Asymmetries in central bank intervention

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Outline

Understanding more-flexible but not floating rates

- Highly inflexible exchange rates: easy to understand, near-zero flexibility.
  Example: China
- Less inflexible exchange rates, or dirty floats
  Example: India

Fine structure of pegged exchange rates

Frankel and Wei, ZSP, methodology:
classify exchange rates based on R^2 of currency basket estimation:

- Fixed pegs with $R^2 \approx 1$ – nothing complicated there
- Intermediate regimes with $R^2 \approx 0.6 - -0.8$
- Floating rates with $R^2 \approx 0.3 - -0.4$

What is going on in this middle zone?

Asymmetries in trading of central bank?

Three possible behaviours:

- Symmetric intervention
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Can we test for asymmetry in the behaviour of the central bank when trading on the currency market?

What might we expect?

- With wide span, when a country has had many changes in the exchange rate regime, results will be relatively unclear
- Apply ZSP methodology to identify structural breaks and sub-periods
  Focusing on sub-periods will clarify the picture
- In periods where $R^2 > 0.95$ there is no asymmetry.

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- Asian countries respond more to appreciations
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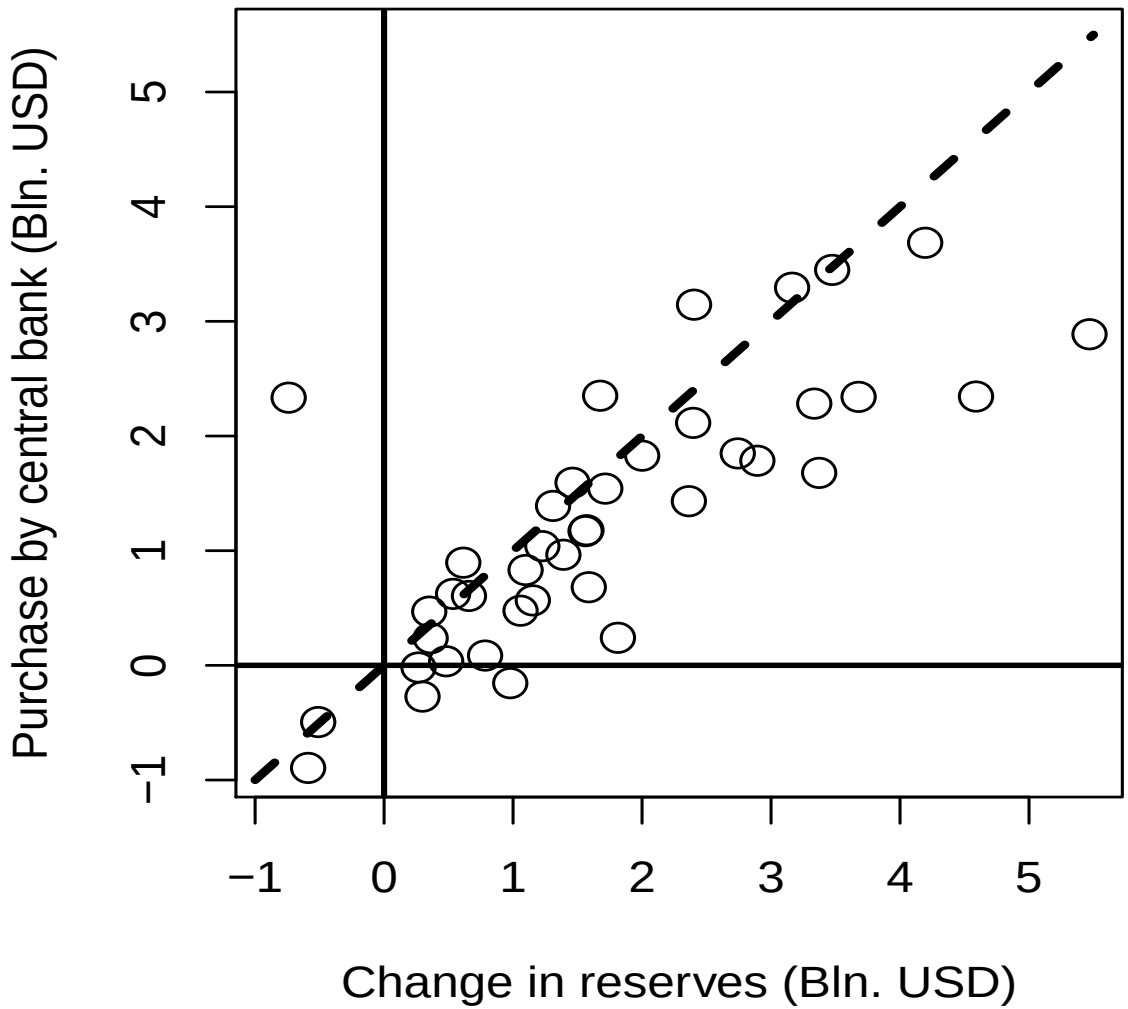
Some drawbacks:

- Changes in reserves as proxy for intervention
- Simultaneity/endogeneity in estimation
- Few country release daily intervention data

Changes in reserves as proxy for intervention



Models for asymmetries

- Univariate analysis on the exchange rate only
- Use regime switching models for asymmetries in appreciation/depreciation:

Definition (Regime switching Models)

Capture regime-specific dynamics by estimating different regimes.

Threshold autoregressive processes (TAR)

Threshold auto-regressive (TAR) process of the nominal exchange rate time-series y_t:

$$y_t = \begin{cases} \mu_L + \zeta_{L1} y_{t-1} + \zeta_{L2} y_{t-2} + \ldots + \zeta_{Lp} y_{t-p} + \varepsilon_t & \text{if } y_{t-1} \leq \theta \\ \mu_H + \zeta_{H1} y_{t-1} + \zeta_{H2} y_{t-2} + \ldots + \zeta_{Hp} y_{t-p} + \varepsilon_t & \text{if } y_{t-1} > \theta \end{cases}$$

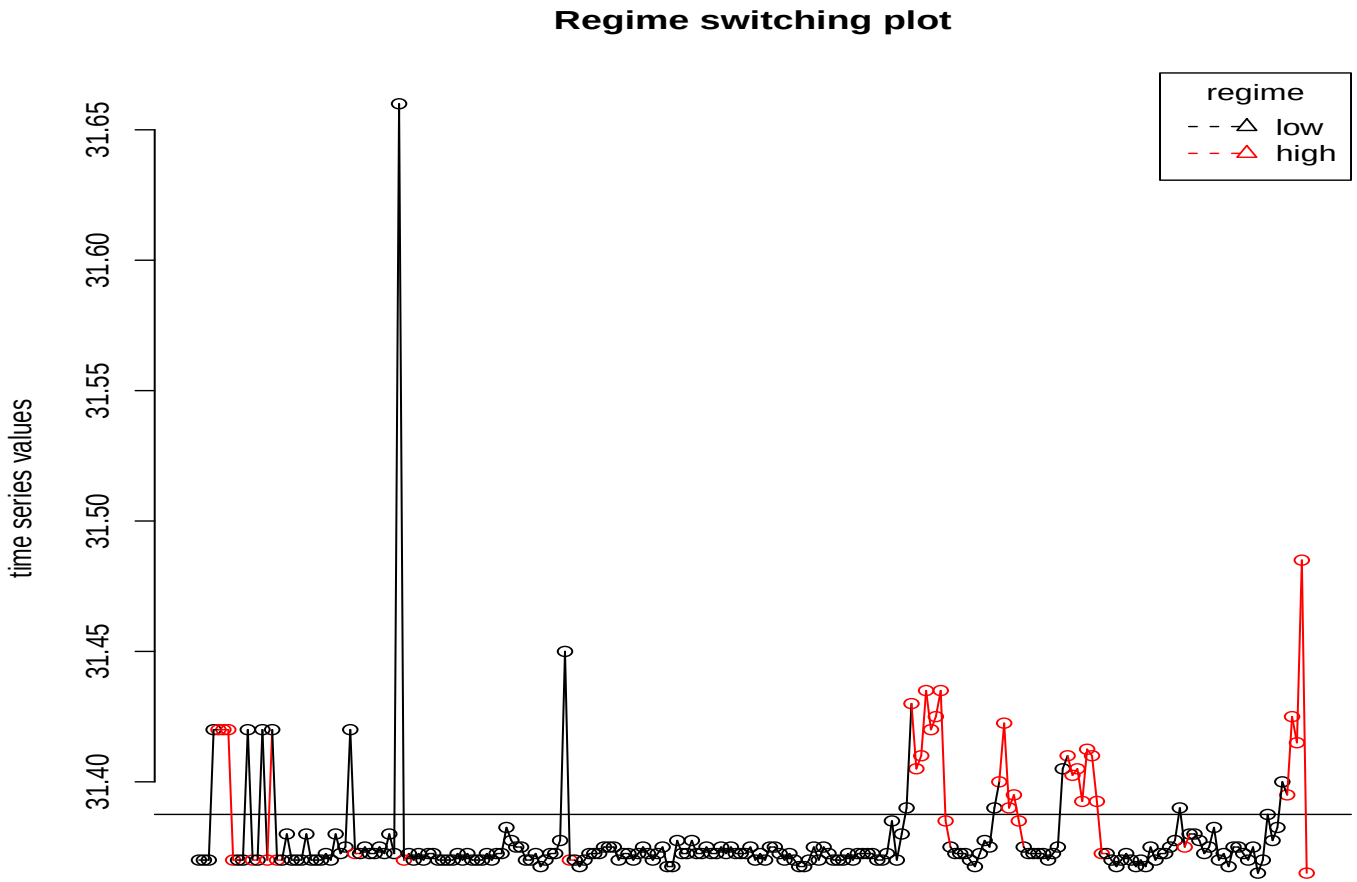
Under this model:

- Regime A: when values are below θ (low values regime)
- Regime B: when values are above θ (high values regime)

TAR models in exchange rate litterature

TAR models are popular (Obstfeld, Taylor 1996, Taylor et al. 2001) to account for:

- Link real exchange rate to LOP/PPP
- Transactions costs
- Transportations costs



Advantages/disadvantages:

- + Indicates different behaviour with low/high exchange rate
- – Clear interpretation only for fix peg

Momentum threshold-autoregressive

Same as TAR but: transition variable is in difference (M-TAR):

$$y_t = \begin{cases} \mu_L + \zeta_{L1} y_{t-1} + \zeta_{L2} y_{t-2} + \ldots + \zeta_{Lp} y_{t-p} + \varepsilon_t & \text{if} \quad \Delta y_{t-1} \leq \theta \\ \mu_H + \zeta_{H1} y_{t-1} + \zeta_{H2} y_{t-2} + \ldots + \zeta_{Hp} y_{t-p} + \varepsilon_t & \text{if} \quad \Delta y_{t-1} > \theta \end{cases}$$

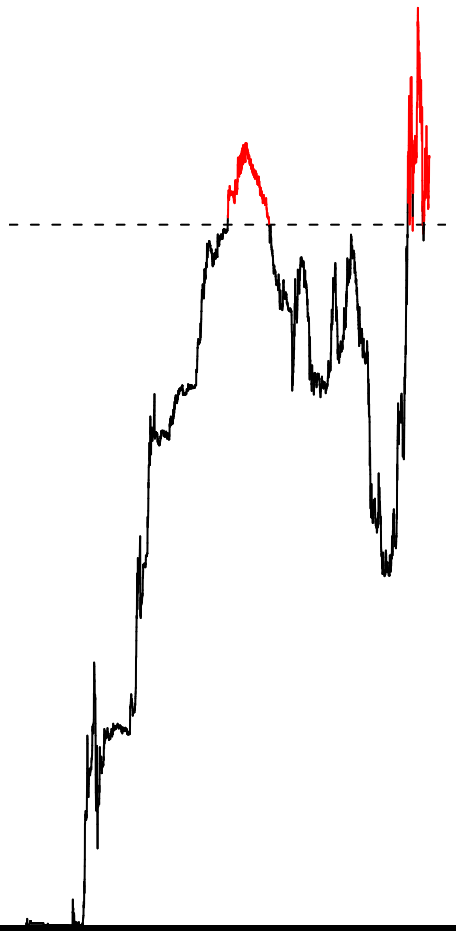
Example (Interpretation)

Say $\theta = 0$:

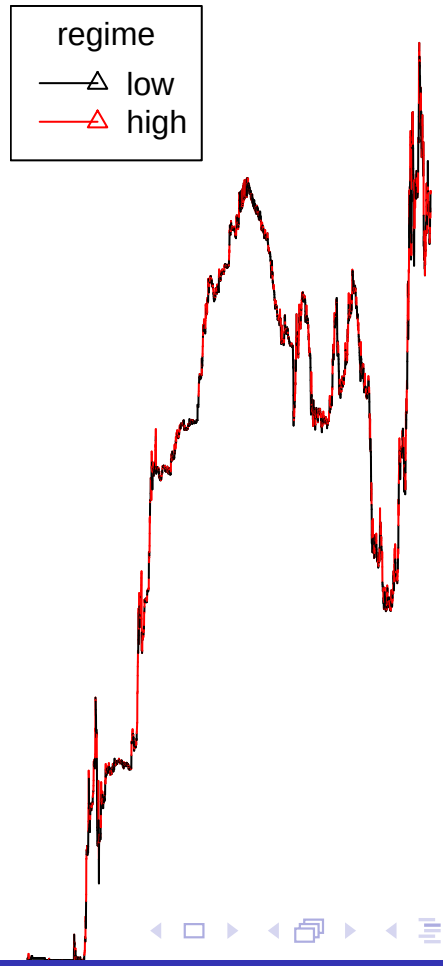
- Regime A: $\Delta y_{t-1} < 0$ for days of appreciation
- Regime B: $\Delta y_{t-1} > 0$ for days of depreciation

TAR: Illustration

Transition variable is level



Transition variable is diff



Reparametrization

We reparametrize the AR as in ADF test, from:

$$y_t = \mu_L + \zeta_{L1} y_{t-1} + \zeta_{L2} y_{t-2} + \ldots + \zeta_{Lp} y_t + \varepsilon_t$$

is equivalent to:

$$\Delta y_t = \mu_L + \rho_L y_{t-1} + \sum_i^{p-1} \phi_{Li} \Delta y_{t-1} + \varepsilon_t$$

We interpret ρ $(= \zeta_1 + \zeta_1 + \ldots + \zeta_p)$ as mean reversion parameter:

$$\begin{aligned} \rho = 0 \quad & \text{Random walk (no mean reversion)} \\ -2 < \rho < 0 \quad & \text{Stationary process (mean reversion } \nearrow \text{ when } \rho \to -1) \end{aligned}$$

Testing procedure

Testing: $\rho_{Ap} \lessgtr \rho_{Dep}$

$\rho_{Ap} < \rho_{Dep}$ Appreciations are more mean-reverting
$\rho_{Ap} > \rho_{Dep}$ Depreciations are more mean-reverting.

Interesting case:

Definition (partial unit root)

$\rho_A < 0$ and $\rho_B = 0$

- Regime A is stationary: there is mean reversion
- Regime B has unit root: no mean reversion,

We interpret partial roots as case of asymmetric intervention.

Type of regime

Recall:

$$y_t = \begin{cases} \mu_L + \zeta_{L1} y_{t-1} + \zeta_{L2} y_{t-2} + \ldots + \zeta_{Lp} y_{t-p} + \varepsilon_t & \text{if} \quad \Delta y_{t-1} \leq \theta \\ \mu_H + \zeta_{H1} y_{t-1} + \zeta_{H2} y_{t-2} + \ldots + \zeta_{Hp} y_{t-p} + \varepsilon_t & \text{if} \quad \Delta y_{t-1} > \theta \end{cases}$$

We do not impose a threshold value of 0 but estimate it.

This can then split:

- Appreciation vs depreciation
- Normal vs extreme regime (say $\theta = -0.5$: large appreciations vs normal appreciations and all depreciations)

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- If asymmetry, compare long-run dynamics: mean reverting or not?
- Interpret:
  - Appreciation prevention?
  - Large appreciations prevention?
  - ...

