International Transmissions of Monetary Shocks

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Abstract:

The well-known trilemma theory states that the nominal exchange rate regime plays a crucial role in a country's ability to pursue monetary policy, that is, for its domestic objectives independent from other countries' influences. In particular, a flexible exchange rate is required for an independent monetary policy. Capital controls may help a country with a fixed exchange rate to gain some policy space but the effect of capital controls is leaky and often short-lived.

We contribute to the current literates in several ways: (1) we examine both short-term and long-term interest rates, different from Obstfeld (2015), by introducing the nominal exchange rate and capital control simultaneously, we found even at the short end of term structure, the flexible exchange rate does not provide monetary policy autonomy; (2) different from Han and Wei (2014), in this analysis, we use the WEO forecast revisions of output and CPI to formulate the domestic factor driven policy rate changes, include the long-term bond yield, and most importantly extend to include the US unconventional monetary policy episodes with its policy rate reaching its lower bounds

In particular, a flexible exchange rate does not reliably deliver monetary policy independence, but capital controls do. This is consistent with the view that most (developing) countries dislike either depreciation or appreciation of their currencies, and therefore would choose to follow US monetary policy moves even if they are on a flexible exchange rate regime, among which, those with more foreign exchange reserves are more likely to follow. In open economies, the flexible exchange rate regime can help the short-term policy rates be less affected by the US monetary policy changes, compared to the fixed exchange rate regime. However, it cannot grant a full immunity. The long-term bond yields show similar pattern as that of short-term interest rates. While conditional on countries allowing free capital flows, a flexible exchange rate help to mitigate the transmission of the US monetary shocks. In other words, to build resilience against international monetary policy shocks, some capital controls (prudential policies on capital flows) appear to be a necessary component.

Key Words: Trilemma, Monetary Policy Independence, Taylor Rule, Exchange Rate Regime, Capital Control

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1. Introduction

When the United States' (US) interest rate rises, there is often a reversal of international capital out of emerging market economies and back to advanced economies. This appears to increase the likelihood that emerging market economies may run into a financial crisis, especially foreign exchange crisis or foreign debt crisis (Frankel and Roubini, 2001). Perhaps for this reason, even before the US started to actually raise its interest rate, mere talk of an end to the quantitative easing policy by the Federal Reserve Chairman in May 2013 triggered jitters in financial markets in countries such as India and Indonesia (Sahay et al., 2014). Governor Raghuram Rajan of the Reserve Bank of India thus complained about the negative spillovers from a change in US monetary policy to emerging market economies.

What can emerging markets do to increase their resilience to foreign monetary policy disturbances? The well-known "trilemma" hypothesis in the international finance literature states that a country cannot simultaneously pursue a fixed nominal exchange rate regime, free capital mobility, and independent monetary policy. In particular, if a country wants its monetary policy to be independent from US (or other foreign) monetary policy so as to attend to its domestic policy objectives, it needs to either pursue a flexible exchange rate regime, or impose capital controls. Since the literature suggests that capital controls are leaky (Edwards, 2012) or costly (e.g., Wei and Zhang, 2007), their effects are regarded as not reliable. Klein and Shambaugh (2015) study the effects of partial capital controls and moderately flexible exchange rate; they find that the former does not confer monetary policy autonomy but the latter does allow for some degree of monetary autonomy. Based on this logic, the IMF has encouraged many of its member countries to pursue exchange rate flexibility (e.g., IMF's Article IV reports on the People's Republic of China, 2014).

However, some in the literature have found that a flexible exchange rate regime does not appear to be that special in reducing the impact of the global financial crisis on developing countries (e.g., Tong and Wei, 2011) because capital that flows out of developing countries do not appear to discriminate across nominal exchange rate regimes, or in facilitating current account adjustments (Chinn and Wei, 2013). Rey (2013) shows that the broad direction of cross-border capital flows appears quite independent from a country's nominal exchange rate regime. This raises the question that, in practice, there may only be a dilemma (a choice between free or controlled capital flows), not a trilemma.

Curiously, very few in the literature formally test whether the relationship between a country's domestic monetary policy and the policy of the dominant economic hegemony (the US Federal Reserve policy) depends on a country's nominal exchange rate regime and capital control regime with the important exception of Obstfeld (2015), Klein and Shambaugh (2015), and Aizenman et al., (2015).

In this paper, we aim to fill this void. For this purpose, we introduce a framework to allow the policy rate of a country to depend on four factors: the one-period lagged policy rate, the desired policy rate driven by domestic needs, the policy rate of the dominant foreign country, and a global financial cycle factor. The dominant country refers to the US in our analysis. If capital controls give a country full monetary independence, the coefficient on the US monetary policy for countries with capital controls should be zero, conditional on the desired domestic monetary policy stance. A nominal exchange rate regime does not matter. On the other hand, if a flexible nominal exchange rate yields monetary policy independence, the coefficient on US interest rate would be zero for countries with a flexible exchange rate system, after taking into account the desired level of interest rate based on domestic fundamentals.

With our methodology, we find that a flexible nominal exchange rate alone does not help a country to gain monetary policy independence. This is consistent with the idea that most developing countries are reluctant to see either a large appreciation of their currency (for fear of hurting their exports) or a large depreciation (for fear of worsening domestic agents' debt problems), even if they have a flexible exchange rate regime. In this sense, (the strict interpretation of) the trilemma hypothesis that a flexible exchange rate regime provides a country monetary policy autonomy does not hold in the data. In the open economies, flexible exchange rate regime allows economies affected less by the foreign monetary shocks than the fixed exchange rate regime. However, it does not provide a full immune as suggested by the trilemma theory.

On the other hand, we find that capital controls are more effective in improving a country's monetary policy independence. The combination of flexible exchange rate and capital controls provides the most effective tool to have a full immune. This finding is robust to different definitions of fixed/flexible exchange rate regimes and capital controls, different ways of specifying a desired policy rate driven by domestic factors, and different estimation methods.

These findings differ from Obstfeld (2015), Klein and Shambaugh (2015), and Aizenman et al., (2015), and therefore require some clarification. While Obstfeld (2015) commented on capital controls, he does not actually measure and investigate their effects explicitly in his regressions. Since many countries with a flexible nominal exchange rate regime also maintain capital flow management, what appears to be the effect of a flexible exchange rate could instead be the effect of capital controls. While Klein and Shambaugh (2015) do check capital controls and exchange rate flexibility separately, their specification does not easily control for common shocks. In other words, a country with capital controls may happen to have shocks to fundamentals similar to shocks to the US such as its optimal monetary policy may be similar to that for the United States. In this case, co-movement in the monetary policies need not indicate lack of monetary autonomy. In our paper, we adopt a different specification that uses a Taylor rule to capture the kind of monetary policy change that is required of based on domestic inflation and growth fundamentals. We can then check if there is any remaining part of the domestic policy change that is linked to foreign (US) policy change, and if the linkage depends on the country's capital control regime or exchange rate regime. As we show, this change in the specification leads us to reach a different conclusion.

Farhi and Werning (2014) uses a New Keynesian model to study whether capital controls are needed for welfare maximization when a country already has a flexible exchange rate. They found that the answer is yes: even with a flexible exchange rate regime, capital controls raise welfare. .In their framework, capital controls are introduced as "tax" over capital inflows during capital inflow surges caused by negative risk premium shock and as "subsidies" to capital outflows when the capital flows revert. That is, capital controls work in an opposite way of risk premium shocks. When the social welfare is affected by both terms of trade and the intertemporal path of consumption, it is generally useful to use both tools.

With a flexible exchange rate to influence terms of trade and capital controls to influence intertemporal consumption, the social welfare is higher than just using one of the tools. Our paper contributes to the literature in several ways. In order to gauge the appropriate monetary policy change based solely on domestic fundamentals, we embed a Taylor rule as a control. Since the required changes in the monetary policy should be based on surprises in inflation and output gap, one innovation of the paper is to use revisions of the WEO forecasts on GDP growth and inflation to proxy surprises. This innovation represents one of the significant improvements over Han and Wei (2014), who also attempt to study similar questions. In addition, we also study movements in long-term interest rates and propose a way to study the monetary policy change during the US quantitative easing episode (when we do not observe much change in US interest rates). We are not aware of any other paper in the literature that does it this way.

Aizenman et al. (2015) introduced both exchange rate stability and financial openness in analyzing the sensitivity of peripheral countries' policy rate to core countries' monetary policy. However, they introduce the exchange rate stability and financial openness separately and not as a policy combination. Obstfeld (2015) tested the interest rate independency in an explicit way, however, only limited to open economies. That is, conditional on freely mobile capital flows, whether flexible exchange rate allows independence. In addition, he finds substantial comovements in the long-term interest rates across countries, regardless of their nominal exchange rate regime. This appears to suggest that exchange rate flexibility confers some monetary policy autonomy in the short run, but not in the long run. Both our specification and country sample are different from his. By introducing the nominal exchange rate and capital control simultaneously, we find that even in the short run, a flexible exchange rate regime does not reliably confer monetary policy autonomy. On the other hand, both in the short run and in the long run, capital controls, especially when combined with a flexible exchange regime, appear to provide some monetary policy autonomy

Another innovation of the paper is to propose a methodology to include the QE episodes when we do not observe much change in the US interest rate (as it has already reached a lower bound). We use a likelihood function to incorporate the latent (but censored) policy rates, in which a money supply equation is used to model the latent unobservable policy rate.

When the US interest rate is outside the lower bound, US monetary policy changes can be directly observed from the changes in its interest rate. However, when the interest rate is at or near the lower bound, we estimate a latent interest rate based on money supply and aggregate output. To our best knowledge, this is the first attempt in the literature to incorporate the low-bound episodes policy rate changes with a censored distribution approach.

This paper is organized as follows. After describing the model and data in Section 2, we present the baseline empirical results in Section 3, and report various robustness checks in Section 4. Section 5 sails out extended analysis including lower-bound episodes. We conclude in Section 6.

2. Model and Data

2.1 Baseline specification

We assume the changes in policy interest rate of country i in time t, $\Delta i_{i,t}^{p}$, is affected by four parts: the one period lagged policy rate $i_{i,t-1}^{p}$, a change in the desired policy rate, $\Delta r_{i,t}^{P*}$, based on purely domestic factors, a change in the interest rate of a foreign monetary policy hegemony, which we will hold to be the US throughout the paper, Δr_{t}^{US}, and a global financial cycle factor, for which we use the percentage changes of Chicago Board Options Exchange Market Volatility Index, ΔVIX_{t}, to approximate i.e.,

(1) $$\Delta i_{i,t}^{p} = \lambda i_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 \Delta r_{t}^{US} + \delta \Delta VIX_{t} + \varepsilon_{i,t}.$$

The one period lagged policy rate $i_{i,t-1}^{p}$ allows flexibility for different policy rate changes. A higher lagged policy rate allows more space for downward policy changes. We expect to have a negative estimate λ.

We derived domestic factor driven policy rate $\Delta r_{i,t}^{P*}$ with Taylor Rule. In other words, $\Delta r_{i,t}^{P*}$ is assumed to be determined by the domestic output gap and the inflation gap. Different from Obstfeld (2015) and Han and Wei (2014), we used the revisions in forecasts of GDP and CPI to represent the output gap and the inflation gap. We expect to have positive estimates for both factors.

We took two approaches to incorporate the Taylor-rule to form the domestic-factors-driven policy rate changes, $\Delta r_{i,t}^{P*}$. The primary approach is to include the output and CPI changes directly into the regression and estimate the coefficients together with other parts of equation (1).[3] An alternative approach uses the classic pre-assigned parameters for the output gap and the inflation gap and introduces it as one variable into equation (1)[4]. Since the domestic factors are not our focus in this analysis and power consideration, we assume the weights on output gap and inflation gap are common across countries. We use the first specification as the baseline but will use the pre-assigned Taylor rule specification as a robustness check. The least squares regression model of the Taylor rule is defined as:

$$(2)\quad \Delta r_{i,t}^{P*} = \tilde{c} + \widetilde{\phi_1} * \Delta GDP\ growth_{i,t} + \widetilde{\phi_2} * \Delta Inflation_{i,t} + \widetilde{e_{i,t}}$$

where $\tilde{c}$ is the intercept term and $\widetilde{e_{i,t}}$ is the error term. The term $r_{i,t}^{p*}$ is the desired monetary policy rate of country i and $\Delta r_{i,t}^{P*}$ is its first order difference.

As the central objective of the paper is to examine effectiveness of capital controls and nominal exchange rate system in gaining monetary policy independence, we further specify the parameter γ_2 in equation (1) by differentiating the capital controls and nominal exchange rate regimes as

$$(3)\quad \gamma_2 = \beta_1 D_{fixed.NC} + \beta_2 D_{fixed.C} + \beta_3 D_{flex.NC} + \beta_4 D_{flex.C},$$

where

$D_{fixed.NC}$ =1, if a country adopts a fixed exchange rate regime without capital controls strategy;

$D_{fixed.C}$ =1, if a country adopts a fixed exchange rate regime with capital controls strategy;

$D_{flex.NC}$ =1, if a country adopts a flexible exchange rate regime with no capital controls strategy; and

$D_{flex.C}$ =1, if a country adopts a flexible exchange rate regime with capital controls strategy.

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[3] According to Basilio (2012) and Coibion and Gorodnichenko (2011), the least squares regression model of the Taylor rule outperforms its classic formulation by including a lagged term of the policy rate, GDP growth, and inflation. Since in formula (1) we have included a lagged term of the policy rate, here we formulate the Taylor Rule-based policy rate changes by including changes in GDP growth and changes in inflation.

[4] We assign the parameter for output gap as 0.5 and the parameter for CPI gap as 1.5. For example, see Hofmann and Bogdanova (2012).

We introduced one dummy for each regime combination rather than using one regime as the benchmark. In this way, we can compare the coefficients of βs directly.

As recommended in Obstfeld (2015), Rey (2013), and Bruno and Shin (2013), the global financial cycle effect is an important variable in this line of analysis. We therefore introduce ΔVIX_t (the implied volatility of S&P 500 index options) in our model. ΔVIX_t has been used to measure risk aversion and uncertainty. Lower values of ΔVIX_t indicates higher risk appetite/greater tolerance of risk-taking.

Substituting Δr_i^{P*} and γ_2 in equation (1) with equations (2) and (3), we have

$$(4)\ \Delta i_{i,t}^{p} = c + \lambda i_{i,t-1}^{p} + \phi_1 * \Delta GDP\ growth_{i,t} + \phi_2 * \Delta Inflation_{i,t} + \beta_1 D_{fixed.NC} \Delta r_{i,t}^{US} + \beta_2 D_{fixed.C} \Delta r_{i,t}^{US} + \beta_3 D_{flex.NC} \Delta r_{i,t}^{US} + \beta_4 D_{flex.C} \Delta r_{i,t}^{US} + \delta \Delta VIX_t + e_{i,t}\ ,$$

where c is the intercept term and $e_{i,t}$ is an error term.

