# Financial Exchange Rates and International Currency Exposures

Philip R. Lane – IIIS, Trinity College Dublin and CEPR
Jay C. Shambaugh – Dartmouth College and NBER

Third Research Meeting of NIPFP-DEA Program on Capital Flows
September 2008
New Delhi

# Overview

- Valuation channel of external adjustment: importance growing in line with financial globalization
- Exchange rates and valuation channel: currency composition of international balance sheets
- Empirical evidence on topic still in its infancy
- This paper tries to fill a gap – provide broad based evidence on the international financial impact of exchange rate changes

# Valuation Effects

- Change in NFA comes from both flows and changes in the value of the stock

  ? NFA = CA + VAL

- In principle, valuation effects can be split into changes in the prices ($VAL^{MV}$) of assets and changes in the exchange rate ($VAL^{XR}$) [also measurement error]

# Valuation Channel and Exchange Rates

- Two strands in research on valuation channel
- Adverse balance sheet impact of depreciation in emerging market economies
  - Eichengreen and Hausmann (2005), Goldstein and Turner (2005)
- Gains to United States from dollar depreciation
  - Lane and Milesi-Ferretti (2001, 2003, 2005, 2007a, 2007b); Tille (2003, 2005); Gourinchas and Rey (2007);
- Full profile of currency exposures lacking for a large number of countries

# Contribution

- Calculate currency exposures in international balance sheet by country over time
  - Compare trade and finance weighted exchange rates
  - Consider countries' aggregate currency exposures
    - And changes over the last decade
  - Consider size and importance of valuation shocks
    - Persistence, correlation of $VAL^{MV}$ and $VAL^{XR}$, magnitudes

# Previous Empirical Work

- Lane and Milesi-Ferretti (2001, 2007a, 2007b) highlighted aggregate role of valuation channel in driving net foreign asset positions
- Lane and Milesi-Ferretti (2003, 2005, 2007c): exchange rate and valuation channel
- Tille (2003): valuation impact of dollar movements on the US external position
- Gourinchas and Rey (2007): valuation channel a stabilizing force for US external position; external imbalance a predictor for the dollar.

# Data Constraint

- IIP data typically do not contain information on currency composition of foreign assets and liabilities
- United States an exception but also atypical: sui generis position in issuing debt in its own currency and the international standard role of the dollar
- Dollar exposures for selected other countries: Warnock (2006), Lane and Milesi-Ferretti (2007c)
- Full list of currency exposures desirable
- We tackle this data gap over 1990-2004 for 117 countries

# Method

- The currency exposures are generated by both combining numerous sources and filling in data with a variety of models and assumptions where necessary.
- Generate currency exposure by asset class and then combine
- Caveats:
  - Hedging
    - Intra country hedging is moot, may also only hedge L making A&L even more unmatched
  - Offsets of $VAL^{XR}$ and $VAL^{MV}$
    - Partial

# Method: ASSETS – portfolio equity

- **Portfolio Equity Assets**:
  - Assume destination equals currency
  - CPIS data on a limited number of reporters
  - Exclude Offshores
  - Use LMF- IIP model of equity holdings (distance, size, etc) to predict positions of missing countries

# Method: ASSETS - FDI

- **FDI**:
  - Again, assume destination equals currency
  - Use UNCTAD data on FDI outward and inward stocks.
  - Missing data: inferences based on inward reporting by other countries
    - For a limited number of countries more *ad hoc* process relying on flows data

# Method: ASSETS – portfolio debt

- **Portfolio Debt Assets**:
  - Destination does **not** equal currency
  - Use gravity augmented CPIS data to generate geographical holdings.
  - Then use BIS issuance data, national sources, and World Bank external debt data to calculate currency by geographical location.
  - Use national sources (US, ECB, BoJ) to remove major currency investor holdings, then use residuals for rest of world
    - That is, subtract US holdings by country by currency from the issuance of each country before calculating the average currency profile by destination.

# Method: Assets – Other Debt

- **Other Debt Assets**:
  - use BIS data on bank assets and liabilities. Gives us geographical distribution as well as home vs. foreign breakdown.
  - Using both A & L, we can triangulate towards currency.

