PART 2

PERSPECTIVES AND EVIDENCE

Chapter 3

THE TRILEMMA CHALLENGE FOR SEACEN MEMBER ECONOMIES: TESTING THE TRILEMMA HYPOTHESIS [1]

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1. Introduction

Facing a fragile recovery of the world economy from the global financial crisis of 2008-09, policymakers around the globe are contemplating what would be an optimal mix of open macroeconomic policies that are effective enough to guide their economies to stable and sustainable economic growth.

As of this writing, four years since the breakout of the crisis, the world economy is still full of unstable factors. Generally, the advanced economies only show feeble, if any, recovery while the developing and emerging market economies are doing well. The Greek debt crisis is affecting other southern european economies such as Italy, Spain, and Portugal and posing threats to the eurozone as a whole. The U.S. economy is experiencing its own debt problem and "jobless recovery," unable to wipe out the possibility of a double-dip recession. The Japanese economy has been hit by the triple disaster of the 11 March 2011 earthquake, tsunami, and nuclear plant failure.

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Unlike the Asian financial crisis of 1997-98 and the Latin American debt crisis in the 1980s, developing and emerging economies are not facing a crisis of their own. Although they experienced the tsunami of crisis in 2008-09 mainly through the international trade channel, in retrospect, the global financial crisis only dented the growth of developing and emerging economies including those in Asia.

However, the better performance of emerging economies can slip out of the hand, if the conditions in the eurozone and the US deteriorate significantly. Many emerging economies have been experiencing volatile capital flows: large capital outflows due to US and European banking sector difficulties, causing shortages of international liquidity and sharp currency depreciation; and large capital inflows due to unusually lax monetary policy taken by advanced economies' central banks, causing upward pressure on both their currency values and on the levels of asset price inflation. Whether they deteriorate or recover, advanced economies can rapidly change the direction of capital flows, possibly causing disruptions in the capital markets of emerging economies. In short, regardless of what happens to the world, policymakers in developing and emerging economies must consider how to keep their economies immune from the unstable parts of the world and sustain stable economic growth. Their task is, however, complex in such a globalised environment.

Despite the complexity of policy management, monetary authorities face a simple, old theoretical constraint, called the "impossible trinity," or "trilemma". This is a hypothesis that was first made popular by Mundell (1963). The hypothesis states that an economy simultaneously may choose any two, but not all, of the three goals of monetary policy independence, exchange rate stability, and financial market openness to the full extent. This hypothesis has been widely taught and recognised because it is quite intuitive and helpful to understand the constraints policymakers must face in an open economy setting.

Despite its pervasive recognition, the hypothesis has not been subject to rigorous empirical scrutiny until recently. The main reason for this is because it is quite difficult to create systematic metrics that measure the extent of achievement in the three policy goals of the trilemma. If one does not know to what extent each of the policy choices has been achieved, it is difficult to estimate what kind of other policy choices are still available and to what extent.

Aizenman, Chinn and Ito (2008) developed a set of "trilemma indexes" that measure the degree of achievement of the three policy choices for a wide coverage of economies and periods. Using the indexes, they empirically proved

that the hypothesis is valid by showing that the three measures of the trilemma are linearly related to each other.

Although the indexes by Aizenman, et al (2008), cover many countries and years, the systematic approach they employ to get a wider coverage may have sacrificed some nuances, potentially exposing the metrics to debate. While there cannot be "perfect metrics" that depict the state of policy implementations with decent precisions and subtlety, the bottom line is that this sort of exercise must be an endless exploration for economists.

We join this exploration and develop a set of indexes that measures the extent of exchange rate stability, monetary policy independence, and financial market openness. In our exploration, we take different, more nuanced and detailed methodologies than Aizenman, et al (2008). While building on the past literature, we attempt to overcome the weaknesses of the indexes developed previously. However, our aim for a higher level of subtlety for the indexes comes with a cost since the coverage of countries is smaller. The indexes are available for about 90 economies for the period of 1970-2009 when those for developing economies tend to be missing in early years.

Once the new indexes are introduced, we analyse if the indexes are consistent with the concept of the trilemma, that is, if the indexes are linearly dependent. Given that the indexes are normalised to take values between zero and one, the linearity of the indexes can be tested by examining whether the sum is statistically different from the value of two. These results show that policymakers do face a linear constraint of the three policy choices as theory suggests.

Extending this exercise, we also illustrate the policy mixes of our sample economies using the famous trilemma triangle, which is often illustrated in textbooks on international macroeconomics and is an intuitive way of showing how monetary authorities face the trade-off of choosing a mix of the three policies while having to stay inside the triangle. Our attempt to show the policy mix in the trilemma triangle, using actual metrics of the three policies instead of drawing the triangle abstractly, must be the first attempt in the literature of international macroeconomics. The triangle based on our indexes turns out to be useful in illustrating the development of policy mixes for economies over years.

Although we show that the sum of the three indexes adds up to two *on average,* we do not exclude the possibility of the sum deviating from the value of two for an individual economy for a certain period. Conceptually, we could

assume that if the sum of the three indexes surpasses the value of two for an extended period, such a policy combination is unsustainable. Furthermore, such an unsustainable combination of policies—if not addressed by policy actions—could be corrected by market forces, leading to an occurrence of economic disruptions such as a currency crisis. We show how the sum of the three indexes behaves for a group of Asian economies at the time of the Asian financial crisis.

We review the concept of the trilemma in Section 2. In Section 3, we define our indexes of the trilemma by carefully discussing the methodologies for constructing the indexes. We also look into the linearity of the indexes by examining whether the sum of the three indexes statistically equals to the value two. In Section 4, we make observations of the indexes for selected economies and economy groups by plotting combinations of the three indexes in the famous trilemma triangles. In Section 5, we examine how the sum of the three indexes evolved for Asian economies in the period before and after the Asian financial crisis. We conclude the main findings of the paper and discuss future research agendas in Section 6.

2. The Hypothesis of "Impossible Trinity" or the "Trilemma"

The trilemma is often illustrated using an equilateral triangle like the one shown in Figure 1. Each of the three sides represents monetary policy independence, exchange rate stability, and financial market openness. Starting from one corner, as one goes vertically toward one of the three sides, this represents a higher degree of the outcome in the policy represented by that side. In other words, one can stand on one of the three sides only when the full extent of a policy is achieved (represented by the side). Hence, although it is possible to achieve the full extent of two policy goals, i.e., standing on one corner in the triangle, it is impossible to be on all the three sides simultaneously. The fact that one may simultaneously choose any two, but not all, of the three goals of monetary policy independence, exchange rate stability, and financial market openness to the full extent signifies the trilemma. The top vertex in the triangle illustrated in Figure 1, labeled "flexible exchange rate regime", is, for example, associated with the full extent of monetary policy independence and financial market openness, but not exchange rate stability.

Since the time of the Gold Standard, different international monetary systems have attempted to achieve different combinations of two out of the three policy goals. In other words, history is full of "corner solutions". The Bretton Woods system sacrificed international capital mobility for monetary policy independence and exchange rate stability. The euro system is built upon the fixed exchange

rate arrangement and free capital mobility, but essentially abandoned monetary policy autonomy of the small member countries.

Countries do not always have to adopt "corner solutions," however. For example, one can implement a policy to achieve one particular side without achieving any of the remaining two, in which case one of the goals is fully achieved and the other two goals are achieved only partially. Or one can also implement a policy combination represented by a "dot" inside the triangle, for which the extent of achievement of the three goals can be measured by the vertical distance from a vertex to the dot.[4] Hence, once two of the three distances from the corners are determined, the last one can be determined, that is, knowing two policies would be sufficient to determine the policy combination.

