	(2.0086)	(200.63)	(101.11)	(2.1017)	(231.53)	(91.449)	(2.0152)	(200.54)	(100.83)	(2.1058)	(230.68)
Output Gap	416.46***	11.799***	475.32***	418.60***	7.6155***	476.96***	408.71***	11.252***	455.81***	410.67***	7.2180***	457.73***
	(31.234)	(2.9979)	(49.858)	(31.252)	(2.9698)	(49.846)	(31.167)	(3.0190)	(50.050)	(31.199)	(2.9883)	(50.068)
Openness	1.3581*	0.0269*	3.0901	1.3390*	0.0332**	3.1947	1.5965**	0.0254*	3.6743*	1.5751**	0.0319**	3.7494*
	(0.7404)	(0.0139)	(2.0322)	(0.7402)	(0.0135)	(2.0326)	(0.7398)	(0.0139)	(2.0313)	(0.7399)	(0.0136)	(2.0319)
FD	-20.327***	-0.1834***	-39.647***	-20.052**	-0.1893***	-38.667***	-19.887***	-0.1779***	-37.187***	-19.670***	-0.1850***	-36.406***
	(3.0504)	(0.0653)	(6.8144)	(3.0544)	(0.0635)	(6.8514)	(3.0395)	(0.0654)	(6.8312)	(3.0438)	(0.0636)	(6.8642)
US Inflation				-9.1009	0.8588***	-19.407				-7.5432	0.8526***	-16.732
				(5.9564)	(0.1161)	(14.786)				(5.9470)	(0.1162)	(14.741)
Unemployment							17.058***	-0.1441	28.054***	16.660***	-0.1127	27.327***
							(4.4589)	(0.0981)	(9.8070)	(4.4691)	(0.0955)	(9.8258)
Constant	92.115*	15.953***	172.26	158.81**	9.8311***	319.94*	-42.459	17.105***	-44.209	15.968	10.775***	88.727
	(53.776)	(1.0880)	(128.04)	(69.248)	(1.3434)	(170.40)	(64.067)	(1.3404)	(148.12)	(78.898)	(1.5636)	(188.80)
R^2	0.1195	0.1152	0.1553	0.1208	0.1640	0.1576	0.1275	0.1172	0.1659	0.1284	0.1653	0.1676
Adjusted R^2	0.0973	0.0916	0.1318	0.0981	0.1408	0.1328	0.1050	0.0927	0.1414	0.1053	0.1412	0.1418
No. of cross sections	37	22	15	37	22	15	37	22	15	37	22	15
No. of observations	1629	963	666	1629	963	666	1629	963	666	1629	963	666

Note: The table reports coefficients from fixed effect estimation. The dependent variable is inflation. The symbols *, **, 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.

Appendix B

Appendix to Chapter 3

Table B.1: VAR Lag Selection Criteria Model 1

Lags	**Full Sample**	**Group 1**	**Group 2**	**Group 3**
0	10.0227	9.36157	6.3628	10.0536
1	-11.6558	-13.8891	-13.7670	-11.0274
2	-12.3951*	-15.0995	-15.1868	-11.6374*
3	-12.3630	-15.1347*	-15.2080*	-11.5931
4	-12.3362	-15.0983	-15.1483	-11.5532

Note: The superscripts * indicate a lag order selected by Akaike information criterion (AIC).

Table B.2: Panel VAR Regression Model 1

	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.2973***	-0.0319***	0.1423***	0.0545***
	(0.0184)	(0.0087)	(0.0283)	(0.0111)
Exchange Rate (-2)	-0.3013***	0.0321***	-0.1457***	-0.0552***
	(0.0183)	(0.0087)	(0.0282)	(0.0111)
CBI (-1)	0.0139	0.9856***	-0.0175	-0.0066
	(0.0411)	(0.0194)	(0.0631)	(0.0248)
CBI (-2)	-0.0200	-0.0009	0.0189	0.0102
	(0.0410)	(0.0194)	(0.0630)	(0.0248)
Consumption (-1)	0.0166	0.0070	1.0087***	0.0191***
	(0.0126)	(0.0059)	(0.0194)	(0.0076)
Consumption (-2)	-0.0161	-0.0077	-0.0136	-0.0165***
	(0.0126)	(0.0060)	(0.0194)	(0.0076)
Investment (-1)	0.0718***	0.0239**	0.2697***	1.6565***
	(0.0225)	(0.0106)	(0.0346)	(0.0136)
Investment (-2)	-0.0714***	-0.0233**	-0.2648***	-0.6594***
	(0.0224)	(0.0106)	(0.0345)	(0.0136)
C	0.0130	0.0109***	0.0321***	0.0106**
	(0.0085)	(0.0040)	(0.0130)	(0.0051)

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 B.3: Panel VAR Regression Model 1 Group 3

	Exchange Rate	**CBI**	**Consumption**	**Investment**
Exchange Rate (-1)	1.2643***	-0.0430***	0.1472***	0.0721***
	(0.0243)	(0.0102)	(0.0278)	(0.0154)
Exchange Rate (-2)	-0.2719***	0.0428***	-0.1525***	-0.0736***
	(0.0242)	(0.0102)	(0.0277)	(0.0153)
CBI (-1)	0.0221	0.9839***	-0.0655	-0.0228
	(0.0607)	(0.0256)	(0.0695)	(0.0386)
CBI (-2)	-0.0509	-0.0045	0.0439	0.0219
	(0.0606)	(0.0256)	(0.0694)	(0.0385)
Consumption (-1)	0.0124	0.0084	1.1037***	0.0271*
	(0.0221)	(0.0093)	(0.0253)	(0.0140)
Consumption (-2)	-0.0165	-0.0095	-0.1113***	-0.0242*
	(0.0220)	(0.0093)	(0.0253)	(0.0140)
Investment (-1)	0.0386	0.0209*	0.1995***	1.6110***
	(0.0298)	(0.0125)	(0.0341)	(0.0189)
Investment (-2)	-0.0321	-0.0195	-0.1904***	-0.6138***
	(0.0298)	(0.0126)	(0.0342)	(0.0190)
C	0.0264**	0.0124***	0.0382***	0.0143*
	(0.0116)	(0.0049)	(0.0133)	(0.0074)

