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Monetary Trilemma, Dilemma or Something in Between?

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ABSTRACT

This paper re-visits the monetary Trilemma versus Dilemma debate by empirically examining interest rate policy independence for a large sample of both advanced and developing countries over the time period 1973-2014. We broadly concur with the growing body of literature that suggests that the Trilemma still holds, emphasizing the important insulating effects afforded by exchange rate flexibility. However, as with Han & Wei (2018), we also document the existence of an asymmetric pattern or 2.5-lemma between the Trilemma and Dilemma; though in contrast to them we find there seems to be evidence of "fear of capital reversal" rather than a "fear of appreciation". We further find that while completely flexible exchange rates allow a country to maintain monetary policy autonomy, intermediate degrees of flexibility do not seem to do so. However, partial capital account openness seems to work just as well as having a completely closed capital account. We also find that while macroprudential policies (MaPs) cannot substitute for capital controls, they can help circumvent the Trilemma constraints and insulate a country with open capital account from foreign monetary shocks.

Keywords: Asymmetry; Capital controls; Exchange rate regime; Macroprudential policies (MaPs); Trilemma; Dilemma

1. Introduction

For many economies cross-border capital flows on a large scale has been a double-edged sword. Since the 1990s, debates have been centered on whether global capital mobility is welfare-enhancing or whether it has imparted greater instability to the national economy and complicated macroeconomic management (Ostry et al., 2012). The classical "monetary Trilemma" suggests that if a peripheral small open country wishes to use monetary policy to manage the domestic economy it will need to forsake a fixed exchange rate regime (or will eventually be forced to do so via a currency crisis). Consistently a number of emerging market and developing economies (EMDEs hereafter) have, over time, been moving towards greater exchange rate flexibility (Corbacho & Peiris, 2018; Duttagupta et al., 2005). This reflects in part the belief that more flexible exchange rates afford a country a greater degree of monetary policy autonomy in responding to external shocks, including surges and sudden stops in capital flows (Friedman, 1953).[1]

However, Rey (2013) challenged the relevance of the Trilemma in this era of financial globalization, declaring that a country with an open capital account would inevitably be affected by the "global financial cycle" regardless of the exchange rate regime. She specifically emphasized the role of the VIX (the Chicago Board Options Exchange Volatility Index, which is commonly used as an indicator to measure market uncertainty and risk aversion) as being the key driver of large co-movements in asset prices, gross flows and bank leverage. In this sense the "Trilemma" collapses into a "Dilemma" due to the existence of the common global factor. Therefore, a small open economy can maintain an independent monetary policy if and only if it forsakes capital account openness (also see Cavoli et al., 2018). In similar vein, Bruno & Shin (2015) and their colleagues at the Bank for International Settlements (BIS) have highlighted the role of the U.S. dollar cross-border lending and thus U.S. monetary policy in impacting EMDEs via the risk taking channel regardless of the type of exchange rate regime. From a policy perspective, acknowledging the concerns posed by the possible existence of a monetary dilemma, former RBI Governor

[1] Using a sample of 40 EMDEs covering the period 1986–2013, Obstfeld et al. (2018) find that the exchange rate regime does matter and the transmission of global financial shocks is magnified under fixed exchange rate regimes relative to more flexible exchange rate regimes.

Raghuram Rajan has repeatedly suggested the need for some "Rules of the Game" in managing cross-border monetary spillovers from the U.S. in particular and advanced economies in general.[2]

This paper furthers the foregoing debate by investigating interest rate policy independence for a large sample of eighty eight countries comprising both advanced economies (AEs hereafter) and EMDEs over the time period 1973-2014.[3] While this paper builds on the earlier studies on this issue (Shambaugh, 2004; Obstfeld et al., 2005; Klein & Shambaugh, 2015), it differs from them by empirically also taking into account possible asymmetries in the manner in which peripheral countries respond to changes in base country interest rate (Han & Wei, 2018). The paper also considers whether macro-prudential policies (MaPs hereafter), which are increasingly widely implemented by central banks, can be a substitute for capital controls to circumvent the Trilemma constraints and insulate a country from foreign monetary shocks.[4]

The remainder of the paper is organized as follows. Section 2 discusses the methodology and empirical model. Section 3 presents the baseline results and shows that the Trilemma still very much holds and both exchange rate regime and capital controls matter. Section 4 reports the findings for potential asymmetric responses by peripheral countries to a rise or fall in the base interest rates and presents a partial dilemma pattern. In particular, peripheral countries tend to follow suit when base countries raise interest rates independent of the exchange rate regime but not when base countries loosen their monetary policy stance. We interpret this so-called 2.5-lemma as due possibly to a "fear of capital reversals". Section 5 further considers the role of domestic factors in impacting local interest rates and reports estimation results based on the augmented equations incorporating a simple Taylor rule. Section 6 undertakes some robustness tests to verify the baseline results as well as the 2.5-lemma pattern. Section 7 investigates whether the middle

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[2] There is a body of papers that suggest that the impact of global factors on cross-border capital flows may in fact be overstated (see Cerutti et al., 2017). Nelson (2017) offers a broader critique of the Rey thesis. As he notes:

> In an open economy with a floating exchange rate, it is to be expected that many asset prices will largely move in tandem with asset prices abroad and will be influenced by capital flows. Such financial integration does not preclude, or constitute evidence of the absence of, monetary policy autonomy for a small country whose exchange rate floats. The evidence that has been offered that open-economy central banks lack autonomy is, at bottom, based on the invalid premise that such autonomy implies a complete disconnection of asset-price movements across economies (p.17).

[3] Data are limited by availability of short-term interest rates (short-term treasury bill rate in baseline). See Section 3.

[4] Aizenman (2018) proposes the existence of a Quadrilemma, arguing that financial stability is an additional goal that needs to be considered.

ground of policy regimes (partial capital controls and managed floating) affords a degree of monetary policy autonomy. Section 8 touches on the role of MaPs and examines whether it serves as a substitute for capital controls in terms of conferring a country a degree of monetary autonomy. Section 9 concludes the paper.

2. Methodology

Following the general approaches by Shambaugh (2004), Obstfeld et al. (2005) and Klein & Shambaugh (2015), the methodology starts with the simple interest rate parity equation:

$$R_{it} = R_{bit} + (E^{e}_{i,t+1} - E_{it}) + \rho_{it} \qquad (1)$$

R_{it} is the nominal local interest rate for country i at time t. R_{bit} is the nominal interest rate of the base country of the country i at time t. E_{it} is the log of the current bilateral exchange rate (domestic price of foreign currency) at time t, E^{e}_{it+1} is the log of the expected exchange rate next period at time $t + 1$. The term in parenthesis captures the expected change in the nominal exchange rate between country i and the base country from this period to the next. If investors are risk neutral, $\rho_{it} = 0$. However, if we assume investors are risk averse, ρ_{it} is the premium for compensation for risk-taking. If the exchange rate regime is credibly fixed, $E^{e}_{i,t+1} - E_{it} = 0$. If ρ_{it} is also zero, the local interest rate should equal the base interest rate. However, if the peg is not credible, is broken, or exchange rates can fluctuate within a narrow band, the two interest rates could differ even with a pegged arrangement. It would be ideal to include the expected change in exchange rate and the risk premium in the regressions, though both are unobservable.

Estimating equation (1) directly poses some further problems. Usually nominal interest rate exhibit strong persistence and there exists a unit root, so spurious regressions are possible if level regressions are estimated. Because of this we follow much of the literature and adopt the first difference estimation of equation (1) and the baseline model specification is as follows[5]:

$$\Delta R_{it} = \alpha + \beta \Delta R_{bit} + u_{it} \qquad (2)$$

[5] We assume that the base interest rate is exogenous to local interest rates. This is likely to hold in general since a large portion of the sample includes the U.S. dollar as the base country. It is especially likely to hold for the EMDE sub-sample which we focus on later in the paper.

where $u_{it} = \Delta[(E^e_{i,t+1} - E_{it}) + \rho_{it} + \varepsilon_{it}]$, ε_{it} is the idiosyncratic error term or time-varying unobserved heterogeneity. We estimate regressions for different sub-samples of data to capture the effects of different combinations of exchange rate and capital account regimes. Specifically, we can divide the data into four sub-samples according to whether the exchange rate regime is a peg or non-peg, and whether the country imposes capital controls. The four sub-samples are peg with closed capital account (Quadrant 1), non-peg with closed capital account (Quadrant 2), peg with open capital account (Quadrant 3); and non-peg with open capital account (Quadrant 4).

