Ph.D. Thesis

Research on International Finance:

Current Account, Financial Crisis and Trilemma Policy

A thesis submitted for the degree of Ph.D in Economics

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1. Introduction

The motivation to reduce the transaction costs and uncertainty in the financial system has promoted international financial development and integration. Most countries have reaped a large steady-state welfare gain from global financial integration (Obstfeld, 1994). International financial integration has also been recognized to accelerate economic growth, regardless of the level of economic development (Edison et al., 2002). However, due to the expanded scale and globalization of the financial sector, a small disturbance may also cause a widespread chain reaction internationally. The heightened global risk and several large-scale global financial crises over the past two decades have proven the vulnerability of the current global financial system. The catastrophic damage of the contagion effect from the financial crisis in neighboring countries also induces the debate of the pros and cons of financial globalization, especially for developing countries.

Several factors contribute to the vulnerability of the global financial system. Generally, the degree of global integration is an important factor in determining the countries financial market transmission process (Ehrmann and Fratzscher, 2009). However, simultaneously, the importance of country-specific macro policy is also emphasized by some research. For example, Bekaert et al. (2013) indicated that a lax monetary policy increases domestic risk and uncertainty. Moreover, not only to bring effect to domestic country, but the national policy stabilization by one country can also benefit other countries, reducing incentives to implement credit policies in a classic free-riding problem (Dedola et al. 2013).

Against the backdrop of these heightened potential risks, financial globalization benefits a country directly by allowing a faster capital accumulation through free capital flows and reducing investors' risk through international portfolio diversifications. In addition, Kose et al. (2009) argue that the indirect effects of financial globalization on financial market development, better institutions and governance, and macroeconomic discipline are likely to be far more important than any direct impacts. So, under this background, an appropriate home country financial policy seems particularly more important than ever before. Therefore, this study focuses on recent unsolved issues in international finance, which constitute the following three subjects.

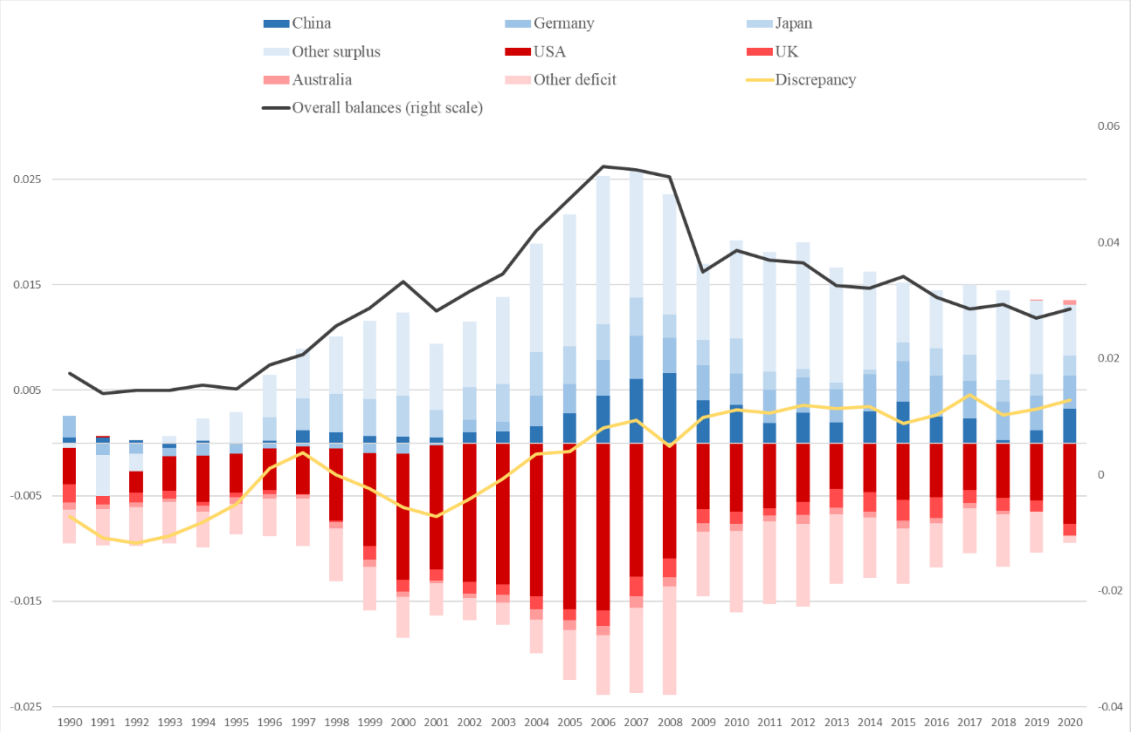
Current account

Firstly, as Obstfeld (2012) emphasized, the current account remains one of the most important policy issues in recent years. A large current account deficit is considered a significant indicator of the financial crisis (Catao and Milesi-Ferretti 2014 and Kaminsky and Reinhart 1999). On the other hand, a persistent current account surplus can lead to a

current account imbalance between domestic and partner countries, which may provoke political conflicts, like the 1980s US-Japan trade conflict and the US-China trade war in recent years.

Figure 1-1 plot the current account balances in the past thirty years. Obviously, until the 2008 global financial crisis (henceforth, GFC), the current account surpluses and deficits experienced relatively stable growth. After the 2008 GFC, current account surpluses and deficits narrowed modestly. In recent 2020 the world's overall current account balance (the absolute sum of all surpluses and deficits) declined from five percent to roughly three percentage points (right scale) of world GDP. Among the deficit countries, China, Germany, and Japan account for nearly half of the total. US-China trade tensions significantly decline China's current account balance during 2018 and 2019. With the US and China agreeing to a "Phase One" economic and trade agreement, this situation improved after 2020. As for the deficit countries, as is known to all, the most representative one is still the US, and the remaining two surpluses countries are the UK and Australia.

Figure 1-1 Current Account Balances, 1990–2020



Note: Overall balances are the absolute sum of world surpluses and deficits. *Source*: World Development Indicators, the World Bank.

Based on their theoretical current account model, Glick and Rogoff (1995) developed an empirical model of current accounts to highlight the relationship of productivity with investment and current accounts. Current account changes are explained by country-specific productivity shocks, global productivity shocks, and lagged investments. The model performs surprisingly well with G7 data during 1975-1990. Their results show that current accounts had a negative response only to country-specific shocks, indicating a growing economy is likely to experience a current account deficit. In contrast, investment positively responded to both global and country-specific productivity shocks.

In Chapter 2, we revisit Glick-Rogoff's model, in which productivity shocks act as a key driver of current account changes, and apply the model to the fast growth BRICS countries. We aim to contribute to the literature by achieving the following three goals. First, a model that emphasizes productivity shocks should be tested against fast-growing countries such as the BRICS countries. This is because the BRICS countries experience much-more-volatile productivity shocks than developed countries in the G7. Second, understanding the current account changes of the largest economies is essential for the surveillance of the global economy. Third, in addition to knowing the G7 countries, understanding the BRICS countries' current account movements, including the world's second-largest economy, is essential for policymakers to adopt appropriate macroeconomic policies. After investigating the sample period between 1983 and 2017, we find the Glick-Rogoff model fits poorly to fast-growing BRICS countries despite the model's usefulness in explaining current accounts of G7 prior to the 1990s. A set of global and country-specific productivity shocks alone cannot explain BRICS country's current account. We suggest that policymakers should search for a framework in which the current account adjusts through its own country-specific mechanism.

Financial structure and financial crisis

Several large-scale financial crises have ravaged the world over the past two decades. The first was the Asian financial crisis of 1997, and the second was the GFC of 2008. These financial crises have revealed the vulnerability of economic systems in both developed and developing countries. Because the determinants and impacts of financial crises vary by type of crisis, i.e., banking crisis and currency crisis, and by country, it is critical to identify the determinants of each kind of crisis in various settings.

Two main empirical approaches have been adopted in the financial crisis literature. The first group of studies focuses on clarifying the determinants of financial crises. For instance, Gourinchas and Obstfeld (2012) analyze the effects of the GFC in 2008 and suggest that domestic credit expansion and real currency appreciation have been the most

robust predictors of financial crises for both developed and developing countries. Davis et al. (2016) estimate a probabilistic model to find the marginal effect of private sector credit growth on the probability of a banking crisis. Davis et al. (2016) introduce an economic model as an early-warning system for predicting crisis events that were very popular in the periods following the Tequila and Asian financial crises. Specifically, many researchers have focused on abnormal changes occurring before a crisis event. Sachs et al. (1996) report that overvalued exchange rates and lending booms coupled with low international reserves are necessary conditions for crises. Kaminsky and Reinhart (1999) find that after a prolonged boom accompanied by an overvalued currency, an appreciation of a real exchange rate episode can trigger a crisis.

At the same time, several works have reported that the type of financial structure, whether bank-based, market-based, or a combination of the two, matters for economic performance. For countries such as Germany and Japan, the bank-based financial structure has a positive effect on the economy because it offers advantages in terms of (1) acquiring information about firms to improve capital allocation and corporate governance, (2) managing risk and enhancing investment efficiency and economic growth, and (3) mobilizing capital to achieve economies of scale. On the other hand, in countries such as the US and UK, the market-based financial structure has a positive effect on their economies by (1) creating stronger incentives for research-intensive firms, (2) enhancing corporate governance by easing takeovers, and (3) facilitating risk management (Levine, 2002). In the early empirical literature, supporting evidence is provided for both types of financial structures. However, more studies appear to report the superiority of market-based financial structures over bank-based ones, especially in recent years. For example, state-owned banks are associated with less economic growth because they tend to supply credit to fully developed industries rather than strategic industries, where innovation and opportunities for growth potentially exist (La Porta et al., 2002). In the post-financial-crisis period, market-based economies exhibit significantly and consistently stronger rebounds than bank-based economies (Beck et al., 2002). The banking sector played an important role in earlier years of economic growth, but in recent years, the stock market has played an even more important role in economic growth (Lee, 2012). Finally, some works find no merits for either bank- or market-based structures and argue that the overall development of financial systems, i.e., efficient legal systems and efficient capital allocation, is more important (Levine, 2002; Beck and Levine, 2002).

As a combination of those previous studies, we believe that it is important to empirically test whether financial structure affects the probability of the financial crisis occurrence. In the second part, our main objective is to clarify whether and how financial

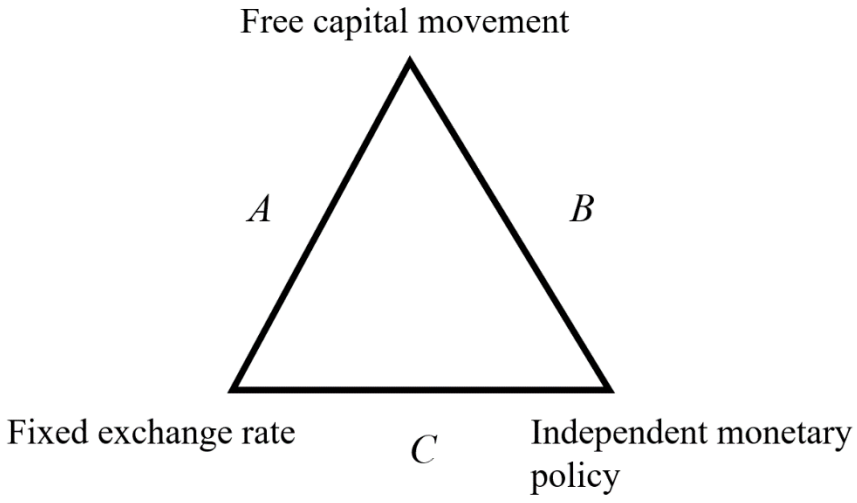
structure affects the likelihood of a financial crisis and the role of capital openness within this effect.

In Chapter 3, we use binary response models for the panel data approach to investigate the relationship between financial structure and capital openness with respect to financial crises. After applying the data of 38 advanced and emerging sample countries from 1996-2016 to the model, our main results are summarized by the following three points. First, financial structure plays an essential role in reducing the probability of a currency crisis. An economy with a more market-based structure is less likely to experience a currency crisis. Second, capital openness is also an essential factor in the occurrence of a currency crisis. Higher capital openness is associated with a lower probability of a currency crisis. Third, capital openness can increase the effect of financial structure on a currency crisis.

Trilemma policy

As depicted in Figure 1-2, the trilemma hypothesis as a concept in international economics states that a country can only achieve two but not all three polity goals: monetary independence, exchange rate stability, and free capital movement. Obstfeld et al. (2005) examined the movements of interest rates over more than 130 years (covering the Gold Standard, the Bretton Woods, and the Post Bretton Woods periods) and concluded that constraints implied by the trilemma are largely borne out by history. As a typical example, Euro countries are considered to have chosen a pattern of exchange rate stability and free capital movement (situation A in Figure 1-2) by giving up monetary independence. Unfortunately, the Euro-crisis has demonstrated that the fragility of this structure.

Figure 1-2 The Impossible Trinity



Several previous works have examined the relationship between trilemma policy and macro-economic performance. Aizenman et al. (2010) find that greater monetary independence lowers output volatility, while greater exchange rate stability is associated with greater output volatility. They also find that greater exchange rate stability and greater financial openness are linked to lower inflation rates. Developing countries' trilemma policy variables such as the exchange rate stability and financial openness are influenced by the center economies - the US, Japan, and Eurozone (Aizenman et al., 2016). Since 1990, the trilemma variables in the developing countries have converged towards intermediate levels, characterized by managed flexible exchange, using sizable international reserves as a buffer while retaining some degree of monetary autonomy (Aizenman et al., 2013).

Some question follows: Under the impossible trinity hypothesis, are policy makers forced to choose only two policy goals out of monetary independence, exchange rate stability, and free capital movement to achieve an optimal solution indeed? How can we keep the trilemma policy in an optimal situation? Around these questions, our main objective of the third part is to clarify whether, and how if yes, trilemma policy and macro-economic performance affect each other.

Chapter 4 aims to clarify the relationship between trilemma policy and macroeconomic performance. We analyzed a dataset that covers 42 emerging and developing countries from 1990 to 2017. The following points summarize the main results. First, higher capital openness is linked to lower output volatility and can suppress rises in the inflation rate. Second, trilemma policy decisions are also associated with domestic and global economic performance. Third, by investigating the adjustment path for individual trilemma variables, we find that policy-makers tend to adjust the exchange rate stability and capital openness when faced with domestic and global volatility shocks. These adjustments are also associated with a country’s level of democracy: a country with a lower democracy score may adjust more freely.

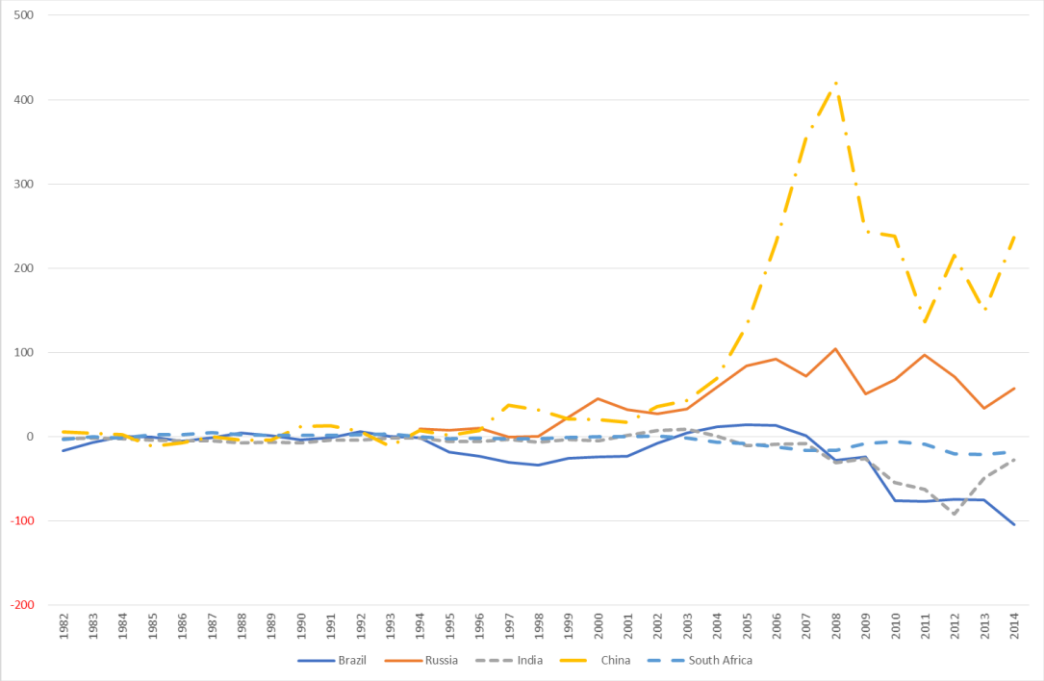
The construction of the rest of this paper is as follows. Chapter 2 investigates the determinants of current account changes for these BRICS countries with the Glick-Rogoff (1995) model and its modified model. Chapter 3 verifies whether and how financial structure affects the likelihood of a financial crisis and the role of capital openness within this effect. Chapter 4 clarifies whether and how trilemma policy and macro-economic performance affect each other. Chapter 5 summarizes the main conclusions and argues the policy implications from previous chapters' results.

2. Revisiting the Glick-Rogoff Current Account Model: An Application to the Current Accounts of BRICS countries[1]

2.1 Background

Understanding what drives the changes in current accounts is one of the most important macroeconomic issues for developing countries. Excessive surplus in a current account can trigger trade wars, and excessive deficits in the current account can lead to currency crises. For example, Brazil's current account has frequently fallen into a deficit since the 1990s, and India experienced a current account deficit of 91 billion US dollars in 2012, whereas China's current account surplus has become the world's largest (see Figure 2-1).

Figure 2-1. Current Accounts of BRICS Countries



Note: Current accounts are in terms of current billion US dollars. Source: World Development Indicators, the World Bank.

The current trade war between the US and China began under the administration of

[1] This chapter is based on the original publication of (Yushi Yoshida and Weiyang Zhai, 2020, Revisiting the Glick-Rogoff Current Account Model: An Application to the Current Accounts of BRICS countries, *Dynamic Modeling and Econometrics in Economics and Finance* 27, 265-291.) and numerous modifications are made to the original work.

President Trump following a decade in which the US's bilateral trade deficit with China remained large. Against the backdrop of the worldwide effort being made to reduce tariff and nontariff barriers, the US raised the tariffs for steel products and thousands of products in other industries from China in consecutive sequences starting in 2018, and China responded with retaliatory tariff increases.

Currency crises are, in many cases, preceded by a current account deficit. Obstfeld (2012) documents that many crises have been preceded by a large current account deficit, pointing out the crises of Chile in 1981, Finland in 1991, Mexico in 1994, and Thailand in 1997, which subsequently led to the outbreak of the Asian currency crisis. It should be noted that current account deficits are not a prerequisite for currency crises. However, as shown in previous studies, a current account deficit is considered an important warning signal of consequent crises. Roy and Kemme (2011) and Catao and Milesi-Ferretti (2014) find that current accounts are a powerful predictor of crisis; a higher current account deficit position is associated with a higher risk of crisis. Zorzi et al. (2012) conculde that current accounts are not aligned with economic fundamentals prior to the financial crisis. During the Asian currency crisis, Corsetti et al. (1999) pointed to Taiwan's current account surplus as what prevented contagion from neighboring countries. Davis et al. (2016) show that a higher private sector debt increases the probability of a crisis, especially when the current account is in a sizable deficit. Observing trade balance as a key determinant of current accounts, Kaminsky and Reinhart (1999) also conclude that exports often decrease just before a crisis.

Among other current account models, Glick and Rogoff (1995) developed an empirical model of current accounts to highlight the relationship of productivity with investment and current accounts. Current account changes are explained by country-specific productivity shocks, global productivity shocks, and lagged investments. The model performs surprisingly well with G7 data during 1975-1990. Their results show that current accounts had a negative response only to country-specific shocks, whereas investment showed a positive response to both global and country-specific productivity shocks.

In this chapter, we revisit Glick-Rogoff's model, in which productivity shocks act as a key driver of current account changes, and apply the model to the BRICS countries. This chapter aims to contribute to the literature by having the following goals. First, a model that emphasizes productivity shocks should be tested against fast-growing countries such as the BRICS countries. The BRICS countries experience much-more-volatile productivity shocks than developed countries in the G7 do. Second, understanding the current account changes of the largest economies is important for the surveillance of the global economy. In addition to having knowledge of the G7 countries, understanding the

BRICS countries' current account movements, including the world's second largest economy, is essential for policymakers to adopt appropriate macroeconomic policies.

The results of the empirical application of the Glick-Rogoff model to BRICS countries show that the empirical model with productivity shocks works relatively well for developing countries except for Russia. However, the empirical Glick-Rogoff model collapses when the sample is extended to cover the post-crisis period. The fitness of regression in terms of adjusted R-squared becomes close to zero. Following the recent development of the empirical current account literature, we extended the Glick-Rogoff model with five macroeconomic variables, namely, financial deepening, old dependency ratio, young dependency ratio, net foreign assets, and trade openness. The results of the extended model improve the fitness of regression for the pre-crisis period in India, China, and South Africa by more than ten percent and that in Brazil by two-fold[2]. Interestingly, the modified model even works well during the sample including the post-crisis period for Brazil, China, and Russia.

From the empirical investigations in this chapter, we obtained the following conclusions for developing countries. (i) Productivity is only important in non-turbulent environments. The Glick-Rogoff model performs well in the period prior to the global financial crisis but loses all explanatory power in the sample period, which includes the global financial crisis. (ii) Other macroeconomic variables are important determinants regardless of the inclusion of the crisis in the sample period. Additional five macroeconomic variables in the modified Glick-Rogoff model improved the fitness of regression in both samples.

In comparison with developed countries, we also find the following implications. (iii) Productivity shocks explain the movements of the current account better for developing countries than for developed countries. (iv) However, productivity shocks retain some explanatory power for the current account of developed countries even in the post-crisis period, whereas productivity shocks have no effect on the current account of developing countries in the post-crisis period. (v) Inclusion of macroeconomic variables sometimes deteriorates the performance of the current account regression of developed countries, especially for euro countries.

The construction of the rest of this chapter is as follows. Section 2.2 reviews the theoretical model of Glick and Rogoff (1995) and the subsequent developments of both theoretical and empirical studies. Section 2.3 examines the empirical application of the Glick-Rogoff model and its modified model with macroeconomic variables as controls to

[2] The extended model cannot be applied to Russia for the pre-crisis period due to the lack of data availability.

the BRICS countries. Section 2.4 compares the results of the BIRCS countries with those of the G7 countries and discusses the characteristics of the current account for fast-growing emerging economies. Section 2.5 discusses how the five macroeconomic variables used in this empirical study are related to other macroeconomic variables used in the literature. Section 2.6 concludes the chapter.

2.2 Productivity shocks and current account

Glick and Rogoff (1995) introduced a theoretical small-country model in which productivity shocks play crucial roles in determining current account movements. The next section briefly reviews the assumptions and underlying structure of their model. We discuss the applicability of the model assumptions that may lead to the misspecification of the empirical model for developing countries in section 2.2.2.