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 B.4: Splitting model 1

Country	**CBI**	**Money Suply**	**Inflation**	**Exchange Rate Arrangement**	**Capital Control**
Group 1					
Guatemala	0.7406	34.8759	13.0250	7.0000	0.0552
Morocco	0.3588	85.0877	4.2804	7.6154	0.7601
Paraguay	0.5799	32.9120	15.2093	10.2692	0.0865

Continued on next page

Table B.4 – *Continued*

Country	**CBI**	**Money Suply**	**Inflation**	**Exchange Rate Arrangement**	**Capital Control**
Thailand	0.2200	104.7696	5.3353	9.1923	0.7365
Malaysia	0.4902	124.0735	4.7260	7.8846	0.7931
Trinidad and Tobago	0.4420	48.2702	10.1755	3.8462	0.0000
Average Group 1	**0.4719**	**71.6648**	**8.7919**	**7.6346**	**0.4052**
Group 2					
Tunisia	0.5181	54.7790	6.9880	8.0000	1.0000
Uruguay	0.5445	44.2457	29.2257	10.0000	0.0250
Pakistan	0.3192	48.2686	14.2623	7.3462	0.7228
Philippines	0.6173	57.2600	9.5637	9.1154	0.8404
Egypt	0.4901	83.8688	14.9066	5.8846	0.1504
Average Group 2	**0.4978**	**57.6844**	**14.9893**	**8.0692**	**0.5477**
Group 3					
Mexico	0.6194	35.8761	15.6881	11.0769	0.5751
Honduras	0.6002	45.5186	17.9976	6.5769	0.0000
Mauritania	0.4867	92.3699	9.6362	8.0769	0.0000
Suriname	0.4618	50.0210	50.9858	6.7692	0.0000
Argentina	0.7631	24.9493	20.2267	5.9231	0.5091
Ghana	0.4528	26.8950	30.4840	10.0000	0.5816
Kenya	0.5116	37.8868	19.4738	8.9231	0.3256
South Africa	0.3389	62.6375	11.3456	12.4615	0.6143
Turkey	0.7332	40.1662	51.4683	12.4615	0.3772
Zambia	0.4616	18.4128	44.6631	11.8462	0.0000
Bolivia	0.7067	59.0471	11.0994	6.0000	0.1633
Ethiopia	0.4254	35.8363	16.3077	7.9615	0.7572
Nicaragua	0.6964	29.4110	83.0620	4.7692	0.1400
Venezuela	0.6974	28.3389	48.5877	7.3846	0.3234
Indonesia	0.7562	42.9868	15.9173	9.2692	0.6080
Average Group 3	**0.5807**	**42.0236**	**29.7962**	**8.6333**	**0.4523**

The numbers show the annual averages.
ER arrangement measures Reinhart and Rogoff (2004).
Capital control is based on Fernández et al. (2016).

Table B.5: VAR Lag Selection Criteria Model 2

Lags	Full Sample	Group 1	Group 2
0	12.0300	7.44884	12.5722
1	-9.85824	-10.8295	-9.57338
2	-10.9320*	-11.8846*	-10.5715*
3	-10.8918	-11.8527	-10.5140
4	-10.8485	-11.8383	-10.4524

Note: The superscripts * indicate a lag order selected by Akaike information criterion (AIC).

Table B.6: Panel VAR Regression Model 2

	Stock Index	CBI	Consumption	Investment
Stock Index (-1)	1.0750***	-0.0010	0.0304	0.0285***
	(0.0262)	(0.0049)	(0.0198)	(0.0039)
Stock Index (-2)	-0.0792***	0.0010	-0.0318	-0.0291***
	(0.0261)	(0.0049)	(0.0197)	(0.0039)
CBI (-1)	0.3088**	0.9856***	-0.0781	-0.0134
	(0.1375)	(0.0261)	(0.1041)	(0.0206)
CBI (-2)	-0.3017**	0.0007	0.0895	0.0184
	(0.1372)	(0.0260)	(0.1039)	(0.0205)
Consumption (-1)	0.0089	-0.0004	0.9607***	0.0038
	(0.0345)	(0.0065)	(0.0261)	(0.0051)
Consumption (-2)	-0.0049	0.000003	0.0317	-0.0028
	(0.0346)	(0.0065)	(0.0262)	(0.0051)
Investment (-1)	0.3759***	0.0354*	0.5467***	1.7960***
	(0.0998)	(0.0189)	(0.0755)	(0.0149)
Investment (-2)	-0.3807***	-0.0347*	-0.5406***	-0.7973***
	(0.0994)	(0.0188)	(0.0752)	(0.0149)
C	0.0514**	0.0049	0.0398**	0.0109***
	(0.0250)	(0.0047)	(0.0189)	(0.0037)

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 B.7: Panel VAR Regression Model 2 Group 2