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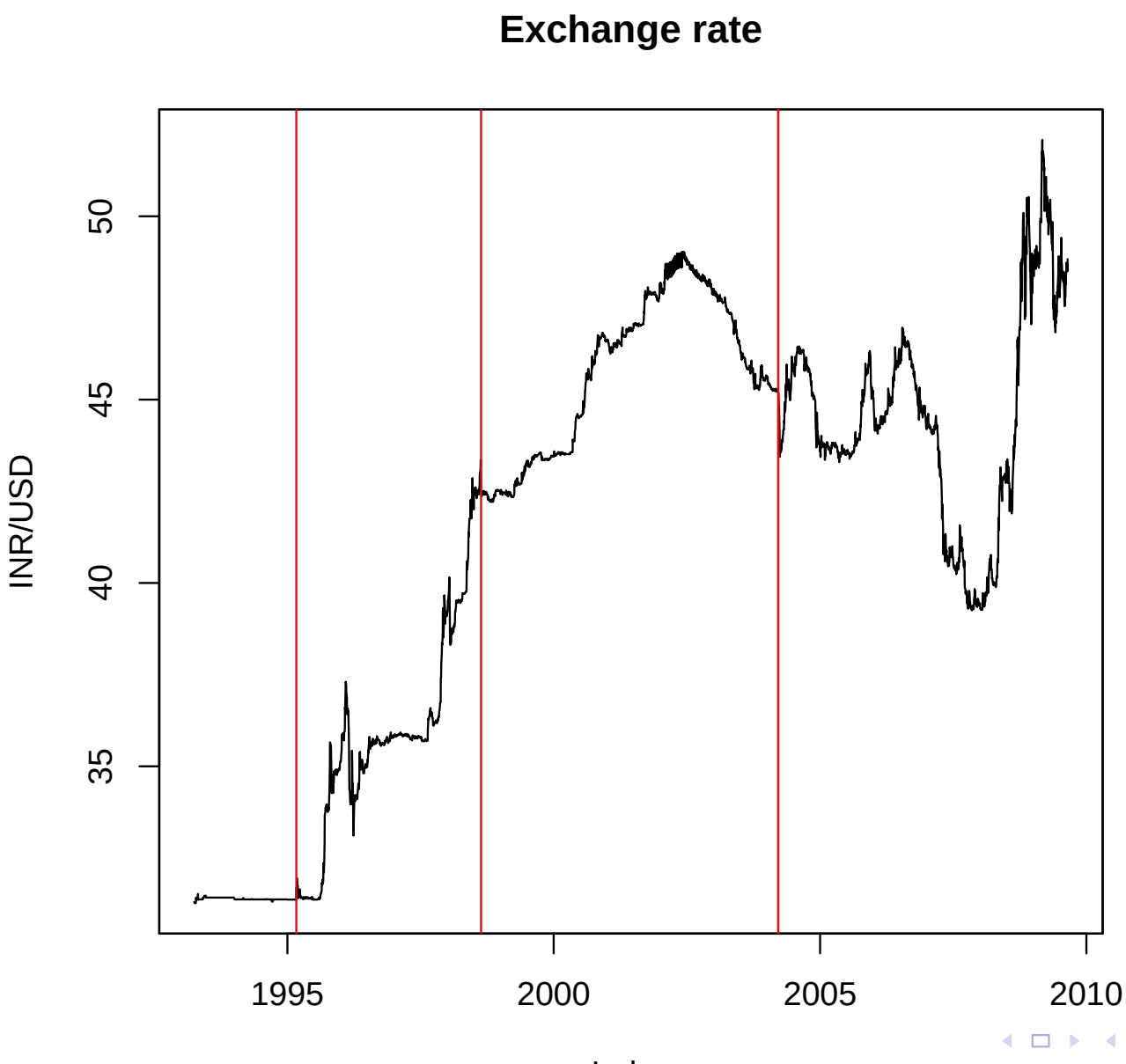

Exchange rate
INR/USD
35
40
45
50
1995
2000
2005
2010

Analysis of sub-periods

Shah and Patnaik (2008): structural breaks in exchange rate management.

Start	End	Peg to	R^2
1993-04-09	1995-03-03	USD	0.98
1995-03-10	1998-08-21	USD	0.72
1998-08-28	2004-03-19	USD	0.97
2004-03-26	2009-08-21	USD, JPY, GBP, EUR	0.69