2.2.1 Glick-Rogoff small-country model with adjustment costs to investment[3]

A small country faces both country-specific productivity shocks and global productivity shocks. Global productivity shock can be mitigated by trading global bonds in the world capital market at the riskless gross world interest rate *r*. However, the representative agent in each country cannot diversify country-specific shocks. The representative firm chooses the path of investments to maximize the present discounted value of future profits under the given aggregate output (2-1)[4]. Taking a linear approximation to the first-order condition yields equations (2-2) and (2-3).

$$Y_t = A_t^c K_t^{\alpha}\left[1-\frac{g}{2}\left(\frac{I_t^2}{K_t}\right)\right] \tag{2-1}$$

$$Y_t \cong \alpha_I I_t + \alpha_K K_t + \alpha_A A_t^c \tag{2-2}$$

$$I_t \cong \beta_1 I_{t-1} + \eta\sum_{s=1}^{\infty}\lambda^s\left(\mathrm{E}_t A_{t+s}^c - \mathrm{E}_{t-1}A_{t+s-1}^c\right) \tag{2-3}$$

In equation (2-3), the first term captures the past investment (or lagged productivity

[3] This section closely follows the work of Glick and Rogoff with special focus on productivity shocks on current account. For the complete derivations of equation (2-8), please refer to the appendix of their original work. See also Marquez (2004) and Bussière et al. (2010) for another extension of the Glick–Rogoff model.

[4] Global productivity, A_t^W, is introduced multiplicatively to the aggregate output in a similar manner as country-specific productivity.

shock) on the current investment, and the second term captures the impact of revisions in expectations about the future path of productivity.

The representative agent chooses the path of consumption to maximize the present discounted utility (2-4).

$$\mathrm{E}_t \sum_{s=0}^{\infty} \beta^s U\left(C_{t+s}\right), \text{ where } U_t = C_t - \frac{h}{2} C_t^2, \text{ s.t. } F_{t+1} = rF_t + Y_t - I_t - C_t, \quad (2\text{-}4)$$

where r is assumed to be equal to β. The solution to the maximization for consumer yields (2-5) and the ex post rate of change of consumption depends only on the unanticipated movement in permanent net income (2-6).

$$C_t = \frac{r-1}{r}(F_t + \mathrm{E}_t \sum_{s=0}^{\infty} \frac{Y_{t+s} - I_{t+s}}{r^s}) = \frac{r-1}{r} F_t + \overline{Y}_t - \overline{I}_t \quad (2\text{-}5)$$

$$\Delta C_t = \left(\mathrm{E}_t - \mathrm{E}_{t-1}\right) \frac{r-1}{r} \left(\mathrm{E}_t \sum_{s=0}^{\infty} \frac{Y_{t+s} - I_{t+s}}{r^s} \right) = \left(\overline{Y}_t - \overline{I}_t\right) - \mathrm{E}_{t-1}\left(\overline{Y}_t - \overline{I}_t\right) \quad (2\text{-}6)$$

Differencing the accounting identity for the current account, we obtain the following equation.

$$\Delta CA_t = (r-1)\Delta F_t + \Delta Y_t - \Delta I_t - \Delta C_t \quad (2\text{-}7)$$

Combining the equations obtained from maximization for ΔI_t, ΔY_t, ΔC_t with equation (2-7) yields the estimating equation for the current account[5].

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + (r-1) CA_{t-1}, \quad (2\text{-}8)$$

$$\text{where } \begin{array}{l} \gamma_1 \equiv (\alpha_I - 1)(\beta_1 - 1) + \alpha_K > 0, \\ \gamma_2 \equiv -\beta_2 [(\alpha_I - 1)(\beta_1 - 1) + \alpha_K] / (r - \beta_1) < 0 \end{array}$$

If all countries are symmetric in terms of preferences, technology, initial capital stocks, and zero initial net foreign asset positions, then the global shock should not affect an individual country's current account because the global shock affects all countries in the same manner; therefore, we obtain the final version of the basic Glick-Rogoff model.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w, \text{ where } \gamma_3 \text{ is assumed to be zero.} \quad (2\text{-}9)$$

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[5] α_I and α_K are marginal production of investment and capital as in equation (2-2). β_1 is the autoregressive coefficient of investment in equation (2-3). The first appearance of β_2 is omitted in this chapter, but it is equal to $\eta[\lambda / (1-\lambda)] > 0$.

In this section, leaving the investment equation aside, we focus on the effect of both country-specific and global productivity shocks on current accounts. The regression model derived from the theoretical result of Glick and Rogoff (1995) is as follows.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w + \varepsilon_t, \qquad (2\text{-}10)$$

where CA_t is the current account of the home country, A_t^c is the total factor productivity of the home country, A_t^W is the total factor productivity of the rest of the world, and I_t is the lagged investment in the home country.

2.2.2 Where can the Glick-Rogoff model go wrong for an application to the BRICS countries?

The effect of global productivity shocks is assumed to have no effect on a change in current accounts, as shown in equation (2-10). However, there are at least two strong arguments against this assumption. For the application to the BRICS countries, there are problems with assuming a zero initial net foreign asset position and assuming that global productivity shocks affect developed and developing countries equally.

First, Glick and Rogoff (1995) state that "zero initial net foreign asset positions … is a reasonable empirical approximation for the G-7 countries over the sample period." However, if positive (or negative) net foreign asset positions are at a level as high as was observed prior to global financial crisis in China, the global productivity shocks affect these countries with nonzero net foreign asset positions asymmetrically.

Second, we followed Glick and Rogoff (1995) in measuring global productivity based on the largest economies of the world. In an application to the G7 countries as in Glick and Rogoff (1995), each sample country's productivity also contributes to the global productivity. Therefore, observed country productivity (from the original data) is decomposed into a country-specific component and a global component. The effect of the global component of productivity shock is nil because it affects both home country and the rest of the world similarly. However, for an application to the developing countries as in this chapter, observed country productivity (from the original data) does not constituent global productivity. The global factor should affect the BRICS countries and the rest of the world asymmetrically.

2.3 Domestic and Global Productivity

In this section, we apply the Glick-Rogoff model to the fast-growing emerging economies, namely, the BRICS countries, Brazil, China, India, Russia, and South Africa. The key determinants of current account change in the Glick-Rogoff model are global and country-specific productivity shocks. To account for the severe negative shocks experienced during the global financial crisis, we estimate the model in two sample periods; one ending in 2008 and the other ending in 2017. In the second section, we also apply the extended model with additional macroeconomic variables after we obtain the base results from the original Glick-Rogoff model[6]. In next section, we apply the same model to developed countries, namely, Canada, France, Germany, Italy, Japan, UK, and US. We discuss similarities and differences in current account determinants between the BRICS and G7 countries.

2.3.1 Estimation results of basic Glick-Rogoff model

Global productivity is constructed from the weighted average of the productivities of the G7 countries, namely, Canada, France, Germany, Italy, Japan, the UK, and the US. Alternatively, the first principal component of the productivities of the G7 countries is also used as a measure of global productivity[7]. The regression model of equation (2-10) is restated here.

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \gamma_3 \Delta A_t^w + \varepsilon_t,$$

From the Glick-Rogoff model, the expected sign of the past investment is positive, that of the first-difference of each country's productivity is negative, and that of the first-difference of worldwide productivity is zero; that is, $\gamma_1 > 0, \gamma_2 < 0,$ and $\gamma_3 = 0$. The dynamic optimization model of Glick and Rogoff (1995) integrates the endogenous decisions of producers and consumers; therefore, the derived parameters of the model are affected by several sources. However, if we simply decompose the dependent variable, which is the first difference of the current account in terms of private saving and investment, and leave aside the government role, we can observe (in the first equality) the

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[6] Source of data used in this chapter are listed in Appendix Table A2-1.

[7] Gregory and Head (1999) used dynamic factor analysis to construct a measure of common economic activity for the G7 countries. They find that the common economic activity has substantial impact on productivity but not on current account. İşcan (2000) further disintegrates overall productivity into traded good productivity and nontraded good productivity. He finds that the most influential of all on current account is country-specific traded good productivity.

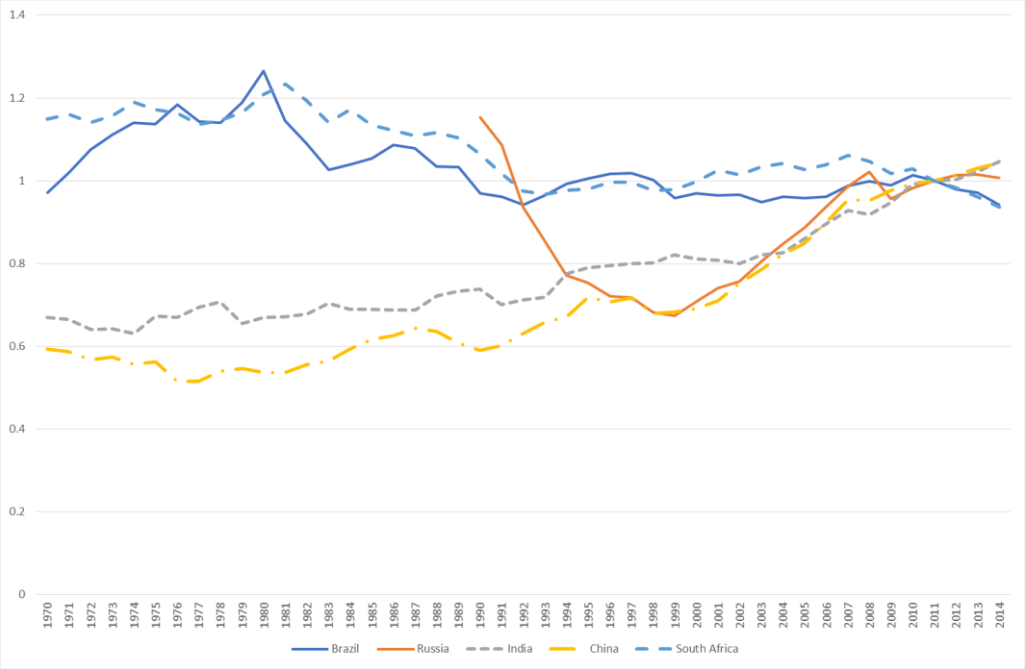
first-degree importance of the current investment and the past investment on the dependent variable. Adjusted for marginal production with respect to investment and capital stock, i.e., α_I and α_K, and the impact of past investment shock on the current investment, i.e., β_1, the coefficient of unity in the equation remains positive, γ_1, as shown in equation (2-8).

$$\Delta CA_t \equiv CA_t - CA_{t-1} = (S_t - I_t) - (S_{t-1} - I_{t-1}) = \Delta S_t - \Delta I_t \qquad (2\text{-}11)$$

It is also clear that a change in a country's productivity negatively affects a change in its current account, γ_2, via a change in investment through the second equality.

The empirical results of estimating the Glick-Rogoff model for the BRICS countries during 1983 – 2008 are provided in Panel 1 of Table 2-1a & 2-1b[8]. The differences in the two tables arise from the way the global productivity index is constructed. The global productivity index is simply a GDP-weighted average of the G7 countries in Table 2-1a and the first principal component of the G7 countries in Table 2-1b. Country-specific productivity is based on total factor productivity, as shown in Figure 2-2.

Figure 2-2. Total Factor Productivity of BRICS Countries



Note: Total factor productivity is normalized for unity in 2011 for each country. Source:

[8] The sample period for Russia only begins in 1995 due to the availability of data.

World Development Indicators, the World Bank.

First, by comparing Table 2-1a and 2-1b, we find that the results are quite similar in terms of both the size of the coefficients and the statistical significance except for the coefficient size of global productivity shock. The result of the basic model is robust regardless of how global productivity is measured.

Second, country-specific productivity shock is not statistically significant for all BRICS countries, although theory predicts a negative effect on change in the current account. This result is quite different from the results obtained for the G7 countries during 1961-1990 in Glick and Rogoff (1995, Table 2-3); the estimated coefficients of the country-specific productivity shock are negative and statistically significant for five countries, namely, the US, Japan, Italy, the UK, and Canada.

Third, except for Brazil and South Africa (only in Table 2-1a), the results for global productivity shock are consistent with the Glick and Rogoff model. Under the assumption that global productivity shock symmetrically affects all countries in the world, the effect of global productivity shock on current account change must be equal to zero. The estimated coefficients for Russia, India, China, and South Africa (only in Table 2-1b) are not significantly different from zero at the conventional significance level. For the case of Brazil, the estimated coefficient is positive and statistically significant. The positive sign is consistent if the global productivity shock represents the rest of the world instead of the world with Brazil included (see the discussion in section 2.2.2). Foreign productivity shock should positively affect home current account change because home productivity shock negatively affects home current account change, as in γ_2.

The basic Glick-Rogoff model is also estimated for the extended sample of 1983-2017, including the post global financial crisis period, and the results are provided in Panel 2 of Table 2-1a and 2-1b. The surprising result is that nothing in the Glick-Rogoff model works for the BRICS countries if the worldwide turbulent period is included in the sample. For all BRICS counties, the fitness of the regression in terms of adjusted R-squared is literally zero.

Table 2-1a. Basic Glick-Rogoff regression with TFP as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.12(1.72)	-0.01(0.04)	0.04(0.07)	0.13(0.08)	-0.06(0.05)
Global		5.14(10.09)	0.91(0.40) **	-0.03(0.20)	0.40(0.26)	-0.38(0.22) *
Investment		0.10(0.09)	0.01(0.03)	-0.02(0.01)	0.06(0.01) ***	-0.10(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.14	0.29	0.20	0.60	0.58
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.11(1.33)	-0.18(0.12)	0.27(0.15) *	0.17(0.18)	-0.14(0.09)
Global		15.17(9.56)	0.15(0.45)	-0.29(0.33)	0.62(0.78)	-0.20(0.70)
Investment		-0.02(0.05)	0.00(0.03)	-0.01(0.01)	-0.02(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.05	-0.01	-0.02	0.02	-0.06

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as the country's total factor productivity. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 2-1b. Basic Glick-Rogoff regression with TFP as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.23(1.58)	-0.00(0.04)	0.02(0.07)	0.14(0.09)	-0.08(0.05)
Global		0.16(0.28)	0.02(0.01) **	0.00(0.01)	0.01(0.01)	0.00(0.01)
Investment		0.11(0.08)	-0.01(0.02)	-0.02(0.01)	0.06(0.01) ***	-0.07(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.13	0.20	0.23	0.58	0.53
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		-0.21(1.39)	-0.18(0.12)	0.23(0.13)	0.16(0.18)	-0.15(0.10)
Global		0.30(0.25)	0.00(0.10)	0.00(0.01)	0.01(0.02)	0.01(0.02)
Investment		-0.02(0.05)	0.00(0.02)	-0.01(0.01)	-0.01(0.07)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.08	-0.01	-0.04	-0.01	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as each country's total factor productivity. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

The productivity shocks implemented in the preceding empirical approach need to meet the requirement assumed in the theoretical model; country-specific productivity and global productivity are independent. In the original Glick and Rogoff (1995) study, global productivity is constructed from the same countries in the sample; therefore, the independent assumption is more likely to be violated if no adjustment is made. Following the methodology implemented in Glick and Rogoff (1995), we regressed the original country productivity on the global productivity and used the residual as country-specific productivity. By design, the independence of country-specific and global productivity shock is guaranteed. The results using the residual as country-specific productivity are shown in Tables 2-2a and 2-2b.

The estimated results in Tables 2-2a and 2-2b are very similar to those of Tables 2-1a and 2-1b in terms of both the size of coefficients and the statistical significance. The only noteworthy point is that the global productivity shock becomes statistically significant for an additional country in the shorter sample. For China in the period between 1983 and 2008, as seen in Table 2-2b, the global productivity shock is positive and statistically significant at the ten percent level. This is similar to the case of Brazil, in which the positive sign indicates foreign productivity shock rather than global productivity shock. As for the results of South Africa in Table 2-2a, it is puzzling that the global productivity shock is negative and statistically significant[9].

Table 2-2a. Basic Glick-Rogoff regression with TFP residual as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.12(1.72)	-0.01(0.04)	0.04(0.07)	0.13(0.08)	-0.06(0.05)
Global		4.10(10.52)	0.90(0.39) **	0.01(0.22)	0.51(0.27) *	-0.44(0.20) **
Investment		0.10(0.09)	0.01(0.03)	-0.02(0.01)	0.06(0.01) ***	-0.10(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.14	0.29	0.20	0.60	0.58
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		0.11(1.33)	-0.18(0.12)	0.27(0.15) *	0.17(0.18)	-0.14(0.09)
Global		15.31(9.32)	-0.04(0.51)	-0.03(0.34)	0.76(0.76)	-0.35(0.73)
Investment		-0.02(0.05)	0.00(0.03)	-0.01(0.01)	-0.00(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.05	-0.01	-0.02	0.02	-0.06

Note: Global shock is calculated as the weighted average of total factor productivity of

[9] Smit et al. (2014) provide an explanation of the irregular movement of South Africa's current account deficit as being driven by substantial net capital inflows and their reversals afterwards.

the G7 and country-specific shocks as the residual of each country's total factor productivity on Global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 2-2b. Basic Glick-Rogoff regression with TFP residual as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period	1995-2008	1983-2008	1983-2008	1983-2008	1983-2008
Country-specific		-1.24(1.58)	-0.00(0.04)	0.02(0.07)	0.14(0.08)	-0.08(0.06)
Global		-0.32(0.71)	0.02(0.01) **	0.01(0.01)	0.02(0.01) *	-0.00(0.01)
Investment		0.11(0.08)	-0.01(0.02)	-0.02(0.01)	0.06(0.01) ***	-0.07(0.02) ***
Number of obs		14	26	26	26	26
Adj R-squared		-0.13	0.20	0.23	0.58	0.53
Panel2	Period	1995-2017	1983-2017	1983-2017	1983-2017	1983-2017
Country-specific		-0.22(1.39)	-0.18(0.12)	0.23(0.13) *	0.16(0.18)	-0.15(0.10)
Global		0.21(0.54)	-0.00(0.01)	0.02(0.02)	0.03(0.02)	-0.01(0.02)
Investment		-0.02(0.05)	0.00(0.02)	-0.01(0.01)	-0.00(0.01)	0.00(0.02)
Number of obs		23	35	35	35	35
Adj R-squared		-0.08	-0.01	-0.04	-0.01	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

2.3.2 Extended models with other macroeconomic variables

Not all empirical models of current account movements emphasize productivity shocks. The advantage of the Glick-Rogoff regression model is its concrete derivation based on the theoretical dynamic model. However, many researchers have continued to explore the possibility of many other macroeconomic variables to explain current account movements, frequently without theoretical models.

Chinn and Prasad (2003) investigated the medium-term determinants of current accounts for a large sample of developed and developing countries. They find that current account balance is positively correlated with government budget balance and the initial level of net foreign assets. Among developing countries, financial deepening is positively associated with current account balance, while trade openness is negatively correlated with current account balance.

Cudre and Hoffmann (2017) and Romelli and Terra (2018) also show that trade

openness is a significant driver of current accounts. Romelli and Terra (2018) investigate the impact of trade openness on the relationship between the current account and the real exchange rate. They find that during the balance of payment distress episodes, currency depreciations are associated with larger improvements in the current accounts of countries that are more open to trade, and the magnitude of exchange rate depreciations over the adjustment process of current accounts is related to the degree of openness to trade. Cudre and Hoffmann (2017) also find that trade openness is an important factor even across regions within a nation.

Following the recent development of the empirical current account literature, we extended the Glick-Rogoff model with five macroeconomic variables: financial deepening, old dependency ratio, young dependency ratio, net foreign assets, and trade openness[10]. First, the fitness of regression substantially improved for Brazil, India, and China. In the shorter sample between 1983 and 2008, the adjusted R-squared increased from 0.29 to 0.60 for Brazil, from 0.60 to 0.69 for India, and from 0.58 to 0.68 for China. In the longer sample that included the post-crisis period, the adjusted R-squared values were 0.31 for Russia, 0.21 for Brazil, and 0.24 for China; all of these values increased from zero or even negative values of the adjusted R-squared in the basic model estimations.

Second, we obtained estimation results that are consistent with the theoretical prediction for country-specific productivity shock although none of the estimates were statistically significant in the base model; negative responses are obtained for South Africa in the shorter sample and Brazil for the longer sample. In addition, by assuming global productivity as foreign productivity, we find a positive association with statistical significance between the current account and global productivity for Russia in the longer sample in addition to those for Brazil.

Third, the importance of additional macroeconomic variables for explaining current accounts varies among the BRICS countries. Financial deepening has no explanatory power for all countries. The old dependency ratio has a positive effect only for Brazil in the longer sample, while the young dependency ratio exerts opposite effects on Russia and Brazil in the longer sample[11]. Net foreign assets have a positive effect for China in

[10] The definitions and sources of macroeconomic variables are provided in the appendix A.

[11] From our results, both the old and young dependency ratio of Brazil positively affects the current account. One possible reason has been indicated by Duryea et al. (2007) that in Brazil, an unemployment shock increases the probability of a child entering the labor force, dropping out of school, and failing to advance in school. It is possible that there also has the same effect on the elders.

the shorter sample and for Russia in the longer sample. Trade openness has a positive effect for South Africa in the shorter sample and China in the longer sample.

