



**ADB Working Paper Series**

**The Financial Crisis, Rethinking of  
the Global Financial Architecture,  
and the Trilemma**

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No. 213  
April 2010

**Asian Development Bank Institute**

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This paper was prepared for the ADBI conference: "Global Financial Crisis: Macroeconomic Policy Issues" on 28–29 July 2009. The authors thank Yung Chul Park, Masahiro Kawai, Shinji Takagi, Ajay Shah, Shin-ichi Fukuda, and the participants at the conference for their useful comments and suggestions. The financial support of faculty research funds of the UCSC, UW-Madison, and PSU is gratefully acknowledged. This paper was drafted when Mr. Ito was visiting ADBI; thanks go to ADBI for its hospitality and financial support.

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Suggested citation:

Aizenman, J., M. D. Chinn, and H. Ito. 2010. The Financial Crisis, Rethinking of the Global Financial Architecture, and the Trilemma. ADBI Working Paper 213. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/working-paper/2010/04/19/3657.financial.crisis.gfa.trilemma/>

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**Abstract**

This paper extends our previous paper (Aizenman, Chinn, and Ito 2008) and explores some of the unexplored questions. First, we examine the channels through which the trilemma policy configurations affect output volatility. Secondly, we investigate how trilemma policy configurations affect the output performance of the economies under severe crisis situations. Thirdly, we look into how trilemma configurations have evolved in the aftermath of economic crises in the past. We find that trilemma policy configurations and external finances affect output volatility mainly through the investment channel. While a higher degree of exchange rate stability could stabilize the real exchange rate movement, it could also make investment volatile, though the volatility-enhancing effect of exchange rate stability on investment can be cancelled by holding higher levels of international reserves (IR). Greater financial openness helps reduce real exchange rate volatility. These results indicate that policymakers in a more open economy would prefer pursuing greater exchange rate stability and greater financial openness while holding a massive amount of IR. We also find that the “crisis economies” could end up with smaller output losses if they entered the crisis situation with more stable exchange rates or if they continue to hold a high level of IR and maintain greater exchange rate stability during the crisis period. Lastly, we find that developing countries are often found to have decreased the level of monetary independence and financial openness, but increased the level of exchange rate stability in the aftermath of a crisis, especially for the last two decades. This finding indicates how vulnerable developing countries, especially emerging market ones, are to volatile capital flows as a result of global financial liberalization.

**JEL Classification: F15, F21, F31, F36, F41, O24**

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# 1. INTRODUCTION

The global financial crisis that began in 2008 in the United States (US), but spread far and wide across borders, had dire consequences for economic growth. While the extent of economic damage varied across countries, economists agree that the current downturn is the worst since the Great Depression. Even now, in the fall of 2009, there are only limited signs that global recession has ended.

Just as the traumas of the Great Depression and World War II underpinned an initiative to set up a stable international financial architecture, the ongoing crisis has sparked a call for action. That action began with the October 2008 meeting of the G20. But that meeting took place in the midst of the financial panic. As the G20 prepared to meet in Pittsburgh, it seemed that the time was ripe for a comprehensive reevaluation of the international financial architecture – one that would probably be accompanied by changes in the macroeconomic policy combinations adopted by countries.

Whatever configuration of international financial architecture policy leaders consider, they cannot avoid confronting the central policy trilemma in international finance, the existence of the “impossible trinity.” The trilemma thesis states that a country simultaneously may choose any two, but not all, of the following three goals: monetary independence, exchange rate stability, and financial integration.

A number of different international monetary and financial arrangements have been in place since the gold standard system. Each set of arrangements imposed different choices on countries. The Bretton Woods system sacrificed capital mobility for monetary autonomy and exchange rate stability. The Euro system is built upon the fixed exchange rate arrangement and free capital mobility, but abandoned monetary autonomy of the member countries. Until recently, developing countries largely pursued monetary independence and exchange rate stability, at the expense of financial openness.

Although the trilemma has widespread adherence in both policy and academic circles, there has been almost no empirical work testing the concept. Our previous paper (Aizenman, Chinn, and Ito 2008) is one of the few exceptions.<sup>1</sup> In that paper, we first developed the “trilemma indexes” that quantify exchange rate stability, monetary independence, and financial openness. Using these indexes, we have shown that the major crises in the last four decades—the collapse of the Bretton Woods system, the debt crisis of 1982, and the Asian crisis of 1997–98—caused structural breaks in the configuration of the trilemma indexes. We also tested whether the indexes are linearly related to each other and confirmed that a change in one of the trilemma variables induces a change with the opposite sign in the weighted average of the other two. This means countries do face a trade-off of the three policy choices. Armed with these results, we feel confident in predicting that the present turbulence in the global financial markets will challenge the current configuration of trilemma choices among countries.

In Aizenman, Chinn, and Ito (2008), we also investigated the normative question of how the policy choices among the three trilemma policies affect macroeconomic performances such as output volatility, inflation volatility, and the average rate of inflation. We found countries with higher levels of monetary independence tend to experience lower output volatility. We also found that emerging market economies with higher levels of exchange rate fixity tend to experience higher output volatility, though this effect can be mitigated if they hold international reserves at a level higher than 19–22% of gross domestic product (GDP). This result is

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<sup>1</sup> Of course, the notable exceptions include the papers by Obstfeld, Shambaugh, and Taylor (2005, 2008, and 2009) and Shambaugh (2004).

consistent with the observation of many emerging market countries holding massive foreign exchange reserves.

We also found that countries with greater monetary autonomy tend to experience higher inflation, while countries with higher exchange rate stability tend to experience lower inflation. Furthermore, financial openness helps a country to experience lower inflation, possibly indicating that globalization gives developing countries more discipline than monetary autonomy to a country's macroeconomic management.

While our previous paper shed important light on how the choices between trilemma policies can affect macroeconomic performance, we did not address other important questions relevant to the ongoing financial crisis. This paper deals with those questions. We first identify the channels by which the trilemma policy choices affect output volatility. Second, we focus on the performance of the economies in crisis, and investigate how trilemma policy configurations affect the output loss experienced by these economies. Thirdly, we look into how trilemma configurations have evolved in the aftermath of economic crises in the past, hoping to get some implications for the current crisis.

Section 2 reviews the development of policy configurations based on the trilemma using our "trilemma indexes" (Aizenman, Chinn, and Ito 2008). In Section 3, we revisit the statistical analysis of the effect of trilemma policy configurations on macroeconomic performances, namely, output volatility, inflation volatility, and the average rate of inflation, and focus on the channels through which international macroeconomic policy configurations affect output volatility. In Section 4, we investigate the determinants of output losses when a country experiences an economic hardship, not necessarily currency or banking crises. Section 5 concludes.

## **2. DEVELOPMENT OF THE TRILEMMA DIMENSIONS**

In Aizenman, Chinn, and Ito (2008), we demonstrated that major crises in the last four decades—the collapse of the Bretton Woods system, the debt crisis of 1982, and the Asian crisis of 1997–98—caused structural breaks in the trilemma configurations. Here, we revisit the development of policy configurations pertaining to the trilemma and international reserves (IR) holding, using the updated "trilemma indexes."

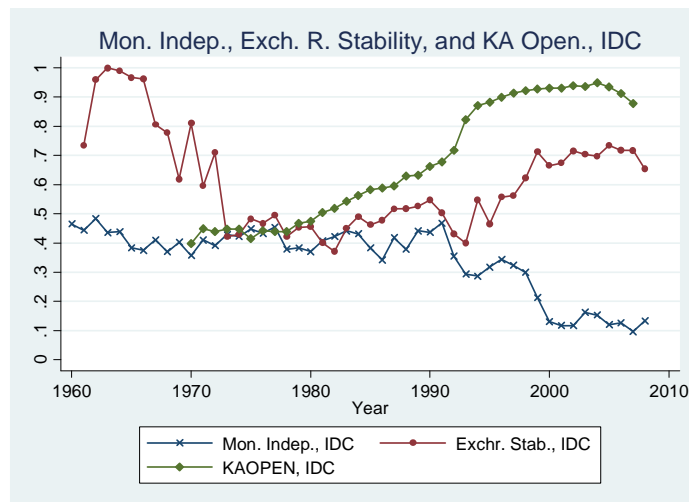
The "trilemma indexes" quantify the degree of achievement along three the dimensions for more than 170 countries for the period of 1970 through 2007. The monetary independence index depends on the correlation of a country's interest rates with the base country's interest rate, the exchange rate stability index is measured by the exchange rate volatility, and the degree of financial integration is measured with the Chinn-Ito (Chinn and Ito 2006, 2008) capital controls index. Additional details on the construction of the indexes can be found in the Appendix.

### **2.1 Development of the Trilemma Configurations over Time**

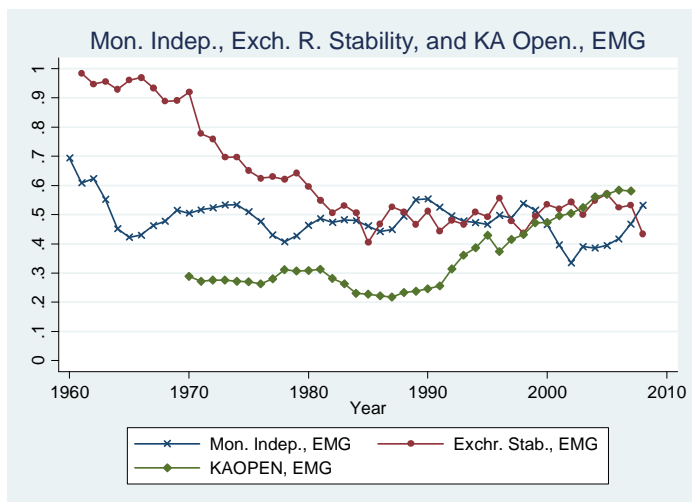
Comparing these indexes provides some interesting insights into how the international financial architecture has evolved over time. Figure 1 shows the development paths of the trilemma indexes for different country groups.

**Figure 1: Development of the Trilemma Configurations Over Time: 1960–2008**

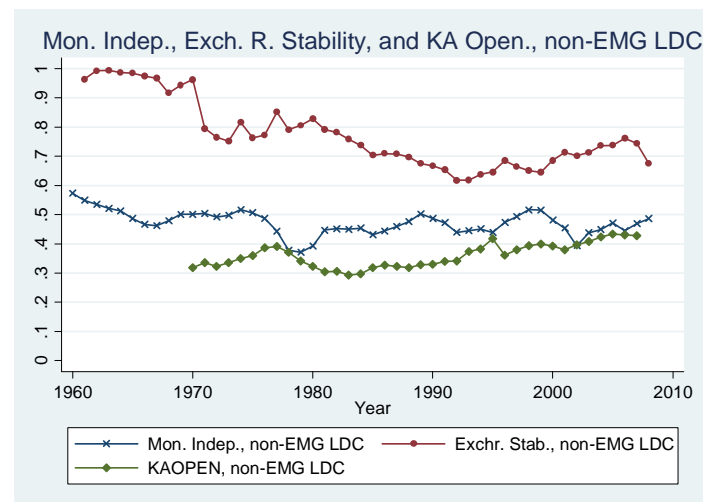
(a) Industrialized Countries



(b) Emerging Market Countries



(c) Non-Emerging Market Developing Countries



Source: Authors' calculations.

For the industrialized countries (Figure 1a), financial openness increased in the 1980s, and surged in the early 1990s, while exchange rate stability rose at the end of the 1990s, reflecting the introduction of the euro in 1999. The extent of monetary independence has trended downward, particularly after the early 1990s.<sup>2</sup>

Developing economies not only differ from industrialized ones in terms of not having a distinct divergence among the indexes, but also differ between emerging and non-emerging market ones.<sup>3</sup> For emerging market countries, exchange rate stability declined rapidly from the 1960s through the mid-1980s. After some retrenchment after the early 1980s (in the wake of the debt crisis), financial openness started rising from 1990 onward. For the other developing countries, exchange rate stability declined less rapidly, and financial openness trended upward more slowly. In both cases, though, monetary independence remained more or less trendless.

Interestingly, for the emerging market economies, our indexes suggest a convergence toward the middle ground, even as talk of the disappearing middle rose in volume. This pattern of results suggests that developing countries may have been trying to cling to moderate levels of both monetary independence and financial openness while maintaining higher levels of exchange rate stability—leaning against the trilemma in other words—which interestingly coincides with the period when some of these economies started holding sizable international reserves, potentially to buffer the trade-off arising from the trilemma.<sup>4</sup>

None of these observations are applicable to non-emerging developing market countries (Figure 1c). For this group of countries, exchange rate stability has been the most aggressively pursued policy throughout the period. In contrast to the experience of the emerging market economies, financial liberalization is not proceeding rapidly for the non-emerging market developing economies.