China is a good example of a country represented by a "corner solution" initially, a "achieving a side" later, and a "dot inside the triangle" most recently. In the triangle in Figure 1, China before 1980 can be represented as the country with the policy combination represented by the bottom left corner (i.e., financially closed system). When it started to open up its capital account in a cautious and step-by-step manner, the policy combination began to gradually move from the corner horizontally toward the right. Since the government exited from the dollar peg and gradually introduced some exchange rate flexibility in July 2005, the country's position in the triangle has been drifting toward inside the triangle, showing greater monetary policy independence.

Thus, the trilemma is "binding" as long as the measures of the three policy choices prove to be linearly related to each other, i.e., as long as the "dot" is either on one of the three sides or inside the triangle. However, the fact that countries have adopted different policy combinations over the years must mean that each of the three policy choices is a mixed bag of both merits and demerits for managing macroeconomic conditions.

A high degree of monetary policy independence could help stabilise the economy against shocks while it could also help monetary authorities to smooth inflation and output movements (at least in the short run in a world with price and wage rigidities), play a lender of last resort function in the event of a systemic banking sector crisis, or monetise fiscal debt independently of other economies' macroeconomic management. Exchange rate stability could provide a nominal anchor and help increase the credibility of policymakers, thereby contributing to

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4. In this case, any dot inside the triangle lies on the plane represented by the triangle. For more details on the geometrics of the trilemma triangle, see Ito and Kawai (2012).

more stable output movement (Aizenman, et al, 2012). However, greater levels of exchange rate fixity could also impede policymakers from a policy choice of using the exchange rate as a tool to absorb external shocks.[5] Financial market opening is also argued to be a double-edged sword. Theoretically, a more open financial market should lead to more efficient resource allocation as well as to more efficient risk sharing. However, it could also become a destabilising factor by making economies more exposed to volatile cross-border capital flows, and thereby to boom-bust cycles.

Despite the double-edged nature of these three policies, policymakers tend to have bias toward their positive aspects and therefore pursue higher levels in all three policies. However, to reiterate, a country can in principle only achieve the full extent of two policies, not all three. An ambitious pursuit of wrong combinations of policies—of trying to achieve all three at the same time—can lead to some economic disruptions. Hence, it would be useful for policymakers to understand where they are located in the trilemma triangle, though this is not an easy task.

3. New Measures for the Trilemma Hypothesis

Aizenman, et al (2008) developed a set of the "trilemma indexes" that measure the degree of the three policy choices countries can make with respect to the trilemma for more than 170 countries for the period 1970 through 2009. The monetary policy independence index is based on the correlation of a country's interest rates with the base country's interest rate.[6] The index for exchange rate stability is an invert of the exchange rate volatility, i.e., standard deviations of the monthly rate of depreciation, for the exchange rate between the home and base countries. The degree of financial openness is measured by the financial openness index developed by Chinn and Ito (2006).

While their systematic approach makes it possible for the indexes to cover a large number of countries, their simple approach may fail to depict the subtlety of the policy arrangements. First, one can argue that simple correlations for the monetary policy independence index may be spurious if they are not properly controlled for. Second, if a country pegs its currency value to a basket of

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5. Exchange rate rigidities could render monetary authorities blind in terms of reading appropriate market signals and therefore make their economies prone to asset boom and bust cycles.

6. 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 country is either one of Australia, Belgium, France, Germany, India, Malaysia, South Africa, the U.K., and the U.S. More details on the construction of the indexes can be found in Aizenman, et al. (2008).

currencies, rather than a particular currency, standard deviations of a simple pair-wise exchange rate may not reflect the reality of the exchange rate arrangements. Third, regulatory policies pertaining to cross-border capital flows (*de jure* approach) may not reflect the actual degree of financial market openness, which can be captured by observed volumes of cross-border capital flows or by the price co-movements in financial assets, including the interest rate parity (*de facto* approach).[7]

Responding to these limitations of the indexes used by Aizenman, et al (2008, 2012), we introduce our new indexes of the trilemma. While there are no such things as perfect measures of the three policy goals, we try to overcome the drawbacks of the previous indexes. Here, while we base our approaches on the methodologies introduced in previous papers and implement theoretically reasonable methods, we attempt to create a set of indexes that may capture more subtleties of the aspects of the three policies in the trilemma hypothesis. The pursuit of more nuanced approaches comes at the expense of a smaller coverage of economies; we cover only about 90 economies for the period from 1970 to 2009.[8] We now explain each one of the three indexes below.

3.1 Exchange Rate Stability

To create an index that measures the extent of exchange rate stability of a particular sample currency *i*, we employ the methodology first introduced by Frankel and Wei (1994). They investigate the extent of influence of major currencies in the Asian region using the following estimation model:

$$\Delta e_{it} = \alpha_i + \beta_{iUS}\Delta e_{US_t} + \beta_{iJP}\Delta e_{JP_t} + \ldots + \beta_{iK}\Delta e_{K_t} + \varepsilon_{it} \quad (1)$$

where e_{kt} is the (log of) exchange rate of currency k against some numeraire currency (such as the Swiss franc and the SDR) and $k = i, US, JP, DM, \ldots, K,$ that is, the sample currency *i*, the U.S. dollar, the Japanese yen, the German deutsche mark or the euro, the British pound, and so forth. The currencies included in the right-hand side of the estimation equation can be thought of comprising an implicit basket in the mind of monetary authorities. Therefore, $\hat{\beta}_k$, the estimated coefficient on the rate of change in the exchange rate of currency k (where

7. The work by Quinn, Schindler and Toyoda (2010) reviews a variety of indexes that measure the extent of financial openness or capital controls.

8. The list of countries for which the indexes are constructed and the details of the data coverage are reported in Appendix 1 of Ito and Kawai (2012).

k = *US, JP, DM, …, K*) against the numeraire, represents the weight of currency k in the implicit basket. If the sample currency i is pegged to a currency or a basket of major currencies, we must observe either $\hat{\beta}_k = 1$ for the major currency (k) to which currency i is pegged, or $\sum_k^K \hat{\beta}_k = 1$ for the K currencies included in the implicit basket. Also, in such a case, the goodness of fit of the above estimation model must be high.[9]

To suit our purposes, we make several modifications to the Frankel and Wei estimation model. First, we apply the estimation model to each of our sample currencies, but estimate it over rolling windows of 36 months. In other words, $\hat{\beta}_k$'s, the weights of the major currencies in the basket, become time-varying because we believe it is more realistic to assume that policymakers keep updating their information sets. Furthermore, to get more precise estimates, we conduct the estimation in two-stages, i.e., after running the estimation for one time, the estimates whose *p*-values are greater than 20 percent are dropped from the estimation, which leaves only currencies with significant estimates in the estimation.[10] The estimates are now time-varying, so is the goodness of fit, or the adjusted R^2. We use the annual average of the time-varying adjusted R^2 as the measure of exchange rate stability (*ES**) as we ultimately employ annual data in our analysis.

The basic assumption of this exercise is that monetary authorities use an implicit basket of currencies as the portfolio of official foreign exchange reserves, but that the exchange rate response to the change in the value of the entire basket should vary over time and across monetary authorities. If a country wants to maintain a certain level of exchange rate stability, whether against a single currency or a basket of several currencies, the central banker should allow her currency to change its value only in accordance with the change in the *entire* value of the basket of major currencies.[11]

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9. One may also consider imposing the constraint of $\sum_k^K \hat{\beta}_k = 1$ in the estimation. However, we decided not to do so as we would rather have the estimation model as a general form because some of the currencies in our sample may have adopted flexible exchange rates which can be precluded by having the above constraint.