Table 2-3a. Modified Glick-Rogoff regression with TFP residual as country-specific shock and weighted average as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period		1983-2008	1983-2008	1983-2008	1983-2008
Country-specific			0.01(0.03)	0.02(0.06)	0.02(0.08)	-0.13(0.04) **
Global			0.86(0.26) ***	-0.01(0.22)	-0.26(0.43)	-0.43(0.27)
Investment			-0.21(0.07) ***	0.00(0.08)	-0.19(0.15)	-0.14(0.10)
fdeep			-0.01(0.01)	-0.01(0.05)	-0.05(0.05)	-0.03(0.05)
reldepo			0.87(0.98)	2.76(3.20)	1.38(2.69)	-0.79(0.82)
reldepy			-0.15(0.08)	0.02(0.21)	0.02(0.12)	-0.05(0.03)
nfa/GDP			2.87(1.66)	1.50(13.68)	18.58(7.88) **	
open			8.08(7.73)	-11.96(11.37)	8.12(5.10)	7.49(1.84) ***
Number of obs			26	26	26	26
Adj R-squared			0.60	0.29	0.69	0.68
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		7.07(4.46)	-0.23(0.12) *	0.10(0.10)	-0.21(0.14)	0.05(0.13)
Global		40.35(16.75) **	-0.44(0.65)	-0.25(0.34)	0.54(037)	-0.56(0.78)
Investment		0.31(0.26)	-0.26(0.08) **	0.03(0.06)	0.02(0.03)	0.10(0.07)
fdeep		-0.03(0.03)	0.01(0.01)	-0.04(0.09)	-0.01(0.03)	-0.03(0.08)
reldepo		-0.21(0.22)	5.09(1.76) ***	0.95(7.51)	0.45(1.18)	-0.70(2.26)
reldepy		-0.37(0.13) **	0.40(0.17) **	-0.09(0.47)	0.43(0.28)	0.08(0.06)
nfa/GDP		4.30(1.87) *	1.70(2.11)	5.69(21.77)	2.56(5.46)	
open		13.77(12.05)	8.81(20.97)	-14.10(13.64)	24.99(7.79) ***	-6.68(7.64)
Number of obs		17	34	33	35	35
Adj R-squared		0.31	0.22	-0.02	0.24	-0.04

Note: Global shock is calculated as the weighted average of total factor productivity of the G7 and country-specific shocks as residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

Table 2-3b. Modified Glick-Rogoff regression with TFP residual as country-specific shock and principal component as global shock

		Russia	Brazil	India	China	South Africa
Panel1	Period		1983-2008	1983-2008	1983-2008	1983-2008
Country-specific			0.01(0.04)	0.02(0.07)	0.02(0.08)	-0.14(0.04) ***
Global			0.01(0.01) **	0.01(0.01)	0.00(0.01)	-0.00(0.01)
Investment			-0.26(0.08) ***	0.01(0.08)	-0.12(0.14)	-0.05(0.10)
fdeep			-0.01(0.01)	-0.01(0.05)	-0.02(0.05)	-0.06(0.04)
reldepo			1.65(1.00)	2.26(3.24)	0.12(2.64)	-1.70(1.26)
reldepy			-0.12(0.08)	-0.02(0.21)	0.02(0.12)	-0.05(0.04)
nfa/GDP			3.69(1.95) *	0.38(13.35)	16.13(7.25) **	
open			3.64(7.63)	-12.22(11.27)	6.38(5.18)	8.09(2.16) ***
Number of obs			26	26	26	26
Adj R-squared			0.45	0.31	0.68	0.66
Panel2	Period	2001-2017	1983-2016	1983-2015	1983-2017	1983-2017
Country-specific		4.58(4.07)	-0.23(0.12) *	0.06(0.07)	-0.19(0.15)	0.00(0.13)
Global		2.51(1.78)	-0.01(0.01)	0.01(0.05)	-0.01(0.01)	-0.01(0.02)
Investment		0.31(0.26)	-0.25(0.10) ***	0.03(0.08)	0.02(0.03)	0.10(0.09)
fdeep		-0.02(0.03)	0.01(0.01)	-0.04(0.49)	-0.02(0.04)	-0.04(0.08)
reldepo		-0.15(0.21)	5.03(1.77) ***	-0.34(3.24)	0.36(1.21)	-0.75(2.63)
reldepy		-0.38(0.14) **	0.40(0.17) **	-0.18(0.21)	0.30(0.28)	0.06(0.05)
nfa/GDP		3.96(1.88) *	1.85(2.10)	8.69(13.35)	-0.38(5.68)	
open		16.74(13.05)	9.93(23.14)	-14.77(11.27)	23.92(7.52) ***	-5.76(7.32)
Number of obs		17	34	33	35	35
Adj R-squared		0.29	0.22	-0.04	0.20	-0.05

Note: Global shock is calculated as the first principal component of the total factor productivity of the G7 and country-specific shocks as the residual of each country's total factor productivity on global shock. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** represent the 10, 5, and 1 percent statistical significance levels, respectively.

2.4 Can the same current account model be applied to both developed and developing countries?

For the BRICS countries, except for Russia, we find that the Glick-Rogoff model can explain approximately 20 – 60 percent of the changes in the current account for the period between 1983 and 2008; however, productivity shocks completely lose explanatory power when the sample is extended to cover the post-crisis period. The modified model extended with macroeconomic variables improves the fitness of regression for both samples. To conclude, whether these results are general or specific to fast-growing developing countries, we need to compare the results with those of developed countries. Therefore, we also estimated the same regression models for the G7 countries. The results are shown in appendix Tables A2-3 and A2-4[12].

First, the explanatory power of the original Glick-Rogoff model does not work, or at least does not work better for G7 countries than for BRICS countries in the pre-crisis period. The degree of fitness in terms of adjusted R-squared are 0.16, 0.15, 0.08, and 0.28 for France, Germany, Italy, and Japan, respectively. It is less than zero for Canada and the UK. The only exception is the US; 43 percent of current account movements in the US are explained by both global and local productivity shocks and past investment.

Second, similar to the BRICS countries, the basic model fits less well for G7 countries in the post-crisis period. However, unlike the BRICS countries, even in the post-crisis period, the Glick-Rogoff model retains some explanatory power, at least for Canada, Germany, Japan, and the US. This is a surprising finding because developed countries, especially the US, are the most affected countries in the world by the global financial crisis. We may need to adjust our understanding so that the financial crisis per se does not break the relationship between productivity shocks and current account changes.

Third, unlike in the case of the BRICS countries, the modified model does not necessarily improve the fitness of regressions in terms of the adjusted R-squared. More interestingly, the decline in the explanatory power of the overall regression model is found only for European countries, more precisely euro countries. For the pre-crisis sample, additional macroeconomic variables in France, Germany, and Italy reduced the adjusted R-squared from 0.16, 0.15, and 0.08 to 0.12, 0.09, and 0.00, respectively.

By comparing the estimated results of the BRICS and G7 countries, we can draw the

[12] These conclusions are drawn from comparing the results in Table 2-2a (2-2b) and Table 2-3a (2-3b). However, the sample periods for the modified model do not exactly match those in the basic model due to the exclusion of a few years for missing macroeconomic variables. The estimation results in Appendix Tables A2-2a and A2-2b with the sample period adjusted to match those of Table 2-3a and 2-3b confirm that the qualitative results do not change.

following implications for the movement of current accounts. (i) Productivity shocks as determinants of current account movements are more important in developing countries. (ii) However, productivity shocks lose their explanatory power for developing countries in the midst of the financial crisis. (iii) Demography, net foreign assets, and trade openness contribute to the movements of the current account for the BRICS countries, but this is less so for the G7 countries and even the opposite for euro countries.

2.5 Discussions

In this chapter, five macroeconomic variables are selected for the modified Glick-Rogoff model, which examines the effects of productivity shocks on current account changes. In the current account literature, researchers tested many more variables as determinants of current account movements. In this section, we discuss the possibility of other macroeconomic variables that may contribute to an increase in the fitness of the current empirical model. Some of the discussions in this section are meant to help improve future works.

First, in addition to trade openness, financial openness is also an important determinant of current account movements. By interpreting financial openness as unrestricted international capital flow, Yan and Yang (2012) find a shift in causality between the current account and capital inflows after the global financial crisis. Chin and Ito (2007) find that financial market development causes developed countries to have smaller savings and thus a current account deficit, while the opposite is true for Asian countries. Furthermore, Tan et al. (2015) examine the effect of the structure of the financial system on current accounts. They find that a country with a fully developed capital market is more likely to run a current account deficit. In this chapter, the financial deepening variable, i.e., the ratio of broad money to GDP, is most closely related to financial openness; however, this variable is not statistically significant for most of the cases in either the BRICS or the G7 countries. Our study confirmed the finding in the literature that development in capital markets is more relevant for current account adjustment than the growth in bank lending or money supply are.

Second, the income distribution within a country matters for current accounts. Income inequality raises national savings and thus increases current accounts if the savings rate of the richer individuals is higher than that of the poorer individuals. However, there are a variety of theoretical models that can generate the reduction in the current account associated with income inequality; see Behringer and van Treeck (2018). Belabed et al. (2018) suggest that the US current account deficit can be explained in part by rising

income inequality in the US. From investigating a sample of 20 countries, Behringer and van Treeck (2018) also find that income inequality leads to a decline in current accounts. In our study, the dependency ratio of young and elderly individuals may capture the part of the mechanism by which income distribution affects current accounts. The national savings rate should decline if the dependency ratio of elder (or dissaving) cohorts increases. Puzzlingly, in this chapter, the dependency ratio of elder cohorts on current accounts is positive for both BRICS and G7 countries whenever the ratio is statistically significant. One possible explanation for this contradiction between the theoretical predictions and empirical results in this capital may come from regressions based on the time-series of a single country rather than the panel framework used in Chin and Ito (2007). As often experienced in many other applied works, demographical characteristics can only be captured in the difference in cross-sections of countries.

Third, real exchange rates, or terms of trade, is not considered in this chapter. The effects of the terms of trade, i.e., relative price of exports and imports or relative price of tradable and non-tradable goods, on the current account is a classic issue in international macroeconomics. The so-called HLM effect works through the real income effect by which the terms of trade deterioration decreases the current account balance (Harberger, 1950 and Laursen and Metzler, 1950). Sevensson and Razin (1983) examined the effect of terms-of-trade changes on a small country's current account under perfect international capital mobility. A temporary terms-of-trade deterioration implies a deterioration of the current account, whereas a permanent terms-of-trade deterioration has an uncertain effect on the current account. Gervais et al. (2016) analyze a large set of emerging countries over the period from 1975 to 2008. They indicate that real exchange rate adjustment contributed to reducing current account imbalances. Focusing on the non-tradable sector, as in the Balassa-Samuelson effect on the real exchange rate, Hoffmann (2013) claims that the present-value model with non-tradeable goods explains more than 70 percent of China's current account variability over the period 1982-2007.

2.6 Conclusion

Current account adjustment became a classic macroeconomic issue in the 1950s and is still one of the important macroeconomic policy objectives today. Especially for fast-growing developing counties such as Brazil, China, India, Russia, and South Africa, a large current account imbalance can lead to an economic crisis for the worst case. In this chapter, we investigated the determinants of current account changes for these BRICS countries between 1983 and 2017. As an empirical model, we selected the Glick-Rogoff model, which emphasizes productivity shocks at home and in the world and fits well with

developed economies in the 1970s and 1980s (Glick and Rogoff, 1985). However, the Glick-Rogoff model fits poorly when it is applied to fast-growing BRICS countries for the period including the global financial crisis.

Productivity shocks are important determinants of current account movements; however, a set of global and country-specific productivity shocks alone cannot explain a country's current account[13]. A set of macroeconomic variables help to improve the fitness of regression for developing countries but can worsen the adjusted R-squared for euro countries. It is not surprising that different mechanisms of current account adjustment work for different groups of countries, i.e., developed and developing countries, because there are many differences in terms of monetary policy, exchange rate systems, tariffs and trade regulations between the two groups. This result suggests that policymakers should search for a framework in which the current account adjusts through its own country-specific mechanism.

[13] Attanasio and Weber (2010) question the validity of strong assumption of economic agents being able to solve the intertemporal optimization problem as in the standard macroeconomic models

3. Financial structure, capital openness and financial crisis[14]

3.1 Background

Several large-scale financial crises have ravaged the world over the past two decades. The first was the Asian financial crisis of 1997, and the second was the global financial crisis of 2008. These financial crises have revealed the vulnerability of economic systems in both developed and developing countries. Many countries have been prone to financial crises both in the past and at present, and some are on the verge of a crisis. Because the determinants and impacts of financial crises vary by the type of crisis and by country, it is critical to identify the determinants of each kind of crisis in various settings. Numerous works have made an effort to investigate this issue from various perspectives.

Two main empirical approaches have been adopted in the relevant literature. The first group of studies focuses on clarifying the determinants of financial crises. For instance, Gourinchas and Obstfeld (2012) analyze the effects of the twenty-first century's first global crisis and suggest that domestic credit expansion and real currency appreciation have been the most robust predictors of financial crises for both developed and developing countries. Davis et al. (2016) estimate a probabilistic model to find the marginal effect of private sector credit growth on the probability of a banking crisis. Davis et al. (2016) introduce an economic model as a system for predicting crisis events that was very popular in the periods following the Tequila and Asian financial crises. Specifically, many researchers have focused on abnormal changes occurring before a crisis event. Sachs et al. (1996) report that overvalued exchange rates and lending booms coupled with low international reserves are necessary conditions for crises. Kaminsky and Reinhart (1999) find that after a prolonged boom accompanied by an overvalued currency, the appreciation of a real exchange rate episode can trigger a crisis.

Several works have also reported that the financial structure, whether bank based, market based or a combination of the two, matters for economic performance. Such studies describe the superiority or inferiority of different financial structures by focusing on their political, legal, and protective aspects, among other factors. One of the most common approaches involves classifying countries' financial systems as either bank- or market-based. For countries such as Germany and Japan, the bank-based financial structure has a positive effect on the economy because it offers advantages in terms of (1) acquiring information about firms to improve capital allocation and corporate governance,

[14] This chapter is based on the original publication of (Financial structure, capital openness and financial crisis) and numerous modifications are made to the original work.

(2) managing risk and enhancing investment efficiency and economic growth, and (3) mobilizing capital to achieve economies of scale. On the other hand, in countries such as the US and UK, the market-based financial structure has positive effect on their economies by (1) creating stronger incentives for research firms, (2) enhancing corporate governance by easing takeovers, and (3) facilitating risk management (Levine, 2002). In the early empirical literature, supporting evidence is provided for both types of financial structures. However, especially in recent years, more studies appear to report the superiority of market-based financial structures over bank-based ones. For example, state-owned banks are associated with less economic growth because they tend to supply credit to fully developed industries rather than to strategic industries, where innovation and opportunities for growth are more feasible (La Porta, et al. 2002). In the post-financial-crisis period, market-based economies exhibit significantly and consistently stronger rebounds than bank-based economies (Beck, et al. 2002). The banking sector played an important role in earlier years of economic growth, but in recent years, the stock market has played an even more important role in economic growth (Lee, 2012). Finally, some works find no merits for either bank- or market-based structures and argue that the overall development of financial systems, i.e., efficient legal systems and efficient capital allocation, is more important (Levine, 2002; Beck and Levine, 2002).

In considering arguments for the role of financial structure on economic development, we believe that it is important to empirically test whether financial structure affects the likelihood of a financial crisis. A number of existing works in the financial crisis literature have focused on the financial vulnerability of developing countries. Some studies have had similar objectives as those of the present work. Frost and Saiki (2014) find that a more open capital account decreases the probability of currency crises. Kim et al. (2013) show that restrictions on the banking sector and entry requirements have decreased the likelihood of banking crisis, while at the same time, capital regulation and government ownership of banks have increased the likelihood of a currency crisis. Ji et al. (2019) find that a more market-based structure can reduce systemic risks facing the banking sector in China.

Following the line of research described above, our main objective is to clarify whether and how financial structure and capital openness affect the likelihood of a financial crisis. We apply binary models, which include financial structure, capital openness and their interaction terms on the right-hand side, to 38 countries for the period of 1996-2016. Our empirical results can be summarized as follows. First, via a panel probit regression, we find that financial structure, capital openness and their interaction term play an important role in reducing the likelihood of a currency crisis but have no effect on banking crises.

Second, after adding a set of control variables and changing the regression method, our qualitative results remain almost unchanged. We also find that while they have no effect on currency crises, the likelihood of a banking crisis is susceptible to changes in the VIX index, international reserves and the degree of democratic governance.

Considering these results, this sction primarily focuses on differences in countries' financial structures. We seek to explain the relationship between financial structures, capital openness and financial crises. To the best of our knowledge, this is the first research to systematically investigate the impact of long-term financial structure data and interactions between financial structures and both types of financial crisis.

The remainder of this chapter is organized as follows. Section 2.2 presents our data and variables. Section 2.3 discusses the link between the probability of financial crises and financial structures. Section 2.4 presents the results of our sensitivity analysis. Section 2.5 concludes.

3.2 Data

With this study, we aim to clarify the financial crisis formation process over the long term and for a large sample of countries. Due to the availability of both financial structure and capital openness database, the study period covers 1996 to 2016 for 38 countries; the number of observations made varies with the availability of variables included in the regression.

3.2.1 Financial crisis

We first use Laeven and Valencia's (2018) financial crisis database[15]. These authors define a banking crisis as an event that satisfies the following two conditions: (1) significant financial distress in the banking system and (2) significant banking policy intervention measures in response to significant losses in the banking system. Significant policy intervention is considered to include at least three of the following six measures: deposit freezes and bank holidays; significant nationalization; bank restructuring costs (3% of GDP); extensive liquidity support (5% of deposits and liabilities to nonresidents); significant bank guarantees; and significant asset purchases (5% of GDP).

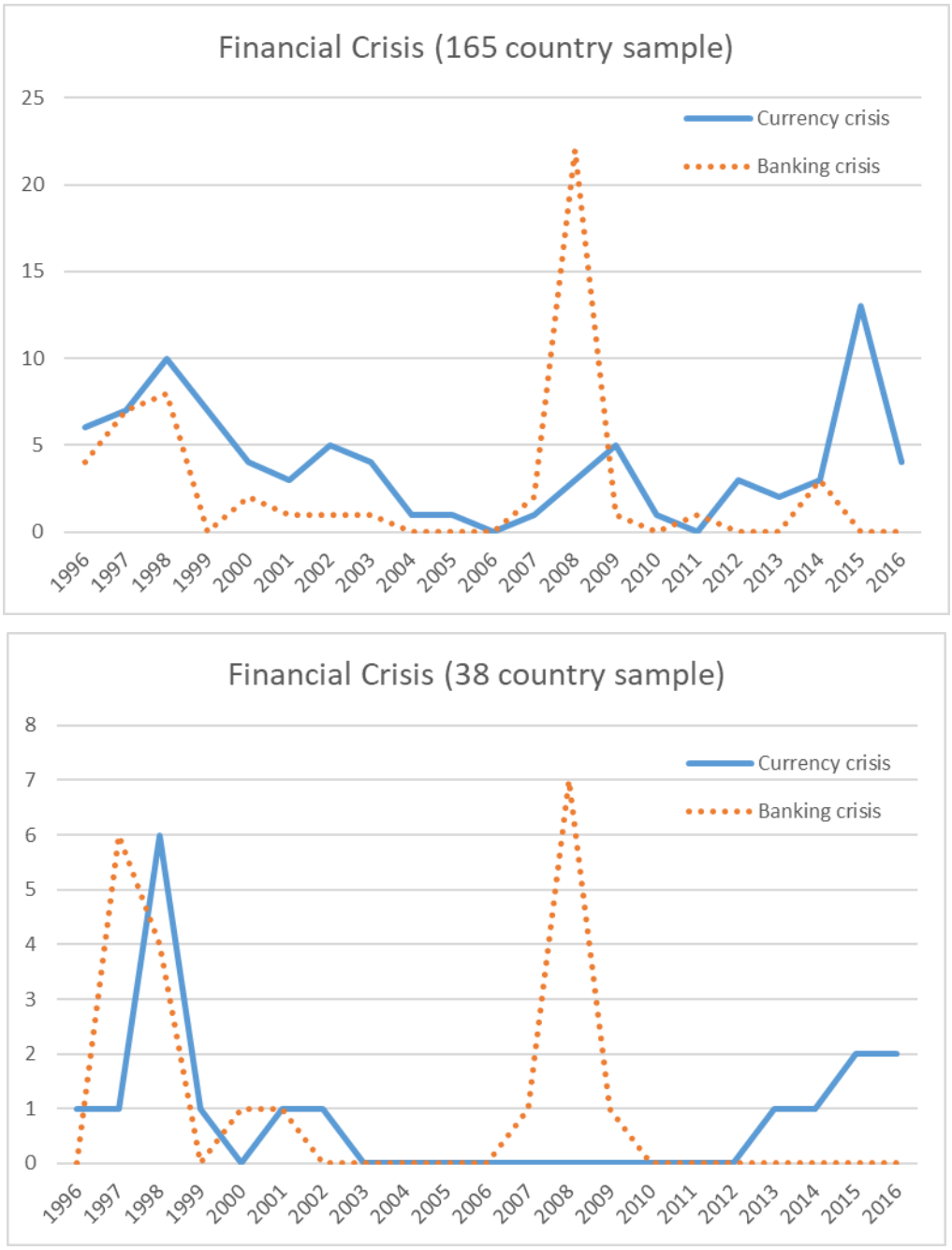
The authors define a currency crisis as involving a significant depreciation of the domestic currency against the US dollar. Significant depreciation is defined as meeting two conditions: (1) a depreciation of the currency vis-à-vis the US dollar of at least 30% relative to the previous year and (2) at least a 10% higher rate of depreciation than that

[15] https://www.imf.org/en/Publications/WP/Issues/2018/09/14/Systemic-Banking-Crises-Revisited-46232

observed in the previous year.

A crisis may continue over a number of years, or one crisis (of less than 12 months) may follow after another crisis (of less than 12 months); Laeven and Valencia's (2018)

Figure 3-1 Distributions of the two types of financial crisis for 1996 to 2016



Source: IMF Laeven and Valencia Database

database, however, only contains information denoting whether a crisis is observed in a given year. This limitation makes it difficult to distinguish an ongoing crisis from a new

crisis, as multiple years of crisis observations are included in the database, further leading to econometric endogeneity problems because the macroeconomic explanatory variables used to predict a crisis in the later years of a crisis are themselves affected by the earlier years of the crisis. We follow the convention outlined by Demirgüç-Kunt and Detragiache (2005) and simply omit crisis years following the initial year in our basic analysis. We will handle this problem in section 3.5 for robustness check.

Figure 3-1 plots the occurrence of the two types of financial crises, i.e., currency and banking crises, over the past twenty years for 165 countries. As presented in Figure 3-1, both crises show a two-modal distribution: the occurrence of banking crises is concentrated in approximately 1997 and 2008, whereas currency crises are concentrated in 1998 and in recent years.

For data constraints, our sample includes 38 advanced and emerging countries for the period 1996-2016. Table 3-1 (a) shows the sampled countries and (b) lists all 21 systemic banking crisis and 17 currency crisis events occurring from 1996-2016 and displays the crisis distributions. We find that global banking crisis incidence peaks during the 1997 Asian crisis and with the bankruptcy of Lehman Brothers in 2008, while currency crises are frequent after the after Asian crisis and peak again in 2015[16].

Table 3-1 Sampled countries and financial crisis events

(a)

Argentina	Hungary	Mauritius	Singapore
Australia	India	Mexico	Slovenia
Brazil	Indonesia	Morocco	South Africa
Chile	Ireland	Nigeria	Spain
China	Israel	Norway	Switzerland
Colombia	Japan	Pakistan	Thailand
Croatia	Jordan	Peru	Turkey
Egypt, Arab Rep.	Korea, Rep.	Philippines	United States
Germany	Lebanon	Poland	
Greece	Malaysia	Russian	

[16] As represented by Kaminsky and Reinhart (1999), some previous research also emphasized the "twin crisis" which is simultaneous occurrence of banking crisis and currency crisis. But Table 3-1 (b) shows that twin crises rarely happen during our sample period and countries. So, in this chapter, we will examine the determinants of banking and currency crises independently.

(b)

Banking crisis		Currency crisis	
Argentina (2001)	Korea (1997)	Argentina (2002, 2013)	Thailand (1998)
China (1998)	Malaysia (1997)	Brazil (1999, 2015)	Turkey (1996, 2001)
Colombia (1998)	Philippines (1997)	Egypt (2016)	
Croatia (1998)	Russian (1998, 2008)	Indonesia (1998)	
Germany (2008)	Slovenia (2008)	Korea (1998)	
Greece (2008)	Spain (2008)	Malaysia (1998)	
Hungary (2008)	Switzerland (2009)	Nigeria (1997, 2016)	
Indonesia (1997)	Thailand (1997)	Philippines (1998)	
Ireland (2008)	Turkey (2000)	Russian (1998, 2014)	
Japan (1997)	United States (2007)	South Africa (2015)	

Source: IMF Laeven and Valencia Database

3.2.2 Financial structure

For financial structure variables, we use the financial structure database (updated July 2018) developed by Beck et al. (2000, 2009) and Čihák et al. (2012)[17]. Three variables are related to banking sector activity, and two are related to equity market development. The first four variables are constructed as the ratio of the two-year average of the financial variable to real GDP in the current year. The formula used is as follows:

$$\{(0.5) * [F_t/P_{et} + F_{t-1}/P_{et-1}]\}/[GDP_t/P_{at}]$$

where F_t denotes financial data for period t, GDP_t is nominal GDP in period t, P_{et} is the consumer price index (CPI) of end-of period t, and P_{at} is the annual average CPI for period t.