	Stock Index	CBI	Consumption	Investment
Stock Index (-1)	1.0586***	0.0060	0.0332	0.0311***
	(0.0327)	(0.0057)	(0.0230)	(0.0050)
Stock Index (-2)	-0.0617*	-0.0060	-0.0345	-0.0315***
	(0.0327)	(0.0057)	(0.0230)	(0.0050)
CBI (-1)	0.5793***	0.9882***	0.0229	0.0034
	(0.1851)	(0.0325)	(0.1301)	(0.0286)
CBI (-2)	-0.5559***	-0.0007	-0.0136	0.0051
	(0.1849)	(0.0325)	(0.1301)	(0.0286)
Consumption (-1)	0.0036	-0.0003	0.9187***	0.0044
	(0.0463)	(0.0081)	(0.0326)	(0.0071)
Consumption (-2)	0.0094	-0.0013	0.0758**	-0.0025
	(0.0465)	(0.0081)	(0.0327)	(0.0072)
Investment (-1)	0.3609***	0.0375*	0.6388***	1.7831***
	(0.1267)	(0.0222)	(0.0891)	(0.0196)
Investment (-2)	-0.3756***	-0.0353	-0.6352***	-0.7856***
	(0.1257)	(0.0221)	(0.0884)	(0.0194)
C	0.0504*	0.0006	0.0441**	0.0148
	(0.0300)	(0.0052)	(0.0211)	(0.00466)

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 B.8: Splitting model 2

Country	CBI	Inflation	Output Gap	Financial Capitalisation
Group 1				
Argentina	0.7631	20.2267	0.0011	15.2739
Kenya	0.5116	19.4738	-0.0005	17.2406
Morocco	0.3588	4.2804	-0.00002	14.8515
Nigeria	0.5227	28.8826	0.0016	15.6352
Sri Lanka	0.5928	14.9950	0.0002	14.1710
Tunisia	0.5181	6.9880	0.0007	12.9304
Average Group 1	**0.5445**	**15.8078**	**0.0005**	**15.0171**
Group 2				

Continued on next page

Table B.8 – *Continued*

Country	**CBI**	**Inflation**	**Output Gap**	**Financial Capitalisation**
Costa Rica	0.6942	17.7427	-0.0003	3.9304
Egypt	0.4901	14.9066	-0.0003	17.1568
Indonesia	0.7562	15.9173	0.0004	27.3820
Malaysia	0.4902	4.7260	0.0008	157.3900
Pakistan	0.3192	14.2623	0.00003	20.7483
Philippines	0.6173	9.5637	-0.0005	46.0461
South Africa	0.3389	11.3456	-0.0009	197.0858
Thailand	0.2200	5.3353	0.0007	64.2979
Turkey	0.7332	51.4683	-0.0003	23.2546
Venezuela	0.6974	48.5877	0.0015	3.5288
Average Group 2	**0.5357**	**19.3855**	**0.0001**	**56.0821**

The numbers show the annual averages.

Table B.9: VAR Lag Selection Criteria Model 3

Lags	**Full Sample**	**Group 1**	**Group 2**	**Group 3**
0	13.7970	13.9800	11.0798	10.8511
1	-4.09068	-3.3574*	-6.4892	-7.1257*
2	-4.55164*	-3.3158	-7.3620*	-6.7603
3	-4.54896	-3.1967	-7.3267	-6.6518
4	-4.50541	-3.0854	-7.2718	-5.6647

Note: The superscripts * indicate a lag order selected by Akaike information criterion (AIC).

Table B.10: Panel VAR Regression Model 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	1.1420***	0.0001	0.0013**	0.0007***
	(0.0220)	(0.0001)	(0.0006)	(0.0002)
Bond Yield (-2)	-0.2626***	0.000003	-0.00005	-0.0003*
	(0.0209)	(0.0001)	(0.0006)	(0.0001)
CBI (-1)	-4.0549	0.9775***	-0.0306	0.0024

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Table B.10 – *Continued*

	Bond Yield	**CBI**	**Consumption**	**Investment**
	(3.4448)	(0.0231)	(0.0990)	(0.0320)
CBI (-2)	3.2389	0.0052	0.0401	0.0006
	(3.4350)	(0.0230)	(0.0987)	(0.0319)
Consumption (-1)	1.5305*	0.0027	0.9674***	0.0108
	(0.8071)	(0.0054)	(0.0232)	(0.0075)
Consumption (-2)	-1.4945*	-0.0032	0.0283	-0.0074
	(0.8103)	(0.0054)	(0.0232)	(0.0075)
Investment (-1)	14.6112***	0.0016	0.1162**	1.6074***
	(2.0130)	(0.0135)	(0.0578)	(0.0187)
Investment (-2)	-14.7588***	-0.0011	-0.1124*	-0.6109***
	(2.0052)	(0.0134)	(0.0576)	(0.0186)
C	2.4883***	0.0077**	0.0184	0.0054
	(0.5126)	(0.0034)	(0.0147)	(0.0047)

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 B.11: Panel VAR Regression Model 3 Group 3

	Bond Yield	**CBI**	**Consumption**	**Investment**
Bond Yield (-1)	0.7793***	0.00009	0.0004	0.00005
	(0.0157)	(0.0001)	(0.0002)	(0.0001)
CBI (-1)	-13.5355***	0.8839***	-0.0636**	-0.0309**
	(1.9238)	(0.0163)	(0.0323)	(0.0146)
Consumption (-1)	-0.5061*	-0.0102***	0.9956***	0.0091***
	(0.2770)	(0.0023)	(0.0046)	(0.0021)
Investment (-1)	0.2024	0.0073***	0.0041	0.9900***
	(0.2826)	(0.0024)	(0.0047)	(0.0021)
C	14.7393***	0.1155***	0.0723**	0.0557***
	(2.0385)	(0.0172)	(0.0342)	(0.0155)