		Peg	
		Yes	No
Capital Controls	Yes	Quadrant 1	Quadrant 2
	No	Quadrant 3	Quadrant 4

We compare β and R^2across all four categories. The larger the β or the more significant the β, the less the degree of monetary autonomy enjoyed. Assume in the first instance that u_{it} is uncorrelated with ΔR_{bit}. Theoretically β would be close to 1 for a sub-sample panel of pegged countries with open capital accounts (Quadrant 3) because a country with a fixed exchange rate regime and an open capital account would have to move its interest rate one-for-one with that of the base country, all else being constant, i.e. no monetary autonomy. The β coefficient ought to be equal to 0 for Quadrant 2 where the country has a flexible exchange rate and has imposed capital controls, i.e. complete monetary autonomy.

However, as documented by Klein & Shambaugh (2015), in reality many situations can cause ΔR_{bit} to be correlated with components in u_{it}. For example, a common shock can cause similar responses in interest rates across countries. In addition, when the exchange rate operates within a credible band, $cov(\Delta R_{bit}, u_{it})$ could also be non-zero. Therefore, in practice we do not expect the benchmark estimated values of β to necessarily be 1 or 0 as there are possible correlations between ΔR_{bit} and u_{it} (also see Obstfeld et al., 2005). In addition, proxies for capital controls and exchange rate regime remain far from perfect. Therefore, more generally we would expect the β in Quadrant 3 to be greater than the rest and the β in Quadrant 2 to be the lowest, while the βs in Quadrants 1 and 4 ought to be somewhere in between if the country retains a degree of monetary policy autonomy. A priori one cannot tell whether the β in Quadrant 1 is greater or less than the β in Quadrant 4 as it depends on whether capital controls or peg grants a country relatively greater monetary autonomy.

We could also gauge the extent of monetary policy independence by comparing R^2 of the estimated equations. A high R^2 indicates that not many other factors drive own interest rates than the base rate and the estimating equation is fully specified. Under the Trilemma, for pure floats with capital controls we would expect a much lower R^2 as many other factors impact local interest rates than base rates (i.e. domestic macroeconomic and financial conditions). The R^2 for pegs with no capital controls should be quite high as base rates are the main determinant of local interest rates. Under the Dilemma, the R^2 for Quadrants 3 and 4 with no capital controls should be relatively higher than Quadrants 1 and 2 with capital controls.

3. Baseline Results

This section presents the baseline results. The main interest rate data we use is short-term Treasury-bill rate (average monthly values) from the *Global Financial Data*.[6] In all, there are 176 countries in the dataset but short-term Treasury-bill rates data are only available for 88 countries. For our baseline model we compile the exchange rate regime data from the Shambaugh dataset based on de facto classification. It focuses on the bilateral exchange rate between a given country and its base country. The Shambaugh dataset is only updated until 2014, thus our panel ends in 2014. We use the Chinn-Ito index as the base to generate our binary index of capital controls. Since Chinn-Ito index (KAOPEN) is a capital account openness index rather than one that directly measures capital controls, we define the index of capital controls as 1- ka_open. We also only consider a binary case, viz. no capital controls when our index takes the value of zero and with at least some capital controls when our index takes the value other than zero.

3.1 Descriptive Statistics

[6] The weblink for the databank: https://www.globalfinancialdata.com/.

We have an unbalanced panel and our sample consists of 703 peg observations, 1309 non-peg observations, 1384 capital control observations and 630 no control observations. There are 25 advanced economies and 62 EMDEs in the sample. AEs constitute 40 percent of observations while EMDEs account for the rest of 60 percent. Among them, 45 EMDEs and 19 AEs in the sample adopt fixed exchange rate regime. In addition, there are 8 base countries in the sample[7], viz. the United States, Germany, France, South Africa, United Kingdom, India, Portugal and Malaysia. The United States is the dominant one as 58 countries (about three-fifths of the observations) are pegged to the U.S. dollar.

Table 1 summarizes the means, standard deviations, minimum values and maximum values of interest rate differential for different sub-samples. We see from the results that, compared to non-pegged countries, the pegged country group has smaller means and standard deviations of annual interest rate differentials. On average, the interest rate differential is positive, indicating that base countries tend to have lower interest rates compared to peripheral countries. This exercise serves as an indication that interest rates of pegged countries are more stable and tend to move more closely with base countries compared to non-pegged countries. An argument has been made that floating countries follow base rates more closely in recent times from the 1990s than in the past (see for example, Frankel et al., 2004). However, eyeballing Table 1 we find that the mean value for the sample post-1990s has actually increased, implying the interest rate gap is widening instead of narrowing.

Insert table 1 here

3.2 Does the Trilemma Hold?

We first test the first-difference specification equation (2) using pooled OLS. The specification was run for these four sub-samples. To correct for potential heteroskedasticity and serial correlation problems, cluster-robust standard errors are reported, and the data are clustered at the country level. The results are reported in Table 2.

Insert table 2 here

[7] According to Shambaugh (2004), the choice of the base country is determined by countries' previous pegging histories, which is relevant in almost all cases, but otherwise determined by the dominant currency in the region, i.e., the one to which neighbouring countries peg. For most of the European countries, the base is Germany. They follow the information from IMF AREAER and Global Financial Database reference guide for coding.

As the Trilemma predicts, countries with pegged regimes with no capital controls must surrender monetary autonomy. This subgroup has the highest β coefficient of 0.94, which is statistically significant at the 99% confidence level, while the R^2 is relatively high at 0.42. At the other end of the spectrum, for countries without pegs with capital controls, the β coefficient is 0.09 and is statistically insignificant with rather low R^2 of close to 0, suggesting multiple other factors impacting domestic interest rate changes, consistent with the priors of the Trilemma. Capital controls do not make the exchange rate regime choice meaningless as the β coefficient for pegged countries with capital controls is 0.31, statistically significant at the 99% level, which is far greater than that for non-pegged countries with capital controls (0.09). The β for the sub-sample of non-pegged countries with no capital controls is 0.48, significant at the 99% level, with a modest R^2 of 0.10. These results reaffirm the existence of the monetary Trilemma rather than the Dilemma. Since the coefficient for the sub-sample of non-pegged countries with no capital control (0.48) is greater than the coefficient for the sub-sample of pegged countries with capital controls (0.31), this suggests that exchange rate flexibility offers somewhat less monetary policy autonomy than capital controls.[8]

It is plausible that the results are driven in part by common shocks. If the shocks facing every country are similar, we would expect the β coefficients to be biased upwards. Table 3 replicates the results from Table 2 but includes year fixed effects. From Table 3 we see that there is little change in the coefficients in the two peg sub-samples with and without capital controls when time dummies are added. This suggests that the significant coefficients for the pegged samples are not driven spuriously by global common shocks. It shows that the value of β for the sub-sample of pegged countries with no capital controls is slightly lower but still relatively high at 0.80, while the R^2 indicates that the base interest rate shocks explains over half of local country interest rate changes.[9] In comparison to the results from Table 2, the β coefficient for the sub-sample of non-pegged countries with closed capital account is even smaller, reaffirming the earlier

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[8] We do not differentiate between *ability* versus *willingness* to use monetary policy autonomy which is partly dependent on effectiveness of monetary policy transmission.

[9] The coefficient in the open peg sample is reduced a little from 0.94 to 0.80. Some effects are soaked up by the year effects. However, the value of the β is still the highest among all sub-samples which supports the Trilemma proposition.

results.[10] Thus, our priors still hold after accounting for common shocks. The β coefficient for countries with pegged regimes with capital controls is 0.30, very similar to results in Table 2, though the confidence level is slightly reduced. The one notable change is the sub-sample of non-pegged countries without capital controls. The β is now neither economically nor statistically significant, indicating that the β for the non-peg samples may actually be driven by common shocks[11].

Insert table 3 here

How do our results compare to others using similar methodologies but different samples? Table A1 in the Annex offers a summary. Shambaugh (2004) uses a sample of over 100 developing and industrial countries from 1973 through 2000. Obstfeld et al. (2005) build on Shambaugh (2004) and extend the sample to three historical stages/periods, viz. the Gold standard era, the Bretton Woods (BW) era and the post-BW era. They have 15 countries in the sample for the Gold standard era from 1870 to 1914, and 21 countries for the BW era from 1959-1970 and 103 countries for the post-BW era (1973-2000). Compared with the sub-sample results for the post-BW era in Obstfeld et al. (2005), our coefficients obtained from the first-differenced model are qualitatively of similar magnitudes except that our estimated coefficient for the sub-sample of pegged countries with open capital accounts is much greater (coefficient being 0.94 in this paper, while 0.61 in Obstfeld et al. (2005)). In addition, Klein & Shambaugh (2015) present results for both a dataset using the Chinn-Ito capital control data which covers the period 1973-2011, and one using gates, walls, and open division of countries, which spans the period 1995-2011. Compared with their sub-sample regression results we have a larger estimated coefficient for the subgroup of pegged countries with open capital account (0.94 in this paper versus 0.68 in theirs, both significant at 99% level). Their coefficient for the subgroup of non-pegged countries with closed capital account is 0.09, significant at 90% level, while ours is also 0.09 but not statistically significant. For the subgroup of non-open pegged countries, their coefficient is 0.40, while ours is 0.31, slightly smaller than

[10] The coefficient for the subgroup of non-pegged countries with closed capital account is reduced from 0.09 (Table 2) to -0.05 (Table 3), both statistically insignificant. Whereas the value of the β is still the lowest among all sub-samples in Table 3.