The “Diamond charts” shown in Figures 3 and 4 are also useful for tracing the changing patterns of the trilemma configurations. Each of the charts shows the levels of the three policy goals as well as international reserves (as a ratio to GDP) with the origin normalized so as to represent zero monetary independence, pure float, zero international reserves, and financial autarky. Figure 2 summarizes the trends for industrialized countries, those excluding the 12 eurozone countries but including Germany, emerging market countries, and non-emerging market developing countries.<sup>5</sup>

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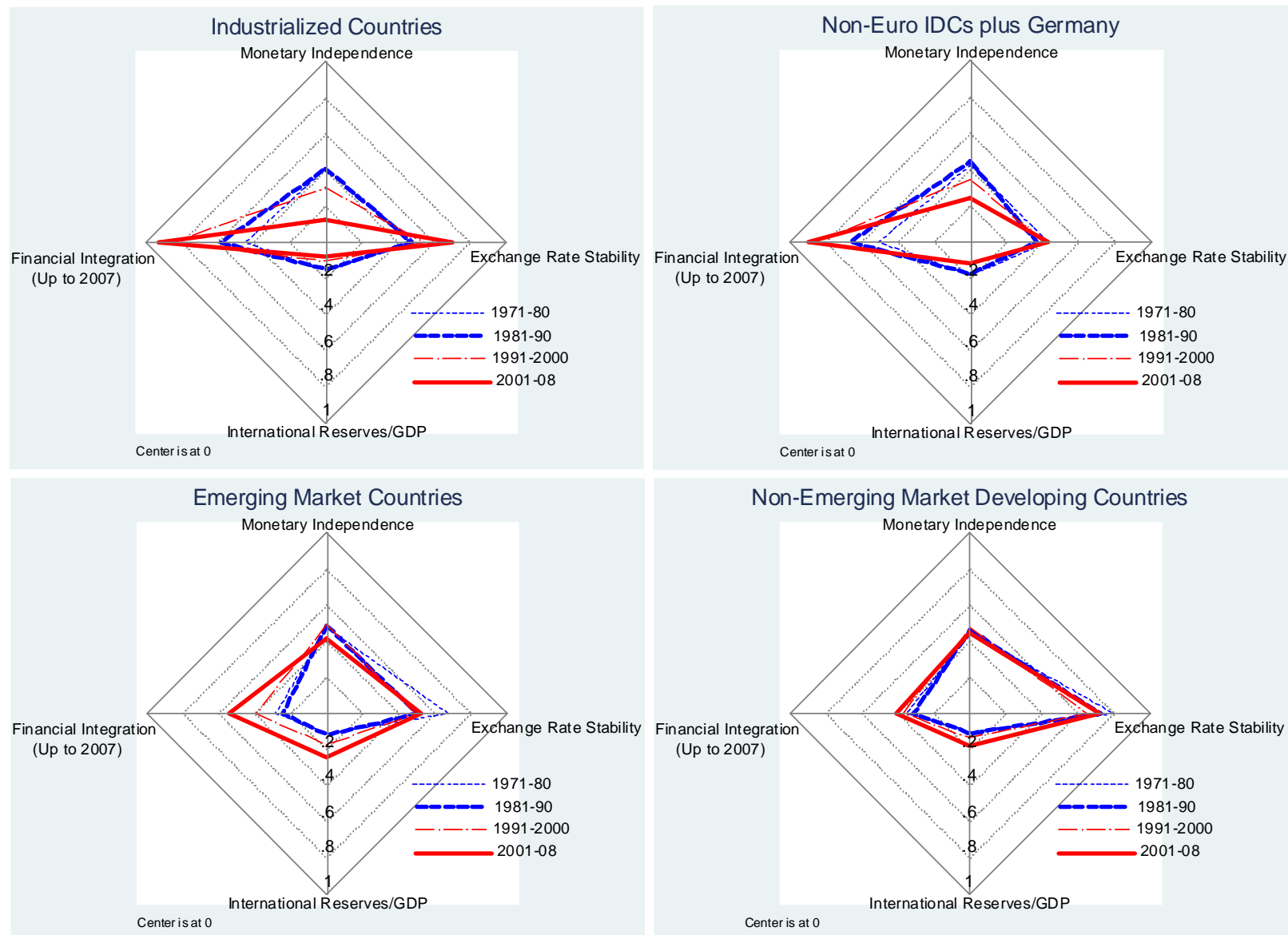
<sup>2</sup> If the euro countries are removed from the sample (not reported), financial openness evolves similarly to the industrial countries (IDC) group that includes the eurozone countries, but exchange rate stability hovers around the line for monetary independence, though at a bit higher levels, after the early 1990s. The difference between exchange rate stability and monetary independence has been slightly diverging after the end of the 1990s.

<sup>3</sup> The emerging market countries are defined as the countries classified as either emerging or frontier during the period of 1980–1997 by the International Financial Corporation, plus Hong Kong, China and Singapore.

<sup>4</sup> Willett (2003) has called this compulsion by countries with a mediocre level of exchange rate fixity to hoard reserves the “unstable middle” hypothesis (as opposed to the “disappearing middle” view).

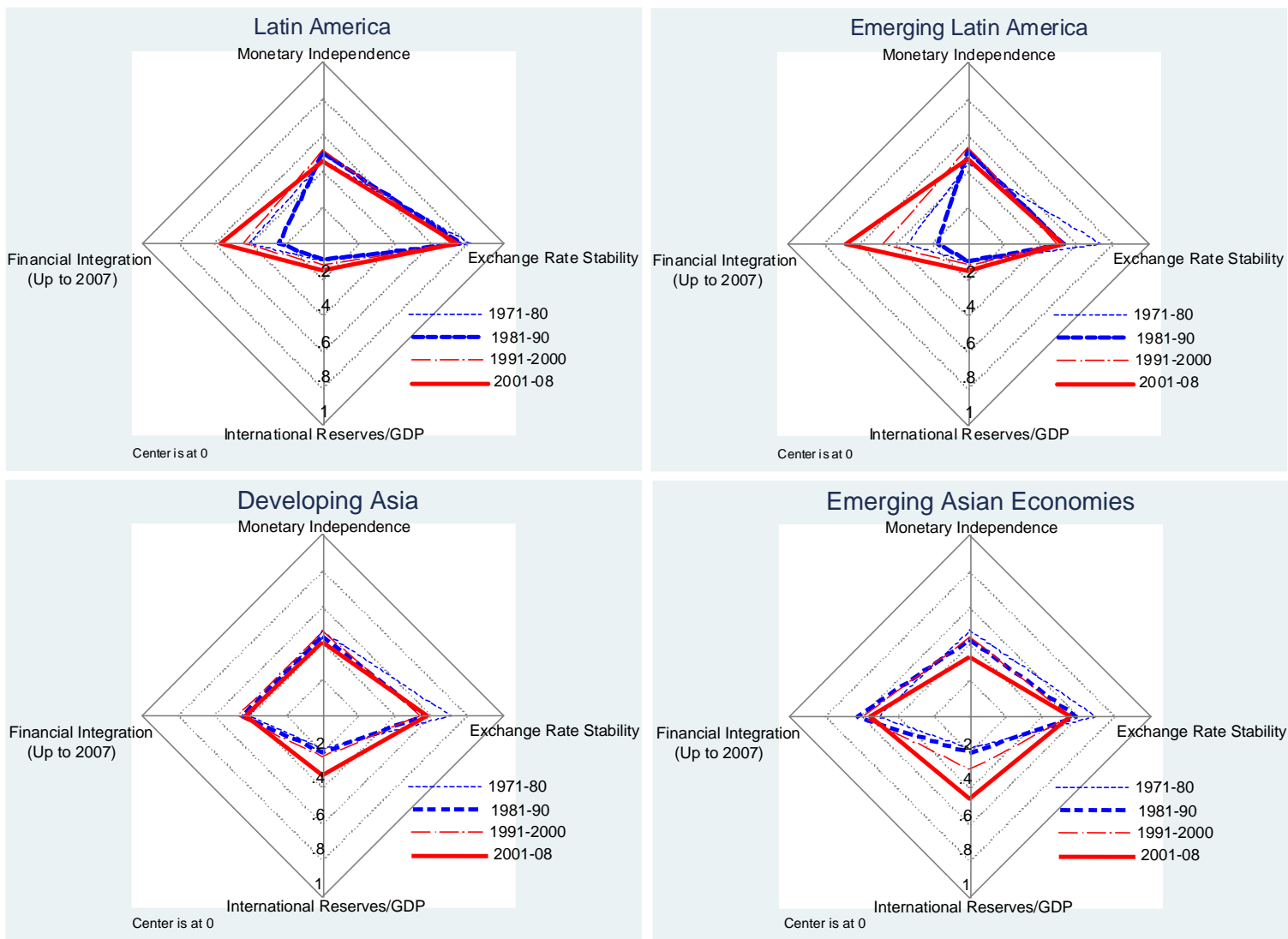
<sup>5</sup> Germany is included as one of the “non-Euro industrialized countries” because, unlike the other Euro member countries, Germany retains monetary independence.

**Figure 2: The “Diamond Charts”: Variation of the Trilemma and IR Configurations Across Different Country Groups**



Source: Authors' calculations.

**Figure 3: Regional Patterns of the Trilemma and IR Configurations**



NOTES: Emerging Asian Economies include The People’s Republic of China; Hong Kong, China; Indonesia; Republic of Korea; Malaysia; Philippines; Singapore; Taipei,China; and Thailand. Emerging Latin America includes Argentina, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru, Trinidad and Tobago, and Venezuela.

Source: Authors’ calculations.

That figure reveals that, while both industrialized countries and emerging market countries have moved towards deeper financial integration and declining monetary independence, non-emerging market developing countries have only inched toward financial integration. Emerging market countries, after giving up some exchange rate stability during the 1980s, have not changed their stance with respect to exchange rate stability, whereas non-emerging market developing countries seem to be remaining at, with some fluctuations, a relatively high level of exchange rate stability. The pursuit of greater financial integration is much more pronounced among industrialized countries than developing countries, while emerging market countries have increased financial openness. Interestingly, emerging market countries stand out from other groups by achieving a relatively balanced combination of the three macroeconomic goals by the 2000s, i.e., middle-range levels of exchange rate stability and financial integration while retaining more monetary independence than industrialized countries did. The recent policy combination has been matched by a substantial increase in the IR/GDP ratio; such an occurrence is not observed in any other groups.

Figure 3 compares developing countries across different geographical groups. Developing countries in both Asia and Latin America (LATAM) have moved toward exchange rate flexibility, but LATAM countries have rapidly increased financial openness while Asian counterparts have not. The emerging market sub-groups of each regional group exhibited a much smaller difference, however.<sup>6</sup> Yet one key difference between the two groups is that the former held much more international reserves than the latter. More importantly, Asian emerging market countries have opted for a more balanced combination of the three policy goals, which can easily make one suspect it is the large international reserve accumulation that may have allowed this group of countries to achieve such a trilemma configuration.

### 3. REGRESSION ANALYSES

The above observations of the trilemma and IR configurations do not answer the question of what kind of goals policymakers would like to achieve by choosing a certain policy combination based on the trilemma. In Aizenman, Chinn, and Ito (2008), we tested how the three policy choices individually or interactively could affect the macroeconomic outcomes such as output volatility, inflation volatility, and medium-term inflation rates among developing countries.

Here, we replicate the model that examines the impact of the trilemma configurations and IR holding while controlling for the impact of external finance, which is most useful for examining the impact of the current crisis, given the magnification effect attributed to interlinked financial markets.

The specification is given by:

$$y_{it} = \alpha_0 + \alpha_1 TLM_{it} + \alpha_2 IR_{it} + \alpha_3 (TLM_{it} \times IR_{it}) + ExtFin_{it} B + X_{it} \Gamma + Z_t \Phi + D_i \Theta + \varepsilon_{it} \quad (1)$$

$y_{it}$  is the measure for macro policy performance for country  $i$  in year  $t$ . More specifically,  $y_{it}$  is either output volatility measured as the five-year standard deviations of the growth rate of per capita real output (using Penn World Table 6.2); inflation volatility as the five-year standard deviations of the monthly rate of inflation; or the five-year average of the monthly rate of inflation.  $TLM_{it}$  is a vector of any two of the three trilemma indexes, namely, monetary

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<sup>6</sup> These are unweighted averaged; if we weighted by GDP, the differences would be larger.

independence ( $MI$ ), exchange rate stability ( $ERS$ ), and  $KAOPEN$ .<sup>7</sup>  $TR_{it}$  is the level of international reserves (excluding gold) as a ratio to GDP, and  $(TLM_{it} \times TR_{it})$  is an interaction term between the trilemma indexes and the level of international reserves, that may allow us to observe whether international reserves complement or substitute for other policy stances.