Equation (4) is the baseline model we use in this paper to do the empirical estimations.

To examine whether the trilemma argument holds, we divide countries into groups according to two dimensions: fixed/flexible exchange rate regime and with/without capital controls strategy[5]. As listed in Table 1, the baseline combination is the fixed exchange rate regime without capital controls. The coefficients estimate of β_1 shows how much spillover of the US policy rate changes has on economies with fixed exchange rate regime without capital control.

According to the logic of the trilemma hypothesis, we expect β_1 >0. Indeed, if $\beta_1 = 1$, then the country with a fixed exchange rate regime without capital controls should see their interest rates change one for one with any change in the US interest rate. As long as β_1 >0, we cannot reject the original argument of the trilemma. However, if we want to pursue more the effectiveness of policy choices in terms of exchange rate and capital control regimes, this can be accomplished through the lens of $\beta_2, \beta_3,$ and β_4.

[5] Table 2 presents country/month classifications based on the four combinations.

If a flexible nominal exchange rate is enough to allow the country to obtain monetary policy independence (irrespective of its capital control regime), we would expect $\beta_3 = 0$ and $\beta_4 = 0$. If capital controls would also provide monetary policy independence, we would further expect $\beta_2 = 0$.

Obstfeld (2015) argued that in open economies, flexible exchange rate help obtaining monetary policy autonomy at the short-end of term structure, which, in our framework, is to test hypothesis $\beta_1 > 0$ and $\beta_3 = 0$

Under the alternative hypothesis following the "fear of floating" argument, most countries without capital controls do not wish to see large movements in their exchange rates and therefore adjust their interest rates in tandem with the US rate even if they have a flexible exchange rate. In that case, we would expect $\beta_3 > 0$.

2.2 Data

In addition to the US, our original sample contains 60 economies, including 24 emerging economies. The country names are listed in Appendix Table A1. In this table, countries using the euro as their currency and the year of joining euro zone are labeled. In our baseline analysis, we include Germany to represent the euro currency country and exclude all the other euro currency counties since they have their own regional central banks and are assumed to be affected in the same way by the monetary policy of the US. We further exclude countries pegged with the euro (post-1999) or pegged with the German mark (pre-1999). The resulting dataset includes 28 countries[6] (excluding the US) and 827 observations. However, we did include euro zone economies back so to make our results comparable to the previous literature in section 5.

The short term interest rates are monthly policy rate data covering M1 1990 to M6 2014 from IMF's IFS dataset. Our primary purpose in this paper is to investigate the policy rate response of each country toward monetary policy changes in the US. Therefore, for countries

[6] Argentina; Australia; Belarus; Bolivia; Brazil; Canada; Chile; China, People's Rep. of; Colombia; Costa Rica; Ecuador; Germany; Hong Kong, China; India; Indonesia; Israel; Japan; Korea, Republic of; Mexico; New Zealand; Pakistan; Peru; Philippines; Singapore; South Africa; Thailand; Turkey; United Kingdom.

reporting their monetary policy interest rate, we use the policy rate itself. For those do not report their monetary policy rate, we use the discount rate instead. A detailed description of the rates used by each country as the policy rate in the IFS dataset can be found in Appendix Table A2. The policy rates are used to construct the changes in policy rate, $\Delta i_{i,t}^{p}$. In the baseline model we also examine the long-term interest rates' response to the US long-term interest rate changes. For this purpose, we use 10 year government bond yield. Among the 28 countries used in the short-term policy rate analysis, Argentina, Belarus, and Ecuador do not have appropriate long-term government bond yields data and are excluded from the dataset used for long-term rate analysis. In Table A2, we list the details of data source and period coverage of government bond yields.

To incorporate the effects of domestic factors, as shown in equation (4), we need two variables – changes in GDP growth and changes in inflation. To get more "exogenous" changes in GDP growth and changes in inflation, instead of using the first-order difference of GDP growth and inflation, we use IMF's World Economic Outlook (WEO) forecast and the revisions in their forecasts of GDP growth and inflation. WEO's forecast data starts from 1990. Each year, WEO has two publications: one in April and the other in September (for some years, the second issue was released in October). For the forecast of each year, we use two revisions. For example, for the forecast of GDP (output) growth for year 2000, we use the forecasts published in WEO in October 1999, April 2000, and September 2000 to calculate two changes (revisions).[7] The same rules apply to the changes in inflation calculations. The left-hand side policy rate changes $\Delta i_{i,t}^{p}$ and the changes in US policy rate are calculated as the difference of monthly policy rates between the two adjacent WEO publication months.

We use the Ilzetzki et al. (2010) de facto exchange rate regime classification to define fixed and flexible exchange rate regimes. Classification 1[8] is defined as fixed exchange rate. The remaining categories 2, 3, and 4 are defined as flexible exchange rate. Countries that were pegged with the German mark or euro were re-defined as flexible exchange rate since we solely focus on the US monetary policy shocks in this analysis. The detailed descriptions

[7] That is, $\Delta GDP\ Growth_{i,Apr.2000} = GDP\ Growth_{i,Apr.2000} - GDP\ Growth_{i,Oct.1999}$ and $\Delta GDP\ Growth_{i,Sep.2000} = GDP\ growth_{i,Sep.2000} - GDP\ growth_{i,Apr.2000}$.

[8] Including: no separate legal tender, pre-announced peg or currency board arrangement, pre-announced horizontal band that is narrower than or equal to +/-2%, and de facto peg.

drawn from Ilzetzki et al. (2010) can be found Table A3 in the Appendix.[9] An alternative regime classification by AREAER is used in the robustness check analysis. It starts from 1999. We label countries in category 1-3 (pre-2008) and 1-4(post-2008) as the ones with fixed exchange rate regime. Detailed descriptions can be found in Table A4 in the appendix.

For capital controls, we use the index of financial openness/integration proposed by Chinn and Ito (2008), which is the first principal component of various variables that indicate the presence of multiple exchange rate regimes, restrictions on current and capital account transactions, and the requirement of the surrender of export proceeds based on information provided in AREAER. We construct our index by taking 1–Chinn-Ito Index. Higher values imply more controls or less freedom to move capital across national borders. In our baseline model specification, countries that have capital controls are those with a capital control index that is larger than zero; they are considered as having no capital controls otherwise.

Since there are no policy rate changes in the US starting from September 2009, our baseline analysis is limited to the period from May 1990 to April 2009. The period coverage with latent policy rate approximated by money supply is extended to September 2012.

3. Analysis

We start our analysis with the short-term policy rate as the focus. Before running the regression, we first examine the effectiveness of capital controls and exchange rate regimes by checking the associations of domestic policy rate changes and US policy rate changes. In Figure 1, we select one country for each regime and plot the policy rates together with that of the US. The strongest association between domestic and US interest rates comes from Hong Kong, China, an economy with a combination of a fixed exchange rate without capital controls. The second strongest association comes from Peru, a country with a combination of a flexible exchange rate without capital controls. The remaining two economies, Ecuador (with a fixed exchange rate and capital controls) and the Philippines (with a flexible exchange rate and capital controls) exhibit a weaker link with the US interest rate. In these

[9] We further revise the classification for Hong Kong, China. In the Ilzetzki et al. (2010) classification, from 1974 to 1997, it was defined as category 3. However, the Hong Kong dollar has been pegged to the US dollar since 1983. Therefore, in our dataset, we classify it as fixed exchange rate regime.

examples, capital controls appear to provide some insulation to domestic monetary policy from foreign influence, but a flexible exchange rate does not.

We further our exploration with two additional plots: one is unconditional plot and the other is conditional plot for each of the four regimes. In the unconditional plot, as shown in Figure 2, the changes of domestic policy rate (vertical axis) is plotted against the changes of US policy rate (horizontal axis). To reduce the noises, we first grouped observations in each regime into twenty groups evenly and took the group average. Therefore, for each regime, we have twenty observations. Based on these constructed observations, a linear regression line was fitted, as shown by the solid red line with the 90% confidence interval (in dashed red lines). The fitted regression lines for regimes without capital control are significantly positive whereas those for regimes with capital controls are not. Figure 3 presents a conditional plotting. Different from Figure 2, we first regressed the changes of domestic policy rate and the changes in US policy rate on their one-period lagged policy rate, changes in growth rate, changes in inflations, andΔVIX_t respectively. The residuals of the regressions (adjusted changes of domestic policy rate and adjusted changes of US policy rate) are used to represent the domestic and the US monetary policy changes. Following the same procedures as in the unconditional analysis case, we have similar results in Figure 3 as in Figure 2: significantly positive slope for regimes without capital controls.

To test the hypothesis systematically, we turn to a regression analysis based on equation (4) and report the baseline estimation in Table 3.

As presented in column 1 of Table 3, consistent with our expectation, the coefficient estimate of λ for the lagged policy rate (–0.048) is negative and statistically significant at 10%. It implies that there is a stabilizing tendency for policy rate adjustments. With a higher lagged policy rate per se, the policy maker tends to adjust the current policy lower.

The coefficient estimate for $\Delta GDP\ growth_{i,t}$ is 0.096, but with no statistically significant difference from zero. The coefficient estimate for $\Delta Inflation_{i,t}$ is 0.329, statistically significant at 10%. These estimates are different from the classic Taylor rule parameters for output gap and inflation gap.[10] However, selected recent empirical findings with various Taylor rule-derived formulas provide comparable estimates. For example, Boivin and Giannoni (2006) estimate a forward-looking Taylor rule with two lagged policy rates as additional explanatory variables to formulate US monetary policy. Their estimate for output gap is 0.000 for both pre-1979 and post-1979 periods and their estimate for inflation gap is 0.276 for pre-1979 and 0.508 for post-1979. Comparable estimates were also found in Kawai and Liu (2015) for the PRC and Coibion and Gorodnichenko (2011) for selected years in the US. Engel (2011) argues that when there are currency misalignments,[11] the optimal monetary policy trades off targeting misalignments with inflation and output goals, under which the resulting Taylor rule relates the nominal interest rate in each country only to the CPI inflation in that country, the efficient real interest rate, and markup shocks. The absence of output gap in this optimal monetary policy partially justifies the coefficient estimate of 0.096 for $\Delta\text{GDP growth}_{i,t}$ in our results.

The coefficient for the benchmark regime – fixed exchange rate without capital controls – turns out to be positive and statistically significant at 10%. That is, an increase in the US interest rate by 100 basis points is followed by an increase in a peripheral country's interest rate by 65 basis points on average.

The coefficients for regimes with capital controls are not statistically significantly different from zero. This is consistent with an interpretation that capital controls in combination with a fixed exchange rate or a flexible exchange rate allow a country's monetary policy to be immune from the influence of the US rate.

However, the coefficient for the regime with flexible exchange rate without capital controls is positive and statistically significant at 10% too, with an increase in interest rate of 45 basis points following a 100 basis point increase in the US interest rate. This means, without capital controls, countries on a flexible exchange rate regime generally follow US monetary policy moves with their own moves in the same direction, albeit not one for one. In terms of point estimates, since $\beta_4 = 0.45 < \beta_1 = 0.65$, we could say that, without capital

[10] As shown in the robustness check section, the coefficient for output gap is defined as 0.5 and that for inflation gap is 1.5 in the pre-assigned parameter Taylor rule.

[11] Households in the home and foreign countries pay different prices for the identical good.

controls, a flexible exchange rate may buy the country a little bit more policy space, such that its monetary policy doesn't have to move as much as its counterpart with a fixed exchange rate regime in response to a change in US monetary policy. However, a formal F test[12] for the difference between the two (with the restriction of $\beta_4 = \beta_1$) fails to reject the null hypothesis that the two regimes are statistically the same.

Since year 1999 is the starting year of the euro zone (also the middle point of our sample), we examine whether the start of the euro zone has changed the power of our model by splitting the sample into two subsamples: 1990–1998 and 1999–2009. As shown in columns (2) and (3) of Table 3, none of the coefficients for the period 1990-1998 are significant. The adjusted R-squared is 0.000. On the contrary, the coefficients for the period 1999–2009 (column 3) show similarity with that of the whole sample (column 1). The adjusted R-squared is 0.30. The difference between the periods 1990–1998 and 1999–2009 implies that the resilience of monetary policy to international monetary policy shocks gets weaker from 1990–1998 to 1999–2009 (significant positive coefficient estimates for regimes of fixed exchange rate without capital controls and flexible exchange rate without capital controls), which is consistent with the common observations for higher integration of global capital markets, for example, see Rey (2013). The robustness check in the following analysis is thus based on the period of 1999–2009.

As discussed in the alternative hypothesis in section 2, countries with flexible exchange rates without capital controls tend to adjust their policy rates in tandem with the US rate. For this particular regime (flexible exchange rate without capital control), we differentiated US policy rate hikes and cuts by adding one more term $D_{flex.NC}\Delta r_{i,t}^{US} * Dummy_{\Delta r_{i,t}^{US}>0}$, where $Dummy_{\Delta r_{i,t}^{US}>0} = 1$ when the US rate is increased. As shown in column (5) in Table 3, the estimate of β_3 for the term $D_{flex.NC}\Delta r_{i,t}^{US}$ now is dedicated to periods with negative US rate changes, which is 0.673 (similar to the magnitude of β_1 as 0.678). However, when the change in the US rate is positive, the coefficient estimate $\beta_{4,\Delta r_{i,t}^{US}>0}$ is –0.585 (almost offsetting the positive effect of β_3). We carried out a formal F test to test the hypothesis that $\beta_3 + \beta_{3,\Delta r_{i,t}^{US}>0} = 0$, the resulting F test is 0.0775. We cannot reject the hypothesis that

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[12] $F \frac{(R_{UR}^2 - R_R^2)/1}{(1 - R_{UR}^2)/827} = 1.11$

$\beta_3 + \beta_{3,\Delta r_{i,t}^{US}>0} = 0$. That is, there is asymmetry in the monetary policies of countries with flexible exchange rates and without capital controls: they only voluntarily follow US rate changes when the US rate decreases. When the US rate increases, they tend not to move. Our findings are consistent with what Di Giovanni and Shambaugh (2008) have argued: the comparative interest rate independence allows countries with flexible exchange rates to shield themselves from the contractionary output effects of higher interest rates abroad.

Different from short-term policy rate, Hellerstein (2001) and Dahlquist and Hasseltoft (2012) argued that the long-term interest rates are more correlated across countries than short-term rates because of the integrated bond markets across countries, in which, countries' term premiums are closely linked to the US bond premium. Obstfeld (2015) therefore compared the short-term interest rate with long-term interest rate in evaluating the monetary policy independence and found that in open economics, the flexible exchange rate allows countries exercise considerable monetary autonomy at the short-term structure, but does not have much power at the long-term structure.

