

Inflation Targeting and Real Exchange Rates in Emerging Markets

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Introduction

- IT: Most OECD CBs and many EM CBs
- No “Rules of the Game”
- Why? Perceived Benefits
- Controversy over benefits, and if IT represents substantive policy shift

Motivation

1. Most work on ICs, but EMs different
 - Institutions, credibility, exposure to external shocks, financial development
2. Mixed IT strategy? Real exchange rate targeting
3. Distinction b/t commodity and non-commodity export concentration
4. Advantages of panel approach: focus on common elements associated with IT regimes

Relevance to India?

- Further external and internal liberalization >> stable monetary policy regime?
- Evaluate existing regime in light of proven alternatives

Literature Review: IT Macro Effects

1. Mixed results for ICs in terms of average inflation, inflation volatility, expected inflation, output volatility
 - Johnson, 2002
 - Mishkin and Schmidt-Hebbel, 2007
 - Ball and Sheridan, 2005
2. More supportive results for IT in EMs
 - IMF, 2005 (13 IT, 29 non-IT EMs)
 - Conçalves and Salles, 2008 (36 EMs)

Literature Review: Policy Functions

1. ICs

- Find differences in IT and non-IT policy rules
 - Mohanty and Klau (2005), Edwards (2006), Corbo et al. (2001)
- Do not find differences: Drueker and Fisher (1996, 2006)

2. EMs

- Schmidt-Hebbel and Werner (2002):
 - Brazil, Chile, Mexico: Taylor Rules, time series
 - Short samples (Monthly, Quarterly)
 - Real interest rate equations
 - Inflation gap significant only for Brazil
 - Respond to exchange rates: “dirty floaters”

EM Policy Functions (cont.)

- Cordo et al. (2001)
 - Taylor rules, 8 EMs, 1990-99, Quarterly data, time series
 - Classification: IT, potential IT, non-IT
 - IT and potential IT: 4 of 6 respond to inflation
 - Do not test external variables

- Mohanty and Klau (2004)
 - Modified Taylor rules for 13 EMs and transition economies
 - Times series, and focus on real exchange rates
 - RER significant in 10/13 cases, frequently stronger than response to inflation; conclude “fear of floating”

- Edwards (2006)
 - Cross section regressions on 13 EMs
 - Taylor rule regressions with real exchange rates
 - Finds countries with historically high inflation rates and high real exchange rate volatility tend to respond to RER movements stronger

■ Our work

- Focuses on policy functions (Taylor rules)
- Compares EM regimes: IT and non-IT
- Focus:
 - Is it real in EMs?
 - Mixed IT Strategy: Real exchange rates
 - Differences b/t commodity and non-commodity IT countries
 - Panel data– common elements

Why might real exchange rates enter in EM policy functions?

- RER may influence future inflation, and hence be an indicator for a forward-looking central bank
- Potential output, \tilde{y} depends negatively on exchange rate volatility:

$$\tilde{y} = \tilde{y}(V(e)); \quad \tilde{y}' < 0$$

- Why? E.g. Aghion, Bachcetta, Ranciere, Rogoff (2006): RER volatility reduces potential output (growth) due to financial channels;
 - Increasing expected costs of funds when agency and contract enforcement costs are prevalent
 - Financial system is shallow
 - Trade openness is significant

Simplification and Extension of Ball's Model

(A1) $L = V(\mathbf{p}) + \mathbf{m}V(y)$ Loss Function

(A2) $\hat{L} = V(\mathbf{p}) + \mathbf{m}V(y) + \mathbf{f}V(e)$ Modified Loss Function

