International transmissions of monetary shocks: Between a trilemma and a dilemma

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Outline

1. Introduction
2. Specification and data
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4. The lower-bound episodes
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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.
- *An important finding:*
  - **US interest rates***(2000---2016)* increase or QE

international **capital flows** to emerging markets reacted

interest rates in many developing countries also appeared to have reacted

Q: What does it take for a country to have some **buffer against** foreign monetary shocks?

1. Introduction

- Two views:
  a) Narrow trilemma: cannot simultaneously have three.

     A broad trilemma : a country can have an independent monetary policy if it pursues a flexible exchange rate, or imposes capital controls, or does both.
  - The notion that **a flexible exchange rate regime** provides insulation against foreign shocks is said to be supported in the data.
    - *Edwards (2012), Klein and Shambaugh (2015), and Obstfeld (2015), among others.*

  b) Tong and Wei (2011) find that **a flexible nominal exchange rate** by itself does not provide much help, but **capital flow management** can.

     Rey (2015): 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.

1. Introduction

- Motivation
  - 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, which we aim to do in this paper.

  - 三元悖论：固定汇率制下，且资本不管制，货币政策是绝对不独立的。
  - 二元悖论：**无论汇率是否固定，货币政策都不独立的。只有资本控制，可以使得货币政策独立。**
  - 但缺乏考虑浮动汇率制度下，资本自由流动，美联储加息或者降息是否会对周围国家产生溢出。

1. Introduction

- Finding
- **2.5-lemma**
- **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.**

Under a flexible exchange rate regime,

interest rate ↑ ⇨ **independent** monetary policy

interest rate ↓ ⇨ **dependent** monetary policy

1. Introduction

- **A key challenge in the empirical work on this question** is that co-movement in interest rates across countries does not automatically imply policy spillovers.

- **Yet,** the existing literature does not formally separate co-movement in interest rates between a peripheral and a center country due to common shocks and policy shocks

1. Introduction

- We use a set of innovations to address this challenge.

① First, we estimate **a desirable change** in a peripheral country's interest rate based on the changes in the variables that go into that country's **Taylor rule.**

② Second, we use **revisions** in the (semi-annual) projections of a country inflation rate and growth rate *by the IMF's World Economic Outlook (WEO)* to approximate the **surprised changes** in the relevant variables.

③ Another innovation of the paper is to provide a specification and an estimation method that can include the **QE episodes,** when we do not observe much change in the US interest rate.

2. Specification and data

-2.1 Empirical model

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.

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

$r_{i,t-1}^{p}$ could capture policy momentum or policy space.

$\Delta r_{i,t}^{P*}$ should be driven by news about the domestic output gap and the inflation gap

$$\Rightarrow \Delta r_{i,t}^{P_*} = \tilde{c} + \tilde{\phi}_1 * \Delta GDP\,\text{growth}_{i,t} + \tilde{\phi}_2 * \Delta Inflation_{i,t} + \tilde{e}_{i,t}$$

VIX: **global financial cycles** may affect a country‘s monetary policy stance separately from transmissions of monetary policies from the center to periphery countries.

2. Specification and data

-2.1 Empirical model

Our purpose is to find out which combinations of capital control regimes and nominal exchange rate systems can provide monetary policy independence:

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

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

2. Specification and data

-2.1 Empirical model

Replacing $\Delta r_{i,t}^{P}$ and γ_2 in Eq. (1) , we have

$$\Delta r_{i,t}^{p} = c + \lambda r_{i,t-1}^{p} + \phi_1 * \Delta GDP \text{ growth }_{i,t} + \phi_2 * \Delta \text{ Inflation}_{i,t}$$
$$+\beta_1 D_{\text{fixed. NC}} \Delta r_t^{US} + \beta_2 D_{\text{fixed. C}} \Delta r_t^{US} + \beta_3 D_{\text{flex.NC}} \Delta r_t^{US} + \beta_4 D_{\text{flex.c}} \Delta r_t^{US}$$
$$+\delta \Delta VIX_t + e_{i,t}$$

trilemma hypothesis narrowly

$\beta_1 = 1$ or at least $\beta_1 > 0$ — there is no monetary policy autonomy for any economy

trilemma hypothesis board:

$\beta_3 = \beta_4 = 0$ — Common interpretations of the trilemma hypothesis often go beyond this. In particular, one expects that a flexible exchange rate system would confer monetary autonomy.

2. Specification and data

-2.1 Empirical model

$$\Delta r_{i,t}^{p} = c + \lambda r_{i,t-1}^{p} + \phi_1 * \Delta GDP \text{ growth}_{i,t} + \phi_2 * \Delta \text{ Inflation}_{i,t}$$
$$+\beta_1 D_{\text{fixed. NC}} \Delta r_t^{US} + \beta_2 D_{\text{fixed. C}} \Delta r_t^{US} + \beta_3 D_{\text{flex.NC}} \Delta r_t^{US} + \beta_4 D_{\text{flex.c}} \Delta r_t^{US}$$
$$+\delta \Delta VIX_t + e_{i,t}$$

Capital controls

Case1: If capital controls are **not fully effective** because they are "leaky"	➡ $\beta_2 > 0$
Case2: if capital controls are **completely effective** in conferring monetary policy autonomy	➡ $\beta_2 = \beta_4 = 0$
Case3: if capital controls are **partially effectively** (but a flexible exchange rate system is not effective on its own)	➡ $\beta_1 > \beta_2 > 0$ $\beta_3 > \beta_4 > 0$

2. Specification and data

- 2.2 Two extended specifications

① we will use a more general loss function by the central banks that also incorporates stability of real exchange rate as an additional goal in the desired interest rate (following Engel, 2011).