We re-visited the conclusion with our modeling specification by replacing the policy rates with the 10 year government bond yield. As shown in the Table A2 in the appendix, 10 year government bold yield data is more limited than that of the policy rate. For the long-term bond yield, we exclude three countries - Argentina, Belarus, and Ecuador because these countries did not have appropriate long-term government yield data; and exclude certain episodes since for some countries, such as PRC and Brazil, they only have shorter coverage. The empirical estimation results with long-term government bond yield as the dependent variable are presented in column (4) in Table 3. Our general conclusion for the short-term interest analysis holds for the long-term interest rates. The one period lagged long-term interest rate $i_{i,t-1}^{L}$ has significant negative sign. The revisions in GDP and CPI forecasts have significant positive signs, but with a much lower coefficient for CPI revision (compared with the baseline case for short-term interest rate as in column (3) of Table 3), which implies that the role of long-term interest rate in domestic macroeconomic targeting is much smaller than that of the short-term policy rate. Our findings are also echoing the argument of Obstfeld (2015): the domestic macro variables play roles in determining long-term interest rates.

As shown in column (4) in Table 3, the coefficients of the exchange rate and capital control regimes for the long-term interest rate are similar to those under the short-term interest rates. Both regimes without capital controls are significantly positive with higher estimate for regime with fixed exchange rate as 0.68 and lower estimate for regime with flexible exchange rate as 0.41. Therefore, our conclusion that capital controls are more effective in helping economies being less affected by the US monetary policy shocks holds for both short-end and long-end of the term structures.

To verify that our findings are not subject to bias induced by the smaller sample for the long-term bond yield data, we reduced the short-term policy dataset size by including the same country-episodes as that of the long-term data. The results are shown in column (2) in Table 5A in the appendix. It shows that the conclusion of the baseline model does not change either.

By introducing the capital controls differentiation explicitly in the model, our findings are partially agree and partially divert from those of Obstfeld (2015). We found that at the short-end of the term structure, in open economies (regimes without capital controls in our framework), while the flexible exchange rate allows higher autonomy compared with the fixed exchange rate, however, not total immunity. We provide our conjectures on the reason that for open economies with flexible exchange rate, they are willingly to go in tandem with the US monetary policy changes.

We further carried out F-test for two null hypothesis: $\beta_2 = \beta_3$ and $\beta_4 = \beta_3$. It is to testify the coefficients of the regime with fixed exchange rate and capital controls and the regime with flexible exchange rate and capital controls are significantly different from that of the regime with flexible exchange rate and no capital controls. As shown by the F-test results in Table 3, for column (1), (2), and (4), β_2 is not significantly different from β_3. For column (1) and (3), β_4 is significantly different from β_3. The F-test results tend to reveal that the regime with flexible exchange rate and capital control (β_4) is the most effective policy tools to yield monetary independence. This conclusion is also supported by the SUR robustness check as shown in the following Table 5.

To summarize, we provide evidence that capital controls offer a country some ability to focus its monetary policy on domestic objectives, unaffected by changes in US monetary policy. On the other hand, there is no significant evidence that a flexible exchange rate regime confers reliable monetary policy independence.

4. Robustness Check

4.1. Re-defining capital controls

Instead of using a dummy variable to indicate the presence or absence of capital controls as in the baseline estimation, we now use a continuously valued index, defined as 1–Chinn-Ito index (closer to 1 means stricter capital controls) for both the short-term policy rate and the long-term government bond yields.

As shown in column (1) and (2) of Table 4, the results using the continuous capital control index is quite similar to the results of the baseline for both short-term policy rate analysis and long-term bond yield analysis: significant and positive coefficient estimates for the two regimes without capital controls. In particular, $\beta_1 = 0.558$ and $\beta_3 = 0.322$ for short-term policy rate analysis and $\beta_1 = 0.667$ and $\beta_3 = 0.402$ for long-term bond yield analysis. This means that for the short-term policy rate, a country with a fixed exchange rate regime without capital controls does not have an independent monetary policy. On average, when the US raises its interest rate by 100 basis points, the peripheral country with fixed exchange rate without capital controls hikes its interest rate by 56 basis points while a country with flexible exchange rate without capital controls hikes its interest rate by 32 basis points.

4.2. *Re-defining the fixed/flexible exchange rate regime*

As robustness check, we adopt IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) for the exchange rate regime classification alternative. The AREAER exchange rate classification has 10 categories, with higher numbers indicating more flexible exchange rate regimes. Before 2008, the AREAER classification has eight categories. Detailed classifications can be found in Table A4 in the Appendix. We use the "peg" as fixed exchange rate regime and the remaining categories as flexible exchange rate regime. Following Habermeier et al. (2009), we define the "peg" by including category one (no separate legal tender), category two (currency board arrangements), and category three (other conventional fixed peg arrangements) under the pre-2008 AREAER classification and category one (no separate legal tender), category two (currency board), category three (conventional peg), and category four (stabilized arrangement) under post-2008 AREAER classifications. The remaining categories are classified as flexible exchange rate regime. In our analysis, we solely focus on the influence of US monetary policy changes. Therefore, we adjust the AREAER exchange rate classification so that countries with currencies pegged to the euro are classified as those with "flexible" exchange rate regime, rather than with "fixed" exchange rate regime. More details can be found in Table A1 of the Appendix.

With this alternative classification of nominal exchange rate regimes, as shown in column (3) and (4) of Table 4, we obtain essentially the same qualitative conclusions as in the baseline case. That is, significant and positive estimates for regimes without capital controls and insignificant estimates for regimes with capital controls for both short-term policy rate and long-term bond yield analysis.

4.3. Use of the imposed-parameter Taylor rule rate to construct r_i^{P*}.

We now use an alternative specification to calculate the Taylor rule rate. In particular, the parameters for the inflation gap and the output gap are assigned rather than estimated. Following Taylor (1993) and Hofmann and Bogdanova (2012), we choose the following specification:

(5) $r_{i,t}^{P*} = r^* + \pi^* + 1.5(\pi - \pi^*) + 0.5y,$

where r^* is the long-run or equilibrium real rate of interest. Empirically, the trend growth rate of real GDP is used to approximate r^*. The term π is the inflation rate and $\pi^*$is the central bank's inflation objective[13]. In our specification we focus on the changes in desired monetary policy driven by the Taylor rule, that is, $\Delta r_{i,t}^{P*}$, which can be obtained simply by multiplying $\Delta GDP\ growth_{i,t}$ and $\Delta Inflation_{i,t}$ with 0.5 and 1.5, respectively.

[13] Empirically, several scenarios can be estimated by setting π^* for all countries equal to 2 (inflation target most commonly used), equal to 4 (as suggested by Huang and Wei, 2006), or equal to the sample average for advanced countries, as well as the Hodrick-Prescott trend for emerging countries while limiting the rates within the range announced by central banks if the countries adopted inflation-targeting strategies as described in Hofmann and Bogdanova (2012).

Replacing the Taylor rule rate in equation (4) with equation (5), we have

$$(6)\ \Delta i_{i,t}^{p} = +\lambda i_{i,t-1}^{p} + \gamma_1 \widetilde{\Delta r_{i,t}^{P*}} + \beta_1 D_{fixed.NC} \Delta r_{i,t}^{US} + \beta_2 D_{fixed.C} \Delta r_{i,t}^{US} + \beta_3 D_{flex.C} \Delta r_{i,t}^{US} + \beta_4 D_{flex.NC} \Delta r_{i,t}^{US} + \delta VIX_t + e_{i,t},$$

where $\widetilde{\Delta r_{i,t}^{P*}}$ is calculated by taking the first order difference of $r_{i,t}^{P*}$ based on equation (5).

As shown in column (5) and (6) in Table 4, for the short-term policy rate, the estimated γ_1 is 0.256. To translate it into the coefficients of $\Delta GDP\ growth_{i,t}$ and $\Delta Inflation_{i,t}$ comparable to those in the baseline specification, we multiply the imposed coefficients with the estimated γ_1.[14] It turns out that the coefficient for $\Delta Inflation_{i,t}$ is very close to the baseline result while the coefficient for $\Delta GDP\ growth_{i,t}$ at 0.128 is higher than the baseline result. However, for the long-term bond yield analysis, both the coefficients for $\Delta Inflation_{i,t}$ (0.170) and $\Delta GDP\ growth_{i,t}$ (0.057) are similar to those of the baseline result (0.162 and 0.064).

Similar to the baseline and the other two robustness-checking models, we have significant and positive estimates for the two regimes without capital controls. The baseline model and the robustness check models show that the regime with flexible exchange rate and capital controls is the most resilient policy choice.

4.4. Seemingly Unrelated Regression Equations (SUR) System

To deal with the possible correlations between the error terms of equations for countries with different combinations of exchange rate regimes and capital control styles, we use seemingly unrelated regression equations to do another robustness check. We divide the countries/periods into four groups as classified in Table 2. Each group of countries has the same combination of exchange rate regime and capital control style. Therefore, we revise the regression equations as

$$\Delta i_{fixNC,it}^{p} = c_1 + \lambda_1 i_{fixNC,it-1}^{p} + \phi_1 * \Delta GDP\ growth_{fixNC,it} + \phi_2 * \Delta Inflation_{fixNC,it} + \beta_1 \Delta r_t^{US} + \delta_1 VIX_t + e_{1,it},$$

[14] Using the imposed parameters of 0.5 for output gap and 1.5 for inflation gap, we approximate that the coefficient of $\Delta GDP\ growth_{i,t}$ is 0.128 (0.5*0.256) and $\Delta Inflation_{i,t}$ is 0.384 (1.5*0.256).

$$
\begin{aligned}
&\Delta i^{p}_{fixC,it} = c_2 + \lambda_2 i^{p}_{fixC,it-1} + \phi_1 * \Delta GDP\ growth_{fixC,it} + \phi_2 * \Delta Inflation_{fixC,it} + \beta_2 \Delta r^{US}_t + \delta_2 VIX_t + e_{2,it}, \\
(7) \quad &\Delta i^{p}_{fleNC,it} = c_3 + \lambda_3 i^{p}_{fleNC,it-1} + \phi_1 * \Delta GDP\ growth_{fleNC,it} + \phi_2 * \Delta Inflation_{fleNC,it} + \beta_3 \Delta r^{US}_t + \delta_3 VIX_t + e_{3,it}, \\
&\Delta i^{p}_{fleC,it} = c_4 + \lambda_4 i^{p}_{fleC,it-1} + \phi_1 * \Delta GDP\ growth_{fleC,it} + \phi_2 * \Delta Inflation_{fleC,it} + \beta_4 \Delta r^{US}_t + \delta_4 VIX_t + e_{4,it}.
\end{aligned}
$$

In the SUR, we allow λs and βs to vary across countries with different regime combinations but restrict the Taylor rule parameters constant across regimes. That is, for all four equations, we have the same estimates for ϕ_1 and ϕ_2. We use the generalized least squares method to incorporate the correlations between the error terms of the four equations. Since the SUR estimation requires the same number of observations for each equation and the fewest observations we have for the short-term policy rate analysis are 32 for the fixed exchange rate regime without capital controls,[15] we carried out bootstraps (with replacement) to enlarge the number of observations of all four regimes to 345 (the number of observations for flexible exchange rate regime without capital controls). We repeated the bootstrap 500 times (Monte Carlo simulation) to get the mean and standard errors.

Note that this specification relaxes a restriction embedded in the baseline estimation, namely, we do not require the error terms across the regimes to be independent in SUR. With this relaxation, as shown in panel A and B in Table 5, we still find the same qualitative results as before for both short-term policy rate analysis and long-term bond yield analysis. In particular, a flexible exchange rate regime per se does not confer monetary policy autonomy. In the third equation, the coefficient on US interest rate is positive and statistically significant. That is, with a flexible exchange rate but no capital controls, a peripheral country's monetary policy co-moves with the US monetary policy. The SUR results show that the long-term bond yield of periphery countries with fixed exchange rate regime without capital control are affected more as 0.830 than the baseline result as 0.680. Unlike in the baseline results, in the SUR results, capital controls with a fixed exchange rate regime do not confer autonomy effectively either: for short-term policy rate analysis, it is a significant negative effect as -0.204 while for the long-term bond yield, it is a significant positive effect as 0.406. Consistent with the F-test results shown in Table 3, the SUR results suggest a more demanding policy combination for autonomy: capital controls with a flexible

[15] We have 32/203/345 observations for regimes of fixed exchange rate without capital controls/flexible exchange rate with capital controls/flexible exchange rate without capital controls. For the long-term bond yield, we have 16/22/139/124 observations for regimes of fixed exchange rate with capital controls, fixed exchange rate without capital controls, flexible exchange rate with capital controls, and flexible exchange rate without capital controls.

exchange rate regime, which is also echoing the result in column 1 in Table 4. Our general conclusion drawn from the baseline model still holds that a flexible exchange rate per se does not confer monetary policy autonomy.

4.5. Comparable Analysis with Obstfeld (2015) and Georgiadis and Mehl (2015)

One riddle raised by our baseline results is that the variable indicating global financial cycle-ΔVIX_t was not significant estimated as suggested by Rey (2013) and Obstfeld (2015). To reduce the country-episodes coverage discrepancy between our sample and that of Obstfeld (2015), we include the euro zone economies and episodes between 1990 and 1998 back and re-run the regression. As column (1) in Table 6 shown, after aligning the countries/episodes, our modeling framework has the ΔVIX_t significantly estimated too. In column (2), we exclude the episodes between 1990 and 1998 and still have similar results as column (1). Our results might imply that the global financial cycle effects matter more through the euro zone economies. The much lower coefficient estimate for the regime with flexible exchange rate without capital controls as 0.24 (compared with 0.45 in the baseline result) shows the other side of the story: the euro zone economies (flexible exchange rate regime) are more influenced by the common global financial cycle but less affected by the US monetary policy changes.

Another argument to support the flexible exchange rate regime granting more effectiveness of monetary policy is through the so-called valuation effects; see for example, Georgiadis and Mehl (2015) and Meier (2013). They argued that when countries have net foreign currency assets, an appreciation of the domestic currency in response to a tightening in local monetary policy (with flexible exchange rate regime) reduces the value of their net foreign currency asset (so to their total wealth), which, in turn, contracts domestic consumption and investment so to enhance the monetary policy effectiveness. Meanwhile, they acknowledge the global financial cycle effects - global financial cycle weakens the effectiveness of monetary policy by allowing consumption smoothing through borrowing from abroad.
In our baseline framework, we have global financial cycle variable –ΔVIX_t included. Symmetrically, we added the net foreign asset variable – share of foreign exchange reserve to GDP interacting with the US rate changes in our regression. As shown in column (3) in Table 6, the interacting term of foreign exchange reserve and US rate changes has

insignificant estimate, which means that we do not find supporting evidence for valuation effect as suggested by Georgiadis and Mehl (2015) and Meier (2013).