a. $y = -\mathbf{b}r - \mathbf{d}e + \mathbf{e}$ IS Curve

(A3) *b.* $\mathbf{p} = \mathbf{a}y - \mathbf{g}e + \mathbf{h}$ Phillips curve

c. $e = \mathbf{q}r + \mathbf{u}$ Interest rate-Exchange Rate

(A4) $r = \mathbf{a}\mathbf{p} + \mathbf{b}y + \mathbf{c}e$ Modified IT Rule

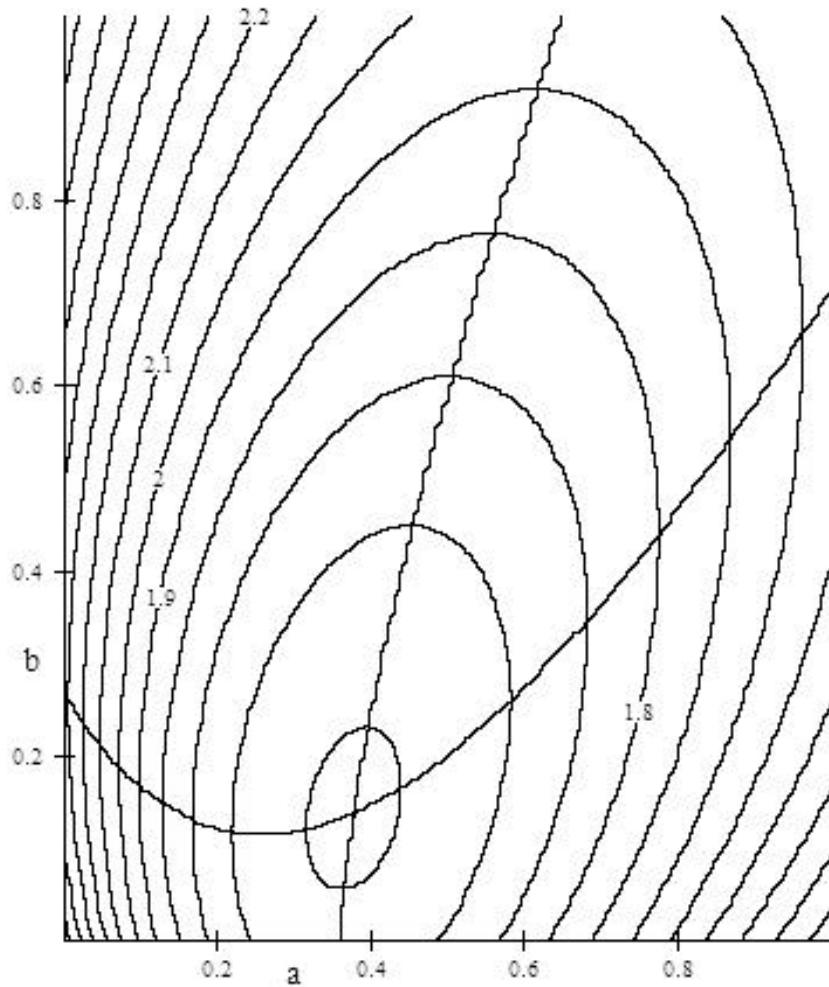
$$a. \quad V(e) = \frac{(b + aa)^2 \mathbf{q}^2 V(\mathbf{e}) + [1 + \mathbf{b}(b + aa)]^2 V(\mathbf{u}) + (a\mathbf{q})^2 V(\mathbf{m})}{[1 + B(b + aa) + \mathbf{q}(aa - c)]^2}$$

$$b. \quad V(y) = \frac{(1 + \mathbf{q}(aa - c))^2 V(\mathbf{e}) + [\mathbf{b}(aa - c) - \mathbf{d}]^2 V(\mathbf{u}) + (aB)^2 V(\mathbf{m})}{[1 + B(b + aa) + \mathbf{q}(aa - c)]^2}$$

