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ABSTRACT

This paper re-examines international transmissions of monetary policy shocks from advanced economies to emerging market economies. In terms of methodologies, it combines three novel features. First, it separates co-movement in monetary policies due to common shocks from spillovers of monetary policies from advanced to peripheral economies. Second, it uses surprises in growth and inflation and the Taylor rule to gauge desired changes in a country's interest rate if it is to focus exclusively on growth, inflation, and real exchange rate stability. Third, it proposes a specification that can work with the quantitative easing episodes when no changes in US interest rate are observed. In terms of empirical findings, we differ from the existing literature and document patterns of "2.5-lemma" or something between a trilemma and a dilemma: without capital controls, a flexible exchange rate regime offers some monetary policy autonomy when the center country tightens its monetary policy, yet it fails to do so when the center country lowers its interest rate. Capital controls help to insulate periphery countries from monetary policy shocks from the center country even when the latter lowers its interest rate.

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1. Introduction

In an inter-connected world, foreign monetary shocks are often a key risk for emerging market economies and other developing countries. This paper re-examines the roles of the nominal exchange rate regime and capital flow management in a country's resilience to foreign monetary shocks. There is no shortage of recent reminders of foreign monetary shocks. When the US Federal Reserve raised the interest rate multiple times in the early 2000s, when it rolled out quantitative easing (QE) after the onset of the Global Financial Crisis (GFC), when it talked about "tapering" in May 2013, when the increase in the US interest rate actually took place in December 2015, when the market revised downward expectations in March 2016 about the number of US interest rate increases that might happen in 2016, and when the Fed further postponed another rate increase in June and August of 2016, we saw each time that international capital flows to emerging markets reacted and interest rates in many developing countries also appeared to have reacted – often (but not always) to follow the actual or anticipated changes in US interest rates.

What does it take for a country to have some buffer against foreign monetary shocks? The literature is somewhat split on this topic. The textbook notion that a flexible exchange rate regime provides insulation against foreign shocks is said to be supported by the data in Edwards (2012), Klein and Shambaugh (2015), and Obstfeld (2015), among others. On the other hand, using equity prices for firms across emerging market economies, Tong and Wei (2011) find that, in terms of the extent to which an emerging market economy was affected by the GFC, a flexible nominal exchange rate by itself does not provide much help but capital flow management encouraging more FDI and less non-FDI type of capital flows before the GFC tends to provide some cushion during the GFC. In terms of pair-wise correlations among cross-border capital flows, Rey (2015) points out that whether a country has a flexible or a fixed nominal exchange rate regime does not seem to make a difference, but whether it has capital controls does. The findings of the last two papers are consistent with each other. Rey's (2015) title, "dilemma not trilemma," succinctly highlights a view that capital controls appear necessary (whereas a flexible exchange rate regime is not) for a country to be insulated from global financial cycles. Interestingly, neither Tong and Wei (2011) nor Rey (2015) directly examine how combinations of nominal exchange rate regimes and capital controls affect a country's conduct of monetary policy in relation to foreign monetary shocks.

In this paper, we investigate the effectiveness of different combinations of exchange rate regimes and capital control measures, and we pay special attention to accounting for possible correlations in monetary policies due to common shocks. We will report evidence of "2.5-lemma" or something between a trilemma and a dilemma: a flexible exchange rate regime appears to convey monetary policy autonomy to peripheral countries when the center country raises its interest rate, but does not do so when the center lowers its interest rate. In other words, "fear of floating" mostly takes the form of "fear of appreciation." Capital controls provide insulation to peripheral countries from foreign monetary policy shocks even when the center lowers its interest rate. The "2.5-lemma" pattern is more nuanced than the findings in the existing literature.

The paper makes a number of methodological innovations. First, we use an estimated surprise component of the inflation forecast and an estimated surprise component of the growth forecast together with the Taylor rule specification to capture the desired change in a peripheral country's monetary policy based on a country's own domestic needs. The Taylor specification includes the stability of real exchange rates as a goal of domestic monetary policy, in addition to output and price stabilization, as suggested by Engle (2011). Such a framework allows us to control for possible coincidental co-movement of a country's monetary policy with that of the United States (US). In other words, sometimes the domestic needs of two different central banks may coincide such that their chosen monetary policies are similar even when there is no policy spillover. Hence, not all co-movements of interest rates in the peripheral and center countries would be interpreted as transmission of monetary policies or lack of monetary policy autonomy.

Second, the paper provides a specification and an estimation method that can include the QE episodes, when we do not observe much change in the US interest rate. We use a likelihood function to incorporate the latent (but censored) changes in the US policy rate. When the US interest rate is above the lower bound, changes in US monetary policy stance can be directly observed from the changes in its interest rate. When the US interest rate is at or near the lower bound, on the other hand, changes in the US policy stance are inferred from changes in the US money supply relative to its aggregate output. Instead of using a pre-estimated "shadow rate" for the zero-lower-bound period, as done by Wu and Xia (2016) and Krippner (2014), we estimate the parameters jointly with the equation on international transmission of monetary shocks[3]. To our best knowledge, this is among the first attempts in the literature to incorporate the lower-bound episodes in a study of international monetary policy transmissions.

There are important precursors to this paper in the literature. Obstfeld (2015) examines the role of the nominal exchange rate regime but does not explicitly examine the role of capital controls in the international transmission of monetary policy shocks. 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. Han and Wei (2014) and Klein and Shambaugh (2015) look at both but do not fully account for common shocks that can give the appearance of lack of policy independence of the peripheral country. They also reach opposite conclusions. While Han and Wei (2014) find that a flexible exchange rate by itself does not confer monetary policy autonomy, Klein and Shambaugh (2015) find that a moderately flexible exchange rate does but partial capital controls do not. Aizenman et al. (2016) introduced both exchange rate stability and financial openness in analyzing the sensitivity of peripheral countries' policy rates to core countries' monetary policies. They found that economies that pursue greater exchange rate stability and financial openness face stronger links with center economies, which is consistent with our conclusion. However, they introduced exchange rate stability and financial openness separately and not as a policy combination. In our specification, a policy regime is jointly determined by a combination of capital controls and a nominal exchange rate regime.

The paper also differs from the previous papers by explicitly allowing for asymmetric responses by peripheral countries on a flexible exchange rate regime to central country interest rate changes. That is, peripheral countries may or may not feel equally compelled to follow the center country's policy moves depending on whether the center loosens or tightens its monetary policy. In addition, this paper is the first to use estimated surprise components in GDP growth and inflation forecasts in gauging domestic policy need and the

[3] Aizenman et al. (2016) analyzed the US quantitative easing episode using the Wu and Xia (2016) shadow rate directly instead of estimating the shadow rates and other parameters jointly.

first in incorporating the quantitative easing episode in the context of international monetary policy transmission.

Farhi and Werning (2014) use 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 "taxes" over capital inflows during capital inflow surges caused by negative risk premium shocks 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 social welfare is affected by both terms of trade and the intertemporal path of consumption, it is generally useful to employ both tools. With a flexible exchange rate to influence terms of trade and capital controls to influence intertemporal consumption, social welfare is higher than just using one of the tools. This theoretical result is consistent with the "2.5-lemma" pattern we will report. That is, when the center country loosens its monetary policy (which tends to generate a capital flow surge into other countries), peripheral countries appear to feel compelled to follow suit by lowering their interest rates, unless they have capital control measures in place.

This paper is organized as follows: Section 2 sets up the modeling specification and introduces the data; Section 3 presents the empirical estimation results; Section 4 extends the analysis by proposing a method to include more recent episodes in which US interest rates may reach the zero lower bound; Section 5 reports additional robustness checks; finally, Section 6 concludes.

2. Specification and Data

2.1 Empirical model

Our baseline specification is built on two steps. The first step describes the relationship between the monetary policy of a periphery country and that of a center country, which we assume is the United States, conditional on other determinants of the periphery's monetary policy. Let $\Delta i_{i,t}^{p}$, denote the changes in policy interest rate of (peripheral) country i in time t. We assume it depends on four factors: the value of the policy rate one period ago, $i_{i,t-1}^{p}$; a change in the desired policy rate, $\Delta r_{i,t}^{P*}$, driven solely by domestic factors; a change in the interest rate driven by the center country, Δr_t^{US}; and a global financial cycle factor, which we approximate by the percentage changes of the Chicago Board Options Exchange Market Volatility Index, ΔVIX_t. More precisely,

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

The lagged policy rate, $i_{i,t-1}^{p}$, could capture policy momentum or a notion of policy space. For example, a higher lagged policy rate allows more space for downward policy changes. We expect to have a negative estimate of the coefficient, λ.