10. When all of the right-hand side variables turn out to be insignificant (with all the p-values greater than 20 percent), the currency that has the lowest *p*-value is retained in the estimation.

11. Even when a country adopts a floating exchange rate system, it is often the case that the central banker has a target currency in mind whose movement affects the currency policy (which is the same as the "base country" in the context of Shambaugh, (2004) and Aizenman, et al (2008)). This is detected as the currency that has the lowest p-value even if all the currencies on the right-hand side of the estimation are found insignificant.

As for the explanatory variables in the estimation, we will include the major currencies which are often held by monetary authorities as foreign exchange reserves, such as the U.S. dollar, the British pound, the Japanese yen, and the euro. In the years before the introduction of the euro in 1999, the German deutsche mark is included in place of the euro. For the former French or Belgian colony countries, the French or Belgian franc is included, respectively, instead of the deutsche mark[12,13]. We use the Swiss franc as the numeraire.

3.2 Monetary Policy Independence

For the index on monetary policy independence, we consider the following simple estimation model:

$$i_{it} = \phi_i + \gamma_i i^*_{it} + u_{it} \tag{2}$$

where i^*_{it} is the "synthetic foreign interest rate", which is the weighted average of the foreign interest rates, with the weights being the estimated $\hat{\beta}'s$ from the Frankel-Wei estimation given by equation (1), i.e.,

$$i^*_{it} = \hat{\beta}_{iUSt} i_{i1t} + \hat{\beta}_{iJPt} i_{i2t} + \ldots + \hat{\beta}_{iKt} i_{iKt} \tag{3}$$

where we assume that monetary authorities choose a basket of K currencies.[14]

Similarly to the exchange rate stability estimation, we could use the adjusted R^2 of equation (2) for the measure of monetary policy independence.[15] However, merely basing the estimation on equation (2) can be problematic because of the

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12. Since Bhutan and Sri Lanka peg their currencies to the Indian rupee, the Indian rupee is also included in the estimation for these countries. For the same reason, the estimations for Botswana, Lesotho, Namibia, and Swaziland include the South African rand as one of the right-hand side currencies. For several countries in the Pacific, the Australian dollar is included.

13. The estimation also includes a dummy variable that takes the value of one if the monthly rate of change in the exchange rate of the domestic currency is greater than 10 percent in absolute terms so as to minimise noise from exchange rate disruptions such as abortion of an exchange rate regime and sudden re/devaluation of the currency. Similarly, we include a dummy that takes the value of one in the first month after the introduction of the euro.

14. As explained in the estimation of equation (1), only significant estimates of $\hat{\beta}'s$ (or the one that has the lowest p-value) are included.

15. That is, if home country i closely follows the monetary policy of the countries included in the basket, the goodness of fit of equation (2) must be high (while γ_{it} should be close to the value of one), which means the home country's monetary policy is *dependent* on the (weighted average) behaviour of the basket countries.

following two reasons. First, either of the variable i_{it} and i^*_{it} can be non-stationary, which makes γ_{it} spurious and therefore, adjusted R^2 unreliable (see Obstfeld, Shambaugh and Taylor, 2005). Second, a model like equation (2) can involve missing variable bias; it does not control for other factors that can affect the authorities' decisions on the policy interest rate, namely, domestic and global factors (other than those of the economies for which conditions are embedded in the basket). For example, in the case of both the domestic and foreign countries facing common shocks, the estimated coefficient on the foreign interest rate could be spuriously significant and possibly close to one, even though the domestic authorities do not follow the foreign country's monetary policy.

Assuming that it is safe to assume non-stationarity in the interest rate level series,[16] and incorporating other factors, we modify equation (2) and consider the following 12-month differenced estimation model:

$$\Delta i_{it|t-12} = \gamma_{it}\Delta i^*_{it|t-12} + \phi_{iyt}\tilde{y}_{it} + \phi_{i\pi t}\tilde{\pi}_{it} + \phi_{iy_Gt}y_{Gt} + \phi_{ioil\pi t}oil\pi_{it} + D_i'\Phi_D + \varepsilon_{it}. \quad (4)$$

where $\Delta i_{it|t\text{-}12}$ and $\Delta i^*_{it|t\text{-}12}$ refer to the change in the home and (synthetic) foreign policy interest rates, respectively, over a 12 month period[17]. Hence, we examine the correlation between the change in the home and foreign policy rates over a 12 months period. $\tilde{y}_{it}$ is a proxy for the output gap, measured by the year-to-year growth rates of industrial production; $\tilde{\pi}_{it}$ is a proxy for the inflation gap, measured by the year-to-year CPI inflation rates; y_{Gt} is the year-to-year growth rate of the world economy, measured by the average rate of change in industrial production of the G7 and BRIC countries; and $oil\pi_{it}$ is the year-to-year rate of change in the price of crude oil. Inclusion of $\tilde{y}_{it}$ and $\tilde{\pi}_{it}$ is supposed to control for the domestic conditions the monetary authorities in country i would consider

16. Given the Fisher equation, the stationarity of the nominal interest rate series is conditional upon the stationarity of the expected rate of inflation series or that of the real interest rate series. Theoretically, it is difficult to argue the non-stationarity of the real interest rate, although the real interest rate series can involve structural breaks, causing non-stationarity in a statistical test (See Huizinga and Mishkin (1984) and Garcia and Perron (1996)). Given the past episodes of hyperinflation in many countries, it is possible that the rate of inflation series is non-stationary, which has been shown in many studies.

17. We use the change in the policy rate over 12 months instead of month-to-month changes, i.e., first-differences, because of the following reasons. First, estimation with the first-differenced policy rates would involve too much noise that affects both the estimated coefficients and adjusted R^2. Second and more importantly, estimating equation (2) in first-difference form is essentially the same as assuming that the home country must react to a change in the foreign interest rate i^* within one month, which is too restrictive an assumption.

in setting the policy interest rate and, hence mimics the Taylor rule.[18] D is a vector of dummies to control for high- or hyper-inflation as well as for currency crises that are identified based on the often-used exchange market pressure (EMP) indexes first developed by Eichengreen, Rose and Wyplosz (1994).[19,20]

Along with equation (4), we also consider the following two other estimation equations.

$$\Delta i_{it|t-12} = \phi_{iyt}\tilde{y}_{it} + \phi_{i\pi t}\tilde{\pi}_{it} + \phi_{iy_G t}y_{Gt} + \phi_{ioil\pi t}oil\pi_{it} + D_i'\Phi_D + \varepsilon_{it} \tag{5}$$

$$\Delta i_{it|t-12} = \gamma_{it}\Delta i^*_{it|t-12} + D_i'\Phi_D + \varepsilon_{it} \tag{6}$$

Equation (5) is obtained by excluding the foreign interest rate from equation (4) while equation (6) is obtained by excluding the control variables that represent the domestic and global conditions from equation (4) although it still includes the

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18. We do not necessarily assume all the economies in our sample follow the Taylor rule. The domestic variables can be insignificant contributors to the decision making of the policy rates.

19. More specifically, we include the interest rate dummy that takes the value of one if the policy interest rate is greater than 100 percent; the inflation dummy that takes the value of one if the change in the rate of inflation from the same month in the previous year is greater than 50 percent; and the interest rate change dummy that takes the value of one if the change in the policy rate is greater than 5 percent points from the previous month or 50 percent points from the same month in the previous year. The currency crisis dummy takes the value of one when the EMP index exceeds the threshold of mean plus or minus 2 standard deviations of the index.

