Monetary Trilemma, Dilemma or Something in Between?

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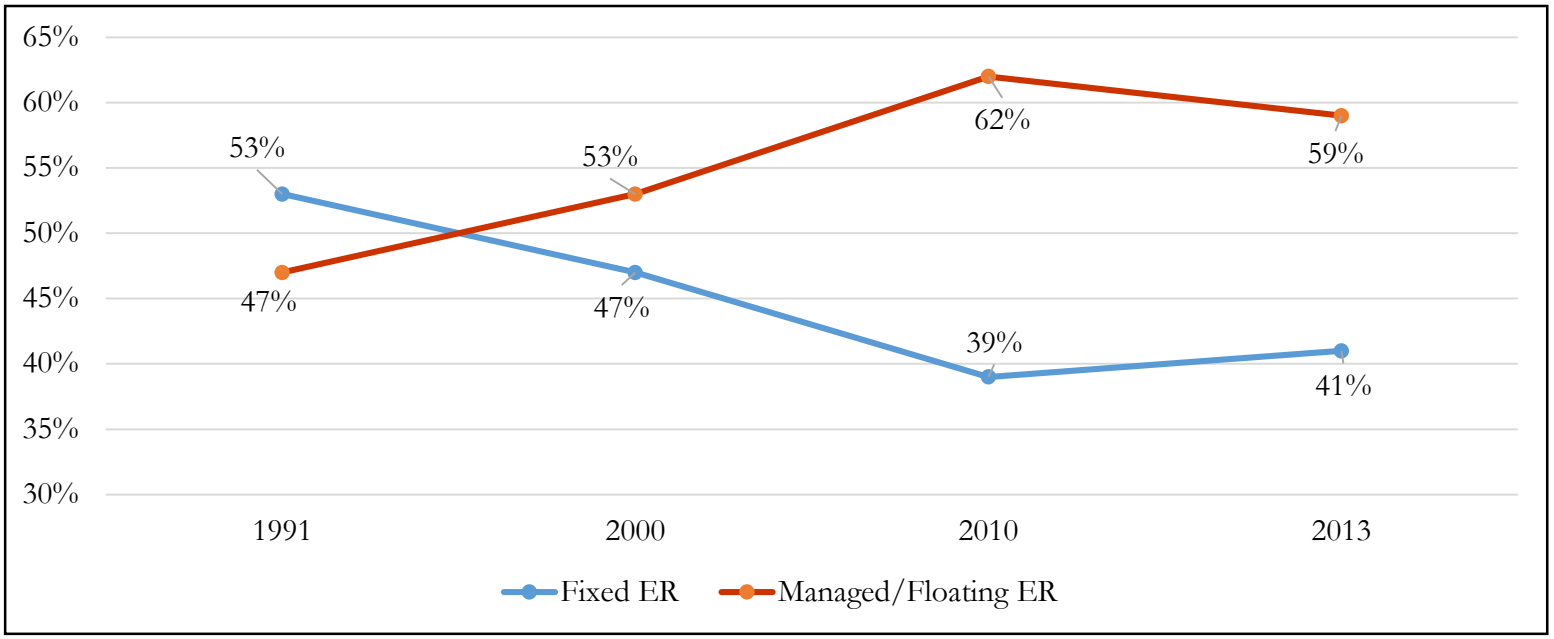
1. Introduction

- ✓ Overall tendency towards enhanced currency flexibility among developing and emerging economies.
- ✓ Freed up use of interest rate as an instrument to stabilize the economy with internal price stability as paramount objective.

Trends in De facto Exchange Rate Regimes



Note: Developing and Emerging Economies
Source: Levy-Yeyati and Struzenegger (2016)

- ✓ In practice, has exchange rate flexibility really afforded a country greater monetary autonomy?

- ✓ Global financial cycle may have undermined ability of central banks to manage own monetary conditions regardless of exchange rate regime. (Rey, 2013; 2016; Passari and Rey, 2015)
  - Significant co-movement of prices of risky financial assets, gross capital flows and credit growth across countries.
  - Given sizeable financial spillovers from US monetary policy, capital controls only way of regaining monetary autonomy. – *Dilemma not Trilemma.*
  - US dollar funding; role of intermediaries (global banks, MNCs), etc.

2. Literature

✓ Three broad strands of literature contesting the Rey thesis:

i) Relative importance of global financial cycle as driver of capital flows and domestic financial conditions.