When country i's interest rate is observed to have changed alongside with that of the United States, is it lack of monetary policy independence or coincidence of a common shock? To separate the two, we have to specify the desired change in country i's policy rate that is driven solely by its domestic need, $\Delta r_{i,t}^{P*}$. We do this by a combination of the Taylor rule and the estimated surprise components in growth and inflation forecasts. In other words, $\Delta r_{i,t}^{P*}$ is assumed to be driven by news about the domestic output gap and the inflation gap. However, different from Obstfeld (2015) and Han and Wei (2014), we use the revisions in semi-annual forecasts of GDP and CPI by the IMF's World Economic Outlook (WEO) to represent the surprise components in the output gap and the inflation gap. Economic theory tells us to expect positive coefficients on both factors.

Since domestic factors are not our focus in this study, in our baseline analysis, we do not differentiate the weights on the output surprise and the inflation surprise across countries. Let $r_{i,t}^{p*}$ be the desired monetary policy rate of country i; then $\Delta r_{i,t}^{P*}$ is the desired change in the policy rate since the previous period. 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. Crucially, $\Delta GDP\ growth_{i,t}$ and $\Delta Inflation_{i,t}$ are revisions to the projections of GDP growth and inflation rates by the IMF between its two projection horizons. The IMF releases its projections (typically) twice a year, in early April and September (sometimes October), respectively. For each country, the projections are done by desk economists in the Fund, with the overall coordination by its

Research Department to ensure global consistency. The projections presumably take into account all available information to the Fund and the best judgments of the relevant Fund staff at the time of making the projections. Our maintained assumption is that the IMF projections of a member country's growth and inflation are unbiased estimates of the member central bank's projections. Due to IMF's privileged access to member countries' central banks and information and the caliber of its staff, such an assumption seems reasonable. It is also useful to note that IMF projections of growth and inflation are formally made conditional on the government's existing macroeconomic policies. That's why the projections are called projections rather than forecasts.[4] One (helpful) consequence of the IMF methodology is that we do not need to worry about potentially endogenous responses of inflation and growth to anticipated changes in the interest rate.

In addition to inflation and output gaps, Engel (2011) included exchange rate misalignment into the loss function of policy makers and showed that exchange rate misalignments affect welfare. In our framework, instead of introducing the exchange rate arrangement into the Taylor rule, we allow the exchange rate to interact with capital controls and then to differentiate the spillover from the monetary policy of the core country (the United States). In other words, the role the exchange rate regime plays depends on the capital control and exchange rate arrangements.

Since our purpose is to find out which combinations of capital control regimes and nominal exchange rate systems can provide monetary policy independence, we make γ_2 in equation (1) a function of different regimes:

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

Where $D_{fixed.NC}$ =1 if an economy chooses a fixed exchange rate regime without capital controls, and zero otherwise; $D_{fixed.C}$ =1 if an economy chooses a fixed exchange rate regime plus capital controls, and zero otherwise; $D_{flex.NC}$ =1 if an economy chooses a flexible exchange rate regime and no capital controls, and zero otherwise; finally, $D_{flex.C}$ =1 if an economy chooses a flexible exchange rate regime plus capital controls, and zero otherwise.

[4] See the Assumptions and Conventions (page ix) of World Economic Outlook October 2015 at https://www.imf.org/external/pubs/ft/weo/2015/02/pdf/text.pdf. The assumptions for the projections are described as "that established policies of national authorities will be maintained."

With this specification,[5] we can compare different β coefficients directly and easily.

According to Obstfeld (2015), Rey (2015), and Bruno and Shin (2015), global financial cycles may affect a country's monetary policy stance separate from transmissions of monetary policies from the center to periphery countries. Following these authors, we introduce ΔVIX_t—the implied volatility of S&P 500 index options, which is a common measure of global financial uncertainty—into our model. Lower values of ΔVIX_t are often interpreted as higher global risk appetite or greater tolerance of risk-taking.

Replacing $\Delta r_{i,t}^{P*}$ 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.

We are going to use equation (4) to test our hypothesis. As listed in Table 1, the baseline combination is the fixed exchange rate regime without capital controls. We interpret coefficient β_1 as a measure of spillover from a change in the US policy rate to the interest rate in an economy with a combination of a fixed exchange rate regime and no capital controls. If one wishes to interpret the trilemma hypothesis narrowly, one would expect $\beta_1 = 1$ or at least $\beta_1 > 0$. That is, there is no monetary policy autonomy for any economy with a fixed nominal exchange rate system and no capital controls. Common interpretations of the trilemma hypothesis often go beyond this. In particular, one expects that a flexible exchange rate system would confer monetary autonomy: $\beta_3 = \beta_4 = 0$.

If capital controls are not effective because they are "leaky," we would observe $\beta_2 > 0$. On the other hand, if capital controls are completely effective in conferring monetary policy autonomy, we would expect $\beta_2 = \beta_4 = 0$. On the other hand, if capital controls are partially effectively (but a flexible exchange rate system is not effective on its own), we may observe that $\beta_1 > \beta_2 > 0$, and $\beta_3 > \beta_4 > 0$. In other words, by checking for the signs and relative magnitudes of different βs, we can find out whether a given policy regime (a combination of

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

nominal exchange rate regime and capital control regime) provides no, partial, or complete monetary policy autonomy.

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

We extend the baseline specification to incorporate the stability of real exchange rate as an additional goal in the desired policy rate (following Engel, 2011). The extended model is as follows:

(5) $\Delta r_{i,t}^{P*} = \tilde{c} + \widetilde{\phi_1} * \Delta GDP\ growth_{i,t} + \widetilde{\phi_2} * \Delta Inflation_{i,t} + \widetilde{\phi_3} * \Delta Real\ exchange\ rate_{i,t} + \widetilde{e_{i,t}},$

(6) $\gamma_2 = \beta_1 D_{fixed.NC} + \beta_2 D_{fixed.C} + \beta_{3,pos} D_{flex.NC,USpos} + \beta_{3,neg} D_{flex.NC,USneg} + \beta_{4,pos} D_{flex.C,USpos} + \beta_{4,neg} D_{flex.C,USneg},$

where

$D_{flex.NC,USpos}$ =1 for a flexible exchange rate regime, no capital controls, with positive US rate changes, and zero otherwise; $D_{flex.NC,USneg}$ =1 for a flexible exchange rate regime, no capital controls, with negative US rate changes, and zero otherwise;
$D_{flex.C,USpos}$ =1 for a flexible exchange rate regime, with capital controls, positive US rate changes, and zero otherwise; and $D_{flex.C,USneg}$ =1 for a flexible exchange rate regime, with capital controls, negative US rate changes, and zero otherwise;

Real exchange rate is nominal exchange rate (in units of local currency per US dollar) adjusted by the differential in inflation rates between the country in question and the United States. Therefore, an increase in the value of real exchange rate means depreciation of local currency; if the country wishes to reduce RER instability, we expect $\phi_3 > 0$.

In equation (6), we allow economies with flexible exchange rate regime to respond differently to an increase or decrease in the US rate. If $\beta_3 = 0$ and $\beta_4 > 0$, it would imply that the countries are reluctant to follow tightening monetary policy by the United States but generally would follow a reduction in the interest rate by the United States. This would be interpreted as evidence of “fear of appreciation.” For countries with capital controls (and still a flexible exchange rate), if there is no spillover in monetary policies regardless of a rise or fall of the US interest rate, we expect $\beta_{4,pos} = \beta_{4,neg} = 0$.

2.2 Data

We include all economies with relevant data in our sample (60 countries in total), of which 24 are developing or emerging market countries. They are listed in Appendix Table A1. In our baseline analysis, we include Germany to represent euro currency countries and exclude all other euro currency countries since they have the same monetary policy as Germany. 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. As a robustness check, we did bring euro zone economies back in Section 5 to make our results comparable to the existing literature (such as Obstfeld, 2015).

From IMF's IFS dataset, we collected short-term interest rates – monthly policy rate data covering M1 1990 to M6 2014. If the monthly policy rate is not available, we use the discount rate. A detailed description can be found in Appendix Table A2. The policy rates are used to construct changes in policy rate, $\Delta i_{i,t}^{p}$. Based on equation (4) we also examine the long-term interest rates' response to US long-term interest rate changes. For this purpose, we use 10-year government bond yields. Among the 28 countries included in the short-term policy rate analysis, Argentina, Belarus, and Ecuador do not have appropriate long-term government bond yields data and therefore are not included in the long-term rate analysis. In Table A2, we list the details of the data sources 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 the IMF's WEO forecasts 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

[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.