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

- An **increase** in the value of the real exchange rate means a **depreciation** of the local currency.
- if the country wishes to **reduce RER instability**, we expect $\tilde{\phi}_3 > 0$, **Why**?

➡ 本币贬值引起通货膨胀上升，所以利率目标是降低通货膨胀，所以也要上升

2. Specification and data

- 2.2 Two extended specifications

② The second extension is to allow for **potentially asymmetric responses** of the peripheral country's monetary policy under a **flexible exchange rate regime** to a change in the US monetary policy

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

$\begin{cases} \beta_{3,pos} = 0 \\ \beta_{3,neg} > 0 \end{cases}$	**reluctant** to follow **tightening** monetary policy by the United States but generally **would** follow a **reduction** in the interest rate by the United States**.**
$\beta_{4,\text{pos}} = \beta_{4,neg} = 0$	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.

2. Specification and data

- 2.3 Data

- They consist of **the United States and 28 other countries**.
- We use **Germany** to represent euro countries.

short-term interest rates	From the IMF's IFS dataset, monthly policy rate data covering M1 1990 to M6 2014.
long-term interest rates	use yields on 10-year government bonds.
GDP growth and inflation	use the IMF’s WEO projections of national GDP growth and inflation.
exchange rate regime	classification by Ilzetzki et al. (2011) to define fixed and flexible exchange rate regimes.
The index of capital controls	1–Chinn and Ito's (2008) financial openness index

2. Specification and data

- 2.3 Data

- 汇率制度界定：沿用Ilzetzki et al.(2011)对各国汇率制度的划分。固定汇率制度包括：**盯住汇率制度、区域货币协定和汇率变动区间小于或等于2%的汇率制度以及实际上的盯住汇率制度。其余的汇率制度被划分为浮动汇率制度。**在实证中，汇率制度的取值为0或1。
- 资本管制界定：沿用Chinn-Ito(2008)编制的资本开放指数。该指数是一个法律上的指数，基于书面报告信息构建的。它涵盖了比其他指数更多的国家和更长的时间跨度。

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 on de facto exchange rate regimes and financial openness are based on Ilzetzki et al. (2011) and Chinn and Ito (2008), respectively.