# Method: Assets - reserves

- **Reserves**:
  - Begin with COFER database on world currency breakdown by year.
  - Use regression results from Eichengreen and Mathieson on confidential individual country data to back out currency composition of reserves.
    - Using time varying constants to match COFER annual world totals
  - Use evidence from Truman and Wong to fill in some actual data for ~20 countries for 2000-2004
  - Output is matched to a variety of sources and individual country reports.
    - Country announcements
    - Lim (2006)

# Method: Liabilities

- Equity and FDI liabilities are considered to be in the local (ie home) currency.
- World Bank data gives a combined breakdown for external debt that pools portfolio debt, bank debt, and official lending.
- For industrial countries BIS issuance data and BIS banking data are combined to generate the equivalent series.

# Method: weights

- A, L, Gross, and Net weights are created using these currency weights across the asset classes.
  - $$w_{ijt}^{A} = \sum_{k=1}^{k=N} l_{it}^{Ak} * w_{ijt}^{Ak}$$
  - where $?^{Ak}$ is the currency weight for a given asset class and $?^{Ak}$ is the asset class weight within assets.
  - EWN data is used to create the $?^{Ak}$
  - Same construction is done for liabilities

# Weights: continued

- NET financial weights show the overall exposure of a country to a particular currency:

$$w_{ijt}^{F} = w_{ijt}^{A} \frac{A}{A+L} - w_{ijt}^{L} \frac{L}{A+L}$$

$$\frac{\partial VAL_{it}}{\partial E_{ijt}} = w_{ijt}^{F} * (A_{it-1} + L_{it-1})$$

# Index Construction

- We create exchange rate indices based on these weights.
  - They are approximations of geometric indices based on summing the percentage changes across partner countries
    - In this manner changing weights do not change index on their own
    - Negative is an appreciation
  - Under our construction, if a country hyperinflates, the value for that country in all other countries will head towards zero, rather than take an outsized role.
  - $$I_{it}^{A} = I_{it-1}^{A} * (1 + \sum w_{ijt}^{A} * \%\Delta E_{ijt})$$

# Index Construction (continued)

- This allows us to write:

$$VAL_{it}^{XR} = \%\Delta I_{it}^{A} * A_{t-1} - \%\Delta I_{it}^{L} * L_{t-1}$$

  - Where A and L are as % of GDP

- As well as create a NET index

$$I_{it}^{F} = I_{it-1}^{F} * \left( \%\Delta I_{it}^{A} * \frac{A_{t-1}}{A_{t-1} - L_{t-1}} - \%\Delta I_{it}^{L} * \frac{L_{t-1}}{A_{t-1} - L_{t-1}} \right)$$

$$VAL_{it}^{XR} = \%\Delta I_{it}^{F} * (A_{t-1} + L_{t-1})$$

# Quick comment on NET

- The NET weights and index are a bit different than normal indices
- NET weights can be negative
- NET weights do NOT necessarily sum to 1
  - A country can have perfect balance (they sum to zero), or be long or short
- The NET index can be stable if you are balanced even if E is moving.

# Aggregate Foreign Currency Exposures

- Optimal portfolios in DSGE open-economy models: new wave in the literature
  - Key issue: optimal pattern in foreign currency exposure (long or short rest of world)
- Define foreign currency exposure by:

$$FX_{it}^{AGG} = w_{it}^{A} s_{it}^{A} - w_{it}^{L} s_{it}^{L}$$

  - Where ? $^{A}$ is the share of foreign assets in foreign currencies and $s^{A}$ is the share of assets in A+L
- In turn, the impact can be summarized by:

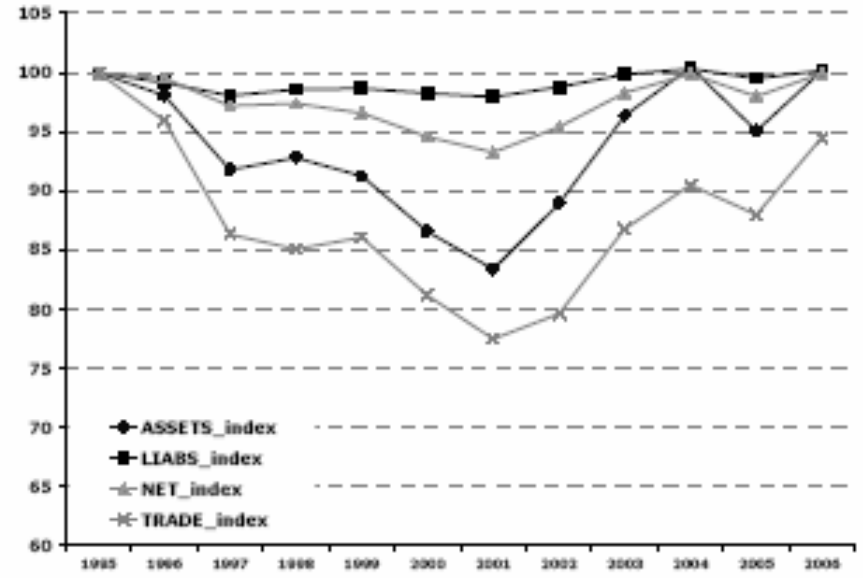
$$NETFX_{it}^{AGG} = FX_{it}^{AGG} * IFI_{it-1}$$

# RESULTS

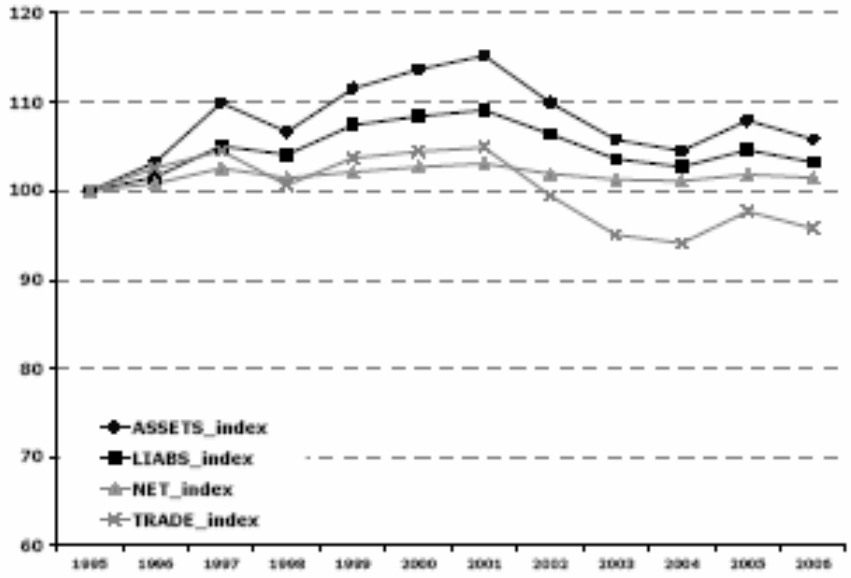
- We will examine:
  - Do “financial” exchange rates look different
    - Correlation with trade indices
  - Are countries positions mismatched ?
    - Correlation of A & L indices
  - Aggregate foreign currency exposures
    - Net weight vs. rest of the world
    - How has it changed ?
  - What are the general properties of $VAL^{XR}$