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 IMF de facto exchange rate regime classification by Ilzetzki et al. (2011) to define fixed and flexible exchange rate regimes. Classification 1[8] is defined as fixed exchange rate. The remaining categories 2–6[9] 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 US monetary policy shocks in this analysis. The detailed descriptions drawn from Ilzetzki et al. (2011) can be found in Table A3 in the Appendix.[10] An alternative regime classification by the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) is used in the robustness check analysis. It starts from 1999. We label countries in categories 1–3 (pre-2008) and 1–4 (post-2008) as the ones with a fixed exchange rate regime. Detailed descriptions can be found in Table A4 in the Appendix.

While the People's Republic of China (PRC) was classified under a flexible exchange rate regime (category 3) from 2002 to 2009 in the IMF de facto regime classification, (as shown in Table 2), it is classified as fixed during 2002–2005 and flexible during 2006–2007 by AREAER. We will use the alternative classification as a robustness check. As it turns out, our main inferences are not affected by this change in classification. The index of

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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.

9 Category 2 includes pre-announced crawling pegs, pre-announced crawling bands that are narrower than or equal to +/–2%, de facto crawling pegs, and de facto crawling bands that are narrower than or equal to +/–2%; category 3 includes pre-announced crawling bands that are wider than or equal to +/–2%, de facto crawling bands that are narrower than or equal to +/–5%, moving bands that are narrower than or equal to +/–2% (i.e., that which allow for both appreciation and depreciation over time), and managed floating; category 4 includes freely floating; category 5 is "freely falling" (typically with hyperinflation); and category 6 is dual market in which parallel market data is missing.

10 We further revise the classification for Hong Kong, China. In the Ilzetzki et al. (2011) 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.

capital controls is defined as 1–Chinn and Ito's (2008) financial openness index. In the baseline estimation, we focus on two discrete cases: no capital controls, and with at least some capital controls.

The nominal exchange rates and the money supply variables (M1 and M2) are from IMF's International Financial Statistics. The aggregated real GDP of the US from CEIC (Bureau of Economic Analysis) is used to calculate implied interest rate for the zero-bound periods.

Since the policy rate in the US reached zero bound since September 2009, our baseline analysis is from May 1990 to April 2009. In Section 4, we will introduce a method to cover the period when the US interest rate is nearly zero.

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. We classify all countries within a 2x2 matrix, depending on whether they have a flexible or a fixed exchange rate regime, and whether they have capital controls or not. We illustrate the relationship between the degree of monetary policy dependence and the features of the "regime" by a scatter plot (Figure 1): changes in domestic policy rate (vertical axis) are plotted against changes in US policy rate (horizontal axis). To reduce noise, 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; the 90% confidence interval is represented by the dashed red lines. The fitted regression lines for regimes without capital control are significantly positive whereas those for regimes with capital controls are not.

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%. This 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.[11] 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 the 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,[12] 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 $\Delta GDP\ growth_{i,t}$ in our results.

The coefficient for the benchmark regime, β_1, turns out to be positive and statistically significant at 10%. That is, the interest rate of a peripheral country with a fixed exchange rate regime and without capital controls tends to increase by 65 basis points when there is a 100 basis point increase in the US interest rate.

The coefficients for regimes with capital controls, β_2 and β_4, are not statistically significantly different from zero. This is consistent with an interpretation that capital controls allow a country's monetary policy to be immune from changes in the US rate.

However, the coefficient for the regime with flexible exchange rate without capital controls, β_3, is positive and statistically significant at 10% too, with an increase in interest

[11] As a robustness check in a later section, we pre-assign a coefficient of 0.5 for both the output gap and inflation gap.

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

rate of 45 basis points following a 100 basis point increase in the US interest rate. This casts some doubt on the notion that a flexible exchange rate can provide monetary policy independence. Instead, our findings suggest that countries adopting a flexible exchange rate but without capital controls do not have policy insulation, and tend to follow changes in US monetary policy ($\beta_3 = 0.45$). Because $\beta_3 = 0.45 < \beta_1 = 0.65$, one could say that the dependence of monetary policy on the US in this regime is somewhat milder than if the country also has a fixed exchange rate regime but still without capital controls.

In other words, a mere flexible exchange rate regime does not confer monetary policy autonomy. Some forms of capital control appear to provide some buffer. Judging from the point estimates, a combination of capital controls and a flexible exchange rate regime yields the estimates closest to zero across all specifications and may provide the most autonomy.

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 the regimes of fixed exchange rate without capital controls and flexible exchange rate without capital controls), which is consistent with the common observation of higher integration of global capital markets (see, for example, Rey (2015)). The extensions and robustness check in the following analysis are thus based on the period 1999–2009. In column (4), we present the estimation results after excluding one outlier (Argentina in April 2001).[13] The results still hold except for the coefficient estimate for β_2 at –0.05. All the remaining estimations for short-term policy rate are going to be based on the dataset used in column (4). Meanwhile, Hellerstein (2011) and Dahlquist and Hasseltoft (2013) argued that the long-

[13] Note that the coefficient estimate for β_2 is –0.249 (although not significant). For all country-periods with a fixed exchange rate and capital controls, when we plot peripheral countries' interest rate changes against US interest rate changes, Argentina in April 2001 is a visible outlier that drives the negative estimate. We exclude this data point in the remaining estimations.

term interest rate is more correlated across countries than the short-term rate because of 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 the long-term interest rate in evaluating monetary policy independence and found that in open economies, the flexible exchange rate allows countries to 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 policy rates with 10-year government bond yields. As shown in Table A2 in the Appendix, 10-year government bond yield data are more limited than those of the policy rate. For long-term bond yields, we exclude three countries – Argentina, Belarus, and Ecuador – because these countries did not have appropriate long-term government bond yield data; and exclude certain episodes since some countries, such as the PRC and Brazil, only have shorter coverage. The empirical estimation results with long-term government bond yields as the dependent variable are presented in column (5) in Table 3. Our general conclusion for the short-term interest rate analysis holds for long-term interest rates. The one period lagged long-term interest rate $i^L_{i,t-1}$ has a 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 (4) of Table 3), which implies that the role of long-term interest rates in domestic macroeconomic targeting is much smaller than that of the short-term policy rate. Our findings also echo the argument of Obstfeld (2015): the domestic macro variables play roles in determining long-term interest rates.

As shown in column (5) in Table 3, the coefficients of the exchange rate and capital control regimes for the long-term interest rate analysis are similar to those under the short-term interest rate analysis. Coefficients for both regimes without capital controls are significantly positive with a higher estimate for the regime with fixed exchange rate at 0.68 and a lower estimate for the regime with flexible exchange rate at 0.41. Therefore, our conclusion that capital controls are more effective in helping economies to be less affected by US monetary policy shocks and countries with flexible exchange rates without capital controls tend to adjust their policy rates in tandem with the US rate holds for both short-end and long-end of the term structures.

To verify that our findings are not subject to bias induced by a smaller sample for the long-term bond yield data, we intentionally reduced data set of the short-term policy rates by focusing on the same country-episodes as in the data for the long-term rates. The results are shown in column (2) in Table A5 in the appendix and do not change from the baseline case.

By introducing capital control differentiation explicitly in the model, our findings partially support and partially refute 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, it does not provide total immunity. Our conjecture is that open economies with flexible exchange rates willingly go in tandem with US monetary policy changes.

We carried out F-tests for the null hypotheses $\beta_2 = \beta_4$ and $\beta_4 = \beta_3$. As shown by the F-test results in Table 3, for columns (1), (2), and (5), β_2 is not significantly different from β_4. This means that interest rate responses are not different between fixed or flexible exchange rates if there are capital controls. On the other hand, from columns (1), (3), and (4), β_4 is significantly different from β_3. This means that flexible regimes with capital controls are different from flexible regimes without capital controls when it comes to monetary policy transmission.

Table 4 presents the estimation results for an extended model that allows for asymmetric responses under a flexible exchange rate regime and incorporates real exchange rate stability in the Taylor rule as described by equations (5) and (6). The results are broadly similar to before. In particular, a flexible exchange rate regime appears to offer policy autonomy when the center country raises its interest rate, but not when it lowers the rate. A flexible exchange rate regime in combination with capital controls appears to offer monetary policy autonomy to peripheral countries. These results are summarized in Figure 1b.

4. The Lower-bound Episodes

The QE approach of the US Federal Reserve creates complications for specification (4) above, as downward adjustments in the US interest rate are not observed even though the QE is clearly intended to further loosen the monetary policy stance. More importantly, it is conceptually possible that the transmission patterns of monetary policy change qualitatively under QE. In particular, if the US interest rate is stuck near zero, emerging market exchange rate responses to changes in the US monetary aggregates can be weaker than when the US interest rate is above zero. Does this happen in the data? Does the effectiveness of capital controls and the nominal exchange rate regime change from the normal to the QE world?