Financial liberalization has increased its pace over the last two decades. Nonetheless, the increasing volume of cross border transactions of capital is increasingly blamed for economic instability. Motivated by this observation, we incorporate the effect of external financing in our specification by including in the vector  $ExtFin_{it}$  variables that capture net FDI inflows, net portfolio inflows, net “other” inflows (which mostly include bank lending in *International Financial Statistics* [IFS]), short-term debt, and total debt service. For net capital flows, we use the IFS data and define them as external liabilities (= capital inflows with a positive sign) minus assets (= capital inflows with a negative sign) for each type of flows – negative values mean that a country experiences a net outflow capital of the type of concern. Short-term debt is included as the ratio of total external debt and total debt service as is that of Gross National Income (GNI). Both variables are retrieved from the World Development Indicators database.

$X_{it}$  is a vector of macroeconomic control variables that include the variables most used in the literature, namely, relative income (to the US based on Penn World Table per capita real income); its quadratic term; trade openness  $(=(EX+IM)/GDP)$ ; the TOT shock as defined as the five-year standard deviation of trade openness times TOT growth; fiscal procyclicality (as the correlations between Hodrick-Prescott (HP)-detrended government spending series and HP-detrended real GDP series); M2 growth volatility (as five-year standard deviations of M2 growth); private credit creation as a ratio to GDP as a measure of financial development; the inflation rate; and inflation volatility.  $Z_t$  is a vector of global shocks that includes change in US real interest rate; world output gap; and relative oil price shocks (measured as the log of the ratio of oil price index to the world’s Consumer Price Index).  $D_i$  is a set of characteristic dummies that includes a dummy for oil exporting countries and regional dummies. We also include the dummy for currency crises.<sup>8</sup> Explanatory variables that persistently appear to be statistically insignificant are dropped from the estimation.  $\varepsilon_{it}$  is an *i.i.d.* error term.

The data set is organized into five-year panels of 1972–1976, 1977–81, 1982–1986, 1987–91, 1992–96, 1997–2001, 2002–06. All time-varying variables are included as five-year averages. The regression is conducted for the group of developing countries (LDC) and a subgroup of emerging market countries (EMG).

We use the robust regression method for the estimation because it reduces the weight of outliers that can arise in both the dependent variable and explanatory variables such as inflation volatility.<sup>9</sup> Furthermore, for comparison purposes, the same set of explanatory variables is used for the three subsamples, except for the regional dummies.

<sup>7</sup> In Aizenman, Chinn, and Ito (2008), we have shown that these three measures of the trilemma are linearly related. Therefore, it is most reasonable to include two of the indexes concurrently, not just individually nor all three collectively.

<sup>8</sup> The currency crisis dummy variable is derived from the conventional exchange rate market pressure (EMP) index pioneered by Eichengreen *et al.* (1996). The EMP index is defined as a weighted average of monthly changes in the nominal exchange rate, the international reserve loss in percentage, and the nominal interest rate. The weights are inversely related to the pooled variance of changes in each component over the sample countries, and adjustment is made for the countries that experienced hyperinflation following Kaminsky and Reinhart (1999). For countries without data to compute the EMP index, the currency crisis classifications in Glick and Hutchison (2001) and Kaminsky and Reinhart (1999) are used.

<sup>9</sup> The robust regression procedure conducts iterative weighted least squares regressions while downweighting observations that have larger residuals until the coefficients converge. Also, we remove the observations if their

### **3.1 Estimation Results of the Basic Models**

#### **3.1.1 Output Volatility**

The regression results are reported in Tables 1 and 2 for developing countries and emerging market countries, respectively. The estimation results for output volatility are shown in columns 1 through 3.

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values of inflation volatility are greater than a value of 30 or the rate of inflation (as an explanatory variable) is greater than 100%.

**Table 1: The Impact of the Trilemma Configurations and External Financing: Less Developed Countries (LDC)**

	Output volatility			Level of Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Relative Income	-0.03 [0.035]	-0.13 [0.036]***	-0.143 [0.036]***	-0.163 [0.087]*	-0.157 [0.087]*	-0.182 [0.084]**
Relative Income, sq.	0.007 [0.066]	0.278 [0.067]***	0.311 [0.067]***	0.25 [0.149]*	0.25 [0.150]*	0.278 [0.144]*
Change in US real interest rate	0.122 [0.049]**	0.11 [0.050]**	0.119 [0.050]**			
Volatility of (TOT*Trade openness)	0.026 [0.009]***	0.03 [0.009]***	0.027 [0.009]***	0.021 [0.021]	0.019 [0.021]	0.018 [0.020]
Inflation volatility	0.023 [0.006]***	0.02 [0.006]***	0.023 [0.006]***	0.299 [0.015]***	0.284 [0.015]***	0.297 [0.015]***
Fiscal Procyclicality	0.002 [0.002]	0.004 [0.002]*	0.004 [0.002]*	-0.006 [0.005]	-0.005 [0.005]	-0.005 [0.005]
Relative oil price shocks				0.014 [0.006]**	0.007 [0.006]	0.012 [0.006]**
World Output Gap				0.323 [0.304]	0.159 [0.308]	0.276 [0.294]
M2 growth				0.425 [0.023]***	0.481 [0.023]***	0.417 [0.022]***
Currency Crisis	0.005 [0.003]*	0.005 [0.003]*	0.005 [0.003]*	0.031 [0.006]***	0.032 [0.007]***	0.029 [0.006]***
Private credit creation	-0.003 [0.006]	-0.008 [0.006]	-0.005 [0.007]	-0.018 [0.017]	-0.014 [0.017]	-0.019 [0.016]
Total Reserve (as % of GDP)	0.072 [0.052]	-0.055 [0.052]	0.065 [0.034]*	-0.053 [0.122]	-0.182 [0.123]	-0.198 [0.076]***
Monetary Independence (MI)	-0.019 [0.014]	-0.035 [0.014]**		-0.002 [0.033]	-0.017 [0.034]	
MI x reserves	0.005 [0.085]	0.112 [0.089]		-0.04 [0.199]	0.055 [0.208]	
Exchange Rate Stability (ERS)	0.008 [0.007]		0.012 [0.006]*	-0.04 [0.016]**		-0.04 [0.015]***
ERS x reserves	-0.086 [0.044]*		-0.095 [0.044]**	0.074 [0.104]		0.071 [0.098]
KA Openness		-0.02 [0.008]**	-0.014 [0.008]*		-0.055 [0.019]***	-0.055 [0.018]***
KAOPEN x reserves		0.086 [0.045]*	0.048 [0.042]		0.261 [0.107]**	0.254 [0.097]***

	Output volatility			Level of Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Net FDI inflows/GDP	0.047 [0.068]	0.092 [0.071]	0.109 [0.070]	-0.477 [0.177]***	-0.442 [0.184]**	-0.441 [0.173]**
Net portfolio inflows/GDP	0.241 [0.122]**	0.289 [0.129]**	0.286 [0.127]**	0.064 [0.286]	0.297 [0.302]	0.228 [0.287]
Net 'other' inflows/GDP	0.069 [0.029]**	0.063 [0.029]**	0.071 [0.029]**	0.037 [0.069]	0.09 [0.070]	0.045 [0.068]
Short-term Debt (as % of total external debt)	-0.009 [0.016]	-0.008 [0.016]	-0.007 [0.016]	-0.007 [0.037]	-0.003 [0.038]	0.012 [0.036]
Total debt service (as % of GNI)	0.063 [0.035]*	0.081 [0.035]**	0.078 [0.035]**	0.176 [0.088]**	0.184 [0.088]**	0.154 [0.086]*
Observations	311	311	311	311	310	310
Adjusted R-squared	0.37	0.39	0.4	0.86	0.86	0.86

Notes: Robust regressions are implemented. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The dummy for Sub-Saharan countries is included in the regressions for output and inflation volatility, so are the dummies for Latin America and Caribbean and East Europe and Central Asia in the regression for the level of inflation. "Trade openness" that is insignificant is omitted from presentation to conserve space.

Source: Authors' calculations.

**Table 2: The Impact of the Trilemma Configurations and External Financing: Emerging Market Countries (EMG)**

	Output volatility			Level of Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Relative Income	-0.04 [0.066]	-0.028 [0.068]	-0.043 [0.068]	0.086 [0.223]	0.005 [0.202]	0.035 [0.218]
Relative Income, sq.	0.048 [0.145]	0.025 [0.151]	0.059 [0.150]	-0.398 [0.458]	-0.215 [0.421]	-0.281 [0.449]
Change in US real interest rate	0.124 [0.056]**	0.112 [0.057]*	0.118 [0.056]**			
Volatility of (TOT*Trade Openness)	0.01 [0.015]	0.013 [0.015]	0.01 [0.015]	0.038 [0.046]	0.013 [0.042]	0.038 [0.044]
Inflation volatility	0.037 [0.007]***	0.034 [0.007]***	0.036 [0.007]***	0.325 [0.025]***	0.381 [0.023]***	0.322 [0.024]***
Fiscal Procyclicality	0.002 [0.003]	0.003 [0.003]	0.003 [0.003]	-0.012 [0.009]	-0.011 [0.008]	-0.009 [0.009]
Relative oil price shocks				-0.005 [0.010]	-0.008 [0.009]	-0.007 [0.009]
World Output Gap				0.73 [0.465]	0.511 [0.424]	0.6 [0.453]
M2 growth				0.449 [0.034]***	0.417 [0.031]***	0.436 [0.033]***
Currency Crisis	0.007 [0.003]**	0.008 [0.003]**	0.006 [0.003]*	0.025 [0.009]***	0.02 [0.009]**	0.022 [0.009]**
Private credit creation	-0.001 [0.006]	-0.005 [0.006]	-0.001 [0.006]	-0.039 [0.025]	-0.032 [0.022]	-0.046 [0.024]*
Total Reserve (as % of GDP)	0.083 [0.051]	-0.04 [0.054]	0.078 [0.032]**	-0.165 [0.156]	-0.185 [0.151]	-0.171 [0.095]*
Monetary Independence (MI)	-0.018 [0.016]	-0.035 [0.017]**		-0.032 [0.049]	-0.044 [0.047]	
MI x reserves	0.009 [0.081]	0.089 [0.090]		0.048 [0.249]	0.095 [0.248]	
Exchange Rate Stability (ERS)	0.017 [0.008]**		0.021 [0.008]***	-0.053 [0.026]**		-0.049 [0.025]**
ERS x reserves	-0.11 [0.048]**		-0.12 [0.047]**	0.243 [0.145]*		0.233 [0.137]*
KA Openness		-0.012 [0.009]	-0.005 [0.008]		-0.057 [0.024]**	-0.042 [0.024]*
KAOPEN x reserves		0.066 [0.045]	0.035 [0.039]		0.203 [0.125]	0.099 [0.119]

	Output volatility			Level of Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Net FDI inflows/GDP	-0.115 [0.098]	-0.082 [0.107]	-0.13 [0.104]	-0.823 [0.330]**	-0.582 [0.318]*	-0.667 [0.335]**
Net portfolio inflows/GDP	-0.028 [0.130]	-0.02 [0.139]	0.026 [0.136]	-0.338 [0.399]	-0.119 [0.382]	-0.19 [0.404]
Net 'other' inflows/GDP	0.031 [0.034]	0.03 [0.035]	0.028 [0.034]	0.037 [0.115]	0.08 [0.106]	0.032 [0.112]
Short-term Debt (as % of total external debt)	-0.007 [0.017]	-0.004 [0.018]	-0.005 [0.018]	0.051 [0.055]	0.05 [0.051]	0.073 [0.054]
Total debt service (as % of GNI)	0.049 [0.040]	0.058 [0.041]	0.053 [0.040]	0.212 [0.150]	0.093 [0.138]	0.217 [0.147]
Observations	159	159	159	159	159	159
Adjusted R-squared	0.32	0.29	0.31	0.88	0.9	0.88

Notes: Robust regressions are implemented. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The dummy for Sub-Saharan countries is included in the regressions for output and inflation volatility, so are the dummies for Latin America and Caribbean and East Europe and Central Asia in the regression for the level of inflation.

Source: Authors' calculations.

