International Capital Movement and Monetary Independence in Asia

Simeon Nanovsky
University of North Florida
s.nanovksy@unf.edu

Yoonbai Kim*
Nazarbayev University &
University of Kentucky
ykim01@uky.edu

Abstract

In this paper, we investigate the extent of monetary independence in a group of 10 Asian countries: China, Malaysia, Japan, India, Indonesia, Philippines, Thailand, Korea, Singapore, and Hong Kong. While the traditional investigation has considered only the bivariate relationship between the home interest rate and the base rate, we employ both single-equation and vector autoregressive representations of the bivariate and the trivariate relationship including the desired (or optimal) interest rate. We find in most countries, the ranking of monetary independence is relatively consistent across the models and methodologies although model specifications produce important differences for some countries such as Japan, Indonesia, and India.

Trilemma suggests that there are two ways a country can enhance its monetary independence: one is greater flexibility in the exchange rate and the other is lower degree of capital mobility. The fact that China and Malaysia – the two countries that are known to have imposed strictest capital controls – consistently rank high in various setups while Hong Kong – which has maintained a nearly freest regime in capital markets – is lowest in monetary independence indicates that perhaps capital controls may play a more important role than does exchange rate flexibility in securing independence in monetary policy making. On the other hand, countries that maintain greater exchange rate stability do not necessarily rank low, unless it is combined with greater capital mobility as in the case of Hong Kong.

Keywords: Trilemma, monetary independence, capital controls, exchange rate flexibility

JEL codes: F3, F4

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1. Introduction

In an open economy, a monetary authority is subject to the trilemma, which states that it is impossible to have all three policy objectives of (a) unrestricted capital movement, (b) a stable exchange rate, and (c) an independent monetary policy.[1] If it wishes to retain (c), for instance, it has to give up either (b) a stable exchange rate and then move to a floating exchange rate or drop (a) unrestricted capital movement and impose capital controls.

In this paper, we investigate the extent of monetary independence (MI) in a group of 10 Asian countries: China, Malaysia, Japan, India, Indonesia, Philippines, Thailand, Korea, Singapore, and Hong Kong. While the traditional investigation has considered only the bivariate relationship between the home interest rate and the base rate, we also employ the single-equation and VAR representations of the trivariate relationship including the desired (or optimal) interest rate in addition to the traditional two variables. We find in most countries, the relative ranking is relatively consistent across the models and methodologies although model specifications produce important differences for some countries such as Japan, Indonesia, and Korea.

Trilemma suggests that there are two ways a country can increase its MI: greater flexibility in the exchange rate and lower degree of capital mobility. We find that China and Malaysia – the two countries that are known to have imposed strictest capital controls – consistently rank high in various setups while Hong Kong – that has maintained a nearly freest regime in capital markets – is lowest in MI. On the other hand, countries that maintain greater exchange rate stability do not necessarily rank low in MI, unless it is combined with greater capital mobility as in the case of Hong Kong. Thus, the international monetary policy trilemma is alive and valid in this group of 10 countries. Our results seem to give more weight on capital controls than on greater exchange rate flexibility as a source of MI. The case of Hong Kong suggests that a fixed

[1] In simple terms, independent monetary policy means the ability of the monetary authority (the central bank) to set its policy interest rate for the purpose of domestic stabilization.

exchange rate and high capital mobility are a perfect duo that achieves a complete loss of monetary independence.

The rest of the paper is constructed as follows: in Section 2, we illustrate our methodology of measuring capital mobility and monetary independence. Section 3 reports the results on the extent of MI in 10 countries using various metrics. In Section 4, we investigate the source of MI: exchange rate flexibility or capital controls. The paper ends with concluding remarks in Section 5.

2. Methodology

2.1 Measurement of capital controls and their intensity

To investigate the empirical relevance of trilemma, one needs to quantify its three legs. Regarding capital controls, the International Monetary Fund (IMF) reports whether its member countries impose restrictions in various categories of capital movement. *De jure* measures of capital controls such as Chinn and Ito (2006) capital openness indicator are based on the IMF report. Main disadvantages of those measures are that they are available only at the annual frequency and they do not show the intensity of controls. *De facto* measures based on the magnitudes of capital movement in flows or stocks are popular as well. However, they suffer from identification problems. For instance, if the magnitude of capital flows declines, it may be due to the imposition of capital controls or global financial turmoil and general decline in investor motivation.