3. Analysis

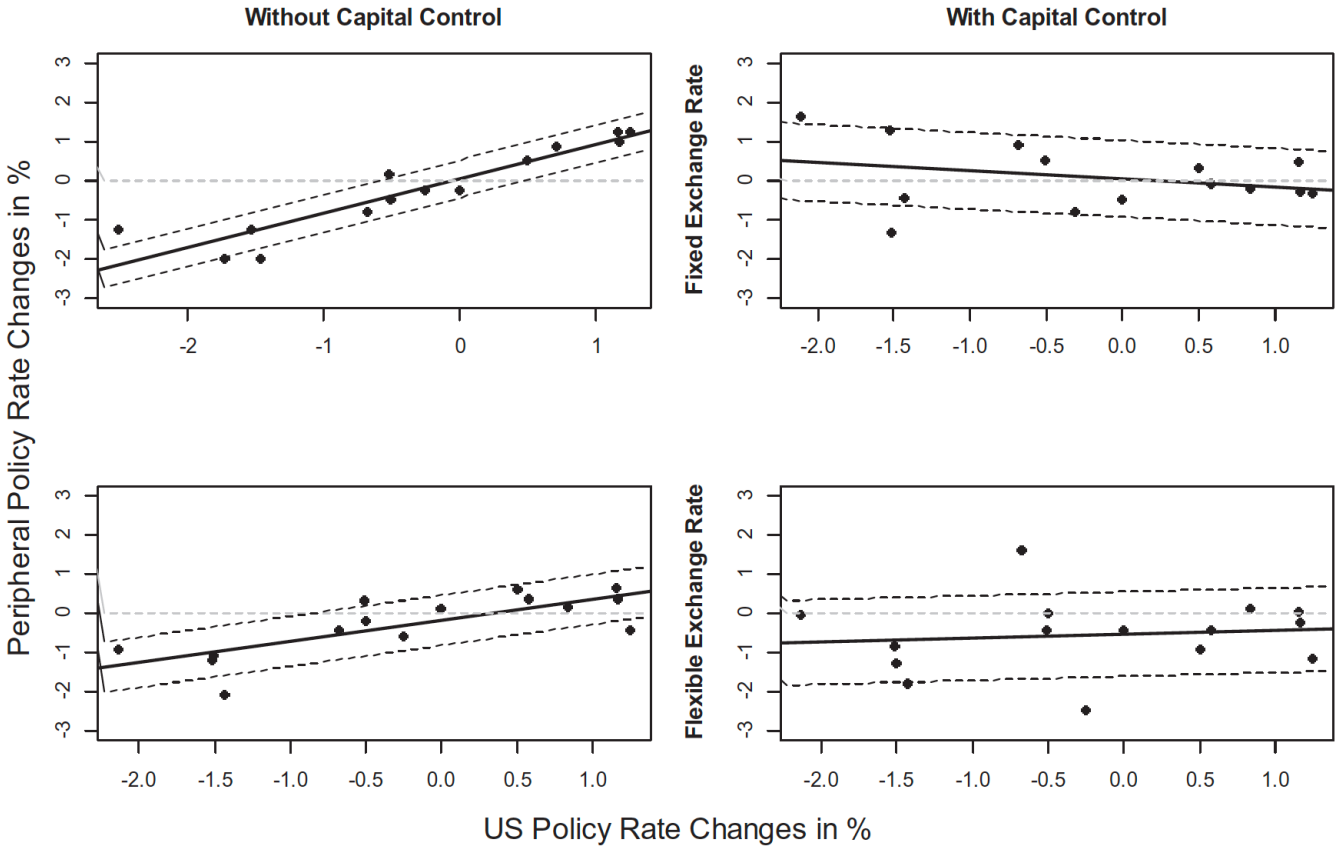

Fig. 1. Changes in peripheral countries' policy rates versus changes in the US policy rate.

Finding:

a) capital controls offer monetary policy autonomy to peripheral countries

b) without capital controls, peripheral countries appear to follow US policy moves in the same direction **even if the former have a flexible exchange rate regime.**

3. Analysis

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[a] (2)	Short-term 1999–2009[b] (2)	Long-term 1999–2009 (4)
$r^{p}_{i,t-1}$	λ	−0.048[e]	−0.007	−0.11[e]	−0.071[e]
		(0.008)	(0.015)	(0.01)	(0.013)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.096	0.237	0.044	0.027
		(0.06)	(0.144)	(0.053)	(0.025)
$\Delta Inflation_{i,t}$	ϕ_2	0.329[e]	0.134	0.413[e]	0.172[e]
		(0.048)	(0.096)	(0.049)	(0.039)
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	0.649[e]	0.402	0.648[e]	0.665[e]
		(0.39)	(2.09)	(0.297)	(0.259)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	0.034	1.998	−0.047	0.118
		(0.325)	(1.286)	(0.262)	(0.302)
$D_{flex.\ NC}\Delta r^{US}_{i,t}$	β_3	0.450[e]	0.492	0.493[e]	0.473[e]
		(0.176)	(0.438)	(0.153)	(0.111)
$D_{flex.C}\Delta r^{US}_{i,t}$	β_4	0.029	0.008	0.059	0.251[e]
		(0.127)	(0.334)	(0.109)	(0.099)
ΔVIX_t	δ	0.23	0.086	0.172	0.177[e]
		(0.199)	(0.584)	(0.168)	(0.089)
t-Test:[c] $\beta_1 > \beta_3$		−0.473	0.042	−0.472	−0.682
t-Test: $\beta_4 < \beta_3$		1.998[e]	−0.892	−2.416[e]	−1.514
Adjusted R-squared		0.09	0.00[d]	0.30	0.22
No. of Obs.		827	295	531	356
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

- Beta1: This pattern is consistent with a part of the implications of the **trilemma hypothesis.**
- Beta2 & Beta4: **capital controls** allow a country's monetary policy to **be immune from changes in the US rate.**
- Because Beta3 = 0.45 & Beta1 = 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 fixed,NC.
- In other words, a **mere** flexible exchange rate regime does not automatically confer monetary policy autonomy.

NBER :

In search of **asymmetric** responses

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

		(1) Asymmetric responses	(2) Adding exchange rate	(3) Only countries with policy rates[a]	(4) Long-term bond yield as dependent variable
$r^{p}_{i,t-1}$	λ	**−0.114***	**−0.117***	**−0.116***	**−0.069***
		(0.03)	(0.03)	(0.03)	(0.04)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.04	0.064	0.073	0.035
		(0.07)	(0.08)	(0.08)	(0.03)
$\Delta Inflation_{i,t}$	ϕ_2	**0.413***	**2.442***	**2.56***	0.861
		(0.09)	(1.36)	(1.33)	(0.57)
$\Delta Real\ Exchange\ Rate_{i,t}$	ϕ_3	–	2.03	2.145	0.693
		–	(1.34)	(1.31)	(0.57)
$\boldsymbol{D_{fixed.NC}\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_1}$	**0.656***	**0.617***	**0.595***	**0.663***
		(0.17)	(0.17)	(0.17)	(0.19)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	−0.048	−0.039	−0.095	0.161
		(0.15)	(0.15)	(0.14)	(0.14)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	0.152	0.114	0.127	0.329*
		(0.23)	(0.24)	(0.25)	(0.12)
$\boldsymbol{D_{flex.NC}Neg\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_{3,neg}}$	**0.630***	**0.616***	**0.592***	**0.526***
		(0.160)	(0.170)	(0.17)	(0.12)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	$\beta_{4,pos}$	0.215	0.192	0.169	0.001
		(0.25)	(0.24)	(0.24)	(0.24)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.013	0.025	0.037	**0.367***
		(0.16)	(0.16)	(0.16)	(0.22)
ΔVIX_t	δ	0.172	0.047	−0.032	0.116
		(0.15)	(0.18)	(0.19)	(0.10)
Adjusted R-squared		0.304	0.307	0.303	0.223
No. of Obs.		531	531	514	356

Note: Robust standard errors clustered at the level of country-period are reported for all columns.
Bold and an asterisk means significant at the 10% level.
[a] Argentina is excluded as it is an obvious outlier.