# Some examples

United States

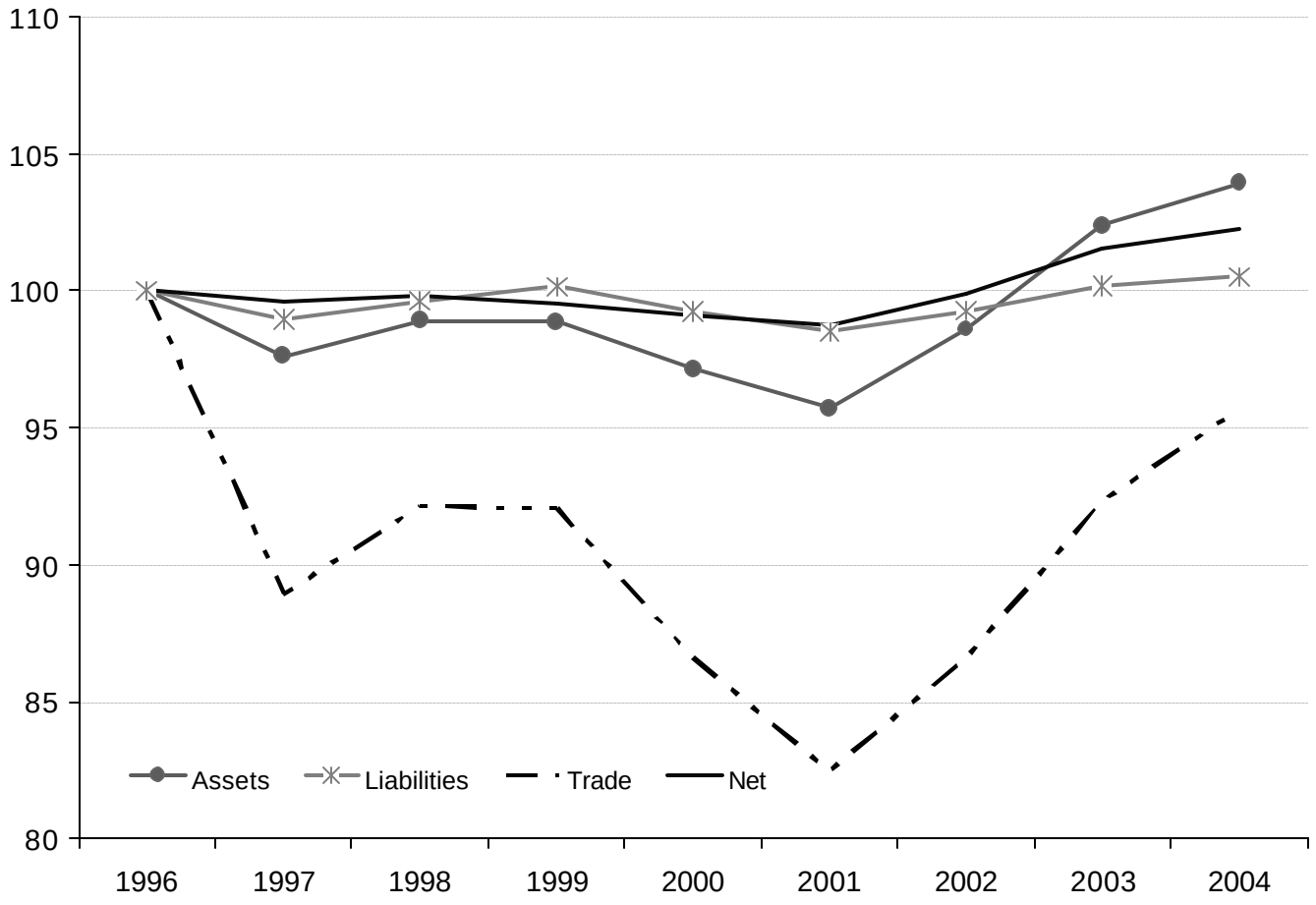



France

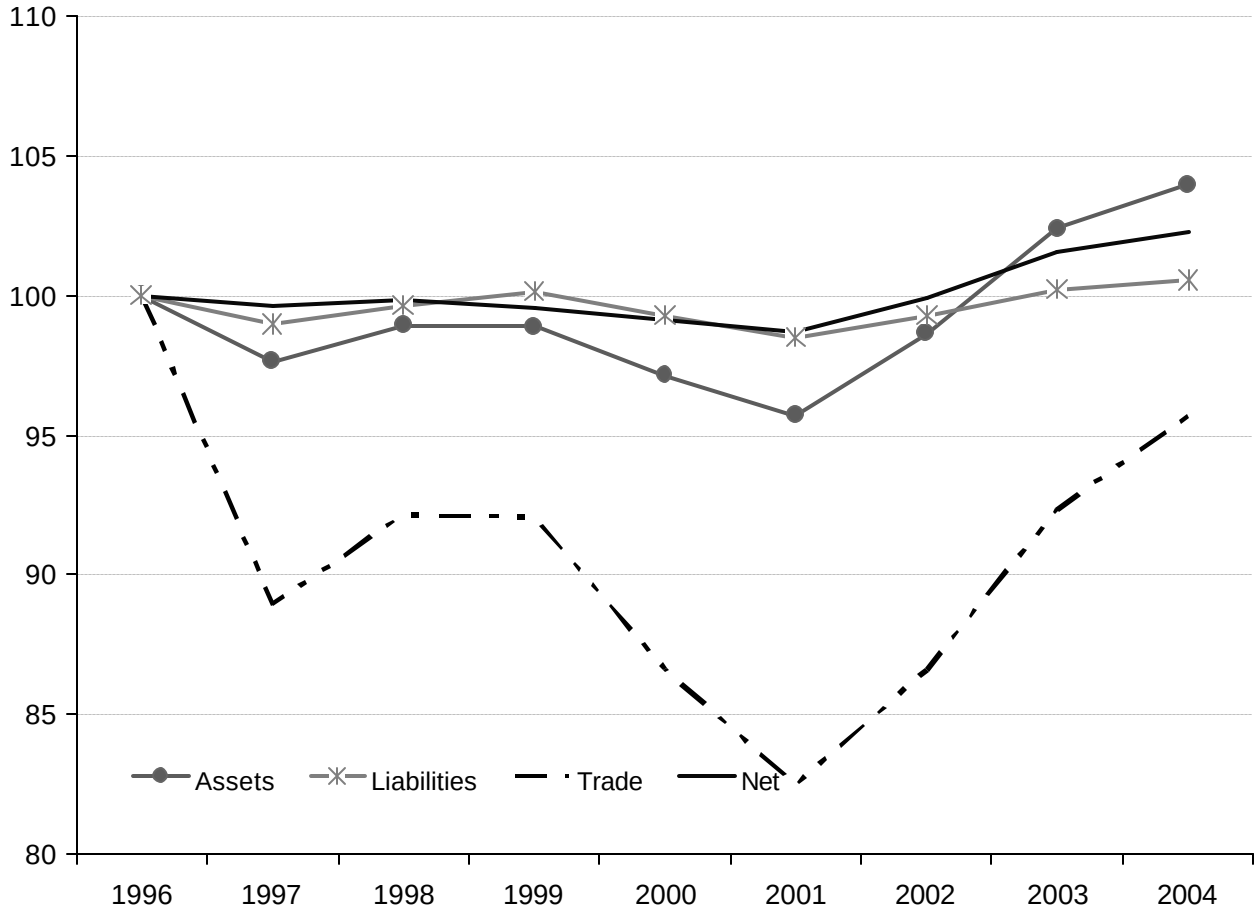



- US liabilities index is stable.
- France A&L indices move together, but post-euro, all are stable

# Exchange Rate Indices: India



# Exchange Rates: China



# Correlation of Indices

Table 1: Correlations between Financial and Trade-Weighted Exchange Rate Indices

| Group | Statistic | Assets Liabilities | Assets Trade | Liabilities Trade | Net Finance Trade | Exports Imports |
|---|---|---|---|---|---|---|
| All | mean | 0.96 | 0.90 | 0.86 | -0.30 | 0.95 |
| | median | 0.98 | 0.95 | 0.92 | -0.72 | 0.98 |
| Advanced | mean | 0.97 | 0.92 | 0.88 | 0.41 | 0.97 |
| | median | 0.98 | 0.93 | 0.89 | 0.70 | 0.98 |
| Dev. & Emging | mean | 0.96 | 0.90 | 0.86 | -0.47 | 0.95 |
| | median | 0.99 | 0.96 | 0.95 | -0.82 | 0.98 |
| Developing | mean | 0.96 | 0.88 | 0.84 | -0.61 | 0.94 |
| | median | 0.99 | 0.95 | 0.94 | -0.89 | 0.97 |
| Emerging | mean | 0.94 | 0.93 | 0.88 | -0.13 | 0.98 |
| | median | 0.97 | 0.97 | 0.95 | -0.37 | 0.99 |

Correlations between the percentage change in monthly Financial and Trade-weighted Exchange Rates Indices. Monthly data, 1990.1-2004.12. Full sample of countries.