5. Extend the Analysis to the Lower-bound Episodes

In this section, we extend our analysis to include the episodes from 2009 to 2012[16] so to include the episodes with the US policy rate reaching the lower bound, for which, we use money supply to simulate the latent unobservable policy rate.

The baseline results, the corresponding robustness check, and the extended analysis so fart are based on data till Q1 2009 since after June 2009, the US Fed rate reached the lower bound and did not change further. Instead, the US employed an unconventional monetary policy tool (Quantitative Easing) to stimulate economy recovery. However, with those QE episodes excluded, the credibility of our conclusions is subject to suspicion. Because the US policy rate did not change for those lower-bound episodes and the policy rate itself did not represent the monetary policy of the US anymore, the baseline modeling framework cannot incorporate those lower-bound episodes.

Therefore, we developed a model with latent unobservable policy rate for lower-bound episodes. In this model, for those lower-bound episodes, agents would be unable to gauge the US monetary policy by observing the policy rate changes. We assume that agents form their views on the US monetary policy by using the monetary supply instead. We adopted the relationship defined by Obstfeld and Rogoff (1996) between policy rate and real money supply (real M2) and real aggregated output, as shown in the following equation (10), to approximate the latent unobservable policy rate for lower-bound episodes. The model includes three equations as below:

(8) $\Delta i_{i,t}^{p} = \lambda i_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 \Delta r_t^{US\#} + \delta VIX_t + \varepsilon_{i,t},$

(9) $\Delta r_t^{US\#} = \begin{cases} \Delta r_t^{US}, & r_t^{US*} > Lower\ Bound \\ \Delta r_t^{US*}, & r_t^{US*} = Lower\ Bound \end{cases}$,

[16] The reason we do not extend it further is because the exchange rate regime classification (AREAER) ends in 2012

(10) $r_t^{US*} = \theta_1 + \theta_2 logM_t + \theta_3 logY_t + \epsilon_t$[17].

Equation (8) is the same formula as equation (1) except for the changes in US monetary policy $\Delta r_t^{US\#}$. As shown in equation (9), before the US rate reached its lower bound, agents would use the observed US policy rate changes to represent $\Delta r_t^{US\#}$. While when the policy rate reached its lower bound, the unchanged policy rate was not a good approximate for US monetary policy changes anymore. The monetary policy changes therefore are approximated by real money supply M_t and real aggregated output Y_t, as indicated in equation (10). The terms of $\varepsilon_{i,t}$ and ϵ_t are assumed i.i.d distributed. The reason we assume agents prefer the observed policy rate changes to the money-supply-simulated policy changes before the US rate reached its lower bound to gauge the monetary policy change is that the observed policy rate changes if observable is less noisy than simulated policy changes by equation (10).

Based on equation (8) to (10), we construct the likelihood function as

(11)

$$L = \prod_{i=1}^{N} \frac{\left(\phi\left(\frac{\Delta i_{i,t}^{p} - \left(\lambda i_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 \Delta r_t^{US} + \delta VIX_t\right)}{\sigma_\varepsilon}\right)\left(1 - \Phi\left(\frac{0 - (\theta_1 + \theta_2 logM_t + \theta_3 logY_t)}{\sigma_\epsilon}\right)\right)\right)^{Y_i}}{\left(\phi\left(\frac{\Delta i_{i,t}^{p} - \left(\lambda i_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 (\theta_2 \Delta logM_t + \theta_3 \Delta logY_t) + \delta VIX_t\right)}{\gamma_2 \sigma_{\epsilon_t - \epsilon_{t-1}} + \sigma_\varepsilon}\right) \Phi\left(\frac{0 - (\theta_1 + \theta_2 logM_t + \theta_3 logY_t)}{\sigma_\epsilon}\right)\right)^{1 - Y_i}},$$

where $Y_i = 1$, if $r_t^{US*} > Lower\ Bound$; $Y_i = 0$, otherwise.

That is, when $r_t^{US*} > Lower\ Bound$, the observation of policy rate $\Delta i_{i,t}^{p}$ is a joint event of an observable Δr_t^{US} (the density function of $\phi(\cdot)$ in the first half part of the likelihood function) and $r_t^{US*} > Lower\ Bound$ (the right section above the lower bound in the distribution function as $1 - \Phi(\cdot)$), which is included as the first half part of the likelihood function. When

[17] The resulted first-order difference would take the form as $\Delta r_t^{US*} = \theta_2(logM_t - logM_{t-1}) + \theta_3(logY_t - logY_{t-1}) + (\epsilon_t - \epsilon_{t-1})$.

$r_t^{US*} = Lower\ Bound$, the policy rate $\Delta i_{i,t}^p$ is a joint event of approximated changes in US policy rate changes as indicated as $\theta_2 \Delta log M_t + \theta_3 \Delta log Y_t$ (the density function of $\phi(\cdot)$ in the second half part of the likelihood function) and $r_t^{US*} = Lower\ Bound$ (the left section below the lower bound in distribution function as $\Phi(\cdot)$).

After optimizing the logarithm transformed likelihood function L using the quasi-Newton algorithm, we got the results shown in Table 7. The significance was judged based on the standard error simulated by bootstrap strategy and Monte Carlo simulation. We bootstrapped the sample with the same size (with replacement) for one hundred times and repeated the optimization for each bootstrapped sample. The standard error of the one hundred optimization estimates was used to judge the significance.

As shown in Table 7, after considering the censored lower-bound episodes, our general conclusions are still held. The coefficient estimates for the international transmission of monetary shock equation are very similar to those of our baseline model presented in Table 3 and very stable across optimization procedures with different initial values (as shown from column (1) to (7) in Table 7). The capital controls can help insulate the spillover effect of the US interest rate changes while for the open economies, the flexible exchange rate cannot grant immunity. Compared to the fixed exchange rate, the spillover effect is lower (0.5 against 0.65) for the flexible exchange rate regime. Different from the baseline model estimates, ΔVIX_t is now significantly estimated and with a larger value as 0.25, which might imply that the global financial cycle works stronger for the QE episodes (2009-2012).

6. Conclusions

This paper studies policy choices that affect a country's resilience to foreign monetary policy shocks. The well-known trilemma hypothesis has often been invoked to provide guidance to policy makers who wish to pursue domestic monetary policies for domestic objectives, unencumbered by foreign monetary disturbances. The standard policy advice is for countries to pursue a flexible exchange rate regime. While capital controls may also buy a country some monetary independence, the literature is quick to point out efficiency costs and the difficulty of maintaining their effects beyond the short term.

In this paper, we find that the trilemma doesn't really hold in a strict way in the data. In particular, countries with a flexible exchange rate system do not appear to be able or be willing to insulate themselves from the influence of US monetary policy if they do not have capital controls. This is consistent with the view that most (developing) countries dislike either appreciation of their currencies (for fear of worsening export competitiveness) or depreciation (for fear of worsening the burden of foreign currency denominated liabilities); they particularly feel compelled to follow US monetary policy moves to avoid appreciation of their currencies when the US decreases its rate. On the other hand, capital controls do appear to buy countries a significant measure of monetary policy independence. Therefore, our overall conclusion is that for a country to build resilience against foreign monetary shocks, capital controls may be a necessity, and the virtue of a flexible exchange rate may be exaggerated for this topic. (A flexible exchange rate may still be useful to prevent undesirable buildup of real exchange rate overvaluation. But that is a different topic.)

Different from Han and Wei (2014), this paper has advanced the analysis in the several ways: (1) using the WEO forecast revision of GDP and inflation to formulate the exogenous shocks of GDP and inflation; (2) extending the data coverage backward to 1990 and documenting that our policy modeling framework works much better for the period of 1999-onward compared with the period of 1999-backward; (3) including both the conventional episodes with changes in Fed rate observable and unconventional episodes with Fed rates reaching its lower-bound; (4) formulating changes in monetary policy with money supply and changes in aggregated output for episodes when the US reached its lower bound; and (5) including long-term government bond yield analysis and examining the valuation effect of net foreign currency asset.

This paper might subject to some limitations, for example, not all capital controls are equally effective in providing insulation from foreign monetary policy influence. One could look into which types of capital controls are most useful. We leave such investigations for future research.

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Table 1 Combinations of exchange rate regime and capital controls and the coefficients on foreign policy influence

	Without Capital Controls	With Capital Controls
Fixed Exchange Rate Regime	β_1	β_2
Flexible Exchange Rate Regime	β_3	β_4

Table 2 Country classifications for the baseline estimation

	Without Capital Controls	With Capital Controls
Fixed Exchange Rate Regime	Hong Kong, China, (199905–200904) Ecuador, (200704–200810) Israel, (200604–200904)	Argentina, (199905–200109) China, People's Rep. of, (199905–200109) Ecuador, (200109–200604;200904) Israel, (200404–200509) Korea, Republic of, (200404–200904) Pakistan, (200404–200904)
Flexible Exchange Rate Regime	Canada, (199905–200904) Chile, (200504–200710) Germany, (199905–200904) Japan, (200005–200904) New Zealand, (199909–200904) Peru, (199909–200904) Singapore, (200204–200904) United Kingdom, (199905–200904)	Argentina, (200309–200904) Australia, (199905–200904) Belarus, (200109–200904) Bolivia, (199905–200904) Brazil, (200005–200904) Chile, (199905–200904) China, People's Rep. of, (200204–200904) Colombia, (199905–200904) Costa Rica, (199905–200904) India, (199905–200904) Indonesia, (199909–200904) Israel, (199905–200309) Japan, (199905–199909) Korea, Republic of, (199905–200309) Mexico, (200810–200904) Pakistan, (199905–200309) Philippines, (199905–200904) South Africa, (199905–200904) Thailand, (200009–200904) Turkey, (199909–200904)

Table 3. Coefficient estimates for baseline model for short-term policy rate and long-term government bond yield

		Short-term 1990–2009 (1)	Short-term 1990–1998[18] (2)	Short-term 1999–2009 (3)	Long-term 1999-2009 (4)	Short-term with Asymmetry 1999–2009 (5)
$i^{p}_{i,t-1}$	λ	**-0.048***	-0.007	**-0.110***	**-0.068***	**-0.113***
		(0.008)	(0.015)	(0.01)	(0.02)	(0.01)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.096	0.237	0.041	**0.064***	0.035
		(0.06)	(0.144)	(0.054)	(0.03)	(0.054)
$\Delta Inflation_{i,t}$	ϕ_2	0.**329***	0.134	**0.413***	**0.162***	**0.414***
		(0.048)	(0.096)	(0.049)	(0.05)	(0.049)
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	0.**649***	0.402	**0.654***	**0.680***	**0.678***
		(0.39)	(2.09)	(0.3)	(0.31)	(0.3)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	0.034	1.998	-0.249	0.34	-0.244
		(0.325)	(1.286)	(0.258)	(0.52)	(0.257)
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.450***	0.492	**0.497***	**0.407***	**0.673***
		(0.176)	(0.438)	(0.154)	(0.13)	(0.192)
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	0.029	0.008	0.063	0.12	0.08
		(0.127)	(0.334)	(0.11)	(0.13)	(0.111)
ΔVIX_t	δ	0.23	0.086	0.176	0.14	0.162
		(0.199)	(0.584)	(0.169)	(0.10)	(0.169)
$D_{flex.NC}\Delta r^{US}_{i,t} * Dummy_{\Delta r^{US}_{i,t}>0}$	$\beta_{3,\Delta r^{US}_{i,t}>0}$					-0.585
						(0.379)
F test[19]: $\beta_2 = \beta_3$		1.33	1.26	**6.48***	0.00	
F test: $\beta_4 = \beta_3$		**4.07***	0.82	**5.79***	2.62	
F test: $\beta_3 + \beta_{3,\Delta r^{US}_{i,t}>0} = 0$						0.08
Adjusted R-squared		0.09	0.000[20]	0.30	0.20	0.30
No. of Obs.		827	295	532	301	532

*Significant at 10%

[18] For 1990–1999, there is only one country/quarter observed for regime of fixed exchange rate regime and no capital controls (HKG 1998 Oct)

[19] $F = \frac{(R^2_{UR} - R^2_{R})}{\text{no.of restriction}} \Big/ \frac{(1 - R^2_{UR})}{\text{no.of total observation}}$

[20] The unadjusted R-squared is 0.0272.

Table 4. Coefficient estimates for robustness checks (M1 1999 to M3 2009)

		Re-defining capital controls		Re-defining the exchange rate regime		Using pre-assigned Taylor Rule	
		Short-term (1)	Long-term (2)	Short-term (3)	Long-term (4)	Short-term (5)	Long-term (6)
$i^{p}_{i,t-1}$	λ	**-0.109***	**-0.067***	**-0.11***	**-0.068***	**-0.111***	**-0.068***
		(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.038	**0.065***	0.041	**0.064***	**0.128**[1]**	**0.057**[2]**
		(0.054)	(0.03)	(0.054)	(0.03)		
$\Delta Inflation_{i,t}$	ϕ_2	**0.416***	**0.160***	**0.413***	**0.162***	**0.384**[1]**	**0.170**[2]**
		(0.05)	(0.05)	(0.049)	(0.05)		
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.558***	**0.667***	**0.654***	**0.680***	**0.571***	**0.680***
		(0.273)	(0.31)	(0.3)	(0.31)	(0.297)	(0.31)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	**-0.659***	0.10	-0.249	0.340	-0.311	0.360
		(0.400)	(1.02)	(0.258)	(0.52)	(0.255)	(0.52)
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.322***	**0.402***	**0.497***	**0.407***	**0.441***	**0.411***
		(0.135)	(0.12)	(0.154)	(0.13)	(0.151)	(0.13)
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	0.005	-0.09	0.063	0.12	0.005	0.13
		(0.187)	(0.21)	(0.11)	(0.13)	(0.105)	(0.12)
ΔVIX_t	δ	0.17	0.14	0.176	0.14	0.148	0.14
		(0.17)	(0.10)	(0.169)	(0.10)	(0.169)	(0.10)
Adjusted R-squared		0.29	0.20	0.30	0.20	0.30	0.20
No. of Obs.		532	301	532	301	532	301

* Significant at 10%

**[1] The coefficient estimate for changes in desired policy rate is 0.256 with standard error 0.031for short-term policy rate. The corresponding coefficient for output gap is 0.256* x0.5=0.128 and that for inflation gap is 0.256* x1.5=0.384.

**[2] The coefficient estimate for changes in desired policy rate is 0.113 with standard error 0.02 for long-term bond yield. The corresponding coefficient for output gap is 0.113* x0.5=0.057 and that for inflation gap is 0.113* x1.5=0.170.