- In particular, for countries with a flexible exchange rate regime but no capital controls, the peripheral country does not follow the United States when the latter **raises** **its interest rate.**
- On the other hand, with capital controls, the peripheral country does not follow US interest rate moves **regardless of a rise or a fall** in the US interest rate.

➢ This pattern fits **neither** the **trilemma** view that **a flexible exchange rate regime is sufficient for monetary policy autonomy**, **nor** the **dilemma** view that **only capital controls offer a buffer between the monetary policy of a peripheral country and that of the center country.**

➢ In this sense, the real world is somewhere between a dilemma and a trilemma (which we might call "**2.5-lemma**" for short).

➢ Perhaps it is also worthwhile to note that the VIX variable is not statistically significant.

In search of asymmetric responses

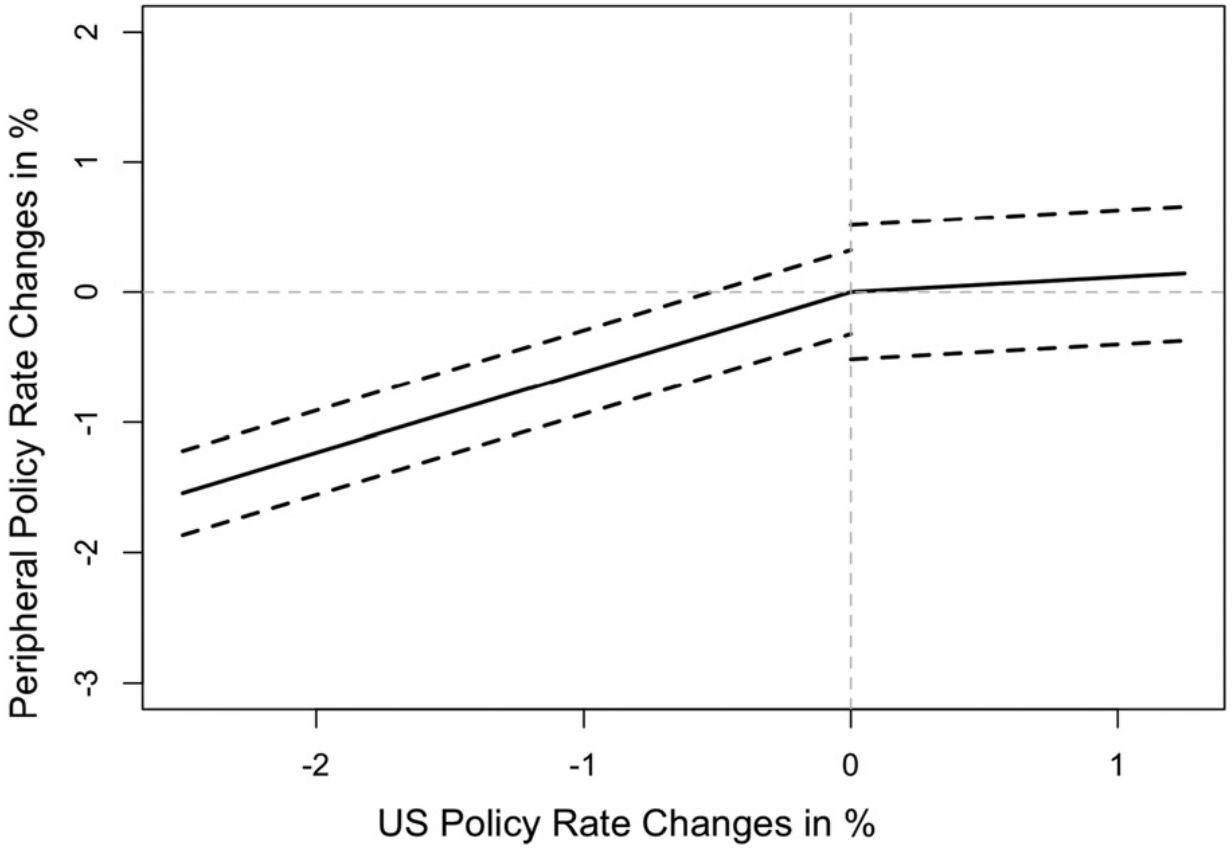

Fig. 2. Policy rate responses to changes in the US policy rate. The case of countries with a **flexible exchange rate but no capital controls**, simulated based on estimates in column (2) in Table 4.

- When the US **lowers** its policy rate, peripheral countries tend to **follow** the US action by lowering its own rate (in order to dampen or avoid an appreciation of their currencies).
- In comparison, when the US **raises** its policy rate, peripheral countries do **not follow** suit (in a statistically significant way).
- This graph summarizes the idea of a "**2.5 lemma**" – **a flexible exchange rate regime offers only partial monetary policy autonomy**.