Private credit by deposit money banks to GDP (prcb): Private credit by deposit money banks to GDP is calculated from the above formula: F_t is credit to the private sector in period t. These variables are drawn from the IFS database of the IMF. IFS indicator codes include FOSAOP, PCPI, and NGDP for F, P, and GDP, respectively.

Stock market capitalization to GDP (smcap): This variable is the ratio of the value of listed shares to real GDP. F is stock market capitalization. The original data are drawn from the World Federation of Exchanges and Standard and Poor's Emerging Market Database.

Stock market total value traded to GDP (smtrd): F is total shares traded on the stock market exchange to GDP (World Federation of Exchanges and Standard and Poor's Emerging Market Database).

Bank overhead costs to total assets (overhead): This last variable does not use the

[17] https://www.worldbank.org/en/publication/gfdr/data/financial-structure-database

above formula. It denotes the accounting value of a bank's overhead costs as a share of its total assets. The original data are taken from the Bankscope and Orbis Bank Focus databases.

Following the methodology proposed by Levine (2002), we construct three indicators that proxy for finance *size*, *activity*, and *efficiency*. They are defined as follows. Finance *size* is the logarithm of the ratio of stock market capitalization to private credit. *Activity* is the logarithm of the ratio of the stock market's total value traded to private credit. Efficiency is the logarithm of the ratio of the stock market's total value traded times overhead costs[1819]. For financial structure (FS), i.e., the main variable used in our study, we use the first principal component of the size and activity indicator variables following Allen et al (2018). We also use the first principal component of size, activity and efficiency as an alternative financial structure index (FS_alt), and we use this alternative index for a robustness check of our main results in Section 3.5.

Financial structure is concerned with the development of domestic financial institutions and markets. The degree to which external factors may affect currency crises and banking crises depends on how open and accessible financial markets are to foreign investors. To address this external channel, we include capital account openness (*KAO*) as an explanatory variable in the crisis regression. This variable is Chinn and Ito's (2008) capital account openness index. *KAO* is based the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.

3.2.3 Other control variables

In addition to financial structure and capital openness, we consider other explanatory variables that have been shown to have a significant influence on financial crises in previous studies. These include the reserve to GDP, inflation, political factors and the volatility of global financial markets. We review our financial crisis analysis of these potentially important variables based on a bivariate-dependent variable panel regression

[18] As Levine (2002) also points out, the calculation of efficiency may cause problems. Instead of our efficiency index, Kim et al (2013) and Allen et al (2018) consider the ratio of value traded to overall costs of the bank sector as relative efficiency because the total value traded may reflect the efficiency of market, and conversely, overhead costs reflect banking sector inefficiency. However, the application of market efficiency to bank efficiency will introduce considerable bias. It is more reasonable to consider a higher value as denoting a more market-based financial structure. Consequently, for the calculation of efficiency, we use the original methodology given by Levine (2002).

in this section.

Reserves to GDP (RES): This variable is defined as total official reserves excluding gold to GDP. As an indicator of international liquidity, a shortage of foreign reserves can become an immediate cause of a currency crisis. As Catao and Milsei-Ferretti（2014) and Frost and Saiki (2014) have confirmed, we expect this variable to have a negative effect on currency crises.

Inflation (INF): The theoretical effect of inflation is ambiguous from both positive and negative points of view. On one hand, inflation has negative effects by increasing the opportunity cost of holding money; on the other hand, inflation reduces the real value of debt and unemployment. Some previous studies identify a negative impact of inflation on economic growth, leading to an increase in the likelihood of a banking crisis (Kaminsky and Reinhart, 1999). Conversely, some studies find no evidence of inflation affecting banking crisis (Guerineau and Leon, 2019).

Polity (POL): Data for this variable are taken from the POLITY IV dataset. The variable is computed by subtracting the institutionalized autocracy score from the institutionalized democracy score. We use the extended version of the POLITY variable to facilitate our use of the POLITY regime measure in our time-series analyses. We expect a country with a lower polity score to be more likely to fall into financial crisis.

VIX: As a proxy variable expressing global uncertainty, we include a theoretical expectation of stock market volatility in the near-future VIX index. VIX has been confirmed to be negatively correlated with the likelihood of a banking crisis (Cesa-Bianchi, 2019).

3.2.4 Summary Statistics

Table 3-2 provides descriptive statistics for the independent variables. Of the variables related to financial structure, Activity and Efficiency show higher variability than Size. FS, an index representing financial structure, shows less variation than Activity and Efficiency, whereas the Alternative financial structure index (*FS_alt*) shows more volatility.

The unconditional correlations between these variables are presented in Table 3-3. The correlations between Size and Activity and Efficiency are valued at nearly 0.4, whereas activity and efficiency have a strong correlation of over 0.9. Similarly, correlations between Financial structure and Size and Activity are valued at nearly 0.45. As expected, the correlation between Financial structure (*FS*) and Alternative financial structure (*FS_alt*) is high at approximately 0.95. We use *FS_alt* as an alternative proxy variable to Financial structure. Notably, there seems to be no relationship between the capital

openness and financial structure variables. As a preliminary check to determine whether there is any relationship between our key financial variables and the prosperity of countries, we also compute correlations between GDP per capita and the financial variables. From the results, we confirm a strong correlation between capital openness and GDP per capita and a comparatively weaker correlation between activity and efficiency and GDP per capita, but there appears to be no correlation between GDP per capita and the two financial structure indices. From these results, we assume that financial structure is not only a proxy of economic growth (since, in general, a more developed country may have a larger financial market) but also related to other factors.

Table 3-2 Descriptive Statistics

	Obs.	Mean	S.Dev	Min	Max	Median
Size	798	-0.13	0.69	-2.46	1.64	-0.14
Activity	798	-1.23	1.31	-5.17	1.64	-1.03
Efficiency	798	3.55	1.45	-0.61	7.94	3.72
Financial structure (FS)	798	0.00	1.26	-3.74	3.36	0.02
FS_alt	798	0.00	1.51	-4.50	3.93	0.07
Capital openness	798	0.73	1.43	-1.91	2.36	1.07
Inflation rate (%)	798	5.82	9.69	-5.99	143.69	3.67
Reserves to GDP	798	0.19	0.18	0.00	0.99	0.15
Polity	789	6.27	5.10	-7.00	10.00	8.00
VIX	798	20.73	5.80	12.81	32.69	21.98

Source: IMF International Financial Statistics, World Development Indicators, Financial Structure Database, Polity IV Project, CBOE Volatility Index, and author's own calculations.

Table 3-3 Correlations between the variables

	Size	*Activity*	*Efficiency*	*Financial structure*	*Aggregate*	*Capital openness*	*Inflation rate*	*Reserves to GDP*	*Currnet account*	*VIX index*	*GDP per capital*
Size	1.000										
Activity	0.450	1.000									
Efficiency	0.371	0.899	1.000								
Financial structure (FS)	0.491	0.462	0.382	1.000							
FS_alt	0.445	0.492	0.398	0.949	1.000						
Capital openness	-0.089	0.019	0.062	0.041	0.074	1.000					
Inflation rate	0.124	0.041	-0.027	0.017	0.004	-0.325	1.000				
Reserves to GDP	0.158	0.078	0.102	0.107	0.107	0.092	-0.142	1.000			
Polity	-0.008	-0.032	0.025	0.001	-0.004	0.280	-0.057	-0.397	1.000		
VIX index	-0.058	0.089	0.075	0.058	0.092	-0.009	0.053	-0.038	-0.002	1.000	
GDP per capital	-0.111	0.189	0.211	-0.011	0.011	0.596	-0.262	0.034	0.339	-0.064	1.000

Note: Correlations are calculated for the full sample period of 1996-2016.

3.3 Methodology

Using a single method is limited to focusing on only one variable's threshold and ignores the information provided by other variables. In this sense, the binary response models can make the best possible use of information provided by all explanatory variables (Demirgüç-Kunt and Detragiache, 2005). We use a binary response models for panel data approach in this chapter[20]. To investigate the relationship between financial structure and capital openness with respect to financial crises, we estimate the following panel OLS regression equation (3-1) as a base model:

$$Pr(Crisis_{it} = 1) = \alpha_0 + \alpha_1 FS_{it} + \alpha_2 KAO_{it} + \alpha_3 FS_{it} \times KAO_{it} + \varepsilon_{it} \qquad (3-1)$$

where $Crisis_{it}$ is a dummy variable of one when a banking or currency crisis event occurs in country i and in year t and zero otherwise. FS_{it} is a country's financial structure defined as an index indicating whether a country is bank- or market-based where a higher value of this index means that a country is more oriented toward a market-based economy. KAO_{it} is the value of the Chinn-Ito capital openness index. The Chinn-Ito index is based on binary dummy variables that the IMF classifies as restrictions on cross-border financial transactions.

The effect of capital openness on financial crises may depend on the financial structure. We expect the effect of capital openness to be stronger in a more market-based economy. Because the interaction between financial structure and capital openness may have an important effect on the occurrence of a financial crisis, we also evaluate the influence of the interaction term $FS_{it} \times KAO_{it}$ on financial crises. This interaction term can be problematic because both financial structure and capital openness variables can take both positive and negative values, so that interaction term indicates positive for case (i) financial structure and capital openness are both positive, and case (ii) financial structure and capital openness are both negative. We will address this problem in section 3.5 with two alternative methods; however, the qualitative results remain almost unchanged.

As financial shocks are transmitted to both banking and currency crises quickly, we assume that using the current year's explanatory variables is appropriate. If the explanatory variables are lagged by one year, the true correlation between the crisis and macroeconomic variables may be distorted[21]. Thus, we use year t on the right-hand side

[20] Specific methodological econometric issues of panel binary regression can be found in Greene (2012) and Wooldridge (2010).

[21] Considering the endogenous problem, that macro variables can also be affected by the crisis event. We have also checked the effect of financial structure and capital

of the regression model for year t. This approach is commonly used in studies in the literature (Gourinchas and Obstfeld, 2012; Davis et al, 2016). However, we are also concerned with endogeneity problems where independent variables are influenced by the crisis itself. Our dataset includes 38 sample countries with 20 having experienced banking crisis events and 12 having experienced currency crisis events. We expect including both crisis and noncrisis countries to control for the reverse causality of crisis to independent variables and to mitigate bias in our regression results.

$$Pr(Crisis_{it} = 1) = \alpha_0 + \alpha_1 FS_{it} + \alpha_2 KAO_{it} + \alpha_3 FS_{it} \times KAO_{it} + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \quad (3-2)$$

Finally, we add a vector of control variables as in equation (3-2) to check the robustness of the results of our key variables, i.e., financial structure and capital openness. $\boldsymbol{X_{it}}$ is a vector that includes the inflation rate, official reserves, the current account and the CBOE volatility index (VIX), i.e., a popular measure of the stock market's expected volatility.

3.4 Empirical results

In this section, we empirically investigate whether financial structure and capital openness affect the likelihood of the two types of financial crises by estimating the regression equations presented in the previous section. As emphasized by Cameron and Miller (2015), failure to control for within-cluster error correlation can misleadingly lead to small standard errors, and thus consequently narrow confidence intervals. Our regression models group sample countries into clusters, with errors uncorrelated across clusters but correlated within cluster (cluster-robust standard errors). The primary results are based on the panel probit model[22]. Column (i) and (ii) of Table 3-4 report results for the estimated coefficient and for the marginal effects of regression equation (3-1).

The results for currency crisis listed in column (ii) show that capital openness, financial structure and their interaction are significant, which means that the more market-based the financial system is and the more open capital accounts are, the less likely a country is

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openness in year $t-1$ to financial crisis in year t. The qualitative results remain unchanged, but the synergy effect becomes less clear.

[22] Since regular specification tests applied in a linear model, such as the Hausman test, cannot be directly applied in a binary dependent variable model, we estimated all pooled, random and fixed effect models. Because it can estimate partial effects for the specific countries in which we are interested, we present the results of the random effect model as our main results. The qualitative results remain unchanged for two other specifications and the corresponding results are available upon request.

Table 3-4 Random-effect probit model panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.122	-0.495 ***	-0.194 *	-0.463 ***
	(0.083)	(0.152)	(0.100)	(0.151)
KAO	0.017	-0.806 ***	0.031	-0.679 ***
	(0.067)	(0.260)	(0.088)	(0.253)
FS*KAO	0.022	-0.276 **	0.022	-0.242 **
	(0.052)	(0.120)	(0.060)	(0.119)
POL			-0.043 *	0.001
			(0.023)	(0.024)
VIX			0.109 ***	0.009
			(0.024)	(0.024)
RES			-4.578 ***	0.012
			(1.541)	(1253)
INF			0.004	0.017 ***
			(0.008)	(0.006)
Marginal effect				
FS	-0.007	-0.021 ***	-0.010 *	-0.018 ***
	(0.005)	(0.007)	(0.005)	(0.007)
KAO	0.001	-0.033 ***	0.002	-0.027 **
	(0.004)	(0.012)	(0.004)	(0.011)
FS*KAO	0.001	-0.011 **	0.001	-0.010 *
	(0.003)	(0.005)	(0.003)	(0.005)
POL			-0.002 *	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.001)	(0.001)
RES			-0.232 ***	0.000
			(0.084)	(0.050)
INF			0.000	0.001 ***
			(0.000)	(0.000)
Cons	-1.971 ***	-2.596 ***	-3.782 ***	-2.860 ***
	(0.111)	(0.338)	(0.637)	(0.650)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.971	-64.230	-75.031	-60.092

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 3.2.

to fall into a currency crisis. Our result of capital openness being associated with a lower probability of a currency crisis is consistent with the findings of Frost and Saiki (2014), and the combined effects of capital openness within the financial structure, including both level and interaction term effects, can be strengthened nearly twofold. Our finding of financial structure and capital openness working in the same direction in preventing financial crises corroborates the empirical work of Dal Bianco et al. (2017), according to whom capital openness helps mitigate the negative impact of an external shock but is conditional on the level of financial development.

However, there appears to be no association between financial structure and banking crises. Additionally, echoing the results reported in Davis et al (2016), we confirm that capital openness has no effect on banking crises.

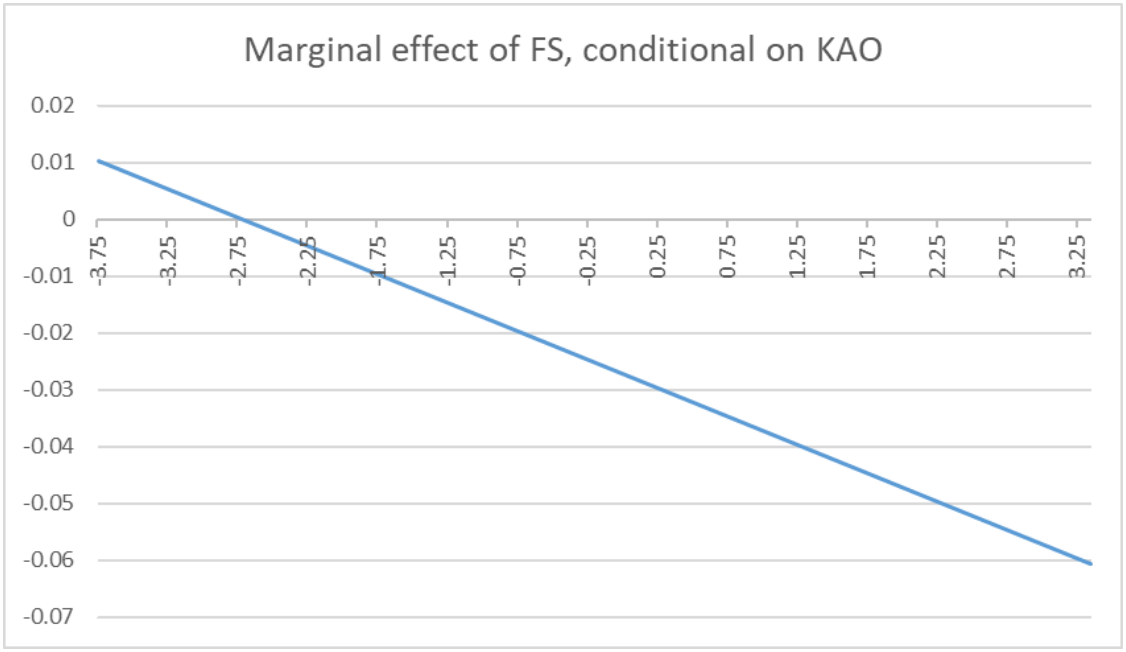
Next, we add a set of control variables to the model[23] as in regression equation (3-2), and columns (iii) and (iv) of Table 3-4 report the estimated results. Both the signs of the coefficients and the statistical significance of the key variables, i.e., *FS* and *KAO*, remain unchanged. From column (iii) of Table 3-4, we find that Polity, the VIX index and Reserves to GDP have statistically significant impacts on banking crises. More precisely, a higher VIX index is associated with an increased probability of a banking crisis, and conversely, a higher reserve rate and polity score can reduce the probability of a banking crisis. For the currency crisis results listed in column (iv), in contrast to financial structure and capital openness, a higher inflation rate is associated with a higher probability of a currency crisis. From these results, it is clear that banking crises are influenced by the polity score, VIX index and reserve rate but are not affected by financial structure or capital openness, whereas currency crises are greatly affected by financial structure.

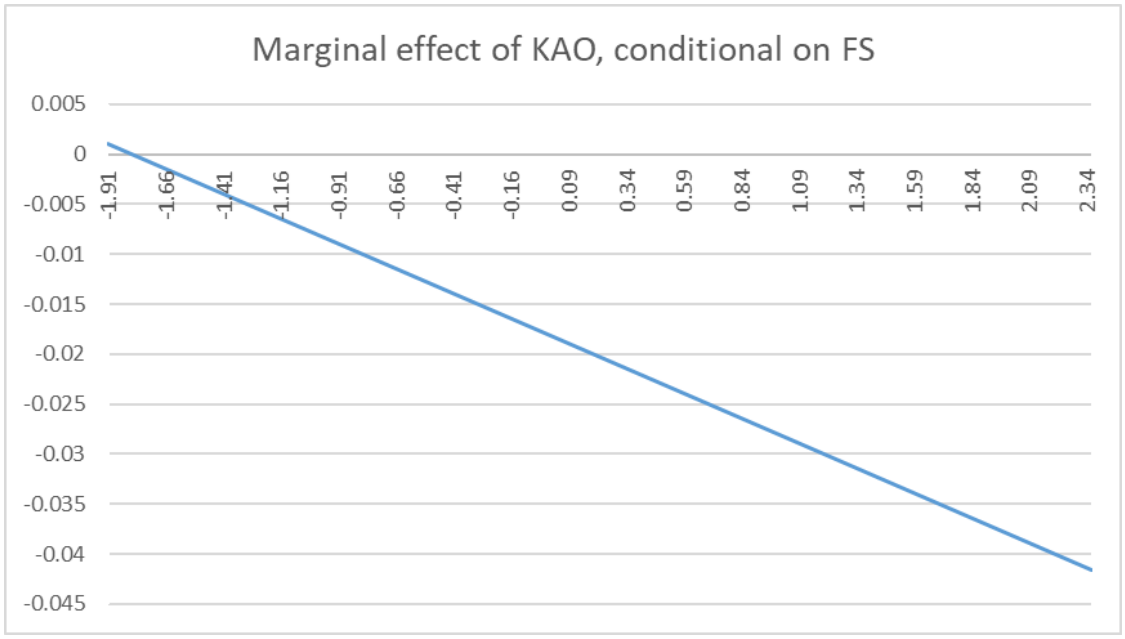
In order to be more specific about the effect of capital openness and financial structure to currency crisis, based on the results of column (iv) of Table 3-4, we plot the marginal effect of capital openness conditional on financial structure, and the marginal effect of financial structure conditional on capital openness, separately. Figure 3-2 shows that both capital openness and financial structure have a negative marginal effect on currency crisis in almost all cases. But for an extremely banking based financial system (below -2.7) and low capital openness (below -1.8), the marginal effect may work in the opposite direction.

From the results of our basic and extended models, we can draw the following two conclusions. First, a more market-based financial system in a country is more likely to prevent a currency crisis but does not affect the probability of banking crises. Second, a more open capital account strengthens the negative relationship between market-based

[23] Due to missing polity data for Lebanon, we needed to decrease the size of our country sample from 38 to 37 countries.

Figure 3-2 Marginal effect of capital openness and financial structure to currency crisis





Note: Based on the results of column (iv) of Table 3-4

financial systems and currency crises. For a country with a market-based financial system, a more open capital account further reduces the probability of a currency crisis. Laeven et al. (2016) provide some supporting evidence based on a perspective that differs from ours. The authors argue that systemic risk grows with bank size and is inversely related to bank capital and that this effect exists above and beyond the effect of bank size and capital on independent bank risk. Our empirical results demonstrate that more reliance on market-based finance can mitigate the vulnerability of economic systems in both developed and developing countries. Moreover, Langfield and Pagano (2016) argue that the over expansion of the banking sector is not only associated with more systemic risk but also with less economic growth. With the development of the world's economies over the last few decades, both bank- and market-based financial sectors have become larger. However, economic yield sensitivity to bank development has also decreased, while its sensitivity to market development has increased (Demirgüç-Kunt et al, 2013). Overall, we expect both developed and developing countries to focus on a more developed market-based financial sector in the future, which will benefit economic growth and stability.

From the results of our basic and modified models, we can draw the following conclusions. First, countries with a lower probability of experiencing currency crises are more likely to have a market-based system, but a weaker relation to banking crises is found. Second, capital account openness is associated with this relationship. For a market-based country with more open capital accounts, the probability is further reduced. Laeven et al. (2016) provide further proof of this trend from the opposite perspective. The authors argue that systemic risk grows with bank size and is inversely related to bank capital and that this effect exists above and beyond the effect of bank size and capital on independent bank risk. We believe that a relatively more active market sector can mitigate the vulnerability of economic systems in both developed and developing countries. Simultaneously, an overexpansion of the banking sector is associated with more systemic risk and less economic growth (Langfield and Pagano, 2016). With the development of the world's economies, both bank and market sectors have been become more developed. However, the sensitivity of economic yields to bank development has also decreased, while their sensitivity to market development has increased (Demirgüç-Kunt et al, 2013). Overall, we expect a more developed market sector to be more important in the future in terms of both economic growth and stability.