The least controversial measures of capital mobility would be (i) deviations from covered interest arbitrage and (ii) differences in the offshore and onshore interest rate for the same currency as proposed in Frankel (1994) and Obstfeld (1995), respectively. In this paper, we employ the second method. Using information from the non-deliverable forward (NDF) market, we estimate the offshore interest rate that would prevail in the absence of government restrictions on capital movement as follows:[2]

[2] The NDF market is an offshore market to trade and hedge in currencies of countries wherein there is no full convertibility (both the financial account and the current account). The NDF market traded currencies are Indian Rupee, Chinese Yuan, Philippine Peso, Taiwan Dollar, and Korean Won. NDFs are distinct from deliverable forwards as the NDFs trade outside the countries of the corresponding currencies. See McCauley et al (2014).

$$(1) \quad 1 + i_t^{NDF} = \frac{NDF_t}{S_t}\left(1 + i_t^b\right)$$

where S_t and NDF_t are the spot and NDF rate and i_t^b is the base interest rate. i_t^{NDF} is the hypothetical domestic interest rate that would prevail in the absence of government controls and regulations on capital flows.

The (absolute value of the) difference between the implied unregulated offshore interest rate, i_t^{NDF}, and the actual (onshore) interest rate, i_t, produces a continuous and uncontroversial measure of the existence and the intensity of capital controls.

2.2 Measurement of monetary policy independence

Monetary independence is an elusive concept. Several measures have been advanced. A popular measure is one developed by Frankel et al (2002), Obstfeld et al (2005), and Shambaugh (2004). In interdependent economies, changes in the base-country interest rate (such as the US Federal Funds rate) would translate to changes in the local interest rate. Thus, the extent of monetary autonomy is often measured by $1 - \alpha_2$

$$(2) \quad \Delta i_t = \alpha_1 + \alpha_2 \Delta i_t^b + \varepsilon_t$$

where i_t and i_t^b are the local and the base interest rates and ε_t is the error term.[3]

There are some issues in taking $1 - b$ as measure of monetary independence. For instance, if the domestic interest rate is regulated under general financial repression. In this case, the resulting deviations of the domestic interest rate from the base rate would be taken as indication of monetary independence. Another problem arises when Δi_t^b and ε_t are correlated. If the local monetary authority would choose to mimic the monetary policy of the base country, the observed high correlation between the local and the base interest rate would not necessarily indicate the lack of monetary policy independence. It can be considered as an expression of free and autonomous decision of the local monetary authority.

In this paper, we define monetary independence as the ability of the central bank to set its policy rate at the optimal level given the external influence from the base

[3] Aizenman, Chinn, and Ito (2010) propose a measure similar to the regression coefficient. It is based on the correlation of the interest rates.

country. Consider a following setup in which the monetary authority determines the policy interest rate as a weighted average of the base rate and its own optimal rate, i_t^o.

$$(3) \qquad i_t = \mu_1 \, i_t^o + (1 - \mu_1) \, i_t^b$$

In this formulation, μ_1 measures the extent of monetary independence (MI). $\mu_1 = 1$ would indicate full MI while $\mu_1 = 0$ no MI at all. In the case of low or no MI, changes in the base interest rate would translate to changes in the local interest rate one for one regardless of the choice that would prevail under full MI. In the case where capital controls are in place, we use i_t^{NDF} instead of i_t for the local interest rate.

The interest rate setting by the major central banks such as the Fed, the European Central Bank, and the Bank of England is often approximated by the Taylor rule that stipulates that the central bank should change the nominal interest rate in response to changes in inflation, output, or other economic conditions.[4]

More formally,

$$(4) \qquad i_t^{TR} = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t).$$

In this equation, i_t^{TR} is the target (short-term) nominal interest rate, π_t is the rate of inflation, π_t^* is the desired rate of inflation, r_t^* is the assumed equilibrium real interest rate, y_t is the logarithm of real GDP, and $\bar{y}_t$ is the logarithm of potential output.[5]

3. Empirical Results

Data sources

In our empirical study, we use data on ten Asian countries – China, Malaysia, Japan, India, Indonesia, Philippines, Thailand, Korea, Singapore, and Hong Kong. The

[4] The Taylor rule, first proposed by John B. Taylor, is a monetary-policy rule that stipulates how much the central bank should change the nominal interest rate in response to changes in inflation, output, or other economic conditions.