Overall, macroeconomic variables retain the characteristics consistent with what has been found in the literature. In the regressions for output volatility, it is found that the higher the level of income is (relative to the US), the more reduced output volatility is, though the effect is nonlinear. The bigger change occurs on the US real interest rate, the higher output volatility of developing countries may become, indicating that the US real interest rate may represent the debt payment burden on these countries. The higher TOT shock there is, the higher output volatility countries experience. This finding is consistent with Rodrik (1998) and Easterly, Islam, and Stiglitz (2001) who argued that volatility in world goods through trade openness can raise output volatility.<sup>10</sup> Countries with a procyclical fiscal policy tend to experience more output volatility, while oil exporters also experience more output volatility. Not surprisingly, currency crises increase the level of output volatility. The results hold qualitatively for the subsample of emerging market countries, though the statistical significance is weaker, reflecting the smaller variations of the variables for this group of economies.

Countries with more developed financial markets tend to experience lower output volatility, although the estimated effect is not statistically significant.<sup>11</sup> In Aizenman, Chinn, and Ito (2008), we showed that financial development interacts with the exchange rate stability in a nonlinear fashion for emerging market economies. Medium-levels of financial development raise the volatility-enhancing impact of exchange rate stability. Highly developed financial markets boost the effect of financial openness on the reduction of output volatility while underdeveloped financial markets exacerbate output volatility. This last effect highlights the synergistic effects between financial development and financial opening.

Among the trilemma indexes, the monetary independence variable is found to have a significantly negative effect on output volatility; the greater monetary independence one embraces, the less output volatility the country tends to experience.<sup>12</sup> This finding is no surprise, considering that stabilization measures should reduce output volatility, especially more so under higher degree of monetary independence.<sup>13</sup> Mishkin and Schmidt-Hebbel (2007) found that countries that adopt inflation targeting—one form of increasing monetary independence—are found to reduce output volatility, and that the effect is bigger among emerging market countries.<sup>14</sup> This volatility reducing effect of monetary independence may explain the tendency

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<sup>10</sup> The effect of trade openness is found to have insignificant effects for all subgroups of countries and is therefore dropped from the estimations. This finding reflects the debate in the literature, in which both positive (i.e., volatility enhancing) and negative (i.e., volatility reducing) effects of trade openness has been evidenced. The volatility enhancing effect in the sense of Easterly et al. (2001) and Rodrik (1998) is captured by the term for (TOT\*Trade Openness) volatility. For the volatility reducing effect of trade openness, refer to Calvo et al. (2004), Cavallo (2005, 2007), and Cavallo and Frankel (2004). The impact of trade openness on output volatility also depends on the type of trade, i.e., whether it is inter-industry trade (Krugman 1993) or intra-industry trade (Razin and Rose 1994).

<sup>11</sup> For theoretical predictions on the effect of financial development, refer to Aghion et al. (1999) and Caballero and Krishnamurthy (2001). For empirical findings, see Blankenau et al. (2001) and Kose et al. (2003).

<sup>12</sup> In model (1), once the interaction term between monetary independence and international reserves is removed from the model, the variable for monetary independence enters the model with the 5% significant negative coefficient. The same trait is also found for the EMG regression in Model (1) of Table 2.

<sup>13</sup> This finding can be surprising to some if the concept of monetary independence is taken synonymously to central bank independence because many authors, most typically Alesina and Summers (1993), have found more independent central banks would have no or little at most impact on output variability. However, in this literature, the extent of central bank independence is usually measured by the legal definition of the central bankers and/or the turnover ratios of bank governors, which can bring about different inferences compared to our measure of monetary independence.

<sup>14</sup> The link is not always predicted to be negative theoretically. When monetary authorities react to negative supply shocks, that can amplify the shocks and exacerbate output volatility. Cechetti and Ehrmann (1999) find the positive association between adoption of inflation targeting and output volatility.

for developing countries, especially non-emerging market ones, to not reduce the extent of monetary independence over years.

More interestingly, the coefficient for exchange rate stability is found to be positive, significantly for model (3) among developing countries, and both models (1) and (3) for emerging market countries. This result implies a stabilizer effect of more flexible exchange rates, as in Edwards and Levy-Yeyati (2005) and Haruka (2007). However, the interaction term is found to have a statistically negative effect, suggesting that countries pursuing exchange rate stability can dampen output volatility enhancing effects by holding high levels of international reserves. The threshold level of international reserves holding is found to be 12.5% of GDP in model (3) for developing countries and 15.3–17.2% for emerging market countries. The volatility dampening effect can be large for some of the countries, as we will discuss later on.

Countries with more open capital account tend to experience lower output volatility according to model (2) in Table 1. However, those with IR holding higher than 23% of GDP experience higher volatility by pursuing more financial openness -- a somewhat counterintuitive finding.<sup>15</sup>

Among the external finance variables, the more “other” capital inflows, i.e., bank lending or more net portfolio inflows, a country receives, the more likely it is to experience higher output volatility, reflecting the fact that countries which experience macroeconomic turmoil often experienced an increase in inflows of bank lending or “hot money,” such as portfolio investment, especially prior to the outbreak of the turmoil. Total debt service is found to be a positive contributor to output volatility while short-term debt does not seem to have an effect. This results contrasts with the conventional wisdom regarding short term external debt.<sup>16</sup>

### 3.1.2 Inflation Volatility

The regression models for inflation volatility do not turn out to be as robust as those for output volatility. We do not report the results in the table. The findings on the macro variables are generally consistent with the literature. Countries with higher relative income tend to experience lower inflation volatility, and naturally, those with higher levels of inflation and those which experience currency crises are expected to experience higher inflation volatility. The TOT shock increases inflation volatility, but only for emerging market countries.

The performance of the trilemma indexes appears to be the weakest for this group of estimations overall. However, once the interaction terms are removed from the models, the performance improves (results not reported), and monetary independence is found to be an inflation volatility decreasing factor. FDI inflows appear to contribute to lowering inflation volatility. One possible explanation is that countries tend to stabilize inflation movement to attract FDI. Net portfolio inflows on the other hand positively contribute to inflation volatility.

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<sup>15</sup> However, the result of model (2) in Table 1-1 is consistent with those of models (1) and (3). That is, model (2) predicts that if a country increases its level of monetary independence and financial openness concurrently, it could reduce output volatility. As long as the concept of the trilemma holds true, i.e., the three policy goals are linearly related, which we empirically proved to be true in Aizenman, Chinn, and Ito (2008), the efforts of increasing both MI and KAOPEN is essentially the same as lowering the level of exchange rate stability. Models (1) and (3) predict that lower ERS leads to lower output volatility. But these models also predict that if the country holds IR more than thresholds, it would have to face higher output volatility, which is found in model (2).

<sup>16</sup> One might suspect that this result can be driven by multicollinearity between the short-term debt variable and the variables for the various net inflows. However, even when the three net inflow variables are removed from the models, still the total debt service continues to be a positive factor while the short-term debt variable continues to be an insignificant one.

### 3.1.3 Medium-run Level of Inflation

The models for the medium-run level of inflation fit as well as those for output volatility (shown in Columns (4) through (6) in Tables 1 and 2). Countries with higher inflation volatility, higher M2 growth, and oil price shocks tend to experience higher medium-run levels of inflation while currency crises lead to higher inflation, possibly reflecting the abortion of fixed exchange rates during the crisis.

Among the trilemma variables, higher exchange rate stability is associated with lower inflation for both developing and emerging market countries, a result consistent with the literature (such as Ghosh et al. 1997). This finding and the previously found positive association between exchange rate stability and output volatility are in line with the theoretical prediction that establishing stable exchange rates is a trade-off issue for policymakers; it will help the country to achieve lower inflation by showing a higher level of credibility and commitment, but at the same time, the efforts of maintaining stable exchange rates will rid the policymakers of an important adjustment mechanism through fluctuating exchange rates – which would explain the negative coefficient on monetary independence in the output volatility regressions.

Financial openness contributes negatively to inflation in the medium run. The negative association between “openness” and inflation has been frequently remarked upon.<sup>17</sup> This finding may explain the reason why many countries, including developing countries, have experienced synchronized disinflation, with many of them having liberalized trade of goods and services as well as financial assets. Furthermore, the interaction term between the financial openness variable and IR holding is found to be significantly positive for both developing and emerging market countries. For emerging market countries, the interaction term between exchange rate stability and IR holding is also found to be positive. These results may indicate that if the ratio of reserves holding to GDP is greater than some threshold - it ranges around 22–27% of GDP - the efforts of pursuing exchange rate stability and/or financial openness helps increase the level of inflation. This means that countries with excess levels of reserve holdings will eventually face a limit on foreign exchange sterilization.<sup>18</sup>

## 3.2 Channels to Output Volatility

Given the current state of the world economy, one cannot help but focus on the estimation results for output volatility. One natural question that arises is through what channels do these factors contribute to output volatility. To answer this question, we estimate similar models for output volatility but replace the dependent variable with real exchange rate stability, through which net exports can be affected, and the volatility of investment.

The first three columns in Tables 3 and 4 are the same as those in Tables 1 and 2, respectively. The results shown in columns (4) through (6) and those (7) through (9) correspond to the real exchange rate stability and investment volatility specifications, respectively. However, for the estimation of the real exchange rate stability, some of the explanatory variables are changed; the variables for the change in the US real interest rate, fiscal procyclicality, and financial development (measured by private credit creation as a ratio to GDP) are dropped from the

<sup>17</sup> Rogoff (2003) argues that globalization contributes to dwindling mark-ups, and thereby, disinflation. Razin and Binyamini (2007) predicted that both trade and financial liberalization will flatten the Phillips curve, so that policymakers will become less responsive to output gaps and more aggressive in fighting inflation. Loungani et al. (2001) provides empirical evidence for the link.

<sup>18</sup> Aizenman and Glick (2008) and Glick and Hutchison (2008) show that China, whose ratio of reserves holding to GDP is estimated to be 50%, has started facing more inflationary pressure in 2007 as a result of intensive market interventions to sustain exchange rate stability (though the onset of global crisis has reversed these trends).

estimation, and replaced with inflation volatility, and differentials in inflation volatility between the home and base countries are included instead.<sup>19</sup>

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<sup>19</sup> Interest rate differentials are also tested, but did not turn out to be significant. Therefore, they are not included in the estimation.

**Table 3: Determinants of Output Volatility: Less Developed Countries (LDC)**

	Output volatility			Real exchange rate volatility			Investment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Relative Income	-0.03 [0.035]	-0.13 [0.036]***	-0.143 [0.036]***	-0.016 [0.020]	0.027 [0.031]	-0.015 [0.020]	-0.098 [0.143]	-0.15 [0.142]	-0.125 [0.139]
Relative Income, sq.	0.007 [0.066]	0.278 [0.067]***	0.311 [0.067]***	0.017 [0.037]	-0.041 [0.057]	0.019 [0.038]	0.12 [0.264]	0.239 [0.265]	0.211 [0.258]
Change in US real interest rate	0.122 [0.049]**	0.11 [0.050]**	0.119 [0.050]**				0.388 [0.199]*	0.306 [0.198]	0.259 [0.194]
Volatility of TOT*OPN	0.026 [0.009]***	0.03 [0.009]***	0.027 [0.009]***	0.007 [0.005]	0.011 [0.008]	0.008 [0.005]	0.095 [0.036]***	0.121 [0.036]***	0.103 [0.035]***
Inflation volatility (Infl. vol. differentials in (4)-(6))	0.023 [0.006]***	0.02 [0.006]***	0.023 [0.006]***	0.038 [0.003]***	0.031 [0.005]***	0.038 [0.004]***	0.135 [0.025]***	0.133 [0.025]***	0.131 [0.025]***
Fiscal Procyclicality	0.002 [0.002]	0.004 [0.002]*	0.004 [0.002]*				-0.001 [0.009]	0.003 [0.009]	0.004 [0.009]
Trade openness				-0.005 [0.003]*	-0.011 [0.004]***	-0.005 [0.003]*			
Currency Crisis	0.005 [0.003]*	0.005 [0.003]*	0.005 [0.003]*	0.009 [0.002]***	0.013 [0.002]***	0.009 [0.002]***	0.009 [0.011]	0.002 [0.011]	0.007 [0.011]
Private credit creation	-0.003 [0.006]	-0.008 [0.006]	-0.005 [0.007]				-0.011 [0.026]	-0.012 [0.026]	-0.001 [0.025]
Total Reserve (as % of GDP)	0.072 [0.052]	-0.055 [0.052]	0.065 [0.034]*	0.021 [0.029]	0.038 [0.045]	-0.013 [0.019]	-0.232 [0.210]	-0.393 [0.205]*	0.158 [0.132]
Monetary Independence (MI)	-0.019 [0.014]	-0.035 [0.014]**		0.004 [0.008]	0.025 [0.012]**		-0.181 [0.056]***	-0.159 [0.057]***	
MI x reserves	0.005 [0.085]	0.112 [0.089]		-0.049 [0.048]	-0.086 [0.076]		1.2 [0.342]***	0.785 [0.351]**	
Exchange Rate Stability (ERS)	0.008		0.012	-0.037		-0.038	0.077		0.07