Table 5 Coefficient estimates for four groups of countries using SUR

		Fixed exchange rate without capital controls	Fixed exchange rate with capital controls	Flexible exchange rate without capital controls	Flexible exchange rate with capital controls
Panel A Short-term Policy Rate					
$i^{p}_{i,t-1}$	λ	0.011	**-0.056***	**-0.118***	**-0.118***
		(0.023)	(0.016)	(0.069)	(0.033)
$\Delta GDP\ growth_{i,t}$	ϕ_1	**0.075***	**0.075***	**0.075***	**0.075***
		(0.026)	(0.026)	(0.026)	(0.026)
$\Delta Inflation_{i,t}$	ϕ_2	**0.26***	**0.26***	**0.26***	**0.26***
		(0.036)	(0.036)	(0.036)	(0.036)
$\Delta r^{US}_{i,t}$	β	**0.669***	**-0.204***	**0.434***	0.047
		(0.051)	(0.091)	(0.091)	(0.098)
ΔVIX_t	δ	**-0.55***	0.238	0.059	**0.504***
		(0.129)	(0.19)	(0.102)	(0.27)
Panel B Long-term Government Bond Yield					
$i^{p}_{i,t-1}$	λ	**-0.144***	0.01	-0.02	**-0.093***
		(0.02)	(0.01)	(0.02)	(0.04)
$\Delta GDP\ growth_{i,t}$	ϕ_1	**0.066***	**0.066***	**0.066***	**0.066***
		(0.01)	(0.01)	(0.01)	(0.01)
$\Delta Inflation_{i,t}$	ϕ_2	**-0.047***	**-0.047***	**-0.047***	**-0.047***
		(0.03)	(0.03)	(0.03)	(0.03)
$\Delta r^{US}_{i,t}$	β	**0.830***	**0.406***	**0.414***	0.15
		(0.05)	(0.05)	(0.05)	(0.19)
ΔVIX_t	δ	-0.14	**0.387***	0.05	**0.607***
		(0.09)	(0.05)	(0.06)	(0.29)

Table 6. Estimations align with Obstfeld (2015) and Georgiadis and Mehl (2015)

		Compare with Obstfeld (2015): including Euro Economies: 1990-2009 (1)	Compare with Obstfeld (2015) including Euro Economies: 1999-2009 (2)	Compare with Georgiadis and Mehl (2015): including Euro Economies: 1999-2009 (3)
$i^{p}_{i,t-1}$	λ	**-0.051***	**-0.105***	**-0.105***
		(0.01)	(0.01)	(0.01)
$\Delta GDP\ growth_{i,t}$	ϕ_1	**0.122***	0.05	0.05
		(0.04)	(0.04)	(0.04)
$\Delta Inflation_{i,t}$	ϕ_2	**0.293***	**0.385***	**0.384***
		(0.03)	(0.04)	(0.04)
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.614***	**0.641***	**0.675***
		(0.32)	(0.26)	(0.30)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	-0.03	-0.23	-0.21
		(0.26)	(0.21)	(0.23)
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.236***	**0.288***	**0.307***
		(0.11)	(0.10)	(0.13)
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	-0.04	0.01	0.03
		(0.08)	(0.08)	(0.10)
ΔVIX_t	δ	**0.231***	**0.218***	**0.218***
		(0.13)	(0.12)	(0.12)
$FX\ reserve * \Delta r^{US}_{i,t}$				-0.06
				(0.23)
Adjusted R-squared		0.10	0.28	0.28
No. of Obs.		1403	844	844

Table 7. Extended analysis with the lower-bound episodes (1999-2012)

		Using OLS est. as the initial values (1)	Initial values in (1) + Standard Error*1 (2)	Iv(1) + SE*2 (3)	Iv(1) + SE *3 (4)	Iv(1) - SE *1 (5)	Iv(1)- SE *2 (6)	Iv(1) - SE *3 (7)	Initial values (OLS estimate) for the baseline optimization
$i^{p}_{i,t-1}$	λ	**-0.11***	**-0.11**	**-0.11**	**-0.11**	-0.11	-0.11	-0.11	-0.11
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03
$\Delta Inflation_{i,t}$	ϕ_2	**0.39***	0.39*	0.39*	0.39*	0.39*	0.39*	0.39*	0.39*
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.65***	**0.66***	**0.65***	**0.65***	**0.65***	**0.65***	**0.65***	**0.66***
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.5***	**0.5***	**0.5***	**0.5***	**0.5***	**0.5***	**0.5***	**0.5***
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
ΔVIX_t	δ	**0.25***	**0.25***	**0.25***	**0.25***	**0.25***	**0.25***	**0.25***	**0.28***
σ_{ε}		**1.78***	**1.78***	**1.78***	**1.78***	**1.78***	**1.78***	**1.78***	1.78
$logM_t$	θ_2	-11.75	-4.48	-12.52	-13.47	-11.74	-11.75	-11.75	-24.89
$logY_t$	θ_3	11.05	4.21	11.77	12.68	11.04	11.05	11.05	33.16
σ_{ϵ_t}		0.39	0.15	0.42	0.45	0.39	0.39	0.39	1.08
Log L at optimal		-1305.351	-1305.278	-1305.360	-1305.374	-1305.350	-1305.350	-1305.350	-

Note: columns (1)-(7) are results using different initial values to do the optimization. Column (1) uses the OLS estimate as the initial values. Columns (2) to (4) are results using the column (1) plus 1-3 standard errors as the initial values while columns (5) to (7) are based on column (1) minus 1-3 standard errors. Column (8) presents the OLS estimates for the monetary policy equation (baseline estimates as in Table 3) and for the money supply equation using the above-lower-bound data.

Figure 1 Associations of periphery policy rate and the United States' policy rate

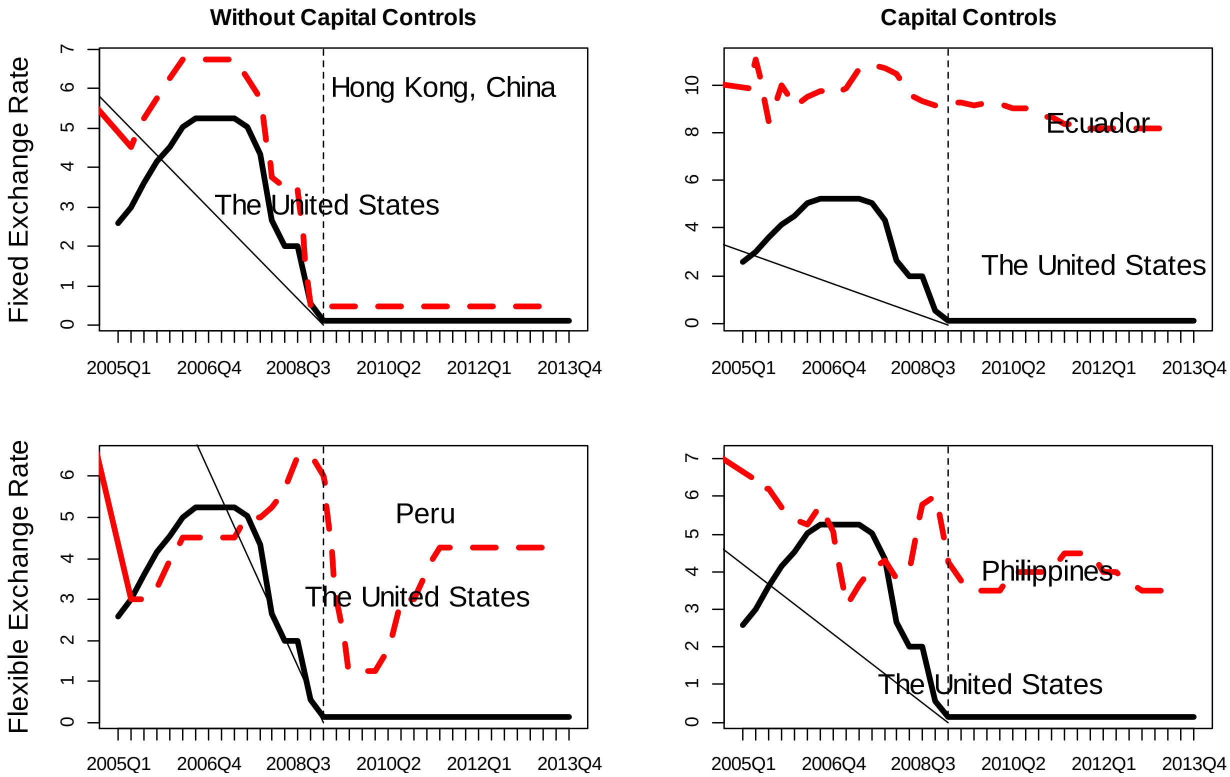


Figure 2 Unconditional Plotting of Periphery Policy Rate Changes vs. US Policy Rate Changes

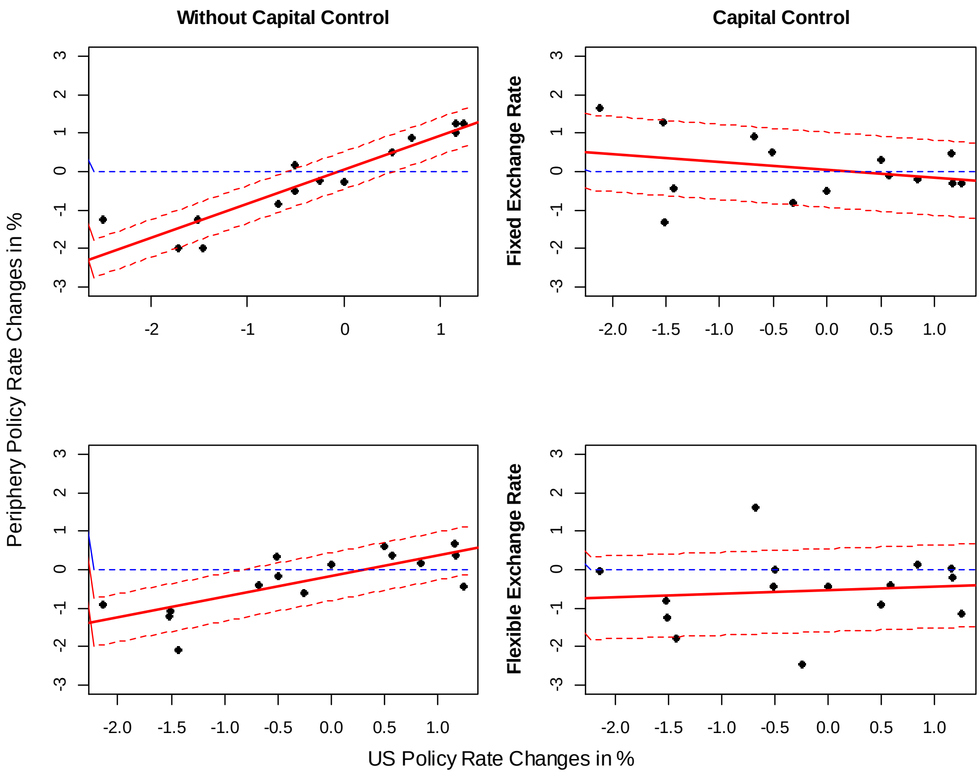
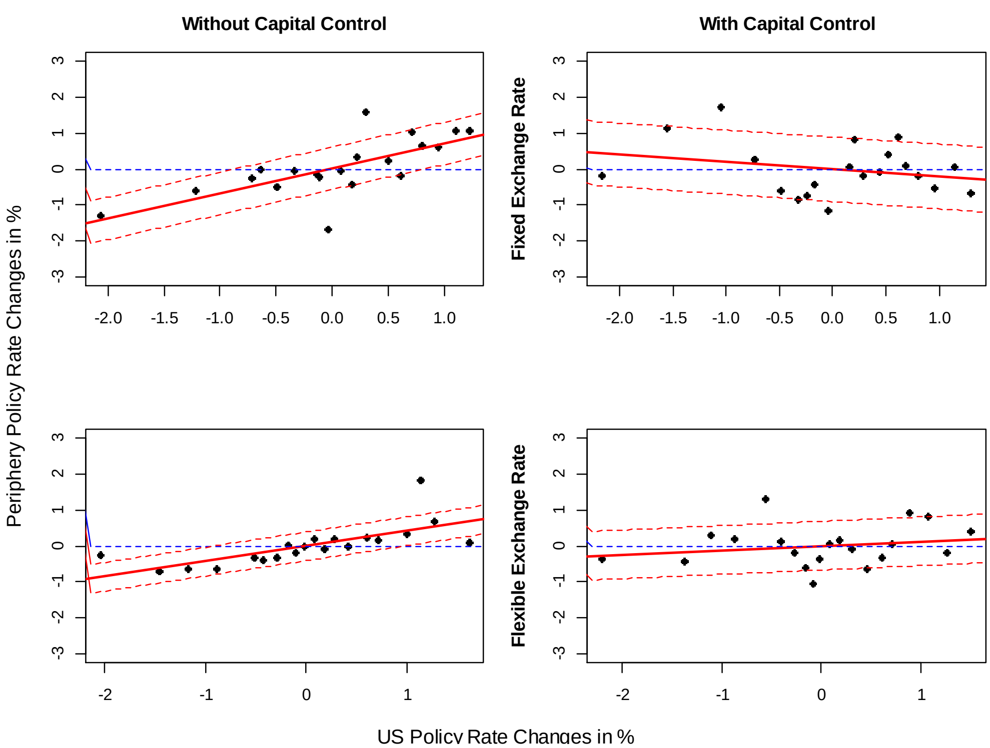


Figure 3 Conditional Plotting of Periphery Policy Rate Changes vs. US Policy Rate Changes



Appendix

Table A1. Countries included in the analysis and their basic information[21]

Economy	Emerging Markets	Euro Area[22]	Exchange Rate Structure Classification indicated in online yearly AREAER Data[23]	Other Information
Argentina	EM	0	Managed floating	
Australia	No	0	Independently floating	
Austria	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Belarus	No	0	Crawling band	The ruble is de jure pegged to the Russian ruble; however, the National Bank of Belarus maintains a de facto crawling band system vis-à-vis the USD
Belgium	No	1	No separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Bolivia	No	0	Crawling peg	USD is the legal tender
Brazil	EM	0	Independently floating	
Bulgaria	No	0	Currency board arrangement	The peg currency is the euro
Canada	No	0	Independently floating	
Chile	EM	0	Independently floating	
China, People's Rep. of	EM	0	Conventional pegged arrangement	A benchmark rate for USD
Colombia	EM	0	Independently floating	
Costa Rica	No	0	Crawling peg	Anchoring currency not specified, but nearly all payments for exchange transactions are made in USD
Croatia	No	0	Managed floating with no pre-determined	

[21] Effective January 1, 2007, the exchange arrangement of the EMU countries has been reclassified as 'independently floating' from 'exchange arrangement with no separate legal tender'. The new classification was based on the behavior of the common currency, whereas the previous classification was based on the lack of a separate legal tender.