- Global factors (global risk, US monetary conditions and centre country fundamentals) may be overstated in impacting cross-border capital flows. (Cerutti, Claessens, and Rose, 2017; Goldberg and Krogstrup, 2018)

ii) Insulating properties of exchange rate flexibility in the face of global shocks

- Faced with external shocks, countries with more flexible exchange rate regimes experience smaller impact on financial variables, growth or on net capital flows compared to more heavily managed regimes (di Giovanni and Shambaugh, 2008; Aizenman et al., Obstfeld et al., 2017; IMF, 2018)

iii) Degree of correlation of domestic interest rate with base interest rate depending on exchange rate regime and openness.

Correlation of Interest Rates

- ✓ This paper revisits the issue based on Shambaugh (2004); Klein & Shambaugh (2015); Obstfeld, Shambaugh & Taylor (2010); Obstfeld (2015).

- ✓ Start with the simple interest rate parity equation:

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

  - R_{it} denotes nominal interest rate of 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).
  - E^{e}_{it+1} is the expected (log) exchange rate at time $t+1$.
  - ρ_{it} is the risk premium term.

3. Model and Data

- ✓ Challenging to base our estimation on equation (1) for two reasons:
  - Nominal interest rates tend to exhibit strong persistence and there exist unit root concerns.
  - Expected changes in exchange rate and the risk premium are unobservable.

- ✓ Adopt the first difference of equation (1) as follows:

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

where $u_{it} = \Delta[(E^{e}_{i,t+1} - E_{it}) + \rho_{it} + \varepsilon_{it}]$, ε_{it} the idiosyncratic error term or time-varying unobserved heterogeneity.

- ✓ Based on equation (2) we estimate regressions across categories.

		Peg	
		Yes	No
Capital Controls	Yes	Quadrant 1 *(China esp. pre 2005)*	Quadrant 2 *(India esp. since 2015)*
	No	Quadrant 3 *(Hong Kong)*	Quadrant 4 *(ANZ)*

- ✓ Possible complications: error term (u_{it}) correlated with ΔR_{bit}
  - Common shocks (change in global risk), credible target zone, etc.

- ✓ Test for statistical significance across sub-samples by pooling the data (Shambaugh, 2004).

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

  - $(peg)_{it}$ dummy = 1 for pegged exchange rate regime for country **i** at year **t** and 0 otherwise.
  - $(no\ capital\ controls)_{it}$ dummy = 1 if capital control exist for the country **i** at year **t and** 0 otherwise.

Data

- ✓ Interest rate: short-term treasury bill rates for baseline.
- ✓ Sample:
  - Time period: 1973 – 2014; annual frequency.
  - 88 countries comprising both advanced economies (AEs) (25) and emerging and developing economies (EMDEs) (63)
  - 703 peg observations, 1309 non-peg observations, 1384 capital control observations and 630 no control observations.
  - US is dominant base as about three-fifths of the observations are pegged to the U.S. dollar.
- ✓ Exchange rate regime based on Shambaugh's exchange rate regime classification.
- ✓ Capital account openness based on Chinn-Ito financial account openness index.

4. Baseline Results

Two by Two Classification of Exchange Rate and Capital Control Regimes

		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]

Interaction Terms with Regime Type

VARIABLES	ESTIMATE
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

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

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: Since 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.

Interaction Terms with Regime Types (Time Fixed effects)

VARIABLES	ESTIMATE
β	-0.08
β std. error	(0.08)
β_2	0.18***
β_2 std. error	(0.08)
β_3	0.47***
β_3 std. error	(0.10)
Observations	2,012
R-squared	0.15

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

Two by Two Classification of Exchange Rate and Capital Control Regimes (First-difference) with d.VIX

		PEG			
		Yes		No	
		Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
CAPITAL CONTROLS	Yes	0.31*** (0.12)	332 [0.04]	0.01 (0.09)	758 [0.01]
	No	0.87*** (0.08)	266 [0.39]	0.34*** (0.12)	303 [0.06]

Interaction Terms with Regime Types with VIX Index

VARIABLES	ESTIMATE
β	-0.02
β std. error	(0.08)
β_2	0.36***
β_2 std. error	(0.10)
β_3	0.41***
β_3 std. error	(0.10)
β_4 (d.VIX)	0.02***
β_4 std. error	(0.01)
Observations	1,659
R-squared	0.04

Notes:

β = coefficient on ΔR_b.

β_2= coefficient on (peg) × ΔR_b.

β_3= coefficient on (no capital controls) × ΔR_b.

β_4= coefficient on d.VIX.

Cluster-robust standard errors are reported.

