Asymmetries in central bank intervention

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Asymmetries in central bank intervention
Outline

1. The question
2. Methodology
3. Data
4. Results
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
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 $R^2 \approx 0.6 \text{ to } -0.8$
- Floating rates with $R^2 \approx 0.3 \text{ to } -0.4$

*What is going on in this middle zone?*
Asymmetries in trading of central bank?

Three possible behaviours:
- Symmetric intervention
- Depreciation prevention
- Appreciation prevention
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  - Fears of a collapse of confidence
  - Firms have large borrowings in dollar
  - Exchange rate pass-through to inflation is high
- Appreciation prevention
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*Can we test for asymmetry in the behaviour of the central bank when trading on the currency market?*
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.
Methodology to test for asymmetric intervention

Methods track asymmetric behaviour:

- From exchange rate to central bank intervention.
- From central bank intervention to volatility of exchange rate.

Results:
- Asian countries respond more to appreciations.
- Yen: interventions more effective when massive depreciation.
- India: Appreciations lead to reserve change but not depreciations.

Some drawbacks:
- Changes in reserves as proxy for intervention.
- Simultaneity/endogeneity in estimation.
- Few countries release daily intervention data.
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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 $y_t$:

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

Under this model:
- Regime A: when values are below $\theta$ (low values regime)
- Regime B: when values are above $\theta$ (high values regime)
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):

\[
y_t = \begin{cases} 
\mu_L + \zeta_{L1}y_{t-1} + \zeta_{L2}y_{t-2} + \cdots + \zeta_{Lp}y_{t-p} + \varepsilon_t & \text{if } \Delta y_{t-1} \leq \theta \\
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\end{cases}
\]

**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

regime
--- Δ low
--- Δ high

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We reparametrize the AR as in ADF test, from:

\[ y_t = \mu L + \zeta_{L1}y_{t-1} + \zeta_{L2}y_{t-2} + \ldots + \zeta_{Lp}y_t + \epsilon_t \]

is equivalent to:

\[ \Delta y_t = \mu L + \rho L y_{t-1} + \sum_{i}^{p-1} \phi_i \Delta y_{t-1} + \epsilon_t \]

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

\[ \rho = 0 \quad \text{Random walk (no mean reversion)} \]
\[ -2 < \rho < 0 \quad \text{Stationary process (mean reversion \( \uparrow \) when \( \rho \rightarrow -1 \))} \]
Testing procedure

Testing: \( \rho_{Ap} \leq \rho_{Dep} \)

\[ \begin{align*}
\rho_{Ap} &< \rho_{Dep} \quad \text{Appreciations are more mean-reverting} \\
\rho_{Ap} &> \rho_{Dep} \quad \text{Depreciations are more mean-reverting.}
\end{align*} \]

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:

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

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)
Summary of methodology

- Run analysis on sub-periods defined on ZSP methodology
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  - Appreciation vs depreciations? ($\theta = 0$)
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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

1995 2000 2005 2010

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<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Peg to</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993-04-09</td>
<td>1995-03-03</td>
<td>USD</td>
<td>0.98</td>
</tr>
<tr>
<td>1995-03-10</td>
<td>1998-08-21</td>
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<td>2004-03-19</td>
<td>USD</td>
<td>0.97</td>
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<td>2004-03-26</td>
<td>2009-08-21</td>
<td>USD, JPY, GBP, EUR</td>
<td>0.69</td>
</tr>
</tbody>
</table>
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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

<table>
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<th>Start</th>
<th>End</th>
<th>Threshold</th>
<th>Unit roots</th>
<th>$R^2$</th>
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<td>1995-03-03</td>
<td>no</td>
<td>Both stationary</td>
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<td>1995-03-10</td>
<td>1998-08-21</td>
<td>0.24</td>
<td>Depreciation prevention</td>
<td>0.72</td>
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<tr>
<td>1998-08-28</td>
<td>2004-03-19</td>
<td>0.1</td>
<td>No mean reversion</td>
<td>0.97</td>
</tr>
<tr>
<td>2004-03-26</td>
<td>2009-08-21</td>
<td>−0.25</td>
<td>Appreciation prevention</td>
<td>0.69</td>
</tr>
</tbody>
</table>
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,