In order to answer these questions, we generalize specification (4) by replacing the observed US interest rate by a latent interest rate, whose value depends on whether the US interest rate reaches the lower bound. During the lower-bound episodes, agents are assumed to form their views on US monetary policy by using the US money supply (relative to aggregate output) instead. The model includes three equations as follows:

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

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

(9) $r_t^{US*} = \theta_1 + \theta_2 logM_t + \theta_3 logY_t + \epsilon_t.$[14]

Equation (7) is similar as equation (1), where $\Delta r_{i,t}^{P*}$ is the desired change in the interest rate for the peripheral country based on a Taylor rule that takes into account the country's domestic need. The main difference is that the changes in the stance of US monetary policy, $\Delta r_t^{US\#}$, is now defined by Equations (8) and (9). When the US interest rate is above its lower bound, agents would use the observed US policy rate changes to gauge changes in US monetary policy, $\Delta r_t^{US\#}$; however, when the US policy rate reaches its lower bound, the changes in US monetary policy stance is inferred from movements in real money supply M_t in relation to real aggregate output Y_t, as indicated in equation (9). Equation (9) resembles

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

the standard money market equilibrium condition except that the interest rate in question is the latent interest rate. The terms $\varepsilon_{i,t}$ and ϵ_t are assumed to be i.i.d.

Note that when the US interest rate is above the lower bound, the observed policy rate is used to gauge US monetary policy stance because it is less noisy than what is inferred via equation (9).

We estimate the model by maximum likelihood. Based on equations (7) to (9), we construct the likelihood function as

(10)

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

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

The sample is extended to 2012[15] to include the period when the US policy rate practically reached the lower bound and the QE approach was employed. As straightforward extensions of the above specification, we also allow for exchange rate stability in the Taylor rule and asymmetric responses of the peripheral countries with a flexible exchange rate regime. That is, to replace $\Delta r_{i,t}^{P*}$ and γ_2 in the likelihood function (10) with the equation (5)

[15] Note that the exchange rate regime classification (AREAER) ends in 2012.

and (6). For lower-bound episodes, $\theta_2(\log M_t - \log M_{t-1}) + \theta_3(\log Y_t - \log Y_{t-1})$ is used to make judgment on whether there is a positive Δr_t^{US*} or negative Δr_t^{US*}.

We bootstrap the sample with replacement for 100 times and optimize the logarithm using a quasi-Newton algorithm for each bootstrapped sample. The standard error from the 100 estimates on bootstrapped samples is used to judge the significance level.

The results are reported in Table 5. Because the maximum likelihood estimation could be sensitive to the choice of initial values if some initial values lead to a local maximum that is different from the global maximum, we experiment with different sets of initial values. In Column 1, we use the OLS estimates (reported in Column 6) as the initial values. In Columns 2 and 3, we use the OLS estimates plus one or two times their standard errors, respectively, as the initial values. In Columns 4 and 5, we use the OLS estimates minus one or two times their standard errors, respectively, as the initial values.

Comparing across the five columns in Table 5, we find broad agreement in the individual coefficient estimates regardless of the choices of initial values. In particular, we see evidence in support of the "2.5-lemma" pattern. First, a fixed nominal exchange rate without capital control offers no monetary policy autonomy (as suggested by β_1=0.50 to 0.52). Second, a flexible exchange rate regime without capital controls confers no monetary autonomy when the United States loosens its monetary policy ($\beta_{3,neg}$=0.60 and significant), but it allows somewhat better policy insulation when the United States tightens its monetary policy stance ($\beta_{3,pos} = 0.18 < 0.60 = \beta_{3,neg}$). Finally, capital controls confer monetary policy autonomy to peripheral countries regardless of their nominal exchange rate regimes (statistically, $\beta_2 = \beta_{4,pos}$=$\beta_{4,neg}$= 0 cannot be rejected and numerically these point estimates are also much closer to zero).

Note that the coefficient on ΔVIX_t is now statistically significant, which is different from the baseline estimates in Table 3. This might suggest that the notion of a global financial cycle works more strongly during the QE episodes (2009–2012). Note also that the coefficients on log money supply and log output have the right signs. For example, a negative sign on log money supply means that an increase in money supply implies a reduction in the latent interest rate. However, due to large standard errors, these point estimates are not statistically significant. Finally, Wu and Xia (2016 and Krippner (2014) provided their estimates of the shadow US interest rate during the US QE period. Because we jointly estimate the latent interest rate during the QE episode and the international monetary policy transmissions, our approach is more efficient than pursuing a two-step approach of estimating the shadow interest rate first and estimating the international transmissions second. Nonetheless, as a robustness check, we also feed the shadow US interest rate estimates from Wu and Xia (2016 into Equations (5)–(6) and obtain similar results as those reported in Table 5.

5. Extensions and Robustness Checks

We conduct a series of robustness checks and extensions. In each exercise, we make one change to the specification as specified below while maintaining other features of the baseline case.

Re-defining capital controls

Instead of defining capital controls as a dichotomous variable, we now define it continuously as 1–(Chinn–Ito index). In this case, a greater value means stricter capital controls. The results are reported in Columns 1 and 2 of Table 6, for short-term and long-term interest rates, respectively.

The pattern of "2.5-lemma" can be seen from the results. First, there is no monetary policy autonomy by peripheral countries if they have a combination of a fixed exchange rate and no capital controls. This can be seen from the fact that $\beta_1 = 0.487$ and is statistically significant.

Second, for a country with a flexible exchange rate regime but without capital controls, it follows the US policy moves (i.e., no policy autonomy) when the latter loosens monetary policy (as can be seen by the coefficient on the triple interaction term among a dummy for a flexible exchange rate, a dummy for US loosening monetary policy, and the change in the US policy rate to be 0.369 and statistically significant). On the other hand, it appears to not follow US interest rate moves when the US raises its interest rate.

Third, capital controls generally confer monetary policy autonomy to peripheral countries. For example, for countries on a fixed exchange rate regime, an increase in the value of the capital controls index from the 25th percentile (or 0.31) to the 75th percentile (or 0.84, approximately the value for the PRC during 1999–2001) would almost eliminate the impact from changes in the US interest rate (because 0.487–0.727x(0.84–0.31)=0.101)). However, the coefficient on the interaction term between a fixed rate and the (continuously valued) capital control index is not statistically significant because the standard error is large.

Finally, different from Obstfeld (2015), we find no substantive difference between the result for the long-term interest rate (in Column 2) and that for the short-term interest rate (in Column 1).

Re-classifying exchange rate regimes

As an alternative to the Reinhart and Rogoff classification, we use the exchange rate regime classifications in the IMF's AREAER. We label lack of a separate legal tender, currency board, and a conventional peg as a fixed exchange rate regime for short. All other categories are flexible exchange rate regimes. Since we focus on the influence of US monetary policy changes, the euro zone is represented by one country (Germany) and classified as a flexible exchange rate regime. More details can be found in Table A1 of the Appendix.

Regression results with the alternative classifications of nominal exchange rate regimes are reported in columns (3) and (4) of Table 6. We obtain essentially the same qualitative conclusions as in the baseline case presented in Table 4. In particular, the "2.5-lemma" patterns are confirmed in the data.

Alternative specification of the Taylor rule

Instead of estimating the coefficients on output and inflation gaps in the Taylor rule, we pre-assign 0.5 for the output gap and 1.5 for the inflation gap as suggested by Taylor (1993) and Hofmann and Bogdanova (2012). Transforming by first difference, we have

(11) $$\Delta r_{i,t}^{P*} = 1.5\Delta\pi + 0.5\Delta y,$$

Rewriting the specification, we have

$$(12)\quad \Delta i_{i,t}^{p} = \lambda i_{i,t-1}^{p} + \gamma_1 \widetilde{\Delta r_{i,t}^{P*}} + \beta_1 D_{fixed.NC} \Delta r_{i,t}^{US} + \beta_2 D_{fixed.C} \Delta r_{i,t}^{US} + \beta_3 D_{flex.NC} \Delta r_{i,t}^{US} + \beta_4 D_{flex.C} \Delta r_{i,t}^{US} + \delta \Delta VIX_t + e_{i,t},$$

where $\widetilde{\Delta r_{i,t}^{P*}}$ is calculated by taking the first difference of $r_{i,t}^{P*}$ based on equation (9).

For the short-term policy rate, the estimated value of γ_1 is 0.105. 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, as shown in columns (5) and (6) in Table 6.[16] It turns out that the coefficient for $\Delta Inflation_{i,t}$ is very close to the results in column (3) of Table 4 while the coefficient for $\Delta GDP\ growth_{i,t}$ is more different. However, for the long-term interest rate, both the coefficients for $\Delta Inflation_{i,t}$ (0.21) and $\Delta GDP\ growth_{i,t}$ (0.07) are significant but smaller than the baseline estimations. With the pre-assigned Taylor rule, both the estimates for inflation gap and real exchange rate stability became insignificant and much smaller.