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 B.12: Splitting model 3

Country	CBI	Inflation	Bond Yield	Sovereign Risk
Group 1				
Ghana	0.4528	30.4840	24.5796	16
Malaysia	0.4902	4.7260	4.0348	7
Nigeria	0.5227	28.8826	12.3383	14
South Africa	0.3389	11.3456	11.0737	12
Sri Lanka	0.5928	14.9950	12.6552	14
Thailand	0.2200	5.3353	6.0113	8
Zambia	0.4616	44.6631	30.0672	14
Average Group 1	**0.4399**	**20.0617**	**14.3943**	**12**
Group 2				
Barbados	0.4060	5.6292	4.7344	10
Egypt	0.4901	14.9066	9.9767	14
Mexico	0.6194	15.6881	13.5055	9
Nepal	0.4474	13.0049	7.7663	-
Pakistan	0.3192	14.2623	7.9314	16
Trinidad	0.4420	10.1755	5.8443	6
Average Group 2	**0.4540**	**12.2778**	**8.2931**	**11**
Group 3				
Bolivia	0.7067	11.0994	8.7977	11
Kenya	0.5116	19.4738	13.7345	14
Philippines	0.6173	9.5637	8.2210	11
Tanzania	0.5414	20.7101	14.7451	-
Uganda	0.5232	11.8785	13.4943	14
Uruguay	0.5445	29.2257	19.0844	11
Average Group 3	**0.5741**	**16.9919**	**13.0129**	**12**

The numbers show the annual averages.
Sovereign risk is S & P rating, the numerical scale based on Canuto et al. (2012).
Nepal and Tanzania are not rated by any of the seven rating agencies.

Table B.13: VAR Lag Selection Criteria Model 4

Lags	Full Sample

Continued on next page

Table B.13 – *Continued*

Lags	**Full Sample**
0	14.6475
1	-12.0524
2	-12.9647*
3	-12.7044
4	-12.4681

Note: The superscripts * indicate a lag order selected by Akaike information criterion (AIC).

Table B.14: Panel VAR Regression Model 4

	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 B.15: Splitting model 4

Country	**CBI**	**Inflation**	**Exchange Rate Arrangement**	**Capital Control**	**Financial Capitalisation**	**Sovereign Risk**
Egypt	0.4901	14.9066	5.8846	0.1504	17.1568	14
Kenya	0.5116	19.4738	8.9231	0.3256	17.2406	14
Malaysia	0.4902	4.7260	7.8846	0.7931	157.3900	7
Pakistan	0.3192	14.2623	7.3462	0.7228	20.7483	16
Philippines	0.6173	9.5637	9.1154	0.8404	46.0461	11
South Africa	0.3389	11.3456	12.4615	0.6143	197.0858	12
Thailand	0.2200	5.3530	9.1923	0.7365	64.2979	8

The numbers show the annual averages.
ER arrangement measures Reinhart and Rogoff (2004)
Capital control is based on Fernández et al. (2016)
Sovereign risk is S & P rating, the numerical scale based on Canuto et al. (2012)

Appendix C

Appendix to Chapter 4

C.1. Eviews Code for State Space Model Specification for Macroprudential Policy Index

```
@signal   CG = sv1 + [VAR=1]
@signal   CONC = sv1 + [VAR=1]
@signal   CTC = sv1 + [VAR=1]
@signal   DTI = sv1 + [VAR=1]
@signal   DP = sv1 + [VAR=1]
@signal   FC = sv1 + [VAR=1]
@signal   INTER = sv1 + [VAR=1]
@signal   LEV = sv1 + [VAR=1]
@signal   LTV = sv1 + [VAR=1]
@signal   RR = sv1 + [VAR=1]
@signal   SIFI = sv1 + [VAR=1]
@signal   TAX = sv1 + [VAR=1]
@state   sv1 = sv1(-1) + [VAR=0.1]
```

C.2. Eviews Code for Panel Nonlinear Threshold Model

```
lcre = c(1)+ cbi*(c(2)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+
c(5)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ mapp* (c(6)*
(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(7)* (1-(1/(1+exp(-
(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ inf*( c(8)* (1/(1+exp(-(c(3))*(cbi-
(1/(1+exp(-c(4))))))))+  c(9)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-
c(4))))))))))+ grow*( c(10)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+
c(11)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ ir*( c(12)*
(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(13)*(1-(1/(1+exp(-
(c(3))*(cbi-(exp(1/(1+exp(-c(4)))))))))))+ ler*(c(14)*(1/(1+exp(-(c(3))*(cbi-
(1/(1+exp(-c(4))))))))+ c(15)* (1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-
```

c(4))))))))))

C.3. Eviews Code for Poolability Test using Dummy Variable

lcre = c(1)+ cbi*(c(2)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(5)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ (cbi*(c(6)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(7)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4)))))))))))*dummy + mapp* (c(8)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(9)* (1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ (mapp* (c(10)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(11)* (1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))) *dummy + inf*(c(12)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(13)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+ (inf*(c(14)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(15)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))) *dummy + grow*(c(16)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(17)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+(grow*(c(18)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(19)*(1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))) *dummy + ir*(c(20)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(21)*(1-(1/(1+exp(-(c(3))*(cbi-(exp(1/(1+exp(-c(4)))))))))))+ (ir*(c(22)* (1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(23)*(1-(1/(1+exp(-(c(3))*(cbi-(exp(1/(1+exp(-c(4)))))))))))) *dummy + ler*(c(24)*(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(25)* (1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))+(ler*(c(26)*(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))+ c(27)* (1-(1/(1+exp(-(c(3))*(cbi-(1/(1+exp(-c(4))))))))))) *dummy