[11] However, since the vast majority of pegs are to the U.S. dollar and therefore the same (U.S.) base country, there is likely to be a high degree of collinearity between the year dummies and the base interest rate series. Thus, it can be problematic to use time fixed effects when the number of base countries is limited.

theirs. For the sub-sample of non-pegged countries with open capital account, their coefficient is 0.23, significant at 95% level, much smaller than ours, which is 0.48. While there are slight variations due to sample size and methodology, in general, our study is in line with the previous ones.

3.3 Full Sample with Controls

In order to allow for an explicit examination of differences in the estimates of β across exchange rate and capital account regimes we can test for the statistical significance across these samples by pooling the data and running a regression that includes the interactions of the change in the base interest rate with the exchange rate regime and a proxy for capital controls (Shambaugh, 2004). The equation to be estimated is as follows:

$$\Delta R_{it} = \alpha + \beta \Delta R_{bit} + \beta_2 (peg)_{it} * \Delta R_{bit} + \beta_3 (no\ capital\ controls)_{it} * \Delta R_{bit} + \beta_4 (peg)_{it} + \beta_5 (no\ capital\ controls)_{it} + \varepsilon_{it} \quad (3)$$

The dummy variable $(\text{peg})_{\text{it}}$ equals one for an observation representing a pegged exchange rate regime for the country i at year t, and is zero, otherwise. Similarly, $(\text{no capital controls})_{\text{it}}$ is another dummy variable indicating the country's capital control regime. It equals one if there is no capital control for the country i at year t, and zero otherwise. β captures the effect of a change in the base-country interest rate on the local interest rate for a country that does not peg its exchange rate and closes its capital account in year t. If β is statistically significantly different from 0 this is evidence of "fear of floating" or a large amount of common shocks. $\beta + \beta_2$ captures the effects of a change in the base-country interest rate on the local interest rate for a country that pegs its exchange rate and closes its capital account in year t. A positive value of β_2 indicates that domestic interest rates follow more closely the base country interest rate when countries have a fixed exchange rate, everything else being equal. A t test of the significance of the coefficient β_2 directly and explicitly demonstrates the difference between pegged and non-pegged observations. By the same token, $\beta + \beta_3$ measures the effects for a country that does not peg its exchange rate and has open capital account in year t. The expected positive value of β_3 indicates that domestic interest rate follows more closely the base country interest rate when countries do not impose capital controls, all else being equal. $\beta + \beta_2 + \beta_3$ measures the effects of a change in the base-country interest rate on the local interest rate for a country that operates a pegged regime and also has an open capital account in year t.

Results are reported in Table 4.[12] It appears that the exchange rate regime and capital controls matter as the coefficient for the interaction terms are both significant at the 99 percent confidence level. In general, the results with interaction terms are consistent with the sub-sample results shown in Table 2, and the regime effects of different combinations still follow the same pattern. β_2 and β_3 both are positive, indicating that pegging and having open capital accounts make domestic interest rates more closely follow their base interest rate. The magnitude of β_2 is 0.28 (the degree of monetary policy autonomy a flexible exchange rate regime has imparted), smaller than that of β_3 which is, 0.47 (the degree of monetary autonomy capital controls has conferred), suggesting again that capital controls appear to matter somewhat more to preserve monetary autonomy than the role of exchange rate flexibility.

Insert table 4 here

4. Evidence for Asymmetric Responses of Interest Rate

Overall, we can decisively conclude that the monetary Trilemma still holds in the modern era. Contrary to Rey's (2015) thesis we find that exchange rate regimes do matter in terms of ensuring monetary independence. The combination of floating regime with capital controls offers the greatest degree of monetary autonomy, while countries with fixed exchange rate regime and an open capital account almost completely lose their control over domestic monetary policy. This is consistent with the monetary Trilemma, though we partially concur with Rey in that there is evidence that capital controls are somewhat more effective in helping a country regain a degree of monetary autonomy compared to exchange rate flexibility.

However, countries might not feel equally compelled to follow the base country's policy changes depending on whether the base country raises or cuts its interest rate. In particular, Han & Wei (2018) suggest that there may exist a *2.5 lemma between Trilemma and 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

[12] We omit reporting β_4 and β_5 for peg and capital control variables to conserve space.

> when the center lowers its interest rate…Capital controls provide insulation to peripheral countries from foreign monetary policy shocks even when the center lowers its interest rate" (p.206).[13]

We examine potential asymmetric responses of the peripheral country's monetary policy to a change in the base country's monetary policy. As noted, we have four sub-samples of different regime type combinations and within each sub-sample we further divide the sample into two more subgroups: one in which the base country raises its interest rate and the other where the base country lowers its interest rate. The specification equation (2) was run for these eight sub-samples. The results are reported in Table 5.

Insert table 5 here

Generally speaking, for each of four policy regime combinations the β coefficient for the sub-sample in which base countries raise interest rates is always higher than the β coefficient for the sub-sample where base countries lower interest rates. To be sure, for the set of pegged countries without capital controls, the β coefficient remains very high for the full sample as well as for the two sub-samples in this case. This seems to imply that no matter whether the base countries raises or lowers interest rate, a small open economy follows suit if it has a pegged exchange rate regime and no capital controls are imposed. For non-pegged countries with capital controls this group theoretically has complete monetary policy autonomy. For the sub-sample where base countries lower interest rates, the β coefficient is not significantly different from 0. However, when there is a rise in base interest rates, the β coefficient for this sub-sample rises to 0.30 and is statistically significant at the 95 percent level. This indicates that peripheral countries lose some monetary policy independence and to some degree follow the changes in base interest rate. These results suggest two things. One, capital controls tend to be more effective in preventing inflows than outflows (Mathieson & Rojas-Suarez, 1992; Reinert et al., 2010; IMF, 2012; Montiel, 2013). Two, there is a "fear of capital reversal" or possibly a "fear of reserve loss".

[13] There is a related literature that suggests that EMDEs especially in Asia undertake asymmetric foreign exchange in interventions, i.e. they more likely/more frequent to prevent sharp appreciations than depreciations due to a so-called "fear of appreciation" (see Levy-Yeyati et al., 2013; Pontines & Rajan, 2011; Ramachandran & Srinivasan, 2007).

To be sure, when base countries raise their interest rates, since capital controls have generally been proven to be rather ineffective to prevent outflows, countries may respond by raising interest rates to prevent capital outflows or the loss of reserves (also see Aizenman & Sun, 2012). However, when base country interest rates decline, while peripheral countries may experience massive surges in capital inflows if they stand pat on interest rates, they can maintain monetary policy autonomy via a combination of sterilized foreign exchange intervention (leading to sustained reserve accumulation) as well as tightening of capital controls and/or macroprudential policies (MaPs). To emphasize this point, note that if base countries raise their interest rates, the coefficients for pegs and non-pegs are fairly close no matter whether capital controls are present or not.[14] This indicates that the role of exchange rate regime does not matter when the base country tightens its monetary policy but does matter when the base loosens its monetary policy stance.

We also re-estimate equation (3) to cross check whether the asymmetric responses hold by estimating the equation with interaction terms. As we can see, the results with interaction terms from Table 6 allows us to test the significance of the difference in the coefficients between pegged and non-pegged observations and also the difference in the coefficients between open and closed capital account observations. β_2 and β_3 are statistically significant and positive for the full sample and the sub-sample in which base countries lower interest rate, which is evidence supporting the predictions of the Trilemma. However, for the sub-sample in which base countries raise their interest rates, β_2 is neither statistically nor economically significant, indicating that the role of exchange rate regime does not matter. Note that β_3 for this sub-sample is still significantly positive, suggesting the role of capital controls still matters. These results are consistent with the sub-sample results above. Regardless of whether capital controls are imposed, the coefficients do not differ very much between the pegged and non-pegged groups in the case of a rise in the base interest rate. This suggests that the Trilemma does not hold perfectly when we account for the asymmetry in the movement of base interest rate. When there is a rise in the base interest rates, a flexible exchange rate regime is no longer able to generate greater monetary policy independence. Once again this is evidence of a partial dilemma or a 2.5-lemma.