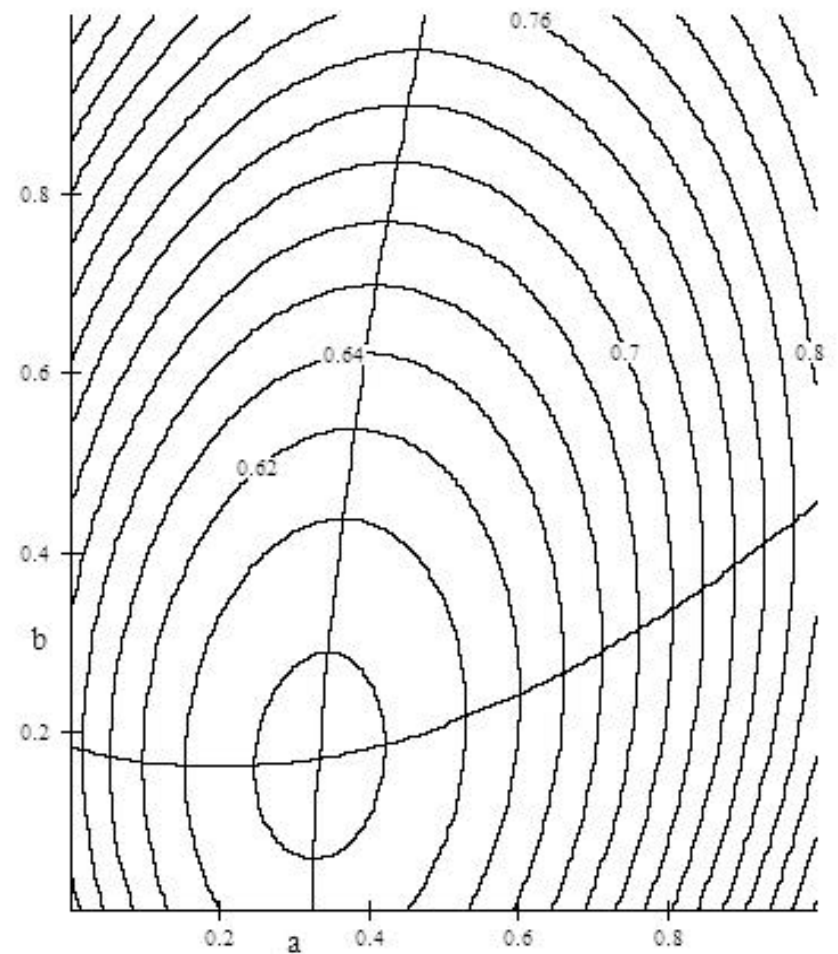
$$c. \quad V(\mathbf{p}) = \frac{(\mathbf{a}(1 - c\mathbf{q}) - b\mathbf{g}\mathbf{q})^2 V(\mathbf{e}) + [\mathbf{b}(\mathbf{a}c + b\mathbf{g}) + \mathbf{d}\mathbf{a} + \mathbf{g}]^2 V(\mathbf{u}) + (1 - c\mathbf{q} + bB)^2 V(\mathbf{m})}{[1 + B(b + aa) + \mathbf{q}(aa - c)]^2}$$

where

$$B = \mathbf{b} + \mathbf{d}\mathbf{q}$$



$c=0$



$c=1$

Two Parameters for RER Response: Pure IT ($c=0$) and Mixed Strategy ($c=1$). Note: Feeding (A5) into (A2), Min Loss Function for alternative values of $\langle a, b, c \rangle$

Data

- 16 EMs from Morgan Stanley MSCI EM list
- Exact date of IT from Mishkin and Schmidt-Hebbel (2006)
- Period: 1989Q1 – 2006Q4
- Delete very high inflation periods (above 40%)
- GDP Gap: HP filter; real effective ex. rate; money market interest rate; CPI for inflation;

Appendix A: Emerging Markets Sample

| IT countries | Start of Inflation Targeting Regime | Non-IT countries |
|---------------------|--|-------------------------|
| Brazil | 1999Q1 | Argentina |
| Colombia | 1999Q1 | Indonesia |
| Czech Republic | 1998Q1 | Jordan |
| Hungary | 2001Q1 | Malaysia |
| Israel | 1992Q1 | Morocco |
| Korea | 1998Q1 | |
| Mexico | 1999Q1 | |
| Peru | 1994Q1 | |
| Philippines | 2001Q1 | |
| Poland | 1998Q1 | |
| Thailand | 2000Q1 | |

Source for IT start dates: Mishkin and Schmidt-Hebbel (2007)

Preliminaries

IT– lower inflation/interest rates, greater rer depreciation, less reserve growth

Table 1 – Descriptive Statistics for Macro Variables

| Variable | IT Sample (456 obs.) | Non-IT Sample (577 obs.) |
|-------------------------------|-------------------------|-----------------------------|
| GDP growth (%) | 1.11 (5.93) | 1.00 (7.84) |
| GDP gap (%) | -0.11 (3.86) | 0.29 (4.62) |
| Inflation (%) | 5.40 (4.21) | 9.60 (9.15) |
| Interest rate (%) | 8.98 (6.09) | 12.68 (10.25) |
| Real exchange rate change (%) | 2.50 (5.76) | -0.49 (13.27) |
| Foreign reserve change (%) | 3.25 (7.89) | 4.66 (22.82) |

Mean and (standard deviation) for all variables. For details, see the data appendix A.