[5] This method of measuring monetary policy independence is innovative and in fact can be applied to a country that is a member of a monetary union and thus does not have its own policy interest rate. Most studies assume away that members of a monetary union completely lose monetary autonomy. What we are proposing here is consistent with observation that Germany and Austria seem to enjoy a greater freedom than does Greece or Spain even when all member countries in the Eurozone are subject to an identical interest rate set by the ECB.

choice of countries is based on data availability, which spans from 1999 to 2015 and includes interbank interest rates, nominal dollar exchange rates, inflation, industrial production and unemployment. NDF market rates are available for five countries – China, India, Indonesia, Philippines, and Korea. For the rest, the onshore forward market rate is used.[6] The 3-month U.S. interest rate is used as the base rate. Appendix A lists the data availability and sources in detail.

Table 1 summarizes the current exchange rate, standard deviation of exchange rate changes and the Chinn-Ito (2008) measure of capital-account openness (KAOPEN). The latter ranges from 0 to 1, with 1 (0) being the most (least) restrictive capital flow management regime.

Table 1 here

Benchmark regression

Table 2 shows the results of the Augmented Dicky-Fuller test for all interest rates using the lag length selected by the Ng-Perron (2001) criteria. The results show that interest rates are stationary to at the 10% level with the exceptions of India, China, Indonesia, and Malaysia. Interestingly, the base rate (of the U.S.) appears the most stationary of all rates. As the results of the unit-root test are split, we proceed to estimate Eq (2) in levels and report the results in Table 4. This could be interpreted as a cointegration regression if the interest rates are nonstationary indeed. In a later section, we also consider the results of estimation of Eq (2) in differences and also using a VAR model with an error correction term. Table 3 also reports the results of cointegration regression and shows that there is little evidence of cointegration in either 2 or 3 variable models.

Table 2 here

Table 3 here

[6] The NDF market in Asia emerged in the late 1990s after the Asian financial crisis when restrictions were placed on foreigners in the onshore forward market. The NDF market is a forward market where physical currencies are not exchanged and the transactions are settled in dollars.

There are no NDF markets for the Japanese yen, the Hong Kong dollar, or the Singapore dollar as cross-border capital flows are largely free from government restrictions. Further, Thailand does not have an NDF market, and the Malaysian time series are too short as their NDF market for their currencies were only developed recently.

Table 4 reports the regression results for Eq (2). The results are listed from countries that are the most independent to least independent according to the goodness of fit (R-squared). According to this criteria, China, Malaysia, and Japan appear to be the most independent while Hong Kong, Singapore, and Korea least independent. In this setup, the magnitude of α_2 is another parameter that is employed to determine MI. The Philippines and Indonesia exhibit the highest estimates near one, and thus, along with Hong Kong, scores the lowest MI. In contrast, China, Malaysia, and Japan continue to maintain the highest MI.

Table 4 here

The Taylor Rule as the Desired Interest Rate

Traditional monetary independence regressions in the above section do not take into account whether correlated movements of the interest rates may be due to the similarities in economic conditions and economic policies instead of a causal relationship. We include the country's desired interest rate that would be chosen by its central bank in the absence of the external pressure from the base country.[7] Following Taylor (1993), we approximate the desired interest rate with the Taylor rule (TR). The TR interest rate is normally estimated from the actual data on inflation and output gap as follows:

$$(5) \qquad i_t^D = \beta_1 + \beta_2 \pi_t + \beta_3 y_t + e_t$$

where π_t is the rate of inflation, and y_t is the output gap – the percentage deviation of actual output from its full-employment level. The fitted value of i_t^D is generally treated as the TR interest rate. In this paper, to be consistent across countries, we use the parameters ($\beta_1,\ \beta_2,\ \beta_3 = 1.0,\ 1.5,\ 0.5$) that were originally suggested by Taylor (1993). As a robustness check, we also estimate the Taylor rule for each country but the overall results remain similar.

We follow Clarida, Gali, and Gertler (CGG, 1998) and employ IMF data on CPI inflation and industrial production (or, if not available, unemployment). The cyclical

[7] For a similar purpose, Klein and Shambaugh (2013) incorporate inflation and GDP growth in their regressions.

component of a Hodrick-Prescott filter is used on the log of deseasonalized industrial production to obtain the output gap. Unlike the actual policy interest rate, the resulting TR interest rates are extremely volatile. Following CGG (1998 and 2000), we smooth the TR rate using the smoothing coefficient of 0.9.[8] Figures 1 to 10 report the TR interest. It appears most countries follow the Taylor rule only loosely.