Insert table 6 here

[14] If there are capital controls, the coefficient for pegs is 0.32, while it is 0.30 for non-pegs. If the capital account is open, the coefficient for pegs is 1 while it is 0.88 for non-pegs.

5. Modified Taylor Rules

Thus far we have not incorporated the role of domestic factors in impacting domestic interest rates. This omission could lead to concerns about misspecification, especially in the case of countries with non-pegged regimes. Accordingly, we re-estimate an augmented equation (2) which now incorporates domestic variables, viz. inflation and output. Following Klein and Shambaugh (2015) the model is specified as follows:

$$\Delta \mathrm{R_{it}} = \alpha + \beta \Delta \mathrm{R_{bit}} + \gamma \Delta Y_{it-1} + \delta \Delta \pi_{it-1} + \mathrm{u_{it}} \quad (4)$$

ΔY_{it-1} is the lagged GDP growth and $\Delta \pi_{it-1}$is the lagged change in inflation. As indicated by the Taylor monetary policy rule, the change in the policy interest rate is a function of the change in growth rate of the economy and the change in the inflation rate. We estimate equation (4) to test whether the change in the local interest rate reacts to local growth and inflation. In the first instance, to account for potential reverse causality that policy rate changes affect current output and inflation, we include lagged, rather than contemporaneous, GDP growth and inflation change. Similar to Klein & Shambaugh (2015) we also focus on the F-test of the joint significance of coefficients on the two Taylor rule variables. As above, we split the sample into four subgroups based on different regime combinations. The specification outlined in equation (4) was run for these four sub-samples. The results are shown in Table 7.

Insert table 7 here

The Trilemma would predict that there is no significant effect of these two Taylor rule variables on the domestic interest rate for a country that adopts a pegged regime and forsakes monetary autonomy, as shocks to the base interest rate determine the changes in domestic interest rate. On the contrary, if a country enjoys monetary policy autonomy and can respond to domestic shocks using interest rates as a policy variable, the base interest rate variable should have a close to zero coefficient and local factors should be able to explain the changes in the domestic interest rate. Table 7 reports the coefficients on the base interest rate changes, output growth and changes in inflation as well as an F-test for the joint significance of the local condition variables.

For the subgroup of pegged countries with no capital controls we can see that its policy interest rate does not respond to either changes in its inflation rate or its output growth. The F-statistic indicates there is no joint significance of these two variables and the coefficient on the base interest rate is almost one and highly significant (as in Table 2), reaffirming the validity of the Trilemma constrains. Estimates in the fourth column show that when a country has a flexible exchange rate regime and imposes capital controls it enjoys the greatest monetary autonomy, as indicated by the near-zero and insignificant coefficient on the base interest rate. And, as predicted, the domestic interest rate responds to both the changes in the inflation rate and the GDP growth. F-statistics on the joint significance of inflation and growth is 5.91, implying the significance at better than the 99 percent confidence level.

For pegged countries with capital controls and non-pegged countries with open capital account, these two subgroups enjoy some degree but not complete monetary policy autonomy. We see from columns (2) and (3) that the coefficients on the base interest rate are 0.29 and 0.47 and statistically significant at the 99 percent confidence level. Domestic policy interest rates only respond to changes in the inflation rate for the sub-sample of pegged countries with capital controls and the F-statistics in this sub-sample is 2.75, implying joint significance of the two variables at the 90 percent level. From these results we can discern a pattern that the higher the values of the coefficients on the base country interest rate, the lower the F-statistics on the joint significance of local economic conditions. This suggests that the more monetary policy autonomy a country enjoys the greater the extent that local economic condition variables can better explain local interest rate changes. These results are consistent with findings by Klein & Shambaugh (2015).

Taking this further, we now consider whether the 2.5-lemma thesis holds in this augmented regression by taking account of the impact of Taylor rule variables. As above, we have eight sub-samples after considering the asymmetric movements of base interest rate. The augmented specification equation (4) was run for these eight sub-samples. The results are shown in Table 8.

Insert table 8 here

From Table 8 (E), we can find that the coefficients and R^2 statistics are qualitatively similar to those in Table 5, confirming that the 2.5-lemma is valid when taking account of local economic conditions. Specifically, Table 8 (A) presents the results for the sub-sample of pegged countries with no capital controls. No matter if there is a rise or a fall in base interest rate, domestic policy interest rate almost perfectly follows the base rate and does not respond to changes in the inflation rate or the GDP growth. The F-statistics in these sub-samples indicate that there is no joint significance of these two Taylor rule variables. So domestic interest rate variations are almost completely explained by shocks to their base interest rate in this group. At the other end of the spectrum, for non-pegged countries with capital controls as shown in Table 8 (D), this group is predicted to enjoy the greatest monetary policy autonomy. For the sub-sample where base countries lower interest rates, the β coefficient is -0.07, not significantly different from 0, indicating full monetary policy autonomy. Local interest rates significantly respond to the changes in the inflation rate and the output growth as expected. F-statistic on the joint significance of inflation and growth is 3.67, implying the significance at the 95 percent confidence level. However, when there is a rise in base interest rates, the β coefficient for this sub-sample becomes 0.23 and is statistically significant at the 95 percent level, suggesting that peripheral countries lose some monetary policy independence and to some degree follow the changes in base interest rate. In this case, domestic policy interest rates only marginally respond to the changes in the inflation rate and the F-statistic indicates there is no joint significance of these two local condition variables. In addition, consistently as before, the higher the values of the coefficients on the base country interest rate, the lower the F-statistics on the joint significance of local economic conditions.

We also re-estimate the augmented equation (3) to investigate whether the asymmetric responses hold by estimating the equation with interaction terms and Taylor rule variables. The specification is as follows：

$$\Delta R_{it} = \alpha + \beta\Delta R_{bit} + \beta_2(peg)_{it} * \Delta R_{bit} + \beta_3(no\ capital\ controls)_{it} * \Delta R_{bit} + \beta_4(peg)_{it} + \beta_5(no\ capital\ controls)_{it} + \gamma\Delta Y_{it-1} + \delta\Delta\pi_{it-1} + \varepsilon_{it} \quad (5)$$

Estimation results are reported in Table 9. When incorporating domestic factors, including the change in the inflation rate and the GDP growth, we see from the results that for the full sample and the sub-sample where there is a fall in the base interest rate, β_2 and β_3 are still statistically significant, reaffirming the Trilemma pattern. However, for the sub-sample in which base countries raise interest rate, β_2 is still statistically and economically insignificant, indicating that the role of exchange rate regime does not matter. These results are broadly comparable to the results from Table 6. F-statistic of the joint significance of inflation and growth is 8.54 for the full sample and 6.05 for the sub-sample where base countries lower interest rate, implying the significance at the 99 percent confidence level. However, the F-statistic is only 1.94 for the sub-sample where base countries increase interest rate, indicating no joint significance of local condition variables in this case.

Insert table 9 here

6. Robustness

We undertake a set of robustness checks to verify our results in baseline and on asymmetry as discussed below.

6.1 Role of U.S. Dollar and U.S. Interest Rates

In emphasizing the Dilemma over the Trilemma, Rey (2013) and Borio & Disyatat (2011) point to the important role of the U.S. dollar and U.S. interest rates specifically. We therefore test whether peripheral countries respond to the U.S. interest rates to the same extent as they do to their base interest rates. We do so by replacing base interest rate ΔR_{bit} with U.S. interest rates ΔR_{USit} and re-run equation (3). Regression results are shown in columns (1) and (2) of Table 10, respectively.[15]

Insert table 10 here

As we can see, if we replace base interest rates with U.S. rates (column 2), the peg coefficient becomes insignificant, and pegs and non-pegs show a similar reaction to U.S. rates, whereas pegs show a much tighter relationship to their own base rates. In addition, the size of capital controls coefficient is also reduced (0.32 in column 2 compared with 0.47 in column 1). These results suggest that small open economies respond to U.S. rates (U.S. rates as a proxy for the world interest rates, are correlated with base rates), but not as much as to their own base rate.

Since in our sample the U.S. is the base country for the majority of peripheral economies, as a further check we only focus on those country observations that specifically peg to the United States. As before, to verify the Trilemma pattern, we first run regressions based on equation (2)

[15] We omit reporting β_4 and β_5 for peg and capital control variables to conserve space.

for the four sub-samples of exchange rate and capital control regime combinations. The results are reported in the two by two matrix in Table 11.