*Mean and median across countries where correlation is done within country*

- TRADE and NET are negatively correlated, (other indices highly correlated)
  - TRADE may miss important information for many countries
- A & L are highly correlated. Currency "mismatch" not strong in the indices

# Stability of the indices

Table 2

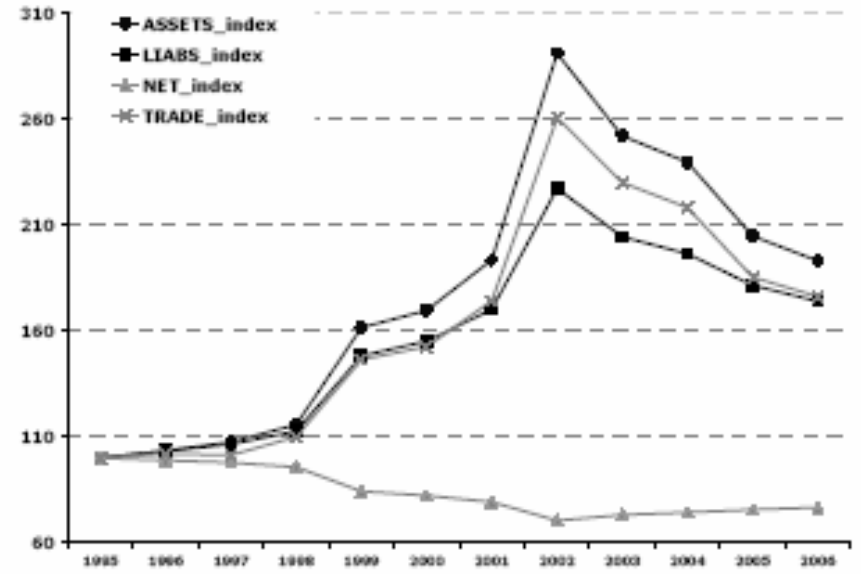
| Group | Statistic | Trade | Net | Assets | Liabilities |
|---|---|---|---|---|---|
| All | Mean | 0.123 | 0.050 | 0.140 | 0.105 |
| | Median | 0.066 | 0.023 | 0.067 | 0.055 |
| Advanced | Mean | 0.050 | 0.013 | 0.058 | 0.035 |
| | Median | 0.046 | 0.010 | 0.053 | 0.034 |
| Dev. & Emging | Mean | 0.140 | 0.058 | 0.159 | 0.122 |
| | Median | 0.081 | 0.028 | 0.071 | 0.068 |
| Developing | Mean | 0.133 | 0.069 | 0.153 | 0.121 |
| | Median | 0.071 | 0.035 | 0.064 | 0.068 |
| Emerging | Mean | 0.158 | 0.036 | 0.173 | 0.123 |
| | Median | 0.090 | 0.021 | 0.101 | 0.071 |
| Sudden Stops | mean % Δ | 44% | -8% | 54% | 41% |
| Big Change | mean % Δ | 88% | -30% | 107% | 88% |

*Std deviation of the percentage change by country*

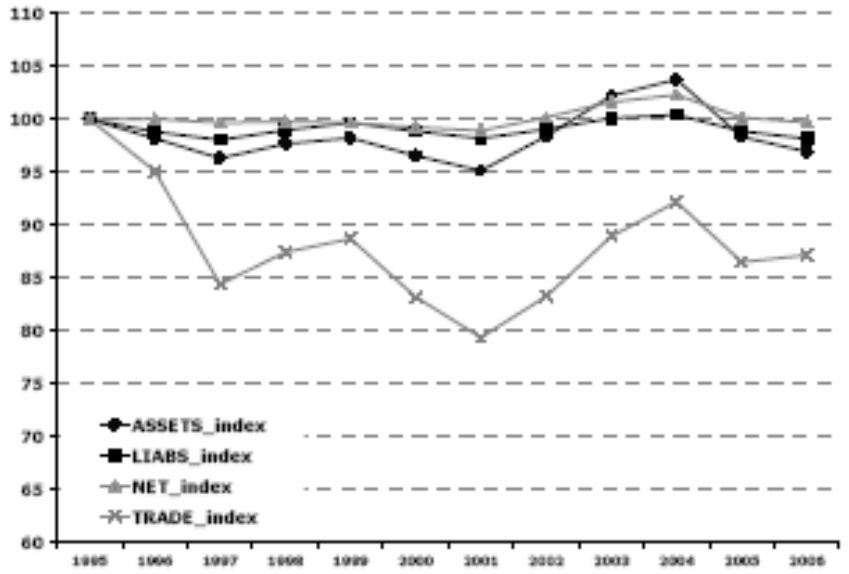
- Net indices are much more stable than the others.
- Liability indices are more stable than Asset
  - despite their high correlation, they are not moving one for one with one another