	Output volatility			Real exchange rate volatility			Investment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ERS x reserves	[0.007] -0.086 [0.044]*		[0.006]* -0.095 [0.044]**	[0.004]*** -0.007 [0.025]		[0.004]*** 0.001 [0.024]	[0.026]*** -0.415 [0.179]**		[0.025]*** -0.254 [0.170]
KA Openness		-0.02 [0.008]**	-0.014 [0.008]*		-0.008 [0.007]	-0.004 [0.004]		-0.042 [0.032]	-0.012 [0.030]
KAOPEN x reserves		0.086 [0.045]*	0.048 [0.042]		0.029 [0.038]	0.019 [0.024]		0.223 [0.178]	0.051 [0.165]
Net FDI inflows/GDP	0.047 [0.068]	0.092 [0.071]	0.109 [0.070]	-0.04 [0.041]	-0.089 [0.064]	-0.033 [0.042]	0.325 [0.274]	0.347 [0.280]	0.25 [0.272]
Net portfolio inflows/GDP	0.241 [0.122]**	0.289 [0.129]**	0.286 [0.127]**	0.051 [0.068]	0.046 [0.108]	0.054 [0.071]	1.482 [0.492]***	1.414 [0.508]***	1.364 [0.494]***
Net 'other' inflows/GDP	0.069 [0.029]**	0.063 [0.029]**	0.071 [0.029]**	-0.027 [0.016]*	-0.014 [0.025]	-0.028 [0.016]*	0.376 [0.116]***	0.38 [0.116]***	0.418 [0.112]***
Short-term Debt (as % of total external debt)	-0.009 [0.016]	-0.008 [0.016]	-0.007 [0.016]	0.006 [0.008]	0.004 [0.013]	0.007 [0.008]	-0.042 [0.062]	-0.042 [0.063]	-0.042 [0.062]
Total debt service (as % of GNI)	0.063 [0.035]*	0.081 [0.035]**	0.078 [0.035]**	0.02 [0.020]	0.081 [0.031]***	0.02 [0.021]	0.262 [0.140]*	0.232 [0.138]*	0.213 [0.136]
Observations	311	311	311	311	311	311	310	309	309
Adjusted R-squared	0.37	0.39	0.4	0.64	0.31	0.64	0.32	0.26	0.25

Notes: Robust regressions are implemented. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The dummy for Sub-Saharan countries is included in the regressions for output and inflation volatility, so are the dummies for Latin America and Caribbean and East Europe and Central Asia in the regression for the level of inflation.

Source: Authors' calculations.

**Table 4: Determinants of Output Volatility Emerging Market Countries (EMG)**

	Output volatility			Real exchange rate volatility			Investment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Relative Income	-0.04 [0.066]	-0.028 [0.068]	-0.043 [0.068]	-0.046 [0.053]	0.077 [0.073]	-0.071 [0.051]	0.298 [0.255]	0.097 [0.256]	0.168 [0.265]
Relative Income, sq.	0.048 [0.145]	0.025 [0.151]	0.059 [0.150]	0.096 [0.118]	-0.119 [0.165]	0.165 [0.113]	-0.767 [0.561]	-0.293 [0.570]	-0.41 [0.585]
Change in US real interest rate	0.124 [0.056]**	0.112 [0.057]*	0.118 [0.056]**				0.007 [0.218]	0.003 [0.217]	-0.083 [0.220]
Volatility of TOT*OPN	0.01 [0.015]	0.013 [0.015]	0.01 [0.015]	0.026 [0.011]**	0.007 [0.016]	0.024 [0.011]**	-0.074 [0.057]	0.005 [0.056]	-0.038 [0.058]
Inflation volatility (Infl. vol. differentials in (4)-(6))	0.037 [0.007]***	0.034 [0.007]***	0.036 [0.007]***	0.049 [0.006]***	0.038 [0.008]***	0.05 [0.005]***	0.153 [0.028]***	0.164 [0.028]***	0.152 [0.029]***
Fiscal Procyclicality	0.002 [0.003]	0.003 [0.003]	0.003 [0.003]				0.013 [0.010]	0.012 [0.011]	0.015 [0.011]
Trade openness				-0.004 [0.005]	-0.003 [0.006]	-0.005 [0.004]			
Currency Crisis	0.007 [0.003]**	0.008 [0.003]**	0.006 [0.003]*	0.01 [0.002]***	0.013 [0.003]***	0.009 [0.002]***	0.033 [0.012]***	0.029 [0.012]**	0.026 [0.012]**
Private credit creation	-0.001 [0.006]	-0.005 [0.006]	-0.001 [0.006]				0.021 [0.025]	0.015 [0.024]	0.022 [0.025]
Total Reserve (as % of GDP)	0.083 [0.051]	-0.04 [0.054]	0.078 [0.032]**	0.031 [0.040]	0.047 [0.058]	-0.002 [0.023]	-0.414 [0.196]**	-0.268 [0.201]	0.147 [0.126]
Monetary Independence (MI)	-0.018 [0.016]	-0.035 [0.017]**		0.027 [0.013]**	0.041 [0.018]**		-0.308 [0.061]***	-0.182 [0.063]***	
MI x reserves	0.009 [0.081]	0.089 [0.090]		-0.066 [0.065]	-0.117 [0.097]		1.911 [0.314]***	0.527 [0.338]	
Exchange Rate Stability (ERS)	0.017 [0.008]**		0.021 [0.008]***	-0.041 [0.007]***		-0.04 [0.006]***	0.113 [0.032]***		0.065 [0.031]**
ERS x reserves	-0.11 [0.048]**		-0.12 [0.047]**	-0.006 [0.038]		0 [0.034]	-0.751 [0.186]***		-0.24 [0.183]
KA Openness		-0.012 [0.009]	-0.005 [0.008]		-0.002 [0.009]	-0.009 [0.006]		-0.036 [0.032]	-0.003 [0.031]
KAOPEN x reserves		0.066	0.035		-0.011	0.012		0.191	0.042

	Output volatility			Real exchange rate volatility			Investment volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		[0.045]	[0.039]		[0.047]	[0.028]		[0.167]	[0.153]
Net FDI inflows/GDP	-0.115 [0.098]	-0.082 [0.107]	-0.13 [0.104]	-0.054 [0.080]	-0.125 [0.116]	0.022 [0.078]	-0.008 [0.379]	0.435 [0.402]	0.162 [0.406]
Net portfolio inflows/GDP	-0.028 [0.130]	-0.02 [0.139]	0.026 [0.136]	-0.046 [0.103]	-0.155 [0.148]	-0.017 [0.100]	0.875 [0.503]*	1.29 [0.523]**	1.036 [0.531]*
Net 'other' inflows/GDP	0.031 [0.034]	0.03 [0.035]	0.028 [0.034]	-0.085 [0.027]***	-0.088 [0.037]**	-0.067 [0.025]***	0.57 [0.133]***	0.664 [0.132]***	0.595 [0.133]***
Short-term Debt (as % of total external debt)	-0.007 [0.017]	-0.004 [0.018]	-0.005 [0.018]	0.016 [0.012]	-0.003 [0.017]	0.013 [0.011]	-0.058 [0.067]	-0.053 [0.067]	-0.06 [0.068]
Total debt service (as % of GNI)	0.049 [0.040]	0.058 [0.041]	0.053 [0.040]	0.029 [0.036]	0.022 [0.050]	0.035 [0.034]	0.302 [0.154]*	0.331 [0.154]**	0.284 [0.156]*
Observations	159	159	159	159	159	159	158	158	158
Adjusted R-squared	0.32	0.29	0.31	0.66	0.36	0.67	0.59	0.42	0.38

Robust regressions are implemented. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The dummy for Sub-Saharan countries is included in the regressions for output and inflation volatility, so are the dummies for Latin America and Caribbean and East Europe and Central Asia in the regression for the level of inflation.

Source: Authors' calculations.

By comparing the results of these different specifications with different dependent variables, we can make some interesting observations. First, the negative effect of monetary independence on output volatility is consistent with its negative effect on investment volatility. However, if the level of IR holding is above 15–23% of GDP, higher monetary independence leads to higher volatility in investment. This may be because higher levels of international reserves could lead to higher levels of liquidity, thus to more volatile movements in the cost of capital. Second, while a higher degree of exchange rate stability could (unsurprisingly) induce greater real exchange rate stability, it could also lead to more volatile investment. But as was the case with output volatility, if the level of IR holding exceeds a given threshold, greater exchange rate stability reduces investment volatility.<sup>20</sup> Third, financial openness has a negative impact on both real exchange rate stability and investment volatility. Hence, we can conclude that financial liberalization could help reduce output volatility by making both real exchange rate and investment more stable. The investment volatility regressions show that net portfolio and bank lending inflows can be volatility-increasing, although banking lending inflows can reduce real exchange rate volatility.

The fact that the results from the investment volatility specification has greater similarities with the output volatility specification is not surprising. At the same time, different dynamics between the trilemma configurations and real exchange rate stability we found suggests that the international macroeconomic policy configurations can depend upon how much weight policymakers place upon these two policy goals. For example, if policymakers put greater weight on real exchange rate stability, it is better to pursue more exchange rate stability and greater financial openness (or lower levels of monetary independence), which could be volatility enhancing in terms of investment and output, although the answer depends on the level of IR holding. More concretely, the results from model (4) in Table 2-2 show that greater (weaker) monetary independence increases (decreases) real exchange rate volatility. The result from model (7) indicates that the threshold of IR holding level (as a ratio to GDP) for greater (weaker) monetary independence to have a positive (negative) effect on investment is 16% of GDP whereas that for greater (weaker) exchange rate stability to have a negative (positive) effect is 14%. Hence, if an emerging market country holds a level of IR higher than 16%, and tries to pursue a higher level of exchange rate stability and a *lower* level monetary independence (i.e., a combination of greater exchange rate stability and greater financial openness), it could achieve lower levels of not only real exchange rate stability, but also investment.<sup>21</sup> This result may explain why many emerging market countries, especially those which are more open to international trade, tend to prefer exchange rate stability and holding a massive amount of IR while also pursuing financial liberalization.

#### **4. SOME PRELIMINARY ANALYSIS ON THE DETERMINANTS OF OUTPUT LOSSES DURING THE CRISIS**

The above investigation focused on the general relationship between the variables of our focus such as the trilemma policy configurations, external finances, and output volatility. However, the nature of the relationship may differ for the countries that are experiencing severe economic hardships such as currency crises, banking crises, and other economic crises caused by socio-political events. This kind of relationship may be obscured in a panel data analysis such as recounted above, but it can still affect the decision making of policymakers even during

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<sup>20</sup> The threshold levels of IR holding are 18% and 28% of GDP in models (7) and (8) in Table 3, respectively. They are 14% and 26% in models (7) and (8) in Table 4, respectively.

<sup>21</sup> This result can be obtained by assuming no interaction effects with IR in model (4) in Table 4.

“tranquil” time periods. Furthermore, shedding light on such an extreme situation may provide some useful insights for the current crisis. Hence, we will examine how the policy coordination based on the trilemma can affect the performance of the economy that is experiencing some extraordinary situation.

## 4.1 Measure of “Excessive Underperformance”

### 4.1.1 Construction of the Measure

The first effort we make here is to create a measure that quantifies the output cost of an economic crisis. To construct our measure, we implement the following procedure. First, we calculate the rolling standard deviations with five-year windows of the per capita growth rate for the 1955–2007 period for the industrialized and developing country groupings. Then, if the actual growth rate is below the rolling one standard deviation band, the gap between the actual growth rate and the lower bound of the range is defined to be the measure of “excessive underperformance (severe recession)”.<sup>22</sup> Last, if the state of “excessive under-performance” persists more than one year, the gaps will be cumulated as long as the actual growth rate is below the lower band.<sup>23</sup> If recovery takes place for one year immediately after the period of excessive underperformance, but is followed by another excessive underperformance period in the following year, the one year of recovery is still considered to be part of the state of excessive underperformance.<sup>24</sup> Thus, one value of the measure of excessive underperformance is given per economic severity episode.