Insert table 11 here

For this U.S. peg sub-sample, we find that the coefficients for the subgroups of observations with capital controls have become insignificant, which means that capital controls are quite stringent and make the role of the exchange rate regime irrelevant. However, the coefficients in Quadrants 2 and 3 are comparable to those baseline results in Table 2, reaffirming that the Trilemma pattern holds.

Furthermore, to check whether the pattern of 2.5-lemma is robust to the U.S. pegs, we consider the asymmetric movements in the base (U.S.) interest rate. The specification equation (2) was re-estimated for the eight sub-samples as above. The results are documented in Table 12 and they are qualitatively similar to before as documented in Table 5. The coefficients for the subgroups of observations with closed capital accounts have all become insignificant. However, when we focus on subgroups of observations without capital controls (Quadrants 3 and 4) we find that domestic interest rate follows the base interest rates more closely for the sub-sample where base countries tighten their monetary policy regardless of the exchange rate regime. However, for the sub-sample in which there is a fall in the base interest rates, we see that a flexible exchange rate regime imparts peripheral countries a degree of monetary policy independence. Thus the 2.5-lemma pattern is largely confirmed in the data that is limited to U.S. dollar pegs.

Insert table 12 here

6.2 Taylor Rule with Exchange Rate Changes

Given the rather complex and often unpredictable impact of exchange rate changes on the domestic economy, many EMDEs have included the exchange rate explicitly in the monetary policy rule (Hutchison et al., 2010; Taylor, 2001). This section re-estimates a modified Taylor rule as below:

$$\Delta \mathrm{R_{it}} = \alpha + \beta \Delta \mathrm{R_{bit}} + \gamma \Delta Y_{it-1} + \delta \Delta \pi_{it-1} + \zeta \Delta e_{it-1} + \mathrm{u_{it}} \quad (6)$$

where Δe_{it-1} is the lagged change in bilateral nominal exchange rate (log) relative to the U.S. dollar. Since e is the domestic price of foreign currency, an increase in e indicates a domestic currency depreciation. ζ is expected to be positive implying a higher domestic policy interest rate if the local currency depreciates.

As above, we segment the sample into four subgroups according to regime combinations. The specification equation (6) was run for these sub-samples. Regression results for each sub-sample are reported in Table 13. As we can see, when incorporating exchange rate changes in the domestic monetary policy reaction function we obtain the same results as those reported in Table 7. Local interest rates only respond to changes in the exchange rate as well as changes in the inflation rate and the GDP growth for the sub-sample of non-pegged countries with capital controls, where there is almost perfect monetary policy autonomy. F-statistic of the joint significance of three local condition variables is also only significant at the 99 percent level for this subgroup. Estimating the modified Taylor rule equation does not substantially change the original pattern and the Trilemma story is confirmed in the data.

Insert table 13 here

Proceeding to the next step, we re-examine whether the 2.5-lemma pattern holds when we further incorporate the change in the exchange rate as another Taylor rule variable. As above, we have eight sub-samples after considering the asymmetric movements of base interest rate. The augmented specification equation (6) was run for these eight sub-samples. Regression results for each regime combination are shown in Table 14 from panel A to panel D. Panel E also presents the consolidated results in a two by two matrix. Compared to the previous results in Table 8 estimated from a simple Taylor rule equation with just two variables viz. inflation and growth, we find that these results are approximately equivalent. Adding the change in the exchange rate to the Taylor Rule does not overturn the original conclusions. From Table 14 (E), we can say with confidence that the partial dilemma pattern or the 2.5-lemma pattern of asymmetric interest rate responses exists and the magnitudes of the coefficients are in general slightly smaller compared to the results in Table 8 (E) above which has not incorporated the role of exchange rate.

Insert table 14 here

6.3 Post 1990 and EMDE Sub-samples

Given the commonly held view that the global financial cycle matters much more since the 1990s we restrict the sample to the post-1990s era and re-estimate equation (3) to check if the asymmetric responses of interest rate are still valid in the post-1990s era by estimating the equation with interaction terms[16]. The results are reported in Table 15.[17] Consistently, we find that β_2 and β_3 are statistically significant and positive for the full post-1990s sample and the sub-sample in which base countries lower interest rates, which is evidence supportive of the predictions of the Trilemma. However, for the sub-sample in which base countries raise interest rate, β_2 is 0.09, slightly greater than that in the Table 6, yet still not statistically significant, indicating that the role of exchange rate regime does not matter in impacting monetary policy autonomy. Based on these results, the partial dilemma pattern is reaffirmed by the post-1990s sub-sample results.

Insert table 15 here

The Trilemma versus Dilemma debate concerns the international monetary policy shock transmission from the centre economies to the peripheral countries which has mainly focused on the experience of EMDEs. We thus have limited our sample to this set of countries. To verify the asymmetric interest rate responses in the EMDE sample, we re-estimate equation (3) with interaction terms for the EMDE sub-sample as well as two subgroups where base countries raise interest rate and base countries lower interest rate. Regression results are reported in columns (1), (2) and (3) of Table 16.[18]

Insert table 16 here

For the subgroup where there is a rise in the base interest rate, β_2, the coefficient on the interaction term between the peg regime and the change in the base interest rate, is negative and insignificant, implying that a flexible exchange rate regime cannot provide greater monetary policy

[16] Due to limited sample size for subsample analyses within the post-1990s and EMDE sub-samples, we only run interaction regressions in this sub-section.

[17] We omit reporting β_4 and β_5 for peg and capital control variables to conserve space.

[18] We omit reporting β_4 and β_5 for peg and capital control variables to conserve space.

autonomy in this case as before. From columns (1) and (3), we can see that the pattern of the Trilemma is overall retained for the full EMDE sample and sub-sample where base countries cut interest rate, however, with one caveat that β_2 in column (3), the coefficient on the interaction term between the peg regime and the change in the base interest rate, though still positive and economically significant (0.27), turns statistically insignificant so strictly we cannot reject the hypothesis that the coefficient β_2 is equal to zero. Roughly speaking, the 2.5-lemma patterns are confirmed by EMDE sub-sample results though not perfectly robust.

7. Managing in the Middle?

Thus far the focus has been on the binary classification of peg versus non-peg. As emphasized by Aizenman et al. (2010) and others, many EMDEs in particular have chosen the middle ground of managed floats and partial capital controls. Accordingly, we reconsider a slightly more nuanced classification of peg, managed float and non-peg and full, no and partial capital controls in our estimation.

Our emphasis in this section is to measure the degree of monetary autonomy in the mid-range of the policy regime between a fixed exchange rate and a pure float and when capital accounts are partially open. With regard to the exchange rate regime, we use dummy variable "soft peg"[19] compiled from Shambaugh dataset to indicate the middle-ground of the exchange rate regime policy. For the capital account regime, we use continuous Chinn-Into index ("kaopen") as the base to construct three dummy variables, one for open capital accounts, one for closed accounts and the third for a middle level of openness. Based on the empirical distribution function of "kaopen", the classification puts 661 observations in the closed category, 3450 observations in the mid-range of capital controls category, and 2060 observations in the open category.

Table 17 presents estimates that are based on three groups of exchange rate regime (peg, soft peg and float), and three categories of Chinn-Ito measures of capital account openness (open, mid-open, and closed). Similar to Klein & Shambaugh (2015), the baseline specification equation (2) was re-estimated for these nine sub-samples of different regime combinations. The sub-sample

[19] A soft peg is defined as occurring when a country-year observation is not classified as a peg, but the bilateral exchange rate with the base country fluctuates by less than +/-5 percent in a given year, or when there is no month where the exchange rate changed by more than 2 percent up or down (Klein & Shambaugh, 2015, p.41). Hence, *peg* refers to a +/- 2% band and *soft peg* refers to a +/-5% band and *float* refers to all other observations. In our previous binary coding, pegs versus non-pegs, the latter includes both floats and soft pegs.

results are shown in the 3 by 3 matrix in bold. We can compare coefficients across rows so as to check the differences across exchange rate regimes and down columns to see the differences across capital control regimes. The marginal columns and rows show the results estimated from an interaction regression. The estimates of the differences across capital control regimes are presented in the marginal columns at the right of the table, while in the marginal rows at the bottom of the table, the estimates of the differences across exchange rate regimes are reported[20].