A modified regression including the desired interest rate (i_t^D) is estimated as follows:

$$(6)\ \Delta i_t = \alpha_1 + \alpha_2 \Delta i_t^B + \alpha_3 \Delta i_t^D + \varepsilon_t$$

Table 5 reports the results. The coefficient estimate for the base rate remains largely unaffected with the exception of Indonesia. The coefficient on the desired rate is significant and correctly signed (positive) in five countries including China, Japan, India, Indonesia, and Thailand. In general, these countries have medium or high-degree of MI in the sample. There are also improvements in regression fit in all countries, significant in several countries such as Indonesia, Japan, and India. As MI is positively related to α_3 and negatively to α_2, in column (IV), we rank order the countries in terms of $\alpha_3 - \alpha_2$. Again, the same three countries – China, Malaysia, and Japan – maintain high MI. The countries that have low MI – Hong Kong, Singapore, Korea, and the Philippines – are also similar to those of the 2-variable model.

Table 5 here

Two cases – Indonesia and India – are interesting. In the presence of the desired rate, the Indonesian interest rate is almost exclusively determined by the desired rate and the coefficient on the base rate turns negative. This may be an indication that monetary policy making in Indonesia is more autonomous than what Table 4 may indicate. In the case of India, the coefficient on the desired rate is high compared to that on the base rate. The combined measure thus indicates a higher level of MI than in the previous estimates.

[8] Smoothing and the smoothing coefficient (δ) are defined as follows: $i_t^{T\ smooth} = \delta\ i_{t-1}^{T\ smooth} + (1-\delta)\ i_t^{T\ actual}$. Clarida, Gali, and Gertler (1998) report the parameter of different countries to lie between .87 and .95. The results remain similar if smoothing parameters in these ranges are used.

Vector Autoregressive Models

This subsection follows Cheung et al. (2008) and uses vector autoregressive (VAR) analysis to incorporate interactions and feedback between the base and the home. The first VAR uses the base rate and the home rate in first differences. The Bayesian Information criterion (BIC) for most countries indicates two lags as optimum. To be consistent across countries, we employ two lags for all countries. Vector error-correction models (VECM) are not employed because the home interest rates do not seem to be cointegrated with the base rate with or without adding the desired rate as reported by the Engle-Granger cointegration tests in Table 3.

The first two columns of Table 6 show variance decompositions (VDs) after the 3-month (short-run) and 3-year (medium-run) horizons of the home interest rate explained by the shocks from the base rate and the home rate. The base-rate shocks explain more than half of the variations in the home interest rate in the medium run in Hong Kong, Singapore, and Korea. On the other hand, they play a minimal role in China and Malaysia. According to this measure, Japan's MI turns out to be lower and more likely to belong in an intermediate MI group. It is interesting to note that India (and Indonesia) show higher degrees of MI according to this measure.

Table 6 here

The next three columns show results from a VAR with the desired interest rate included. The variable is ordered before the home rate on the assumption that it could contemporaneously affect the home interest rate.[9] The addition of the desired interest rate substantially reduces the contribution of the base shocks in Korea, Singapore, and Hong Kong. In four countries – India, Thailand, Korea, and Singapore – the shocks from the desired rate explain more than 20 percent of the variation in the home rate. In four additional countries – Malaysia, Japan, Philippines, and Hong Kong – they are responsible for more than 10 percent of home rate variations. In only China and Indonesia, the desired rate shocks seem to play *unimportant* roles.

When we use the 3-variable model in VAR, MI can be measured as the role of the base rate shocks (negatively) or the role of the desired rate shocks (positively). According to the first measure, the results are nearly identical to that of the 2-variable model. We thus skip them. Using the difference between the VDs of the base rate and

[9] If it is ordered third, the overall effect is a slight decrease in the Taylor rule shock but not enough to change the overall interpretation of the results. There is almost no change at the 3-month horizon, and there is only a few percentage point differences for most countries after the three-year mark.

desired rate shocks, we find some interesting variations. Among the countries that have low MI in the 2-variable model, only Hong Kong maintains such distinction. Other countries such as Singapore, Korea, and Thailand, the role of the base rate shocks declines while the role of the desired rate shocks is quite high. Thus, we may classify them as medium MI countries. China and Malaysia continue to show high MI. With this combined measure, India also joins the group of high MI.