New Idea or Finding

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

		(1) Asymmetric responses	(2) Adding exchange rate	(3) Only countries with policy rates[a]	(4) Long-term bond yield as dependent variable
$r^{p}_{i,t-1}$	λ	**−0.114***	**−0.117***	**−0.116***	**−0.069***
		(0.03)	(0.03)	(0.03)	(0.04)
$\Delta GDP\ growth_{i,t}$	ϕ_1	0.04	0.064	0.073	0.035
		(0.07)	(0.08)	(0.08)	(0.03)
$\Delta Inflation_{i,t}$	ϕ_2	**0.413***	**2.442***	**2.56***	0.861
		(0.09)	(1.36)	(1.33)	(0.57)
$\Delta Real\ Exchange\ Rate_{i,t}$	ϕ_3	–	2.03	2.145	0.693
		–	(1.34)	(1.31)	(0.57)
$\boldsymbol{D_{fixed.NC}\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_1}$	**0.656***	**0.617***	**0.595***	**0.663***
		(0.17)	(0.17)	(0.17)	(0.19)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	−0.048	−0.039	−0.095	0.161
		(0.15)	(0.15)	(0.14)	(0.14)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	0.152	0.114	0.127	0.329*
		(0.23)	(0.24)	(0.25)	(0.12)
$\boldsymbol{D_{flex.NC}Neg\Delta r^{US}_{i,t}}$	$\boldsymbol{\beta_{3,neg}}$	**0.630***	**0.616***	**0.592***	**0.526***
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		(0.25)	(0.24)	(0.24)	(0.24)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.013	0.025	0.037	**0.367***
		(0.16)	(0.16)	(0.16)	(0.22)
ΔVIX_t	δ	0.172	0.047	−0.032	0.116
		(0.15)	(0.18)	(0.19)	(0.10)
Adjusted R-squared		0.304	0.307	0.303	0.223
No. of Obs.		531	531	514	356

Note: Robust standard errors clustered at the level of country-period are reported for all columns.
Bold and an asterisk means significant at the 10% level.
[a] Argentina is excluded as it is an obvious outlier.

- Developed countries tend to follow Fed rate cuts.

$$\Delta r^{US} \uparrow \Rightarrow Exchange\ rate \downarrow \Rightarrow export \uparrow \Rightarrow GDP \uparrow$$

$$\Delta r^{US} \downarrow \Rightarrow fear\ Exchange\ rate \uparrow \Rightarrow follow\ \Delta r^{developed\,(like\ eu\&\ japan)} \downarrow \Rightarrow GDP \uparrow$$

Developing countries tend to follow the Fed‘s rate increasing and rate cut.

加息短期稳定资本流动，中长期抑制经济增长。

3.3. Allowing for country-specific coefficients

- **the same** coefficients on output gap and inflation inside the Taylor rule for all countries.
- we allow for country **heterogeneity** and estimate country-specific coefficients on these two variables.
- In particular, we know that some of the countries pursue **inflation targeting** during part of the sample period, and, if they do what claim to do, the **weights** on avoiding inflation in their monetary policy reaction functions should be higher than the similar weights by countries that do not have an explicit inflation target.

Appendix Table A7: Summary statistics on weights on inflation in the Taylor rule
(from regressions with country specific coefficients on the Taylor rule variables)

	1st Quartile	Median	Mean	3rd Quartile	Standard Error
Inflation targeting countries (16 countries)	0.33	0.49	0.50	0.67	0.23
Non-targeting countries (12 countries)	0.00	0.09	0.14	0.23	0.15

Appendix Table A6: Weight on inflation in the Taylor rule

	Country Name	Coef. on Inflation
Inflation targeting	Australia	0.59
Inflation targeting	Brazil	0.86
Inflation targeting	Canada	0.27
Inflation targeting	Chile	0.73
Inflation targeting	Colombia	0.65
Inflation targeting	United Kingdom	0.27
Inflation targeting	Indonesia	0.46
Inflation targeting	Israel	0.76
Inflation targeting	Korea, Republic of	0.00
Inflation targeting	Mexico	0.79
Inflation targeting	New Zealand	0.26
Inflation targeting	Peru	0.46
Inflation targeting	Philippines	0.35
Inflation targeting	Thailand	0.45
Inflation targeting	Turkey	0.6
Inflation targeting	South Africa	0.51
Non-targeting	Argentina	0.47
Non-targeting	Belarus	0.07
Non-targeting	Bolivia	0.00
Non-targeting	PRC	0.12
Non-targeting	Costa Rica	0.22
Non-targeting	Germany	0.05
Non-targeting	Ecuador	0.24
Non-targeting	HK	0.00
Non-targeting	India	0.10
Non-targeting	Japan	0.00
Non-targeting	Pakistan	0.35
Non-targeting	Singapore	0.00

3.3. Allowing for country-specific coefficients

Table 5A
Country-specific coefficients on the Taylor-rule variables, exchange rate volatility, and VIX.

		(1)	(2)	(3)
$r^{p}_{i,t-1}$	Λ	**−0.106***	**−0.129***	**−0.127***
		(0.04)	(0.03)	(0.03)
Country-specific coefficients on Taylor-rule variables		Yes	Yes	Yes
Country-specific coefficients on real exchange rate		No	Yes	Yes
Country-specific coefficients on VIX		No	No	Yes
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.765***	**0.796***	**0.761***
		(0.25)	(0.16)	(0.16)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	−0.041	−0.014	0.019
		(0.13)	(0.12)	(0.12)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	0.172	0.138	0.129
		(0.21)	(0.21)	(0.22)
$D_{flex.NC}Neg\Delta r^{US}_{i,t}$	$\beta_{3,neg}$	**0.496***	**0.478***	**0.445***
		(0.19)	(0.20)	(0.20)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	$\beta_{4,pos}$	0.224	0.237	0.228
		(0.28)	(0.28)	(0.29)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.037	−0.026	0.006
		(0.22)	(0.22)	(0.22)
ΔVIX_t	δ	**0.329***	0.1	
		(0.14)	(0.16)	
Adj. R-squared		0.383	0.539	0.536
No. of Obs.		531	531	531

Bold and an asterisk means significant at the 10% level.