*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

5. Asymmetric Response: 2.5-Lemma?

- ✓ Han & Wei (2018) suggest existence of *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 .. not .. when the center lowers its interest rate…Capital controls provide insulation .. from foreign monetary policy shocks even when the center lowers its interest rate* (p.206).
  - Tangential literature on asymmetry in FXI -- more likely to prevent sharp appreciations than depreciations, i.e. "Fear of appreciation". (Levy-Yeyati and Struzenegger, 2007; Pontines and Rajan, 2011; Ramachandran and Srinivasan, 2007)

- ✓ We examine potential asymmetric responses of peripheral country's monetary policy to change in base country's interest rate.

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**	0.31*** (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]

- ✓ Clear evidence of asymmetry across all quadrants.
- ✓ Some evidence of Rey thesis of dilemma but only when base rates rise
  - Limited / No -- autonomy afforded by flexibility (0.32 vs 0.30 and 1 vs 0.88)
  - Relative importance of capital controls (bottom vs top two quadrants)

Interaction Terms with Regime Types

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

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

Interaction Terms with Regime Types with VIX Index

VARIABLES	Full sample	base countries raise interest rate	base countries lower interest rate
β	-0.02	0.18	-0.17
β std. error	(0.08)	(0.11)	(0.13)
β_2	0.36***	0.05	0.30*
β_2 std. error	(0.10)	(0.22)	(0.16)
β_3	0.41***	0.42**	0.52***
β_3 std. error	(0.10)	(0.18)	(0.16)
β_4 (d.VIX)	0.02***	-0.02	0.03***
β_4 std. error	(0.01)	(0.01)	(0.01)
Observations	1,659	656	1,003
R-squared	0.04	0.02	0.05

Note:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) × ΔR_b.
β_3= coefficient on (no capital controls) × ΔR_b.
β_4= coefficient on d.VIX.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Interaction Terms with Regime Types (First-difference)
When VIX is above mean (VIX>21.1)

VARIABLES	Full sample (above mean)	base countries raise interest rate	base countries lower interest rate
β	0.05	0.47**	-0.20
β std. error	(0.08)	(0.18)	(0.13)
β_2	0.35***	0.00	0.34**
β_2 std. error	(0.09)	(0.21)	(0.15)
β_3	0.52***	0.53*	0.71***
β_3 std. error	(0.12)	(0.31)	(0.17)
Observations	1,123	386	737
R-squared	0.07	0.08	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.

Why Asymmetric Responses of Interest Rates?

- ✓ When base countries raise interest rates peripheral countries may follow suit to prevent capital outflows, loss of reserves or domestic financial disruptions.
  - Significance of US dollar appreciation on capital flight and emerging market corporate or financial market distress due to risk-taking channel (Avdijev et al., 2018; Bruno and Shin, 2014; 2018)
  - Capital controls have proven to be rather ineffective to prevent outflows (IMF, 2012; Montiel, 2013; Reinert et al., 2010)
  - Growing evidence of asymmetrical effect of macroprudential policies (MaPs) (Aizenman et al, 2017; Cerutti et al, 2017; Cavoli et al, 2019)
  - "Fear of reserve loss" (Aizenman and Sun, 2009)

- ✓ When base country interest rates decline, peripheral countries experience surges in capital inflows if they stand pat but can maintain monetary policy autonomy via combination of:
  - Sterilized FXI (leading to sustained reserve accumulation); tightening of capital controls and/or MaPs

Interaction Terms with Regime Types based on Reserves

VARIABLES	Low reserves sample		High reserves sample	
	base countries raise interest rate	base countries lower interest rate	base countries raise interest rate	base countries lower interest rate
β	0.39**	-0.35*	0.16	-0.06
β std. error	(0.16)	(0.21)	(0.10)	(0.12)
β_2	-0.22	0.58***	0.13	0.03
β_2 std. error	(0.16)	(0.21)	(0.32)	(0.16)
β_3	0.89***	0.96***	0.27	0.34*
β_3 std. error	(0.25)	(0.21)	(0.25)	(0.19)
Observations	445	544	387	636
R-squared	0.06	0.08	0.02	0.01

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

6. Extensions

6.1. Modified Taylor Rules

- ✓ Omission of domestic factors in impacting domestic interest rates could lead to concerns about misspecification.
- ✓ We re-estimate an augmented equation (2) incorporating domestic variables, viz. inflation and output. (Klein & Shambaugh, 2015)
- ✓ Many EMDEs appear to have included the exchange rate explicitly in the monetary policy rule. (Cavoli and Rajan, 2006; Hutchison et al., 2010; Taylor, 2001)
- ✓ We re-estimate a modified Taylor rule as below:

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

  - ΔY_{it-1} is the lagged GDP growth.
  - $\Delta \pi_{it-1}$ is the lagged change in inflation.
  - Δe_{it-1} is the lagged change in bilateral nominal exchange rate (log) relative to the U.S. dollar.