Summary

Table 7 summarizes the results. Overall message is clear. The relative standing in monetary independence remains generally consistent. Among all countries, the following cases stand out: (1) China and Malaysia maintain high MI in all specifications. (2) Hong Kong shows up at the opposite end, having the lowest MI. Changes in specification affect the degree of MI most significantly for Japan and India. In the single-equation model, Japan ranks high while, in the VAR models, it ranks in the intermediate range. With the single-equation models, India seems to belong in a group of intermediate MI. In the VAR models, however, the country exhibits high MI.

Table 7 here

4. Exchange Rate Flexibility or Capital Controls?

What are the sources of monetary independence? Why it is higher in some countries than others? According to the trilemma hypothesis, monetary independence should be positively related to the flexibility of exchange rate and the degree of capital controls. When it comes to empirical analysis, there is little agreement as to how each component of the trilemma is measured. For both exchange rate regimes and capital controls, one can use either the *de jure* index provided by the IMF or *de facto* measurements using actual exchange rate movements and capital movements.

To obtain the trilemma measures we follow Ma et al. (2004), Ma and McCauley (2008), and Kohli (2012). The NDF market is offshore and not restricted by the home country; therefore, the NDF rates could be used to measure expected exchange rates under unrestricted capital movements and also the existence and intensity of capital controls. In particular, Ma et al. (2004), Ma and McCauley (2008) compute the imputed rate $i^I = i^B + \ln(NDF) - \ln(S)$, where NDF is the NDF exchange rate against the

dollar. [10] They then use the difference between the actual home interest rate and the imputed rate measures capital controls, $k = i^H - i^I$, because k, if positive, can be seen as an ad-valorem tax equivalent on capital inflows while a negative k represents an ad-valorem tax equivalent on outflows. Replacing for the imputed rate, a capital control augmented covered interest parity is obtained:

$$(7) \qquad i^H - i^B = \Delta f + k$$

where $\Delta f = \ln(NDF) - \ln(S)$ is the forward discount on the home currency.

In this formulation, variations in the interest rate differential are either due to changes in the forward discount Δf or changes in k. Eq (7) can be used to illustrate trilemma. For instance, (A) under a credibly fixed exchange rate ($\Delta f = 0$) and unrestricted capital mobility ($k = 0$), a country has no monetary independence ($i^H = i^B$). (B) To gain monetary independence ($i^H \neq i^B$), it needs to impose some restrictions on capital movement ($k \neq 0$) or move towards a more flexible exchange rate system ($\Delta f \neq 0$).[11]

Table 8 reports a summary of the sample standard deviations for these components.[12] As we can see the results from the monetary independence regressions tend to be consistent with the interest differential in that the higher the variation in the differential the lower the monetary independence. It appears that based on this measure,

[10] Theoretically, the NDF is supposed to equal the expected future exchange rate. If they are not equal then we know that the expected future exchange rate is pinned down by interest rate parity - if the NDF rate is different from that, there would be arbitrage opportunities by signing a forward contract and moving capital from one country to the other.

[11] In the real world, capital controls are not the only reason covered interest parity will be violated; there might also be risk related reasons. First, if there is counterparty risk in the forward exchange market so that some of the contracts are not fulfilled then this will discourage capital flows. If this risk is present, then it will influence the forward rate and then be part of computed capital controls. To overcome the risk, this paper uses data (where possible) from the less risky offshore NDF market rather than the onshore forward market. As the forward transactions in the NDF market are settled in dollars, there is less risk because the principle amounts do not move and currency does not need to be physically exchanged. See Lipscomb (2002) and Shamah (2008) for details. A second type of risk is country investment risk. From the example, risk on investment in the home country will also discourage inflows. To solve this problem, we follow Shambaugh (2004) and assume that this risk stays constant over time. The overall results of this paper are determined by the movements in capital controls and interest rates over time; constant risks will not change the results.

[12] The first row lists the standard deviation in the capital controls for each country, the second is the standard deviation of Δf, and the third is the standard deviation in the interest rate differential ($i^H - i^B$).