[22] Countries that joined the euro area before 2014Q2. Lithuania joined on Jan 1st, 2015 and is thus not listed as a euro zone country in our dataset.

[23] http://www.elibrary.-areaer.imf.org/Areaer/Pages/YearlyReports.aspx, sampled year 2004

Economy	Emerging Markets	Euro Area[22]	Exchange Rate Structure Classification indicated in online yearly AREAER Data[23]	Other Information
			path for the exchange rate	
Cyprus	No	1	Pegged exchange rate within horizontal band to the euro	Joined the euro zone on Jan 1, 2008
Czech Republic	EM	0	Managed floating with no pre-determined path for the exchange rate	With the euro as the reference currency
Denmark	No	0	Pegged exchange rate within horizontal band to the euro	
Ecuador	No	0	Exchange arrangement with no separate legal tender	Pegged to the USD
Egypt	EM	0	Managed floating with no pre-determined path for the exchange rate	
Finland	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
France	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Germany	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Greece	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 2001
Hong Kong, China	EM	0	Currency board arrangement pegged to the USD	
Hungary	EM	0	Pegged exchange rate within horizontal band to the euro	Pegged to the euro
Iceland	No	0	Independently floating	
India	EM	0	Managed floating with no pre-determined path for the exchange rate	With reference to the USD
Indonesia	EM	0	Managed floating with no pre-determined path for the exchange rate	
Ireland	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Israel	EM	0	Independently floating	
Italy	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Japan	No	0	Independently floating	

Economy	**Emerging Markets**	**Euro Area[22]**	**Exchange Rate Structure Classification indicated in online yearly AREAER Data[23]**	**Other Information**
Korea, Republic of	EM	0	Independently floating	
Latvia	No	1	Conventional pegged arrangement, pegged to the euro	Joined the euro zone on Jan 1, 2014
Lithuania	No	0	Currency board arrangement, pegged to the euro	Joined the euro zone on Jan 1, 2015[24]
Luxembourg	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Malaysia	EM	0	Conventional pegged arrangement, pegged to the USD	
Malta	No	1	Conventional pegged arrangement, pegged to a basket consisting of USD (10%), **the euro (70%)**, and the pound sterling (20%)	Joined the euro zone on Jan 1, 2008
Mexico	EM	0	Independently floating	
Netherlands	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
New Zealand	No	0	Independently floating	
Norway	No	0	Independently floating	
Pakistan	EM	0	Managed floating with no pre-determined path for the exchange rate, no anchoring currency	
Peru	EM	0	Managed floating with no pre-determined path for the exchange rate, with the USD as the reference	
Philippines	EM	0	Independently floating	
Poland	EM	0	Independently floating	
Portugal	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Romania	No	0	Managed floating with no pre-determined path for the exchange rate, with the euro as the reference currency	
Russian	EM	0	Managed floating with no pre-determined	

[24] In our sample period, Lithuania is not labeled as a euro country since it joined the euro zone on January 1, 2015.

Economy	Emerging Markets	Euro Area[22]	Exchange Rate Structure Classification indicated in online yearly AREAER Data[23]	Other Information
Federation			path for the exchange rate, with the USD as the reference currency	
Serbia, Republic of	No	0	Managed floating with no pre-determined path for the exchange rate, with the euro as the reference currency	
Singapore	EM	0	Managed floating with no pre-determined path for the exchange rate, with the USD as the intervention currency	
Slovak Republic	No	1	Managed floating with no pre-determined path for the exchange rate	Joined the euro zone on Jan 1, 2009
Slovenia	No	1	Pegged exchange rate within horizontal band, with the euro as the reference currency	Joined the euro zone on Jan 1, 2007
South Africa	EM	0	Independently floating	
Spain	No	1	Exchange arrangement with no separate legal tender with the euro	Joined the euro zone on Jan 1, 1999
Sweden	No	0	Independently floating	
Switzerland	No	0	Independently floating	
Thailand	EM	0	Managed floating with no pre-determined path for the exchange rate, with the USD as the reference currency	
Turkey	EM	0	Independently floating	
United Kingdom	No	0	Independently floating	

Table A2. Short-term Policy interest rates and Long-term Bond Yields used for each country

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
Argentina[25]	Average rate on loans denominated in national currency of up to 15 days between domestic financial institutions.	-	-	-
Australia	Central Bank Policy Rate (End of Period): Rediscount rate offered by the RBA to holders of treasury notes.	Government Bond Yield: 10 Years	CEIC	Jan 1970 - May 2015
Austria	See Euro area.	Government Bond Yield: Long Term	CEIC	Jan 1971 - Mar 2015
Belarus	Announced rate at which the NBRB lends to banks.	-	-	-
Belgium	See Euro area.	Long-term Government Bond Yield	Haver	Jan 1980 - May 2015
Bolivia	Rate charged by the CBB on loans in national currency to financial corporations collateralized by public (Treasury or CBB) securities.	-	-	-
Brazil	Target rate for overnight interbank loans collateralized by government bonds, registered with and traded on the Sistema Especial de Liquidacao e Custodia (SELIC).	10-year bond yield	Investing.com	Jan 2007 - May 2015
Bulgaria	Data refer to Basic Interest Rate (BIR). BIR is the official reference rate announced by the Bulgarian National Bank (BNB) and published in the State Gazette.	Government Bond Yield: Long Term	CEIC	July 1993 - April 2015
Canada	Refers to the overnight money market (financing) rate, which is a measure or estimate of the collateralized overnight rate compiled at the end of the day by the Bank of Canada through a survey of major participants in the overnight market.	Government Benchmark Bonds Yield: Month End: 10 Years	CEIC	Jan 1993 - May 2015
Chile	Refers to the Monetary Policy Rate (MPR) which is the target interest rate for the interbank money market.	Bond Yield: in CLP 10 Years	CEIC	Sep 2002 - May 2015
China, People's Rep. of	Rate charged by the People's Bank of China on 20-day loans to financial institutions.	10-year bond yield	Investing.com	Jan 1999 - May 2015
Colombia	Intervention rate determined by the BR to either increase or decrease liquidity in the economy.	10 Year Fixed Treasury Bond Mid Yield (% p.a.)	Haver	Jan 2008 - May 2015

[25] There is neither a monetary policy rate nor a discount rate in the IFS for Argentina. We use the short-term money market rate instead.

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
Costa Rica	Monetary Policy Rate on 30-day investments. Beginning on March 15, 2006, rate on overnight deposits in the CBCR's financial services website. Beginning on May 29, 2008, rate charged by the CBCR on one-day loans in the Interbank Money Market. Beginning in August 2009, rate charged by the CBCR on one-day loans in the Integrated Liquidity Market. Beginning June 3, 2011, target rate used by the CBCR as a reference for one-day operations within a band in the Integrated Liquidity Market.	-	-	-
Croatia	Basic rate at which the CNB lends to commercial banks.	Long-term Government Bond Yield: Average (%)	Haver	Dec 2005 - May 2015
Cyprus	Rate charged by the CBC for the discount of treasury bills.	Government Bond Yield: Long Term	CEIC	Nov 1997 - April 2015
Czech Republic	Repurchase Agreement Rate (End of Period): Rate on a 14-day repurchase agreement between the Czech National Bank and commercial banks.	Long-term Government Bond Yield: Average (%)	Haver	April 2000 - May 2015
Denmark	Rate signals the overall level of Denmark National bank's interest rates.	Government Bond Yield: Long Term	CEIC	Jan 1970 - April 2015
Ecuador	Legal rate charged by the CBE to discount eligible commercial paper offered by commercial banks in national currency.	-	-	-
Egypt	The rate at which the CBE discounts eligible commercial paper to commercial banks.	-	-	-
Euro area	Refers to the Eurosystem Main Refinancing Operations Rate, which is the rate for the main open-market operations in the form of regular liquidity-providing reverse transactions with a frequency and maturity of one week. Reverse transactions refer to repurchase agreements or collateralized loans.	-	-	-
Finland	See Euro area.	Benchmark Government Bond Yield: Average: 10 Years	CEIC	Jan 1992 - May 2015
France	See Euro area.	Government Bond Yield: Monthly	CEIC	Jan 1999 - May 2015

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
		Average: 10 Years		
Germany	See Euro area.	Long-term Government Bond Yield: Average (%)	Haver	Jan 1980 - May 2015
Greece	See Euro area.	Government Bond Yield: Average: 10 Years	CEIC	Jan 1993 - May 2015
Hong Kong, China	Exchange Fund's overnight liquidity adjustment facility offer rate.	-	-	-
Hungary	Basic rate at which NBH offers loans with maturity of more than one year to other MFIs.	Long-term Government Bond Yield: Average (%)	Haver	Jan 2001 - May 2015
Iceland	Rate on overdrafts of other depository corporations.	Government Bond Yield: 10 years (% per annum)	Haver	Jan 1992 - May 2015
India	Standard rate at which the Reserve Bank makes advances to scheduled banks against commercial paper and government securities.	10-year bond yield	Investing.com	May 1998 - May 2015
Indonesia	Refers to the Bank Indonesia rate, which is the policy rate reflecting the monetary policy stance adopted by Bank Indonesia and announced to the public.	10-year bond yield	Investing.com	Jan 2006 - May 2015
Ireland	See Euro area.	Government Bonds Yield: 10 Years to Maturity	CEIC	Dec 1992 - April 2015
Israel	Rate on monetary loans offered by tender by the Bank of Israel to commercial banks.	Yield on 10-Year Indexed Government Bonds (AVG, % p.a.)	Haver	Jan 1992 - Dec 2014
Italy	See Euro area.	Government Treasury Bonds Yield: 10 Year	CEIC	Mar 1991 - May 2015
Japan	Rate at which the BOJ discounts eligible commercial bills and loans secured by government bonds, specially designed securities, and eligible commercial bills.	10-Year Benchmark Government Bond Yield (AVG, % p.a.)	Haver	July 1986 - May 2015
Korea, Republic of	Rate that the Monetary Policy Committee sets and announces. The Base Rate is the reference rate applied to transactions between the BOK and financial institutions.	Government Bond Yield: Long Term	CEIC	May 1973 - March 2015
Latvia	Beginning in January 2014, Euro Area policy rates became applicable, and national policy rates were discontinued.	Long-term Government Bond Yield: Average (%)	Haver	Jan 2001 - May 2015
Lithuania	Repurchase Agreement Rate (End of	Long-term	Haver	Jan 2001 -

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
	Period): Bank of Lithuania rate on overnight repurchase agreements.	Government Bond Yield: Average (%)		May 2015
Luxembourg	See Euro area.	Government Bond Yield: Long Term	CEIC	Jan 1970 - Mar 2015
Malaysia	Refers to the overnight policy rate, which is set by BNM for monetary policy direction.	-	-	-
Malta	Rate at which the CBM lends to credit institutions.	Government Bond Rate: Long Term: 10 Years	CEIC	Jan 1999 - April 2015
Mexico	Refers to the target rate.	Government Bond Yield: Long Term	CEIC	Jan 1995 - May 2015
Netherlands	See Euro area.	Government Bond Yield: Long Term	CEIC	Jan 1970 - April 2015
New Zealand	Official Cash Rate (OCR) around which the Reserve Bank transacts with the market. The OCR is reviewed eight times a year (every six and a half weeks).	Government Bond Yield: 10 Years	CEIC	Jan 1985 - May 2015
Norway	Marginal lending rate of the Bank of Norway.	Government Bonds Yield: Monthly Avg: 10 Years	CEIC	Jan 1985 – May 2015
Pakistan	The State Bank of Pakistan rate on its repurchase facility.	Investment Bonds: Wtd Avg Yield: 10-years	Haver	Dec 2000 – May 2015
Peru	Reference rate determined by CRBP to establish a benchmark interest rate for interbank transactions, impacting operations of the financial institutions with the public.	-	-	-
Philippines	Rediscount rate for loans for traditional exports, which account for a large part of total rediscount credits.	10-year bond yield	Investing.com	July 2000 - May 2015
Poland	Repo Rate (End of Period): Reference rate (minimum money market intervention rate) quoted by the NBP on 28-day open market operations (reverse repo rate).	Long-term Government Bond Yield: Average (%)	Haver	Jan 2001 - May 2015
Portugal	See Euro area.	Treasury Bond Yield: 10 Years	CEIC	July 1993 - April 2015
Romania	Monetary policy rate is the rate on one-week deposit-taking operations starting on May 7, 2008, the rate on two-week deposit-taking operations from August 1, 2007 until May 6, 2008 and the rate on one-month deposit-taking operations before August 1, 2007.	Government Bond Yield: Long Term	CEIC	April 2005 - April 2015

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
Russian Federation	Minimum bid rate for one-day repurchase agreements auction of CBR with credit institutions.	Government Bonds Yield: Period End: GKO-OFZ: Redemption Term 10 Years	CEIC	Jan 2003 - May 2015
Serbia	Monthly average rate on the NBS bills of all maturities weighted by volume.	-	-	-
Singapore	Rate charged by the MAS on overnight repurchase agreements using government securities.	Average Buying Rates of Govt Securities Dealers 10-Year Bond Yield	Singapore Government Securities and Monetary Authority of Singapore	June 1998 - May 2015
Slovak Republic	Beginning January 2009, Euro Area policy rates. For periods prior to January 2009, Central Bank Policy Rate (End of Period): National Bank of Slovakia's main policy rate. Rate on two-week repurchase agreements with commercial banks.	10-year Government Bond Yield (% per annum)	Haver	Sept 2000 - March 2015
Slovenia	See Euro area.	Government Bond Yield: Long Term	CEIC	Mar 2002 - April 2015
South Africa	Rate determined by the SARB on repurchase agreements in national currency between the SARB and private sector banks. The repo rate was introduced on March 9, 1998.	Government Bond Yield: Monthly Average: 10 Years and Over	CEIC	Jan 1970 - April 2015
Spain	See Euro area.	Long-term Government Bond Yield: Average (%)	Haver	Jan 1980 - May 2015
Sweden	refer to the reference rate set by the Riksbank at six-monthly intervals, and is based on the repurchase agreement rate applying at the end of the previous six-month period, rounded up to the nearest whole or half percentage point.	Government Bond Yield: Riksbank: Average: 10 Years	CEIC	Jan 1987 - May 2015
Switzerland	Data refer to official discount rates. Beginning in January 2000, data refer to the upper limit of the target range for three-month Swiss franc interbank market for unsecured loans set by the SNB.	Bond Yield: 10 Years	CEIC	Jan 1988 - May 2015
Thailand	Policy rate is the rate announced by the Monetary Policy Committee in conducting monetary policy under the inflation-targeting framework.	Treasury Bill & Government Bond Yield: Average: BOT: 10 Year	CEIC	Jan 2005 - May 2015
Turkey	Interbank rate at which funds can be	10-year bond yield	Investing.com	Feb 2010 -