20. The EMP index is constructed as the weighted average of monthly changes in the nominal exchange rate, the nominal interest rate, and the foreign exchange reserve loss in percentage. The exchange rate is between the domestic currency and the currency of the base country (as defined in Shambaugh, 2004). The nominal interest rate and the foreign exchange reserve loss are included as the differentials from those of the "base country." The base country follows the definition by Shambaugh (2004), and for the countries whose base countries are not defined by Shambough (2004), we follow the base countries defined by Aizenman et al (2008). The weights are inversely related to the variance of changes in each component for each of the sample countries. When we calculate the standard deviations of the EMP index for the threshold, we exclude the EMP values that are lower than the bottom one percentile or greater than the top one percentile because outliers of the EMP index can make the standard deviations unnecessarily large and thereby make the thresholds too lenient for some countries, especially those which have experienced significant swings in their EMP indexes.

vector of dummies. Using these estimation models and focusing on their adjusted R^2's, we come up with the following two types of measures for the level of monetary policy independence: [21]

$$MI\_1 = \frac{Adj.R^2 \text{ of Eq. } 5}{Adj.R^2 \text{ of Eq. } 4} \tag{7}$$

$$MI\_2 = 1 - \frac{Adj.R^2 \text{ of Eq. } 6}{Adj.R^2 \text{ of Eq. } 4} \tag{8}$$

Here, *MI_1* indicates that the lower this ratio is, the more explanatory power the foreign interest rate has as given by $Adj.R^2$ in equation (4), thus implying that a higher ratio indicates higher levels of monetary policy independence.

MI_2, on the other hand, is based on the idea that the better the foreign interest rate explains the variation of the domestic interest rate, the closer the adjusted R^2 of equation (6) will be to that of equation 4. This would make the level of *MI_2* lower.

Whatever the measure for monetary policy independence, it should show how much contribution the foreign interest rate makes in explaining the variation of the domestic interest rate. However, we need to be careful about which measure of MI to use. We can compare the explanatory power of equation (4) with that of equation (5) or (6) only if the foreign interest rate and the vector of domestic and global factors are completely independent from each other. We may not do so in the case of a country that is highly integrated with other economies or a regional economic community, for which case both the domestic and foreign economies can face similar shocks. For example, when the domestic country is geographically close to the foreign country, thereby subject to similar shocks, the domestic authority with full monetary policy independence could behave similarly to the foreign monetary authority. This means that even though equation (5) is the true specification, equation (6) could deliver a good fit because the domestic interest rate and the vector of domestic and global conditions could be highly correlated. On the other hand, even if equation (6) is the true specification, the goodness of fit of equation (5) could be high if the domestic

21. A more straightforward way of measuring the extent of monetary policy dependence would be to use $\hat{\gamma}$ in equation(4). However, $\hat{\gamma}$ is found to be quite unstable (despite inclusion of the dummies). For some developing economies that had experienced episodes of high inflation, it can easily surpass the value of one.

and global factors on the right hand side of (5) are highly correlated with the foreign interest rate.

Hence, we take the following approach for each of our sample economies. We estimate both equations (5) and (6). First, if the adjusted R^2 of equation (5) is greater than that of equation (6), then we choose *MI_1* as the monetary policy independence index, as in this case it is reasonable to conclude that the vector of domestic and global macroeconomic variables is not highly correlated with the foreign interest rate i^*. This procedure allows us to see how much additional explanatory power the foreign interest rate would have in equation (4) compared to equation (5), so *MI_1* can be a good measure of monetary policy independence. Second, if the adjusted R^2 of equation (6) is greater than that of equation (5), then we choose *MI_2*. In this case, we can see how much additional explanatory power the vector of domestic and global variables would have in equation (4) compared to equation (6). Finally, if the adjusted R^2's of equations (5) and (6) are sufficiently close to each other, we use the average of *MI_1* and *MI_2*.[22]

3.3 Financial Market Openness

Here, we base our index of financial market openness on the *de facto* measure of financial openness developed by Lane and Milesi-Ferretti (2000, 2007; *L-MF* hereafter). *L-MF* compile the data for the international investment positions for about 180 economies during the period of 1970-2007. For each economy, total assets are composed of FDI assets, portfolio equity assets, debt assets (= 'debt equity' + 'other' investment (i.e., bank loans and trade credit)), financial derivatives assets, and foreign exchange reserves, while total liabilities include FDI liabilities, portfolio equity liabilities, debt liabilities, and financial derivatives liabilities.

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22. Specifically, we use the following rule: If the adjusted R^2 of equation (5) is greater than the sum of the adjusted R^2 of equation (6) and the standard errors of the difference between the two adjusted R^2's, then we take MI_1 as the MI index. If the adjusted R^2 of equation (6) is greater than the sum of the adjusted R^2 of equation (5) and the standard errors of the difference between the two adjusted R^2's, then we take MI_2 as the MI index. If the difference between the two adjusted R^2's is within its standard errors, then we use the average of the two MI indexes.

L-MF normalise the sum of "total assets" and "total liabilities" as ratios to GDP and total trade volume (i.e., exports + imports) and use these as the measures of financial market openness. For our purpose, we raise the following points and consequently make several modifications. First, normalising the sum of total assets and liabilities as a ratio to GDP would make the financial market openness index susceptible to business cycles. Also, it would make the index appear unnecessarily low for large economies such the U.S. and make the one with international financial centres—such as Ireland, Luxemburg, Singapore, and Hong Kong—appear extremely high, much higher than that of the U.S. which has presumably one of the most open, if not the most open, financial markets in the world. Normalising the sum of total assets and liabilities as a ratio to total trade volume, on the other hand, would make the index of financial openness less susceptible to business cycles and help correct distortions arising from the country being a financial centre. It, however, tends to penalise too harshly economies that are highly open to international trade such as Singapore. Hence, normalising assets and liabilities as ratios to GDP and trade volume has both merits and demerits.

Second, including foreign exchange reserves as part of "total assets" for the purpose of creating an index of financial market openness can be problematic because investment by monetary authorities should not be treated the same as private investment. One can think about China and other East Asian economies, which can appear as "financially open" if their massive foreign exchange reserves are included as part of total assets.

Last, the index of financial market openness based on the *L-MF* data may not be appropriate in the context of the trilemma hypothesis because the data seem to have an explosive trend. In fact, the work by Quinn, Schindler and Toyoda (2010) shows that the index series is non-stationary. Hence, there is a need to normalise and standardise the sum of total external assets and liabilities in both an economically and econometrically reasonable way.