Column (1)

- For countries **without capital controls but on a flexible exchange rate regime**, their interest rates follow a decrease in the US interest rate (to avoid an appreciation of their currencies relative to the US dollar), **but appear to ignore an increase in the US interest rate.**
- One difference from Table 4 is that the VIX now has a positive and statistically significant coefficient.

Column (2)

- In particular, we continue to find an asymmetric policy response pattern in the case of a flexible exchange rate regime without capital controls.

3.3. Allowing for country-specific coefficients

Table 5B
Long-term bond yields as dependent variable, with country-specific coefficients.

		(1)	(2)	(3)
$r^{p}_{i,t-1}$	Λ	**−0.06***	**−0.064***	−0.069
		(0.02)	(0.02)	(0.03)
Country-specific coefficients on Taylor-rule variables		Yes	Yes	Yes
Country-specific coefficients on real exchange rate		No	Yes	Yes
Country-specific coefficients on VIX		No	No	Yes
$D_{fixed.NC}\Delta r^{US}_{i,t}$	β_1	**0.767***	**0.752***	0.682
		(0.14)	(0.14)	(9.41)
$D_{fixed.C}\Delta r^{US}_{i,t}$	β_2	0.351	**0.556***	0.548
		(0.22)	(0.14)	(9.37)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	$\beta_{3,pos}$	**0.368***	**0.375***	**0.405***
		(0.12)	(0.13)	(0.21)
$D_{flex.NC}Neg\Delta r^{US}_{i,t}$	$\beta_{3,neg}$	**0.467***	**0.458***	**0.497***
		(0.11)	(0.14)	(0.08)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	$\beta_{4,pos}$	−0.105	−0.119	−0.108
		(0.22)	(0.18)	(1.80)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	$\beta_{4,neg}$	0.231	0.141	0.077
		(0.16)	(0.20)	(2.23)
ΔVIX_t	δ	−0.045	−0.143	
		(0.08)	(0.09)	
Adj. R-squared		0.491	0.53	0.536
No. of Obs.		356	356	356

Bold and an asterisk means significant at the 10% level.

In Table 5B, we examine the case of long-term interest rates on government bonds while allowing for country-specific coefficients on Taylor-rule variables and VIX. Again, these generalizations do not alter the basic patterns in the key coefficients.

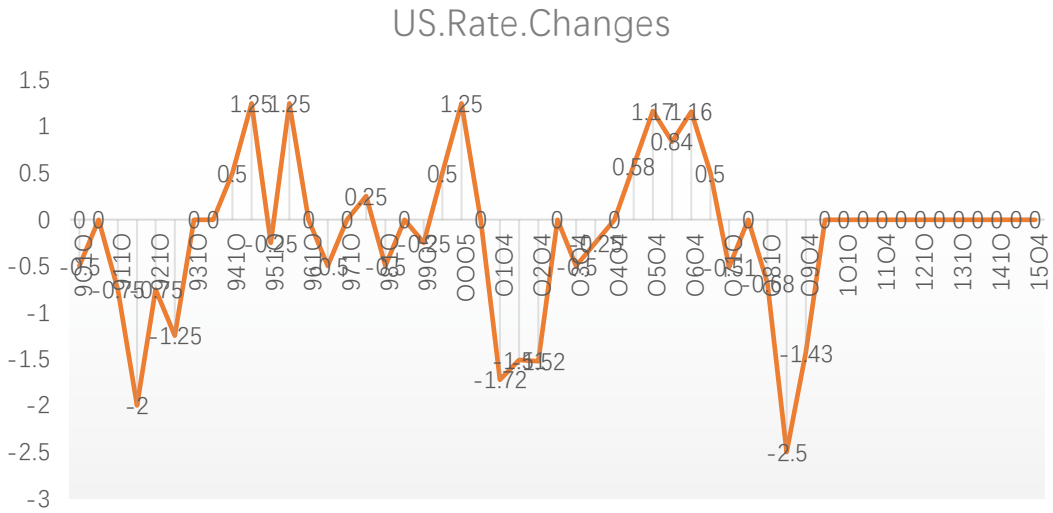
4. The lower-bound episodes

- 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:

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

$$\Delta r_{t}^{US\#} = \begin{cases} \Delta r_{t}^{US}, & r_{t}^{US*} > Lower\ Bound \\ \Delta r_{t}^{US*}, & r_{t}^{US*} = Lower\ Bound \end{cases},$$

$$r_{t}^{US*} = \theta_1 + \theta_2 \log M_t + \theta_3 \log Y_t + \epsilon_t.$$



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

$$L = \prod_{i=1}^{N} \left(\phi\left(\frac{\Delta r_{i,t}^{p} - \left(\lambda r_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 \Delta r_{t}^{US} + \delta \Delta VIX_t \right)}{\sigma_\varepsilon} \right) \left(1 - \Phi\left(\frac{0 - (\theta_1 + \theta_2 \log M_t + \theta_3 \log Y_t)}{\sigma_\varepsilon} \right) \right) \right)^{Yi}$$
$$\left(\phi\left(\frac{\Delta r_{i,t}^{p} - \left(\lambda r_{i,t-1}^{p} + \gamma_1 \Delta r_{i,t}^{P*} + \gamma_2 (\theta_2 \Delta \log M_t + \theta_3 \Delta \log Y_t) + \delta \Delta VIX_t \right)}{\gamma_2 \sigma_{\varepsilon_t - \varepsilon_{t-1}} + \sigma_\varepsilon} \right) \Phi\left(\frac{0 - (\theta_1 + \theta_2 \log M_t + \theta_3 \log Y_t)}{\sigma_\varepsilon} \right) \right)^{1-Yi},$$

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

4. The lower-bound episodes

Table 6
Inclusion of the lower-bound episode (1999–2012); sensitivity analysis with different initial values.