The state of “excessive under-performance” or simply “crisis” does not necessarily mean either a currency crisis or banking crisis, but rather an unpredictable decline in per capita output growth. Therefore, the “crisis” in this exercise includes not only currency and financial crises, but also economic collapse induced by domestic political disorder, social unrests, and civil wars. One merit of this index is that it is strict on identifying an economy as a crisis economy when many other ones are also experiencing a crisis because it has to experience an output loss whose magnitude is greater than a threshold that incorporates the variation of the output growth on a global scale. Lastly, due to data limitations, the current global financial crisis is not captured by this measure.

### 4.1.2 Summary Statistics

With this measure of “excessive underperformance,” we estimate that between 1955 and 2007, there are 93 crisis episodes among industrialized countries and 411 among less developed countries. Figure 4 presents summary statistics of the measure for both industrialized and developing countries.<sup>25</sup> In the figure, we can observe that there is a significant difference in terms of the size of the crises between industrialized countries and developing countries. After peaking in the 1970s, both the size and the duration of the crises have been in the declining trend for less developed countries although such a trend is not observed for industrialized

<sup>22</sup> If it is above the upper bound, then it can be considered to be “excessive over-performance (boom)”. However, we do not look into this issue in this paper.

<sup>23</sup> For example, if the actual growth rate is below the band for country X in 1992 through 1996, the gaps for the five years will be added.

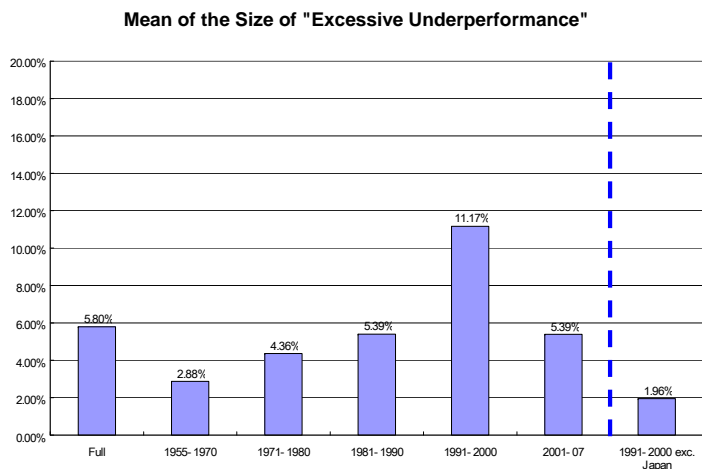
<sup>24</sup> If the actual growth rate lies within the band in 1994 but below it in 1992–93 and 1995–96, the “crisis period” is considered to be from 1992 to 1996.

<sup>25</sup> The episodes of excess underperformances are divided by the decade depending on the beginning year of the episodes. For example, the size and the duration of the Japanese 1990s recession (that continues up to 2006) is included in the 1991–2000 period. As a matter of fact, the Japanese experience is an outlier in terms of both its size and duration. Therefore, the subsample average without Japan is also shown.

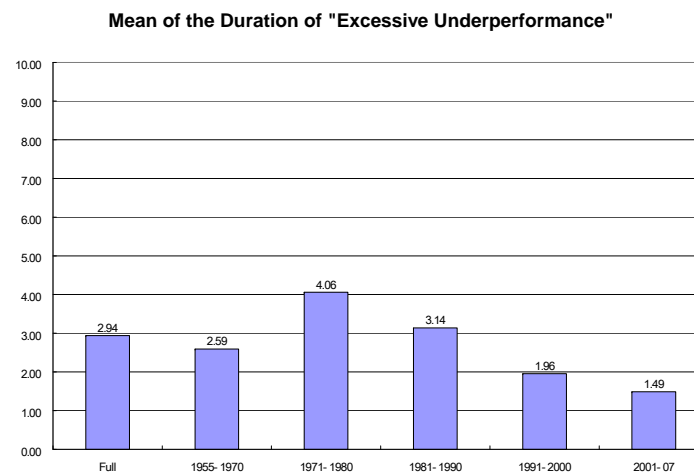
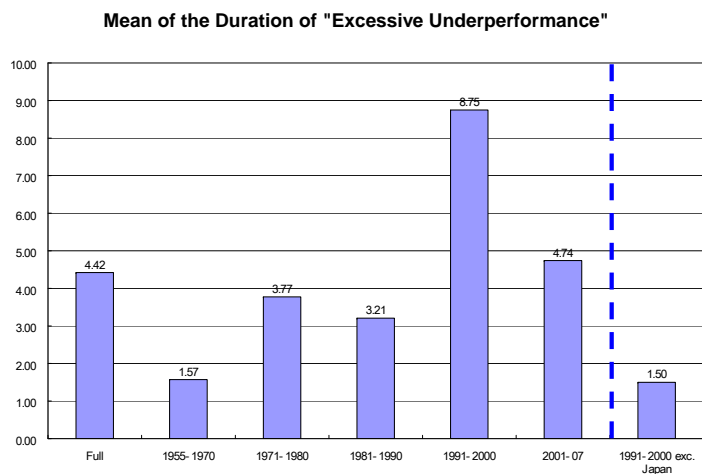
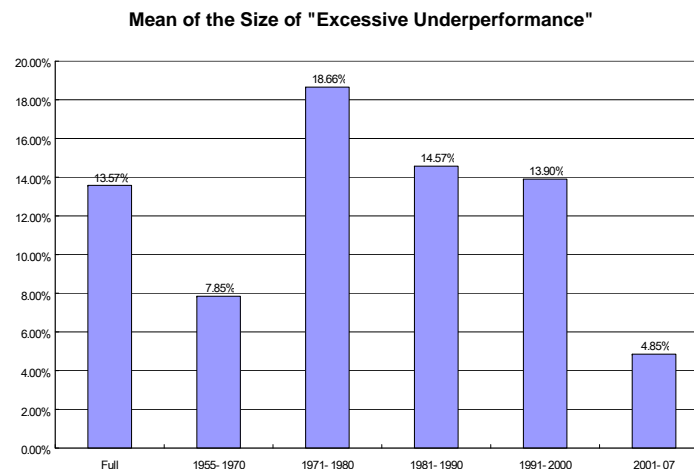
countries. In the 2000s (before the current crisis), developing countries experienced the least number of crises with shorter durations on average. Figure 5 shows that the number of crises has been on the decline trend since the mid-1980s.

**Figure 4: Summary Statistics of the Measure of “Excessive Underperformance”**

**(a) Industrial Countries (IDC)**

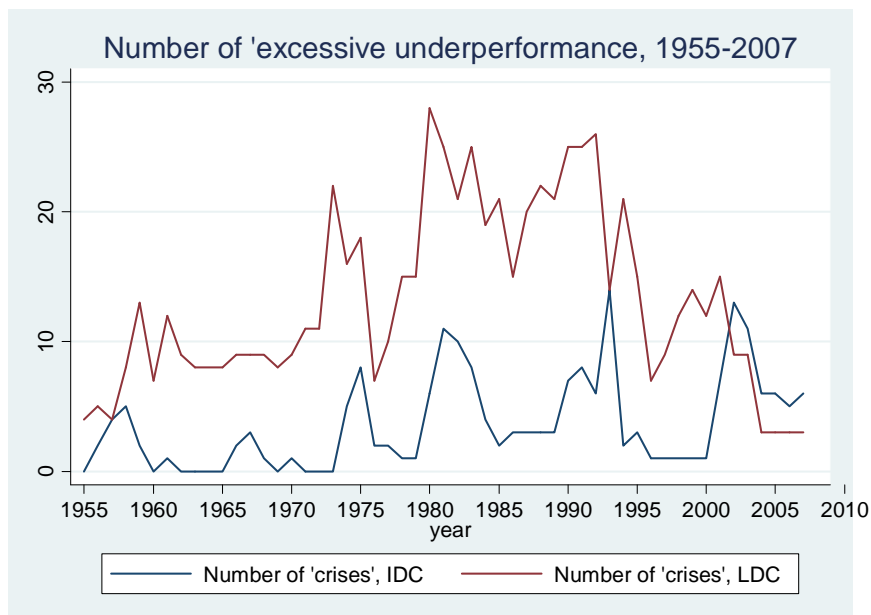


**(b) Less Developed Countries**



Source: Authors' calculations.

**Figure 5: Number of “Crises” Among the Sample Countries**



Source: Authors' calculations.

## 4.2 Preliminary Regression Analysis on the Effect of the Trilemma Configurations on the Output Underperformance

Using this measure of severe economic underperformance, we estimate the determinants of the crises while focusing on the impact of the trilemma configurations. The estimation model is defined as:

$$\begin{aligned}
 SIZE\_CRISIS_{it} = & \alpha_0 + \alpha_1 TLM_{it} + \alpha_2 IR_{it} + \alpha_3 (TLM_{it} \times TR_{it}) \\
 & + X_{it}'B + \phi DUR\_CRISIS_{it} + D_i'\Theta + \varepsilon_{it}
 \end{aligned}
 \tag{2}$$

The dependent variable  $SIZE\_CRISIS_{it}$  is the measure of “excessive underperformance” of country  $i$  in year  $t$ . Higher values mean more severe output losses.  $TLM_{it}$  and  $TR_{it}$  are vectors of two trilemma indexes and the ratio of IR holding to GDP, respectively.  $(TLM_{it} \times TR_{it})$  is a vector of the interaction terms between  $TLM_{it}$  and  $TR_{it}$ . Control variables are included in the vector  $X_{it}$ , and they are relative per capita income level (to the US), its squares, GDP growth rate, and fiscal procyclicality (correlations of detrended real government spending and real GDP series). These control variables are included as the averages over three years prior to years of the first year of underperformance (or just “crisis”) – we use the time notation of  $(t - 1)$  for brevity.<sup>26</sup>  $DUR\_CRISIS_{it}$  is the number of years of underperformance.<sup>27</sup>

<sup>26</sup> The variable for fiscal procyclicality is calculated as the correlation between the de-trended series of real output and real fiscal expenditure over five years since three years are not long enough to provide the general characteristics of fiscal policy.

<sup>27</sup> Other control variables that persistently turned out to be insignificant and are therefore removed include: change in the US real interest rate, TOT shocks, trade openness, real exchange rate overvaluation, regional dummies, and the GDP growth rate of industrialized countries during the crisis.

Additionally, the dummies for banking and currency crises as well as the dummy for civil wars were tested, but they are not significant and therefore removed. The currency crisis is based on the exchange rate market pressure (EMP) index as in the previous regressions, and the banking crisis dummy is based on Caprio and Klingebiel (2003). Another dummy for internal and external military conflict based on the Center for the Study of Civil Wars (CSCW) index on armed conflict was also tested. However, this index turned out to be an insignificant factor, and therefore was removed from the estimation.<sup>28</sup>

As was in the case with the previous exercise, we focus on the impacts of the trilemma indexes, namely,  $MI$ ,  $ERS$ , and  $KAOPEN$ , and  $IR$  holding as well as the interactions between  $IR$  and the trilemma indexes. These variables are included in two ways. In one set of models, these variables are included as the averages over three years prior to the underperformance as an effort to capture the impact of these variables as “precrisis conditions”—we again use the time notation of  $(t-1)$  for brevity. As another way of inclusion, we include them as the averages over the years of underperformance so as to examine the during-crisis conditions—we use the time notation of  $(t)$ .

We use the sample of country-year episodes of excessive underperformance. In other words, the number of observations equals the number of “crises” among less developed countries. We conduct two sets of ordinary least squares (OLS) regressions, one with precrisis conditions of the trilemma configurations,  $MI_{(t-1)}$ ,  $ERS_{(t-1)}$ ,  $KAOPEN_{(t-1)}$ ,  $IR_{(t-1)}$ , and their interactions, and the other with  $MI_{(t)}$ ,  $ERS_{(t)}$ ,  $KAOPEN_{(t)}$ ,  $IR_{(t)}$  and their interactions.

The reason why we have these two separate models is as follows. The model with the precrisis conditions would control for endogeneity and may yield some results about how precrisis conditions affects the size of the crisis. The model with the during-crisis variables may entail the risk of endogeneity, but may provide some insights about how policy decisions made during the crisis can affect the size of the crisis.

### 4.3 Estimation Results

Table 5 presents the estimation results for the regression on the output cost of economic crises. The first six columns of the table show the results of the estimation models with precrisis trilemma configurations, whereas the next six columns report those of the estimation models with the trilemma conditions during the economic crisis. We implement the OLS estimation, and report heteroskedasticity-consistent standard errors.