Outline

Results

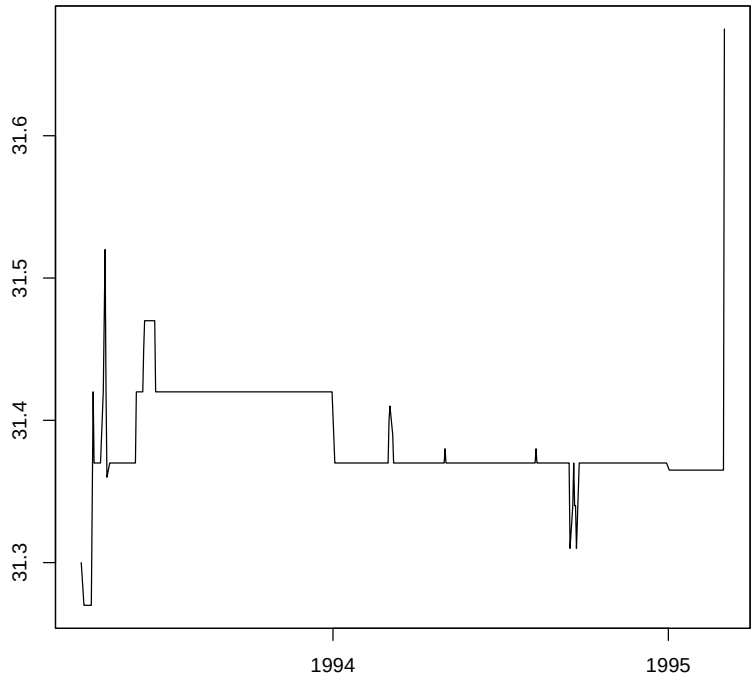
Full sample

- Threshold effects
- Some evidence of appreciation prevention. But very sensitive

Sub-period 1

1993-04-09 to 1998-08-21:

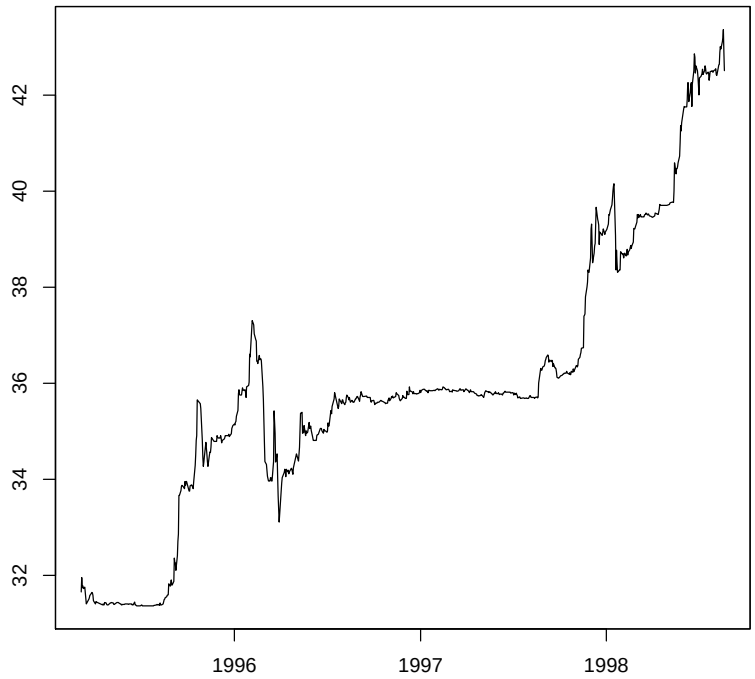
- $R^2 = 0.98$, USD
- Only 17 different values with 400 observations
- Unreliable threshold estimate



Sub-period 2

1993-04-09 to 1998-08-21:

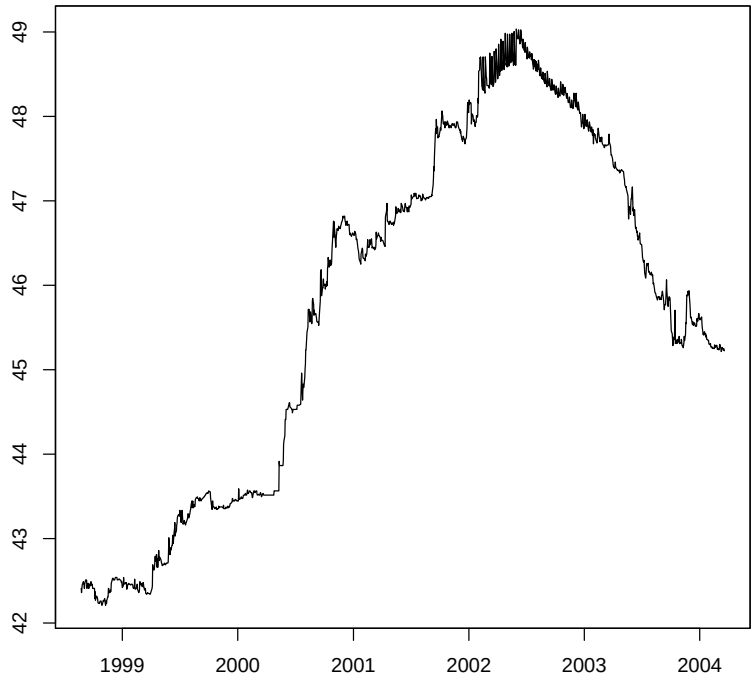
- $R^2 = 0.72$, USD
- Threshold effect: yes, 0.24 (5% $>$ 0.24)
- Partial unit root:
  - Large depreciations: mean reverting
  - Small depreciations and all appreciations: no mean reversion
- $\Rightarrow$ Prevention of large depreciations



