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The "Impossible Trinity" Hypothesis in an Era of Global Imbalances: Measurement and Testing

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JEL Classification Nos.: F31, F36, F41, O24

Keywords: Impossible trinity; international reserves; financial liberalization; exchange rate regime.

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Abstract

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1. Introduction

A fundamental contribution of the Mundell-Fleming framework is the "impossible trinity," or the "trilemma," which states that a country may simultaneously choose any two, but not all, of the following three goals: monetary independence, exchange rate stability and financial integration. The trilemma is illustrated in Figure 1; each of the three sides – representing monetary independence, exchange rate stability, and financial integration – depicts a potentially desirable goal, yet it is not possible to be simultaneously on all three sides of the triangle. The top vertex – labeled "closed capital markets" – is associated with monetary policy autonomy and a fixed exchange rate regime, but not financial integration, the preferred choice of most developing countries in the mid to late 1980s.[1]

Over the last 20 years, most developing countries have opted for increasing financial integration. The trilemma implies that a country choosing this path must either forgo exchange rate stability if it wishes to preserve a degree of monetary independence, or forgo monetary independence if it wishes to preserve exchange rate stability.

The purpose of this paper is to outline a methodology that will allow us to easily and intuitively characterize and assess the choices countries have made with respect to the trilemma during the post Bretton-Woods period. The first part of this paper introduces the "trilemma indexes," that measures the extent of achievement in each of the three policy goals pertaining to the trilemma, namely monetary independence, exchange rate stability, and financial integration. These indexes allow us to trace the evolving configurations of the international financial architecture. Second, using these indexes, we examine whether external shocks such as institutional changes in the international financial architecture (e.g., the collapse of the Bretton Woods system) and large-scale financial crises (e.g., the Mexican debt crisis and the Asian

[1] See Obstfeld, Shambaugh, and Taylor (2005) for further discussion and references dealing with the trilemma.

financial crisis) have affected countries' preferences over the three trilemma policy goals. Lastly, we examine whether the constraints based on the trilemma are binding. That is, using a simple linear specification that links the three trilemma indexes, we test whether the linear combination of the three indexes adds up to a constant. If this is found to be true, it indicates that the notion that countries can only pursue two out of the three policy goals is correct, and that a rise in one trilemma variable should be traded-off with a drop of the weighted sum of the other two.

We begin by observing that over the last two decades, a growing number of developing countries have opted for hybrid exchange rate regimes – e.g., managed float buffered by increasing accumulation of international reserves [IR henceforth]. Despite the proliferation of greater exchange rate flexibility, IR/GDP ratios increased dramatically, especially in the wake of the East Asian crises. Practically all the increase in IR/GDP holding has taken place in emerging market countries [see Figure 2]. The magnitude of the changes during recent years is staggering: global reserves increased from about USD 1 trillion to more than USD 5 trillion between 1990 and 2006 and to more than USD 10 trillion in 2011.

The dramatic accumulation of international reserves has been uneven: while the IR/GDP ratio of industrial countries was relatively stable at approximately 6-8%, the IR/GDP ratio of developing countries increased from about 10% to about 25%. Today, about three quarters of the global international reserves are held by developing countries. Most of the accumulation has been in Asia, where reserves increased from about 10% in 1980 to about 34% in 2010 – still 33% in Asia after excluding China. The most dramatic changes occurred in China, increasing its IR/GDP ratio from about 1% in 1980, to about 48% in 2009 and 2010. In the mid-2000s, its IR holding surpassed that of other East Asian economies that had had an impressive amount of IR holding.

Empirical studies suggest several structural changes in the patterns of reserves hoarding (Cheung and Ito, 2007; Obstfeld, et al. 2008). A drastic change occurred in the 1990s in terms of reserve management among developing countries. The IR/GDP ratios shifted upwards; the ratios increased dramatically immediately after the East Asian crisis of 1997-8, but subsided by 2000. Another structural change took place in the early 2000s, mostly driven by an unprecedented increase in the accumulation of international reserves by China.

The globalization of financial markets is evident in the growing financial integration of all groups of countries. While the original framing of the trilemma was silent regarding the role of reserves, recent trends suggest that hoarding reserves may be closely related to changing patterns of the trilemma for developing countries. The earlier literature focused on the role of international reserves as a buffer stock critical to the management of an adjustable-peg or managed-floating exchange-rate regime.[2] While useful, the buffer stock model has limited capacity to account for the recent development in international reserves hoarding – the greater flexibility of the exchange rates exhibited in recent decades should help reduce reserve accumulation, in contrast to the trends reported above.

The recent literature has focused on the adverse side effects of deeper financial integration of developing countries – the increased exposure to volatile short-term inflows of capital (dubbed "hot money"), subject to frequent sudden stops and reversals (see Calvo, 1998). The empirical evidence suggests that international reserves can reduce both the probability of a sudden stop and the depth of the resulting output collapse when the sudden stop occurs.[3] Aizenman and Lee (2007) link the large increase in reserves holding to the deepening financial integration of developing countries and find evidence that international reserves hoarding serves

[2] Accordingly, optimal reserves balance the macroeconomic adjustment costs incurred in the absence of reserves with the opportunity cost of holding reserves (Frenkel and Jovanovic, 1981).
[3] See Ben-Bassat and Gottlieb (1992), Rodrik and Velasco (1999), and Aizenman and Marion (2004) for papers viewing international reserves as output and consumption stabilizers.

as a means of self-insurance against exposure to sudden stops. In extensive empirical analysis of the shifting determinants of international reserve holdings for more than 100 economies over the 1975-2004 period, Cheung and Ito (2007) find that while trade openness is the only factor that is significant in most of the specifications and samples under consideration, its explanatory power has been declining over time. In contrast, the explanatory power of financial variables has been increasing over time.

The increasing importance of financial integration as a determinant for international reserves hoarding suggests a link between the changing configurations of the trilemma and the level of international reserves. Indeed, Obstfeld, et al. (2008) find that the size of domestic financial liabilities that could potentially be converted into foreign currency (M2), financial openness, the ability to access foreign currency through debt markets, and exchange rate policy are all significant predictors of international reserve stocks.

Holding an adequate amount of IR may allow an economy to achieve a target combination of exchange rate stability, monetary policy autonomy, and financial openness. For example, a country pursuing a stable exchange rate and monetary autonomy may try to liberalize cross-border financial transactions while determined not to give up the current levels of exchange rate stability and monetary autonomy. In such a case, the monetary authorities may try to hold a sizeable amount of IR so that they can stabilize the exchange rate movement while retaining monetary autonomy. Or, if an economy with open financial markets and fixed exchange rate faces a need to independently relax monetary policy, it may be able to do so, though temporarily, as long as it holds a massive amount of IR. Thus, evidently, one cannot discuss the issue of the trilemma without incorporating a role for IR holding.

As an easy and intuitive way to summarize these trends, we illustrate “Diamond charts.” That is, we apply the methodology outlined in the next section and construct for each country a

vector of trilemma and IR configurations that measures each country's monetary independence, exchange rate stability, international reserves, and financial integration. These measures are normalized between zero and one. Each country's configuration at a given instant is summarized by a "generalized diamond," whose four vertices measure the three trilemma dimensions and IR holding (as a ratio to GDP). These diamond charts allow us to compare combinations of the four policy goals and their historical development among different country groups.

A key message of the trilemma is instrument scarcity – policy makers face a tradeoff, where increasing one trilemma variable (such as higher financial integration) would induce a drop in the weighted average of the other two variables (lower exchange rate stability, or lower monetary independence, or a combination of the two). Yet, to our knowledge, the validity of this tradeoff among the three trilemma variables has not been tested properly. A possible concern is that the trilemma framework does not impose an exact functional restriction on the association between the three trilemma policy variables.

We close the paper by applying a regression analysis to test the validity of the simplest functional specification for the trilemma: whether the three trilemma policy goals are linearly related. It is important to note that the trilemma predictions are not a mathematical tautology, and are testable. Specifically, a linear version of the Trilemma predicts that each of the trilemma coefficients is positive [such that a rise in one variable should be traded off with a drop in the weighted sum of the other two], and that the explanatory power of the equation is high enough that higher order terms are insignificant. Of independent interest is the R^2, accounting what portion of the variability is explainable, and the stability of the equation. For this purpose, we examine and validate that the weighted sum of the three trilemma policy variables adds up to a constant while the three trilemma weights are positive so that we can confirm the notion that a

rise in one trilemma variable should be traded-off with a drop of a linear weighted sum of the other two trilemma variables.

Section 2 outlines the methodology for the construction of our "trilemma indexes" that measure the extent of achievement in the three policy goals. This section also presents summary statistics of the indexes and examines whether the indexes entail any structural breaks corresponding to major global economic events. Section 3 tests the validity of a linear specification of the trilemma indexes to examine whether the notion of the trilemma can be considered to be a trade-off and binding. Section 4 concludes the paper.

2. Measures of the Trilemma Dimensions

The empirical analysis of the tradeoffs being made requires measures of the policies. Unfortunately, there is a paucity of good measures; in this paper we remedy this deficiency by creating several policy metrics.

2.1 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.[4]

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

$$MI = 1 - \frac{corr(i_i, i_j) + 1}{2}$$

[4] The data are extracted from the IMF's *International Financial Statistics* (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 (60...ZF...) and the deposit rates (60L..ZF...) series from *IFS*.

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. [5,6]

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 U.K., and the U.S. 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 the 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 of the monthly exchange 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:

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

[5] 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.

[6] We note one important caveat about this index. For some countries and some years, especially early in the sample, the interest rate used for the calculation of the MI index is often constant throughout a year, making the annual correlation of the interest rates between the home and base countries (corr(i_i, i_j) in the formula) undefined. Since we treat the undefined corr the same as zero, it makes the MI index value 0.5. One might think that the policy interest rate being constant (regardless of the base country's interest rate) is a sign of monetary independence. However, it could reflect the possibility that the home country uses other tools to implement monetary policy, rather than manipulating the interest rates (e.g., manipulation of required reserve ratios and providing window guidance; or financial repression). To complicate matters, some countries have used reserves manipulation and financial repression to gain monetary independence while others have used both while strictly following the base country's monetary policy. The bottom line is that it is impossible to fully account for these issues in the calculation of MI. Therefore, assigning an MI value of 0.5 for such a case appears to be a reasonable compromise. However, we also undertake robustness checks on the index.

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.[7] 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.[8] 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.[9] 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

[7] 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.

[8] 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).

[9] 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.

current account transactions, on capital account transactions, and the requirement of the surrender of export proceeds.[10] 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 solely policy decisions with respect to capital controls.[11]

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 dataset covers 184 countries, but data availability is uneven among the three indexes.[12] Both MI and ERS start in 1960 whereas KAOPEN in 1970. All three indexes end in 2010. The data set we examine does not include the United States, since we believe the U.S. is the "Nth country" which is not subject to the constraints of the trilemma. The Appendix presents data availability in more details.