Given these considerations, we create our index of financial market openness in the following way. We first calculate two indexes of financial market openness in a way similar to *L-MF* by normalising the sum of external assets and liabilities, less official foreign exchange reserve assets, as ratios to GDP and trade volume. We then take the average of the two, i.e.,

$$FO_{it}^{*} = \frac{1}{2}\left\{\frac{\text{Total Assets}_{it} + \text{Total Liabilities}_{it} - \text{Official Reserve Assets}_{it}}{GDP_{it}} + \frac{\text{Total Assets}_{it} + \text{Total Liabilities}_{it} - \text{Official Reserve Assets}_{it}}{(EX + IM)_{it}}\right\} \quad (9)$$

We finally assume that the advanced economies as a group achieved full financial openness as of the late 1990s. Using this assumption, we calculate financial market openness as above for advanced economies during the period from 1995 to 1999; and regard this measure, defined FO_{ADV}*, as the highest level of financial market openness.[23] We normalise the above FO* as a ratio to FO_{ADV}*, and define the index to be bound between zero and one.[24]

$$FO_{it}** = \frac{FO_{it}*}{FO_{ADV}*} \quad \text{where } 0 < FO_{it}** < 1 \tag{10}$$

In this way, we define the financial market openness index by normalising the volume of total assets and liabilities (excluding official reserve assets) as a ratio to both GDP and trade volume and ensuring it ranges between zero and one.[25]

3.4 Adjustments

3.4.1 Adjustments for ES and FO

In this exercise, our general approach is to "let the data speak for themselves". However, while there is no theoretical basis for each of the three indexes to be normally distributed, we must also avoid any distorted or lopsided distribution, given the need for each index to range between zero and one. Based on this, we carefully examine the distribution and make the following two observations. First, the index for exchange rate stability hardly takes a value which is below 0.3. This can be driven by a statistical artifact of the estimation model that includes several dummy variables. We know that some advanced economies do not intervene much in the foreign exchange markets, particularly in recent years, and this must mean that the exchange rate stability indexes for these economies are close to zero. Second, the index for financial market openness hardly falls below 0.1. Considering that we normalise actual volumes of gross external assets and liabilities by GDP and total trade, it is understandable

23. We exclude Luxemburg from the calculation since it is an extreme outlier due to its role as an international financial centre. Chinn and Ito's (2006, 2008) *de jure* index of financial market openness also shows that the level of financial regulatory openness reached the highest level in the mid-1990s and has since plateaued.

24. Any FO_i taking a value above one is assumed to be one.

25. We also update the data on external assets and liabilities using the international investment positions data of the IMF's *International Financial Statistics*.

for such a *de facto* index not to fall close to zero. Even if the authorities banned capital flows with regulatory controls, some amount of cross-border capital flows do occur. We know that some economies have essentially closed financial markets, for which the financial market openness indexes must be zero.

To incorporate the above two concerns, we adjust the indexes for exchange rate stability and financial openness as follows:

$$ES_{it} = (ES_{it}^{*} - 0.30)/0.70$$

$$FO_{it} = (FO_{it}^{**} - 0.10)/0.90$$

where ES^{*} and FO^{**} are indexes constructed according to the procedures describe previously.

3.4.2 Adjustments for All Three Indexes

The above adjustments for *ES* and *FO* create some downward bias in the new set of three trilemma indexes. As we will discuss in the next subsection, in order for the indexes to have theoretical validity, the sum of the indexes must equal two, for which the newly created downward bias can be a little problematic. In fact, when we define $\overline{MI} + \overline{ES} + \overline{FO} = 2 \cdot A$ where $\overline{X} = \sum_{1}^{T}\sum_{1}^{I} X_{it}$, i.e., the cross-country, cross-time average of variable *X* (= *MI*, *ES*, or *FO*), *A* is found to be smaller than 1.

Hence, we make a further adjustment to the set of the three indexes so that the sum of the indexes will not become far from theoretical predictions. More specifically, we define the sum of the adjusted measures of exchange rate stability, monetary policy independence and financial market openness to be unity by defining a new set of indexes as: $X^{*} = X/A$ where *X* = *MI*, *ES*, or *FO*.

3.5 Theoretical Validity of the Indexes – Are They Linearly Related to Each Other?

Before making observations of the newly defined indexes, we need to ensure that these indexes hold theoretical validity. Theory predicts that monetary authorities would have to face a trade off in choosing two out of the three policy choices if they are implemented each to the full extent. If they do not implement any combination of two policies fully, they could achieve three policies partially. However, once they make policy choices in any two of the three areas,

they cannot make an independent choice in the third area, as it is automatically determined. That means that the extent of achievement in the three choices must be linearly related to each other. Furthermore, as long as we assume that the triangle to depict the trilemma hypothesis is an equilateral triangle with the height of one, the three indexes must add up to two.[26]

One may wonder if our exercise is tautological because we already make an adjustment to ensure that the cross-time-country average of the three indexes equals to two. However, even if we make this adjustment, it does not guarantee that the sum of the three indexes will be equal to two over the entire sample period for a given economy or a group of economies, or across all economies in a given year. If the indexes are not in line with theoretical predictions, the sum of the three indexes could still deviate from the value of two in subsamples even though the across-the-board average is two.

Figure 2 shows the development of the average sum of the three indexes for different groups of economies. The shaded areas refer to the 90 percent confidence intervals of the mean of the sum. For the full sample, the sum is statistically equal to the value of 2 for most of the 1980s and the 1990s as well as the mid-2000s. While the sum of the three indexes is not statistically different from the value of 2 for most of the sample period for the subgroups of both developing and emerging economies, for the group of advanced economies, it deviates upward from the value of 2 for most of the period in the late 1990s and the mid-2000s.

Overall, it is safe to conclude that the sum of the three indexes is not statistically different from the value of two, confirming the theoretical validity of the indexes.

4. The Three Indexes

4.1 Some Observations of the Indexes

Figure 3 illustrates the average values of the three indexes for different income and regional groups of economies.[27] We can observe that "middle- or

26. See Appendix 2 of Ito and Kawai (2012).

27. "High-," "Middle-," and "Low-income" economy groups are based on the World Bank's Classifications. "Emerging Market Economies" refer to the economies included in the MSCI Emerging Markets Index. They are: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Chinese Taipei, Thailand, Turkey and Venezuela.

low-income" economies have, on average, pursued high levels of monetary policy independence and exchange rate stability over the sample period, but that this is not the case for "high-income" or "emerging" economies for the last twenty years. Since the late 1970s, the level of monetary policy independence for "middle- or low-income" economies, excluding emerging ones, has been taking cycles between high and medium levels while their exchange rate stability indexes have been in a moderately downward trend though they are rising rapidly in the last few years.

Among "high-income" economies, on the other hand, policy priorities seem to have drastically changed from the combination of exchange rate stability and monetary policy independence during the 1970s to that of greater financial market openness and exchange rate stability. Lastly, although there has been much talk about financial globalization among developing and emerging economies, the rise in the level of financial market openness is not as steep as what they experienced in the early 1980s. While "middle-income" or "emerging market" economies have maintained intermediate levels of financial market openness since the late 1980s, those economies which are not perceived to be "emerging" have experienced a *fall* in the level of financial market openness in the last decade.

SEACEN economies appear to have taken somewhat similar paths to other middle- or low-income economies, but these economies distinctively had pursued exchange rate stability persistently until the Asian financial crisis. During the crisis, the level of exchange rate stability plummeted, reflecting the policy decisions of aborting fixed exchange rates taken by the crisis economies. In the few years before the global financial crisis of 2008, the level of exchange rate stability made a large comeback, which seems to be enabled by sacrificing monetary poicy independence. Understandably, these economies increased the level of monetary policy independence during both the Asian financial crisis and the global financial crisis, reflecting the stabilization efforts during the turmoil. The level of financial market openness has risen in two steps, one in the mid-1980s and another in the late 1990s. SEACEN economies appear different from other middle- or low-income economies in that they have been on a steady path for higher levels of financial market openness, even increasing their levels in the aftermath of financial crises.

Emerging market economies in Latin America have maintained relatively high levels of monetary policy independence since the 1980s, though cyclically reducing their levels. The level of exchange rate stability, however, does not appear as high as that of SEACEN economies for most of the sample period

except for the immediate post-Asian financial crisis period. This group of economies rapidly increased the level of financial market openness in the beginning of the 1980s, but since then, there has not been much progress toward more open financial markets. Compared to this group of economies, the progress on financial market opening for SEACEN economies appears more persistent.

4.2 The Trilemma Triangle

The most intuitive way of showing combinations of the three policies, monetary policy independence, exchange rate stability, and financial market openness, for a particular economy is to locate the economy in the trilemma triangle shown in Figure 1.