Sub-period 3

From 1998-08-28 to 2004-03-19:

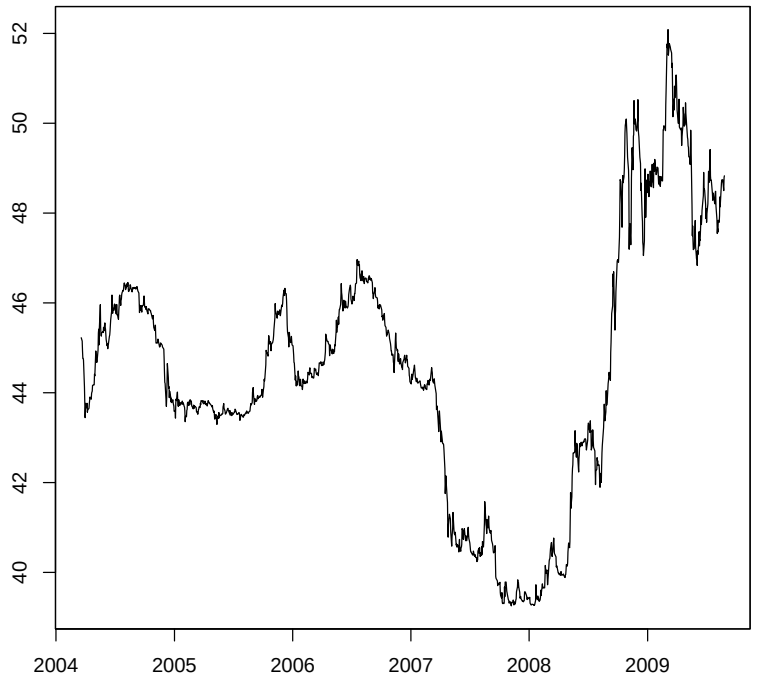
- $R^2 = 0.97$, USD
- Threshold effect: yes, 0.1 (6% $>$ 0.1)
- Unit root: both regimes fluctuated randomly



Sub-period 4

From 2004-03-26 to 2009-05-29:

- $R^2 = 0.75$, USD +EU+GBP
- Threshold effect: yes
  -0.25 ($8\% < -0.25$)
- Partial unit root:
  - Large appreciations: mean reverting
  - Small appreciations and rall depreciations: no mean reversion
- $\Rightarrow$ Prevention of large appreciations



Summary of the results

- Asymmetries (threshold effects) found in all sub-periods
- Different long-run coefficients in sub-periods with intermediate R^2 only

Start	End	Threshold	Unit roots	R^2
1993-04-09	1995-03-03	no	Both stationary	0.98
1995-03-10	1998-08-21	0.24	Depreciation prevention	0.72
1998-08-28	2004-03-19	0.1	No mean reversion	0.97
2004-03-26	2009-08-21	-0.25	Appreciation prevention	0.69

Conclusion

- In intermediate exchange rate regimes, different behaviours are possible:
  - No asymmetry
  - Appreciation prevention
  - Depreciation prevention
- Propose methodology to investigate behaviour of central bank
- Applied to India, find evidence of appreciation and depreciation prevention on different sub-periods
- Methodology works for intermediate regimes, not informative for fixed regimes

Future steps

- M-TAR with three regimes: large appreciations, large depreciations, inaction band.
- Use benchmark model where appreciation prevention is known a priori
- Application to more countries,