Insert table 17 here

As we can see, the first row shows that the coefficient on the base country interest rate for the open peg sub-sample (0.68) is greater than the coefficient for the open soft peg sub-sample (0.50), which is also larger than the coefficient for the open float sub-sample (0.28). This supports the implications of monetary Trilemma with respect to the three broad types of exchange rate regimes. The same pattern can be found for mid-open capital account sub-samples, as documented in the second row. However, this pattern no longer holds for closed capital account sub-samples as shown in the third row.[21] For all pegged sub-samples, we find that the coefficients are statistically significant at the 99 percent confidence level, while we cannot reject the null hypothesis that the coefficients for each of the floating samples are equal to 0 except for the open float sub-sample. The marginal rows at the bottom of the table indicate that there is a statistically significant difference between the coefficients on pegs and floats, between soft-pegs and floats, but we cannot reject the hypothesis that pegged observations have the same β coefficient as soft pegged ones, with a difference of only 0.11 that is not significant. These estimation results from an interaction regression suggest that policy autonomy is only conferred by the most flexible exchange rate regime and that little is gained in terms of monetary policy autonomy with soft pegs or managed floating regime.

Now we turn to the columns which allow for comparisons across capital account openness regimes. For the first and the second columns, we see that the open capital account sub-samples (in the top row) always have higher coefficients than the mid-open sub-samples (in the middle)

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[20] The numbers reported in these columns represent more open minus less open, and those in the rows represent more exchange rate fixity minus less exchange rate fixity, so the expected values of these estimates are positive.
[21] One caveat to note is that there are too few observations for closed capital account sub-samples, which may lead to imprecisely estimated results.

and mid-open sub-samples have higher coefficients than the closed sub-samples (in the bottom). But this pattern does not hold for floating observations (column 3). In addition, the coefficients for the open capital account sub-samples are all statistically different from 0 at the 99 percent confidence level. However, the coefficients for some mid-open and closed capital account sub-samples become insignificant. The estimates in the marginal columns at the far right of the table suggest that the difference between the effect of the base interest rate on the domestic interest rate is 0.31 when comparing open and mid-open capital accounts, and this difference is statistically significantly different from zero at better than the 99 percent confidence level. The gap between open and closed is also significant and the difference is slightly greater (0.36). Nevertheless, we fail to reject the hypothesis that mid-open observations have the same β coefficient as closed ones. The difference is 0.06 and not statistically significant. So, these estimates imply that mid-open financial accounts can indeed afford a country more monetary policy autonomy compared to instances of complete open capital accounts and the effects are comparable to those provided by the closed capital accounts.

In short, these results indicate that there are good reasons for countries to move to partial capital account openness as it is just as effective as a fully closed capital account in affording a country monetary policy autonomy.[22] In addition, based on our sample results, there is little evidence that the mid-range of exchange rate regime, i.e., soft pegs or intermediate degrees of flexibility, can confer monetary policy independence.

8. Macroprudential Policies (MaPs)

Obstfeld et al. (2017) have noted:

> (e)xchange rate flexibility does not provide perfect insulation, but even in today's highly integrated world, the choice of exchange rate regime – alongside choices for other elements of the policy toolkit, including capital controls and macroprudential policy – remains an important lever for managing domestic financial and macroeconomic outcomes in the face of volatile global financial conditions. The time to pronounce the irrelevance of the exchange rate regime has not arrived.

[22] This finding may be somewhat at odds with Klein & Shambaugh (2015) who emphasize "walls" over "gates" in terms of effectiveness of capital controls.

While they explicitly mention MaPs, this has not been explicitly incorporated in the literature on Dilemma versus Trilemma. Since the global financial crisis of 2008-09, MaPs have attracted considerable attention among policy makers.[23] There is a growing body of literature emphasizing the importance of using MaPs to manage financial stability (for example, see Galati & Moessner, 2013; Hanson et al., 2011). What does the interaction between capital controls and MaPs mean in the context of the Trilemma and Dilemma debate? We focus on investigating whether MaPs can be a substitute for capital controls in terms of affording a country a degree of monetary autonomy. To this end we replace the dummy variable for no capital controls with the dummy variable for no MaPs for the full sample and we then consider the sub-sample of open capital account observations only. The specification is as follows:

$$\Delta R_{it} = \alpha + \beta \Delta R_{bit} + \beta_2 (peg)_{it} * \Delta R_{bit} + \beta_3 (no\ MaPs)_{it} * \Delta R_{bit} + +\beta_4 (peg)_{it} + \beta_5 (no\ MaPs)_{it} + \varepsilon_{it} \qquad (7)$$

The results based on equation (7) for the full sample and for the sub-sample of open capital account observations are reported in Table 18[24]. From column (1) in Table 18 we see that β_3 is negative and statistically insignificant, suggesting that for the full sample MaPs cannot replace capital controls in terms of conferring similar degree of monetary policy autonomy. However, when we consider the sample of country observations with no capital controls only, we see from column (2) that β_3, the coefficient on the interaction term between no MaPs with the change in base interest rate is significantly positive at the 90 percent confidence level. With MaPs, the coefficient equals 0.74 (β +β_2), lower than that without MaPs, 1.13 (β +β_2+β_3). This indicates that MaPs, might be able to offer some degree of monetary policy autonomy for countries with open capital accounts.

Insert table 18 here

9. Conclusion

In this paper we have re-investigated the monetary Trilemma versus the Dilemma debate for a large sample of eighty-eight countries over the period 1973-2014. Broadly, we find evidence

[23] See also Cavoli et al. (2019) for brief review of empirical literature.
[24] We omit reporting β_4 and β_5 for peg and macroprudential policy variables to conserve space.

that the Trilemma still holds and a flexible exchange rate affords insulating effects from international monetary policy shocks. However, this conclusion requires two important qualifications. One, similar to Han & Wei (2018), we have documented the existence of "2.5-lemma" pattern. However, unlike their results, we find that for peripheral countries without capital controls a flexible nominal exchange rate allows them to maintain some degree of monetary policy autonomy when the base countries loosen their monetary policy (likely via a combination of sterilized foreign exchange intervention and tightening of MaPs to manage possible credit growth).[25] On the other hand, when the center countries tighten their respective interest rates, peripheral countries may fear sharp capital reversals which leads them to pursue similarly tighter monetary policy domestically.

Two, while completely flexible exchange rates allow a country to maintain monetary policy autonomy, intermediate degrees of flexibility do not seem to do so. However, partial capital account openness seems to work just as well as having a completely closed capital account. This suggests that if a country wants to maintain some degree of monetary policy autonomy, it should either move to a fully flexible exchange rate regime, or a partially or completely inflexible one with at least partial capital controls.[26] Finally, we have shown that while MaPs cannot substitute capital controls in terms of generating buffer to circumvent the Trilemma constrains, for countries with open capital accounts, MaPs still manage to offer some degree of monetary policy autonomy.

[25] While we have not tested this explicitly, see Cavoli et al. (2018) for a discussion of exchange rate and monetary policies in Asia.

[26] There are multiple reasons why EMDEs in particular may be concerned about a "fear of floating" and prefer something less than a fully flexible regime (see Cavoli et al., 2019).

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Table 1. Summary Statistics of the Interest Rate Differential $(R_{it} - R_{bit})$

	Full sample		Pegged countries		Non-pegged countries		Industrial countries		Developing countries	
Time	All	Post 1990s	All	Post 1990s	All	Post 1990s	All	Post 1990s	All	Post 1990s
$(R_{it} - R_{bit})$ mean	4.82	5.31	2.07	2.15	6.30	7.11	1.85	1.16	6.37	7.45
$(R_{it} - R_{bit})$ std dev	8.11	8.41	4.01	3.59	9.30	9.75	3.48	2.49	9.08	9.16
$(R_{it} - R_{bit})$ min	-10.71	-8.37	-10.71	-8.20	-9.76	-8.37	-9.76	-5.59	-10.71	-8.37
$(R_{it} - R_{bit})$ max	128.32	128.32	27.44	27.44	128.32	128.32	14.01	13.18	128.32	128.32

Unit: percent

Table 2. Two by Two Classification of Exchange Rate and Capital Control Regimes (First-difference)

		PEG			
		Yes		**No**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.31*** (0.09)	426 [0.05]	0.09 (0.07)	956 [0.00]
	No	0.94*** (0.08)	277 [0.42]	0.48*** (0.11)	353 [0.10]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 3. Two by Two Classification of Exchange Rate and Capital Control Regimes (Time Fixed Effects)

		PEG			
		Yes		**No**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.30* (0.15)	426 [0.19]	-0.05 (0.11)	956 [0.13]
	No	0.80*** (0.19)	277 [0.54]	0.13 (0.14)	353 [0.31]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 4. Interaction Terms with Regime Types (First-difference)