2.2 Tracking the Indexes

Variations across Country Groupings

Comparing these indexes provides some interesting insights into how the international financial architecture has evolved over time. For this purpose, the "diamond charts" are most useful. Figure 3 summarizes the trends for industrialized countries, those excluding the "original" euro countries but including Germany, emerging market countries, and non-emerging

[10] This index is described in greater detail in Chinn and Ito (2008).
[11] *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.
[12] *MI* is available for 172 countries; *ERS* for 181; and *KAOPEN* for 182.

market developing countries.[13] Each country's configuration at a given instant is summarized by a "generalized diamond," whose four vertices measure monetary independence, exchange rate stability, IR/GDP ratio, and financial integration. The origin has been normalized so as to represent zero monetary independence, pure float, zero international reserves, and financial autarky.[14]

Panels of figures reveal that, over time, industrialized countries and emerging market countries have moved towards deeper financial integration while non-emerging market developing countries have only inched toward financial integration. While pursuing greater financial openness, industrialized countries have lost monetary independence, as have emerging market countries but to a much smaller extent. Emerging market countries, after giving up some exchange rate stability during the 1970s, have not changed their stance on the exchange rate stability at an intermediate level whereas non-emerging market developing countries seem to be remaining at, or slightly oscillating around, a relatively high level of exchange rate stability. 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 not losing as much of monetary independently as industrialized countries. The recent policy combination has been matched by a substantial increase in IR/GDP at a level that is not observed in any other groups.

Figure 4 compares developing countries across different geographical groups. Latin American (LATAM) emerging market countries and countries in Asia, both developing and emerging market ones, have moved somewhat toward exchange rate flexibility in the 1970s,

[13] The "original" euro countries include Austria, Netherlands, France, Germany, Luxemburg, Finland, Ireland, Spain, and Portugal. The emerging market countries are defined as the countries classified as either emerging or frontier during the period of 1980-1997 by the International Finance Corporation, plus Hong Kong and Singapore.
[14] The vertices of the diamond charts by no means correspond to the vertices of the trilemma triangle shown in Figure 1. While each "side" of the trilemma triangle represents the highest degree of attainment in one of the three policy choices, in the diamond charts, the vertices of the three measures correspond to the degree of attainment.

though non-emerging market LATAM countries seem to have retained high levels of exchange rate stability. LATAM countries have rapidly increased financial openness although Asian emerging market economies have retained a stable level of financial openness through the sample period. One distinctive characteristic of the group of Asian emerging market economies is that it holds much more international reserves than any other group. More importantly, Asian emerging market countries have achieved a balanced combination of the three policy goals while the other groups have not, which can easily make one suspect it is the high volume of IR holding that may have allowed this group of countries to achieve such a trilemma configuration. We will revisit this issue later on.

Patterns in a Balanced Panel

Figure 5 again presents the development of trilemma indexes for different subsamples while focusing on the time dimension of the development of the indexes, but also restricts the entire sample to include only the countries for which all three indexes are available for the entire time period. By balancing the dataset, the number of countries included in the sample declines to 60 countries, of which 41 are developing countries (22 of which are in turn emerging market countries). Each panel presents the full sample (i.e., cross-country) average of the trilemma index of concern and also its one-standard deviation band.

There is a striking differences between industrialized and developing countries. The top-left panel shows that, between the late 1970s and the late 1980s, the levels of monetary independence in industrialized and developing countries were close together. However, since the early 1990s, these two groups have been diverging from each other. While developing countries have been hovering around intermediate levels of monetary independence, industrialized countries have steadily become much less independent in terms of monetary policy, and moved

farther away from the cross-country average, reflecting the efforts made by the euro member countries.[15]

In the case of the exchange rate stability index, after the breakup of the Bretton Woods system, industrialized countries significantly reduced the extent of exchange rate stability until the early 1980s. After the 1980s, these countries gradually, but steadily increased the extent of exchange rate stability to the present – though they experienced some intermittent in the early 1990s due to the EMS crisis.[16] Developing countries, on the other hand, maintained relatively high levels of exchange rate stability until the 1980s. Although these countries seem to have adopted some exchange rate flexibility in the early 1980s, they have since maintained constant levels of exchange rate stability, though slightly trending upward since the beginning of the 1990s, through the mid-2000s, which seems to reflect the "fear of floating." In the last ten years, the exchange rate stability index of developing countries has been tracing very closely that of developed economies. In the last few years, both groups of countries decreased the level of exchange rate stability somewhat discretely, possibly reflecting the impact of the global financial crisis of 2008-09.

Not surprisingly, industrialized countries have achieved higher levels of financial openness throughout the period. The acceleration of financial openness in the mid-1990s remained significantly high when compared to the cross-country average of both the full sample and LDC subsample. On the other hand, developing countries also accelerated financial openness in the early 1990s after some retrenchment during the 1980s. Overall, LDC countries have been

[15] When the euro countries are removed from the IDC sample, the extent of the divergence from the average becomes less marked although there is still a tendency among the non-euro countries to move toward lower levels of monetary independence.

[16] The ERS index for the non-euro industrialized countries, persistently hovers around the value of .40 throughout the time period after rapidly dropping in the early 1970s.

in parallel with the global trend of financial liberalization throughout the sample period, but the difference from the industrialized countries has been moderately rising in the last decade.

Broadly speaking, the difference between emerging market countries and non-emerging market developing countries is smaller than that between IDC and LDC subsamples (shown in the bottom row of Figure 5), but comparison between the two groups still yields interesting insights. After the beginning of the 1990s, EMG and non-EMG countries seem to have started behaving differently in terms of how much monetary independence to retain. While EMG countries retained higher levels of monetary independence than non-EMG countries for most of the 1990s, EMG countries tended to have less monetary independence since the late 1990s, though they are more independent than non-EMG countries for the last few years of the sample. As for exchange rate stability, EMG countries are persistently more flexible than non-emerging ones since 1980 and the difference is wider since the early 1990s. EMG countries have also become more financially open compared to non-EMG countries since the mid-1990s. The faster trend of financial liberalization among EMG countries is, however, not matched with a discrete decrease in either monetary independence or exchange rate stability, suggesting that policy alterations are not taking place in a discrete fashion as was the case with industrialized countries in the last 15 years.

Figure 6 shows the development paths of these indexes altogether, making the differences between IDCs and LDCs and those between EMGs and non-EMGs appear more clearly.[17] For the industrialized countries, financial openness accelerated after the beginning of the 1990s and exchange rate stability rose after the end of the 1990s. The extent of monetary independence has experienced a declining trend, especially after the early 1990s, all reflecting the introduction of the euro in 1999.

[17] We continue to use the balanced dataset.

Again, developing countries differ not only from industrialized ones, but also between emerging and non-emerging market developing ones. For emerging market countries, up to the mid-1980s, exchange rate stability was the most pervasive policy among the three, though it has been on a declining trend since the early 1970s, followed by monetary independence that has been relatively constant during the period. Between the mid-1980s and 2000, monetary independence and exchange rate stability became the most pursued policies while the level of financial openness kept rising rapidly in the 1990s. Most interestingly, toward the end of the 1990s, all three indexes converged to the middle ground with the rapid raise in financial openness, which we have already observed as the balanced achievement of the three policy goals in Figure 4. This result 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. This trend is essentially leaning against the trilemma in other words, possibly putting much stress on the open macro policies adopted by this group of countries. Above all, this trend of convergence to the middle ground may explain why some of these economies hold sizable international reserves, potentially to buffer the stress arising from the trilemma. 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).

None of these observations are applicable to non-emerging developing market countries. For this group of countries, exchange rate stability has been the most pervasive policy throughout the period, though there is some variation, followed by monetary independence. There is no discernible trend in financial openness for this subsample.

2.3. Identifying Structural Breaks

To shed more light on the evolution of the index values, we investigate whether major international economic events have been associated with structural breaks in the index series. We conjecture that major events – such as the breakdown of the Bretton Woods system in 1973, the Mexican debt crisis of 1982 (indicating the beginning of 1980's debt crises of developing countries), and the Asian Crisis of 1997-98 (the onset of sudden stop crises affecting high-performing Asian economies (HPAEs), Russia and other emerging countries) – may have affected economies in such significant ways that they opted to alter their policy choices.

We identify the years of 1973, 1982, and 1997-98 as candidate structural breaks, and test the equality of the group mean of the indexes over the candidate break points for each of the subsample groups and periods.[18] The results are reported in Table 1 (a). The first and second columns of the top panel indicate that after the breakdown of the Bretton Woods system, the mean of the exchange rate stability index for the industrialized country group fell, statistically significantly, from 0.71 to 0.43, while the mean of financial openness slightly, but statistically significantly, increase from 0.43 to 0.47. Non-emerging market developing countries, on the other hand, did *increase* the level of fixity of their exchange rates over the same time period while they became less monetarily independent and more financially open. Although emerging market economies reduced the level of monetary independence, they did also move toward more flexible exchange rates while not changing the extent of financial openness.

Even after the Mexican debt crisis, industrialized countries slightly, but significantly increased the level of exchange rate stability and significantly increased the level of financial openness, while holding constant the level of monetary independence. In contrast, the debt crisis led *all* developing countries to pursue further exchange rate flexibility, most likely reflecting the

[18] The data for the candidate structural break years are not included in the group means either for pre- or post-structural break years. For the Asian crisis, we assume the years of 1997 and 1998 are the break years and therefore remove observations for these two years.

fact that crisis countries could not sustain fixed exchange rate arrangements. However, these countries also simultaneously pursued slightly more monetary independence. Interestingly, non-emerging developing market countries tightened capital controls as a result of the debt crisis while emerging market countries did not follow suit.

The trilemma indexes seems to have changed their nature around the time of the Asian crisis in 1997-98. The level of industrialized countries' monetary independence dropped significantly while their exchange rates became much more stable and their efforts of capital account liberalization continued, all reflecting the European countries' movement toward economic and monetary union. Non-emerging market developing countries on the other hand increased the level of all three indexes. Emerging market countries also started liberalizing financial markets, though much more significantly, though they lost monetary independence and slightly gained exchange rate stability.

Several other major events can also be candidates for inducing structural breaks identified. For example, anecdotal accounts date globalization at the beginning of the 1990s, when many developing countries began to liberalize financial markets. Also, China's entry to the World Trade Organization in 2001 was, in retrospect, the beginning of the country's rise as *the* world's manufacturer. Because the effect of these events may have often been conflated with that of the Asian crisis we also test whether the years of 1990 and 2001 can be structural breaks by conducting the same mean-equality tests (results not reported).

Armed with the mean equality test results for different candidate structural breaks, we can now compare the t-statistics across the different structural breaks for each of the indexes and subsamples. Given that the balanced dataset is used in this exercise, the largest t-statistics should indicate the most significant structural break for each of the index series for each subsample.

Table 1 (b) reports the most significant structural break for each of the subsamples and the indexes. For the group of industrialized countries, industrial countries' monetary independence and exchange rate stability series have the largest t-statistics when the structural break of 1997-98 is tested. For financial openness, however, the year of 1990 is identified with the most significant structural break.[19] For the group of non-emerging market developing countries, the structural break of 1990 is the most significant for financial openness while it is the years of 2001 and 1973 for exchange rate stability and monetary independence, respectively. For emerging market countries, however, the most significant structural break is found to have occurred in 2001 for monetary independence, in 1982 for exchange rate stability, and in 1997-98 for financial openness.

3 Theoretical Validity of the Trilemma Indexes

3.1 Linearity among the Trilemma Indexes

While the preceding analyses are quite informative on the evolution of international macroeconomic policy orientation, we have not shown whether these three macroeconomic policy goals are "binding" in the context of the impossible trinity. That is, it is important for us to confirm that countries have faced the trade-offs based on the trilemma. A challenge facing a full test of the trilemma tradeoff is that the trilemma framework does not impose any obvious functional form on the nature of the tradeoffs between the three trilemma variables. To illustrate this concern, we note that the instrument scarcity associated with the trilemma implies that

[19] The finding that both monetary independence and exchange rate stability entail structural breaks around the Asian crisis can be driven merely by the countries that adopted the euro in 1999. We repeat the same exercise using the industrial countries sample without the euro countries, and find that the structural breaks for monetary independence and financial opens remain the same as in the full IDC sample (1997-98 and 1990, respectively), but that the exchange rate stability series is found to have a structural break in 1973, the year when the Bretton Woods system collapsed.

increasing one trilemma variable, say higher financial integration, should induce lower exchange rate stability, or lower monetary independence, or a combination of these two policy adjustments.