Country	Short-term Policy Rate (All from IFS)	Long-term Bond Yield	Source of LTB	Coverage of LTB
	lent and borrowed for one day (overnight). The CBRT uses this base rate for monetary policy purposes.			May 2015
United Kingdom	Refers to the official bank rate, also called the Bank of England base rate or BOEBR, which is the rate that the Bank of England charges banks on secured overnight loans. It is the British government's key interest rate for enacting monetary policy.	Government Bond Yield: Zero Coupon: Monthly Avg: 10 Years	CEIC	Jan 1982 - May 2015
United States	Refers to the federal funds rate, which is the rate at which private depository institutions (mostly banks) lend balances (federal funds) at the Federal Reserve to other depository institutions, usually overnight.	Government Bond Yield: Long Term	CEIC	Jan 1970 - April 2015

Table A3. Exchange Rate Arrangements 1990–2010 from *Ilzetzki et al. (2010)*

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
Argentina	April 1986–December 20, 1990	Freely falling/Freely floating/Dual Market/Multiple rates	The Austral Plan's second phase was a crawling peg which lasted until September 1986 but by then, there was a dual market. For May 1989–March 1990 the regime is a "hyperfloat."
	December 20, 1990–January 29, 1991	Freely falling/Freely floating	
	January 29, 1991–March 1991	Freely falling/Freely floating	A "Target zone"—broad band is introduced.
	April 1991–February 1992	Currency Board/Peg to the US dollar/Freely falling	The Convertibility Plan, no adjustments to central parity.
	March 1992–December 1, 2001	Currency Board/Peg to the US dollar	
	December 1, 2001–June 2002	Freely falling/De facto Dual Market	Capital controls are introduced. There are multiple exchange rates through most of 2001.
	February 2003–January 2007	De facto crawling band around the US dollar	+/-5% band. Workers from INDEC, the state statistical agency, released their own unofficial inflation estimates that far outstripped the government's estimate of an 8.5% y-o-y CPI increase for 2007. They reported that 2007 inflation had in fact been between 22.3% and 26.2%
	February 2007—June 2009	De facto crawling band around the US dollar	+/-2% band.
	July 2009–December 2010	De facto crawling peg to the US dollar	
Australia	December 12, 1983–December 2010	Freely floating	
Austria		De facto peg to the DM	March 1991 registers as a currency crash versus the US dollar—none versus the DM.
	January 1, 1999–December 2010	Currency union	Euro.
Belarus	August 25, 1991–February 3, 1997	Freely falling/Freely floating/Multiple rates	There is no price data before this date.

	February 3, 1997–March 31, 1998	Freely falling/Freely floating	
	March 31, 1998–December 2002	Freely falling/Freely floating	There are multiple rates.
	2003	De facto crawling band around the US dollar	+/-2% band. Officially a crawling band around a basket of currencies.
	January 2003–March 2010	De facto peg to the US dollar	Officially a crawling band around a basket of currencies. Official band widened to +/-15% in 2008.
	April 2010–December 2010	De facto crawling band around the US dollar	+/-5% band.
Belgium	November 1971–March 5, 1990	De facto peg to the DM/Dual Market	
	March 5, 1990–December 31, 1998	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Bolivia	January 1990–October 2008	De facto crawling peg to the US dollar/Multiple rates/parallel market	Parallel market premium is trivial.
	November 2008–December 2010	De facto peg to the US dollar	
Brazil	April 1989–July 1, 1994	Freely falling/Freely floating/Multiple rates	On December 1989, the parallel market premium rises to 235%. December 1989–March 1990 regime is a "hyperfloat."
	July 1, 1994–May 1995	Pre-announced crawling band to the US dollar/Freely falling/Dual Market	The Real Plan has a narrow band width. The real replaces the cruzado. There is a dual market but parallel premium during this period is trivial.
	June 1995–January 18, 1999	Pre-announced crawling band to the US dollar/Dual Market	
	February 1, 1999–August 1999	Freely falling/Managed floating	On January 18, 1999, the two rates were unified.
	September 1999–December 2010	Managed floating	
Bulgaria	May 2, 1990–December 1993	Freely falling/Freely floating	There is no price data before this date.
	January 1994–January 1, 1997	Freely falling/Managed floating	
	January 1, 1997–January 1998	Peg to the DM/Currency board/Freely falling	
	January 1998–January 1, 1999	Currency board/Peg to the DM	
	January 1, 1999–December, 2010	Currency board/Peg to the euro	

Canada	May 31, 1970–May 2002	De facto moving band around the US dollar	+/-2% band.
	June 2002–December 2010	De facto moving band around the US dollar/Managed floating	+/-5% band.
Chile	June 1, 1989–January 22, 1992	Pre-announced crawling band around the US dollar/Dual Market	PPP rule. Official pre-announced +/-5% band.
	January 22, 1992–January 20, 1997	De facto crawling band around the US dollar/Dual Market	PPP rule. +/-5% band. Official pre-announced crawling +/-10% band to the US dollar. Parallel premium declines to below 15% and into single digits.
	January 20, 1997–June 25, 1998	De facto crawling band to the US dollar/Dual Market	Official pre-announced +/-12.5% crawling band to the US dollar. De facto band is +/-5% for the official rate.
	June 25, 1998–September 16, 1998	Pre-announced crawling band to the US dollar/Dual Market	+/-2.75% band. Rates are virtually the same in official and informal markets.
	September 16, 1998–December 22, 1998	Pre-announced crawling band to the US dollar/Dual Market	+/-3.5% band.
	December 22, 1998–September 2, 1999	Pre-announced crawling band to the US dollar/Dual Market	+/-8% band.
	September 2, 1999–December 2010	De facto band around the US dollar	Markets are unified. +/-5% band.
Hong Kong, China	October 17, 1983–December 2010	Currency board/Peg to the US dollar	
China, People's Rep. of	March 1981–July 1992	Managed floating/Multiple rates	
	August 1992–January 1, 1994	De facto crawling band around the US dollar/Multiple rates	+/-2% band. Premium peaks at 124% on June 1991.
	January 1, 1994–July 2005	De facto peg to the US dollar	Unification of markets. There is a parallel market where the premium is in single digits.
	August 2005–September 2009	De facto moving band to the US dollar	+/-2% band.

	October 2009–December 2010	De facto peg to the US dollar	
Colombia	December 1984–January 24, 1994	De facto band around the US dollar/Multiple rates	+/-5% band.
	January 24, 1994–June 28, 1999	De facto crawling band around the US dollar	+/-5% band. Official pre-announced crawling band around the US dollar, width is +/-7.5%.
	June 28, 1999–September 25, 1999	De facto crawling band around the US dollar	+/-5% band. There is an official pre-announced crawling band around the US dollar, which is +/-10%. Parallel market premium remains below 20%.
	September 25, 1999–December 2010	De facto band around the US dollar	+/-5% band.
Costa Rica	November 11, 1983–December 1990	De facto crawling band around the US dollar/Dual Market	De facto +/-5% band, much narrower band if official rate is used.
	January 1991–December 2001	De facto crawling band around the US dollar	De facto +/-2% band. Parallel market premium is in low single digits. De facto crawling peg to US dollar since 1995 if official rate is used.
	January 2002–September 2006	Crawling peg to the US dollar	
	October 2006–April 2010	De facto peg to the US dollar	
Croatia	October 22, 1993–September 1994	Freely falling/Freely floating/Dual Market	There is no price data before this date.
	October 1994–January 1, 1999	De facto band around the DM	+/-2% band.
	January 1, 1999–December 2010	De facto band around the euro	+/-2% band.
Cyprus	July 9, 1973–March 1992	De facto crawling band around the DM	+/-2% band.
	April 1992–January 1, 1999	De facto peg to the DM	Officially there is a +/-2.25% band.
	January 1, 1999–December 2010	De facto peg to the euro	In January 2001, it was announced that the band would be widened to +/-15% to become effective in August 2001. Joined the ERM II on May 2, 2005. Joined the euro zone on January 1, 2008.
	January 2008–December 2010	Currency union	Euro.
Czech Republic	September 1990–February 28, 1996	De facto crawling band around the DM	+/-2% band. Officially tied to a currency basket and then changed to the ECU.

	February 28, 1996–May 27, 1997	De facto crawling band around the DM	+/5-% band. Official pre-announced crawling band around the DM is +/-7.5%.
	May 27, 1997–December 1998	De facto crawling band around the DM	+/-2% band.
	January 1999–December 2001	De facto peg to the euro	
	January 2002–December 2010	De facto crawling band around the euro	+/-5% band.
Denmark	December 1978–January 1, 1999	De Facto moving peg to the DM	
	January 1, 1999–December 2010	De facto peg to the euro	Participant of ERM II. There is an official +/-2.25% band.
Ecuador	April 1987–September 1993	Freely falling/Managed floating	Parallel market premium hits 150% in 1988.
	October 1993–March 3, 1997	De facto crawling band around the US dollar/Dual Market	+/-5% band. Parallel market premium declines into single digits during this period.
	March 3, 1997–September 1997	De facto crawling band around the US dollar/Dual Market	Pre-announced crawling band around the US dollar, official band is +/-5%, the de facto band is +/-2%.
	October 1997– February 12, 1999	Freely falling/Pre-announced crawling band around the US dollar.	The official band is widened to +/-10% on March 25, 1998 and +/-15% on September 14, 1998.
	February 12, 1999–March 13, 2000	Freely falling/Freely floating	Markets are unified.
	March 13, 2000–April 2001	Exchange rate arrangement with no separate legal tender/Freely falling	US dollar.
	May 2001–December 2010	Exchange rate arrangement with no separate legal tender	US dollar.
Egypt	July 25, 1971–October 8, 1991	De facto crawling band around the US dollar/Multiple rates	+/-5% band.
	October 8, 1991–July 2010	De facto moving peg to the US dollar/Multiple rates	Parallel market premium is in single digits through December 1998, when the data ends. Increased exchange rate variability during May–November 2008.
Finland	January 1973–September 8, 1992	De facto band around the DM	+/-2% band. Officially pegged to a basket of currencies or the ECU during this period.

	September 8, 1992–March 1993	Freely falling/Managed floating	ERM crisis.
	April 1993–December 1994	De facto moving band around the DM	+/-2% band.
	January 1995–January 1, 1999	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
France	January 1987–January 1, 1999	De facto peg to the DM	Officially pegged to the ECU.
	January 1, 1999–December 2010	Currency union	Euro.
Germany	January 1973–January 1, 1999	Float	
	January 1, 1999–December 2010	Currency Union	Euro.
Greece	September 1989–January 1, 1999	De facto peg to the DM	On March 15, 1998, the drachma entered the ERM.
	January 1, 1999–December 2010	Currency union	Euro.
Hungary	April 1, 1957–July 1, 1992	De Facto crawling band around the DM/Multiple rates	+/-5% band. Officially pegged to a basket of currencies. On December 1, 1991, the basket was changed to comprise the ECU and the US dollar with equal weights.
	July 1, 1992–May 16, 1994	De facto crawling band around the DM	+/-5% band. On August 2, 1993, the DM replaced the ECU.
	May 16, 1994–January 1, 1999	De facto crawling band around the DM	+/-2% band. At this time, the weight of the DM in the basket was increased to 70%.
	January 1, 1999–June 4, 2003	Pre-announced crawling band around the euro	+/-2.25% band.
	June 4, 2003–December 2010	Pre-announced crawling band around the euro	+/-15% band—the de facto band is +/-5%. De facto peg to the euro during September 2009–February 2010.
Iceland	September 1986–October 2000	De facto crawling band around the DM.	+/-2% band. Officially pegged to a basket of currencies. During this period, the weight attached to the US dollar is declining. On January 3, 1992, the ECU had a weight of 76%.
	October 2000–March 28, 2001	De facto crawling band around the DM/euro.	+/-5% band. Officially pegged to a basket of currencies.
	March 28, 2001–March 2009	De facto crawling band around the euro.	+/-5% band. Officially inflation targeting.
	March 2009–December 2010	Managed floating.	

India	August 1989–July 1991	De facto crawling peg to the US dollar	
	August 1991–June 1995	De facto peg to the US dollar	One devaluation on March 1993—parallel market premium rose to 27% in February.
	July 1995–July 2005	De facto crawling peg to the US dollar	During this period, the parallel market premium has been consistently in single digits.
	August 2005–December 2010	De facto crawling band around the US dollar	+/-2% band.
Indonesia	November 16, 1978–July 1997	De facto crawling peg to the US dollar	Officially pegged to a basket of undisclosed currencies. Premium consistently below 20% and mostly in single digits.
	August 1997–March 1999	Freely falling/Freely floating	A dual rate comes into effect briefly in February 1998, when a subsidized rate was applied to certain food imports.
	April 1999–December 2010	Managed floating/crawling band around the US dollar	+/-5% band.
Ireland	March 30, 1979–October 1996	De facto moving band around the DM	+/-2% band.
	November 1996–January 1, 1999	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Israel	January 3, 1989–March 1, 1990	Pre-announced crawling band around the US dollar	Official band is +/-3% but there is a de facto band that is narrower, at +/-2%.
	March 1, 1990–January 1991	De facto crawling band around the US dollar	Official band width is +/-5%, but de facto band remains at +/-2%.
	February 1991–December 2010	De facto crawling band around the US dollar	Officially, there is a pre-announced crawling band around the US dollar. Since July 26, 1993, the upper limit is 6%, and the lower limit is 2% since August 6, 1998. Hence it is an ever widening band, which was 39.2% as of December 30, 2000. There is a de facto +/-5% band.
Italy	January 1983–September 13, 1992	De facto crawling band around the DM	+/-2% band.
	September 13, 1992–March 1993	Freely falling	
	April 1993–July 1995	De facto crawling band around the DM	+/-2% band.
	August 1995–November 1996	De facto crawling peg to the DM	

	December 1996–January 1, 1999	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Japan	December 1977–December 2010	Freely floating	
Korea, Rep. of	March 2, 1990–September 2, 1991	Pre-announced crawling band around the US dollar	+/-0.4% band. This fits into our definition of crawling peg.
	September 2, 1991–July 1, 1992	Pre-announced crawling band around the US dollar	+/-0.6% band. This fits into our definition of crawling peg.
	July 1, 1992–October 1, 1993	Pre-announced crawling band around the US dollar	+/-0.8% band. This fits into our definition of crawling peg.
	October 1, 1993–November 1, 1994	Pre-announced crawling band around the US dollar	+/-1% band. This fits into our definition of crawling peg.
	November 1, 1994–December 1, 1995	De facto crawling peg to the US dollar	Pre-announced band is +/-1.5%.
	December 1, 1995–November 1997	De facto crawling peg to the US dollar	Officially, the pre-announced band is +/-2.25%.
	December 17, 1997–June 1998	Freely falling	The won was allowed to float.
	July 1998–December 2010	Managed floating	
Latvia	January 1991–January 1994	Freely falling/Managed floating	There is no price data before this date. On July 20, 1992, the Latvian ruble replaced the Russian ruble. On October 19, 1993, the Latvian lats became sole legal tender.
	February 1994–August 1994	Peg to SDR/Freely falling	
	September 1994–August 2001	De facto crawling band around the US dollar	+/-5% band. Official peg to SDR.
	September 2001-December 29, 2004	De facto crawling band around the euro	+/-2% band.
	December 30, 2004–December 2010	De jure peg to the euro	Joined the ERM II on May 2, 2005. Starting December 30, 2004, the lats was pegged to the euro with a +/-1% band. De facto, the band has been +/-2% until June 2009 when the de facto peg to the euro was introduced.
Lithuania	January 1991–June 25, 1993	Freely falling/Managed floating	On May 1, 1992, the talonas was introduced as legal tender.
	June 25, 1993–April 1, 1994	Freely falling/Managed floating	The litas was introduced to replace the temporary talonas and on July 20 became sole legal tender.