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<sup>28</sup> The CSCW index is not a perfect dummy for armed conflicts. It tends to be a little too inclusive. For example, the United Kingdom had been for many years until recently considered to be a country with “internal armed conflicts” because of the Irish Republican Army’s activities, although the country as a whole did not appear to be one with “internal conflicts.” The Philippines has been also a country with internal conflicts due to occasional anti-government movements by Muslim insurgencies.

**Table 5: Regressions on the Output Losses of Economic Crises**

	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)
Relative Income ( $t-1$ )	-0.117 [0.065]*	-0.134 [0.068]**	-0.131 [0.068]*	-0.139 [0.068]**	-0.11 [0.064]*	-0.13 [0.066]**	Relative Income ( $t-1$ )	-0.14 [0.069]**	-0.129 [0.067]*	-0.138 [0.069]**	-0.117 [0.068]*	-0.136 [0.069]**	-0.146 [0.069]**
Relative Income, sq. ( $t-1$ )	0.262 [0.077]***	0.271 [0.081]***	0.271 [0.077]***	0.276 [0.080]***	0.258 [0.075]***	0.275 [0.080]***	Relative Income, sq. ( $t-1$ )	0.278 [0.078]***	0.28 [0.075]***	0.276 [0.076]***	0.268 [0.076]***	0.278 [0.076]***	0.29 [0.077]***
GDP growth ( $t-1$ )	0.255 [0.108]**	0.26 [0.110]**	0.224 [0.111]**	0.227 [0.110]**	0.244 [0.107]**	0.24 [0.106]**	GDP growth ( $t-1$ )	0.24 [0.108]**	0.222 [0.110]**	0.228 [0.108]**	0.21 [0.109]*	0.232 [0.104]**	0.224 [0.104]**
Fiscal Procyclical. ( $t-1$ )	0.011 [0.008]	0.013 [0.009]	0.013 [0.008]	0.013 [0.009]	0.013 [0.008]	0.014 [0.009]	Fiscal Procyclical. ( $t-1$ )	0.012 [0.008]	0.009 [0.008]	0.013 [0.008]	0.01 [0.009]	0.012 [0.008]	0.013 [0.008]
Duration of the Crisis	0.03 [0.006]***	0.03 [0.006]***	0.03 [0.006]***	0.03 [0.006]***	0.03 [0.006]***	0.03 [0.006]***	Duration of the Crisis	0.03 [0.006]***	0.031 [0.006]***	0.029 [0.006]***	0.031 [0.006]***	0.03 [0.006]***	0.03 [0.006]***
Trade openness ( $t-1$ )	-0.028 [0.010]***	-0.03 [0.010]***	-0.028 [0.010]***	-0.028 [0.011]**	-0.025 [0.010]**	-0.022 [0.011]**	Trade openness ( $t-1$ )	-0.022 [0.010]**	-0.022 [0.010]**	-0.025 [0.010]**	-0.027 [0.010]***	-0.018 [0.011]*	-0.015 [0.011]
Private Credit Creation ( $t-1$ )	-0.014 [0.015]	-0.011 [0.015]	-0.009 [0.015]	-0.006 [0.016]	-0.013 [0.015]	-0.009 [0.016]	Private Credit Creation ( $t-1$ )	-0.016 [0.015]	-0.02 [0.015]	-0.008 [0.015]	-0.015 [0.016]	-0.015 [0.015]	-0.013 [0.014]
IR ( $t-1$ )	-0.011 [0.022]	-0.05 [0.093]	0.005 [0.022]	0.135 [0.103]	-0.008 [0.023]	-0.07 [0.091]	IR ( $t$ )	-0.029 [0.019]	-0.315 [0.101]***	-0.011 [0.020]	-0.283 [0.097]***	-0.026 [0.020]	-0.006 [0.067]
MI ( $t-1$ )	-0.017 [0.030]	-0.008 [0.035]	0.004 [0.029]	0.032 [0.034]			MI ( $t$ )	-0.005 [0.026]	-0.081 [0.039]**	0 [0.025]	-0.077 [0.039]**		
MI x IR ( $t-1$ )		-0.082 [0.161]		-0.251 [0.179]			MI x IR ( $t$ )		0.612 [0.222]***		0.609 [0.220]***		
ERS ( $t-1$ )	-0.031 [0.017]*	-0.045 [0.023]*			-0.028 [0.016]*	-0.045 [0.022]**	ERS ( $t$ )	-0.026 [0.012]**	-0.034 [0.015]**			-0.026 [0.012]**	-0.03 [0.016]*
ERS x IR ( $t-1$ )		0.149 [0.108]				0.164 [0.120]	ERS x IR ( $t$ )		0.05 [0.057]				0.019 [0.067]
KAOPEN ( $t-1$ )			-0.022 [0.016]	-0.017 [0.022]	-0.02 [0.016]	-0.016 [0.024]	KAOPEN ( $t$ )			-0.019 [0.018]	-0.029 [0.023]	-0.017 [0.018]	-0.009 [0.021]
KAO x IR ( $t-1$ )				-0.038 [0.103]		-0.053 [0.107]	KAO x IR ( $t$ )				0.031 [0.068]		-0.064 [0.077]
# of Obs.	139	139	139	139	139	139	# of Obs.	139	139	139	139	139	139
Adjusted R2	0.35	0.35	0.34	0.34	0.36	0.36	Adjusted R2	0.35	0.36	0.34	0.35	0.36	0.35

Notes: Robust standard errors in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. These control variables are included as the averages over three years prior to years of the first year of underperformance (or just “crisis”). For the sake of brevity, we use the time notation of ( $t-1$ ) for the variables that refer to the precrisis conditions and ( $t$ ) for those which refer to the conditions during the crisis

Source: Authors’ calculations.

The macroeconomic control variables behave as theory predicts. A country with a higher level of per capita income experiences a smaller output loss once it experiences a crisis, though its effect is nonlinear. A country that enters a crisis after experiencing an economic boom tends to experience a larger output loss in a crisis. The tendency among developing countries to have procyclical fiscal policy is often noted as one of the weaknesses of these countries' macroeconomic management, and we find that procyclical fiscal policy does indeed lead to greater output losses among crisis economies. The estimated coefficient on the duration of the crisis is found to be significantly positive, indicating that if a crisis lasts for one more year, the output loss will be larger by about 3 percentage points.

The estimated coefficient on financial development is persistently negative, though never statistically significant. An economy more open to international trade prior to the crisis tends to weather the crisis well. This result is consistent with the experience of the economies that were affected by the Asian crisis of 1997-98.

Among the trilemma variables, in terms of the precrisis conditions, only the extent of exchange rate stability seems to matter for the size of output loss for crisis economies. An economy with a greater extent of exchange rate stability tends to experience a smaller output loss once it experiences an economic crisis. The level of IR holding prior to the crisis does not seem to matter as much. Financial openness seems to be an output loss reducer, but it is not statistically significant.

In the regressions incorporating the during-crisis conditions, the amount of IR holding does now matter. The greater the level of international reserves a crisis country retains even after a crisis breaks out, the smaller the resulting output loss. The variable for exchange rate stability does again enter positively to the estimation model but this time with greater statistical significance. It appears that a country that can sustain the stability in its exchange rate movement can signal to the investors in both domestic and international capital markets, so that it should not have to lose its access to the markets. Also, an economy with a stable exchange rate can avoid facing high volatility in the prices of goods and services.<sup>29</sup>

The effect of monetary independence in the midst of crises is also found to be significant, but is a little more difficult to interpret. It is found to be a negative factor to the cost of economic crisis, but only up to the threshold of IR holding as 14–15% of GDP. Above it, the impact of greater monetary independence will be positive. The negative impact of greater monetary independence is easier to interpret, as we found in the regression for output volatility, because it reflects the stabilizing function of monetary independence. Using the results from model (8) in Table 6, we can conjecture that, for the countries that hold IR greater than 14–15% of GDP, to reduce the cost of output losses from experiencing an economic crisis, it is better to retain higher levels of exchange rate stability and lower levels of monetary independence.<sup>30</sup> Pursuing both weaker monetary independence and greater exchange rate stability means the country of concern must pursue a higher level of financial openness since these three policy goals need to be linearly related. Considering that the level of IR holding as 14–15% of GDP is well below the average of IR as a ratio to GDP as of 2008 (it is about 21%), the countries with the level of IR holding above the threshold must be relatively more open economies. For those economies, it

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<sup>29</sup> One reviewer pointed out that the finding that exchange rate stability and holding ample IR could help reduce the size of output loss sounds tautological, because crises usually lead to output loss through the balance sheet effect. It could be tautological if we were focusing on the currency crises. However, as we mentioned previously, our definition of the “crises” is more general so that it includes not only currency or banking crises, but also dire economic situations caused by other, potentially non-economic factors. Hence, as long as our identification crisis is not limited to currency crises, the above finding is not tautological.

<sup>30</sup> Since 1996, the average ratio of IR to GDP among developing economies has been about 14%. As of 2008, it is about 21% after dropping from the highest level (24%) of 2007.

seems to be better to pursue greater financial openness rather than retaining greater monetary independence and exchange rate stability.

**Table 6: Results of the Mean-Equality Tests with the Trilemma Indexes Before and After the Crises**

<b>1970– 2007</b>													
	# of Obs.	<b>Monetary Independence (MI)</b>				<b>Exchange Rate Stability (ERS)</b>				<b>Financial Openness (KAO)</b>			
		Up	(%)	Down	(%)	Up	(%)	Down	(%)	Up	(%)	Down	(%)
FULL	230	53	0.230	62	<b>0.270</b>	34	<b>0.148</b>	29	0.126	39	<b>0.170</b>	32	0.139
IDC	49	8	0.163	20	<b>0.408</b>	12	<b>0.245</b>	4	0.082	15	<b>0.306</b>	5	0.102
LDC	151	36	<b>0.238</b>	34	0.225	18	0.119	21	<b>0.139</b>	20	0.132	23	<b>0.152</b>
EMG	49	13	<b>0.265</b>	12	0.245	6	0.122	13	<b>0.265</b>	11	<b>0.224</b>	9	0.184
<b>1970s-1980s</b>													
	# of Obs.	<b>Monetary Independence (MI)</b>				<b>Exchange Rate Stability (ERS)</b>				<b>Financial Openness (KAO)</b>			
		Up	(%)	Down	(%)	Up	(%)	Down	(%)	Up	(%)	Down	(%)
FULL	123	32	<b>0.260</b>	30	0.244	21	0.171	21	0.171	21	<b>0.171</b>	13	0.106
IDC	25	6	0.240	10	<b>0.400</b>	9	<b>0.360</b>	3	0.120	6	<b>0.240</b>	1	0.040
LDC	73	18	<b>0.247</b>	14	0.192	9	0.123	14	<b>0.192</b>	13	<b>0.178</b>	8	0.110
EMG	27	9	<b>0.333</b>	4	0.148	2	0.074	9	<b>0.333</b>	7	<b>0.259</b>	4	0.148
<b>1990s-2000s</b>													
	# of Obs.	<b>Monetary Independence (MI)</b>				<b>Exchange Rate Stability (ERS)</b>				<b>Financial Openness (KAO)</b>			
		Up	(%)	Down	(%)	Up	(%)	Down	(%)	Up	(%)	Down	(%)
FULL	107	21	0.196	32	<b>0.299</b>	13	<b>0.121</b>	8	0.075	18	0.168	19	<b>0.178</b>
IDC	24	2	0.083	10	<b>0.417</b>	3	<b>0.125</b>	1	0.042	9	<b>0.375</b>	4	0.167
LDC	78	18	0.231	20	<b>0.256</b>	9	<b>0.115</b>	7	0.090	7	0.090	15	<b>0.192</b>
EMG	22	4	0.182	8	<b>0.364</b>	4	0.182	4	0.182	4	0.182	5	<b>0.227</b>

Source: Authors' calculations.

## 4.4 Policy Discussions

The above finding seems to contradict our previous finding that greater exchange rate stability leads to greater output volatility unless the economy of concern holds foreign exchange reserves. However, we must keep in mind that the above empirical analysis is only conducted for the sample of crisis economies; the two sets of regression analyses are conducted on two different samples. The finding that greater exchange rate stability can be helpful in a crisis situation, and the finding that exchange rate stability could be output-reducing can be consistent as they apply to different periods.

We can connect this interpretation with the well-known “fear of floating” thesis. That is, while greater exchange rate stability can be output volatility enhancing in tranquil times, it can help countries once they experience economic crises. Therefore, countries can be discouraged to adopt more flexible exchange rates.

We have previously seen that the output volatility enhancing effect of greater exchange rate stability can be mitigated by holding levels of IR higher than certain thresholds. Furthermore, we have also seen that many countries do not attempt to adopt a policy combination of exchange rate stability and IR holding enough to lessen output volatility. However, Figure 2 shows that developing countries, especially non-emerging market developing countries, continue to maintain high levels of exchange rate stability, which can be evidence of the fear of floating.