3.5 Robustness Check

Our main results show that a more market-oriented financial structure can strengthen

vulnerable currencies and that a more open capital account can magnify this effect. After adding a set of control variables to our base model, these results do not change. In this section, we further check the robustness of our results in the following four respects. First, we use a different transformation of our binary dependent variable by implementing the logistic panel method instead of the probit method used in the above section. Second, as mentioned in section 3.3, interaction term can be problematic because both financial structure and capital openness variables can take both positive and negative values. We will suggest two alternative approaches to this problem. Third, we also consider an alternative financial structure. The current financial structure index is based on two of three underlying variables, namely, size and activity. We also construct another financial structure index based on all three underlying variables, including efficiency. The estimated result is broadly similar to the results shown in Section 3.4. Fourth, we consider an alternative econometric estimation model, i.e., the fixed-effect logistic model with cluster-robust standard errors. We introduce one caveat in applying this estimation model to our sample countries: we include countries that did not experience a crisis during the sample period. For these countries, the dependent variable is completely explained by the country dummy, and therefore, the data are automatically removed from the regression process. Fifth, to avoid the possibility of macroeconomic explanatory variables being affected by the crisis itself, we adopt a two-year window to exclude the years after the crisis. We thus also re-estimate the random effect model for the subsample of countries experiencing a financial crisis and compare the result of the fixed-effect logistic model to that of the random effect model for the same countries. Finally, we adopt the receiver operating characteristic (ROC) curve to test the predictive capacities of our models.

Logistic panel model

We obtain almost the same result from the logistic method for our basic and extended models, presenting the same coefficient sign and statistical significance and similar marginal effects. From columns (i) and (iii) of Table 3-5 for banking crises, we find that the coefficients of Polity and Reserves are negative and statistically significant, and the coefficients of VIX are positive and statistically significant. Financial structure is statistically significant only in the extended model, echoing the results of the probit estimates. Columns (ii) and (iv) show that financial structure and capital openness remain as important factors related to decreasing changes in a currency crisis.

Table 3-5 Random-effect logistic model panel robust estimates for banking and currency crises

Dep Var	Basic model		Extended model	
	Banking crisis	Currency crisis	Banking crisis	Currency crisis
	(i)	(ii)	(iii)	(iv)
Coefficient				
FS	-0.310	-1.055 ***	-0.494 **	-1.005 ***
	(0.204)	(0.299)	(0.232)	(0.302)
KAO	0.050	-1.712 ***	0.087	-1.488 ***
	(0.165)	(0.513)	(0.187)	(0.517)
FS*KAO	0.064	-0.563 **	0.096	-0.505 **
	(0.126)	(0.228)	(0.130)	(0.227)
POL			-0.109 **	0.000
			(0.050)	(0.052)
VIX			0.242 ***	0.021
			(0.053)	(0.052)
RES			-10.518 ***	0.464
			(3.542)	(2.708)
INF			0.006	0.029 **
			(0.017)	(0.011)
Marginal effect				
FS	-0.008	-0.021 ***	-0.012 **	-0.019 ***
	(0.005)	(0.007)	(0.006)	(0.007)
KAO	0.001	-0.033 ***	0.002	-0.028 **
	(0.004)	(0.012)	(0.004)	(0.011)
FS*KAO	0.002	-0.011 **	0.002	-0.010 **
	(0.003)	(0.005)	(0.003)	(0.005)
POL			-0.003 **	0.000
			(0.001)	(0.001)
VIX			0.006 ***	0.000
			(0.002)	(0.001)
RES			-0.251 ***	0.009
			(0.092)	(0.051)
INF			0.000	0.001 **
			(0.000)	(0.000)
Cons	-3.710 ***	-5.027 ***	-7.721 ***	-5.666 ***
	(0.275)	(0.690)	(1.462)	(1.421)
Obs.	798	798	777	777
Log pseudo-Likelihood	-95.897	-64.640	-74.672	-61.068

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. The first two columns, (i) and (ii), and the next two columns, (iii) and (iv), present the estimated coefficients and calculated marginal effects for regression equations (1) and (2), respectively. Dependent variables are binary, taking a value of one when a financial crisis is observed in year t and zero otherwise. FS is financial structure, KAO is capital account openness, POL is the democracy index, VIX is the stock market volatility index, RES is the ratio of official reserves to GDP, and INF is the inflation rate. For more precise definitions of these variables, see Section 3.2.

Alternative interaction term

The interaction term between financial structure and capital openness variables can be problematic because both variables can take both positive and negative values, so that interaction term indicates positive for case (i) financial structure and capital openness are both positive, and case (ii) financial structure and capital openness are both negative. In this section, we will suggest two alternative approaches to this problem.

Firstly, we distinguish the case in which both financial structure and capital openness are negative from other cases in which at least one of two variables are positive. Appendix figure A3-1 plots the distribution of banking and currency crisis, which the vertical axis represents financial structure and the horizontal axis represents capital openness. Interestingly, in the case financial structure and capital openness both have positive values, no currency crisis event has been observed. Appendix table A3-1 shows the result of basic and extended models. From columns (ii) of basic model, we find that after decomposing interaction terms to two separate indexes, the coefficients of both indexes are negative and statistically significant. For $FS_{it} \times KAO_{it}(1,2,4)$, it means the synergy effect of financial structure and capital openness remain as important factors related to decreasing the chance of currency crisis. On the other hand, negative significant coefficient of $FS_{it} \times KAO_{it}(3)$ means, for countries with banking based financial system and low capital openness, the synergy effect may work in opposite direction. However, this result is not robust because we cannot find significant effect in column (iv) of extended model,

Secondly, we use the capital openness index modified to [0,1] interval, instead of the original index with the range including both positive and negative values. In Table A3-2 we find results almost consistent with the main results, only difference appears in statistically insignificant coefficient for financial structure in a currency crisis regression. From these robustness check, we find financial structure is important factor via interacting with capital openness in explaining currency crisis.

Alternative financial structure index

Table A3-3 in the appendix provides the estimated results for an alternative financial structure index, which uses the first principal component of the efficiency variable and two variables used in the other financial structure index. Echoing the results of the currency crisis model, we obtain statistically significant coefficients for financial structure and capital openness; however, their interaction term is no longer statistically significant. We attribute this result to the problems with the efficiency calculation method mentioned in Section 3.2 (see footnote iii). Alternatively, the interaction effect of the two

variables may be not as intuitive as their direct effect on financial crisis[24].

Omitting countries without crisis experience

After removing countries not experiencing a crisis in the sampled period from the set of originally sampled countries, the results of the fixed-effect logistic regression based on the extended model with control variables are reported in Table A3-4 in the appendix. To make our comparison meaningful, we re-estimate random-effect logistic regressions for the reduced sample and present the results in Table A3-4. Even after limiting the number of sample countries, the results of the fixed effect and random models are similar to the estimated results for the full sample. From these results, we can confirm that the likelihood of a currency crisis is mainly affected by financial structure and capital openness, including their interaction term. In addition, the inflation rate still has a positive effect on currency crisis probability.

The results also show that in our model, the likelihood of a banking crisis is mainly affected by polity, the VIX index and Reserves to GDP. We also confirm that banking crisis likelihood is independent of financial structures and capital openness levels. Although we found a statistically significant negative effect of financial structure on banking crises from our extended model with control variables for the full sample of countries, from Tables A3-1 and A3-2 in the appendix, we suspect that the effect may not be robust.

Window regression

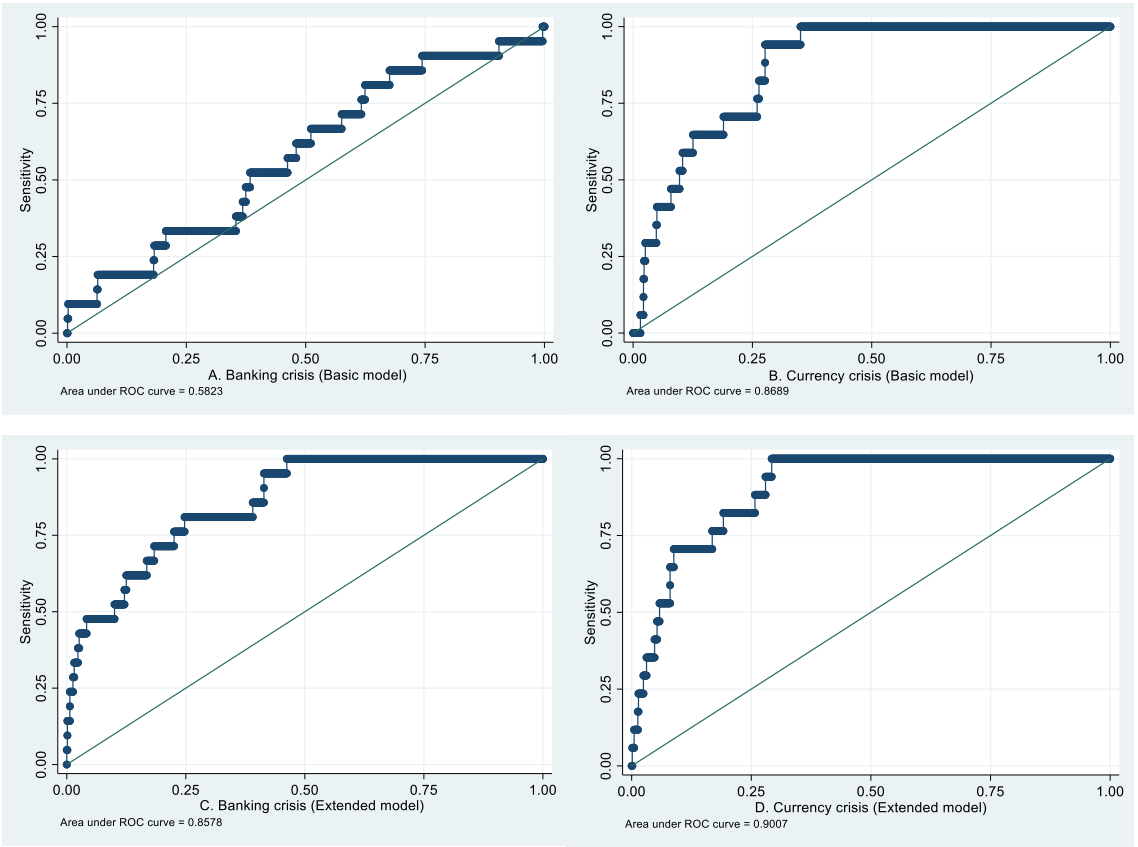
Laeven and Valencia's (2018) financial crisis database only identify the crisis occurrence year although crisis may continue over a number of years. To avoid the possibility of macroeconomic explanatory variables being affected by the crisis itself in the earlier years, we adopt a two-year window to exclude the years after the crisis. we re-estimate probit robust regressions for the reduced sample and present the results in Table A3-5. Columns (ii) and (iv) show for currency crisis that the results are similar to the estimated results for the full sample. On the other hand, from columns (i) and (iii), we find the coefficients of VIX are positive and statistically significant, but the coefficients of Polity and Reserves are no longer significant.

[24] We applied our two financial structure calculation to pooled, random and fix effect models; the qualitative results remained almost unchanged. To conserve space, we only show the FS_alt random effect results to facilitate a direct comparison.

Receiver operating characteristic curve

To test the predictive capacities of binary classifier models, the receiver operating characteristic curve (ROC) has been applied in many previous studies. This approach has been widely used in laboratory medicine in recent years. It is also used to test financial crisis predictive ability in Davis et al. (2016) and many previous studies. The ROC curve is created by plotting the true positive rate against the false positive rate. If the area under the ROC curve is 1, the model makes a perfect prediction. If the area under the ROC curve is less than 0.5, the model is considered to have no predictive ability because it predicts outcomes worse than random chance. The closer the ROC curve is to the upper left corner, the higher the overall accuracy of the test. The ROC curve results are presented in Figure 3-3.

Figure 3-3 Receiver operating characteristics (ROC) curves



Note: Points located above the diagonal represent good prediction results, and points positioned below the line represent poor prediction results. The best possible prediction method would yield a line that crosses the point in the upper left corner.

We plot the ROC curves for our basic and modified models using the logistic panel method[25]. The top two panels are based on the basic model with panels A and B pertaining to banking and currency crises, respectively. For banking crises, the area under the ROC curve is valued at approximately 0.58, indicating that the model has a nearly 58% chance of providing the correct signal. It is thus difficult to determine whether the model can predict a banking crisis occurrence. However, for currency crises, we obtain a ROC curve with an area of nearly 0.85 even without the interaction term between financial structure and capital openness, which is not shown in Figure 3-3. After including the interaction term in the model, the ROC curve moves upward to approximately 0.87. It is thus clear that our model performs well in the prediction of currency crises.

The ROC curves plotted based on our extended model are reported in panels C and D. Note that we removed one country (Lebanon) from the sample due to data restrictions. For banking crises, the area under the ROC curve rises to approximately 0.86. We confirm again the important roles of polity, the VIX index and reserves in predicting banking crises. For currency crises, the area under the ROC curve rises to approximately 0.90, and the inclusion of the inflation rate may have contributed to an increase in the predictive power. In summary, we believe that financial structure and capital openness in the basic model best predict currency crises, whereas polity, the VIX index, and reserves are more important in predicting banking crises.

3.6 Conclusion

In this chapter, we investigated the effect of financial structure and capital openness on the occurrence of two types of financial crisis: banking crises and currency crises. Our main results are summarized by the following four points. First, financial structure plays an important role in reducing the probability of a currency crisis. An economy with a more market-based structure is less likely to experience a currency crisis. Second, capital openness is also an important factor in the occurrence of a currency crisis. Higher capital openness is associated with a lower probability of a currency crisis. Third, capital openness can increase the effect of financial structure on a currency crisis. This means that a country with a more market-based structure is more likely to enjoy a more stable economy in terms of reducing a sudden drop in the value of its currency by maintaining a more open capital account. Fourth, in contrast to what is found for currency crises, both financial structure and capital openness have no effect on banking crises.

[25] We also plotted the figure using the logistic panel method and obtained nearly identical results.

These results have important two policy implications. First, as many studies have also shown (Gourinchas and Obstfeld, 2012 and Kim et al, 2013, among others), it is important to associate different types of crisis with different sets of macroeconomic conditions, especially for recent years. Restrictions on bank activities and entry requirements can lower the likelihood of a banking crisis. On the other hand, financial agency supervisory power can reduce the probability of a currency crisis. In particular, the banking sector has come to play a much larger role, and its growth has led to the accumulation of debt in credit and assets, which has increased the probability of a banking crisis (Reinhart and Rogoff, 2008). At the same time, financial market development can stabilize the foreign exchange market and mitigate information asymmetry, through which currency crisis likelihood can be reduced (Kim et al, 2013). Our analysis also confirms completely different sets of determinants of banking and currency crises. Second, developing countries must work simultaneously to foster the development of domestic financial markets and to open their capital accounts. Currently, a large set of capital controls tend to exist especially in countries in which domestic financial markets are relatively undeveloped and are more bank oriented. Frost and Saiki (2014) also point out that a closed capital account does not provide a country sufficient capacity to build a more robust financial market. In contrast, a country with a more developed and open financial market can mitigate currency sensitivity to external shocks.

This chapter's main purpose is to distinguish the response of different types of crisis to different sets of macro variables. However, it may be fruitful to analyze the effect of capital openness and financial structure for the twin crises as heighted by Kaminsky and Reinhart (1999). This chapter is left for future research. Moreover, capital openness is also known as a constituent of the impossible trinity of international finance. In a seminal work on trilemma configurations, Aizenman et al. (2010) suggest that a crisis spurs a comprehensive reevaluation of international macroeconomic policies and of the international financial architecture. Policy makers will have to face constraints on choices posed by such a trilemma. In contrast, both the present work and Forst and Saiki (2014) confirm that more capital open markets can lower the probability of a crisis. We believe that clarifying the direction of causality between financial crisis and trilemma policies will be an interesting challenge for future studies

4. "Impossible Trinity" Hypothesis: The causal Relation between Trilemma and Macro Policy Performance [26]

4.1 Background

The trilemma hypothesis in international economics states that a country can only achieve two but not all three policy goals: monetary independence, exchange rate stability, and free capital movement. Obstfeld et al. (2005) examined the movements of interest rates over more than 130 years (covering the gold standard, Bretton Woods, and post-Bretton Woods periods) and concluded that the constraints implied by the trilemma are largely borne out by history.

As a typical example, euro countries have chosen a pattern of exchange rate stability and free capital movement by giving up their monetary independence. Unfortunately, the euro crisis has demonstrated the fragility of this structure. Featherstone (2016) is suspicious of the extent to which a member country of the Eurozone can respond to domestic monetary issues. Hereafter, we use the term 'trilemma policy' to indicate a given combination of the three policy goals. How countries determine their trilemma policy is an issue that needs to be clarified to achieve sound and stable economic growth.

Several works have examined the relationship between trilemma policy and macroeconomic performance. Aizenman et al. (2010) find that greater monetary independence lowers output volatility while greater exchange rate stability is associated with greater output volatility. They also find that greater exchange rate stability and greater financial openness are linked with a lower inflation rate. Developing countries' trilemma policy variables such as exchange rate stability and financial openness are influenced by the core economies—the US, Japan and the Eurozone (Aizenman et al. 2016). Since 1990, the trilemma variables in developing countries have converged toward intermediate levels, characterized by managed flexible exchange rates and the use of sizable international reserves as a buffer with retention of some degree of monetary autonomy (Aizenman et al., 2013).

A question follows: Are policy-makers indeed forced to choose only two policy goals out of monetary independence, exchange rate stability, and free capital movement, in line with the impossible trinity hypothesis, or can they choose an optimal mixture of all three? How can a government set its trilemma policy at the optimal level?

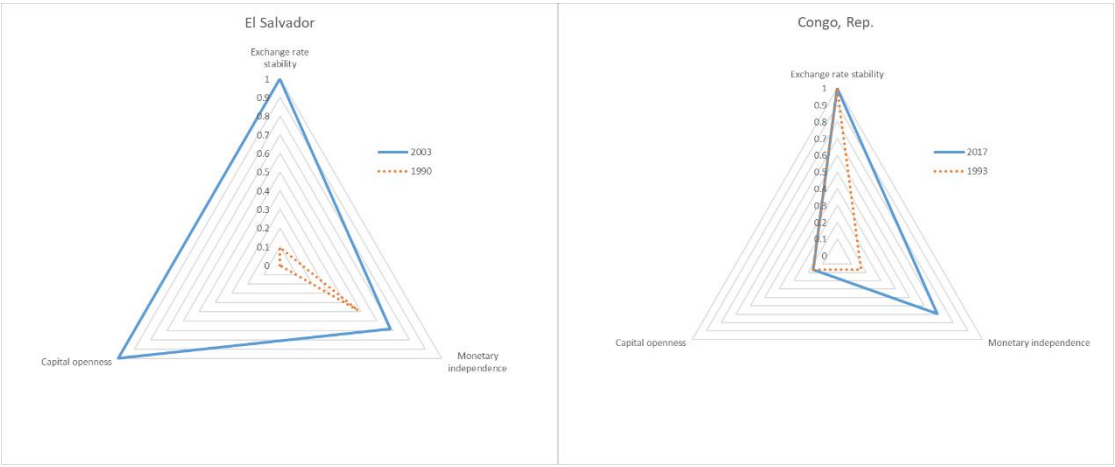
[26] This chapter is based on the original publication of ("Impossible Trinity" Hypothesis: The causal Relation between Trilemma and Macro Policy Performance) and numerous modifications are made to the original work.

By using the trilemma index, Aizenman and Ito (2014) found that countries respond to financial crisis experiences by adjusting their mixture of the three policy goals. We expect that financial crises and macroeconomic performance pressure may lead countries to reduce their trilemma policy integration from the optimal level.

To make the framework easier to understand, Figure 4-1 presents two extreme examples among our sample countries[27]. Panel (a) shows El Salvador, which experienced the most remarkable trilemma policy change among these countries during the sample period. As the most extreme case, El Salvador increased its exchange rate stability and capital openness from 0 to almost 1 in nearly ten years. The following specific features of El Salvador may be a reason for this drastic change. The smallest country in Central America, El Salvador has high exposure to natural disasters. As a result, El Salvador has suffered from a low level of economic growth during the past twenty years, despite its advantages for potential economic growth, such as its strategic location to access other markets and growing labor force.

Figure 4-1. Trilemma policy changes

(a) (b)



Note: Plotted by the max and minimum value during the full sample period from 1990 to 2017, large area means high level of trilemma policy integration. Source: The Trilemma Indexes

As the other extreme case, Congo is one of the countries with the most stable trilemma policies, as depicted in Panel (b) of Figure 4-1. There was no change in its exchange rate stability and capital openness and only a moderate change in its monetary independence

[27] We explain the specific calculation methods of the three trilemma policy variables in Section 4.2.

(from 0.1 to 0.7). Congo is richly endowed with natural resources and has had a stable economic growth rate since the 1990s. It is also a member of the Economic and Monetary Community of Central Africa (CEMAC, Communauté Économique et Monétaire de l'Afrique Centrale). Even when the region experiences economic deteriorations, such as during region-wide economic crises, to restore confidence in the common currency, Congo, along with other CEMAC partners, can make only fiscal policy adjustments. This is the reason for their relatively low level of monetary independence.

Following the studies described above in the literature, this paper first examines how trilemma policy affects economic performance, namely, output volatility and inflation, in developing and emerging countries. However, trilemma policy may, in turn, need to be reconsidered when changes in macroeconomic performance impose pressure on policy-makers. We thus also estimate reverse causality in this relationship. This feedback raises an endogeneity problem in our first regression, and we address it with instrumental variable estimation. To the best of our knowledge, this is the first paper to systematically investigate the direction of the causal relationship between trilemma policy and macroeconomic performance in general.

Our main objective is to clarify whether and how trilemma policy and macroeconomic performance affect each other. To clarify the effects of trilemma policy on economic performance, we apply robust OLS models[28]: We regress economic performance variables on three trilemma policy variables and a set of other control variables for 42 developing and emerging countries for the period of 1990-2017. Next, as an extension of Aizenman et al. (2013), we also focus on a possible causal effect of underlying macroeconomic conditions on a trilemma policy decision. This second regression has a trilemma index on the left-hand side and variables that potentially express home and foreign economic performance on the right-hand side.

Our empirical results can be summarized as follows. First, with our sample countries between 1990 and 2017, we find that only one trilemma policy variable out of the three affects macroeconomic performance: higher capital openness lowers output volatility and the inflation rate. Second, underlying economic conditions affect policy-makers' trilemma policy decisions. Among local economic variables, a high inflation rate and the occurrence of financial crises pressure a country to reduce the scope of its trilemma policy,

[28] As emphasized by Cameron and Miller (2015), a failure to control for within-cluster error correlation can misleadingly lead to small standard errors and consequently narrow confidence intervals. Our regression models group sample countries into clusters, with errors uncorrelated across clusters but correlated within clusters (cluster-robust standard errors).

leaving some space around the imposed limits. For global economic variables, a higher global risk in stock market pressure leads a country to reduce its financial integration with the rest of the world. Third, after we address the endogeneity problem with GMM estimation, we find that policy-makers tend to adjust the exchange rate stability and capital openness when faced with domestic and global volatility shocks. Moreover, we find that less democratic countries pursue more flexible exchange rates and more control over capital flows.