2.5-lemma in Modified Taylor Rules – 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]

Interaction Terms with Regime Types in Modified Taylor Rules

VARIABLES	Full sample	base countries raise interest rate	base countries lower interest rate
β	0.08	0.24**	-0.07
β std. error	(0.07)	(0.11)	(0.13)
β_2	0.26***	-0.03	0.28**
β_2 std. error	(0.08)	(0.17)	(0.12)
β_3	0.46***	0.60***	0.61***
β_3 std. error	(0.10)	(0.22)	(0.16)
F-stat	6.86***	1.54	5.69***
Observations	1,848	737	1,111
R-squared	0.07	0.06	0.06

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

Interaction Terms with Regime Types in Modified Taylor Rules based on Reserves

VARIABLES	Low reserves sample		High reserves sample	
	base countries raise interest rate	base countries lower interest rate	base countries raise interest rate	base countries lower interest rate
β	0.43**	-0.31	0.11	0.13
β std. error	(0.18)	(0.25)	(0.09)	(0.13)
β_2	-0.24	0.57***	0.04	0.04
β_2 std. error	(0.20)	(0.21)	(0.29)	(0.17)
β_3	0.86***	0.95***	0.21	0.30
β_3 std. error	(0.28)	(0.25)	(0.23)	(0.21)
F-stat	2.39*	2.59*	0.15	3.00**
Observations	379	503	358	608
R-squared	0.13	0.11	0.01	0.04

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

6.2. Broad Pegs

Two by Two Classification of Exchange Rate and Capital Control Regimes with Broad Pegs

		BROAD PEG			
		Yes		No	
		Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
CAPITAL CONTROLS	Yes	0.30*** (0.07)	853 [0.03]	-0.01 (0.09)	529 [0.00]
	No	0.77*** (0.12)	448 [0.27]	0.44*** (0.12)	182 [0.08]

Interaction Terms with Regime Types based on Reserves
Binary Capital Controls + Broad Peg

VARIABLES	Full sample	Low reserves sample		High reserves sample	
		base countries raise interest rate	base countries lower interest rate	base countries raise interest rate	base countries lower interest rate
β	-0.01	0.32*	-0.41	0.08	-0.09
β std. error	(0.09)	(0.18)	(0.25)	(0.11)	(0.16)
β_2	0.32***	-0.01	0.56**	0.22	0.07
β_2 std. error	(0.09)	(0.21)	(0.26)	(0.23)	(0.22)
β_3	0.47***	0.87***	0.93***	0.18	0.34*
β_3 std. error	(0.09)	(0.23)	(0.18)	(0.27)	(0.20)
Observations	2,012	445	544	387	636
R-squared	0.06	0.07	0.09	0.02	0.02

Notes:
β = coefficient on ΔR_b.
β_2= coefficient on (broad peg) × ΔR_b.
β_3= coefficient on (no capital controls) × ΔR_b.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

6.3. High/Low Capital Controls

Interaction Terms with Regime Types based on Reserves
High / Low Capital Controls + Peg

VARIABLES	Full sample	Low reserves sample		High reserves sample	
		base countries raise interest rate	base countries lower interest rate	base countries raise interest rate	base countries lower interest rate
β	0.05	0.27	-0.44*	0.17	-0.06
β std. error	(0.08)	(0.20)	(0.24)	(0.15)	(0.14)
β_2	0.30***	-0.20	0.60***	0.15	0.04
β_2 std. error	(0.09)	(0.17)	(0.22)	(0.31)	(0.17)
β_3	0.30***	0.58**	0.80***	0.07	0.19
β_3 std. error	(0.10)	(0.26)	(0.23)	(0.18)	(0.18)
Observations	2,012	445	544	387	636
R-squared	0.04	0.05	0.08	0.02	0.01

Notes:
β = coefficient on ΔR_b.
β_2= coefficient on (peg) × ΔR_b.
β_3= coefficient on (low capital controls) × ΔR_b.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

7. Conclusion

- ✓ Generalized movement away from pegged exchange rate regimes in many emerging and developing economies though FXI still persists.
  - Fear of pegging as well as Fear of floating.

- ✓ Ongoing debate on whether exchange rates have any insulating effects in face of global shocks and spillovers.

- ✓ In this paper we re-examined the Trilemma versus Dilemma debate for sample of 88 countries over the period 1973-2014.