Theory does not provide any specific functional form to express the relationships between the three policy goals. However, using the trilemma triangle of Figure 1 and the trilemma indexes we have used, we can conceptualize the linear hypothesis of the trilemma by placing a simplex on a plane in a third-dimensional domain constructed by the three indexes (as the axes). A combination of the three policy goals may be expressed as a point within or on (one of the three vertexes or sides of) the simplex whose coordinates are determined by the three indexes.

That means a trilemma linear version implies that the weighted sum of the three trilemma policy variables adds up to a constant. In which case, a rise in one of the three trilemma variables leads to a drop in the weighted sum of the other two – corresponding to a move from one point to another within or on the generalized triangle. Hence, we can test the validity of the trilemma hypothesis using a simple linear functional form such as equation (1):

$$1 = a_j MI_{i,t} + b_j ERS_{i,t} + c_j KAOPEN_{i,t} + \varepsilon_t \qquad (1)$$

where j can be either IDC, ERM, or LDC.

Because we have shown that different subsample groups of countries have experienced different development paths, we allow the coefficients on all the variables to vary across different groups of countries – industrialized countries, the countries that have been in the European Exchange Rate Mechanism (ERM), and developing countries – allowing for interactions between the explanatory variables and the dummies for these subsamples.[20] The regression is run for the full sample period as well as the subsample periods identified in the preceding subsection.

[20] The dummy for ERM countries is assigned for the countries and years that corresponds to participation in the ERM (i.e., Belgium, Germany, France, Ireland, Italy, and Luxembourg from 1979 on; Spain from 1989; U.K. only

The rationale behind this exercise is that policy makers of an economy must choose a weighted average of the three policies in order to achieve a best combination of the two. Hence, if we can find the goodness of fit for the above regression model is high, it would suggest a linear specification is rich enough to explain the trade-off among the three policy dimensions. In other words, the lower the goodness of fit, the weaker the support for the existence of the trade-off, suggesting either that the theory of the trilemma is wrong, or that the relationship is non-linear.

Secondly, the estimated coefficients in the above regression model should give us some approximate estimates of the weights countries put on the three policy goals. However, the estimated coefficients alone will not provide sufficient information about "how much of" the policy choice countries have actually implemented. Hence, looking into the predictions using the estimated coefficients and the actual values for the variables (such as $\hat{a}MI$, $\hat{b}ERS$, and $\hat{c}KAOPEN$) will be more informative.

Thirdly, by comparing the predicted values based on the above regression, i.e., $\hat{a}MI + \hat{b}ERS + \hat{c}KAOPEN$ **,** over a time horizon, we can get some inferences about how "binding" the trilemma is. If the trilemma is found to be linear, the predicted values should hover around the value of 1, and the prediction errors should indicate how much of the three policy choices have been "not fully used" or to what extent the trilemma is "not binding."[21]

Table 2 presents the regression results. The results from the regression with the full sample data are reported in the first column, and the others for different subsample periods are in

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for 1990-91; Portugal from 1992; Austria from 1995; Finland from 1996; and Denmark and Greece from 1999) or ERM II (Estonia, Lithuania, and Slovenia from 2004; and Cyprus, Latvia, Malta, and Slovak Rep. from 2005).

[21] If the trilemma is not binding, i.e., the predicted value based on equation (1) is below the value of one, such a policy combination can be shown as a point within the space between the origin and the triangle plain. A policy combination that yields the prediction above the value of 1 would be located somewhere "outside" the triangle (from the origin), so that it would be an "infeasible" policy combination.

the following columns.[22] First of all, the adjusted R-squared for the full sample model as well as for the subsample periods is found to be above 95%, which indicates that the three policy goals are linearly related to each other and add up to a constant. Hence, we have evidence that countries face the trade-off among the three policy options. Across different time periods, the estimated coefficients vary, suggesting that countries alter over time the weights on the three policy goals.

Figure 7 illustrates the goodness of fit from a different angle. In the top panels, the solid lines show the means of the predicted values (i.e., $\hat{a}MI + \hat{b}ERS + \hat{c}KAOPEN$) based on the full sample model in the first column of Table 2 for the groups of industrial countries (left) and developing countries (right).[23] To incorporate the time variation of the predictions, the subsample mean of the prediction values as well as their 95% confidence intervals (that are shown as the shaded areas) are calculated using five-year rolling windows. [24] The panels also display the rolling means of the predictions using the coefficients and actual values of only two of the three trilemma terms – $\hat{a}MI + \hat{b}ERS$ (gray solid line), $\hat{a}MI + \hat{c}KAOPEN$ (black dashed line), $\hat{b}ERS + \hat{c}KAOPEN$ (gray dashed line). The regression results allow a simple description of the changing ranking of policy combinations (of the two out of the three trilemma policy goals) overtime.

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[22] The fact that all three indexes involve structural breaks, as was shown in the previous section, it is possible for the estimated coefficients from the full sample estimation to entail coefficient instability.

[23] For this exercise, predictions also incorporate the interactions with the dummy variables shown in Table 2.

[24] Both the mean and the standard errors of the predicted values are calculated using the rolling five-year windows. The formula for the mean and the standard errors can be shown as $\bar{x}_{t|t-4} = \sum_{t}^{t-4}\sum_{i=1}^{n}\hat{x}_{i_t} \Big/ n\times 5$ and $SE(\hat{x}) = \sqrt{\sum_{t}^{t-4}\sum_{i=1}^{n}\left(\hat{x}_{i_t} - \bar{x}_{t|t-4}\right)^2 \Big/ n\times 5 - 1} \Big/ \sqrt{n\times 5}$, respectively, where *n* refers to the number of countries in a subsample (i.e., IDC and LDC), $\hat{x}_{it}$ to the prediction values, and $\bar{x}_{t|t-4}$ to the mean of $\hat{x}_{it}$ in the rolling five-year window. Because of the use of rolling five-year windows, the lines in the figures only start in 1974.

From these panels of figures, we can first see that the predicted values based on the model hover around the value of one closely for both subsamples. For the group of industrial countries, the prediction average is statistically below the value of one in the late 1970s through the beginning of the 1990s. However, since then, one cannot reject the null hypothesis that the mean of the prediction values is one, indicating that the trilemma is "binding" for industrialized countries. For developing countries, the model is under-predicting from the end of the 1970s through the late 1990s. However, unlike the IDC group, the mean of the predictions becomes statistically smaller than one in the early 2000s and goes back to around the value of one in the last few years of the sample period. More importantly, for both subsamples, the mean of the predictions never rises above the value of one in statistical sense, implying not only that the three macroeconomic policies are linearly related with each other, but also that countries have never implemented an infeasible combination of policies.

3.2 Development of Policy Preferences

The top panels also show that, among industrialized countries, the policy combination of increasing exchange rate stability and more financial openness rapidly became prevalent after the beginning of the 2000s. Among developing countries, the policy combinations of monetary independence and exchange rate stability has been quite dominant throughout the sample period while the policy combination of exchange rate stability and financial openness has been the least prevalent over, most probably reflecting the bitter experiences of currency crises.

In the lower panels, we can observe the contributions of each policy orientation (i.e., $\hat{a}MI$, $\hat{b}ERS$, and $\hat{c}KAOPEN$) for the IDC and LDC groups.[25] While less developed countries maintained high, though fluctuating, levels of monetary independence, both exchange rate

[25] They are again the means based on five-year rolling windows.

stability and financial integration remained at much lower levels throughout the period with the latter slightly increasing. In the last decade or so, while monetary independence is on a declining trend, the gap between the predictions based on exchange rate stability and financial openness has been shrinking somewhat. For the EMG group (not reported), exchange rate stability has been in a moderately declining trend since the 1980s while financial openness has been in a moderately rising trend since the 1990s. This may indicate that more countries tend to try to achieve certain levels of exchange rate stability and financial openness together while maintaining high levels of monetary independence. This kind of effort can be done only when the countries accumulate high levels of international reserves that allow them to intervene in foreign exchange markets, consistent with the fact that many developing countries increased international reserves in the aftermath of the Asian crisis of 1997-98. However, as the concept of the trilemma predicts, this sort of environment must involve a rise in the costs of sterilized intervention especially when the actual volume of cross-border transactions of financial assets increase and when there is no reversal in the three policies.[26]

The experience of the industrialized countries casts a stark contrast. Although monetary independence was also IDC's top priority until the early 1990s, it yielded to financial integration in the late 1990s and to exchange rate stability in the early 2000s, continuing to fall to become the lowest priority in the 2000s. Such changes in the relative weights of the three policy goals do not require the countries to accumulate international reserves as was the case with developing countries.[27]

[26] Refer to Aizenman and Glick (2008) and Glick and Hutchison (2009) for more analysis on the limit of sterilized interventions. Aizenman, et al. (2010) show that if a country pursues greater exchange rate stability while holding a massive volume of international reserves, it would experience higher levels of inflation, indicating the limit in the efforts of fully sterilizing foreign exchange intervention to maintain exchange rate stability.

[27] We also repeat the exercise using the regression models (whose results shown in Table 2) for each of the subsample period (excluding the break years). The results (not reported) are qualitatively the same as in Figure 7.

3.3 Robustness Checks

3.3.1 Different Estimation Specifications

One may question the uniqueness of this regression exercise since our estimation model has an identity scalar as the dependent variable. As a robustness check, we ran a regression of $MI_{i,t}$ on $ERS_{i,t}$ and $KAOPEN_{i,t}$. Using the estimated coefficients for *ERS* and *KAOPEN*, we recover the estimates for a_j, b_j, and c_j in equation (1), and recreate panels of figures comparable to those in Figure 7. These alternative figures appear to be very much comparable to Figure 7 (not reported) and therefore confirm our conclusions about the linearity of the trilemma indexes as well as the development of the subsample mean of prediction values based on equation (1).

Showing the linearity of the three trilemma indexes using a pooled panel estimation method as we did previously may be misleading. That is, a rise in one index for one country can involve a fall in the weighted sum of the other two for *another* country, which can still be captured as a linear relationship among the three indexes in a panel context. Hence, we test the linearity of the three indexes for each of our sample countries (with balanced data). The results confirm our prior findings. Among the countries tested, the smallest adjusted R-squared is 89%, followed by the second smallest adjusted R-squared of 92%. The mean adjusted R-squared is 97%, and more than 90% of the sample countries have the adjusted R-squared over 95%. These findings reconfirm that the three indexes are linearly related with each other.

Although all three indexes range between zero and one, it is possible that these indexes are not stationary, in which case estimation results could be spurious. However, even if the indexes are non-stationary, if one could show that they are cointegrated, the linearity of the indexes still holds. Although our primary purpose is not to show any specific long-run equilibrium relationship among the three indexes, we conduct cointegration tests for each of the sample countries to show the linearity of the three indexes. More specifically, following

Johansen's (1991) method, we find the rank of the cointegration relationship among *MI*, *ERS*, and *KAOPEN* by conducting multiple trace tests.[28] In this analysis, the rank refers to the number of cointegration equations when the three indexes are shown in a vector error correction (VECM) specification. Given that we have three variables to test the cointegration of, the rank of three would mean that all three indexes for that particular country are stationary. The rank of either one or two would mean the indexes are linearly related while the rank of zero means there is no linear relationship among the three indexes.