Table C.1: Splitting for Poolable and Not Poolable groups

Country	CBI	Inflation	MAPP	Credit per GDP	Interest Rate	Exchange Rate Clasification	Economic Growth	Financial dev. Index
Group 1								
Argentina	0.7823	18.4017	0.3981	13.8349	14.5278	7	2.1625	0.3267
Bhutan	0.4294	4.2406	0.1574	30.5311	5.2222	2	7.6118	0.1724
Djibouti	0.6783	2.9260	0.0093	27.6703	11.3889	2	4.4064	0.1601
Dominican Rep	0.6457	8.1637	0.1806	24.0134	8.9750	7	4.8922	0.1444
Kenya	0.5266	8.9179	0.0509	27.8385	10.0972	8	4.2965	0.1588
Maldives	0.4233	3.5510	0.1667	32.8926	5.5278	3	5.5856	0.1574
Nicaragua	0.7081	6.8743	0.0093	26.0048	3.2917	5	3.9681	0.1255
Rwanda	0.7037	6.5650	0.0926	14.5515	9.4028	7	7.6168	0.0855
Average Group 1	**0.6122**	**7.4550**	**0.1331**	**24.6671**	**8.5542**	**5**	**5.07**	**0.17**
Group 2								
Algeria	0.4025	3.9288	0.1620	14.4966	4.3056	8	3.5816	0.1447
Azerbaijan	0.5006	6.3088	0.1991	16.3535	7.6111	6	9.7058	0.1443
Belarus	0.5399	24.1194	0.1250	19.6805	26.0278	9	4.8097	0.1503
Croatia	0.8272	2.1834	0.1667	57.6343	5.9444	4	2.7823	0.3633
Egypt	0.4886	9.2277	0.0185	40.3755	10.6250	7	4.5339	0.3133
Indonesia	0.8589	6.7154	0.1157	26.3150	8.7222	10	5.3455	0.3210
Kazakhstan	0.5367	8.2000	0.1204	33.6461	8.8472	8	6.7278	0.2984
Nepal	0.5926	6.3667	0.2176	47.2166	6.7222	8	4.1771	0.1788
Sierra Leone	0.7082	7.2668	0.0556	4.6299	19.5972	8	5.7779	0.0702
South Africa	0.3560	5.2407	0.0556	68.4232	7.9306	12	2.8261	0.5418
Sri Lanka	0.6022	8.0789	0.1019	33.5834	13.4167	7	5.4997	0.2664
Tanzania	0.5690	7.0941	0.0833	10.5522	16.0972	8	7.0288	0.1097
Average Group 2	**0.5819**	**7.8942**	**0.1184**	**31.0756**	**11.3206**	**8**	**5.23**	**0.21**

1. The numbers show the annual averages; 2. Exchange Rate regime categories are based on Reinhart and Rogoff (2004).

C.4. Regression Estimation for Linear Model

Dependent Variable: LCRE
Method: Least Squares
Date: 07/12/19 Time: 13:53
Sample: 1 1440
Included observations: 1440

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CBI	0.575130	0.163008	3.528221	0.0004
MAPP	0.573482	0.200449	2.860981	0.0043
INF	-0.027428	0.002715	-10.10282	0.0000
LER	-0.068984	0.010332	-6.676571	0.0000
C	3.150884	0.094847	33.22058	0.0000

R-squared	0.087443	Mean dependent var	3.083008
Adjusted R-squared	0.084899	S.D. dependent var	0.932968
S.E. of regression	0.892486	Akaike info criterion	2.613854
Sum squared resid	1143.022	Schwarz criterion	2.632161
Log likelihood	-1876.975	Hannan-Quinn criter.	2.620688
F-statistic	34.37598	Durbin-Watson stat	0.209703
Prob(F-statistic)	0.000000		

C.5. Regression Estimation for Non-linear Model

Dependent Variable: LCRE
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/11/19 Time: 13:00
Sample: 1 1440
Included observations: 1440
Estimation settings: tol= 0.00100, derivs=numeric
Initial Values: C(1)=3.79242, C(2)=0.30165, C(3)=5.75328, C(4)=0.20000,
C(5)=11.5738, C(6)=-0.14430, C(7)=-8.40336, C(8)=-0.00616,
C(9)=0.86717, C(10)=-0.02376, C(11)=-0.68955, C(12)=-0.03406,
C(13)=-3.83007, C(14)=-0.09350, C(15)=1.48956
Convergence achieved after 154 iterations
Coefficient covariance computed using outer product of gradients
LCRE = C(1)+ CBI*(C(2)* (1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4))))))))+
C(5)*(1-(1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4)))))))))))+ MAPP* (C(6)*
(1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4))))))))+ C(7)* (1-(1/(1+EXP(
-(C(3))*(CBI-(1/(1+EXP(-C(4)))))))))))+ INF*(C(8)* (1/(1+EXP(-(C(3))
(CBI-(1/(1+EXP(-C(4))))))))+ C(9)(1-(1/(1+EXP(-(C(3))*(CBI-(1/(1
+EXP(-C(4)))))))))))+ GROW*(C(10)* (1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(
-C(4))))))))+ C(11)*(1-(1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4)))))))))))+
IR*(C(12)* (1/(1+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4))))))))+ C(13)*(1-(1
/(1+EXP(-(C(3))*(CBI-(EXP(1/(1+EXP(-C(4))))))))))))+ LER*(C(14)*(1/(1
+EXP(-(C(3))*(CBI-(1/(1+EXP(-C(4))))))))+ C(15)* (1-(1/(1+EXP(-(C(3))
*(CBI-(1/(1+EXP(-C(4))))))))))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	5.305561	0.633213	8.378800	0.0000
C(2)	-1.629204	0.815127	-1.998711	0.0458
C(3)	8.592432	1.039349	8.267127	0.0000
C(4)	-1.901436	0.289542	-6.567038	0.0000
C(5)	-15.08247	11.31725	-1.332698	0.1828
C(6)	-0.148028	0.231026	-0.640742	0.5218
C(7)	-7.805790	5.406879	-1.443678	0.1490
C(8)	-0.001303	0.004777	-0.272855	0.7850
C(9)	0.436567	0.110855	3.938196	0.0001
C(10)	-0.029995	0.007578	-3.958307	0.0001
C(11)	-0.297533	0.127189	-2.339306	0.0195
C(12)	0.458124	0.103313	4.434307	0.0000
C(13)	-0.514597	0.102051	-5.042549	0.0000
C(14)	-0.084350	0.010869	-7.760620	0.0000
C(15)	0.766322	0.312795	2.449913	0.0144