Methodology : Taylor Equations

$$i_t = \rho i_{t-1} + \alpha(y_t - y^*) + \beta(\pi_t - \pi^*) + \gamma X_t \quad (1)$$

$$i_{i,t} = \mu_i + \rho i_{i,t-1} + \alpha(y_{i,t} - y_i) + \beta\pi_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (2)$$

-Panel Fixed Effects

-Hausman-Taylor 3-Step IV Estimator (bias with predetermined or endogenous variables)

Taylor Rules: Persistence, No GDP gap response, Inflation Response in IT, RER response in non-IT

Table 2 – Taylor Rule Regressions

| Variable | IT | | | Non IT | | |
|-------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Interest rate (t-1) | 0.84*** (43.97) | 0.83*** (43.36) | 0.84*** (43.91) | 0.76*** (22.50) | 0.74*** (22.48) | 0.77*** (23.17) |
| Inflation | 0.22* (1.86) | 0.29** (2.43) | 0.22* (1.86) | 0.01 (0.72) | 0.15*** (5.08) | 0.01 (0.62) |
| GDP gap | 0.03 (1.05) | 0.05 (1.55) | 0.03 (1.05) | 0.02 (0.37) | 0.03 (0.62) | 0.02 (0.52) |
| RER change | | 0.07*** (3.46) | | | 0.13*** (5.78) | |
| Reserve change | | | 0.09 (0.05) | | | -0.06*** (-3.95) |
| Observations | 387 | 387 | 387 | 472 | 472 | 472 |
| Adjusted-R ² | 0.76 | 0.77 | 0.76 | 0.79 | 0.80 | 0.73 |
| F-test | 272.10 | 206.89 | 203.60 | 177.55 | 151.01 | 141.35 |

Note: Panel fixed-effects estimation. The associated t- statistics are noted below each estimated coefficient. ***, **, * indicate the significance level at 1, 5, and 10 percent, respectively.

Persistence, Inflation gap in IT, output gap in non-IT, response to RER and reserves in non-IT

Table 3c – Taylor-type Regressions

| Variable | IT | | | | Non IT | | | |
|-------------------------------------|--------------------|--------------------|---------------------|--------------------|--------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Interest rate (t-1) | 0.77*** (30.12) | 0.78*** (29.67) | 0.68*** (26.46) | 0.78*** (29.92) | 0.82*** (26.15) | 0.80*** (25.65) | 0.73*** (22.28) | 0.78*** (25.10) |
| Inflation | 0.21* (1.60) | 0.21* (1.61) | 0.70*** (4.72) | 0.21* (1.60) | 0.02 (1.26) | 0.04** (2.33) | 0.02 (0.93) | 0.04*** (2.43) |
| GDP gap | 0.04 (1.17) | 0.04 (1.17) | -0.01 (-0.26) | 0.04 (1.14) | 0.06* (1.69) | 0.07** (1.97) | 0.004 (0.10) | 0.06* (1.80) |
| RER change (t-1) | | -0.02 (-0.39) | | -0.04* (-0.80) | | 0.16*** (4.20) | | 0.17*** (4.41) |
| RER change (t-1) *trade openness | 0.07** (2.26) | 0.09 (1.44) | | 0.10* (1.61) | 0.02 (1.24) | -0.19*** (-3.52) | | -0.21** (-3.74) |
| Reserve change (t-1) | | | -0.05*** (-2.65) | -0.04** (-2.30) | | | -0.11*** (-7.02) | -0.04*** (-2.80) |
| Observations | 399 | 399 | 451 | 399 | 412 | 412 | 466 | 412 |
| Adjusted-R2 | 0.83 | 0.83 | 0.77 | 0.83 | 0.84 | 0.84 | 0.80 | 0.85 |
| F-test | 244.67 | 195.34 | 208.64 | 165.48 | 180.04 | 153.63 | 150.42 | 131.54 |

Note: The associated t- statistics are noted below each estimated coefficient. ***, **, *, indicate the significance level at 1, 5, and 10 percent, respectively.