When we apply this cointegration test to each of the sample countries in the balanced dataset, 13 out of 60 countries (or 22%) are found to have the rank of three, meaning that all the indexes are stationary for these countries, for which the previous simple linear analysis is sufficient. 29 countries, or 48%, of the sample are found to have either one linear relationship (23 countries) or two linear relationships (6 countries).[29] For eighteen countries, or 30% of the sample, the three indexes are not cointegrated. If we use information criteria to determine the number of cointegration equations, the proportion of no cointegration drops. When the Schwarz Bayesian information criterion is used, 45 countries out of 60 yield one or two cointegration ranks (i.e., 25% of the sample countries have no cointegration), whereas the Hannan and Quinn information criterion yields 8 countries (13%) having no cointegration relationship.

At the very least, we can safely conclude that the trilemma indexes are linearly related as theory predicts.

[28] Since our primary focus is not an intensive time series analysis, we systematically implement this analysis for each of our sample countries while assuming the lag length to be 2.

[29] Given the nature of the indexes, it is possible that one or some of the three indexes do not change values at all for some time period, which creates the issue of (perfect) multicollearity among the indexes and which therefore makes it impossible for the cointegration test to be executed using all the three indexes. In such a case, we would remove the variable that is apparently causing the multicollearity and apply the cointegration test to the remaining two variables. Or, we would apply the cointegration test (while using all three indexes) only to the period when there appears to be no multicollearity if multicollearity is an issue in a short period.

3.3.2 Revisit of the Role of International Reserves Holding

As we have already discussed, international reserves holding has been increasing its importance in the financially globalized world. Given the rapid increase in the IR holding especially among developing economies, it may be necessary to think about the relationship among the three trilemma policy goals in the terms of not just the trilemma, but the quadrilemma (See Aizenman, 2011 and Aizenman and Ito, 2012).[30]

That said, Table 3 reports the estimation results when a variable for IR holding (as a share of GDP), along with its interactions with the LDC and ERM dummies, is included in the estimation based on equation (1). Several findings must be noted. First, including the variable for IR holding barely improves the goodness of fit of the estimations. The adjusted R-squared for the full sample goes up only by one percentage point (from 95% to 96%). The same observation is also applicable to other estimations for the subsample periods. Second, the coefficient on the IR holding variable is significant for the subsample periods that start in 1983 or later, suggesting that the role of IR holding is important in the context of the trilemma, but after the 1980s. Third, the role of IR holding in the trilemma seems to be more limited among developing countries – when the LDC subgroup has a significantly different coefficient on IR holding than industrialized countries, the magnitude of the coefficient is usually smaller than that of industrialized countries.

[30] Aizenman, et al. (2010) empirically show that pursuing greater exchange stability can be increasing output volatility for developing economies, but that that can be mitigated by holding a greater amount of international reserves than the threshold of about 20% of GDP. Aizenman, et al. (2011) find that Asian emerging market economies seem to have adopted a policy combination of the three trilemma policies and international reserves that allow these economies to lessen output volatility through reduced real exchange volatility. Aizenman and Ito (2012) show that in the last two decades, emerging market economies with relatively low levels of IR holdings have experienced higher levels of output volatility when they chose a policy combination with a greater degree of policy divergence while this output volatility effect did not apply to economies with relatively high international reserves holdings, suggesting that high levels of IR holding may allow countries to choose a policy combination from a wider range of spectrum of policy combinations.

These findings indicate that the linearity does exist primarily for the original three policy variables under the trilemma, i.e., monetary independence, exchange rate stability, and financial openness. Despite the increasing importance of IR holding, the role of IR holding in the linear relationship among the trilemma policy goals is limited. It may be possible that the role of IR holding in the context of the trilemma is increasing in the last two decades of financial globalization, but scrutinizing the changing role of IR holding is outside the scope of this paper.

4. Concluding Remarks

In this paper, we have described a methodology to trace the changing patterns in the configurations of the trilemma that have taken shape. Our methodology reveals the striking differences in the choices that industrialized and developing countries have made over the 1970-2010 period. The recent trend suggests that among emerging market countries, the three dimensions of the trilemma configurations: monetary independence, exchange rate stability, and financial openness, are converging towards a "middle ground" with managed exchange rate flexibility, which they attempted to buffer by holding sizable international reserves, while maintaining medium levels of monetary independence and financial integration. Industrialized countries, on the other hand, have been experiencing divergence of the three dimensions of the trilemma and moved toward the configuration of high exchange rate stability and financial openness and low monetary independence as most distinctively exemplified by the euro countries' experience.

The system has evolved over time, it would be a mistake to think of the process as being smooth and continuous. Rather, there have been a number of discrete, structural breaks associated with significant events: the collapse of the Bretton Woods system, the debt crisis of

1982, and the Asian crisis of 1997-98. For both industrialized and developing countries, the major events in the last decade, such as the emergence of rapid globalization and the rise of China, have also impacted the policy arrangements significantly. With these results, we can safely expect that the present turbulence in the global financial markets could challenge the stability of the current trilemma configuration.

We also tested whether the three macroeconomic policy goals are "binding" in the context of the impossible trinity. That is, we attempted to provide evidence that countries have faced the trade-offs based on the trilemma. Because there is no specific functional form of the trade-offs or the linkage of these three policy goals, we tested a simplest linear specification for the three trilemma indexes and examined whether the weighted sum of the three trilemma policy variables adds up to a constant. Our results confirmed that countries do face the binding trilemma. That is, a change in one of the trilemma variables would induce a change with the opposite sign in the weighted average of the other two. In that sense, we have provided substantial content to the hypothesis of the "impossible trinity."

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Appendix: Data Availability of the Trilemma measures

	Country Code	Country Name	Base Country	Monetary Independence (MI)	Exchange rate stability (ERS)	KA Openness (KAOPEN)
1	512	Afghanistan	U.S.	–	1961-2010	1970-2010
2	914	Albania	U.S.	1992-2010	1992-2010	1995-2010
3	612	Algeria	France	1974-2010	1961-2010	1970-2010
4	614	Angola	U.S.	1995-2010	1961-2010	1993-2010
5	311	Antigua and Barbuda	U.S.	1981-2010	1961-2010	1985-2009
6	213	Argentina (E)	U.S.	1977-2010	1961-2010	1970-2010
7	911	Armenia	U.S.	1995-2010	1992-2010	1996-2010
8	314	Aruba	U.S.	1986-2010	1986-2010	1992-2010
9	193	Australia	U.S.	1969-2010	1961-2010	1970-2010
10	122	Austria	Germany	1960-2010	1961-2010	1970-2010
11	912	Azerbaijan	U.S.	1993-2010	1995-2010	1996-2010
12	313	Bahamas, The	U.S.	1970-2010	1961-2010	1977-2010
13	419	Bahrain	U.S.	1975-2010	1966-2010	1976-2010
14	513	Bangladesh (E)	U.S.	1972-2010	1972-2010	1976-2010
15	316	Barbados	1960-74 U.K.; 1975-U.S.	1967-2010	1961-2010	1974-2010
16	913	Belarus	U.S.	1993-2010	1992-2010	1996-2010
17	124	Belgium	Germany	1960-2010	1961-2010	1970-2010
18	339	Belize	U.S.	1979-2010	1961-2010	1985-2010
19	638	Benin	France	1964-2010	1961-2010	1979-2010
20	514	Bhutan	India	1982-2007	1961-2010	1985-2010
21	218	Bolivia	U.S.	1960-2010	1961-2010	1970-2010
22	616	Botswana (E)	S. Africa	1976-2010	1961-2010	1972-2010
23	223	Brazil (E)	U.S.	1964-2010	1964-2010	1970-2010
24	516	Brunei	U.S.	2003-2010	1961-2010	-
25	918	Bulgaria (E)	Germany	1991-2010	1961-2010	1994-2010
26	748	Burkina Faso	France	1964-2010	1961-2010	1988-2010
27	618	Burundi	1960-70 Belgium; 1971-U.S.	1977-2010	1961-2010	1970-2010
28	662	Côte d'Ivoire (E)	France	1964-2010	1961-2010	1970-2010
29	522	Cambodia	U.S.	1994-2010	1961-2010	1973-2010
30	622	Cameroon	France	1968-2010	1961-2010	1970-2010
31	156	Canada	U.S.	1960-2010	1961-2010	1970-2010
32	624	Cape Verde	Germany	1985-2010	1961-2010	1982-2010
33	626	Central African Rep.	France	1968-2010	1961-2010	1970-2010
34	628	Chad	France	1968-2010	1961-2010	1970-2010
35	228	Chile (E)	U.S.	1977-2010	1961-2010	1970-2010
36	924	China (E)	U.S.	1980-2010	1961-2010	1984-2010
37	233	Colombia (E)	U.S.	1964-2010	1961-2010	1970-2010
38	632	Comoros	France	1983-2010	1961-2010	1981-2010
39	636	Congo, Dem. Rep.	U.S.	1982-2010	1961-2010	1970-2000
40	634	Congo, Rep.	France	1968-2010	1961-2010	1970-2010
41	238	Costa Rica	U.S.	1964-2010	1961-2010	1970-2010
42	960	Croatia	Germany	1992-2010	1992-2010	1996-2010
43	423	Cyprus	Germany	1969-2010	1961-2010	1970-2010
44	935	Czech Republic (E)	Germany	1993-2010	1993-2010	1996-2010
45	128	Denmark	Germany	1960-2010	1961-2010	1970-2010
46	611	Djibouti	U.S.	1996-2009	1961-2010	1982-2010
47	321	Dominica	U.S.	1981-2010	1961-2010	1982-2010
48	243	Dominican Republic	U.S.	1995-2010	1961-2010	1970-2010
49	248	Ecuador (E)	U.S.	1970-2008	1961-2005	1970-2010
50	469	Egypt, Arab Rep. (E)	U.S.	1964-2010	1961-2010	1970-2010
51	253	El Salvador	U.S.	1983-2005	1961-2010	1970-2010
52	642	Equatorial Guinea	France	1985-2010	1961-2010	1973-2010
53	643	Eritrea	U.S.	-	1961-2010	1998-2010
54	939	Estonia	Germany	1993-2010	1992-2010	1996-2010
55	644	Ethiopia	U.S.	1985-2008	1961-2010	1970-2010
56	819	Fiji	U.S.	1974-2010	1961-2010	1975-2010
57	172	Finland	Germany	1960-2010	1961-2010	1970-2010
58	132	France	Germany	1964-2010	1961-2010	1970-2010
59	646	Gabon	France	1968-2010	1961-2010	1970-2010
60	648	Gambia, The	U.K.	1977-2010	1961-2010	1971-2010
61	915	Georgia	U.S.	1995-2010	1995-2010	1996-2010
62	134	Germany	U.S.	1960-2010	1961-2010	1970-2010
63	652	Ghana (E)	U.S.	1964-2009	1961-2010	1970-2010
64	174	Greece	1960-80 U.S.; 1981-Germany	1960-2010	1961-2010	1970-2010
65	328	Grenada	U.S.	1981-2010	1961-2010	1979-2010
66	258	Guatemala	U.S.	1960-2010	1961-2010	1970-2010
67	656	Guinea	1960-73 France; 1974-U.S.	1986-2006	1961-2009	1970-2010
68	654	Guinea-Bissau	U.S.	1975-2010	1961-2010	1981-2010
69	336	Guyana	1960-75 U.K.; 1976-U.S.	1966-2010	1961-2010	1970-2010
70	263	Haiti	U.S.	1994-2010	1961-2010	1970-2010
71	268	Honduras	U.S.	1979-2010	1961-2010	1970-2010
72	532	Hong Kong, China (E)	U.S.	1982-2010	1961-2010	1970-2010
73	944	Hungary (E)	1960-91 U.S.; 1992-Germany	1971-2010	1968-2010	1986-2010
74	176	Iceland	1960-90 U.S.; 1991-Germany	1964-2010	1961-2010	1970-2010