The remainder of this capital is organized as follows. Section 4.2 describes our data and explains the constructions of trilemma policy variables. Section 4.3 examines the link between the trilemma policy and economic performance. Section 4.4 presents the results robust to reverse-causality problems. Section 4.5 concludes.

4.2 Data

In this chapter, we examine how trilemma policy variables and economic performance interact in developing and emerging countries. Our sample period covers 1990 to 2017 and 42 developing and emerging countries[29]. Table 4-1 lists the sample countries.

Table 4-1. Sample countries list by area

Africa	Asia	Latin America and Caribbean	Middle East
Algeria	Korea	Brazil	Egypt
Cameroon	Malaysia	Colombia	Turkey
Central African Republic	Philippines	Peru	Jordan
Congo, Rep.	Singapore	Ecuador	
Gabon	Bangladesh	Guatemala	
Kenya	India	Bolivia	
Morocco	Pakistan	Argentina	
Rwanda	Sri Lanka	Chile	
South Africa	China	El Salvador	
Tunisia	Indonesia	Mexico	
Botswana	Thailand	Panama	
Comoros		Uruguay	
Mauritius			
Seychelles			
Swaziland			
Uganda			

4.2.1 Trilemma policy indexes

For trilemma variables, we use the Aizenman, Chinn and Ito database of trilemma

[29] We refer to the definition of developing and emerging countries of the World Bank and choose the countries for which full datasets for our sample period are available.

indices. We briefly explain the definition of three trilemma variables in this subsection; one can refer for more details to Aizenman et al. (2008) and Aizenman et al. (2010). First, monetary independence is defined as the transformation of the annual correlation of the monthly interest rate in the domestic (i) and base (j) countries[30], where the base country is defined as the country with which a home country's monetary policy is most closely linked. The index for monetary independence is calculated as[31]:

$$MI = 1 - \frac{corr(i_i, i_j) - (-1)}{1 - (-1)}$$

The indicator takes values between 0 and 1. Higher values of the MI index mean a more independent monetary policy. MI takes the value of zero when there is a perfect positive correlation between a country's interest rate and the base country's interest rate. In this case, a country literally pegs its interest rate to that of the base country. Note that MI is only 0.5 when there is no correlation between the interest rates of two countries.

Next, exchange rate stability is defined as the transformation of the annual standard deviation of the 12 monthly exchange rates between the domestic (i) and base (j) countries. The index of exchange rate stability is defined as follows:

$$ERS = \frac{0.01}{0.01 + sd(\Delta log(exch\_rate)}$$

The values are also normalized to between 0 and 1, and higher values mean a more stable exchange rate. To avoid a downward bias, whereby even a small monthly change in the exchange rate would make the standard deviation large and the exchange rate stability value small, the method applies a threshold to the exchange rate movement such that the exchange rate is defined as fixed and the exchange rate stability index takes value one if the rate of monthly change in the exchange rate stays within plus or minus 0.33%.

Last, for the financial openness variable, we use Chinn and Ito's (2008) capital account openness index, which is based on binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. The Chinn and Ito index is normalized to between 0 and 1. Higher values of the index mean a more open capital account.

[30] Base countries are defined based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions and the CIA Factbook; details can be confirmed in Aizenman, Chinn and Ito (2008).

[31] The correlation of domestic and base countries' monetary policies can be negative. To solve this problem, MI is defined to take the value of 1 in the case of a perfect negative correlation.

4.2.2 Other economic variables

Following Aizenman et al. (2010), we choose output volatility and the inflation rate as the main indicators to represent economic performance. Output volatility is measured as the five-year standard deviation of real per capita GDP growth.

Other macro control variables are defined as follows: inflation volatility, measured as the five-year standard deviation of the yearly rate of inflation; trade openness, calculated by dividing the aggregate value of imports and exports by GDP; terms of trade (TOT) shocks, defined as five-year standard deviation of TOT growth times trade openness; fiscal procyclicality, measured as the correlation between HP-filtered government spending and HP-filtered real GDP; broad money growth volatility, measured as the five-year standard deviation of broad money growth; private credit, measured as the ratio of private credit by deposit money banks to GDP; reserves, defined as total official reserves excluding gold to GDP; and the change in the US real interest rate.

In section 4.4, we also investigate the trilemma policy responses of policy-makers to global risk, measured by the VIX, a proxy variable expressing global uncertainty. We expect financial market volatility to be negatively correlated with the trilemma policy index.

For financial crises, we use Laeven and Valencia's (2018) financial crisis database, which includes both a banking crisis index and a currency crisis index. They define banking crises as events satisfying the following two conditions: (1) significant financial distress in the banking system and (2) significant banking policy intervention measures in response to significant losses in the banking system. Currency crises need to meet two conditions: (1) a depreciation of the currency vis-à-vis the US dollar of at least 30% relative to the previous year and (2) at least a 10% higher rate of depreciation than that observed in the previous year. We expect that both kinds of country-specific financial crisis events force policy-makers to abandon their pursuit of a restrictive trilemma policy.

For the democracy level of a country, Polity, data are taken from the Polity IV dataset. The variable is computed by subtracting the institutionalized autocracy score from the institutionalized democracy score. We expect the democracy score to affect the trilemma policy decision.

4.2.3 Summary statistics

Table 4-2 provides the unconditional correlations between variables. As expected, the correlations between output volatility and inflation (as well as inflation volatility) are lower than 0.1, and we think that these two indicators represent completely different aspects of economic performance. At a matter of course, broad money growth and the

inflation rate have a strong correlation, whereas broad money growth and inflation volatility have a correlation of over 0.9. Notably, the correlation of monetary independence and exchange rate stability is nearly -0.2. As defined by the impossible trinity hypothesis, stability in one component may be accompanied by instability in another. Similarly, the correlations between exchange rate stability and the Polity index are nearly -0.3. As expected, the democracy score can affect the exchange rate policy decision. From these results, we confirm that a collinearity problem does not exist in our analysis.

Table 4-2. Correlations between the variables

	outputvol	infvol	inf	pc	totshock	fiscyc	m2gr	polity2	res	dusi	vix	ers	mi	kao
outputvol	1.00													
infvol	0.09	1.00												
inflation	0.06	0.51	1.00											
pc	-0.03	-0.10	-0.06	1.00										
totshock	0.27	-0.05	-0.03	0.00	1.00									
fiscyc	-0.08	0.02	0.05	-0.06	-0.10	1.00								
m2gr	0.09	0.99	0.51	-0.09	-0.05	0.03	1.00							
polity2	-0.18	0.02	0.05	0.01	-0.08	0.07	0.03	1.00						
res	0.19	-0.08	-0.05	0.35	0.16	-0.16	-0.07	-0.07	1.00					
dusi	0.02	-0.01	-0.02	0.02	-0.06	-0.05	-0.01	0.01	0.00	1.00				
vix	0.09	-0.05	0.01	0.00	0.07	-0.10	-0.05	0.00	0.04	-0.62	1.00			
ers	0.10	-0.08	-0.11	-0.09	0.07	-0.10	-0.08	-0.32	-0.09	0.04	-0.05	1.00		
mi	-0.07	0.00	0.00	0.04	-0.02	0.04	0.00	0.11	-0.01	0.04	-0.01	-0.23	1.00	
kao	-0.03	-0.05	-0.09	0.17	0.10	-0.02	-0.06	0.21	0.23	0.02	0.03	-0.04	0.01	1.00

Note: Correlations are calculated for the full sample period of 1990-2017.

4.3 Empirical results on the effect of trilemma policy on economic performance

4.3.1 Empirical model

In this section, we use the same methodology as that in Aizenman et al. (2010) to confirm the relationship between trilemma policy variables and macroeconomic performance during our sample periods. In the preceding section, we demonstrated that the trilemma policy choice may be quite different for each country. Addressing this with an individual country dummy, our analysis focuses mainly on the fixed effects model. From the finding of Aizenman and Ito (2014), it is obvious that trilemma variables have autocorrelation properties. To address this issue, we also revisit the results with an instrumental variable estimation in a later section. We estimate the following panel robust OLS regression equation as the base model:

$$y_{it} = a_0 + \alpha_1 MI_{it} + \alpha_2 ERS_{it} + \alpha_3 KAO_{it} + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \quad (4-1)$$

where y_{it} is the macro policy performance (output volatility or inflation rate) for country i and year t. MI_{it} is a country's monetary independence, where a higher value of MI

means a more independent monetary policy. ERS_{it} is a country's exchange rate stability, where a higher value means a more stable exchange rate. KAO_{it} is the value of the Chinn-Ito capital openness index, for which a higher value means a more open capital account. Considering the impossible trinity hypothesis, according to which the policy space is restricted to two of the three trilemma variables when the trilemma is binding, we include only two of the three variables in each estimation model.

$\boldsymbol{X_{it}}$ is a vector of control variables that includes inflation volatility, TOT shocks, fiscal procyclicality, private credit, reserves and the change in the US real interest rate when output volatility is the dependent variable in a regression. The control variables are trade openness, TOT shocks, fiscal procyclicality, broad money growth volatility, private credit, reserves and the change in the US real interest rate when the inflation rate is the dependent variable[32].

4.3.2 Output volatility regression

Table 4-3 shows the estimated coefficient of regression Equation (4-1) with output volatility as the dependent variable. The left panel from Columns 1 to 3 summarizes the fixed effect estimation results.

From these results in column 1 to 3, we can observe a positive relationship of TOT shocks and output volatility, which means that a greater TOT shock leads to higher output volatility. This finding is consistent with results from Rodrik (1998) and Aizenman et al. (2010), who claim that volatility in world commodities measured as trade openness can raise output volatility. For inflation volatility, we also find a significant positive effect on output volatility, which means that among developing and emerging countries, an unstable inflation rate also deteriorates output stability. For the three trilemma variables, we observe only a negative association between capital openness and output volatility at the ten percent statistical significance level, which suggests that a more open capital account can subdue output volatility. However, in contrast, we find no statistically significant effect of monetary independence and capital openness.

[32] As a robustness check, we estimate the same regression while excluding control variables that show no significant influence in the baseline regression. The results are almost consistent with the baseline, except for a slight change in the statistical significance level of exchange rate stability and capital openness with respect to the inflation rate.

Table 4-3 Output volatility panel regression

Dependent variable: Output volatility						
	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	0.118	0.120	0.101	0.126	0.133	0.095
	(0.115)	(0.116)	(0.111)	(0.121)	(0.120)	(0.111)
Inflation Volatity	0.002 ***	0.001 ***	0.001 ***	0.002 ***	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Private Credit	-0.015	-0.007	-0.006	-0.016	-0.010	-0.006
	(0.015)	(0.015)	(0.014)	(0.015)	(0.016)	(0.015)
TOT Shock	13.735 ***	13.802 ***	14.095 ***	13.269 ***	13.515 ***	13.923 ***
	(4.792)	(4.707)	(4.792)	(4.628)	(4.670)	(4.709)
Fiscal Procyclicality	0.264	0.241	0.240	0.273	0.247	0.249
	(0.210)	(0.208)	(0.215)	(0.209)	(0.202)	(0.216)
Reserves/GDP	3.820	3.618	3.531	3.929	3.722	3.585
	(2.534)	(2.620)	(2.653)	(2.512)	(2.564)	(2.640)
Exchange Rate Stability	-1.587	-1.437		-2.714	-2.529	
	(1.151)	(1.141)		(1.911)	(1.939)	
Moneytary Independence	0.416		0.399	1.066		1.140
	(0.627)		(0.641)	(1.185)		(1.156)
Capital Openness		-1.433 *	-1.582 *		-1.146	-1.476
		(0.757)	(0.808)		(1.005)	(0.957)
Obs	1129	1129	1129	1129	1129	1129
Adjusted R2	0.13	0.14	0.21	0.06	0.09	0.20

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

4.3.3 Inflation rate regression

The results of the estimated coefficients for Equation (4-1) with the inflation rate as the dependent variable are shown in Table 4-4. The three columns differ by the pair of variables selected from the three trilemma policy variables for inclusion in the regression. From Column 1, we find that a country with higher private credit experiences a lower inflation rate, consistent with the findings of Ostry et al. (1995) and Aizenman et al. (2010). When capital openness is included as a trilemma policy variable, however, the results change substantially. Columns 2 and 3 in Table 4-4 show that higher trade openness is associated with a higher inflation rate. In contrast, a higher foreign exchange reserve rate has a moderating effect on rising inflation. Similarly, consistent with Aizenman et al. (2010), we find a negative relationship between capital openness and inflation: the more open capital flow is allowed, the lower is the inflation rate. As in the case of the result of the output volatility regression, we cannot observe a statistically significant effect of monetary independence and capital openness on the inflation rate. For the instrumental variable analysis, the results (from Columns 4 to 6) are almost consistent with the fixed effect results.

We find no robust results in the inflation rate analysis. An important reason for this may be that many developing countries (especially some Latin American and African

countries, such as Argentina, Bolivia, Brazil, Mexico, Peru, Uruguay, and Uganda) experienced high inflation (over 100 percent annually) from the 1990s to the 2000s. This may introduce some bias in the results[33].

Table 4-4 Inflation rate panel regression

	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.177	0.172	0.171	0.177	0.172	0.173
	(0.137)	(0.134)	(0.132)	(0.136)	(0.133)	(0.134)
Trade openess	6.254	9.440 *	11.193 *	7.565	10.163 *	10.778 *
	(4.456)	(5.233)	(6.499)	(5.618)	(5.888)	(6.117)
Private Credit	-0.214 ***	-0.051	-0.017	-0.208 ***	-0.052	-0.062
	(0.074)	(0.086)	(0.100)	(0.076)	(0.092)	(0.083)
TOT Shock	15.234	15.017	21.997	17.535	21.010	19.518
	(21.698)	(21.976)	(26.613)	(25.627)	(28.112)	(25.122)
Fiscal Procyclicality	4.802	4.361	4.358	5.038	4.393	4.679
	(2.862)	(2.646)	(2.725)	(3.095)	(2.699)	(3.000)
Reserves/GDP	-9.820	-15.861 **	-18.521 ***	-10.447	-17.016 ***	-16.283 ***
	(6.995)	(6.205)	(5.791)	(6.584)	(5.746)	(5.411)
Exchange Rate Stability	-29.196	-25.345		-11.354	-6.510	
	(22.617)	(21.583)		(9.787)	(9.929)	
Moneytary Independence	4.896		3.915	26.211		23.992
	(7.389)		(7.797)	(29.159)		(28.348)
Capital Openness		-32.901 *	-35.858 *		-29.282 *	-28.219 **
		(17.048)	(18.668)		(15.136)	(12.617)
Obs	1119	1119	1119	1119	1119	1119
Adjusted R2	0.14	0.15	0.14	0.14	0.14	0.14

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

[33] As shown in Appendix Table A4-1, our sample includes several countries that have experienced hyperinflation. Some may worry that this generates bias in the regression. Therefore, we confirm our results by excluding countries that experienced an annual inflation rate over 200 percent (including the following four countries: Bolivia, Peru, Argentina, and Brazil) from the regression. Except for M2 growth volatility becoming positive and statistically significant, the qualitative results remain almost unchanged. It is noteworthy that these four removed countries all belong to the Latin American region.

4.3.4 Sub-sample regression

We have investigated the relationship between trilemma policy variables and macroeconomic performance; however, we have found only weak evidence of an effect of trilemma policy variables on output volatility and the inflation rate. One of the possible reasons for the weak link may be that countries in different regions have dissimilar economic characteristics, which may differently influence government policy decisions. In this section, we address this issue by dividing our sample countries into three regional subsamples as follows: Asia, Africa, and Latin America[34].

Table 4-5 shows the output volatility regression results separately for the three subsamples. For Asian (Panel 1) and Latin American (Panel 3) countries, we can observe a positive relationship of inflation volatility with output volatility. This finding is consistent with the aggregate regression results in Table 4-3. In addition, for Latin American countries, greater TOT shocks lead to higher output volatility, but this effect does not appear in Asia and Africa (Panel 2). For trilemma policy variables, we can observe a negative relationship between capital openness and output volatility only in Asian countries, consistent with the aggregate regression result. This finding can be explained as follows. Capital openness significantly boosts capital accumulation and productivity (Guru and Yadav, 2021) but also heightens the risk of experiencing a financial crisis. If a developing country wants to benefit from capital openness and yet reduces output volatility at the same time, high economic integration is a prerequisite. In contrast to countries in other regions, Asian countries are helped in managing the adverse impacts of financial crises by solid financial institutions, swift policy responses, and stable macroeconomic environments with adequate reserves (Ito et al., 2009). Regarding African countries, we find a negative association between exchange rate stability and output volatility at the five percent statistical significance level. In contrast, we find a positive relationship of monetary independence and output volatility in the instrumental variable regression, which implies that for African countries, greater monetary independence leads to higher output volatility.

The inflation rate regression results for the regional subsamples are reported in Table 4-6. From Panel 1, we can confirm the statistically significant effect of trade openness on the inflation rate, which means that among Asian countries, a country with greater trade openness experiences a higher inflation rate. In the case of Africa, the influence of trade openness is relatively indecisive, but the relationship of money supply growth volatility with the inflation rate is clear. In addition, we confirm a negative influence of reserves in both regions. For Latin America, we observe almost no effects with statistical significance

[34] For this subsample analysis, we have not included Middle Eastern countries.

among the explanatory variables. This may be due to the extremely high inflation rate of Latin American countries (e.g., Argentina and Brazil) during the beginning of the 1990s biasing the results. For the three trilemma policy variables, we also observe markedly different results among the three regions. For Asian countries, consistent with previous studies in the literature, e.g., Devereux et al. (2006), a stable exchange rate can help a country maintain a lower inflation rate. However, simultaneously, higher monetary independence raises the inflation rate. As indicated by Aizenman et al. (2010), a possible reason is that countries with higher monetary independence are more likely to engage in debt monetization. Similar to the Asian case, for Africa, we confirm a negative influence of exchange rate stability on the inflation rate, but monetary independence is not statistically significant; instead, we observe a negative relationship of capital openness with the inflation rate.

In this section, we checked how regions' distinct economic characteristics may have affected the results in the previous section. As we expected, we find evidence that the link between trilemma policy variables and macroeconomic performance for the entire sample countries is weakened by different government policy decisions in different regions with dissimilar economic characteristics.

Table 4-5 Sub-sample output volatility panel regression

Panel 1: Asia	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	-0.204	-0.182	-0.181	-0.213	-0.183	-0.177
	(0.124)	(0.127)	(0.132)	(0.135)	(0.127)	(0.139)
Inflation Volatity	0.308 ***	0.315 ***	0.319 ***	0.293 ***	0.310 ***	0.324 ***
	(0.061)	(0.054)	(0.052)	(0.076)	(0.061)	(0.054)
Private Credit	0.016	0.023	0.025	0.014	0.023	0.027
	(0.027)	(0.025)	(0.025)	(0.028)	(0.024)	(0.025)
TOT Shock	-2.846	-1.823	-1.930	-3.929	-1.954	-2.067
	(5.497)	(5.421)	(5.514)	(5.693)	(5.384)	(5.657)
Fiscal Procyclicality	0.307	0.442	0.448	0.316	0.454	0.474
	(0.403)	(0.466)	(0.467)	(0.373)	(0.459)	(0.468)
Reserves/GDP	4.458	3.640	3.617	4.101	3.485	3.446
	(4.790)	(5.139)	(5.042)	(5.156)	(5.408)	(5.210)
Exchange Rate Stability	-0.430	-0.075		-1.841	-0.420	
	(1.464)	(1.318)		(2.947)	(2.642)	
Moneytary Independence	-0.398		-0.448	-1.260		-1.115
	(1.189)		(0.822)	(1.555)		(1.052)
Capital Openness		-3.731 *	-3.765 *		-4.064 *	-4.275 *
		(1.793)	(1.760)		(2.180)	(2.210)
Obs	295	295	295	295	295	295
Adjusted R2	0.42	0.09	0.08	0.40	-0.28	0.05

Panel 2 Africa	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	0.288	0.305	0.206	0.289	0.365	0.159
	(0.266)	(0.266)	(0.264)	(0.295)	(0.279)	(0.271)
Inflation Volatity	0.129	0.123	0.161	0.112	0.095	0.162
	(0.133)	(0.141)	(0.154)	(0.131)	(0.147)	(0.156)
Private Credit	-0.031	-0.029	-0.030	-0.032	-0.028	-0.031
	(0.032)	(0.031)	(0.032)	(0.034)	(0.034)	(0.036)
TOT Shock	13.730	13.843	14.659	12.760 *	13.123 *	14.203
	(8.210)	(8.248)	(8.902)	(7.326)	(7.775)	(8.654)
Fiscal Procyclicality	0.269	0.279	0.341	0.154	0.215	0.264
	(0.379)	(0.389)	(0.374)	(0.424)	(0.424)	(0.373)
Reserves/GDP	6.701	6.532	6.359	7.145 *	6.728 *	6.606 *
	(3.941)	(4.012)	(3.937)	(3.862)	(4.023)	(3.840)
Exchange Rate Stability	-7.223 **	-7.385 **		-11.347	-12.832 **	
	(3.171)	(3.156)		(7.346)	(6.337)	
Moneytary Independence	0.963		1.323	4.453 *		5.168 **
	(0.928)		(1.076)	(2.444)		(2.396)
Capital Openness		-0.565	0.080		-1.012	0.068
		(1.297)	(1.373)		(1.846)	(1.919)
Obs	428	428	428	428	428	428
Adjusted R2	0.02	0.01	0.23	0.00	0.00	0.19

Panel 3 Latin America	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	0.113	0.113	0.124	0.115	0.124	0.119
	(0.097)	(0.097)	(0.094)	(0.100)	(0.097)	(0.093)
Inflation Volatity	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Private Credit	-0.004	-0.005	-0.006	-0.005	-0.012	-0.013
	(0.013)	(0.013)	(0.014)	(0.015)	(0.017)	(0.018)
TOT Shock	15.869 **	15.392 **	16.270 **	17.729 ***	15.970 ***	18.130 ***
	(6.761)	(6.511)	(6.471)	(6.625)	(5.917)	(6.113)
Fiscal Procyclicality	0.062	0.109	0.087	-0.032	0.168	0.028
	(0.232)	(0.265)	(0.241)	(0.220)	(0.275)	(0.253)
Reserves/GDP	-3.362	-3.355	-3.454	-3.410	-3.434	-3.432
	(2.234)	(2.232)	(2.238)	(2.352)	(2.393)	(2.274)
Exchange Rate Stability	0.548	0.543		0.274	-0.027	
	(0.726)	(0.732)		(1.376)	(1.535)	
Moneytary Independence	-0.603		-0.625	-2.447		-2.399
	(1.140)		(1.156)	(1.669)		(1.667)
Capital Openness		0.212	0.279		0.948	0.765
		(0.678)	(0.693)		(1.283)	(1.078)
Obs	324	324	324	324	324	324
Adjusted R2	0.04	0.04	0.04	0.05	-0.28	-0.26