Main findings:

- ✓ Trilemma still holds and flexible exchange rates provide insulating effects from global monetary shocks.
- ✓ Similar to Han & Wei (2018) we have documented the existence of "2.5-lemma" pattern but in reverse.
- ✓ Flexible exchange rate allow maintenance of a degree of monetary policy autonomy when the base countries loosens monetary policy.
  - Likely via a combination of sterilized FXI and tightening of capital/controls / MaPs to manage possible credit growth.
- ✓ When base countries tighten their interest rates, peripheral countries may fear sharp capital reversals which leads them to pursue similarly tighter monetary policy domestically.

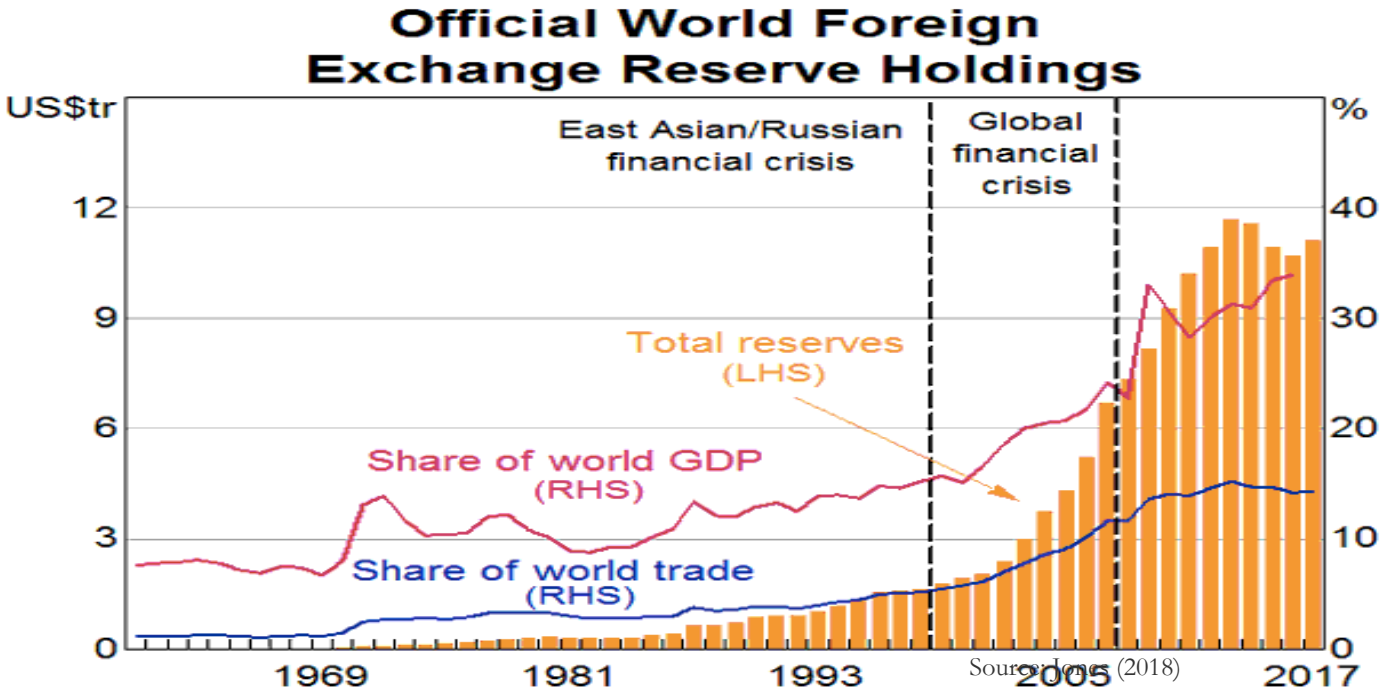
Main findings:

- ✓ Results robust to broad pegs, high/low capital controls, as well as inclusion of monetary policy rules.
- ✓ Larger reserve holdings help a country regain monetary policy autonomy.

Thank You!

Extra Slides

- ✓ No exchange rate targeting per se but FX intervention to manage currency movements persists.
  - Fear of complete floating? -- What role for stabilizing exchange rate in an optimal monetary policy framework in emerging economies? (Engel, 2011; Garcia et al., 2011)
  - Financial frictions? -- Concerns about effectiveness of interest rate transmission (first and second stages). (Gopalan and Rajan, 2017)



Using the sample from Han & Wei (2018)
Interaction Terms with Regime Types in Modified Taylor Rules

VARIABLES	Full sample	base countries raise interest rate	base countries lower interest rate
β	0.00	-0.00	-0.01
β std. error	(0.11)	(0.31)	(0.16)
β_2	0.76**	0.35	1.00**
β_2 std. error	(0.29)	(0.69)	(0.38)
β_3	0.41**	0.07	0.50**
β_3 std. error	(0.16)	(0.37)	(0.21)
Observations	401	138	263
R-squared	0.10	0.19	0.09

Notes:

β = coefficient on ΔR_b.