	Country Code	Country Name	Base Country	Monetary Independence (MI)	Exchange rate stability (ERS)	KA Openness (KAOPEN)
75	534	India (E)	1960-79 U.K.; 1980-U.S.	1960-2010	1961-2010	1970-2010
76	536	Indonesia (E)	U.S.	1983-2010	1967-2010	1970-2010
77	429	Iran, Islamic Rep.	U.S.	1960-2009	1961-2010	1970-2010
78	433	Iraq	U.S.	-	1961-2010	1970-2010
79	178	Ireland	1960-78 U.K.; 1979-Germany	1960-2010	1961-2010	1970-2010
80	436	Israel (E)	U.S.	1982-2010	1961-2010	1970-2010
81	136	Italy	Germany	1964-2010	1961-2010	1970-2010
82	343	Jamaica (E)	U.S.	1961-2010	1961-2010	1970-2010
83	158	Japan	U.S.	1960-2010	1961-2010	1970-2010
84	439	Jordan (E)	U.S.	1966-2010	1961-2010	1970-2010
85	916	Kazakhstan	U.S.	1994-2010	1994-2010	1996-2010
86	664	Kenya (E)	U.S.	1967-2010	1961-2010	1970-2010
87	826	Kiribati	Australia	-	1961-2010	1990-2005
88	542	Korea, Rep. (E)	U.S.	1964-2010	1961-2010	1970-2010
89	443	Kuwait	U.S.	1975-2010	1961-2010	1970-2010
90	917	Kyrgyz Republic	U.S.	1993-2010	1993-2010	1997-2010
91	544	Lao PDR	U.S.	1979-2008	1961-2010	1970-2010
92	941	Latvia	Germany	1993-2010	1992-2010	1996-2010
93	446	Lebanon	U.S.	1964-2010	1961-2010	1970-2010
94	666	Lesotho	S. Africa	1980-2010	1961-2010	1972-2010
95	668	Liberia	U.S.	1981-2010	1961-2010	1970-2010
96	672	Libya	U.S.	1963-2010	1961-2010	1970-2010
97	946	Lithuania (E)	Germany	1994-2010	1992-2010	1996-2010
98	137	Luxembourg	1960-78 Belgium; 1979- Germany	1985-2010	1961-2010	-
99	674	Madagascar	France	1970-2010	1961-2010	1970-2010
100	676	Malawi	U.S.	1963-2010	1961-2010	1970-2010
101	548	Malaysia (E)	U.S.	1966-2010	1961-2010	1970-2010
102	556	Maldives	U.S.	1978-2010	1961-2010	1982-2010
103	678	Mali	France	1964-2010	1961-2010	1970-2010
104	181	Malta	France	1969-2010	1961-2010	1972-2010
105	682	Mauritania	1960-73 France; 1974-U.S.	1964-2008	1961-2010	1970-2010
106	684	Mauritius (E)	U.K.	1967-2010	1961-2010	1972-2010
107	273	Mexico (E)	U.S.	1976-2010	1961-2010	1970-2010
108	868	Micronesia, Fed. Sts.	U.S.	1996-2010	1961-2010	1996-2010
109	921	Moldova	U.S.	1995-2010	1992-2010	1996-2010
110	948	Mongolia	U.S.	1993-2010	1990-2010	1995-2010
111	686	Morocco (E)	France	1969-2010	1961-2010	1970-2010
112	688	Mozambique	U.S.	1994-2010	1961-2010	1988-2010
113	518	Myanmar	U.S.	1975-2010	1961-2010	1970-2010
114	728	Namibia	S. Africa	1991-2010	1961-2010	1994-2010
115	558	Nepal	1960-82 U.S.; 1983-India	1974-2009	1961-2010	1970-2010
116	138	Netherlands	Germany	1960-2010	1961-2010	1970-2010
117	353	Netherlands Antilles	U.S.	1980-2010	1961-2010	1970-2009
118	196	New Zealand	Australia	1969-2010	1961-2010	1970-2010
119	278	Nicaragua	U.S.	1990-2010	1961-2010	1970-2010
120	692	Niger	France	1964-2010	1961-2010	1970-2010
121	694	Nigeria (E)	U.S.	1964-2010	1961-2010	1970-2010
122	142	Norway	Germany	1964-2010	1961-2010	1970-2010
123	449	Oman	U.S.	1980-2010	1961-2010	1977-2010
124	564	Pakistan (E)	U.S.	1964-2010	1961-2010	1970-2010
125	283	Panama	U.S.	1986-2010	1961-2010	1970-2010
126	853	Papua New Guinea	1960-85 Australia; 1986-U.S.	1974-2010	1961-2010	1979-2010
127	288	Paraguay	U.S.	1990-2010	1961-2010	1970-2010
128	293	Peru (E)	U.S.	1960-2010	1961-2010	1970-2010
129	566	Philippines (E)	U.S.	1964-2010	1961-2010	1970-2010
130	964	Poland(E)	Germany	1991-2010	1961-2010	1986-2010
131	182	Portugal	Germany	1960-2010	1961-2010	1970-2010
132	453	Qatar	U.S.	1980-2010	1966-2010	1976-2010
133	968	Romania	U.S.	1994-2010	1961-2010	1976-2010
134	922	Russia (E)	U.S.	1995-2010	1992-2010	1996-2010
135	714	Rwanda	1960-73 Belgium; 1974-U.S.	1966-2008	1961-2010	1970-2010
136	716	Sao Tome and Principe	U.S.	1988-2010	1961-2010	1981-2010
137	862	Samoa	Australia	1983-2010	1961-2010	1975-2010
138	135	San Marino	Germany	-	1961-2010	1996-2010
139	456	Saudi Arabia	U.S.	1997-2010	1961-2010	1970-2010
140	722	Senegal	France	1964-2010	1961-2010	1970-2010
141	718	Seychelles	U.S.	1979-2010	1961-2010	1981-2010
142	724	Sierra Leone	1960-77 U.K.; 1978-U.S.	1966-2008	1961-2010	1970-2010
143	576	Singapore (E)	Malaysia	1972-2010	1961-2010	1970-2010
144	936	Slovak Rep. (E)	Germany	1993-2010	1993-2010	1996-2010
145	961	Slovenia (E)	Germany	1993-2010	1992-2010	1996-2010
146	813	Solomon Islands	1960-85 Australia; 1986-U.S.	1981-2010	1961-2010	1982-2010
147	726	Somalia	U.S.	-	1961-1990	1970-2010
148	199	South Africa (E)	U.S.	1960-2010	1961-2010	1970-2010
149	184	Spain	Germany	1964-2010	1961-2010	1970-2010
150	524	Sri Lanka (E)	1960-92 U.S.; 1993-India	1964-2010	1961-2010	1970-2010

	Country Code	Country Name	Base Country	Monetary Independence (MI)	Exchange rate stability (ERS)	KA Openness (KAOPEN)
151	361	St. Kitts and Nevis	U.S.	1981-2010	1961-2010	1988-2010
152	362	St. Lucia	U.S.	1981-2010	1961-2010	1983-2010
153	364	St. Vincent & the Grenad.	U.S.	1981-2010	1961-2010	1983-2010
154	732	Sudan	1960-71 U.K.; 1972-U.S.	1978-1984	1961-2010	1970-2010
155	366	Suriname	U.S.	1991-2010	1961-2010	1970-2010
156	734	Swaziland	S. Africa	1974-2010	1961-2010	1973-2010
157	144	Sweden	Germany	1960-2010	1961-2010	1970-2010
158	146	Switzerland	Germany	1964-2010	1961-2010	1996-2010
159	463	Syrian Arab Republic	U.S.	2003-2008	1961-2005	1970-2010
160	923	Tajikistan	U.S.	1997-2010	1992-2010	1997-2010
161	738	Tanzania	U.S.	1973-2010	1961-2010	1970-2010
162	578	Thailand (E)	U.S.	1977-2010	1961-2010	1970-2010
163	742	Togo	France	1964-2010	1961-2010	1970-2010
164	866	Tonga	Australia	1981-2010	1961-2010	1989-2010
165	369	Trinidad & Tobago (E)	1960-75 U.K.; 1976-U.S.	1965-2010	1961-2010	1970-2010
166	744	Tunisia (E)	France	1964-2010	1961-2010	1970-2010
167	186	Turkey (E)	U.S.	1964-2010	1961-2010	1970-2010
168	925	Turkmenistan	U.S.	-	1994-2001	1996-2010
169	746	Uganda	U.S.	1980-2010	1961-2010	1970-2010
170	926	Ukraine	U.S.	1992-2010	1993-2010	1996-2010
171	466	United Arab Emirates	U.S.	-	1966-2010	1976-2010
172	112	United Kingdom	Germany	1960-2010	1961-2010	1970-2010
173	111	United States	U.S.	1960-2010	1961-2010	1970-2010
174	298	Uruguay	U.S.	1976-2010	1964-2010	1970-2010
175	927	Uzbekistan	U.S.	-	1999-2000	1996-2010
176	846	Vanuatu	1960-89 France; 1990-U.S.	1981-2010	1961-2010	1985-2000
177	299	Venezuela, RB (E)	U.S.	1964-2010	1961-2010	1970-2010
178	582	Vietnam	U.S.	1996-2010	1961-2010	1970-2010
179	474	Yemen, Rep.	U.S.	1996-2010	1990-2010	1995-2010
180	754	Zambia	U.S.	1965-2010	1961-2010	1970-2010
181	698	Zimbabwe (E)	U.S.	1965-2007	1961-2008	1984-2010

Notes: The base countries are primarily based on Shambaugh (QJE) and complemented by information from IMF's *Annual Report on Exchange Arrangement and Exchange Restrictions* and *CIA Factbook*

Table 1 (a): Tests for Structural Breaks in the Trilemma Indexes

			1970-72	1974-81	1983-96	1999-2010
Industrial Countries	Monetary Independence	Mean	0.379	0.408	0.393	0.149
		Change		+0.029	-0.015	-0.245
		t-stats (p-value)		1.32 (0.11)	0.72 (0.24)	14.69 (0.00)***
	Exchange Rate Stability	Mean	0.705	0.430	0.466	0.671
		Change		-0.274	+0.036	+0.205
		t-stats (p-value)		7.68 (0.00)***	2.04 (0.03)**	13.28 (0.00)***
	Financial Openness	Mean	0.430	0.468	0.704	0.955
		Change		+0.038	+0.236	+0.251
		t-stats (p-value)		1.95 (0.04)**	4.84 (0.00)***	6.37 (0.00)***
			1970-72	**1974-81**	**1983-96**	**1999-2010**
Non-Emerging Developing Countries	Monetary Independence	Mean	0.500	0.422	0.448	0.485
		Change		-0.078	+0.026	+0.037
		t-stats (p-value)		1.75 (0.06)*	1.12 (0.14)	1.41 (0.09)*
	Exchange Rate Stability	Mean	0.756	0.804	0.687	0.803
		Change		+0.048	-0.117	+0.112
		t-stats (p-value)		0.74 (0.76)	5.44 (0.00)***	6.15 (0.00)***
	Financial Openness	Mean	0.232	0.330	0.287	0.364
		Change		+0.098	-0.042	+0.077
		t-stats (p-value)		3.79 (0.00)***	2.00 (0.03)**	4.71 (0.00)***
			1970-72	**1974-81**	**1983-96**	**1999-2010**
Emerging Market Countries	Monetary Independence	Mean	0.524	0.466	0.514	0.440
		Change		-0.058	+0.048	-0.074
		t-stats (p-value)		2.21 (0.03)**	2.15 (0.02)**	3.15 (0.04)**
	Exchange Rate Stability	Mean	0.834	0.697	0.499	0.543
		Change		-0.136	-0.199	+0.044
		t-stats (p-value)		4.35 (0.00)***	10.01 (0.00)***	1.89 (0.00)***
	Financial Openness	Mean	0.212	0.230	0.243	0.483
		Change		+0.018	+0.013	+0.240
		t-stats (p-value)		5.03 (0.04)**	0.49 (0.32)	10.52 (0.00)***