Most important for our purpose, we note that the main features of the "2.5-lemma" continue to hold. For example, under a flexible exchange rate regime, peripheral countries still follow the United States when the latter loosens its monetary policy (i.e., no autonomy) but the peripheral countries appear to be able to not follow the United States when the latter tightens monetary policy. In other words, there is fear of appreciation but not so much with depreciation. In addition, capital controls appear to offer peripheral countries monetary policy independence. Also, the difference between the short-term and long-term interest rates appears minor. So the "2.5-lemma" description also applies to long-term interest rates.

[16] 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 0.053 (0.5*0.105) and $\Delta Inflation_{i,t}$ is 0.158 (1.5*0.105).

Seemingly unrelated regressions

The error terms in the four different regimes might be correlated with each other even after controlling for the global financial cycle and the Taylor rules. In order to account for this possibility, we use seemingly unrelated regressions (SUR).

(13)
$$\triangle i^{p}_{fixNC,it} = c_1 + \lambda_1 i^{p}_{fixNC,it-1} + \phi_1 * \triangle GDP\ growth_{fixNC,it} + \phi_2 * \triangle Inflation_{fixNC,it} + \beta_{fixNC,pos} D_{Pos} \Delta r^{US}_{i,t} + \beta_{fixNC,neg} D_{Neg} \Delta r^{US}_{i,t} + \delta_1 \Delta VIX_t + e_{1,it},$$
$$\triangle i^{p}_{fixC,it} = c_2 + \lambda_2 i^{p}_{fixC,it-1} + \phi_1 * \triangle GDP\ growth_{fixC,it} + \phi_2 * \triangle Inflation_{fixC,it} + \beta_{fixC,pos} D_{Pos} \Delta r^{US}_{i,t} + \beta_{fixC,neg} D_{Neg} \Delta r^{US}_{i,t} + \delta_2 \Delta VIX_t + e_{2,it},$$
$$\triangle i^{p}_{fleNC,it} = c_3 + \lambda_3 i^{p}_{fleNC,it-1} + \phi_1 * \triangle GDP\ growth_{fleNC,it} + \phi_2 * \triangle Inflation_{fleNC,it} + \beta_{fleNC,pos} D_{Pos} \Delta r^{US}_{i,t} + \beta_{fleNC,neg} D_{Neg} \Delta r^{US}_{i,t} + \delta_3 \Delta VIX_t + e_{3,it},$$
$$\triangle i^{p}_{fleC,it} = c_4 + \lambda_4 i^{p}_{fleC,it-1} + \phi_1 * \triangle GDP\ growth_{fleC,it} + \phi_2 * \triangle Inflation_{fleC,it} + \beta_{fleC,pos} D_{Pos} \Delta r^{US}_{i,t} + \beta_{fleC,neg} D_{Neg} \Delta r^{US}_{i,t} + \delta_4 \Delta VIX_t + e_{4,it}.$$

In a standard SUR specification, one usually has the same number of observations for each regime. We use a bootstrap approach to create a balanced sample (to obtain 307 observations in each regime, the same as the regime with the most observations). We repeat the sampling 500 times in Monte Carlo simulations to generate the means and the associated standard errors. We allow the λs and βs to vary while keeping ϕ_1 and ϕ_2 constant across regimes.

The results are reported in Table 7. In this estimation, we allow for potentially different parameters in the four regimes (a regime is a combination of nominal exchange rate arrangement and capital control arrangement). Strikingly, we still get something between a trilemma and a dilemma: no monetary policy autonomy for peripheral countries with a fixed exchange rate and no capital controls; partial monetary policy autonomy for countries with a flexible exchange rate and no capital controls; and monetary policy autonomy for countries with capital controls.

Another look at the global financial cycle effect

One interesting result from our baseline estimation is that the variable representing the global financial cycle – ΔVIX_t is not statistically significant, in contrast to Rey (2015) and Obstfeld (2015). Because Obstfeld (2015) includes all individual euro area countries as separate observations whereas we group all euro countries into a single observation, the difference in the samples could be responsible for the difference in the result. To examine this possibility, we bring the euro zone economies back and re-run the regression. As column (1) in Table 8 shows, once we replicate the sample of Obstfeld (2015), ΔVIX_t becomes significantly positive in our specification too. In column (2), we exclude the episodes between 1990 and 1998 but still obtain similar results, This suggests that the "global financial cycle effects" are mostly driven by treating euro zone economies as separate observations. There is no robust support for a global financial cycle that is independent from changes in the center country monetary policy.

The coefficient estimate for the regime with a flexible exchange rate but no capital controls is 0.24, which is much lower than 0.45, the value of the same coefficient in the baseline case. This suggests that the euro zone economies collectively are more influenced by a common global financial cycle but less affected by US monetary policy changes.

It has also been argued that a valuation channel also allows a flexible exchange rate regime to augment monetary policy effectiveness (see Georgiadis and Mehl, 2015, and Meier, 2013). According to this hypothesis, when a country has positive net foreign currency assets, an appreciation of the domestic currency in response to a tightening in local monetary policy reduces the value of their net foreign currency assets in the local currency (and so too their total wealth). This leads to a contraction of domestic consumption and investment, augmenting monetary policy effectiveness. Meanwhile, they suggest that a global financial cycle can weaken the effectiveness of domestic monetary policy by allowing consumption smoothing through borrowing from abroad.

We would point out that the valuation channel is precisely one of the reasons why a flexible exchange rate regime without capital controls tends to follow the US when the US decreases its interest rate. When the US expands its monetary policy, if the periphery country does not follow suit, an appreciation of its currency could lead to a contraction of domestic investment and consumption. The periphery country, even if it has a flexible exchange rate, chooses to follow the US policy move precisely to nullify the valuation effect. While if the country has capital controls, the capital controls can effectively help avoid the "forced" appreciation of the local currency even if the periphery interest rate does not follow the US interest rate's movement.

In our baseline framework, the global financial cycle effect is captured by ΔVIX_t. Symmetrically, we add a net foreign asset variable – the share of foreign exchange reserves to GDP interacting with changes in the US rate. As shown in column (3) of Table 8, this interaction term has an insignificant estimate, in contrast to Georgiadis and Mehl (2015) and Meier (2013).

Exchange rate responses to US interest rate changes

Previous discussions suggest that, even for countries with a flexible exchange rate regime, presence or absence of capital controls makes a difference for the transmission of monetary policy shocks. Another way to investigate this possibility is to look at exchange rate responses to changes in the US interest rate. More precisely, we now look at the difference in the log exchange rate between two WEO reporting times (six months apart) as the dependent variable (where the exchange rate is defined as units of local currency per US dollar). The specification on the right hand side is similar to those in Table 3.

The results are reported in Table 9. The key coefficients of interest are the two associated with the policy regimes. For countries with a flexible exchange rate but no capital controls, the local currency tends to depreciate by about 2% following a US interest rate increase by one percentage point, according to Columns 1 or 3. However, for countries with a flexible exchange rate but with capital controls, the extent of depreciation is much less at only 0.6%, according to the same two columns. Thus, capital controls appear to blunt the exchange rate response even for countries with a flexible exchange rate system.

If we use a Talor rule with pre-assigned parameter values (similar to the last two columns of Table 6), then, following the US interest rate increase, the periphery country's currency would depreciate by about 1% if it does not have capital controls, and the exchange rate appears unresponsive to the US interest rate if the country has capital controls.

Note that the exchange rate response presumably has already taken into account the tendency for a periphery country's interest rate to respond to changes in the US interest rate. The fact that the observed exchange rate depreciation is bigger for countries without capital controls than for those with capital controls is consistent with the finding in earlier tables that the periphery country's interest rate response tends to be less than one for one.

6. Conclusions

In an increasingly inter-connected world, foreign monetary shocks are often a key risk for emerging market economies and other developing countries. This paper re-examines the roles of the nominal exchange rate regime and capital flow management in the transmission of international monetary shocks.

Relative to the existing literature, we introduce several methodological innovations/improvements. First, we introduce a measure of a country's desired change in the interest rate based on a Taylor rule and use the surprise components in inflation forecasts and growth forecasts by the IMF's World Economic Outlook to gauge the terms in the Taylor rule. We also incorporate exchange rate stability as a potential goal of monetary policy as suggested by Engel (2011). This modification allows us to effectively decompose co-movements between a country's and the US interest rates into two parts, that which is caused by common shocks to fundamentals in the US and the peripheral country, and that which reflects the dependence of the peripheral country on US monetary policy, or "fear of deviations." Second, since quantitative easing has become a non-trivial part of the recent US monetary policy history, and little change in the US interest rate is observed during this period, we also develop a methodology that allows this part of the time series to be incorporated in the estimation. Third, we examine monetary autonomy both in terms of long-term and short-term interest rates.