However, to do that, the sum of the three policy indexes must equal to two *exactly* for every year and every economy. Although we have shown that the sum of the three indexes is statistically equal to the value of two, it is often the case that the sum of the three indexes deviates from the value of two for a certain economy and year. Hence, an adjustment was made to ensure that the sum of the three indexes to amount to two for every economy and year.[28]

With this adjustment, we are now able to show combinations of the three policies in the trilemma triangle using the metrics that represent the extent of actual achievement in the three policy goals. To our knowledge, plotting a combination of the three policies in a trilemma triangle is the first attempt in the literature of international macroeconomics.

Figure 4 shows the trilemma triangles with the re-adjusted three indexes for three five-year periods, 1986-90, 1996-2000, and 2006-09, and for different economy groups: advanced economies,[29] SEACEN economies, and emerging Latin American economies. We can make several interesting observations. Generally speaking, while advanced economies used to have a wide variety in the combinations of the three policies, these economies moved toward higher degrees of financial market openness over years. By the end of the 2000s, there are two types of advanced economies: one group composed of economies

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28. This is spelt out in Appendix 2-2 in Ito and Kawai (2012). Essentially, we divide each index by scalar B_{it} when $MI_{it} + ES_{it} + FO_{it} = 2B_{it}$.

29. The group of advanced economies is a subset of high-income economies and includes: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, and the U.K.

that have pursued higher levels of financial market openness and exchange rate stability, most notably the eurozone economies, and the other composed of economies that have achieved greater degrees of monetary policy independence and financial market openness (i.e., flexible exchange rate systems) such as Germany, Iceland, Scandinavian countries, Japan, and Australia.

While advanced economies have steadily increased the level of financial market openness, this is not the case for SEACEN or Latin American economies. Among the SEACEN economies, starting from the combination of relatively stable exchange rates and relatively high monetary policy independence (i.e., left-bottom corner of the triangle), many economies tried to maintain monetary policy independence, but gave up some degree of exchange rate stability in the late 1990s, mostly reflecting the abortion of fixed exchange rate regimes during and in the immediate aftermath of the Asian financial crisis. As of the last half of the 2000s, there seems to be a wider variety of policy combinations among the SEACEN economies—some have retained full monetary policy independence while others have gradually moved toward financial market openness, though many are still clustering inside the triangle distant from full financial market openness.

Emerging Latin American economies, after pursuing relatively high levels of monetary policy independence and exchange rate stability by limiting financial market openness till the end of the 1990s (except for Argentina and Peru, which had open financial markets), there seem to be two groups of economies in the second half of the 2000s: one group has achieved high levels of financial market openness and monetary policy independence while the other group has continued to pursue relatively high levels of monetary policy independence and exchange rate stability. Argentina and Peru made a big swing from a combination of highly open financial markets with relatively flexible exchange rates to the second group above, particularly toward greater exchange rate stability.

Figure 5 illustrates the trilemma triangles for select individual economies in Asia. The values of the trilemma indexes are five-year averages, and the year in the triangle refers to the last year of the five-year periods. As has been discussed widely, China has maintained high levels of exchange rate stability and monetary policy independence. Despite the government's announcement to increase the level of exchange rate flexibility in 2005, the triangle plot suggests that the country has retained *de facto* rigid fixed exchange rates while it does seem to have started opening financial markets. Other Asian economies, on the other hand, seem to have reduced the level of exchange rate stability after the 1997-98 Asian financial crisis though they also seem to have continued to retain

monetary policy independence. Asian emerging markets do not appear to have been as financially open as has been discussed. Interestingly, many Southeast Asian economies appear to have increased the level of exchange rate stability in the last period though financial market openness has not increased very much.

5. The Asian Financial Crisis: The Trilemma View

Although the three indexes of the trilemma hypothesis must be linearly dependent, in reality, actual policy arrangements of exchange rate stability, monetary policy independence, and financial market openness may deviate from the theoretical linear relationship. Anecdotally, we sometimes observe monetary authorities trying to implement an "inconsistent" policy in the face of the trilemma policy constraint. For example, the authorities of an economy experiencing capital flight and speculative attacks on their currency may try to maintain the (overvalued) fixed parity of the currency and retain monetary policy independence without limiting financial market openness. The authorities in such a situation will eventually have to lose control of monetary policy, abort the fixed exchange rate, or implement capital controls. In other words, authorities can deviate from the constraint of the trilemma only in the short run, but not in the long run. After all, a policy that deviates from the trilemma will eventually have to end. Otherwise, markets will punish authorities and force them to change policies in a way consistent with the trilemma.

Given this observation and using the indexes we have developed, we should be able to identify policy combinations that yield MI + ES + FO > 2 and are "unsustainable". Once we do this, we can hypothesise that such "unsustainable" policy combinations that deviate from the trilemma constraint must be correlated with macroeconomic disruptions, such as a currency crisis, debt crisis, and banking crisis.

Figure 6 depicts the sum of the three indexes for several Asian economies (upper panel) in the 1990s and Latin American economies (lower panel) in the 1980s. The upper panel of the figure shows that the sum of Thailand's trilemma indexes surpasses the value of two in the period leading to the baht crisis, while those of other crisis-affected countries do not seem to exceed the value of two. This suggests that Thailand likely implemented "unsustainable" policies in the period leading to the baht crisis while other countries maintained "sustainable" policy combinations and may have encountered the currency crisis

mainly due to contagion from Thailand. Also, once the currency crises broke out, all countries appear to have lowered the sum of the three indexes as a reaction to the crises. Thus, the Thai baht crisis was likely driven by the mismanagement of the country's policies, which likely affected the neighboring economies through contagion.

The lower panel of the figure suggests that many Latin American economies implemented "unsustainable" policy combinations throughout most of the 1980s, although the sum of the three policy indexes was in a declining trend toward the end of the decade in most of the countries. The lingering debt and currency crisis situation of these economies may be attributed to the mismanagement of policies.

Although we must conduct a more formal analysis to reach more definitive conclusions, the evidence indicates that Thailand implemented "unsustainable" open macroeconomic policies prior to the baht crisis in a way similar to the Latin American economies during the debt crisis period of the 1980s.

6. Concluding Remarks

We have introduced a new set of indexes of exchange rate stability, monetary policy independence, and financial market openness, all of which are theoretically constrained as a trilateral trade-off as predicted by the famous "impossible trinity" or "trilemma" hypothesis. In our exploration, we have taken a different and more nuanced approach than the previous indexes such as those developed by Aizenman et al (2008).

Using the new indexes, we have presented our sample economies' policy mixes by plotting them in the famous trilemma triangle. The triangle is very useful in illustrating how policy mixes of economies have evolved over time. We have shown that much room remains for the SEACEN economies to open financial markets, moving away from the current policy preferences of maintaining relatively high levels of monetary policy independence and exchange rate stability with limited financial market openness.

While the sum of the newly defined indexes must add up to two theoretically, it in reality can deviate from the value of two. The trilemma hypothesis suggests a policy combination that creates a large, persistent deviation is unsustainable, and, hence, will be corrected by economic disruptions such as currency and banking crises.

We showed how the sum of the three indexes evolved for Asian economies at the time of the 1997-98 Asian financial crisis and for Latin American economies during debt crises in the 1980s. Before the baht crisis, Thailand seems to have implemented "unsustainable" policies while other crisis–affected Asian economies do not seem to have had such unsustainable policies, implying that they were affected by crisis contagion from Thailand. Also, most of the Asian economies experienced a decline in the sum of the three indexes in the post-crisis period. Latin American economies seem to have had policies that were unsustainable throughout the 1980s, suggesting that mismanagement of macroeconomic policies had a long-lasting impact on their economic performance.