R-squared	0.315994	Mean dependent var	3.083008
Adjusted R-squared	0.309274	S.D. dependent var	0.932968
S.E. of regression	0.775389	Akaike info criterion	2.339458
Sum squared resid	856.7502	Schwarz criterion	2.394379
Log likelihood	-1669.410	Hannan-Quinn criter.	2.359960
F-statistic	47.02257	Durbin-Watson stat	0.247138
Prob(F-statistic)	0.000000		

Table C.2: Descriptive Statistic Chapter 4

Country	CBI			Ln Credit per GDP			MaPP			Inflation			Growth			Interest Rate			Ln Exchange Rate		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Algeria	0.4025	0.4525	0.3625	2.5885	3.1924	1.7075	0.1620	0.2500	0.0833	3.8885	9.1117	-1.3344	3.5816	7.2019	1.6322	4.3056	6.0	3.5	4.3742	4.7443	4.1070
Argentina	0.7823	0.8026	0.7602	2.6137	3.1733	2.2514	0.3981	0.4167	0.2513	17.7639	42.8000	-1.1752	2.1625	16.2442	-16.3391	14.5278	41.3	2.0	1.3977	2.9232	-0.000
Azerbaijan	0.5006	0.5715	0.2524	2.6049	3.6485	1.3114	0.1991	0.3333	0.0013	6.3059	21.6616	-0.8906	9.7058	34.5000	-3.1000	7.6111	15.0	2.0	-0.0570	0.5714	-0.243
Belarus	0.5399	0.7487	0.3729	2.0831	3.7098	-7.1115	0.1250	0.2500	0.0833	24.3915	118.5881	4.8033	4.8097	11.4497	-3.8296	26.0278	80.0	10.0	-0.9435	0.6998	-3.135
Bhutan	0.4294	0.5426	0.3389	3.2275	3.9196	2.1292	0.1574	0.4167	0.0833	4.3681	10.9200	-18.1100	7.6118	17.9258	2.1425	5.2222	8.3	2.0	3.9210	4.2188	3.6741
Croatia	0.8272	0.8940	0.4423	4.0200	4.2501	3.4700	0.1667	0.3333	0.0833	2.1818	6.4824	-1.7357	2.7823	20.3853	-8.6143	5.9444	9.0	2.5	1.8215	2.1659	1.5247
Djibouti	0.6783	0.6984	0.6260	3.3040	3.5316	2.9995	0.0093	0.0833	0.0000	2.9269	13.5275	-2.3456	4.4064	9.6838	0.7000	11.3889	12.8	10.3	5.1806	5.1953	5.1759
Dominican Rep	0.6457	0.6482	0.6250	3.1620	3.4783	2.8887	0.1806	0.2500	0.0000	8.1647	48.7540	-1.0945	4.8922	9.4282	-2.9277	8.9750	24.3	4.0	3.5043	3.8774	2.7757
Egypt	0.4886	0.4926	0.4875	3.6708	4.0061	3.2429	0.0185	0.1666	0.0000	9.2208	27.8813	2.1425	4.5339	16.7676	-4.3338	10.6250	19.3	8.5	1.8285	2.8973	1.2276
Indonesia	0.8589	0.9040	0.8460	3.2443	3.4999	2.8990	0.1157	0.3333	0.0000	6.7158	16.3669	-0.5957	5.3455	7.9564	1.5616	8.7222	17.5	4.3	9.2218	9.5927	8.9346
Kazakhstan	0.5367	0.5699	0.3709	3.4146	4.0765	2.1395	0.1204	0.2498	0.0833	8.2124	18.3646	3.9907	6.7278	13.5000	1.1000	8.8472	16.0	5.5	5.0853	5.8395	4.7765
Kenya	0.5266	0.5374	0.5096	3.3154	3.5319	3.1253	0.0509	0.0833	0.0000	8.9188	25.5861	1.2034	4.2965	8.3308	0.2426	10.0972	20.0	2.0	4.4028	4.6567	4.1380
Maldives	0.4233	0.4282	0.4157	3.4140	4.0208	2.8063	0.1667	0.3333	0.0000	3.5872	16.0627	-3.2319	5.5856	26.1115	-13.1291	5.5278	7.0	3.0	2.6116	2.7350	2.4656
Nepal	0.5926	0.6443	0.1791	3.7556	4.3944	3.1139	0.2176	0.3333	0.1667	6.2078	12.6441	0.0000	4.1771	7.4994	0.1203	6.7222	8.0	5.5	4.3949	4.6821	4.1518
Nicaragua	0.7081	0.7218	0.6910	3.2124	3.6637	2.6153	0.0093	0.0833	0.0000	6.8746	21.0592	-0.0083	3.9681	6.4961	-3.2927	3.2917	8.8	1.3	2.9902	3.4272	2.5256
Rwanda	0.7037	0.7625	0.6662	2.6246	3.0380	2.2963	0.0926	0.3320	0.0000	6.5651	20.0411	-4.8583	7.6168	13.1921	2.2024	9.4028	14.5	5.5	6.3732	6.7373	5.9029
Sierra Leone	0.7082	0.7247	0.6977	1.4138	2.0991	0.4203	0.0556	0.1667	0.0000	7.3231	17.8719	-3.2900	5.7779	26.4173	-20.5988	19.5972	26.3	9.5	8.1547	8.9276	7.4186
South Africa	0.3560	0.3652	0.3487	4.2229	4.3605	4.0259	0.0787	0.2500	0.0000	5.2405	12.7244	-1.7771	2.8261	5.6037	-1.5381	7.9306	13.5	5.0	2.1564	2.7437	1.7281
Sri Lanka	0.6022	0.6055	0.5755	3.4968	3.8190	3.2365	0.1019	0.2487	0.0833	8.0782	23.5354	1.0430	5.4997	8.5673	-1.5454	13.4167	25.0	6.0	4.7228	5.0338	4.2996
Tanzania	0.5690	0.5872	0.5326	2.2712	2.7100	1.4080	0.0833	0.4167	0.0000	7.0947	17.6947	2.2471	7.0288	11.2141	2.9244	16.0972	21.5	14.0	7.2004	7.7132	6.6835