The paper reaches different conclusions from some of the well-known papers in the literature. In particular, neither a dilemma nor a trilemma characterizes the patterns in the data completely. Instead, something in between seems to be the norm: for peripheral countries without capital controls, a flexible nominal exchange rate allows them to have some policy autonomy when the center country tightens its monetary policy. On the other hand, when the center country loosens its monetary policy, their "fear of appreciation" takes over and they often pursue similarly looser monetary policy even if the domestic Taylor rule suggests otherwise. In this sense, a flexible exchange rate offers asymmetric or incomplete insulation from foreign monetary policy shocks. In comparison, capital controls do offer insulation from foreign monetary policy shocks for peripheral countries on either a fixed or a flexible exchange rate regime.

Separately, we do not find robust support for the notion of a global financial cycle that is separate from the spillover of center country monetary policy shocks.

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Table 1: Coefficients for different combinations of regimes

	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 in the baseline case

	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)

Note: The classifications are based on de facto exchange rate regime classification as coded by Ilzetzki et al. (2010) and financial openness by Chinn-Ito (2008).

Table 3: Baseline model for both short-term policy rates and long-term government bond yields

		Short-term 1990–2009 (1)	Short-term 1990–1998[1] (2)	Short-term 1999–2009 (3)	Short-term Without Argentina 2001/April (4)	Long-term 1999–2009 (5)
$i^{p}_{i,t-1}$	λ	**–0.048***	–0.007	**–0.110***	**–0.11***	**–0.068***
		(0.008)	(0.015)	(0.01)	(0.01)	(0.02)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.096	0.237	0.041	0.044	**0.064***
		(0.06)	(0.144)	(0.054)	(0.053)	(0.03)
$\Delta Inflation_{i,t}$	ϕ_2	**0.329***	0.134	**0.413***	**0.413***	**0.162***
		(0.048)	(0.096)	(0.049)	(0.049)	(0.05)
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.649***	0.402	**0.654***	**0.648***	**0.680***
		(0.39)	(2.09)	(0.3)	(0.297)	(0.31)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	0.034	1.998	–0.249	–0.047	0.34
		(0.325)	(1.286)	(0.258)	(0.262)	(0.52)
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.450***	0.492	**0.497***	**0.493***	**0.407***
		(0.176)	(0.438)	(0.154)	(0.153)	(0.13)
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	0.029	0.008	0.063	0.059	0.12
		(0.127)	(0.334)	(0.11)	(0.109)	(0.13)
ΔVIX_t	δ	0.23	0.086	0.176	0.172	0.14
		(0.199)	(0.584)	(0.169)	(0.168)	(0.10)
F test:[2] $\beta_2 = \beta_4$		1.33	1.26	**0.23***	**0.23**	0.00
F test: $\beta_4 = \beta_3$		**4.07***	0.82	**5.79***	**5.96***	2.62
Adjusted R-squared		0.09	0.000[3]	0.30	0.30	0.20
No. of Obs.		827	295	532	531	301

* Significant at 10%.

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

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

[3] The unadjusted R-squared is 0.0272.

Table 4: Asymmetric responses under flexible exchange rate regimes plus an alternative Taylor rule specification

		(1) Asymmetric responses under flexible exchange rates	(2) Country specific Taylor rules	(3) Adding exchange rate stability to Taylor rule	(4) Combining (2) and (3)	(5) Long-term bond yield as dependent variable
$i^p_{i,t-1}$	λ	**–0.114***	**–0.106***	**–0.117***	**–0.111***	**–0.067***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.017)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.04	not	0.064	not	**0.075***
		(0.053)	reported	(0.055)	reported	(0.032)
$\Delta Inflation_{i,t}$	ϕ_2	**0.413***	not	**2.442***	not	**1.207***
		(0.049)	reported	(1.137)	reported	(0.674)
$\Delta Real\ ExchangeRate_{i,t}$	ϕ_3	–	–	**2.03***	not	1.053
		–	–	(1.136)	reported	(0.677)
$\boldsymbol{D_{fixed.NC}\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_1}$	**0.656***	**0.765***	**0.617***	**0.726***	**0.674***
		(0.298)	(0.322)	(0.298)	(0.321)	(0.313)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	–0.048	–0.041	–0.039	–0.014	0.4
		(0.262)	(0.258)	(0.261)	(0.257)	(0.524)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	0.152	0.172	0.114	0.117	0.348
		(0.314)	(0.302)	(0.314)	(0.302)	(0.262)
$\boldsymbol{D_{flex.NC}Neg\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_{3,neg}}$	**0.63***	**0.496***	**0.616***	**0.47***	**0.396***
		(0.196)	(0.22)	(0.196)	(0.219)	(0.19)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	$\beta_{4,pos}$	0.215	0.224	0.192	0.185	–0.084
		(0.244)	(0.244)	(0.244)	(0.243)	(0.252)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.013	0.037	0.025	0.042	0.213
		(0.146)	(0.149)	(0.145)	(0.148)	(0.185)
ΔVIX_t	δ	0.172	**0.329***	0.047	0.175	0.069
		(0.169)	(0.17)	(0.183)	(0.182)	(0.107)
Adjusted R-squared		0.30	0.38	0.31	0.39	0.20
No. of Obs.		531	531	531	531	301

Note: Country specific coefficients for the Taylor rule variables are incorporated in Specifications (2) and (4) but not reported to save space.

Table 5: Including the lower-bound episode (1999–2012); Sensitivity analysis with different initial values

		Using OLS est. as the initial values (1)	Initial values in (1) + Standard Error (SE) (2)	Initial values in (1) + 2*SE (3)	Initial values in (1) – SE (4)	Initial values in (1) – 2*SE (5)	Initial values (OLS estimate) from the baseline optimization (6)
$i^{p}_{i,t-1}$	λ	**–0.11***	**–0.11***	**–0.11***	**–0.11***	**–0.11***	**–0.11***
$\Delta\ GDP\ growth_{i,t}$	ϕ_1	**0.06***	**0.06***	**0.06***	**0.06***	**0.06***	0.06
$\Delta\ Inflation_{i,t}$	ϕ_2	**2.60***	**2.39***	**2.45***	**2.38***	**2.42***	**2.48***
$\Delta Real\ Exchange\ Rate_{i,t}$	ϕ_3	**2.23***	**2.02***	**2.08***	**2.01***	**2.05***	**2.11***
$D_{fixed.NC}\ \Delta\ r^{US}_{i,t}$	β_1	**0.52***	**0.50***	**0.51***	**0.51***	**0.51***	**0.57***
$D_{fixed.C}\ \Delta\ r^{US}_{i,t}$	β_2	–0.05	–0.07	–0.05	–0.06	–0.06	–0.11
$D_{flex.NC} Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	**0.18***	**0.20***	**0.18***	**0.20***	**0.19***	0.25
$\boldsymbol{D_{flex.NC} Neg \Delta r^{US}_{i,t}}$	$\beta_{3,neg}$	**0.60***	**0.58***	**0.60***	**0.57***	**0.59***	**0.54***
$D_{flex.C} Pos\ \Delta r^{US}_{i,t}$	$\beta_{4,pos}$	0.22	0.23	0.21	0.23	0.22	0.26
$D_{flex.C} Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.04	0.02	0.05	0.02	0.04	0.002
ΔVIX_t	δ	**0.16***	**0.19***	**0.16***	**0.19***	**0.17***	0.16
σ_{ε}		2.51	2.81	2.60	2.66	2.68	1.07
$logM_t$	θ_2	–0.17	–10.60	–0.15	–12.18	–5.67	0
$logY_t$	θ_3	0.16	9.97	0.14	11.45	5.33	0
σ_{ϵ_t}		0.005	0.32	0.004	0.37	0.17	1.07
Log L at optimal		–1505.719	–1505.997	–1505.700	–1506.070	–1505.814	–
Obs.		736	736	736	736	736	

Note: Columns (1)–(5) are results using different initial values for the optimization. More specifically, Column (1) uses the OLS estimate as the initial values. Columns (2) and (3) use the coefficients in Column (1) plus 1 and 2 standard errors as the initial values, respectively, while Columns (4) and (5) use the coefficients in Column (1) minus 1 and 2 standard errors as the initial values. Column (6) 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.