Note: * significant at 10%; ** significant at 5%; *** significant at 1%

Table 1(b): Summary of the Structural Breaks Tests

		Structural Breaks
Industrial Countries (IDC)	Monetary Independence	1997-98
	Exchange Rate Stability	1997-98 (1973 for non-Euro Countries)
	Financial Openness	1990
Non-Emerging Developing Countries (NOEMG)	Monetary Independence	1973
	Exchange Rate Stability	2001
	Financial Openness	1990
Emerging Market Countries (EMG)	Monetary Independence	2001
	Exchange Rate Stability	1982
	Financial Openness	1997-98

Table 2: Regression for the Linear Relationship between the Trilemma Indexes: $1 = a_j MI_{i,t} + b_j ERS_{i,t} + c_j KAOPEN_{i,t} + \varepsilon_t$

	(1) FULL	(2) 1970-72	(3) 1974-81	(4) 1983-96	(5) 1999-2010	(6) 1983-89	(7) 1991-2010	(8) 1983-2000	(9) 2002-2010
Monetary Independence	1.084	0.932	1.354	0.970	0.708	1.150	0.680	0.923	0.773
	(0.040)***	(0.132)***	(0.068)***	(0.065)***	(0.128)***	(0.077)***	(0.080)***	(0.063)***	(0.136)***
Exch. Rate Stability	0.568	0.640	0.582	0.665	0.077	0.648	0.320	0.637	0.098
	(0.030)***	(0.075)***	(0.084)***	(0.050)***	(0.081)	(0.065)***	(0.070)***	(0.049)***	(0.082)
KA Openness	0.457	0.398	0.295	0.415	0.817	0.324	0.714	0.459	0.788
	(0.020)***	(0.047)***	(0.062)***	(0.033)***	(0.056)***	(0.047)***	(0.038)***	(0.030)***	(0.059)***
ERM x MI	-0.175	–	0.356	-0.232	-0.379	-0.462	-0.158	-0.078	-0.660
	(0.073)**	–	(0.343)	(0.119)*	(0.150)**	(0.321)	(0.101)	(0.090)	(0.145)***
ERM x ERS	-0.024	–	0.299	0.024	0.017	0.170	-0.092	-0.093	-0.071
	(0.053)	–	(0.189)	(0.075)	(0.080)	(0.120)	(0.078)	(0.065)	(0.076)
ERM x KAOPEN	0.013	–	-0.282	0.041	0.094	0.174	0.062	0.006	0.188
	(0.049)	–	(0.131)**	(0.057)	(0.058)	(0.151)	(0.051)	(0.053)	(0.054)***
LDC x MI	0.149	0.532	-0.102	0.364	0.333	0.243	0.458	0.396	0.235
	(0.045)***	(0.163)***	(0.095)	(0.070)***	(0.132)**	(0.086)***	(0.084)***	(0.068)***	(0.141)*
LDC x ERS	-0.151	-0.398	-0.142	-0.254	0.399	-0.269	0.130	-0.233	0.395
	(0.033)***	(0.091)***	(0.091)	(0.053)***	(0.079)***	(0.070)***	(0.072)*	(0.052)***	(0.079)***
LDC x KAOPEN	-0.185	-0.222	-0.082	-0.144	-0.485	0.045	-0.423	-0.256	-0.439
	(0.027)***	(0.075)***	(0.080)	(0.048)***	(0.064)***	(0.063)	(0.045)***	(0.043)***	(0.069)***
Observations	0.95	0.98	0.95	0.96	0.96	0.96	0.96	0.96	0.96
Adjusted R-squared	2,450	180	480	840	710	420	1,190	1,080	530

Robust standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

NOTES: The dummy for ERM countries is assigned for the countries and years that corresponds to participation in the ERM (i.e., Belgium, Germany, France, Ireland, Italy, and Luxembourg from 1979 on; Spain from 1989; U.K. only for 1990-91; Portugal from 1992; Austria from 1995; Finland from 1996; and Denmark and Greece from 1999) or ERM II (Estonia, Lithuania, and Slovenia from 2004; and Cyprus, Latvia, Malta, and Slovak Rep. from 2005).

Table 3: Regression for the Linear Relationship between the Trilemma Indexes: $1 = a_j MI_{i,t} + b_j ERS_{i,t} + c_j KAOPEN_{i,t} + d_j IR_{i,t} + \varepsilon_t$

	(1) FULL	(2) 1970-72	(3) 1974-81	(4) 1983-96	(5) 1999-2010	(6) 1983-89	(7) 1991-2010	(8) 1983-2000	(9) 2002-2010
Monetary Independence	1.050	0.941	1.359	0.862	0.606	1.065	0.581	0.825	0.650
	(0.041)***	(0.117)***	(0.070)***	(0.074)***	(0.086)***	(0.090)***	(0.067)***	(0.069)***	(0.093)***
Exch. Rate Stability	0.536	0.598	0.600	0.562	-0.056	0.590	0.247	0.531	-0.023
	(0.031)***	(0.083)***	(0.081)***	(0.049)***	(0.082)	(0.065)***	(0.074)***	(0.048)***	(0.083)
KA Openness	0.438	0.384	0.292	0.423	0.832	0.337	0.699	0.455	0.802
	(0.020)***	(0.048)***	(0.059)***	(0.033)***	(0.044)***	(0.046)***	(0.034)***	(0.030)***	(0.046)***
ERM x MI	-0.229	–	0.300	-0.223	-0.291	-0.340	-0.126	-0.086	-0.690
	(0.078)***	–	(0.354)	(0.122)*	(0.135)**	(0.267)	(0.101)	(0.098)	(0.113)***
ERM x ERS	-0.026	–	0.252	0.017	0.146	0.066	-0.039	-0.062	0.004
	(0.054)	–	(0.198)	(0.072)	(0.087)*	(0.114)	(0.084)	(0.064)	(0.086)
ERM x KAOPEN	0.036	–	-0.279	0.004	0.080	0.040	0.079	-0.007	0.210
	(0.048)	–	(0.131)**	(0.058)	(0.051)	(0.128)	(0.049)	(0.052)	(0.048)***
LDC x MI	0.162	0.526	-0.166	0.451	0.430	0.296	0.544	0.479	0.352
	(0.046)***	(0.153)***	(0.102)	(0.079)***	(0.091)***	(0.098)***	(0.073)***	(0.074)***	(0.100)***
LDC x ERS	-0.127	-0.339	-0.131	-0.157	0.476	-0.229	0.171	-0.131	0.458
	(0.033)***	(0.098)***	(0.090)	(0.052)***	(0.078)***	(0.070)***	(0.077)**	(0.051)***	(0.077)***
LDC x KAOPEN	-0.229	-0.188	-0.171	-0.207	-0.580	-0.000	-0.472	-0.302	-0.531
	(0.030)***	(0.106)*	(0.085)**	(0.051)***	(0.057)***	(0.078)	(0.044)***	(0.046)***	(0.062)***
IR as % of GDP	0.657	0.596	-0.192	1.368	0.649	0.964	0.952	1.416	0.624
	(0.153)***	(0.551)	(0.682)	(0.333)***	(0.226)***	(0.467)**	(0.178)***	(0.287)***	(0.220)***
LDC x IR	-0.317	-0.943	0.534	-1.019	-0.171	-0.367	-0.559	-1.145	-0.169
	(0.166)*	(0.580)	(0.704)	(0.352)***	(0.245)	(0.490)	(0.197)***	(0.308)***	(0.243)
ERM x IR	0.076		0.664	0.484	-0.562	1.346	-0.433	0.037	-0.277
	(0.295)		(1.082)	(0.473)	(0.247)**	(0.702)*	(0.323)	(0.464)	(0.224)
Observations	0.96	0.98	0.95	0.96	0.96	0.97	0.96	0.96	0.96
Adjusted R-squared	2,421	173	471	835	705	415	1,185	1,075	525

Robust standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

NOTES: The dummy for ERM countries is assigned for the countries and years that corresponds to participation in the ERM (i.e., Belgium, Germany, France, Ireland, Italy, and Luxembourg from 1979 on; Spain from 1989; U.K. only for 1990-91; Portugal from 1992; Austria from 1995; Finland from 1996; and Denmark and Greece from 1999) or ERM II (Estonia, Lithuania, and Slovenia from 2004; and Cyprus, Latvia, Malta, and Slovak Rep. from 2005).