Persistence, Inflation gap in IT, output gap in non-IT, response to RER in IT, response to reserves in non-IT

Table 3 – Taylor Rule Regressions – Hausman-Taylor Estimation

| Variable | IT | | | Non IT | | |
|---------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Interest rate (t-1) | 0.81*** (32.82) | 0.79*** (31.69) | 0.79*** (31.39) | 0.88*** (34.59) | 0.86*** (32.28) | 0.87*** (33.10) |
| Inflation | 0.17 (1.32) | 0.24* (1.78) | 0.24* (1.76) | -0.01** (2.29) | 0.00 (0.31) | 0.02 (1.47) |
| GDP gap | 0.03 (0.75) | 0.03 (1.07) | 0.04 (1.08) | 0.07* (1.91) | 0.07** (2.08) | 0.07** (2.11) |
| RER change | | 0.10** (2.08) | 0.10** (2.22) | | 0.07* (1.85) | 0.06 (1.42) |
| RER change*trade openness | | -0.03 (-0.56) | -0.04 (-0.68) | | -0.11* (-1.91) | -0.08 (1.40) |
| Reserve change | | | 0.01 (0.88) | | | -0.06*** (5.20) |
| Observations | 355 | 355 | 355 | 418 | 418 | 418 |
| Adjusted-R ² | 0.83 | 0.84 | 0.84 | 0.84 | 0.84 | 0.85 |
| F-test | 155.18 | 136.64 | 127.62 | 143.51 | 127.64 | 129.90 |

Note: Hausman-Taylor estimation. The associated t- statistics are noted below each estimated coefficient. ***, **, * indicate the significance level at 1, 5, and 10 percent, respectively.

Commodity Intensive IT EMs

- Commodity intensive EMs that IT
 - Brazil, Colombia, Mexico and Peru
 - Non-commodity: Czech Republic, Hungary, Israel, Korea, Philippines, Poland, Thailand
- Are they different in the way they follow IT regime?

Table 4 - Descriptive statistics of commodity comparison

| Variable | IT Commodity (116 obs.) | IT Non-Commodity (271 obs.) |
|-------------------------------|----------------------------|--------------------------------|
| GDP growth (%) | 1.03 (5.14) | 1.14 (6.24) |
| GDP gap (%) | 0.28 (3.32) | -0.29 (3.98) |
| Inflation (%) | 6.75 (5.26) | 4.83 (3.53) |
| Interest rate (%) | 12.69 (7.36) | 7.41 (4.65) |
| Real exchange rate change (%) | 2.82 (6.79) | 2.37 (5.27) |
| Foreign reserve change (%) | 3.14 (8.81) | 3.29 (7.48) |

Commodity IT countries include Brazil, Colombia, Mexico, and Peru. The non-commodity IT countries are Czech Republic, Hungary, Israel, Korea, Philippines, Poland and Thailand.

Table 5 – Taylor Rule Regressions: – Hausman-Taylor Estimation

| | IT Commodity | IT Non-commodity |
|-------------------------|--------------------|--------------------|
| Variable | (1) | (2) |
| Interest rate (t-1) | 0.72*** (17.24) | 0.91*** (54.39) |
| Inflation | 0.56** (1.96) | -0.03 (-0.40) |
| GDP gap | 0.08 (1.01) | 0.03* (1.62) |
| RER change | 0.10** (1.99) | 0.06*** (3.52) |
| Observations | 116 | 239 |
| Adjusted-R ² | 0.74 | 0.93 |
| F-test | 56.21 | 347.01 |

Note: Hausman-Taylor estimation. The associated t- statistics are noted below each estimated coefficient. ***, **, * indicate the significance level at 1, 5, and 10 percent, respectively.

Is the RER targeted because it is an indicator of future inflation?