	April 1, 1994–April 1995	Peg to the US dollar/Freely falling	Currency board was introduced.
	May 1995–February 1, 2002	Peg to the US dollar	Currency board.
	February 2, 2002–December 2010	De facto band around the euro	Band is +/-2%. Joined ERM II on June 28, 2004. En route to joining the euro zone in 2010.
Luxembourg	July 18, 1955–March 5, 1990	De facto peg to the DM/Dual Market	Small parallel market premium.
	March 5, 1990–December 31, 1991	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Malaysia	September 5, 1975–July 1997	De facto moving band around the US dollar	Band is +/-2%. Officially, the ringgit is pegged to a basket of currencies.
	August 1997–September 30, 1998	Freely floating	
	September 30, 1998–June 2005	Peg to the US dollar	
	July 2005–December 2010	De facto band around the US dollar	+/-2% band. Officially, it is a managed float against an undisclosed basket of currencies.
Malta	January 1978–January 1, 1999	Moving band around the DM	
	January 1, 1999–December 2000	Moving band around the euro	+/-2% band.
	January 2001–December 2010	De facto crawling peg to the euro	Joined the ERM II on May 2, 2005. Joined the euro zone on January 1, 2008.
Mexico	December 1988–November 11, 1991	Crawling Peg/Dual Market	
	November 11, 1991–April 1992	De facto crawling peg to the US dollar	The rates were unified in November 1991. The official arrangement was an ever widening crawling band (see below).
	May 1992–January 1994	De facto peg to the US dollar	Officially there is a band. The annualized rate of crawl of the upper limit of the band is 2.4% through October 20, 1992, and 4.7% through June 30, 1993.
	February 1994–December 22, 1994	Pre-announced crawling band around the US dollar	Pre-announced band becomes binding.
	December 22, 1994–March 1996	Freely falling/Freely floating	In December 1994, the parallel market premium jumped to 27% from single digits.

	April 1996–December 2010	Managed float/de facto crawling band	+/-5% band (98% of the observations are within the band). Significant depreciation in October 2008.
Netherlands	March 1983–January 1, 1999	De facto peg around the DM	One currency crash versus the US dollar on March 1991, none versus the DM.
	January 1, 1999–December 2010	Currency union	Euro.
New Zealand	March 4, 1985–December 2010	Managed floating	
Norway	July 1987–December 10, 1992	Moving band around the DM	+/-2% band. December 1992 does not register as a currency crash.
	December 10, 1992–December 2010	Managed floating/de facto band around the euro	+/-5% band.
Pakistan	September 1989–April 1991	De facto crawling peg/Parallel Market	
	May 1991–April 1994	De facto crawling band around the US dollar/Parallel Market	Band width is +/-2%. If the parallel rate is used, the band width is +/-5%. From August 1993 through May 1998, the parallel market premium is in single digits.
	May 1994–July 22, 1998	De facto crawling peg/Parallel Market	A more precise description of the post-November 1996 period is mini pegs lasting a few moths interspersed with a regular devaluation.
	July 22, 1998–May 19, 1999	De facto crawling band/Dual Market/ Multiple exchange rates	Band width is +/-2% (on the basis of the parallel market rate).
	May 19, 1999–February 2008	De facto crawling peg to the US dollar/Parallel Market	
	August 2008–December 2010	De facto crawling band around the US dollar	Band width is +/-2%, following a freely falling episode from March–July 2008.
Peru	December 2, 1986–August 9, 1990	Freely falling/Freely floating/ Multiple exchange rates	Parallel market premium hits 1,067% in August 1988—September 1988 classifies as a "hyperfloat." The 12-month rate of inflation reaches 12,378%.
	August 9, 1990–November 1993	Freely falling/Freely floating	Unification of rates.
	November 1993–December 2010	De facto crawling band around the US dollar	+/-2% band. Parallel market premium in single digits. Officially began inflation targeting on January 1, 2003. De facto peg starting in October 2009.

Philippines	March 1985–April 1992	De facto crawling peg to the US dollar	
	May 1992–April 1993	De facto band around the US dollar	+/-2% band.
	May 1993–August 1995	De facto band around the US dollar	+/-5% band.
	September 1995–June 1997	De facto peg to the US dollar	
	July 1997–December 1997	Freely falling/Freely floating	Parallel market premium peaked at 17% on July 1997.
	December 1997–November 1999	Managed floating	
	December 1999–December 2007	De facto crawling band around the US dollar	+/-2% band. Band appears to have broadened to +/-5% since October 2007.
Poland	March 15, 1989–January 1, 1990	Freely falling/ Freely floating/Dual Market	Parallel market is legalized.
	January 1, 1990–May 17, 1991	Freely falling/Dual Market	Official rate is pegged to the US dollar.
	May 17, 1991–April 1993	Freely falling/Dual Market	Official rate is set as a pre-announced crawling peg to the US dollar.
	May 1993–May 16, 1995	Dual Market	Official rate is set as a pre-announced crawling peg to the US dollar. There is no parallel market data for this period.
	May 16, 1995–February, 25 1998	De facto crawling band around the euro	+/-5% band. There is a pre-announced crawling band around the DM and US dollar that is +/-7%.
	February 25, 1998–October 29, 1998	De facto crawling band around the euro	+/-5% band. There is a pre-announced crawling band around the DM and US dollar that is +/-10%.
	October 29, 1998–March 24, 1999	De facto crawling band around the DM/euro	+/-5% band. There is a pre-announced crawling band around the DM and US dollar that is +/-12.5%.
	March 24, 1999–April 12, 2000	De facto crawling band around the euro	+/-5% band. There is a pre-announced crawling band around the DM and US dollar that is +/-15%.
	April 12, 2000–December 2010	Managed floating/de facto band around the euro	+/-5% band. Fluctuations have remained consistently inside this band at least 95% of the time. Significant depreciation during 2008Q4 to 2009Q1.
Portugal	March 1981–August 1993	De facto crawling band around the DM	+/-2% band.

	September 1992–June 1993	De facto crawling peg to the DM	
	July 1993–January 1, 1999	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Romania	July 1957–January 1990	Dual Market/Multiple exchange rates	25 rates were applied to exports alone. On July 1, 1983 the number of rates was reduced to two.
	February 1990–November 11, 1991	Freely falling/Freely floating/Dual Market	CPI data available only from October 1989.
	November 11, 1991–March 2001	Freely falling/Freely floating	
	April 2001–December 2010	Managed float/De facto band around the euro.	+/-5% band. August 2005 marks the beginning of inflation targeting. Since then, the exchange rate has remained within a 5% band around the euro (90% of the observations). Until adoption of inflation targeting, currency shadows the US dollar more closely than the euro.
Russian Federation	January 1992–June 1, 1995	Freely falling/Dual Market	There is no price data before this date.
	July 6, 1995–July 1996	Freely falling/Dual Market	Pre-announced crawling band around the US dollar for the official rate.
	August 1996–August 17, 1998	Dual Market	Pre-announced crawling band around the US dollar for the official rate.
	August 17, 1998–November 1999	Freely falling/Dual Market	The band was widened on August 17 and eliminated on September 2. On June 29, 1999, the two rates are unified temporarily.
	December 1999–December 2010	De facto crawling band around the US dollar/Multiple exchange rates	Band width is +/-2%. In principle, it targets a US dollar-euro basket. Band appears to widen to +/-5% starting October 2009.
Serbia & Montenegro	November 2001–December 2010	Managed float/De facto band around the euro	+/-5% band. Montenegro uses the euro as legal tender. Significant devaluation in October 2008–January 2009.
Singapore	June 21, 1973–December 2010	De facto moving band around the US dollar	+/-2% band. Officially adjusted on the basis of a basket of currencies.
Slovak Republic	February 8, 1993–March 1993	Freely falling	The Slovak koruna is introduced.

	April 1993–July 31,1996	De facto crawling band around the DM	Band width is +/-2%
	July 31, 1996–January 1, 1997		+/-2% band. Pre-announced crawling band is +/-5%. The official basket also includes the US dollar with a lower weight than the DM.
	January 1, 1997–September 1997	De facto crawling band around the DM	+/-2% band. Pre-announced crawling band is +/-7%.
	September 1997–October 1, 1998	De facto crawling band around the DM	+/-5% band. Pre-announced crawling band is +/-7%.
	October 1, 1998–December 2008	De facto crawling band around the DM, then the euro	+/-2% band. The official band is +/-15%. Joined the ERM II on November 25, 2005.
	January 2009–December 2010	Currency union	Euro.
Slovenia	October 1991–February 1992	Freely falling	There is no price data before this date. The tolar is introduced to replace the Yugoslav dinar.
	March 1992–March 1993	Freely falling/De facto crawling band around the DM	+/-2% band.
	April 1993–January 1, 1999	De facto crawling band around the DM	+/-2% band.
	January 1, 1999–August 2001	De facto crawling band around the euro	+/-2% band.
	September 2001–December 2006	Peg to the euro	Joined ERM II on June 28, 2004. De facto crawling band around the euro until December 2003.
	January 1, 2007–December 2010	Currency union	Euro.
South Africa	September 2, 1985–March 13, 1995	Dual Rate/Managed floating	There are several spikes in the premium including in 1985 and 1987, when the premium approached 40%.
	March 13, 1995–December 2010	Freely floating	
Spain	January 1981–April 1994	De facto crawling band around the DM	+/-2% band.
	May 1994–January 1, 1999	De facto peg to the DM	
	January 1, 1999–December 2010	Currency union	Euro.
Sweden	March 19, 1973–November 19, 1992	De facto crawling band around the DM	+/-2% band.
	November 19, 1992–January 1999	Managed floating	Inflation targeting begins in 1993.

	February 1999–December 2010	Managed floating/De facto moving band around the euro	+/-5% band
Switzerland	September 1981–December 1998	De facto moving band around the DM	+/-2% band.
	January 1999–December 2010	De facto moving band around the euro	+/-2% band.
Thailand	March 8, 1978–July 1997	De facto peg to the US dollar	The baht is officially pegged to a basket of currencies.
	July 1997–January 1998	Freely falling/Freely floating	
	January 1998–September 1999	Managed floating	
	October 1999–December 2010	De facto moving band around the US dollar	+/-2% band. Inflation targeting since May 2000.
Turkey	May 1984–January 1998	Freely falling/Managed floating	
	February 1998–January 1, 1999	Crawling band around the DM/Freely falling	+/-5% band. The crawling band is only detected with the 24-month window.
	January 1, 1999–January 2001	Crawling band around the euro/Freely falling	+/-5% band.
	February 2001–March 2003	Freely falling/Freely floating	
	April 2003–July 2007	Freely floating	
	August 2007–December 2010	Managed floating/De facto band around the US dollar	Band is +/-5%. Significant depreciation in October 2008, accompanied with annualized inflation nearing 40%.
United Kingdom	June 23, 1972–October 8, 1990	Managed floating	Until the dissolution of the Sterling Area on October 24, 1979 and the dismantling of capital controls, the UK had a dual rate system.
	October 8, 1990–September 12, 1992	Pre-announced band around the ECU/DM	+/-6% band.
	September 12, 1992–December 2001	Managed floating	
	January 2001–December 2008	De facto moving band around the euro	+/-2% band.
	January 2009–December 2010	Managed floating	
United States	February 13, 1973–December 2010	Freely floating	Further devaluation versus gold and other currencies. On April 1, 1978 the law that required the par value of the US dollar in terms of gold and SDRs is repealed.

Table A4. Exchange Rate Arrangements in AREAER pre-2008 and post-2008

Category	Pre-2008	Post-2008
1	Exchange arrangement with no separate legal tender	No separate legal tender
2	Currency board arrangements	Currency board
3	Other conventional fixed peg arrangements	Conventional peg
4	Pegged exchange rates within horizontal bands	Stabilized arrangement
5	Crawling pegs	Crawling peg
6	Crawling bands	Crawl-like arrangement
7	Managed floating with no pre-determined path for the exchange rate	Pegged exchange rate within horizontal bands
8	Independently floating	Other managed arrangement
9	-	Floating
10	-	Free floating

Table 5A. Coefficient Estimates using Long-term Government Bond Yield as Dependant Variable (M1 1999 to M3 2009)

	Using Long-term Government Bond Yield as Dependent Variable (1)	Robustness Check: Using Policy Rate Changes as Dependent Variable with the Same Country-Episodes as Long-term Bond (2)
$i^L_{i,t-1}$	**-0.068***	**-0.111***
	(0.02)	(0.02)
$\Delta GDP\ growth_{i,t}$	**0.064***	**0.122***
	(0.03)	(0.04)
$\Delta Inflation_{i,t}$	**0.162***	**0.37***
	(0.05)	(0.05)
$D_{fixed.NC}\Delta r^{US}_{i,t}$	**0.680***	**0.603***
	(0.31)	(0.20)
$D_{fixed.C}\Delta r^{US}_{i,t}$	0.34	0.09
	(0.52)	(0.23)
$D_{flex.NC}\Delta r^{US}_{i,t}$	**0.407***	**0.352***

	(0.13)	(0.08)
$D_{flex.C}\Delta r_{i,t}^{US}$	0.12	0.13
	(0.13)	(0.08)
ΔVIX_t	0.14	0.06
	(0.10)	(0.11)
Adjusted R-squared	0.20	0.41
No. of Obs.	301	301