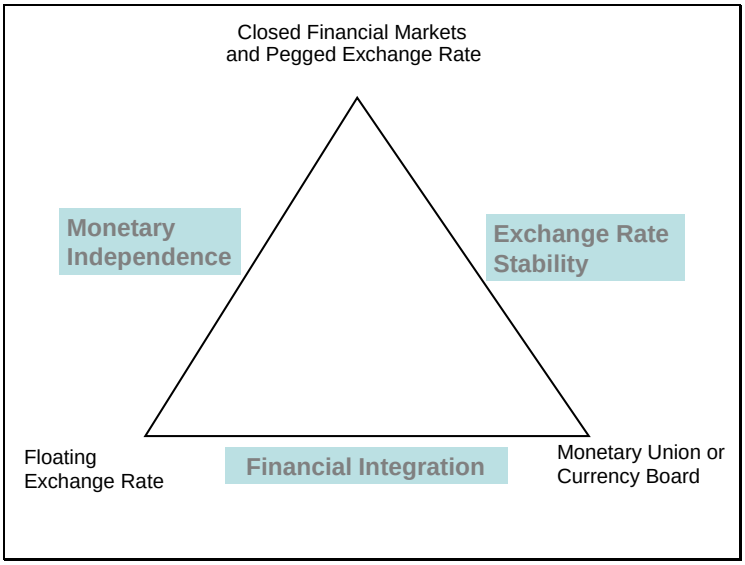


Figure 1: The Trilemma

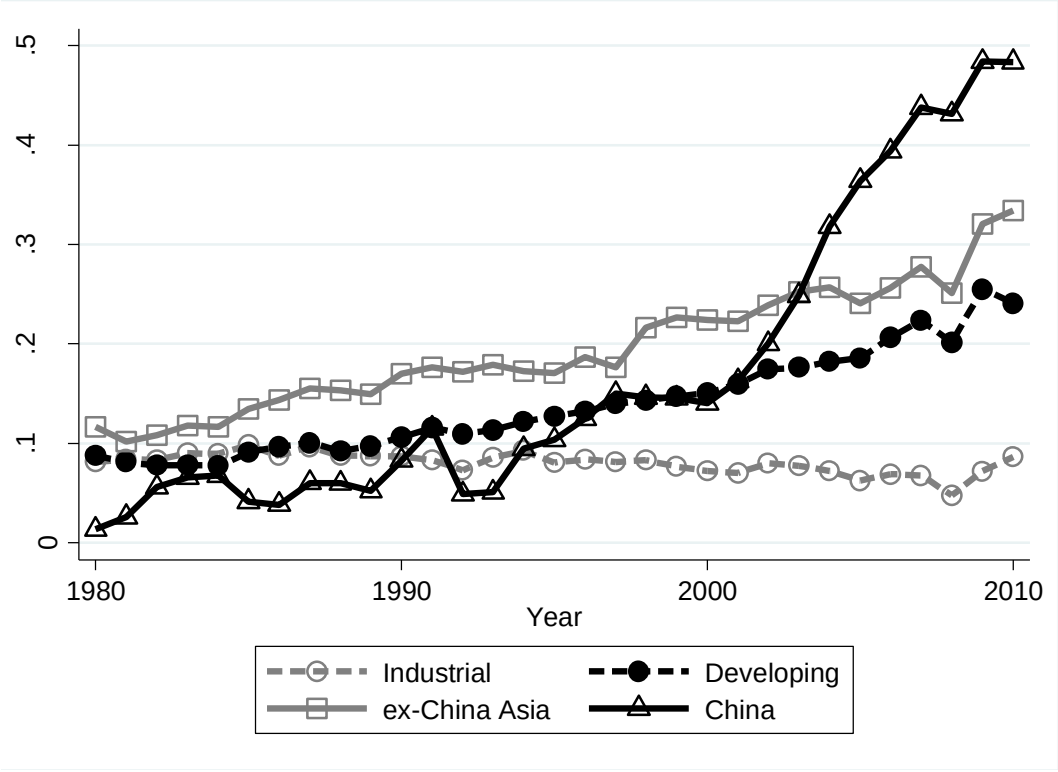


Figure 2: International Reserves/GDP, 1980-2010

Figure 3: The Trilemma and International Reserves Configurations over Time

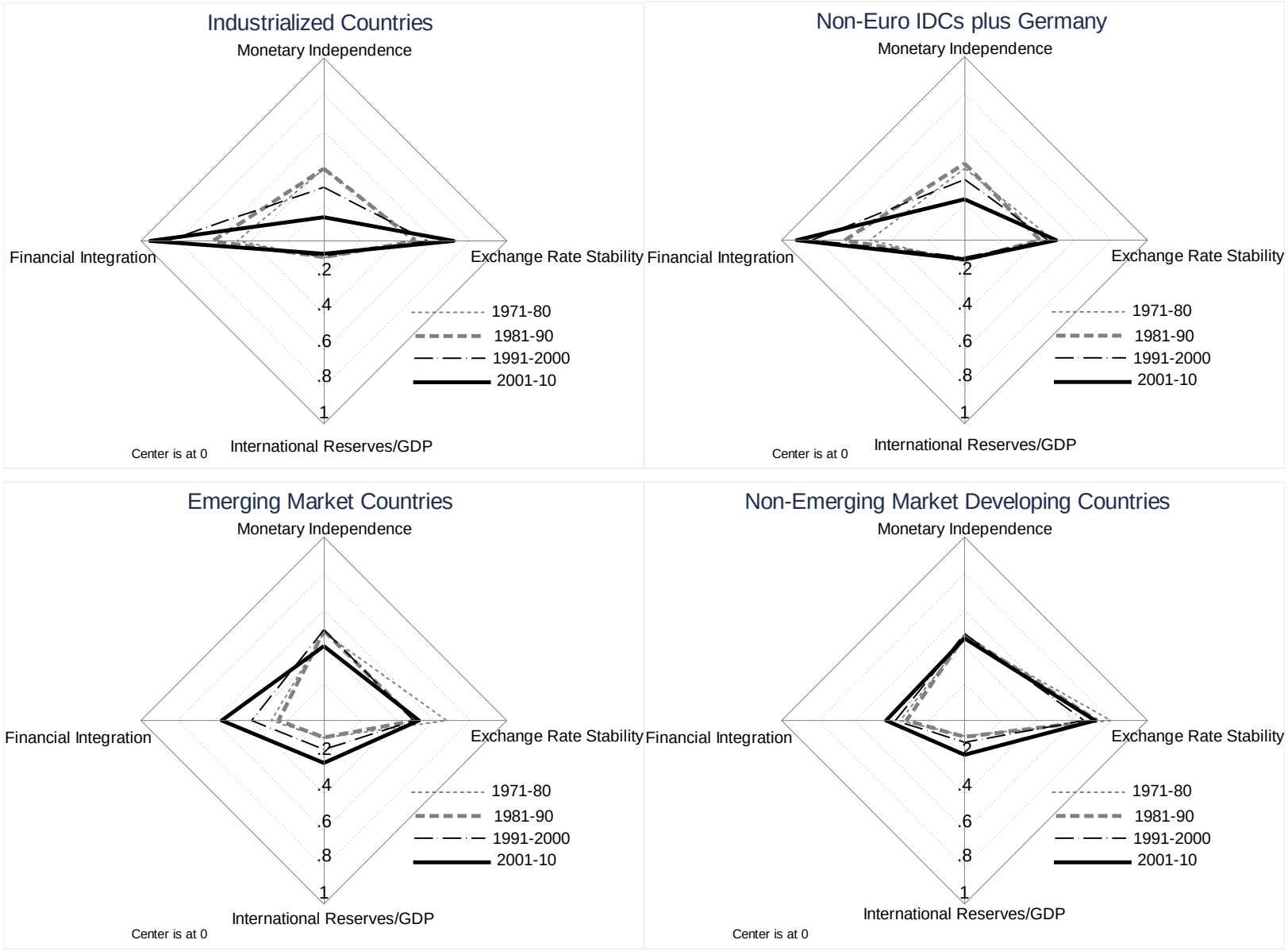


Figure 4: The Trilemma and International Reserves Configurations over Time: Regional Patterns for Developing Countries

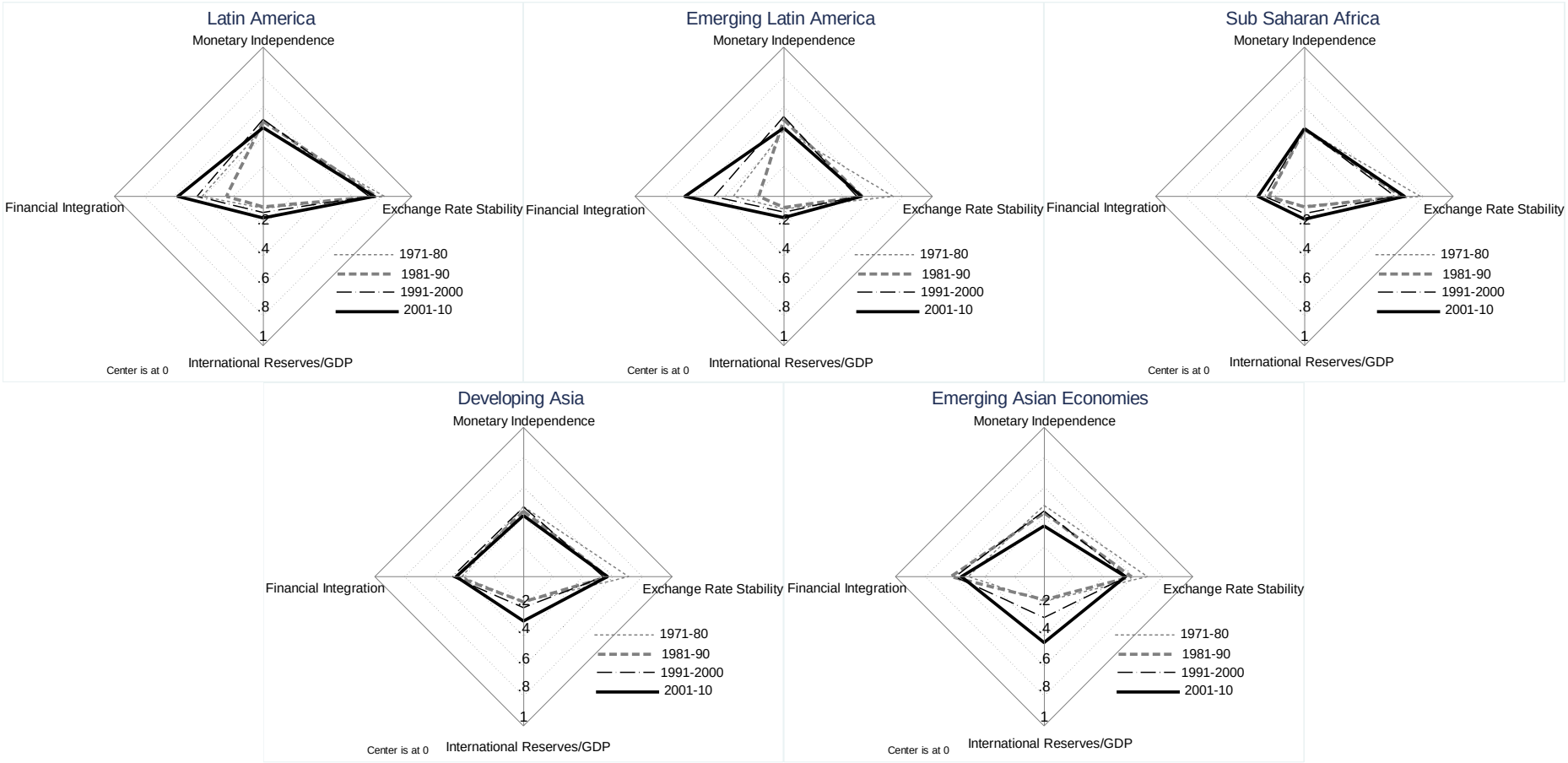
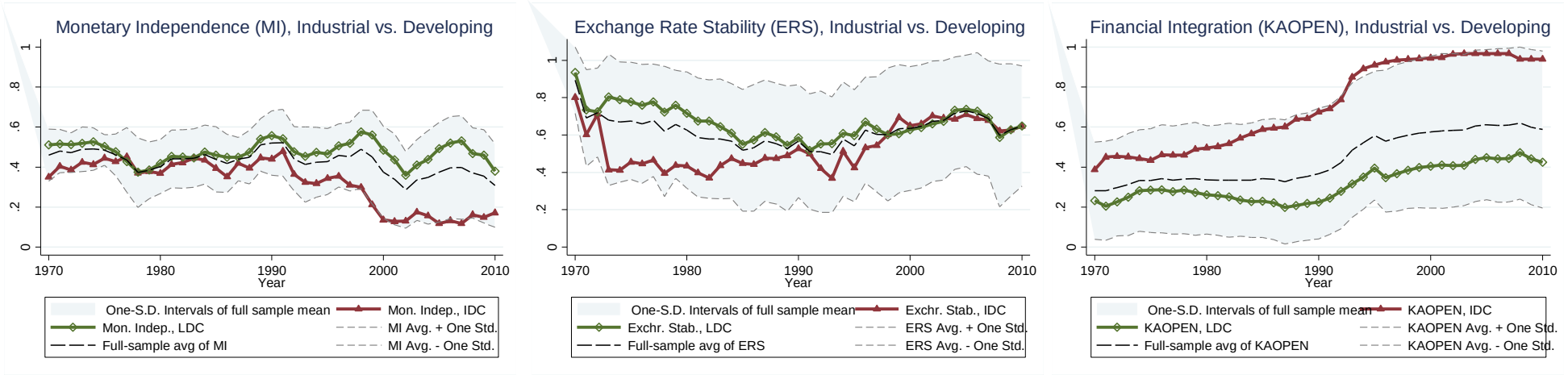