VARIABLES	Pool
β	0.07
β std. error	(0.07)
β_2	0.28***
β_2 std. error	(0.08)
β_3	0.47***
β_3 std. error	(0.10)
Observations	2,012
R-squared	0.05

Note:
β = coefficient on ΔR_h.
β_2= coefficient on (peg) $\times \Delta R_h$.
β_3= coefficient on (no capital controls) $\times \Delta R_h$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 5. Asymmetric Responses – Sub-sample Results (First-difference)

		PEG											
		Yes						**No**					
		Baseline		**Raise IR**		**Lower IR**		**Baseline**		**Raise IR**		**Lower IR**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.31*** (0.09)	426 [0.05]	0.32** (0.15)	198 [0.03]	0.00 (0.15)	228 [0.00]	0.09 (0.07)	956 [0.00]	0.30** (0.12)	362 [0.01]	-0.19 (0.12)	594 [0.00]
	No	0.94*** (0.08)	277 [0.42]	1.00*** (0.21)	129 [0.27]	0.87*** (0.12)	148 [0.25]	0.48*** (0.11)	353 [0.10]	0.88*** (0.22)	143 [0.11]	0.35** (0.14)	210 [0.03]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 6. Interaction Terms with Regime Types (First-difference)

VARIABLES	Full sample	base countries raise interest rate	base countries lower interest rate
β	0.07	0.31***	-0.22*
β std. error	(0.07)	(0.11)	(0.11)
β_2	0.28***	-0.01	0.30**
β_2 std. error	(0.08)	(0.17)	(0.14)
β_3	0.47***	0.57***	0.65***
β_3 std. error	(0.10)	(0.19)	(0.15)
Observations	2,012	832	1,180
R-squared	0.05	0.04	0.04

Note:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) $\times \Delta R_b$.
β_3= coefficient on (no capital controls) $\times \Delta R_b$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 7. Trilemma in Modified Taylor Rules (First-difference)

VARIABLES	(1) Peg and No Capital Controls	(2) Peg with Capital Controls	(3) Nonpeg and No Capital Controls	(4) Nonpeg with Capital Controls
β	0.94***	0.29***	0.47***	0.09
β std. error	(0.08)	(0.09)	(0.12)	(0.07)
γ	1.63	0.69	2.04	2.04**
γ std. error	(1.42)	(1.04)	(1.38)	(0.87)
δ	-0.01	-0.10**	-0.08	-0.09***
δ std. error	(0.04)	(0.04)	(0.05)	(0.03)
F-stat	0.78	2.75*	1.81	5.91***
Observations	272	377	333	866
R-squared	0.46	0.08	0.14	0.02

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 8. 2.5-lemma in Modified Taylor Rules (First-difference)

(A) Peg Without Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.94***	1.06***	0.94***
β std. error	(0.08)	(0.21)	(0.12)
γ	1.63	1.73	1.62
γ std. error	(1.42)	(1.85)	(1.85)
δ	-0.01	-0.00	-0.02
δ std. error	(0.04)	(0.08)	(0.05)
F-stat	0.78	0.89	0.39
Observations	272	125	147
R-squared	0.46	0.35	0.28

(B) Peg With Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.29***	0.28*	0.10
β std. error	(0.09)	(0.17)	(0.13)
γ	0.69	-1.24	1.10
γ std. error	(1.04)	(1.43)	(1.13)
δ	-0.10**	-0.01	-0.14***
δ std. error	(0.04)	(0.08)	(0.04)
F-stat	2.75*	0.41	6.45***
Observations	377	172	205
R-squared	0.08	0.02	0.06

(C) Non-peg Without Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.47***	0.78***	0.45***
β std. error	(0.12)	(0.25)	(0.14)
γ	2.04	0.60	2.40
γ std. error	(1.38)	(2.06)	(1.78)
δ	-0.08	-0.13*	-0.07
δ std. error	(0.05)	(0.07)	(0.08)
F-stat	1.82	2.18	1.05
Observations	333	133	200
R-squared	0.14	0.13	0.08

(D) Non-peg With Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.09	0.23**	-0.07
β std. error	(0.07)	(0.11)	(0.14)
γ	2.04**	0.71	2.41**
γ std. error	(0.87)	(1.17)	(1.06)
δ	-0.09***	-0.13*	-0.07*
δ std. error	(0.03)	(0.07)	(0.04)
F-stat	5.91***	1.47	3.67**
Observations	866	307	559
R-squared	0.02	0.03	0.02

(E) Asymmetric Responses – Sub-sample Results

		PEG											
		Yes						**No**					
		Baseline		**Raise IR**		**Lower IR**		**Baseline**		**Raise IR**		**Lower IR**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.29*** (0.09)	377 [0.08]	0.28* (0.17)	172 [0.02]	0.10 (0.13)	205 [0.06]	0.09 (0.07)	866 [0.02]	0.23** (0.11)	307 [0.03]	-0.07 (0.14)	559 [0.02]
	No	0.94*** (0.08)	272 [0.46]	1.06*** (0.21)	125 [0.35]	0.94*** (0.12)	147 [0.28]	0.47*** (0.12)	333 [0.14]	0.78*** (0.25)	133 [0.13]	0.45*** (0.14)	200 [0.08]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 9. Interaction Terms with Regime Types in Modified Taylor Rules (First-difference)

VARIABLES	(1) Full sample	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.07	0.24**	-0.10
β std. error	(0.07)	(0.11)	(0.13)
β_2	0.27***	-0.02	0.27**
β_2 std. error	(0.08)	(0.18)	(0.12)
β_3	0.47***	0.61***	0.64***
β_3 std. error	(0.10)	(0.22)	(0.16)
β_4	-0.33***	0.05	-0.39**
β_4 std. error	(0.11)	(0.20)	(0.15)
β_5	0.05	-0.21	0.33**
β_5 std. error	(0.10)	(0.19)	(0.16)
γ	1.72**	0.60	2.06**
γ std. error	(0.66)	(0.81)	(0.82)
δ	-0.09***	-0.09*	-0.08***
δ std. error	(0.02)	(0.05)	(0.03)
F-stat	8.54***	1.94	6.05***
Observations	1,848	737	1,111
R-squared	0.07	0.06	0.05

Note:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) $\times \Delta R_b$.
β_3= coefficient on (no capital controls) $\times \Delta R_b$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 10. Respond to U.S. Rates?

	(1)	(2)
VARIABLES	Base rate	U.S. rate
β	0.07	0.03
β std. error	(0.07)	(0.07)
β_2	0.28***	0.08
β_2 std. error	(0.08)	(0.08)
β_3	0.47***	0.32***
β_3 std. error	(0.10)	(0.10)
Observations	2,012	1,994
R-squared	0.05	0.02

Note:
In column (1)
β = coefficient on ΔR_h.
β_2= coefficient on (peg) $\times \Delta R_h$.
β_3= coefficient on (no capital controls) $\times \Delta R_h$.
In column (2)
β = coefficient on R_{US}.
β_2= coefficient on (peg) $\times R_{US}$.
β_3= coefficient on (no capital controls) $\times R_{US}$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 11. Two by Two Classification of Exchange Rate and Capital Control Regimes (First-difference) U.S. Pegs Only

		PEG			
		Yes		**No**	
		Coef. **(s.e.)**	**N** **[R^2]**	**Coef.** **(s.e.)**	**N** **[R^2]**
CAPITAL CONTROLS	**Yes**	0.18 (0.11)	223 [0.01]	-0.09 (0.09)	651 [0.00]
	No	0.86*** (0.19)	83 [0.33]	0.46*** (0.14)	222 [0.08]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 12. Asymmetric Responses – Sub-sample Results (First-difference) U.S. Pegs Only

		PEG											
		Yes						**No**					
		Baseline		**Raise IR**		**Lower IR**		**Baseline**		**Raise IR**		**Lower IR**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.18 (0.11)	223 [0.01]	-0.15 (0.29)	96 [0.00]	-0.12 (0.15)	127 [0.00]	-0.09 (0.09)	651 [0.00]	0.29 (0.21)	234 [0.01]	-0.30** (0.15)	417 [0.01]
	No	0.86*** (0.19)	83 [0.33]	0.94* (0.44)	32 [0.10]	0.69*** (0.17)	51 [0.22]	0.46*** (0.14)	222 [0.08]	1.22*** (0.24)	83 [0.13]	0.24 (0.16)	139 [0.01]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 13. Trilemma in Modified Taylor Rules with Exchange Rate Changes (First-difference)