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

Table 4-6 Sub-sample inflation rate panel regression

Panel 1: Asia	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.100	0.083	0.109	0.091	0.052	0.102
	(0.109)	(0.107)	(0.112)	(0.110)	(0.092)	(0.102)
Trade openess	5.661 **	5.032 *	5.439 **	5.743 ***	4.806 **	5.235 **
	(2.298)	(2.337)	(2.425)	(2.198)	(2.034)	(2.157)
Private Credit	-0.034	-0.032	-0.029	-0.038	-0.046	-0.031
	(0.026)	(0.025)	(0.026)	(0.031)	(0.031)	(0.024)
TOT Shock	-2.962	-4.169 **	-0.233	-4.745 **	-7.383 **	-0.343
	(1.652)	(1.799)	(2.835)	(2.415)	(3.439)	(3.017)
Fiscal Procyclicality	0.015	-0.002	-0.055	0.045	-0.041	-0.094
	(0.413)	(0.411)	(0.344)	(0.441)	(0.450)	(0.335)
Reserves/GDP	-14.598 ***	-13.931 ***	-13.516 ***	-15.108 ***	-13.723 ***	-13.006 ***
	(3.180)	(2.826)	(3.528)	(2.952)	(2.853)	(3.793)
Exchange Rate Stability	-3.061 **	-3.654 **		-5.043 **	-7.077 **	
	(1.150)	(1.229)		(2.508)	(3.236)	
Moneytary Independence	3.821 *		4.547 **	3.496		4.467 *
	(1.880)		(1.737)	(2.290)		(2.418)
Capital Openness		1.550	0.711		4.149	1.896
		(1.828)	(1.561)		(3.665)	(2.573)
Obs	295	295	295	295	295	295
Adjusted R2	0.02	0.03	0.01	0.03	0.04	0.01

Panel 2 Africa	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.294 ***	0.254 ***	0.307 ***	0.287 ***	0.228 ***	0.306 ***
	(0.072)	(0.063)	(0.064)	(0.056)	(0.057)	(0.059)
Trade openess	3.610	4.899 *	4.653	3.224	4.900 *	4.532
	(2.760)	(2.761)	(3.311)	(2.673)	(2.707)	(3.526)
Private Credit	-0.076	-0.056	-0.055	-0.075	-0.051	-0.048
	(0.051)	(0.048)	(0.054)	(0.050)	(0.047)	(0.055)
TOT Shock	-16.309 *	-15.719 *	-14.201	-17.332 **	-16.762 *	-14.553 *
	(8.147)	(8.154)	(8.343)	(8.730)	(9.093)	(8.254)
Fiscal Procyclicality	0.246	0.254	0.321	0.159	0.169	0.253
	(0.433)	(0.531)	(0.602)	(0.457)	(0.585)	(0.630)
Reserves/GDP	-9.301 *	-10.711 **	-11.461 ***	-8.695 *	-10.345 ***	-11.524 ***
	(4.644)	(3.768)	(3.122)	(4.829)	(3.848)	(3.017)
Exchange Rate Stability	-13.109 ***	-13.796 ***		-17.795 *	-20.728 *	
	(3.170)	(3.035)		(9.708)	(11.601)	
Moneytary Independence	3.316		3.210	4.968		5.253
	(3.191)		(3.340)	(5.106)		(5.634)
Capital Openness		-6.061 *	-5.259		-7.491 ***	-6.825 **
		(2.890)	(3.268)		(2.610)	(2.963)
Obs	428	428	428	428	428	428
Adjusted R2	0.15	0.13	0.02	0.14	0.12	0.02

Panel 3 Latin America	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.174	0.163	0.162	0.175	0.164	0.166
	(0.149)	(0.141)	(0.135)	(0.149)	(0.137)	(0.142)
Trade openess	14.359	28.910	43.240	36.302	35.218	55.007
	(24.469)	(26.611)	(42.201)	(40.865)	(31.542)	(51.372)
Private Credit	-0.414	0.444	0.467	-0.419 *	0.314	0.335
	(0.251)	(0.428)	(0.398)	(0.253)	(0.371)	(0.338)
TOT Shock	405.436	353.297	307.062	367.460	323.069	305.527
	(397.656)	(374.601)	(340.012)	(352.570)	(344.871)	(333.437)
Fiscal Procyclicality	15.930	8.506	8.378	20.127	8.338	13.998
	(12.425)	(9.470)	(10.378)	(16.525)	(9.820)	(15.794)
Reserves/GDP	-65.397	-78.259	-79.275	-78.014	-72.890	-90.640 *
	(57.900)	(53.733)	(52.332)	(53.991)	(45.568)	(52.410)
Exchange Rate Stability	-73.087	-61.417		-31.304 *	-7.845	
	(62.340)	(62.155)		(16.227)	(20.771)	
Moneytary Independence	18.433		20.095	97.626		94.341
	(29.132)		(29.254)	(106.495)		(109.138)
Capital Openness		-89.571	-99.458		-84.333 *	-80.861 **
		(52.033)	(55.792)		(49.290)	(39.372)
Obs	324	324	324	324	324	324
Adjusted R2	0.05	0.17	0.16	0.13	0.16	0.17

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

4.3.5 Resource curse problem

The resource curse is a phenomenon whereby countries with more abundant natural resources have less economic growth and worse development than those with relatively fewer resources. This phenomenon has been investigated by many studies. After summarizing and extending previous research, Sachs and Warner (2001) claimed that countries with great natural resource wealth tend to grow more slowly than resource-poor countries. In addition, this negative association of resource dependence and economic growth is more evident in developing countries (Badeeb et al., 2017). Since this issue may also influence our results, in this section, we address it by dividing our sample countries into two subsamples based on their total natural resource rents, a data series provided by the World Development Indicators (WDI)[35].

Table 4-7 shows the output volatility regression results separately for the two groups. For countries with both high (Panel 1) and low (Panel 2) rates of rents, we can observe a positive relationship of inflation volatility with output volatility. This finding is consistent with the aggregate regression results in Table 4-3. In addition, only for countries with high rents do greater TOT shocks lead to higher output volatility. This finding is consistent with the argument of Papyrakis and Gerlagh (2004), who propose that terms of trade are especially important to economic growth in countries with abundant natural resources. For trilemma policy variables, from the fixed effect regression results in Panel 1, we can observe a negative relationship between capital openness and output volatility only in countries with high rents, consistent with the aggregate regression result.

The inflation rate regression results for the two resource level groups are reported in Table 4-8. From both Panels 1 and 2, we can confirm that the effect of M2 growth volatility on the inflation rate is statistically significant. Nonetheless, for countries with high rents, the coefficient of M2 growth volatility is lower than that for countries with low rents; the reason for this difference may be that resource-abundant countries have, on average, lower budget deficits and inflation (Polterovich et al., 2007). The inflation rate of countries with high rents is also more likely to be affected by other factors; appropriate macro policies and institutions seem particularly important in resource-abundant countries. More specifically, in Panel 1, higher fiscal procyclicality raises the inflation rate. The possible reason is that countries where the resource curse exists are those where the combination of natural resource and public expenditure policies leads to a low rate of genuine saving (Atkinson and Hamilton, 2003), and the decreases in net savings worsen the inflation rate (Lindh and Malmberg, 2000). We also confirm the negative effects of

[35] The countries in the two groups, along with the country's average total natural resources rents, are listed in Table A4-2.

reserves and exchange rate stability on the inflation rate. Generally, resource-abundant countries have higher foreign reserves but simultaneously are susceptible to an overvalued real exchange rate (Polterovich et al., 2007). Stable exchange rates are more important in resource-abundant countries than in resource-poor countries. Finally, we can also observe a negative relationship between capital openness and the inflation rate.

In this section, as a robustness check, we have divided our sample countries into two subsamples (resource-abundant and resource-poor). Our results support that this classification is meaningful: the economic performance of resource-abundant countries is sensitive to trilemma policy variables as well as to the external environment.

Table 4-7. output volatility panel regression by resource rents groups

Panel 1: High rents rate	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	0.272	0.284	0.274	0.255	0.289	0.249
	(0.196)	(0.201)	(0.199)	(0.202)	(0.202)	(0.201)
Inflation Volatity	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Private Credit	-0.026	-0.015	-0.013	-0.030	-0.020	-0.017
	(0.029)	(0.028)	(0.026)	(0.030)	(0.032)	(0.029)
TOT Shock	22.341 ***	21.972 ***	22.543 ***	21.337 ***	21.398 ***	22.359 ***
	(6.379)	(6.108)	(6.542)	(6.131)	(5.868)	(6.696)
Fiscal Procyclicality	0.111	0.065	0.083	0.131	0.059	0.128
	(0.261)	(0.255)	(0.273)	(0.276)	(0.243)	(0.293)
Reserves/GDP	4.893	4.669	4.583	5.053	4.807	4.712
	(4.104)	(4.131)	(4.129)	(4.042)	(4.117)	(4.095)
Exchange Rate Stability	-1.944	-1.763		-3.696	-3.590	
	(1.883)	(1.876)		(2.993)	(3.085)	
Moneytary Independence	0.669		0.458	2.783 *		2.640 *
	(0.681)		(0.667)	(1.553)		(1.445)
Capital Openness		-1.813 *	-1.946 *		-1.369	-1.436
		(1.006)	(1.056)		(1.226)	(1.187)
Obs	564	564	564	564	564	564
Adjusted R^2	0.25	0.28	0.36	0.12	0.17	0.34
Panel 2: Low rents rate	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
Changes in US Real interest Rate	-0.010	-0.013	-0.036	0.009	-0.001	-0.034
	(0.093)	(0.091)	(0.093)	(0.100)	(0.092)	(0.096)
Inflation Volatity	0.002 **	0.002 **	0.001 **	0.002 **	0.002 ***	0.001 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private Credit	-0.003	0.000	0.002	-0.004	0.000	0.003
	(0.017)	(0.016)	(0.017)	(0.017)	(0.017)	(0.018)
TOT Shock	1.698	2.034	2.202	1.815	1.885	2.536
	(8.409)	(8.522)	(8.675)	(8.610)	(8.288)	(8.864)
Fiscal Procyclicality	0.505	0.494	0.471	0.518	0.507	0.465
	(0.347)	(0.350)	(0.351)	(0.341)	(0.338)	(0.349)
Reserves/GDP	1.381	1.251	1.149	1.389	1.320	1.048
	(2.520)	(2.682)	(2.781)	(2.511)	(2.539)	(2.861)
Exchange Rate Stability	-1.162	-1.069		-1.967	-1.664	
	(1.302)	(1.281)		(2.284)	(2.131)	
Moneytary Independence	0.221		0.318	-0.597		-0.361
	(1.078)		(1.137)	(1.672)		(1.746)
Capital Openness		-0.762	-0.916		-0.705	-1.209
		(1.133)	(1.240)		(1.357)	(1.496)
Obs	565	565	565	565	565	565
Adjusted R^2	0.03	0.01	0.01	0.02	0.01	0.00

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

Table 4-8. inflation rate panel regression by resource rents groups

Panel 1: High rents rate	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.052 ***	0.050 ***	0.051 ***	0.050 ***	0.049 ***	0.051 ***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Trade openess	3.999	7.852	6.923	5.181	8.944	7.273
	(4.057)	(4.639)	(4.534)	(5.474)	(5.724)	(4.873)
Private Credit	-0.204 **	-0.088 *	-0.067	-0.219 ***	-0.100 *	-0.056
	(0.075)	(0.049)	(0.052)	(0.086)	(0.057)	(0.061)
TOT Shock	-12.588	-18.029 *	-12.950	-18.103 *	-23.245 *	-13.094
	(7.304)	(9.721)	(8.272)	(10.661)	(12.716)	(8.386)
Fiscal Procyclicality	2.277 **	1.902 **	2.000 **	2.154 **	1.820 **	1.920 **
	(0.900)	(0.730)	(0.753)	(0.949)	(0.773)	(0.758)
Reserves/GDP	-11.625 ***	-15.564 ***	-15.886 ***	-11.535 ***	-15.472 ***	-16.312 ***
	(3.292)	(3.963)	(4.202)	(4.265)	(4.586)	(4.722)
Exchange Rate Stability	-15.557 **	-13.709 **		-29.444 *	-25.998 *	
	(6.759)	(5.436)		(15.486)	(13.451)	
Moneytary Independence	4.255		1.948	1.999		-1.484
	(3.371)		(3.984)	(8.650)		(9.709)
Capital Openness		-19.003 *	-20.130 *		-19.320 **	-21.631 *
		(9.239)	(10.076)		(9.837)	(11.523)
Obs	564	564	564	564	564	564
Adjusted R^2	0.31	0.31	0.26	0.27	0.29	0.25

Panel 2: Low rents rate	Fixed robust			Instrumental variable		
	[1]	[2]	[3]	[4]	[5]	[6]
M2 Growth volatility	0.521 ***	0.513 ***	0.489 ***	0.511 ***	0.504 ***	0.496 ***
	(0.169)	(0.166)	(0.148)	(0.167)	(0.165)	(0.155)
Trade openess	8.776	9.659	22.094 *	16.394	14.953	22.484
	(9.546)	(10.333)	(12.431)	(10.572)	(10.004)	(13.289)
Private Credit	-0.257 *	-0.142	-0.036	-0.243 *	-0.160	-0.132 *
	(0.127)	(0.115)	(0.113)	(0.146)	(0.117)	-(0.132)
TOT Shock	-2.692	9.071	31.299	1.700	16.946	17.502
	(20.033)	(21.551)	(39.897)	(23.271)	(24.233)	(33.904)
Fiscal Procyclicality	15.613	15.216	13.899	15.178	14.606	14.403
	(10.223)	(9.841)	(9.762)	(10.385)	(9.793)	(10.257)
Reserves/GDP	1.973	-3.601	-18.787	-3.074	-9.547	-12.651
	(29.423)	(25.148)	(11.459)	(27.508)	(20.048)	(17.246)
Exchange Rate Stability	-93.239	-90.658		-41.338	-44.351	
	(84.602)	(86.896)		(52.738)	(62.925)	
Moneytary Independence	15.827		24.692	60.165		66.021
	(25.289)		(32.924)	(63.581)		(72.175)
Capital Openness		-24.883	-39.035 *		-14.261	-20.646 *
		(15.852)	(22.042)		(14.194)	(12.480)
Obs	555	555	555	555	555	555
Adjusted R^2	0.31	0.31	0.31	0.31	0.32	0.30

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For instrumental variable estimation, we add additional instrument for three trilemma variables.

4.4 Causality problem

In the previous section, we investigated how each trilemma policy variable affects economic performance; however, we could not find a clear-cut relationship between them. One possible reason for the weak causal link from trilemma policy to economic performance is that as argued in section 4.2, affected by regional economic characteristics and resources, countries have unique trilemma policies and adjustment paths. We also suspect that policy-makers are frequently forced to make adjustments to the trilemma policy when faced with economic turmoil at home or in the world, and it is hard for an economy to keep its trilemma policy stable. When faced with rising risk from both the domestic and global economic situations, policy-makers must temporarily give up the optimal or their targeted trilemma policy to weather the economic distress for the time being. As confirmed in Aizenman and Ito (2014), trilemma policy is affected by past crisis experiences. We also expect macroeconomic performance and global risk to affect the trilemma policy decision.

4.4.1 Trilemma index

In this section, we follow a methodology of Aizenman and Ito (2012) to measure a trilemma policy index as follows:

$$T_{it} = \sqrt{(MI_{it} - 1)^2 + (ERS_{it} - 1)^2 + (KAO_{it} - 1)^2} \qquad (4-2)$$

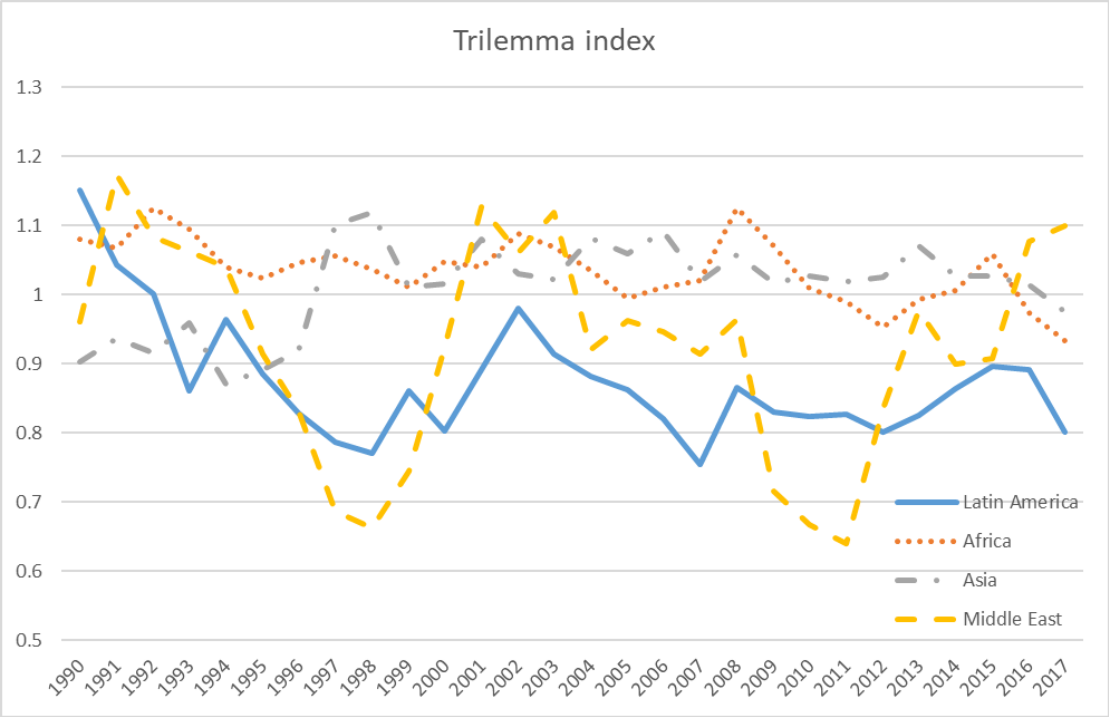
T_{it} is an index to measure the scope of three trilemma variables together; T_{it} is greater if any one of the trilemma policy variables is lower. Figure 4-2 plots T_{it} for different geographical area groups. As Aizenman and Ito (2012) have shown, trilemma configurations converged toward a middle ground among developing and emerging countries, especially during the period after the 1990s. From Figure 4-2, we can find different variations among the four country groups. The trilemma index of Latin American countries tended to decline gradually during the sample period. For Asian countries, a remarkable rise in the trilemma index can be observed for the period of the 1997 Asian financial crisis period, and in the postcrisis period, the trilemma index became relatively stable between 1.0 and 1.1. Similarly, the trilemma index of African countries is relatively stable. Among the four groups, the Middle East displays the most drastic fluctuations. A significant trilemma index hike can be observed in two occasions: after 1997 and 2011. It seems evident that policy adjustment was necessitated after the shock of the Asian financial crisis and the end of the fallout from the oil price shock[36]. To

[36] In 2011, the oil market was broadly stable, having recovered from the Lehman shock (when the oil price fell to nearly 40 USD per barrel) to a well-balanced state (with the price at nearly 110 USD per barrel).

compare the trilemma policy changes by region, we also calculate the average ratio of T_{Max}/T_{Min} by different groups and obtain the comparatively high-fluctuation groups of Latin America (2.62) and the Middle East (2.93) and lower-fluctuation groups of Asia (1.70) and Africa (1.73).

These results may also be partial evidence of our hypothesis that it is difficult for a developing and emerging economy to maintain trilemma policy at the same level for a long period. Many factors both at home and abroad can affect trilemma policy decisions, and a changing policy in a relatively short period may be the reason for the muted effect of the trilemma policy mix on economic performance, which involves outcomes affected by relatively longer-run economic environments.

Figure 4-2. Degree of trilemma policy index among different country groups



Note: Calculated by average of group countries separately

4.4.2 Trilemma policy decision

To test the hypothesis that domestic and global risk force a country to move away from its optimal trilemma policy, we estimate the impact of potential risk factors on trilemma variables in the following model:

$$T_{it} = \alpha_0 + \alpha T_{it-1} + \boldsymbol{\beta Dom_{it}} + \boldsymbol{\gamma Glob_{it}} + \varepsilon_{it} \quad (4-3)$$

where T_{it} is the trilemma policy index. $\boldsymbol{Dom_{it}}$ is a vector of control variables that

include domestic economic performance, i.e., output volatility and the inflation rate, banking crises, currency crises, and the democracy level. $\boldsymbol{Glob_{it}}$ is a vector including the VIX that represents global risks. Because the trilemma index has a strong autocorrelation property (Aizenman and Ito, 2014), we also add T_{it-1} as an explanatory variable, and we apply the dynamic panel model of Arellano and Bond (1991).

The results are based on a GMM regression and are robust to heteroscedastic variances in the error terms. Column 1 of Table 4-9 reports the results for the estimated coefficient of Equation (4-3). The statistically significant coefficient of T_{it-1} certifies that our choice of a dynamic panel framework is correct. The results for the trilemma index in Column 1 show that the estimated coefficient of the inflation rate is positive and statistically significant. This means that when a developing or emerging country experiences a rising inflation rate, it tends to reduce the overall trilemma policy integration[37]. Moreover, the estimated coefficients of both kinds of financial crisis are positive and statistically significant. This means that developing and emerging countries tend to reduce their trilemma policy integration to address financial crises. The result that financial crises are associated with lower trilemma integration is consistent with the findings of Aizenman and Ito (2014). As an indicator of global financial market volatility, the VIX also has a positive and statistically significant effect on the trilemma index. However, there appears to be no effect of the Polity index on trilemma integration.

From the above, we have confirmed that not only financial crisis events and global financial volatility but also the domestic economic performance indicators that we used in the previous section cause developing and emerging countries to reduce their trilemma integration. Thus, we confirm the hypothesis that when faced with high risks from both domestic and global economic conditions, policy-makers are forced to abandon the optimal trilemma policy.

[37] It should be recalled that a rise in the trilemma index indicates a reduction in the level of the trilemma policy variables.

Table 4-9 Trilemma index and variables panel robust regression

	Dependent variable:			
	Trilemma index	Exchange rate stability	Moneytary Independence	Capital Openness
T/ERS/MI/KAO t-1	0.616 ***	0.446 ***	0.688 ***	0.821 ***
	(0.029)	(0.068)	(0.026)	(0.033)
Output Volatility	-0.003	0.000	0.000	-0.002 *
	(0.002)	(0.003)	(0.002)	(0.001)
Inflation rate	0.000 ***	0.000 *	0.000	0.000 **
	(0.000)	(0.000)	(0.000)	(0.000)
VIX Index	0.002 ***	-0.003 ***	-0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.000)
Polity Index	0.001	-0.005 *	0.003	-0.004 **
	(0.002)	(0.003)	(0.002)	(0.002)
Currency Crisis Dummy	0.100 ***	-0.130 ***	-0.003	-0.044 ***
	(0.028)	(0.041)	(0.022)	(0.015)
Banking Crisis Dummy	0.132 ***	-0.141 **	-0.027	-0.028
	(0.034)	(0.057)	(0.028)	(0.023)
Obs	1080	1080	1080	1080
Wald chi2	543.47	86.41	851.61	849.80

Note: ***, **, *, indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Figures in parenthesis are t-statistics. For the data restriction of POLITY index, we exclude Congo, Rep., and Seychelles for sample countries.