Figure 5: The Evolution of Individual Trilemma Indexes

(a) Industrialized countries vs. Developing countries



(b) Emerging market countries vs. Non-emerging market, developing countries

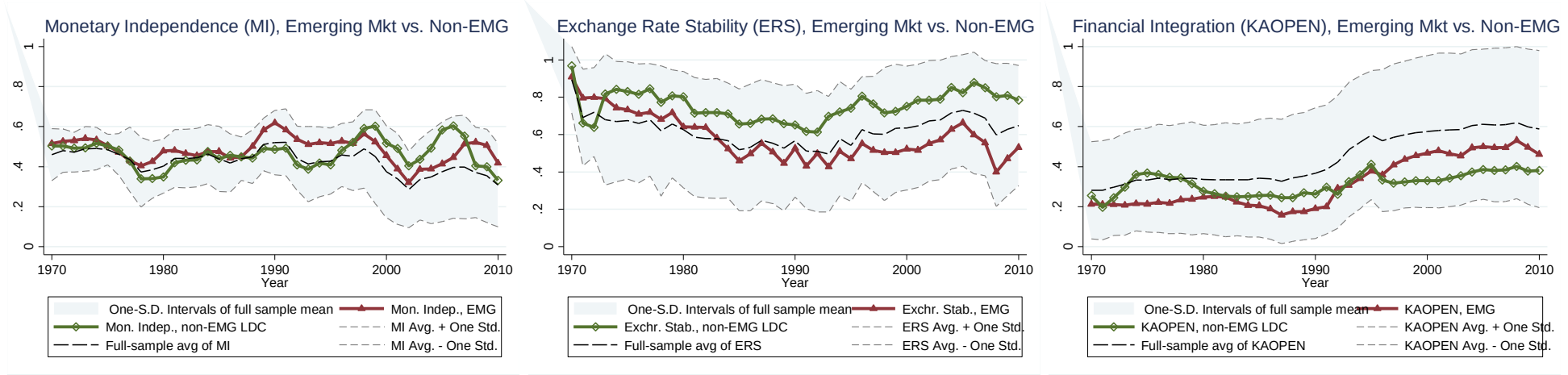
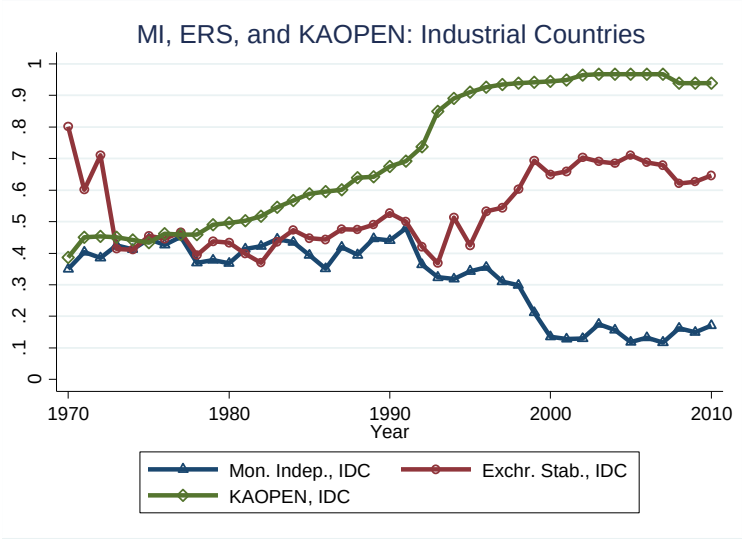
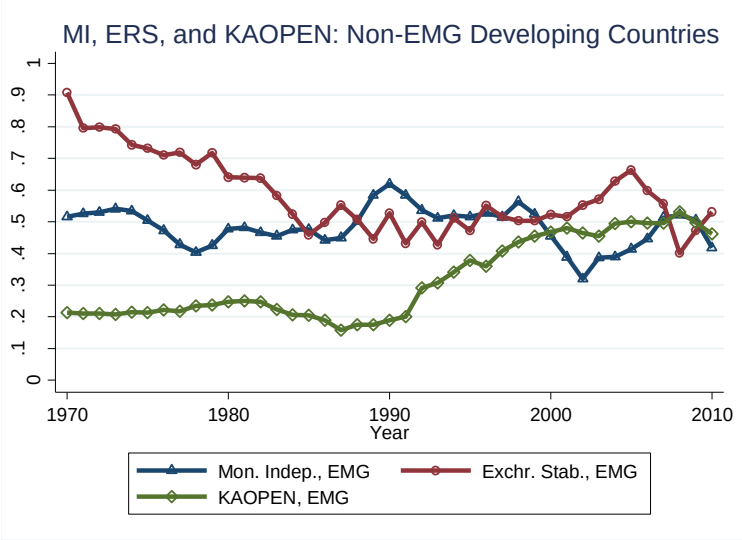


Figure 6: The Evolution of Trilemma Indexes

(a) Industrialized Countries



(b) Emerging Market Countries



(c) Non-Emerging Market Developing Countries

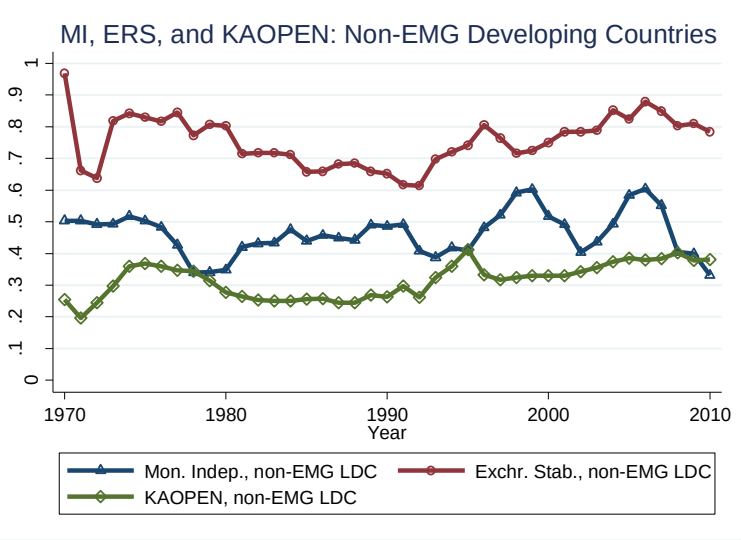
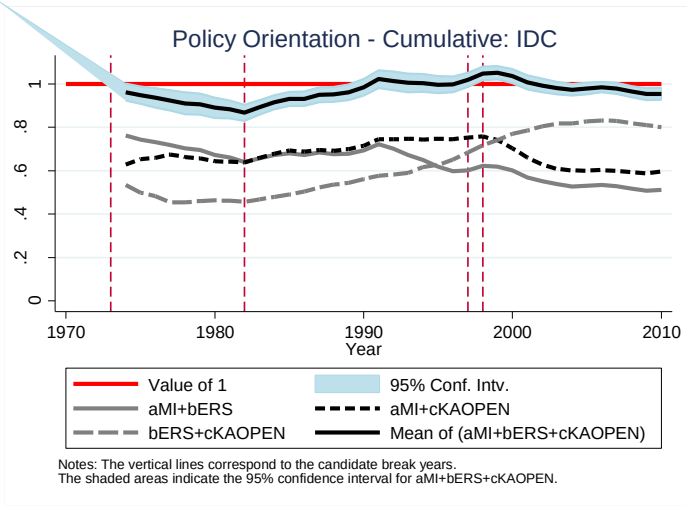


Figure 7: Policy Orientation of IDCs and LDCs

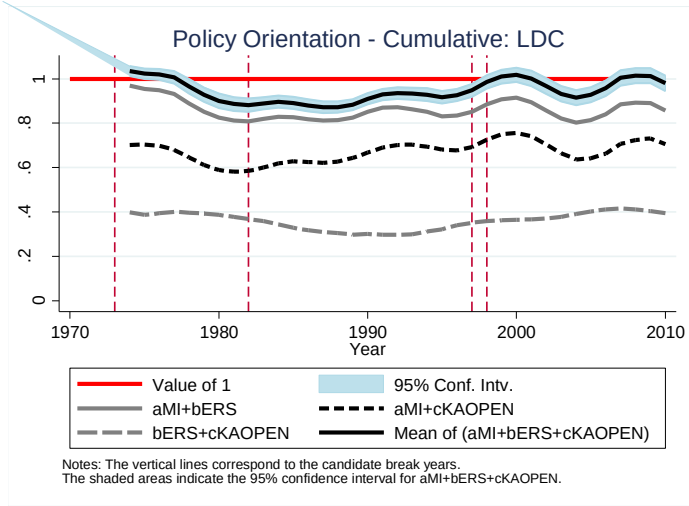
(a) Cumulative Effects: $(\hat{a}MI + \hat{b}ERS)$, $(\hat{a}MI + \hat{c}KAOPEN)$, $(\hat{b}ERS + \hat{c}KAOPEN)$, and $(\hat{a}MI + \hat{b}ERS + \hat{c}KAOPEN)$

Industrial Countries



Notes: The vertical lines correspond to the candidate break years.
The shaded areas indicate the 95% confidence interval for aMI+bERS+cKAOPEN.

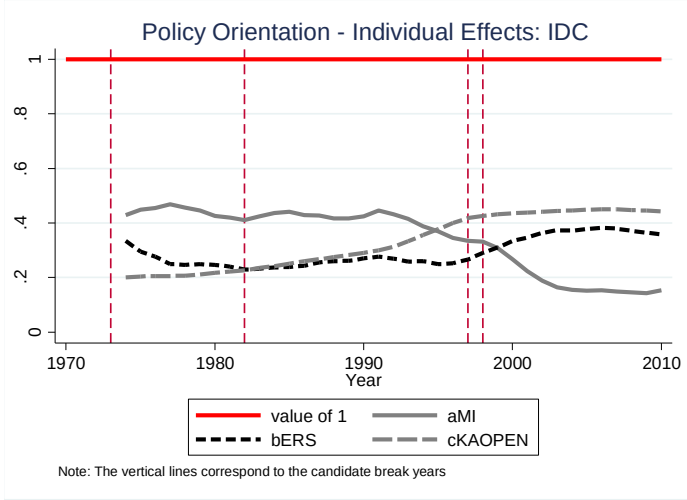
Developing Countries



Notes: The vertical lines correspond to the candidate break years.
The shaded areas indicate the 95% confidence interval for aMI+bERS+cKAOPEN.

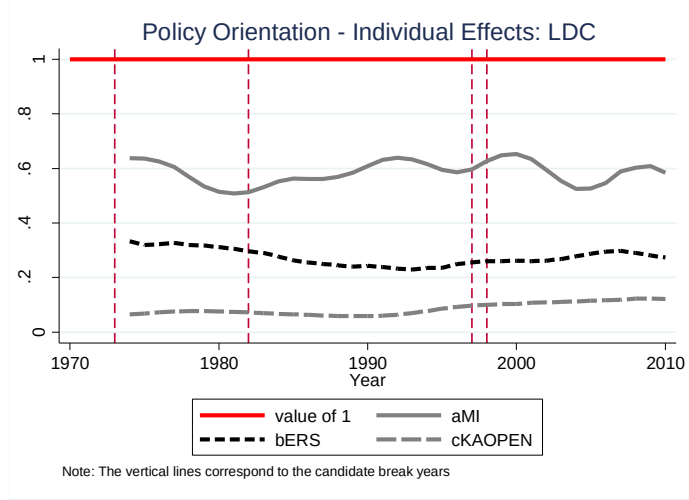
(b) Individual Effects $\hat{a}MI, \hat{b}ERS,$ and $\hat{c}KAOPEN$

Industrial Countries



Note: The vertical lines correspond to the candidate break years

Developing Countries



Note: The vertical lines correspond to the candidate break years