- If RER is a predictor of future inflation, response of IT CBs to rer could be to offset future inflation (not target rer)
- Granger causality tests (VAR models)

RER does not 'granger cause' Inflation

Table 6a – Panel-VAR for RER and CPI (one lag)

| Variable | IT | | Non-IT | |
|------------------|----------------|----------------|----------------|------------------|
| | Inflation | RER change | Inflation | RER change |
| Inflation (t-1) | 0.36 (4.53) | 0.58 (1.73) | 0.71 (.37) | -0.55 (-1.80) |
| RER change (t-1) | 0.01 (0.86) | 0.32 (3.23) | 0.02 (0.87) | 0.10 (1.99) |
| Observations | 432 | | 564 | |

Note: The associated t- statistics are noted below each estimated coefficient. Coefficients and t-statistics obtained by system GMM estimation.

Table 6b – Panel-VAR for RER and CPI (2 lags)

| Variable | IT | | Non-IT | |
|------------------|-----------------|-----------------|------------------|------------------|
| | Inflation | RER change | Inflation | RER change |
| Inflation (t-1) | 0.25 (3.31) | 0.55 (1.74) | 0.54 (1.61) | -0.05 (-0.15) |
| RER change (t-1) | 0.01 (0.93) | 0.45 (1.81) | 0.03 (0.52) | 0.41 (3.75) |
| Inflation (t-2) | 0.27 (4.67) | 0.05 (0.19) | 0.23 (0.98) | -0.27 (-1.08) |
| RER change (t-2) | 0.003 (0.45) | 0.11 (-2.08) | -0.01 (-0.41) | 0.02 (0.56) |
| Observations | 420 | | 547 | |

Note: The associated t- statistics are noted below each estimated coefficient. Coefficients and t-statistics obtained by system GMM estimation.

Conclusions

- Inflation targeting is real policy distinction, much stronger in IT EMs
- EMs following “mixed” IT strategy, esp. wrt real exchange rate
- Response to international reserves and output gap only in in non-IT EMs
- Response to real exchange rates strongest in commodity intensive EM ITers, while response to GDP gap strongest in non-commodity ITers
- Focus on real exchange rates NOT due to future inflation impacts (forward looking argument)

Continuing work...

- Specific target changes...not assumed constant
- Is commodity IT effect a Latin American (high inflation) effect?
- Target zone non-linear estimation, especially for "credible" central banks

Table 7 – Panel-VAR for Inflation, RER and TOT(IMF) Regressions

| Variable | IT | | | Non-IT | | |
|------------------|----------------|------------------|-------------------|------------------|------------------|-----------------|
| | Inflation | RER change | TOT change | Inflation | RER change | TOT change |
| Inflation (t-1) | 0.36 (4.59) | 0.54 (1.63) | -0.07 (-0.99) | 0.71 (2.37) | -0.55 (-1.80) | 0.004 (1.22) |
| RER change (t-1) | 0.01 (0.94) | 0.31 (3.15) | -0.003 (-0.34) | 0.02 (0.88) | 0.10 (2.00) | 0.002 (0.71) |
| TOT change (t-1) | 0.03 (0.74) | -0.25 (-1.44) | 0.85 (13.91) | -0.09 (-1.01) | -0.12 (-0.70) | 0.77 (15.04) |
| Observations | | 432 | | | 564 | |

Note: The associated t- statistics are noted in parenthesis below each estimated coefficient.

Appendix D: Descriptive Statistics for TOT Variable

| Variable | IT | Non-IT |
|--|-------------------------|--------------------------|
| Terms of Trade change (%) (IMF data) | 0.04 (1.65) [456] | -0.09 (1.18) [585] |
| Terms of Trade change (%) (IFS data) | 0.34 (4.11) [268] | 0.07 (7.88) [354] |
| Terms of Trade change (%) (Datastream data) | 0.34 (4.10) [299] | 0.57 (5.88) [191] |

Correlations of TOT Variables

| | | |
|-------------------------|---------------------------|---------------------------|
| TOT(IMF)-TOT(IFS): 0.03 | TOT(IMF)-TOT(DS): 0.08 | TOT(DS)-TOT(IFS): 0.13 |
|-------------------------|---------------------------|---------------------------|

Mean, (standard error), [observations]. For details, see the data appendix.