Hong Kong, Singapore, and Korea are most highly dependent on U.S. policy. They also have lower degrees of capital controls than any other countries in the group except for Japan. It is also interesting to note that the three economies have widely different ranges in exchange rate flexibility with Hong Kong at the firm fix with its currency board system and Korea at a floating exchange rate.[13]

Table 8 here

5. Comparison with Other Studies

Various studies have examined the extent of monetary independence in Asian countries. Similarly, Ma and McCauley (2008) and Kohli (2012) use the NDF market to identify capital controls for China and India respectively. Their results show that indeed the two countries had large capital controls over the 2000s sample period. Ma and McCauley (2008) also test if capital controls enhanced monetary independence by noting that the Chinese exchange rate had been fixed to the dollar until 2005. Because of the fixed exchange regime, in theory, the Chinese and the U.S. interest rates should be the same when there are no capital controls but the authors find that there are substantial differences, which indicate that the capital controls are effective and allow monetary independence in China. They also show the interest differential has declined over time.

Kim and Lee (2008) also focus on testing monetary independence in East Asian countries from 1987-2002. They adopt a similar regression to Eq (2) although it also contains a lagged dependent variable. Because the sample includes the Asian financial crisis, some countries experience structural breaks and different regimes. Korea and Thailand had followed the U.S. base rate more closely before the crisis than after the crisis. Their results also indicate that Hong Kong and the Philippines appear to be monetarily dependent throughout the sample. On the other hand, Malaysia, Japan, Singapore, and Indonesia have insignificant coefficients throughout the period and therefore appear to possess high degree of monetary independence. The authors argue that even though Malaysia had a period of fixed exchange rates after the crisis, its strong capital controls allowed it to be monetarily independent, but no formal testing is done.

[13] It is interesting to note that for many countries, the realized changes in the exchange rate were not anticipated as measured by the forward discount. The discrepancy is largest for Korea and Japan.

Klein and Schambaugh (2015) study the trilemma relationship among countries where either capital controls or exchange rate flexibility is less than perfect. They find that, although both contribute to MI, exchange rate flexibility is given greater importance than capital controls as source of MI. In contrast, our results tend to give more weight to capital controls than exchange rate flexibility. Capital controls seem to be effective in enhancing MI whether the exchange rate is flexible or not while a loss of exchange rate flexibility may or may not mean a loss of MI depending on whether capital controls are binding or not.

6. Concluding Remarks

In this paper, we investigate international monetary policy trilemma in the context of 10 Asian countries. Trilemma suggests that there are two ways a country can increase its MI: greater flexibility in the exchange rate and lower degree of capital mobility. To correct for potential misspecification problems, we modify the existing monetary independence regression to include the desired interest rate (based on the Taylor rule). We have also considered not only the single equation but also the VAR model to address the possibility of feedback among the interest rates.

We find that MI is highest in countries where capital controls are imposed more widely or where exchange rate flexibility is high. MI is also lowest in Hong Kong – where the exchange rate has been fixed under a currency board system and capital controls hardly exist – in various specifications. Thus, our results are broadly consistent with the trilemma hypothesis.

The fact that China and Malaysia – the two countries that are known to have imposed strictest capital controls – consistently rank high in various setups while Hong Kong – which has maintained a nearly freest regime in capital markets – is lowest in MI indicates that perhaps capital controls may play a more important role than does exchange rate flexibility in securing independence in monetary policy making. On the other hand, countries that maintain greater exchange rate stability do not necessarily rank low, unless it is combined with greater capital mobility as in the case of Hong Kong.

Recently there has been a dilemma-trilemma debate. Rey (2015) notes that since the 1990s the world has become more financially integrated and capital flows are highly correlated across countries. She argues that in the presence of global financial cycles,

countries may obtain monetary independence only by imposing capital controls regardless of their exchange rate regime. In other words, the relevant tradeoff now is between monetary independence and free capital mobility. Klein and Shambaugh (2015) argue against Rey (2015) and provide evidence of the trilemma using the traditional methodology. They find that although both capital controls and greater exchange flexibility contribute to enhance monetary independence, exchange rate flexibility plays a greater role than capital controls unless the latter are quite extensive.

Our results tend to support the trilemma hypothesis in that high MI countries employ either greater exchange rate flexibility (as in Japan) or stronger capital controls (as in China and Malaysia). Across the group of all 10 countries, greater MI is consistently observed with stronger capital controls than with greater exchange rate flexibility. In that sense, our results are more supportive of the dilemma hypothesis as proposed by Rey (2015) while somewhat at odds with Klein and Shambaugh (2015).