This table presents summary statistics by country. The sample covers 2000 Q1-2017 Q4.

Figure C.1: CBI and LN Credit per GDP

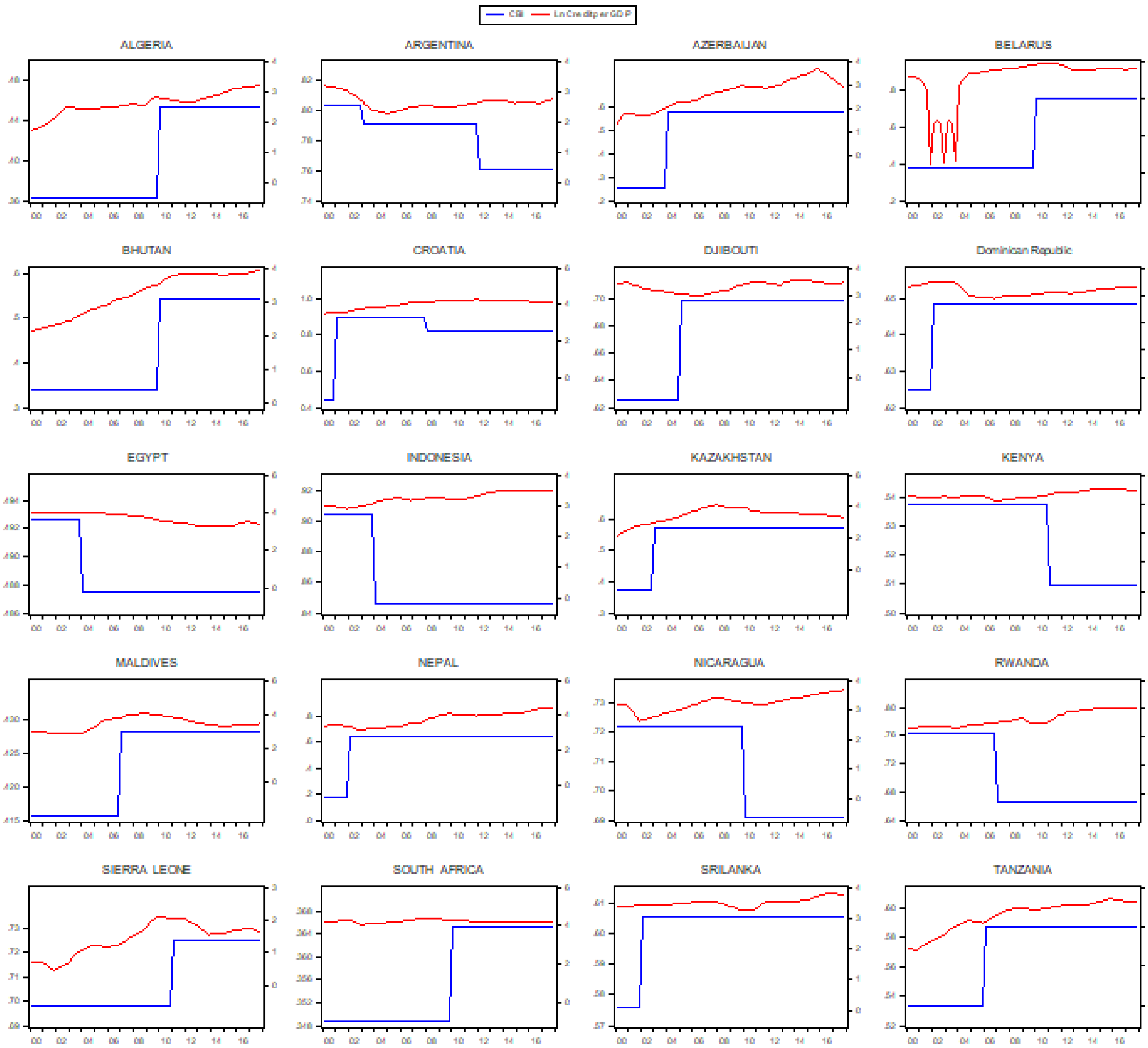

Figure C.2: Macroprudential Policy Index per Country

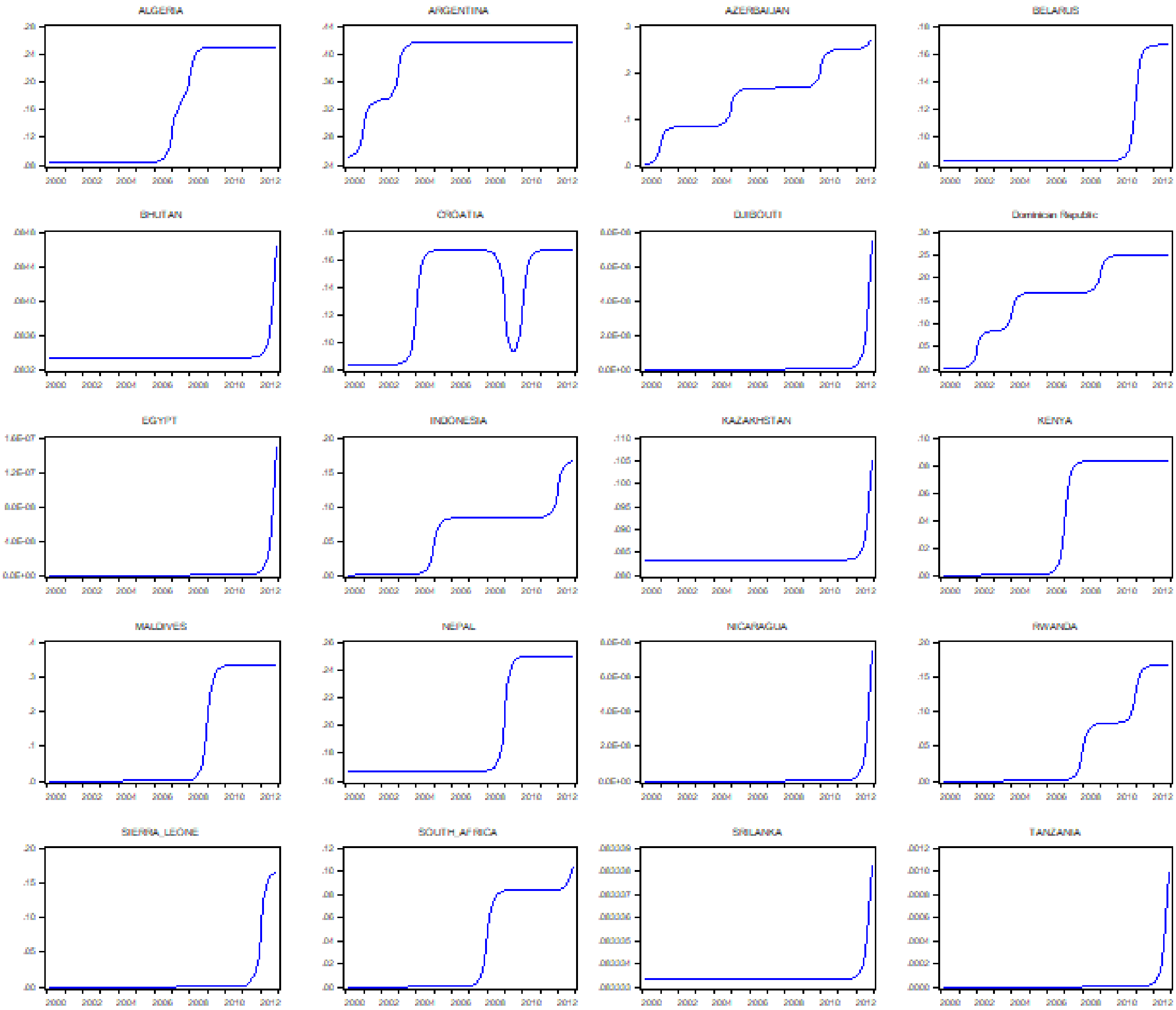

Table C.3: Estimation Result of Non Linear Model

Variable	**High Regime**	**Low Regime**
CBI	-1.6292	-15.082
	(-1.9987)**	(-1.3326)
MaPP	-0.1480	-7.8057
	(-0.6407)	(-1.4436)
Inflation	-0.0013	0.4365

Continued on next page

Table C.3 – *Continued*

Variable	β_0	β_1
	(-0.272855)	(3.9381)**
Growth	-0.0299	-0.2975
	(-3.9583)***	(-2.3393)**
Interest Rate	0.4581	-0.5145
	(4.4343)***	(-5.0425)***
Exchange Rate	-0.0843	0.7663
	(-7.7606)***	(2.4499)**
Threshold (c)	0.1299***	
Slope (γ)	8.5924***	

Dependent variable is credit per GDP. *, **, 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 C.4: Estimation Result of Group 2 (Not Poolable Group)

Variable	**High Regime**	**Low Regime**
CBI	-5.1065	-30.76742
	(-2.5504)***	(-1.3155)
MaPP	3.7615	-29.94492
	(4.0613)***	(-1.780774)*
Inflation	0.0095	0.2450
	(0.8964)	(2.1889)**
Growth	0.0179	-0.4252
	(0.8989)	(-1.9704)**
Interest Rate	0.1931	-0.2808
	(3.2749)***	(-5.5571)***
Exchange Rate	-0.1518	0.5466
	(-7.3160)***	(1.4813)

Continued on next page

Table C.4 – *Continued*

Variable	**High Regime**	**Low Regime**
Threshold (c)	0.1704	
Slope (γ)	4.6298***	

The dependent variable is credit per GDP. *, **, and *** denote statistical significance at the 10 per cent, 5 per cent and 1 per cent respectively. t-statistics are in parentheses.

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