β_2= coefficient on (peg) × ΔR_b.

β_3= coefficient on (no capital controls) × ΔR_b.

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

The sample in Han & Wei (2018) includes 28 countries(Argentina, Australia, Belarus, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Ecuador, Germany, Hong Kong, India, Indonesia, Israel, Japan, Korea, Mexico, New Zealand, Pakistan, Peru, Philippines, Singapore, South Africa, Thailand, Turkey, United Kingdom). Sample period from 1990M1to 2014M6, semi-annual frequency.

We cover these countries in this exercise except Belarus, Costa Rica, Ecuador, Indonesia, Korea, New Zealand and Peru due to data availability. Time period from 1990 till 2014, annual frequency.

Caveat – small sample size in the case when base countries raise interest rate

Details on the Sample & Methodology of Han & Wei (2018)

- 28 countries in the sample. 1990M1--2014M6. Semi-annual frequency;
- They focus on US monetary policy shock, so they use ΔR_{US} (the US rate) as the only base rate;
- They use policy rate instead of treasury-bill rate or money market rate;
- They use the IMF de facto exchange rate regime classification by Ilzetzki et al. (2011).

$$\Delta r_{i,t}^{p} = \mathrm{c} + \phi_1 * \Delta GDP\ growth_{i,t} + \phi_2 * \Delta Inflation_{i,t} + \Delta Real\ exchange\ rate_{i,t} + \beta_1 \boldsymbol{D_{fixed.NC}} \Delta r_t^{US} + \beta_2 \boldsymbol{D_{fixed.C}} \Delta r_t^{US} + \beta_{3,pos} \boldsymbol{D_{flex.NC,USpos}} \Delta r_t^{US} + \beta_{3,neg} \boldsymbol{D_{flex.NC,USneg}} \Delta r_t^{US} + \beta_{4,pos} \boldsymbol{D_{flex.C,USpos}} \Delta r_t^{US} + \beta_{4,neg} \boldsymbol{D_{flex.C,USneg}} \Delta r_t^{US} + \delta \Delta VIX_t + e_{i,t}$$

- ✓ *"(T)he structure of the Singapore economy reduces the scope for using interest rates as a monetary policy tool. First, the corporate sector is dominated by multinational corporations (MNCs), which rely on funding from their head offices (typically in developed economies) rather than on local banking systems or debt markets. Second, Singapore's role as an international financial centre has led to a large offshore banking centre that deals primarily in the G3 currencies, and it is one where assets denominated in those currencies far exceed those of the domestic banking system. As there is no control on capital flows between the offshore (foreign currency) and domestic (Singapore dollars) banking system, small changes in interest rate differentials can lead to large and rapid movements of capital. As a result, it is difficult to target interest rates in Singapore as any attempt by MAS to raise or lower domestic interest rates would be foiled by a shift of funds into or out of the domestic financial system."*

"An Exchange-Rate-Centred Monetary Policy System: Singapore's Experience"

https://www.bis.org/publ/bppdf/bispap73w.pdf

Shambaugh's Exchange Rate Classification

- ✓ Country coded as "peg" if it meets one of the two conditions:
  - Bilateral exchange rate with its base country within a +/- 2% band over course of the year.
  - Country's exchange rate is constant for the year with one discrete devaluation or revaluation in a month of that year.

- ✓ We also consider "broad peg" :
  - Bilateral exchange rate with the base country fluctuates by less than +/-5 percent in given year.

Measurement of Capital Controls

- Chinn-Ito index takes principal component of controls relating to current and capital account transactions, existence of multiple exchange rates, and requirements of surrendering export proceeds.

- **ka_open** is the Chinn-Ito index of capital account openness normalized to range between 0 and 1.
  We use **1 - ka_open** as an index for capital account controls**.**

- We first consider a binary case of no capital controls (when index = 0) or with at least some capital controls (when index ≠ 0).