		Using OLS est. as the initial values	Initial values in (1) + Standard Error (SE)	Initial values in (1) + 2*SE	Initial values in (1) – SE	Initial values in (1) – 2*SE	Initial values (OLS estimate) from the baseline optimization
		(1)	(2)	(3)	(4)	(5)	(6)
$r^p_{i,t-1}$	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
$\log M_t$	θ_2	−0.17	−10.60	−0.15	−12.18	−5.67	0
$\log Y_t$	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 4) and for the money supply equation using the above-lower-bound data.
Bold and an asterisk means significant at the 10% level.

5. Additional extensions and robustness checks

5.1. Re-defining capital controls

Table 7
Alternative ways of measuring capital controls (period: M1 1999 to M3 2009).

	Replacing the capital controls with Walls		With Chinn-Ito measured continuously		With Fernández et al. (2015) measure as capital control	
	Short-term (1)	Long-term (2)	Short-term (3)	Long-term (4)	Short-term (5)	Long-term (6)
$r^{p}_{i,t-1}$	**−0.098***	−0.065	−0.115*	−0.066	−0.074*	−0.06
	(0.04)	(0.05)	(0.03)	(0.05)	(0.03)	(0.04)
$\Delta GDP\ growth_{i,t}$	0.135	0.026	0.065	0.034	0.119	0.035
	(0.08)	(0.03)	(0.08)	(0.03)	(0.08)	(0.03)
$\Delta Inflation_{i,t}$	2.199	0.742	2.564*	0.857	2.458	0.802
	(1.53)	(0.60)	(1.38)	(0.58)	(1.55)	(0.54)
$\Delta Real\ Exchange\ Rate_{i,t}$	1.701	0.552	2.142	0.69	1.98	0.635
	(1.52)	(0.60)	(1.34)	(0.58)	(1.53)	(0.54)
$\boldsymbol{D_{fixed}.\Delta r^{US}_{i,t}}$	**0.438***	**0.603***	**0.456***	**0.71***	**0.415***	**0.656***
	(0.14)	(0.16)	(0.16)	(0.19)	(0.15)	(0.16)
$D_{fixed}\Delta r^{US}_{i,t} * C$	−0.393	−0.537	**−0.659***	**−1.045***	**−0.777***	**−1.579***
	(0.40)	(0.43)	(0.27)	(0.42)	(0.33)	(0.68)
$D_{flex}Pos\ \Delta r^{US}_{i,t}$	0.089	**0.341***	0.038	**0.323***	0.15	**0.478***
	(0.23)	(0.14)	(0.20)	(0.15)	(0.27)	(0.17)
$\boldsymbol{D_{flex}Neg\Delta r^{US}_{i,t}}$	0.26	**0.585***	**0.347***	**0.512***	**0.318***	**0.506***
	(0.17)	(0.18)	(0.14)	(0.17)	(0.15)	(0.14)
$D_{flex}Pos\ \Delta r^{US}_{i,t} * C$	0.148	−0.374	**0.396***	−0.564	−0.162	**−0.991***
	(0.19)	(0.50)	(0.22)	(0.60)	(0.26)	(0.56)
$D_{flex}Neg\Delta r^{US}_{i,t} * C$	0.072	0.183	**−0.409***	−0.215	−0.305	−0.145
	(0.18)	(0.22)	(0.24)	(0.24)	(0.24)	(0.23)
ΔVIX_t	0.022	0.134	0.033	0.115	0.018	0.117
	(0.19)	(0.10)	(0.18)	(0.10)	(0.18)	(0.10)
Adjusted R-squared	0.315	0.258	0.299	0.227	0.255	0.236
No. of Obs.	531	356	531	356	531	356

Notes: Robust standard errors that are clustered at the level of country-period are reported for all columns.
Bold and an asterisk means significant at the 10% level.

5. Additional extensions and robustness checks

5.2. Re-classifying exchange rate regimes

Table 8
Alternative ways of defining exchange rate regimes (period: M1 1999 to M3 2009).