4.4.3 Adjustment paths

Following the previous section, in this section, we investigate how a country adjusts each component of the trilemma policy index when faced with different calamities, which here we call the adjustment path. We expect there to be different routes to instantiating the reduction in the trilemma policy index when an economy experiences different economic hardships. Instead of using the integrated trilemma index, we revisit the analysis above with the three trilemma policy variables separately in this section. From Columns 2 to 4 in Table 4-9, we find unique and different results for each of the three trilemma policies.

The results for exchange rate stability in Column 2 are similar to the results for the trilemma index. Under pressure from either kind of financial crisis or a rising VIX index, countries tend to reduce their exchange rate stability. The inflation rate has a negative effect, but with a lower statistical significance level of ten percent. At the same time, countries with a higher democracy score seem to have less stable exchange rates, indicating that those with lower democracy scores adjust their exchange rate more freely. It should be noted that the evidence is weak; it is statistically significant only at the ten percent level. This result is consistent with Bearce and Hallerberg (2011), who argue that more democratic regimes should be associated with a more flexible exchange rate because the median voter is likely to be a domestically oriented producer with a preference for domestic monetary policy autonomy, requiring a more flexible exchange rate regime.

Column 3 reports the result for the monetary independence regression. Unlike the results for exchange rate stability and capital openness, monetary independence is not affected by any of the variables, regardless of domestic or global risk factors. From Column 4 of Table 4-9, we find that output volatility and the inflation rate have statistically significant impacts on capital openness. More precisely, higher output volatility and a higher inflation rate are associated with lower capital openness. This means that unstable domestic economic conditions can lead a country to reduce its capital openness. This result is also consistent with the finding of Bekaert et al. (2006) that financial liberalizations are associated with declines in the ratio of consumption growth volatility to GDP growth volatility. A negative and statistically significant Polity index effect implies that for less democratic regimes, capital openness can be adjusted more freely, similar to the results for exchange rate stability. Finally, only currency crises, not banking crises, influence capital openness.

From the results of the three individual trilemma variable regressions, we can draw the following conclusions[38]. First, developing and emerging countries tend to reduce their exchange rate stability and capital openness when facing a high inflation rate or a currency crisis, while countries with less democratic regimes can adjust these policies more freely. Second, the VIX and financial crises can influence exchange rate stability. Higher global financial volatility and the occurrence of financial crises may lead a country to reduce its exchange rate stability. Third, capital account openness is affected by output volatility. A freer capital account may eliminate the unstable production problem, consistent with the finding of Bekaert et al. (2006).

4.5 Conclusion

In this chapter, we investigate the relationship between trilemma policy and macroeconomic performance. Our main results are summarized by the following points. First, higher capital openness is linked to lower output volatility and can suppress rises in the inflation rate. Second, trilemma policy decisions are also associated with domestic and global economic performance. Among domestic factors, a high inflation rate pressures a country to reduce its degree of financial integration. Among global factors,

[38] As mentioned above, the possible levels of the three trilemma policy variables are theoretically constrained. Therefore, in Appendix Table A4-3, we introduce another two trilemma policy variables as explanatory variables in addition to these three individual trilemma variable regressions. From the results, the constraints among these three variables are not obvious. We confirmed only a negative effect of exchange rate stability on capital openness at the ten percent significance level.

the occurrence of global crises and higher stock market volatility force a country to reduce its degree of financial integration. Third, by investigating the adjustment path for individual trilemma variables, we find that when faced with domestic and global volatility shocks, policy-makers tend to adjust the exchange rate stability and capital openness. These adjustments are also associated with a country's level of democracy: a country with a lower democracy score may adjust more freely.

These results have the following important implications. First, during the 1990s to 2010s, the trilemma policy of developing and emerging countries had only mild effects on economic performance. As shown by Aizenman et al. (2013), since 1990, the trilemma variables in developing and emerging countries have converged toward an intermediate level. The reason may be that developing and emerging countries targeted the trilemma policy mix at some controllable level and insulated the trilemma issue from improvements in domestic economic performance. Second, it is important for governments of developing countries and emerging economies to adjust their trilemma policy decisions under different macroeconomic conditions. Both domestic economic performance and global shocks can force the trilemma policy mix to drift away from the targeted level. These findings and discussions have important implications for trilemma policy. We should realize that the trilemma restrictions do not exist only among the three policy goals but are also affected by changes in the external macroeconomic environment.

5. Summary and conclusions

In this study we have investigated three critical issues in international finance: Current account adjustments, financial crisis, and trilemma in international finance. Our main results and policy implications can be summarized as follows:

The first part investigated the determinants of current account changes for BRICS countries with the Glick-Rogoff (1995) model and its modified model. However, a set of global and country-specific productivity shocks solely cannot explain the fast-growing developing BRICS country's current account. It is not surprising if the different mechanism of current account adjustment works for different groups of countries and different background conditions. There are many differences in monetary policy, exchange rate system, tariffs, and trade regulations between the two groups.

As provided by many previous studies, the current account is also influenced by various factors, both domestic and global. Our result suggests that future research and policymakers should search for a framework that adjusts the current account through its country-specific mechanism.

In the second part, after confirming the effect of financial structure and capital openness on the occurrence of two types of financial crises, we found the following four points. First, financial structure plays a vital role in affecting the probability of a currency crisis. An economy with a more market-based structure is less likely to experience a currency crisis. Second, capital openness is also an important factor in the occurrence of a currency crisis. Higher capital openness is associated with a lower probability of a currency crisis. Third, a country with a more market-based structure is more likely to enjoy a more stable economy, in terms of reducing a sudden drop in the value of its currency, by maintaining a more open capital account. Fourth, in contrast to what is found for currency crises, both financial structure and capital openness have no effect on banking crises.

These results have two important policy implications. First, as many studies have also shown (Gourinchas and Obstfeld, 2012 and Kim et al., 2013, among others), it is important to associate different types of crisis with different sets of macroeconomic conditions, especially for recent years. Restrictions on bank activities and entry requirements can lower the likelihood of a banking crisis. On the other hand, financial agency supervisory power can reduce the probability of a currency crisis. In particular, the banking sector has come to play a much more significant role. Its growth has led to the accumulation of debt in credit and assets, which has increased the probability of a banking crisis (Reinhart and Rogoff, 2008). At the same time, financial market development can stabilize the foreign exchange market and mitigate information asymmetry, through which currency crisis likelihood can be reduced (Kim et al., 2013).

Our analysis also confirms completely different sets of determinants for banking and currency crises. Second, developing countries must work simultaneously to foster the development of domestic financial markets and open their capital accounts. Currently, a large set of capital controls tend to exist, especially in countries where domestic financial markets are relatively undeveloped and more bank-oriented.

The third part investigated the relationship between trilemma policy and macroeconomic performance. Our main results are the following: First, higher capital openness is linked to lowering output volatility and can suppress the rise of the inflation rate. Second, trilemma policy decision is also associated with domestic and global economic performance. Among domestic factors, a high inflation rate pressures a country to reduce the degree of financial integration. Among global factors, worldwide crises and higher stock market volatility force a country to reduce the degree of financial integration. Third, by investigating the adjustment path for individual trilemma variables, we found that policy makers tend to adjust the exchange rate stability and capital openness when faced with domestic and global volatility shocks. These adjustments are also associated with a country's level of democracy. A country with a lower democracy score tends to adjust more freely.

Our results suggest: First, as shown by Aizenman et al. (2013), since 1990, the trilemma variables in the developing and emerging countries have converged towards intermediate levels. The reason may be because developing and emerging countries may keep trilemma policy mix in a common controllable level and set their goals not to keep trilemma variables always in a high level but make short-term adjustments based on domestic economic conditions frequently. Second, it is important to associate trilemma policy decisions with different macroeconomic conditions. Both domestic economic performance pressure and global shock make the trilemma policy mix deviate from the intermediate level. What we learn from these findings is that the issue for trilemma policy is not only the restrictive choice among the three but is also limited by the external macroeconomic environment changes.

In summary, as King and Levine (1993) indicated, financial development is closely linked with many major economic conditions like future economic growth rates, physical capital accumulation, and economic efficiency improvements. Moreover, it plays a vital role in economic development. However, with international development and integration, it becomes more and more challenging to understand the mechanism of the financial system. This is somewhat similar to the exchange rate disconnect puzzle (which means the exchange rate becomes disconnected from international trade), which Obstfeld and Rogoff (2000) indicated. The role of productivity in international trade has subsided,

especially in fast-growing developing countries. Our first part conclusion has proved that a traditional set of productivity shocks alone cannot explain a country's current account. Under such a circumstance, adequate consideration of country-specific macroeconomic conditions and the choice of macroeconomic policies is crucial. When discussing the causes of the financial crisis, the feature of domestic financial structure and capital movement restriction must be considered. As for arguing the traditional impossible trinity in international finance, one should realize that the trilemma restrictions do not exist only among the three policy goals but are also affected by changes in the external macroeconomic environment.

At the same time, the different external macro-economic environment changes can also influence the effect of the policy. Therefore, policymakers should consider these issues more comprehensively. Based on full consideration of the country-specific economy and policy characteristics, separating the endogenous and exogenous factors is extremely important. For policy recommendations based on earlier economic framework, policymakers should reconsider it under the recent financial environment and restrictions.

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References:

Allen, F., Bartiloro, L., Gu, X., and Kowalewski, O., 2018. Does economic structure determine financial structure? *Journal of International Economics* 114, 389-409.

Allen, F., Gu, X., and Kowalewski, O., 2012. Financial crisis, structure and reform. *Journal of Banking & Finance* 36, 2960-2973.

Aizenman, J., Chinn, MD., and Ito, H., 2008. Assessing the emerging global financial architecture: Measureing the trilemma's configurations over time. *NBER Working Paper Series,* #14533

Aizenman, J., Chinn, MD., and Ito, H., 2010. The emerging global financial architecture: Tracing and evaluating new patterns of the trilemma configuration. *Journal of International Money and Finance* 29, 615-641.

Aizenman, J., Chinn, MD., and Ito, H., 2013. The "Impossible Trinity" Hypothesis in an Era of Global Imbalances: Measurement and Testing. *Review of international Economics* 21, 447-458.

Aizenman, J., Chinn, MD., and Ito, H., 2016. Monetary policy spillovers and the trilemma in the new normal: Periphery country sensitivity to core country conditions. *Journal of International Money and Finance* 68, 298-330.

Aizenman, J., and Ito, H., 2012. Trilemma policy convergence patterns and output volatility. *North American Journal of Economics and Finance* 23, 269-285.

Aizenman, J., and Ito, H., 2014. Living with the trilemma constraint; Relative trilemma policy divergence, crises, and output losses for developing countries. *Journal of International Money and Finance* 49, 28-51.

Arellano, M., and Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies* 58, 277-297.

Atkinson, G., and Hamilton, K. 2003. Savings, growth and the resource curse hypothesis. *World Development* 31(11), 1793-1807.

Attanasio, O. P., and Weber, G. (2010). Consumption and Saving: Models of intertemporal allocation and their implications for public policy. *Journal of Economic Literature*, 48, 693–751.

Badeeb, R.A., Lean, H.H., and Clark, J. 2017. The evolution of the natural resource curse thesis: A critical literature survey. *Resources Policy* 51, 123-134.

Bearce, DH., and Hallerberg, M., 2011. Democracy and de facto exchange rate regime. " *Economics and Politic* 23, 172-194.

Beck, T., Demirgüç-Kunt, A., and Levine, R., 2000. A New Database on Financial Development and Structure. *World Bank Economic Review* 14, 597–605

Beck, T., Demirgüç-Kunt, A., and Levine, R., 2009. Financial Institutions and Markets across Countries and over Time: Data and Analysis. *World Bank Policy Research Working Paper* 4943.

Beck, T., and Levine, R., 2002. Industry growth and capital allocation: does having a market- or bank-based system matter? *Journal of Financial Economics* 64, 147-180.

Behringer, J., van Treeck, T., 2018. Income distribution and the current account. *Journal of International Economics* 114, 238-254.

Bekaert, G., Harvey, CR., and Lundblad, C., 2006. Growth volatility and financial liberalization. *Journal of International Money and Finance* 25, 370-403.

Bekaert G., Hoerova M., and Lo Duca M. 2013. Risk, uncertainty and monetary policy. *Journal of Monetary Economics* 60(7), 771 – 788

Belabed, C.A., Theobald, T., van Treeck, T., 2018. Income distribution and current account imbalances. *Cambridge Journal of Economics* 42, 47-94.

Bussière, M., Fratzscher, M., Müller, G.J., 2010. Productivity shocks, budget deficits and the current account. *Journal of International Money and Finance* 29, 1562-1579.

Cameron, A.C., and Miller, D.L., 2015. A Practitioner's Guide to Cluster-Robust Inference. *Journal of Human Resources* 50(2), 317-372.

Catao, L.A.V., and Milsei-Ferretti, G.M., 2014. External liabilities and crises. *Journal of International Economics* 94. 18-32.

Cesa-Bianchi, A., Martin, F.E., and Thwaites, G., 2019. Foreign booms, domestic busts: The global dimension of banking crises. *Journal of Financial Intermediation* 37, 56-74.

Chinn, M.D., and Ito, H., 2007. Current account balances, financial development and institutions: Assaying the world "saving glut". *Journal of International Money and Finance* 26, 546-569.

Chinn MD and Ito, H., 2008. A New Measure of Financial Openness. *Journal of Comparative Policy Analysis* 10, 309-322.

Chinn, M.D., and Prasad E.S., 2003. Medium-term determinants of current accounts in industrial and developing countries: an empirical exploration. *Journal of International Economics* 59, 47-76.

Čihák, M., Demirgüç-Kunt, A., Feyen, E., and Levine, R., 2012 Benchmarking Financial Development around the World, *World Bank Policy Research Working Paper* 6175.

Corsetti, G., Pesenti, P., Roubini, N., 1999. *What caused the Asian currency and financial crisis? Japan and the World Economy* 11(3), 305-373.

Cudre, S., Hoffmann, M., 2017. A provincial view of global imbalances: regional capital flows in China. *Review of World Economics* 153, 573-599.

Dal Bianco, S., Amini, C., and Signorelli, M., 2017. The Impact of the Global Financial Crisis and the Role of External and Internal Factors in Emerging Economies. *Emerging Market Finance and Trade* 53, 229-249.

Davis, J.S., Mack, A., Phoa, W., and Vandenabeele, A., 2016. Credit booms, banking crises, and the current account. *Journal of international Money and Finance* 60, 360-377.

Dedola L., Karadi P., and Lombardo G. 2013. Global implications of national unconventional policies. Journal of Monetary Economics 60(1), 66 – 85.

Demirgüç-Kunt, A., and Detragiache, E., 2005. Cross-country empirical studies of systemic banking distress: a survey. *IMF Working Paper* 05/96.

Demirgüç-Kunt, A., Feyen, E., and Levine R., 2013. The Evolving Importance of Banks and Securities Markets. *World Economic Review* 27, 476-490.

Devereux, M.B., Lane, P.R., Xu, J. 2006. Exchange rates and monetary policy in emerging market economies. *Economic Journal* 116(511), 478-506.

Duryea, S., Lam, D., and Levison, D. 2007. Effects of economic shocks on children's employment and schooling in Brazil. *Journal of Development Economics* 84(1), 188-214.

Edison H.J., Levine R., Ricci L., and Slok T. 2002. International financial integration and economic growth. Journal of International Money and Finance 21(6), 749 – 776.

Ehrmann M. and Fratzscher M. 2009. Global financial transmission of monetary policy shocks. *Oxford Bulletin of Economics and Statistics* 71(6), 739 – 759.

Featherstone, K., 2016. Conditionality, Democracy and Institutional Weakness: the Euro-crisis Trilemma. *JCMS-Journal of Common Market Studies* 54, 48-64.

Forst, J., and Saiki, A., 2014. Early warning for currency crises: What is the role of financial openness? *Review of International Economics* 22(1), 722-743.

Gervais, O., Schembri, L., Suchanek, L., 2016. Current account dynamics, real exchange rate adjustment, and the exchange rate regime in emerging-market economies. *Journal of Development Economics* 119, 86-99.

Greene, W.H., Econometric analysis. Pearson Education Limited 2012.

Glick, R., Rogoff, K., 1995. Global versus Country-specific productivity shocks and the current account. *Journal of monetary Economics* 35, 159-192.

Gourinchas, P.O., and Obstfeld, M., 2012. Stories of the Twentieth Century for the Twenty-First. *American Economic Journal: Macroeconomics* 4(1), 226-265.

Gregory, A.W., Head, A.C., 1999. Common and country-specific fluctuations in productivity, investment, and the current account. *Journal of Monetary Economics* 44, 423-451.

Guerineau, S., and Leon, F., 2019. Information sharing, credit booms and financial stability: Do developing economies differ from advanced countries? *Journal of Financial Stability* 40, 64-76.

Guru, B.K., Yadav, I.S. 2021. Financial Integration in Asia: A Macroeconomic Perspective. *Developing Economies* 59(1), 64-101.

Harberger, Arnold C. 1950. Currency Depreciation, Income, and the Balance of Trade. *Journal of Political Economy* 58, no.1, 47-60.

Hoffmann, M., 2013. What drives China's current account? *Journal of International Money and Finance* 32, 856-883.

İşcan, T.B., 2000. The terms of trade, productivity growth and the current account. *Journal of Monetary Economics* 45, 587-611.

Ito, H., Jongwanich, J., Terada-Hagiwara, A. 2009. What makes developing Asia resilient in a financially globalized world? *ADB Economics Working Paper Series* 181, 1-59.

Ji, G., Kim, DS., and Ahn, K., 2019. Financial Structure and Systemic Risk of Banks: Evidence from Chinese Reform. *Sustainability* 11, 3721.

Kaminsky, G.L., and Reinhart, CM., 1999. The twin crises: The causes of banking and balance-of-payments problems. *America Economic Review* 89, 473-500.

Kim, T., Koo, B., and Park, M., 2013. Role of financial regulation and innovation in the financial crisis. *Journal of Financial Stability* 9, 662-672.

King R.G., and Levine R. 1993. Finance and growth: schumpeter might be right. *Quarterly Journal of Economics* 108(3), 717 – 737.

Kose M.A., Prasad E., Rogoff K. and Wei S.-J. 2009. Financial globalization: A reappraisal. *IMF Staff Papers* 56(1), 8 - 62.

Laeven, L., Ratnovski, L., and Tong, H., 2016. Bank size, capital, and systemic risk: Some International evidence. *Journal of Banking & Finance* 69, 25-34.

Laeven, L., and Valencia, F., 2018. Systemic banking crises revisited. *IMF Working Paper* 18/206.

Langfield, S., and Pagano, M., 2016. Bank bias in Europe: effects on systemic risk and growth. *Economic Policy* 31, 51-106.

La Porta, R., Lopez-de-Silanes, F., and Shleifer, A., 2002. Government ownership of banks. *Journal of Finance* 57, 265-301.

Laursen, S., Metzler, L.A., 1950. Flexible Exchange Rates and the Theory of Employment. *Review of Economics and Statistics* 32, 281-299.

Lee, BS., 2012. Bank-based and market-based financial systems: Time-series evidence. *Pacific-basin finance journal* 20, 173-197.

Levine, R., 2002. Bank-Based or Market-Based Financial Systems: Which Is Better? *Journal of Financial Intermediation* 11, 398-428.

Lindh, T., and Malmberg, B. 2000. Can age structure forecast inflation trends? *Journal of Economics and Business* 52(1-2), 31-49.

Marquez, J., 2004. Productivity, investment, and current accounts: Reassessing the evidence. *Review of World Economics* 104, 282-301.

Obstfeld M. 1994. Risk-taking, global diversification, and growth. *American Economic Review* 84(5), 1310 - 1329.

Obstfeld, M., 2012. Does the Current Account Still Matter? *American Economic Review* 102, 1-23.

Obstfeld, M. and Rogoff, K. 2000. The six major puzzles in international macroeconomics: Is there a common cause? *NBER Macroeconomics Annual*, Vol. 15, 339-390.

Obstfeld, M., Shambaugh, J., and Taylor, A., 2005. The trilemma in history: Tradeoffs among exchange rates, monetary policies and capital mobility. *The Review of Economics and Statistics* 87, 423-438.

Ostry, J., Gulde, A., Ghosh, A., and Wolf, H., 1995. Does the nominal exchange rate regime matter? *IMF Working Paper* No. 95/121.

Papyrakis, E., and Gerlagh, R. 2004. The resource curse hypothesis and its transmission channels. *Journal of Comparative Economics* 32(1), 181-193.

Polterovich, V., Popov, V., and Tonis, A. 2007. Mechanisms of resource curse and economic policy. *Voprosy Ekonomiki* (6), 4-27.

Reinhart, CM., and Rogoff, KS., 2008. Is the 2007 US sub-prime financial crisis so different? An international historical comparison. *American Economic Review* 98, 339-344.

Rodrik, D., 1998. Why do more open economies have bigger governments? *Journal of Political Economy* 106(5), 997-1032

Romelli, D., Terra, C., Vasconcelos, E., 2018. Current account and real exchange rate changes: The impact of trade openness. *European Economic Review* 105, 135-158.

Roy, S., Kemme, D.M., 2011. What is really common in the run-up to banking crises? *Economics Letters*, 113(3), 211-214.

Sachs, J., Tornell, A., and Velasco, A., 1996 Financial crises in emerging markets: the lessons from 1995. *Brookings papers on economic activity* 1, 147-215.

Sachs, J.D., and Warner, A.M. 2001. The curse of natural resources. *European Economic Review* 45(4-6), 827-838.

Sevensson, L. E. O., and Razin, A. (1983). The terms of trade and the current account:

The Harberger-Laursen-Metzler effect. *Journal of Political Economy*, 91, 97–125.

Smit, B., Grobler, C., Nel, C., 2014. Sudden Stops and Current Account Reversals: Potential Macroeconomic Consequences for South Africa. *South African Journal of Economics*. 82(4) 616-627

Tan, Z.B., Yao, Y., Wei, S.J., 2015. Financial structure, corporate savings and current account imbalances. *Journal of International Money and Finance* 54, 142-167.

Wooldridge, J.M., Econometric Analysis of Cross Section and Panel Data, 2nd ed. Cambridge, MA: MIT Press 2010.

Yan, H.D., Yang, C.L., 2012. Are there different linkages of foreign capital inflows and the current account between industrial countries and emerging markets? *Empirical Economics* 43, 25-54.

Yoshida, Y., and Zhai, W., 2020. Revisiting the Glick-Rogoff Current Account Model: An Application to the Current Accounts of BRICS Countries. *Dynamic Modeling and Econometrics in Economics and Finance* 27, 265 – 291.

Zhai, W., 2021. Financial structure, capital openness and financial crisis. *MPRA Discussion Paper*, 105457.

Zhai, W., 2021. "Impossible Trinity" Hypothesis: The causal Relation between Trilemma and Macro Policy Performance. *MPRA Discussion Paper*, 110680.

Zorzi, M.C., Chudik, A., Dieppe, A., 2012. Thousands of models, one story: current account imbalances in the global economy. *Journal of International Money and Finance*. 31, 1319–1338.