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**	4.16	4.56	2.07	2.15	5.30	5.96	1.84	1.15	5.42	6.29
$(R_{it} - R_{bit})$ **std dev**	5.62	5.49	4.01	3.59	6.04	5.92	3.48	2.49	6.44	6.00
$(R_{it} - R_{bit})$ **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**	29.46	29.46	27.44	27.44	29.46	29.46	14.01	13.18	29.46	29.46

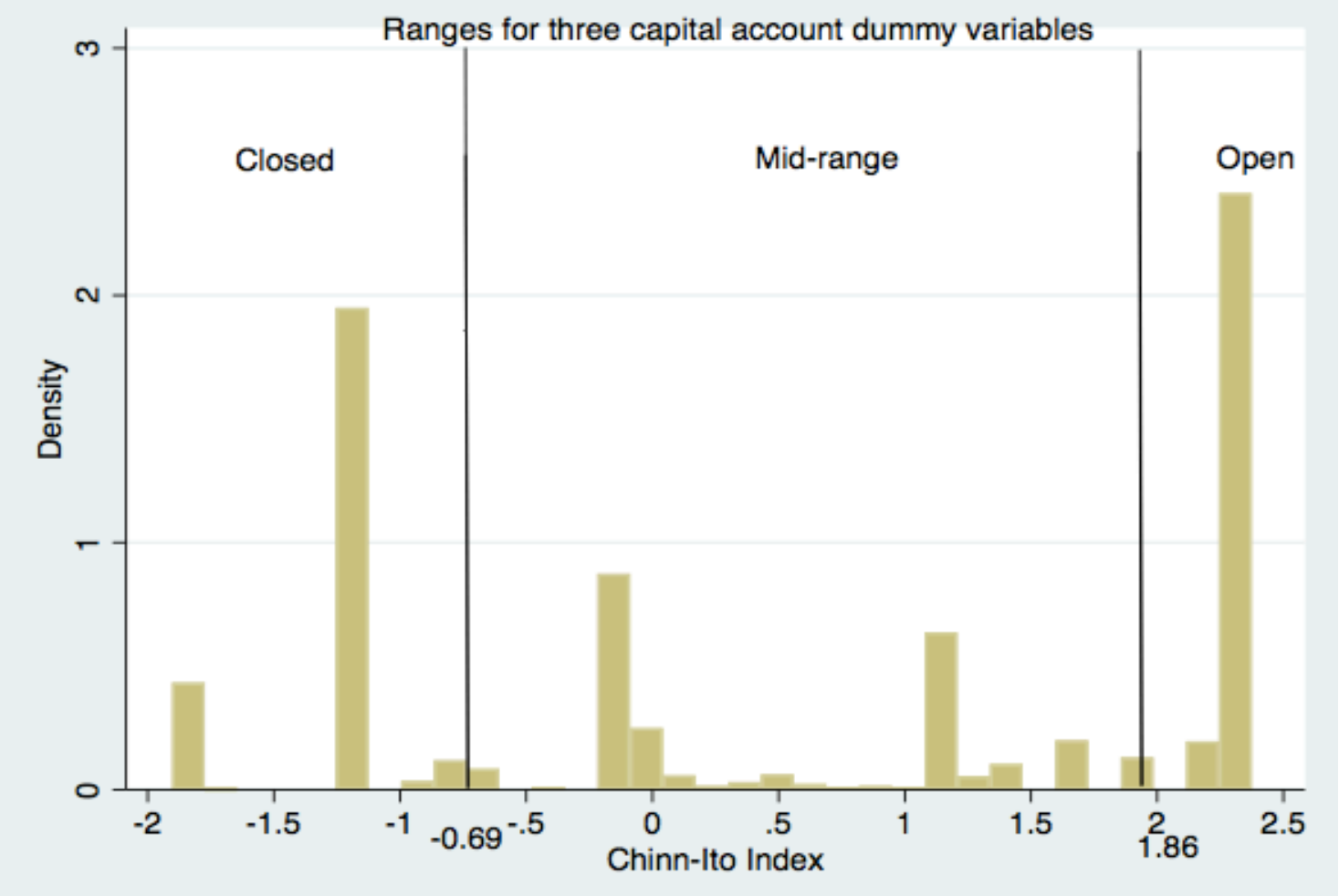
Unit: percent

Unit Root Tests

- ✓ We applied Fisher type unit root test for panel data (Maddala & Wu, 1999).
  - H_0: all series are non-stationary; H_A: at least one series is stationary.
  - Advantage: does not require the panel to be balanced.

- ✓ In levels: We cannot reject the unit root for most of post-BW episodes
- ✓ In first-differences: We can reject the unit root in all of 8 base country episodes and in more than 94% of local country episodes.

- ✓ Since first differences of interest rates are largely stationary we focus on estimating the first difference equation.