	AREAER		Shambaugh (2004)	
	Short-term (1)	Long-term (2)	Short-term (3)	Long-term (4)
$r^{p}_{i,t-1}$	**−0.116***	**−0.068***	**−0.117***	−0.065
	(0.03)	(0.04)	(0.03)	(0.05)
$\Delta GDP\ growth_{i,t}$	0.074	0.034	0.067	0.026
	(0.09)	(0.03)	(0.08)	(0.03)
$\Delta Inflation_{i,t}$	**2.645***	0.868	**2.455***	0.742
	(1.33)	(0.56)	(1.44)	(0.60)
$\Delta Real\ Exchange\ Rate_{i,t}$	**2.228***	0.7	2.039	0.552
	(1.31)	(0.56)	(1.42)	(0.60)
$\boldsymbol{D_{fixed.NC}\Delta r^{US}_{i,t}}$	**0.555***	**0.716***	**0.675***	**0.603***
	(0.18)	(0.18)	(0.23)	(0.16)
$D_{fixed.C}\Delta r^{US}_{i,t}$	−0.176	0.028	−0.092	−0.537
	(0.22)	(0.23)	(0.24)	(0.43)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	0.148	**0.277***	0.165	**0.341***
	(0.25)	(0.13)	(0.24)	(0.14)
$\boldsymbol{D_{flex.NC}Neg\Delta r^{US}_{i,t}}$	**0.603***	**0.544***	**0.61***	**0.585***
	(0.20)	(0.12)	(0.19)	(0.18)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	0.143	−0.032	0.237	−0.374
	(0.24)	(0.19)	(0.27)	(0.50)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	0.063	**0.406***	0.035	0.183
	(0.17)	(0.22)	(0.17)	(0.22)
$\boldsymbol{\Delta VIX_t}$	−0.038	0.114	0.075	0.134
	(0.19)	(0.10)	(0.19)	(0.10)
Adjusted R-squared	0.303	0.227	0.31	0.258
No. of Obs.	514	356	531	356

Notes: Robust standard errors that are clustered at the level of country-period are reported for all columns.
Bold and an asterisk means significant at the 10% level.

5.3. Alternative specification of the Taylor rule

$$\Delta r^{P*}_{i.t} = 1.5\Delta\pi + 0.5y,$$

Table 9
Using pre-assigned parameter values in the Taylor rule (period: M1 1999 to M3 2009).

	With exchange rate volatility		Without exchange rate volatility	
	Short-term (1)	Long-term (2)	Short-term (3)	Long-term (4)
$r^{p}_{i,t-1}$	**−0.113***	−0.066	**−0.114***	−0.066
	(0.03)	(0.04)	−0.03	(0.04)
$\Delta GDP\ growth_{i,t}$	0.053	0.03	0.13	0.049
	–	–	–	–
$\Delta Inflation_{i,t}$	0.158	0.09	0.38	0.147
	–	–	–	–
$\Delta Real\ Exchange\ Rate_{i,t}$	−0.25	−0.073	–	–
	(0.22)	(0.11)	–	–
$\boldsymbol{D_{fixed.NC}\Delta r^{US}_{i,t}}$	**0.645***	**0.672***	**0.568***	**0.669***
	(0.17)	(0.19)	−0.14	(0.19)
$D_{fixed.C}\Delta r^{US}_{i,t}$	−0.06	0.136	−0.11	0.132
	(0.15)	(0.14)	−0.15	(0.14)
$D_{flex.NC}Pos\ \Delta r^{US}_{i,t}$	0.154	**0.358***	0.14	**0.35***
	(0.23)	(0.13)	−0.23	(0.13)
$\boldsymbol{D_{flex.NC}Neg\Delta r^{US}_{i,t}}$	**0.618***	**0.54***	**0.552***	**0.535***
	(0.16)	(0.12)	−0.13	(0.12)
$D_{flex.C}Pos\ \Delta r^{US}_{i,t}$	0.212	−0.014	0.18	−0.025
	(0.25)	(0.24)	−0.25	(0.25)
$D_{flex.C}Neg\ \Delta r^{US}_{i,t}$	−0.001	**0.381***	−0.059	**0.375***
	(0.17)	(0.21)	−0.14	(0.22)
$\boldsymbol{\Delta VIX_t}$	0.183	**0.174***	0.148	**0.181***
	(0.16)	(0.07)	−0.16	(0.07)
Adjusted R-squared	0.303	0.222	0.302	0.223
No. of Obs.	531	356	531	356

5. robustness checks

5.4. Seemingly unrelated regressions

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

Table 10
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
$r^{p}_{i,t-1}$	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)

Bold and an asterisk means significant at the 10% level.

5. robustness checks

5.5. Another look at the global financial cycle effect

Table 11
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)
$r^{p}_{i,t-1}$	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

Bold and an asterisk means significant at the 10% level.

5.6. Exchange rate responses to US interest rate changes

Table 12
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
$\Delta \log Exchange\ Rate_{i,t-1}$	λ	–	–	**0.127***	**0.2***
		–	–	(0.036)	(0.036)
$\Delta GDP\ growth_{i,t}$	ϕ_1	**−0.016***	−0.01	**−0.014***	0.00
		(0.002)		(0.002)	
$\Delta Inflation_{i,t}$	ϕ_2	**0.005***	−0.03	**0.005***	0.00
		(0.002)		(0.002)	
$D_{flex.NC}\Delta r^{US}_{i,t}$	β_3	**0.019***	**0.008***	**0.018***	**0.009***
		(0.005)	(0.005)	(0.005)	(0.005)
$D_{flex.C}\Delta r^{US}_{i,t}$	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

Bold and an asterisk means significant at the 10% level.

6、conclusion

- innovations/improvements
  - desired change in the interest rate based on a Taylor rule
  - use the surprise components in inflation forecasts and growth fore- casts by the IMF's World Economic Outlook
  - exchange rate stability
  - quantitative easing
  - examine monetary autonomy both in terms of long-term and short-term interest rates.
- flexible exchange rate offers asymmetric or incomplete insulation from foreign monetary policy shocks.
- capital controls do offer insulation from foreign monetary policy shocks for peripheral countries on either a fixed or a flexible exchange rate regime

Thanks!