Table 6: Additional robustness checks (M1 1999 to M3 2009)

	Re-defining capital controls as continuous variable as (0,1]			Re-defining nominal exchange rate regime by AREAER		Using pre-assigned Taylor Rule	
	Short-term (1)	Long-term (2)		Short-term (3)	Long-term (4)	Short-term (5)	Long-term (6)
$i^{p}_{i,t-1}$	**–0.114***	**–0.06***	$i^{p}_{i,t-1}$	**–0.116***	**–0.066***	**–0.113***	**–0.062***
	(0.01)	(0.017)		(0.01)	(0.017)	(0.01)	(0.016)
$\Delta\, GDP\ growth_{i,t}$	0.065	**0.078***	$\Delta\, GDP\ growth_{i,t}$	0.065	**0.076***	0.053	**0.070***
	(0.056)	(0.032)		(0.055)	(0.032)	–	–
$\Delta\, Inflation_{i,t}$	**2.522***	**1.176***	$\Delta\, Inflation_{i,t}$	**2.536***	**1.183***	0.158	**0.209***
	(1.147)	(0.671)		(1.139)	(0.672)	–	–
$\Delta Real\ Exchange\ Rate_{i,t}$	**2.102***	1.03	$\Delta Real\ Exchange\ Rate_{i,t}$	**2.122***	1.028	–0.25	0.054
	(1.146)	(0.674)		(1.138)	(0.676)	(0.175)	(0.116)
$D_{fixed.}\, \Delta\, r^{US}_{i,t}$	**0.487***	**0.663***	$D_{fixed.NC}\, \Delta\, r^{US}_{i,t}$	**0.582***	**0.671***	**0.645***	**0.685***
	(0.271)	(0.31)		(0.346)	(0.313)	(0.299)	(0.313)
$D_{fixed}\, \Delta\, r^{US}_{i,t} * C$	–0.727	–0.454	$D_{fixed.C}\, \Delta\, r^{US}_{i,t}$	–0.131	–0.307	–0.06	0.353
	(0.546)	(1.139)		(0.271)	(0.645)	(0.262)	(0.525)
$D_{flex} Pos\ \Delta r^{US}_{i,t}$	0.098	0.392	$D_{flex.NC} Pos\ \Delta r^{US}_{i,t}$	0.116	0.363	0.154	0.395
	(0.285)	(0.241)		(0.309)	(0.263)	(0.314)	(0.26)
$\boldsymbol{D_{flex} Neg \Delta r^{US}_{i,t}}$	**0.369***	**0.365***	$\boldsymbol{D_{flex.NC} Neg\ \Delta r^{US}_{i,t}}$	**0.637***	**0.385***	**0.618***	**0.415***
	(0.173)	(0.177)		(0.191)	(0.191)	(0.196)	(0.19)
$D_{flex} Pos\ \Delta r^{US}_{i,t} * C$	0.218	**–0.95***	$D_{flex.C} Pos \Delta r^{US}_{i,t}$	0.125	–0.032	0.212	–0.084
	(0.504)	(0.493)		(0.246)	(0.248)	(0.244)	(0.253)
$D_{flex} Neg \Delta r^{US}_{i,t} * C$	–0.451	–0.205	$D_{flex.C} Neg\ \Delta r^{US}_{i,t}$	0.074	0.232	–0.001	0.233

	(0.303)	(0.346)		(0.146)	(0.188)	(0.145)	(0.185)
ΔVIX_t	0.036	0.073	ΔVIX_t	0.035	0.077	0.183	0.139
	(0.184)	(0.106)		(0.182)	(0.107)	(0.171)	(0.096)
Adjusted R-squared	0.30	0.20	Adjusted R-squared	0.31	0.20	0.30	0.20
No. of Obs.	531	301	No. of Obs.	531	301	531	301

Notes:

(1) * denotes "statistically significant at 10%."

(2) The coefficient estimate for changes in desired policy rate in the case of short-term policy rate (Column 5) is 0.105 with a standard error of 0.110; The coefficients for the output gap and inflation gaps are 0.105x0.5=0.053 and 0.105x1.5=0.158, respectively. The coefficient estimates in the case of long-term interest rate (Column 6) is 0.139 with a standard error of 0.060. The corresponding coefficients for the output and inflation gaps are 0.139x0.5=0.070 and 0.139x1.5=0.209, respectively.

Table 7: Seemingly Unrelated Regressions

		Fixed exchange rate without capital controls	Fixed exchange rate with capital controls	Flexible exchange rate without capital controls	Flexible exchange rate with capital controls
$i^{p}_{i,t-1}$	λ	0.02	**–0.046***	**–0.115***	**–0.112***
		(0.02)	(0.015)	(0.067)	(0.034)
$\Delta\ GDP\ growth_{i,t}$	ϕ_1	**0.114***	0.028	0.107	0.042
		(0.037)	(0.039)	(0.087)	(0.115)
$\Delta\ Inflation_{i,t}$	ϕ_2	**0.099***	**0.385***	**0.35***	**0.431***
		(0.028)	(0.05)	(0.113)	(0.138)
$D_{Pos}\ \Delta\ r^{US}_{i,t}$	β_{pos}	**1.034***	–0.032	0.243	0.304
		(0.058)	(0.122)	(0.16)	(0.25)
$D_{Neg}\ \Delta\ r^{US}_{i,t}$	β_{neg}	**0.527***	0.056	**0.497***	–0.026
		(0.07)	(0.093)	(0.134)	(0.168)
ΔVIX_t	δ	–0.259*	0.08	–0.029	0.427
		(0.13)	(0.163)	(0.101)	(0.293)

Table 8: Comparisons with Obstfeld (2015) and Georgiadis and Mehl (2015)

		Compared with Obstfeld (2015): including Euro Economies: 1990–2009 (1)	Compared with Obstfeld (2015): including Euro Economies: 1999–2009 (2)	Compared 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 9: Exchange Rate Changes as the Dependent Variable

		(1) With estimated Taylor Rule	(2) With pre-assigned Taylor Rule	(3) With estimated Taylor Rule	(4) With pre-assigned Taylor Rule
$\Delta logExchangeRate_{\mathrm{i,t-1}}$	λ	-	-	**0.127***	**0.2***
		-	-	(0.036)	(0.036)
$\Delta\ GDP\ growth_{i,t}$	ϕ_1	**–0.016***	–0.01[4]	**–0.014***	0.00[5]
		(0.002)		(0.002)	
$\Delta\ Inflation_{i,t}$	ϕ_2	**0.005***	–0.03	**0.005***	0.00
		(0.002)		(0.002)	
$D_{flex.NC}\ \Delta\ r_{i,t}^{US}$	β_3	**0.019***	**0.008***	**0.018***	**0.009***
		(0.005)	(0.005)	(0.005)	(0.005)
$D_{flex.C}\ \Delta\ r_{i,t}^{US}$	β_4	**0.006***	–0.003	**0.006***	–0.001
		(0.004)	(0.004)	(0.004)	(0.004)
ΔVIX_t	δ	**0.064***	**0.059***	**0.066***	**0.064***
		(0.006)	(0.006)	(0.006)	(0.006)
Adjusted R-squared		0.19	0.11	0.20	0.15
No. of Obs.		712	712	712	712

[4] The estimated coefficient is –0.02.

[5] The estimated coefficient is –0.001.

Figure 1a Plot of peripheral countries' policy rate changes vs. US policy rate changes

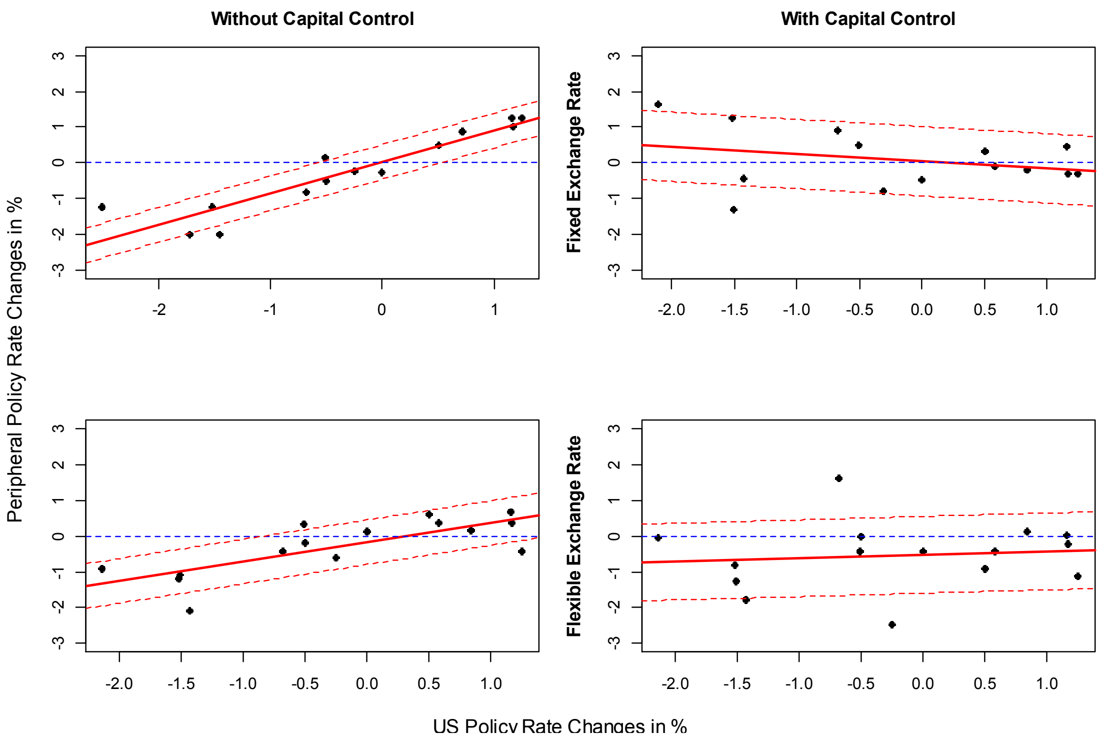
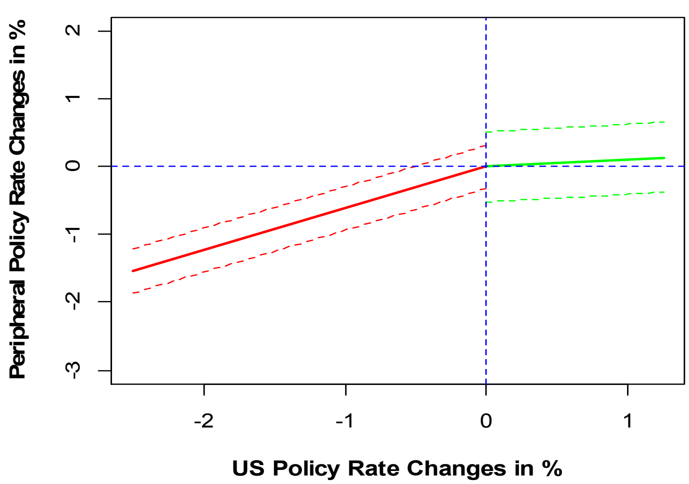