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Table 1. Exchange Rate Regime and Capital Controls (1999-2015)

Country	Exchange Rate Regime	SD (exchange rate changes)	KAOPEN
China	Managed float	3.88	0.84
Malaysia	Managed float	11.77	0.62
Japan	Free Floating	19.50	0.00
India	Floating	14.14	0.84
Indonesia	Managed float	23.58	0.37
Philippines	Floating	13.42	0.63
Thailand	Floating	12.79	0.69
Korea	Floating	20.43	0.50
Singapore	Managed float	9.44	0.00
Hong Kong	Currency board	0.79	0.00

Note: KAOPEN is Chin-Ito (2008) capital control index, estimation is based on data availability for each country from 1999-2015.

Table 2. Augmented Dicky Fuller Test (1999-2015)

	DF	Critical Values		
	Statistic	1%	5%	10%
USA	-3.484	-3.48	-2.849	-2.568
China	-1.369	-3.485	-2.93	-2.642
Malaysia	-1.417	-3.48	-2.892	-2.607
Japan	-2.707	-3.48	-2.826	-2.546
India	-1.983	-3.48	-2.825	-2.546
Indonesia	-2.863	-3.489	-2.941	-2.653
Philippines	-3.366	-3.494	-2.831	-2.552
Thailand	-2.851	-3.48	-2.826	-2.546
Korea	-2.844	-3.48	-2.838	-2.557
Singapore	-3.224	-3.465	-2.824	-2.545
Hong Kong	-2.753	-3.462	-2.824	-2.545

Table 3. Engle-Granger Cointegration Tests (1999-2015)

	Base Rate and Home Rate				Base Rate, Home Rate and Taylor Rate			
	statistic	1% Critical	5% Critical	10% Critical	statistic	1% Critical	5% Critical	10% Critical
China	-1.21	-3.959	-3.371	-3.068	-1.242	-4.376	-3.789	-3.5
Malaysia	-1.411	-3.956	-3.369	-3.067	-1.253	-4.373	-3.788	-3.5
Japan	-1.5	-3.951	-3.367	-3.066	-1.345	-4.367	-3.784	-3.5
India	-1.188	-3.952	-3.367	-3.066	-1.999	-4.368	-3.784	-3.5
Indonesia	-1.482	-3.96	-3.371	-3.069	-2.39	-4.396	-3.801	-3.5
Philippines	-2.271	-3.961	-3.372	-3.069	-3.14	-4.379	-3.791	-3.5
Thailand	-1.474	-3.952	-3.367	-3.066	-2.282	-4.378	-3.791	-3.5
Korea	-1.856	-3.951	-3.367	-3.066	-1.955	-4.368	-3.785	-3.5
Singapore	-2.452	-3.955	-3.369	-3.067	-2.722	-4.372	-3.787	-3.5
Hong Kong	-3.566	-3.953	-3.367	-3.066	-3.05	-4.372	-3.787	-3.5

Table 4. Baseline Regressions (1999-2015)

VARIABLES	China	Malaysia	Japan	India	Indonesia	Philippines	Thailand	Korea	Singapore	Hong Kong
Base Rate	0.00948	0.0836***	0.0388***	0.321***	0.980***	1.083***	0.350***	0.577***	0.428***	0.920***
	(0.0286)	(0.0200)	(0.00720)	(0.0554)	(0.119)	(0.102)	(0.0284)	(0.0250)	(0.0159)	(0.0162)
Constant	0.0239***	0.0307***	0.00167***	0.0740***	0.0741***	0.0386***	0.0200***	0.0277***	0.00358***	-0.00903***
	(0.00115)	(0.000528)	(0.000163)	(0.00204)	(0.00248)	(0.00290)	(0.000780)	(0.000677)	(0.000241)	(0.000340)
Observations	179	188	202	201	176	172	200	202	190	197
R-squared	0.001	0.098	0.104	0.122	0.245	0.452	0.489	0.714	0.876	0.948

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5. Regressions with Desired Interest Rate (1999-2015)

VARIABLES	China	Malaysia	Japan	India	Indonesia	Philippines	Thailand	Korea	Singapore	Hong Kong
Base Rate	0.0269	0.0849***	0.0216***	0.572***	-0.388***	1.177***	0.401***	0.565***	0.431***	0.892***
	(0.0272)	(0.0276)	(0.00696)	(0.0461)	(0.0860)	(0.148)	(0.0208)	(0.0255)	(0.0158)	(0.0152)
Desired Rate	0.0553***	0.0111	0.0550***	0.278***	0.965***	-0.103	0.0889***	0.0126	-0.0181***	0.00186
	(0.0144)	(0.0287)	(0.00990)	(0.0304)	(0.0373)	(0.104)	(0.00466)	(0.0306)	(0.00442)	(0.00495)
Constant	0.0212***	0.0301***	0.00161***	0.0364***	-.0256***	0.0447***	0.0155***	0.0277***	0.00418***	-0.00726*
	(0.00109)	(0.000954)	(0.000215)	(0.00364)	(0.00377)	(0.00638)	(0.000572)	(0.00175)	(0.000335)	(0.000430)
Observations	179	185	199	198	145	172	174	197	188	188
R-squared	0.039	0.111	0.319	0.392	0.866	0.457	0.757	0.713	0.883	0.951