Ranges for three capital account dummy variables
Closed
Mid-range
Open
Density
0
1
2
3
-2
-1.5
-1
-0.69
-.5
0
.5
1
1.5
2
1.86
2.5
Chinn-Ito Index

Comparison Across Studies

	Time Period & Sample Size	Methods	Interest Rates	Exchange Rate	Capital Controls	Sub-sample Results					
								Peg			
								Yes		No	
								Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
Klein & Shambaugh (2015)	1973-2011 134 countries in the sample	First-difference/ pooled OLS	Policy rate	Shambaugh regime	Chinn-Ito	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]
								Peg			
								Yes		No	
								Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
This paper	1973-2014 88 countries in the sample	First-difference/ pooled OLS	Short-term treasury bill rate	Shambaugh regime	Chinn-Ito	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]

Source: Compiled by authors

Interaction Terms with Regime Types (Time Fixed Effects)

VARIABLES	Full sample	base countries raise interest rate	base countries lower interest rate
β	-0.08	0.13	-0.27**
β std. error	(0.08)	(0.20)	(0.13)
β_2	0.18**	-0.15	0.23*
β_2 std. error	(0.08)	(0.17)	(0.13)
β_3	0.47***	0.51***	0.61***
β_3 std. error	(0.10)	(0.19)	(0.15)
Observations	2,012	832	1,180
R-squared	0.15	0.17	0.13

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

Post-1990s Sub-Sample

VARIABLES	Full post-1990s sample	base countries raise interest rate	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

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

"Fear of Reserve Loss" for Non-peg Regimes with Capital Controls?

		Non-Peg					
		Baseline		Raise IR		Lower IR	
		Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
Capital Controls	Full Sample	0.09 (0.07)	956 [0.00]	0.30** (0.12)	362 [0.01]	-0.19 (0.12)	594 [0.00]
	High Reserves	0.07 (0.07)	476 [0.00]	0.16 (0.10)	156 [0.01]	-0.02 (0.12)	320 [0.00]
	Low Reserves	0.08 (0.11)	480 [0.00]	0.38** (0.18)	206 [0.01]	-0.34 (0.22)	274 [0.01]

"Fear of Reserve Loss" for Non-peg Regimes Regardless of Capital Controls?

Non-Peg						
	Baseline		Raise IR		Lower IR	
	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
Full sample	0.18*** (0.07)	1309 [0.01]	0.39*** (0.12)	505 [0.02]	-0.05 (0.10)	804 [0.00]
High Reserves	0.11* (0.06)	658 [0.00]	0.20* (0.10)	226 [0.01]	0.04 (0.10)	432 [0.00]
Low Reserves	0.23** (0.11)	651 [0.02]	0.54*** (0.16)	279 [0.03]	-0.12 (0.20)	372 [0.00]

Taylor Rule with Exchange Rate Changes

Trilemma in Modified Taylor Rules with Exchange Rate Changes

VARIABLES	Peg and No Capital Controls	Peg with Capital Controls	Nonpeg and No Capital Controls	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

Notes:
β = coefficient on ΔR_b.
Cluster-robust standard errors are reported.
*** Significantly different from 0 at the 99% level. ** At 95% level. * At 90% level.

Asymmetric Responses with Broad Pegs – Sub-sample Results

		BROAD 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	0.30*** (0.07)	853 [0.03]	0.42*** (0.11)	377 [0.03]	0.04 (0.12)	476 [0.00]	-0.01 (0.09)	529 [0.00]	0.14 (0.13)	183 [0.00]	-0.28* (0.16)	346 [0.01]
	No	0.77*** (0.12)	448 [0.27]	0.84*** (0.25)	208 [0.16]	0.67*** (0.17)	240 [0.13]	0.44*** (0.12)	182 [0.08]	1.06*** (0.22)	64 [0.12]	0.35** (0.15)	118 [0.03]

Is There a "Fear of Reserve Loss" for Non-peg Regimes Regardless of Capital Controls in Modified Taylor Rules?

Non-Peg						
	Baseline		Raise IR		Lower IR	
	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]
Full sample	0.19*** (0.07)	1199 [0.04]	0.32*** (0.11)	440 [0.04]	0.09 (0.12)	759 [0.04]
High Reserves	0.12** (0.06)	625 [0.02]	0.13 (0.08)	209 [0.01]	0.22* (0.12)	416 [0.03]
Low Reserves	0.25** (0.12)	574 [0.06]	0.63*** (0.17)	231 [0.10]	-0.07 (0.23)	343 [0.06]