Figure 1b Simulated asymmetric peripheral countries' policy rate responses to US policy rate changes for countries with flexible exchange rate and without capital control based on estimates in column (3) in Table 4



Appendix (online posting only)

Table A1 Countries included in the analysis and their basic information6

Economy	Emerging Markets	Euro Area[7]	Exchange Rate Structure Classification indicated in online yearly AREAER Data[8]	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	While pegged to the Russian ruble de jure, 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

6 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.

7 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.

8 http://www.elibrary.-areaer.imf.org/Areaer/Pages/YearlyReports.aspx, sampled year is 2004.

Economy	**Emerging Markets**	**Euro Area**[7]	**Exchange Rate Structure Classification indicated in online yearly AREAER Data**[8]	**Other Information**
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 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	With reference to the USD

Economy	**Emerging Markets**	**Euro Area**[7]	**Exchange Rate Structure Classification indicated in online yearly AREAER Data**[8]	**Other Information**
			path for the exchange rate	
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	
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
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	

Economy	**Emerging Markets**	**Euro Area**[7]	**Exchange Rate Structure Classification indicated in online yearly AREAER Data**[8]	**Other Information**
			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 Federation	EM	0	Managed floating with no pre-determined 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 (LTB) Yield	Source of LTB	Coverage of LTB
Argentina	Average rate on peso loans 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 – Apr 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.	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
Costa Rica	Monetary Policy Rate on 30-day investments. Between Mar 15/2006 – May 28/2008, rate on overnight deposits on the CBCR's financial services website. After May 29, 2008,	–	–	–

Country	Short-term Policy Rate (All from IFS)	Long-term Bond (LTB) Yield	Source of LTB	Coverage of LTB
	rate charged by the CBCR on one-day loans in the Interbank Money Market or 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 – Apr 2015
Czech Republic	Repo rate (14-day) between the Czech National Bank and commercial banks.	Long-term Government Bond Yield: Average (%)	Haver	Apr 2000 – May 2015
Denmark	Denmark National bank's shor term interest rate.	Government Bond Yield: Long Term	CEIC	Jan 1970 – Apr 2015
Ecuador	Legal rate charged by the CBE to discount eligible commercial papers offered by commercial banks	–	–	–
Egypt	The rate at which the CBE discounts eligible commercial papers to commercial banks.	–	–	–
Euro area	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 Average: 10 Years	CEIC	Jan 1999 – May 2015
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	Government Bond	Haver	Jan 1992 –

Country	Short-term Policy Rate (All from IFS)	Long-term Bond (LTB) Yield	Source of LTB	Coverage of LTB
	corporations.	Yield: 10 years (% per annum)		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	Bank Indonesia rate, the policy rate reflecting the monetary policy stance 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 – Apr 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	The Base Rate is the reference rate set by the Monetary Policy Committee and applied to transactions between the BOK and financial institutions.	Government Bond Yield: Long Term	CEIC	May 1973 – Mar 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 Period): Bank of Lithuania rate on overnight repurchase agreements.	Long-term Government Bond Yield: Average (%)	Haver	Jan 2001 – May 2015
Luxembour g	See Euro area.	Government Bond Yield: Long Term	CEIC	Jan 1970 – Mar 2015
Malaysia	The overnight policy rate, 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 – Apr 2015
Mexico	Refers to the target rate.	Government Bond Yield: Long Term	CEIC	Jan 1995 – May 2015
Netherland s	See Euro area.	Government Bond Yield: Long Term	CEIC	Jan 1970 – Apr 2015
New Zealand	Official Cash Rate (OCR) around which the Reserve Bank transacts with the market. Reviewed eight times a year (every six and a half weeks).	Government Bond Yield: 10 Years	CEIC	Jan 1985 – May 2015

Country	Short-term Policy Rate (All from IFS)	Long-term Bond (LTB) Yield	Source of LTB	Coverage of LTB
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	Jul 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	Jul 1993 – Apr 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	Apr 2005 – Apr 2015
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	Jun 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	10-year Government Bond Yield (% per annum)	Haver	Sep 2000 – Mar 2015

Country	Short-term Policy Rate (All from IFS)	Long-term Bond (LTB) Yield	Source of LTB	Coverage of LTB
	two-week repurchase agreements with commercial banks.			
Slovenia	See Euro area.	Government Bond Yield: Long Term	CEIC	Mar 2002 – Apr 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 – Apr 2015
Spain	See Euro area.	Long-term Government Bond Yield: Average (%)	Haver	Jan 1980 – May 2015
Sweden	Data 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 lent and borrowed for one day (overnight). The CBRT uses this base rate for monetary policy purposes.	10-year bond yield	Investing.com	Feb 2010 – 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 – Apr 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.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
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	

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
	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	+/–2% band.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
		dollar	
	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.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
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

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
			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%.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
	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 in 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

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
			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	+/–5% band. Official peg to SDR.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
		US dollar	
	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.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
	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

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
			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

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
			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

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
			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.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
	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.

Country	Date	Classification: Primary/Secondary/Tertiary	Comments
	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 by 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.

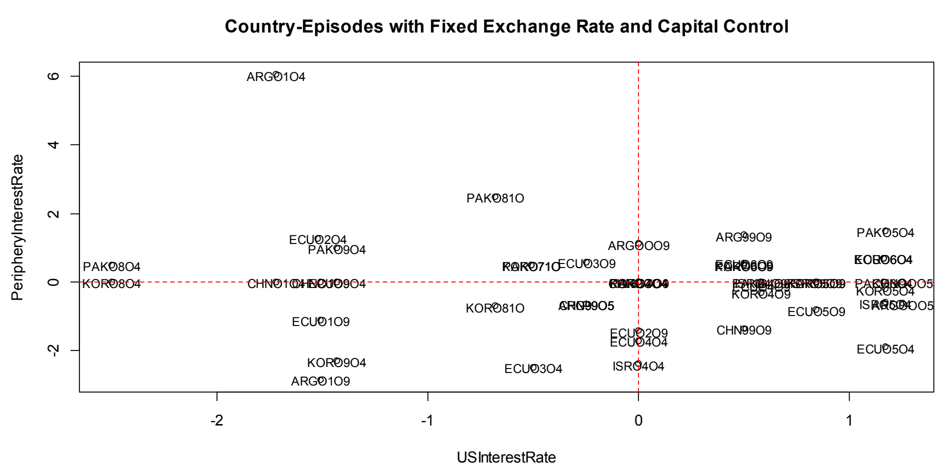
Table A4 Exchange rate arrangements in AREAER pre-2008 and post-2008

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 A5: **Using long-term government bond yield as dependent 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 yield (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)
$D_{flex.C}\Delta r^{US}_{i,t}$	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

Figure A1



Argentina April 2001 appears to be outlier, and is responsible for the negative coefficient, $\beta_2 = -0.249$ in column (3) of Table 3. In subsequent regressions, we remove this observation.