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6. VAR Variance Decompositions of Home Rate (1999-2015)

	Original		With Desired Rate		
	Base rate	Home rate	Base rate	Desired rate	Home rate
China					
3 month	0.9	99.1	0.8	0.4	98.8
3 year	2.3	97.7	2.6	2.7	94.7
Malaysia					
3 month	0.5	99.5	0.3	3.2	96.6
3 year	3.7	96.3	5.5	18.6	75.8
Japan					
3 month	24.7	75.3	23.9	1.9	74.2
3 year	42.2	57.8	41.3	16.0	42.7
India					
3 month	6.3	93.7	6.6	0	93.4
3 year	15.5	84.5	18.8	26.2	55.0
Indonesia					
3 month	2.5	97.5	3.8	.3	95.9
3 year	21.5	78.5	32.7	3.5	63.8
Philippines					
3 month	1.0	99.0	1.1	1.0	97.8
3 year	40.1	59.9	39.6	10.7	49.7
Thailand					
3 month	27.2	72.8	37.1	6.3	56.6
3 year	46.6	53.4	45.2	27.0	27.8
Korea					
3 month	24.3	75.7	22.1	11.3	66.6
3 year	66.8	33.2	41.3	28.1	30.6
Singapore					
3 month	41.6	58.4	37.5	0.4	62.1
3 year	58.3	41.7	38.7	22.6	38.7
Hong Kong					
3 month	72.3	27.7	70.2	0.4	29.5
3 year	94.0	6.0	74.3	17.7	8.1

Table 7: Summary

	Benchmark model		With Desired Interest Rate	Benchmark model (VAR)	With Desired Interest Rate (VAR)
	(I)	(II)	(III)	(IV)	(V)
Criterion	R^2	α_2	$\alpha_2 - \alpha_3$	VD due to the base rate shocks	VD due to Base shocks – VD due to Desired rate shocks
High MI	CH MA JA	CH MA JA	CH MA JA IA	CH MA IN	CH MA IN
Intermediate MI	IN IA PH TH	IN TH KO SI	IN TH	IA JA PH TH	JA IA PH TH KO SI
Low MI	KO SH HK	HK IA PH	KO SI HK PH	KO SI HK	HK

Note: IN and IA denote India and Indonesia, respectively. VD stands for variance decomposition.

Table 8. Sample Standard Deviation of Trilemma Components (1999-2015)

	China	Malaysia	Japan	India	Indonesia	Philippines	Thailand	Korea	Singapore	Hong Kong
Capital Control	3.97	2.62	0.12	2.32	5.20	2.77	6.81	1.16	1.09	0.19
Forward Premium (Δf)	3.66	3.19	2.05	2.98	6.30	4.49	7.21	1.56	1.79	0.52
Interest Differential	2.31	2.07	2.11	2.39	3.08	2.58	1.62	1.22	1.28	0.50
Changes in exchange rate	3.88	11.77	19.50	14.14	23.58	13.42	12.79	20.43	9.94	0.79
Observations	179	188	202	201	176	172	200	202	190	197

Appendix A: Data Description

Monthly data is gathered on countries based on data availability for the following periods.

USA	1999.1 – 2015.9
China	1999.1 – 2013.11
Malaysia	1999.1 – 2015.9
Japan	1999.1 – 2015.9
India	1999.1 – 2015.9
Indonesia	2001.3 – 2015.9
Philippines	1999.1 – 2013.4
Thailand	1999.1 – 2015.9
Korea	1999.1 – 2015.9
Singapore	1999.8 – 2015.9
Hong Kong	1999.6 – 2015.9

Data on the 3-month interbank interest rates, exchange rates, forward rates, and NDF rates are taken from *Bloomberg*.
Data on Industrial Production, Unemployment and inflation are from the IMF – *International Financial Statistics*.