VARIABLES	(1) Peg and No Capital Controls	(2) Peg with Capital Controls	(3) Nonpeg and No Capital Controls	(4) Nonpeg with Capital Controls
β	0.93***	0.29***	0.46***	0.10
β std. error	(0.08)	(0.09)	(0.12)	(0.07)
γ	2.54	0.63	2.66	3.33***
γ std. error	(2.56)	(1.25)	(2.63)	(1.19)
δ	-0.02	-0.10**	-0.09	-0.09***
δ std. error	(0.05)	(0.04)	(0.07)	(0.03)
ζ	2.03	-0.10	1.01	2.05**
ζ std. error	(2.43)	(1.00)	(3.37)	(1.00)
F-stat	0.53	1.90	1.16	5.63***
Observations	272	377	333	866
R-squared	0.46	0.08	0.14	0.03

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 14. 2.5-lemma in Modified Taylor Rules with Exchange Rate Changes (First-difference)

(A) Peg Without Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.93***	0.94***	0.93***
β std. error	(0.08)	(0.17)	(0.12)
γ	2.54	3.84	2.05
γ std. error	(2.56)	(4.40)	(2.69)
δ	-0.02	-0.03	-0.02
δ std. error	(0.05)	(0.10)	(0.05)
ζ	2.03	3.42	1.18
ζ std. error	(2.43)	(4.36)	(2.29)
F-stat	0.53	0.55	0.34
Observations	272	125	147
R-squared	0.46	0.37	0.28

(B) Peg With Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.29***	0.27	0.08
β std. error	(0.09)	(0.17)	(0.13)
γ	0.63	-0.98	0.40
γ std. error	(1.25)	(1.75)	(1.36)
δ	-0.10**	-0.01	-0.13***
δ std. error	(0.04)	(0.08)	(0.04)
ζ	-0.10	0.43	-1.15
ζ std. error	(1.00)	(1.62)	(1.47)
F-stat	1.90	0.30	4.42***
Observations	377	172	205
R-squared	0.08	0.02	0.07

(C) Non-peg Without Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.46***	0.72***	0.45***
β std. error	(0.12)	(0.24)	(0.13)
γ	2.66	3.73	1.80
γ std. error	(2.63)	(5.47)	(2.31)
δ	-0.09	-0.18	-0.06
δ std. error	(0.07)	(0.11)	(0.09)
ζ	1.01	4.46	-1.04
ζ std. error	(3.37)	(5.60)	(3.55)
F-stat	1.16	1.41	0.74
Observations	333	133	200
R-squared	0.14	0.15	0.08

(D) Non-peg With Capital Controls

VARIABLES	(1) baseline	(2) base countries raise interest rate	(3) base countries lower interest rate
β	0.10	0.23**	-0.04
β std. error	(0.07)	(0.11)	(0.14)
γ	3.33***	0.72	4.30***
γ std. error	(1.19)	(1.58)	(1.20)
δ	-0.09***	-0.13*	-0.07*
δ std. error	(0.03)	(0.07)	(0.04)
ζ	2.05**	0.02	3.27***
ζ std. error	(1.00)	(1.20)	(1.17)
F-stat	5.63***	1.11	5.13***
Observations	866	307	559
R-squared	0.03	0.03	0.04

(E) Asymmetric Responses – Sub-sample Results

		PEG											
		Yes						**No**					
		Baseline		**Raise IR**		**Lower IR**		**Baseline**		**Raise IR**		**Lower IR**	
		Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
CAPITAL CONTROLS	**Yes**	0.29*** (0.09)	377 [0.08]	0.27 (0.17)	172 [0.02]	0.08 (0.13)	205 [0.07]	0.10 (0.07)	866 [0.03]	0.23** (0.11)	307 [0.03]	-0.04 (0.14)	559 [0.04]
	No	0.93*** (0.08)	272 [0.46]	0.94*** (0.17)	125 [0.37]	0.93*** (0.12)	147 [0.28]	0.46*** (0.12)	333 [0.14]	0.72*** (0.24)	133 [0.15]	0.45*** (0.13)	200 [0.08]

Note: Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 15. Interaction Terms with Regime Types (First-difference) Post-1990s

VARIABLES	(1) Full post-1990s sample	(2) base countries raise interest rate	(3) base countries lower interest rate
β	-0.09	0.09	-0.16
β std. error	(0.09)	(0.11)	(0.13)
β_2	0.43***	0.09	0.34**
β_2 std. error	(0.11)	(0.23)	(0.16)
β_3	0.44***	0.32*	0.57***
β_3 std. error	(0.10)	(0.19)	(0.16)
Observations	1,553	585	968
R-squared	0.03	0.02	0.04

Note:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) $\times \Delta R_b$.
β_3= coefficient on (no capital controls) $\times \Delta R_b$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 16. Interaction Terms with Regime Types (First-difference) EMDEs

VARIABLES	(1) Full EMDEs sample	(2) base countries raise interest rate	(3) base countries lower interest rate
β	-0.08	0.17	-0.32**
β std. error	(0.08)	(0.12)	(0.13)
β_2	0.33***	-0.08	0.27
β_2 std. error	(0.11)	(0.22)	(0.18)
β_3	0.39**	0.94*	0.41*
β_3 std. error	(0.16)	(0.50)	(0.20)
Observations	1,213	465	748
R-squared	0.02	0.02	0.03

Note:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) $\times \Delta R_b$.
β_3= coefficient on (no capital controls) $\times \Delta R_b$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 17. Three by Three Classification of Exchange Rate and Capital Control Regimes (First-difference)

	Peg		**Soft peg**		**Float**			
	Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**	Versus mid-open	Versus Closed
Open	**0.68*** (0.10)**	**389 [0.24]**	**0.50*** (0.16)**	**293 [0.08]**	**0.28*** (0.09)**	**295 [0.03]**	0.31*** (0.09)	0.36* (0.21)
Mid-open	**0.34*** (0.12)**	**289 [0.06]**	**0.33*** (0.09)**	**287 [0.04]**	**-0.10 (0.12)**	**347 [0.00]**		
Closed	**0.15** (0.05)**	**25 [0.01]**	**-0.37 (0.51)**	**18 [0.04]**	**0.20 (0.36)**	**71 [0.01]**	0.06 (0.20)	
Versus soft peg	0.11 (0.10)				0.27** (0.11)			
Versus float	0.38*** (0.10)							

Note: Entries in shaded areas in marginal columns and rows based on an interaction regression.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Table 18. The Role of Macroprudential Policy (First-difference)

	(1)	(2)
VARIABLES	Full sample	Open capital account sub-sample
β	-0.26	0.02
β std. error	(0.23)	(0.24)
β_2	0.84***	0.72***
β_2 std. error	(0.25)	(0.22)
β_3	-0.06	0.39*
β_3 std. error	(0.36)	(0.21)
Observations	913	353
R-squared	0.01	0.05

Note:
β = coefficient on ΔR_h.
β_2= coefficient on (peg) $\times \Delta R_h$.
β_3= coefficient on (no MaPs) $\times \Delta R_h$.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Annex

Table A1. Comparison of Sub-sample Results from Main Papers

Journal Article	Time Period	Sample Size	Methodology	Sub-sample Results					
						Peg			
						Yes		**No**	
						Coef. (s.e.)	**N $[R^2]$**	**Coef. (s.e.)**	**N $[R^2]$**
Shambaugh (2004)	1973-2000	Over 100 developing and industrial countries	First-difference/ pooled OLS	Capital Controls	**Yes**	0.41*** (0.04)	531 [0.18]	0.15 (0.11)	738 [0.00]
					No	0.67*** (0.09)	214 [0.27]	0.56*** (0.08)	338 [0.07]
						Peg			
						Yes		**No**	
						Coef. (s.e.)	**N $[R^2]$**	**Coef. (s.e.)**	**N $[R^2]$**
Obstfeld et al. (2005)	1973-2000 **(**for the post-BW era**)**	103 countries	First-difference/ pooled OLS	Capital Controls	**Yes**	0.36*** (0.04)	739 [0.13]	0.15 (0.11)	753 [0.00]
					No	0.61*** (0.05)	613 [0.30]	0.53*** (0.07)	423 [0.06]

						Peg			
						Yes		**No**	
						Coef. (s.e.)	**N [R^2]**	**Coef. (s.e.)**	**N [R^2]**
Klein & Shambaugh (2015)	1973-2011 (using the Chinn-Ito capital control data)	134 countries in the sample using Chinn-Ito data	First-difference/ pooled OLS	Capital Controls	**Yes**	0.40*** (0.06)	967 [0.14]	0.09* (0.05)	1145 [0.00]
					No	0.68*** (0.08)	433 [0.28]	0.23** (0.10)	581 [0.02]