These findings suggest that the indexes of the trilemma we have introduced can be collectively used as a warning indicator, to show the extent of an unsustainable policy mix for each economy. However, we still need to conduct a more formal analysis to unravel the nature of the correlation between the indexes and the occurrences (and maybe magnitudes) of economic and financial crises. In addition, it would be useful to identify factors that affect the choice of policy combinations. We leave these as a future research agenda.

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Figure 1
The Trilemma

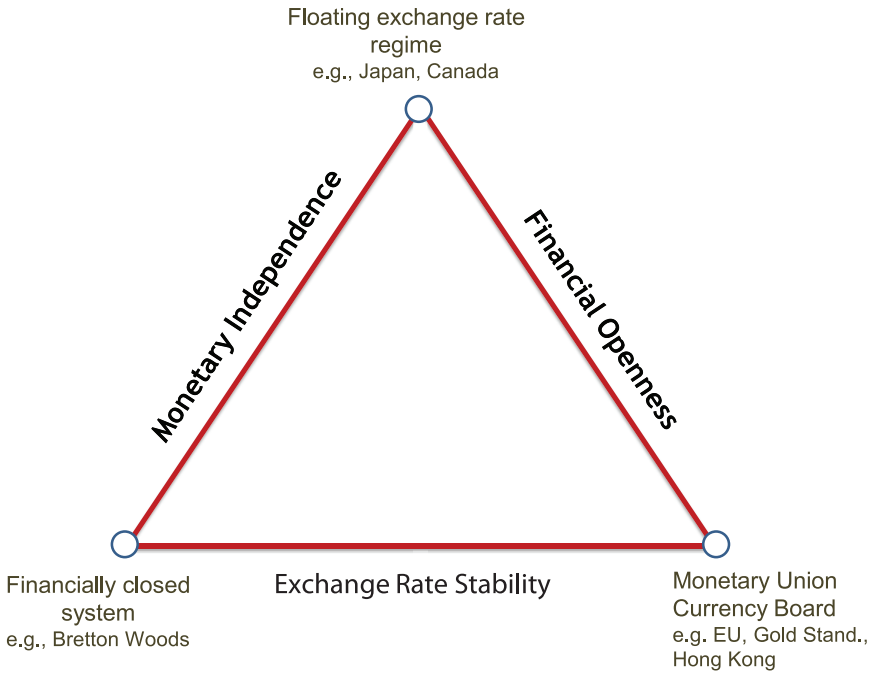


Figure 2
The Sum of the Three Indexes

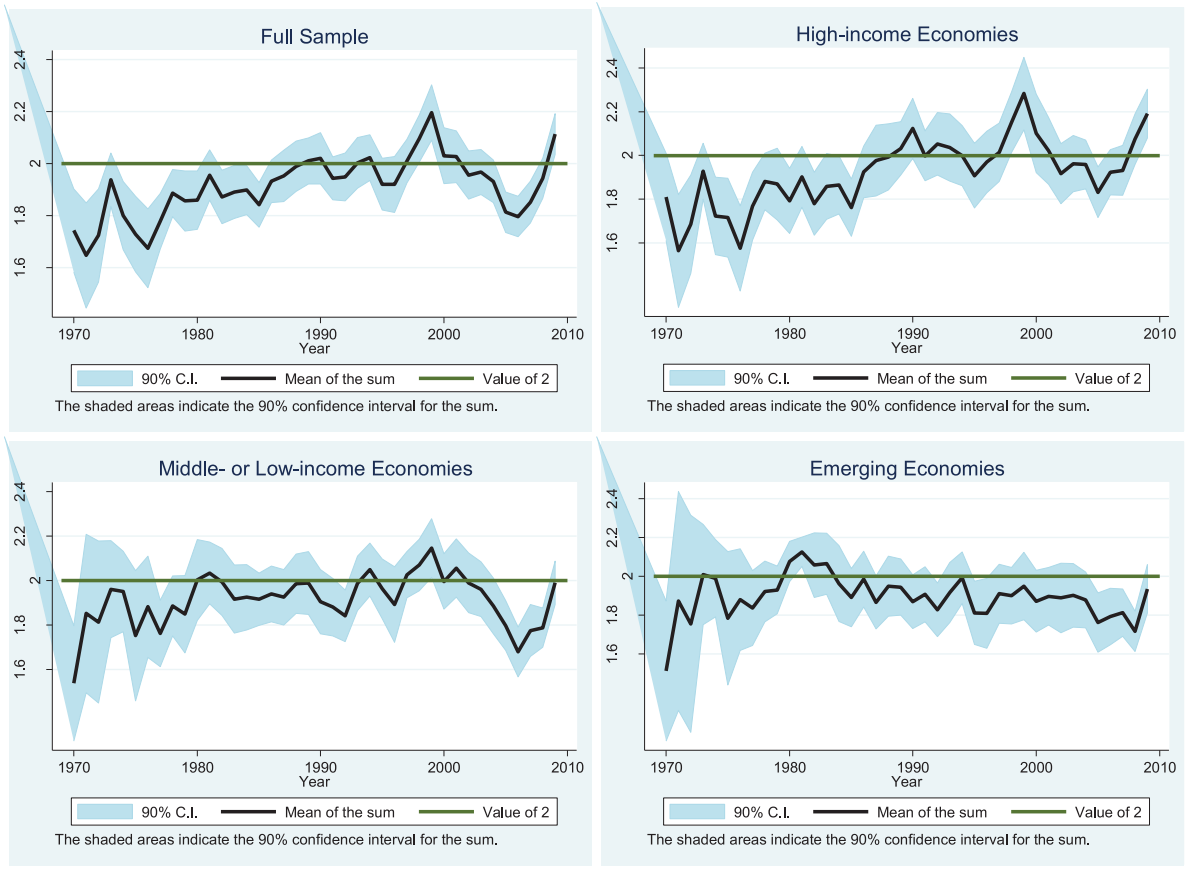


Figure 3
Trilemma Indexes for Groups of Economies

Figure 4
Trilemma Triangles – Groups of Economies

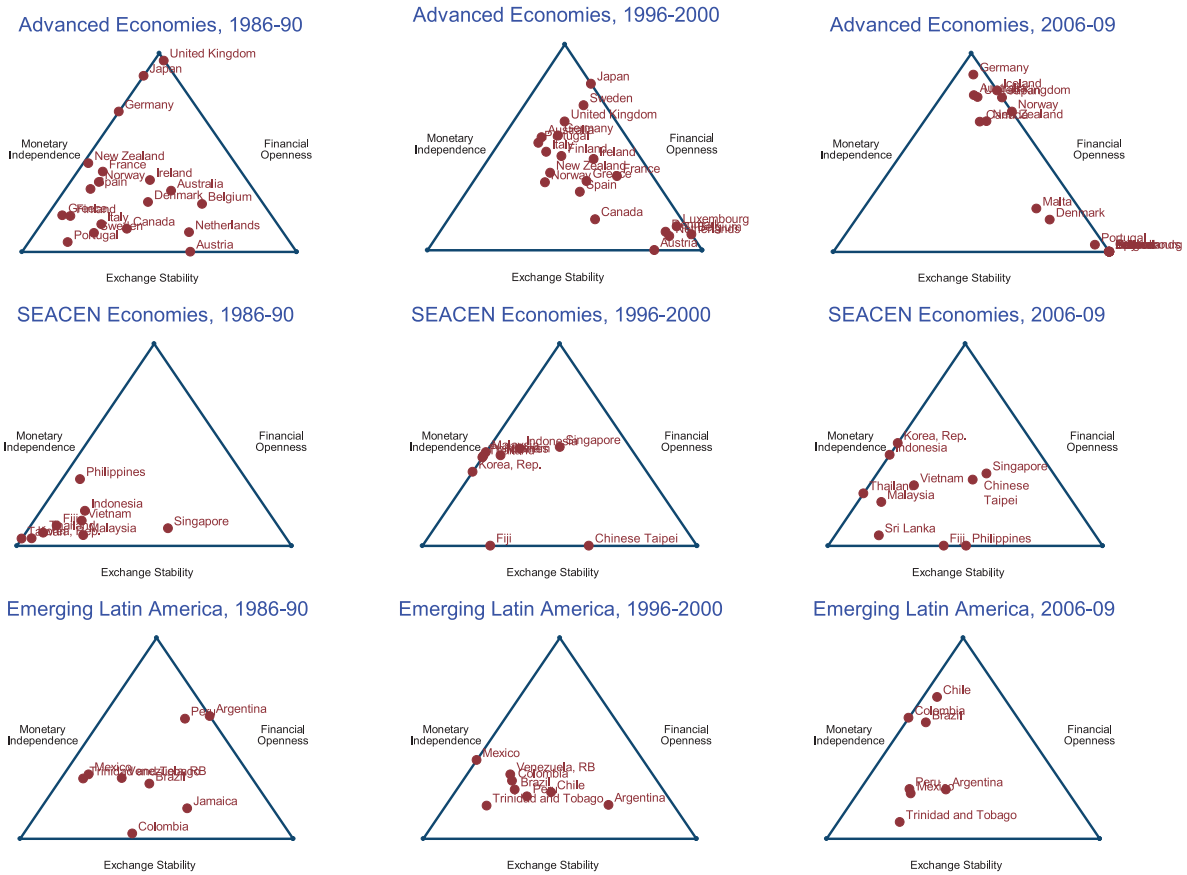


Figure 5
Trilemma Triangles – Individual Economies

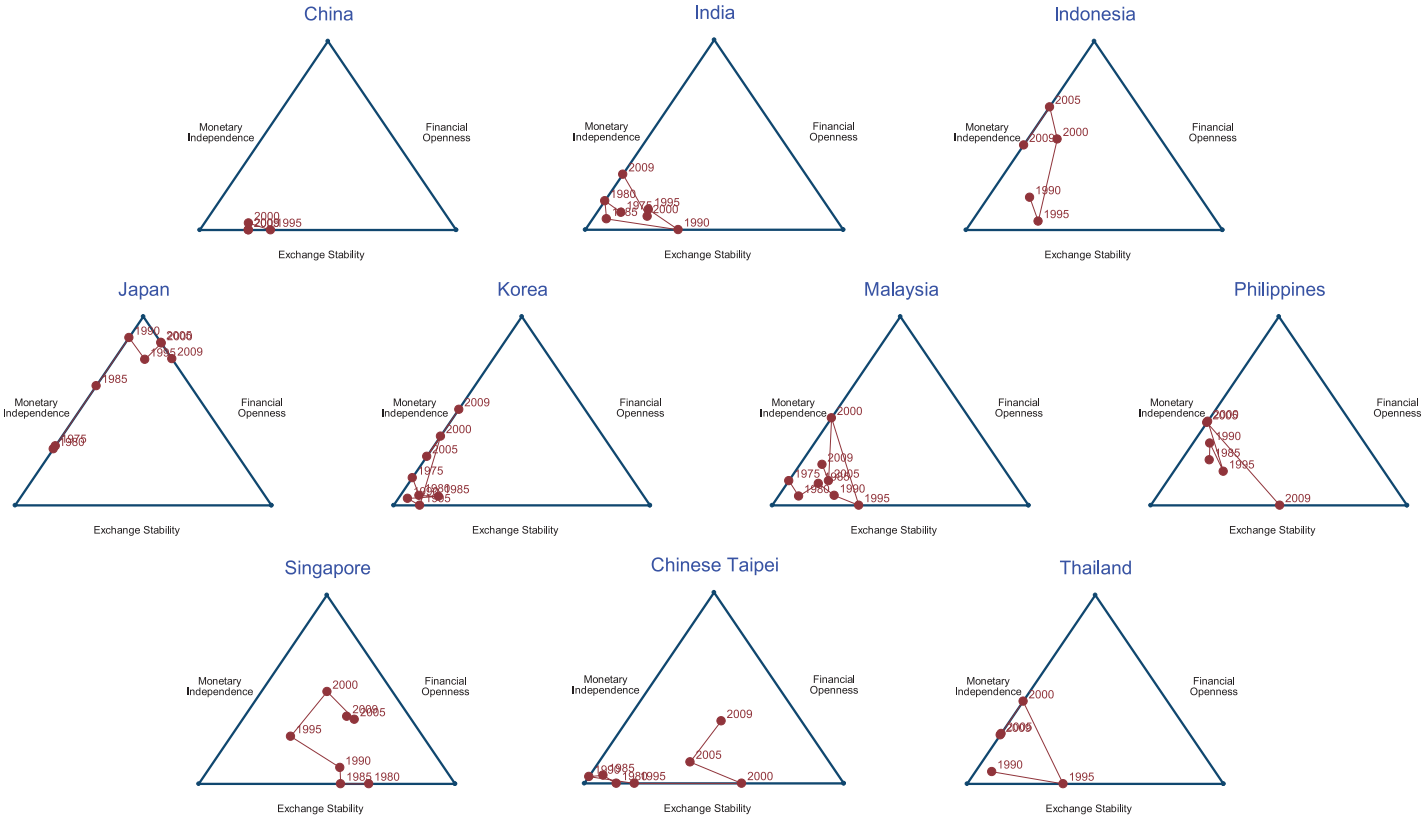
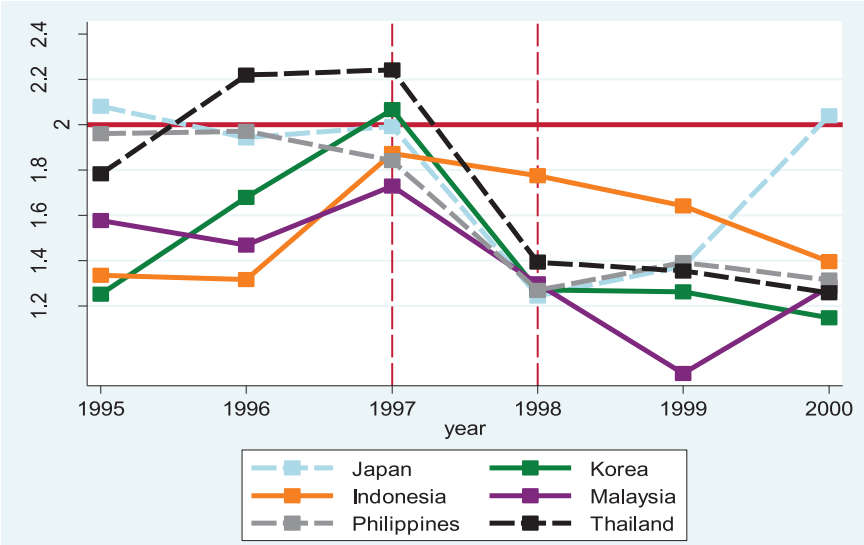


Figure 6
The Sum of the Three Indexes over the Crisis Period
(a) Asian Economies around the Asian Financial Crisis in 1997-98



(b) Latin American Economies around the Debt Crisis in the 1980s