The analogy to the peso problem is clear. Even if economic crises are not that frequent, policymakers are motivated to prepare for costly crises, by maintaining exchange rate stability. Pursuing pure exchange rate stability can make countries prone to higher output volatility because the exchange rate cannot function as automatic stabilizer. However, if a country holds a higher level of foreign reserves, it can mitigate the absence of the automatic stabilizing function of the exchange rate. In addition, we find in Table 3 that having a higher level of IR can allow a country to prepare for an economic crisis as well. Hence, countries that hold high levels of IR can afford to adopt more flexible exchange rates. This may explain why emerging market countries, most of which are large IR holders, have adopted more flexible exchange rates than non-emerging market developing countries.

## 4.5 Does a Regime Change in the Aftermath of a Crisis?

As we write this paper, the global crisis is still far from over. Although there are some signs of recovery or slow down of the plummeting, it is uncertain whether the recovery, if there is, will be sustainable. While many of both industrialized and developing countries are facing a crisis situation on a global scale, some countries are experiencing more severe economic situations than others.

As a last exercise, we will examine one natural question that can arise from the above analysis: if we assume that countries are currently experiencing a “crisis” (in our sense), what kind of financial systems will countries pursue in the aftermath of the current crisis?

For this question, we can only present our plausible expectations from the above analyses. For that, we conduct mean-equality tests of the trilemma indexes before and after the crisis which we identify using the above measure of excessive underperformance. More specifically, we test the equality of each of the indexes between three years before the first year of a crisis and three years after the last year of the crisis for the full sample and the subsamples of IDC, LDC, and EMG during the time period between 1970 and 2007. Table 4 shows the test results for different samples and different time periods. The table also shows the number of crisis episodes over which the trilemma index of concern increases or

decreases its value in a statistically significant sense as well as the percentage of the cases within each sample.<sup>31</sup>

Industrialized countries seem to have gone through a discernable path over the course of the sample period; the industrial crisis countries have reduced the level of monetary independence and increased the levels of both exchange rate stability and financial openness throughout the time period, which dominantly reflects the path of the Euro countries. This tendency has not changed even when one compares the subsample periods.

Developing countries, on the other hand, have increased the level of monetary independence, but reduced the level of exchange rate stability and financial openness in the aftermath of economic hardships. However, this tendency does not appear to be persistent. While increasing the levels of monetary independence and financial openness, and decreasing the level of exchange rate stability was more prevalent a way of overcoming economic hardships before the 1990s, these countries tend to decrease the level of monetary independence and financial openness but increase the level of exchange rate stability. Among emerging market countries, the tendency of decreasing the levels of monetary independence and financial openness in the post-crisis period is more evident.

This finding may reflect the tendency that developing countries, especially those with emerging markets, are more vulnerable to volatile financial flows as financial globalization became more widespread after the 1990s. Countries can be tempted to restrict cross-border capital flows and lose their monetary independence in the face of rapid and massive capital flows. Unlike in the period before the waves of financial globalization hit these economies, it may probably not be a good policy option to adopt a freely flexible exchange rate regime as a means to overcome an economic hardship.

If countries react to the current global crisis as they have in the last two decades, it is very likely that developing countries will try to reduce the level of monetary independence and tighten capital controls policy. However, it is premature to make such a prediction.

## 5. CONCLUDING REMARKS

In the midst of the most severe and persistent crisis since the Great Depression, economists are reevaluating international macroeconomic policies and rethinking architecture for international financial markets issues. For that effort, we need to inform ourselves on how the international financial architecture can affect the macroeconomic performance of individual economies. Theoretically, we know that any international architecture would be bound by the “impossible trinity” or “trilemma” that posits a country cannot achieve all three policy goals of monetary independence, exchange rate stability, and financial openness. Despite its significance, this theory had not been widely tested empirically due to the lack of appropriate metrics to measure the extent of achievement in the three policy goals. Our previous paper (Aizenman, Chinn, and Ito [2008]) attempted to fill the deficiency by developing the “trilemma indexes” and confirmed the validity of the theory. In this paper, we extended our analysis and explored some of the questions that were not addressed in our previous paper.

First, we examined through what channels the trilemma policy configurations affect output volatility. We found that the estimation on output volatility shares similar characteristics with the estimation on investment volatility, suggesting that trilemma policy configurations and external finances affect output volatility through investment. More specifically, like in the estimation on output volatility, greater monetary independence is found to help reduce investment volatility. However, if the level of IR holding gets above 15–23% of GDP, greater monetary independence would become volatility-enhancing for investment by providing too

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<sup>31</sup> For example, there are 53 crisis episodes after which the level of monetary independence increased statistically significantly in the full sample, which accounts for 23% of the total.

much liquidity and thereby making the cost of capital too volatile. While a higher degree of exchange rate stability could stabilize the real exchange rate movement, it could also make investment volatile, though the volatility-enhancing effect of exchange rate stability on investment can be cancelled by holding higher levels of IR. Greater financial openness is found to help reduce real exchange rate volatility. These results indicate that policymakers in a more open economy would prefer pursuing greater exchange rate stability and greater financial openness while holding a massive amount of IR because this policy combination would help them achieve stability in both investment and the real exchange rate. This finding might help explain why open-small economies in East Asia hold massive amounts of IR.

Second, we investigated how trilemma policy configurations could affect the output performance of the economies that are experiencing severe circumstances. We find that the “crisis economies” could end the crisis situation with smaller output losses if they entered the crisis with more stable exchange rates. Furthermore, the crisis country that maintains a higher level of IR and greater exchange rate stability during the crisis period could reduce the size of output loss.

Last, we asked the question of how trilemma configurations will evolve once the current crisis is over. Using the data for the last four decades, we have shown that developing countries are more likely to decrease the level of monetary independence and financial openness but increase the level of exchange rate stability in the aftermath of an economic crisis, which has been the case especially for the last two decades. This finding indicates how vulnerable developing countries, especially emerging market countries, are to volatile capital flows.

## APPENDIX: CONSTRUCTION OF THE TRILEMMA MEASURES

### *Monetary Independence (MI)*

The extent of monetary independence is measured as the reciprocal of the annual correlation of the monthly interest rates between the home country and the base country. Money market rates are used.<sup>32</sup>

The index for the extent of monetary independence is defined as:

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

where  $i$  refers to home countries and  $j$  to the base country. By construction, the maximum and minimum values are 1 and 0, respectively. Higher values of the index mean more monetary policy independence.<sup>33,34</sup>

Here, the base country is defined as the country that a home country's monetary policy is most closely linked with as in Shambaugh (2004). The base countries are Australia, Belgium, France, Germany, India, Malaysia, South Africa, the United Kingdom, and the US. For the countries and years for which Shambaugh's data are available, the base countries from his work are used, and for the others, the base countries are assigned based on IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)* and the *CIA Factbook*.

### *Exchange Rate Stability (ERS)*

To measure exchange rate stability, annual standard deviations (*stdev*) of the monthly exchange rate (*exch\_rate*) between the home country and the base country are calculated and included in the following formula to normalize the index between zero and one:

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

<sup>32</sup> The data are extracted from the IMF's *International Financial Statistics (IFS)* (line 60B..ZF...). For the countries whose money market rates are unavailable or extremely limited, the money market data are supplemented by those from the Bloomberg terminal and also by the discount rates (line 60...ZF...) and the deposit rates (line 60L..ZF...) series from *IFS*.

<sup>33</sup> The index is smoothed out by applying the three-year moving averages encompassing the preceding, concurrent, and following years ( $t-1, t, t+1$ ) of observations.

<sup>34</sup> We note one important caveat about this index. Among some countries and in some years, especially early ones, the interest rate used for the calculation of the MI index (see footnote 7) is often constant throughout a year, making the annual correlation of the interest rates between the home and base countries ( $\text{corr}(i_i, i_j)$  in the formula) undefined. Since we treat the undefined  $\text{corr}$  the same as zero, it makes the MI index value 0.5. One may think that the policy interest rate being constant (regardless of the base country's interest rate) is a sign of monetary independence. However, it can reflect the possibilities not only that 1) the home country's monetary policy is independent from the base country's; but also 2) the home country uses other tools to implement monetary policy than manipulating the interest rates, such as changing the required reserve ratios and providing some window guidance (while leaving the policy interest rate unchanged); and/or that 3) the home country implements a strong control on financial intermediaries, including credit rationing, that makes the policy interest rate appear constant. To make the matter more complicated, some countries have used 2) and 3) to exercise monetary independence while others have used them while strictly following the base country's monetary policy. The bottom line is that it is impossible to incorporate these issues in the calculation of MI without over- or under-estimating the degree of monetary independence. Therefore, assigning an MI value of 0.5 for such a case should be a reasonable compromise. However, it does not preclude the necessity of robustness checks on the index, which we plan to undertake.

Merely applying this formula can easily create a downward bias in the index, that is, it would exaggerate the “flexibility” of the exchange rate especially when the rate usually follows a narrow band, but is de- or revalued infrequently.<sup>35</sup> To avoid such downward bias, we also apply a threshold to the exchange rate movement as has been done in the literature. That is, if the rate of monthly change in the exchange rate stayed within +/-0.33 percent bands, we consider the exchange rate is “fixed” and assign the value of one for the ERS index. Furthermore, single year pegs are dropped because they are quite possibly not intentional ones.<sup>36</sup> Higher values of this index indicate more stable movement of the exchange rate against the currency of the base country.

#### *Financial Openness/Integration (KAOPEN)*

Without question, it is extremely difficult to measure the extent of capital account controls.<sup>37</sup> Although many measures exist to describe the extent and intensity of capital account controls, it is generally agreed that such measures fail to capture fully the complexity of real-world capital controls. Nonetheless, for the measure of financial openness, we use the index of capital account openness, or *KAOPEN*, by Chinn and Ito (2006, 2008). *KAOPEN* is based on information regarding restrictions in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*. Specifically, *KAOPEN* is the first standardized principal component of the variables that indicate the presence of multiple exchange rates, restrictions on current account transactions, on capital account transactions, and the requirement of the surrender of export proceeds.<sup>38</sup> Since *KAOPEN* is based upon reported restrictions, it is necessarily a de jure index of capital account openness (in contrast to de facto measures such as those in Lane and Milesi-Ferretti [2006]). The choice of a de jure measure of capital account openness is driven by the motivation to look into policy intentions of the countries; de facto measures are more susceptible to other macroeconomic effects than policy decisions made solely with respect to capital controls.<sup>39</sup>

The Chinn-Ito index is normalized between zero and one. Higher values of this index indicate that a country is more open to cross-border capital transactions. The index is originally available for 181 countries for the period of 1970 through 2006.<sup>40</sup> The data set we examine does not include the United States.

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<sup>35</sup> In such a case, the average of the monthly change in the exchange rate would be so small that even small changes could make the standard deviation big and thereby the ERS value small.

<sup>36</sup> The choice of the +/-0.33 percent bands is based on the +/-2% band based on the annual rate, that is often used in the literature. Also, to prevent breaks in the peg status due to one-time realignments, any exchange rate that had a percentage change of zero in eleven out of twelve months is considered fixed. When there are two re/devaluations in three months, then they are considered to be one re/devaluation event, and if the remaining 10 months experience no exchange rate movement, then that year is considered to be the year of fixed exchange rate. This way of defining the threshold for the exchange rate is in line with the one adopted by Shambaugh (2004).

<sup>37</sup> See Chinn and Ito (2008), Edison and Warnock (2001), Edwards (2001), Edison et al. (2002), and Kose et al. (2006) for discussions and comparisons of various measures on capital restrictions.

<sup>38</sup> This index is described in greater detail in Chinn and Ito (2008).

<sup>39</sup> *De jure* measures of financial openness also face their own limitations. As Edwards (1999) discusses, it is often the case that the private sector circumvents capital account restrictions, nullifying the expected effect of regulatory capital controls. Also, IMF-based variables are too aggregated to capture the subtleties of actual capital controls, that is, the direction of capital flows (i.e., inflows or outflows) as well as the type of financial transactions targeted.

<sup>40</sup> The original dataset covered 181 countries, but data availability is uneven among the three indexes. *MI* is available for 172 countries; *ERS* for 182; and *KAOPEN* for 178. Data for both *MI* and *ERS* start in 1960 whereas *KAOPEN* data starts in 1970. So, *MI* and *ERS* are updated to 2008 while *KAOPEN* is updated only to 2007 because the information in *AREAER* is available only up to 2007.

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