# Examples

Brazil



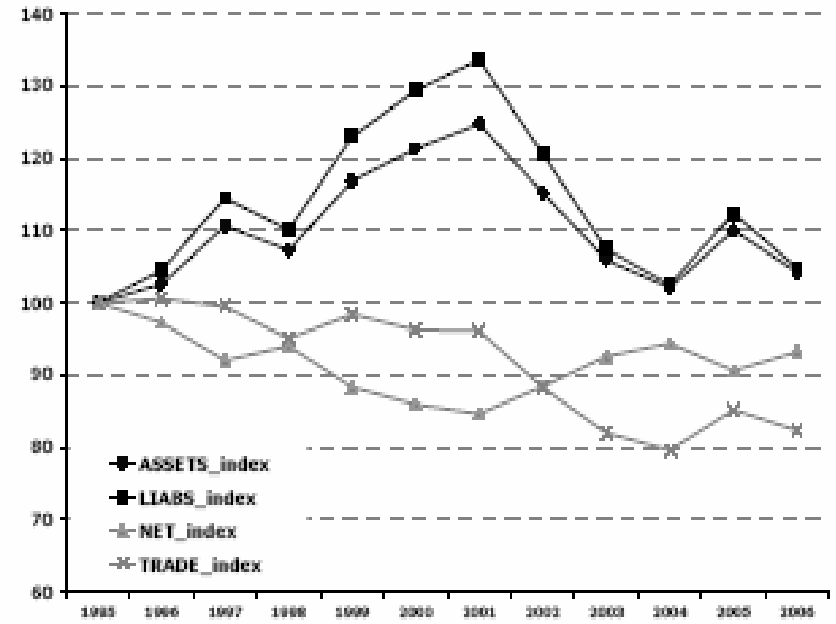

China



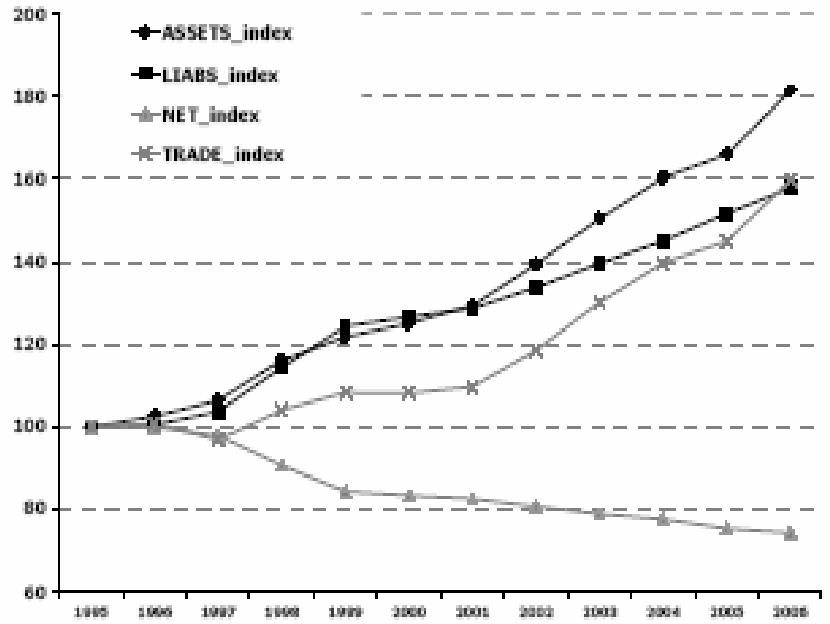

- Brazil: A, L, Trade indices all depreciate while net falls (net debtor: capital losses).
- China: dollar peg stabilized all financial indices

# Examples

Benin

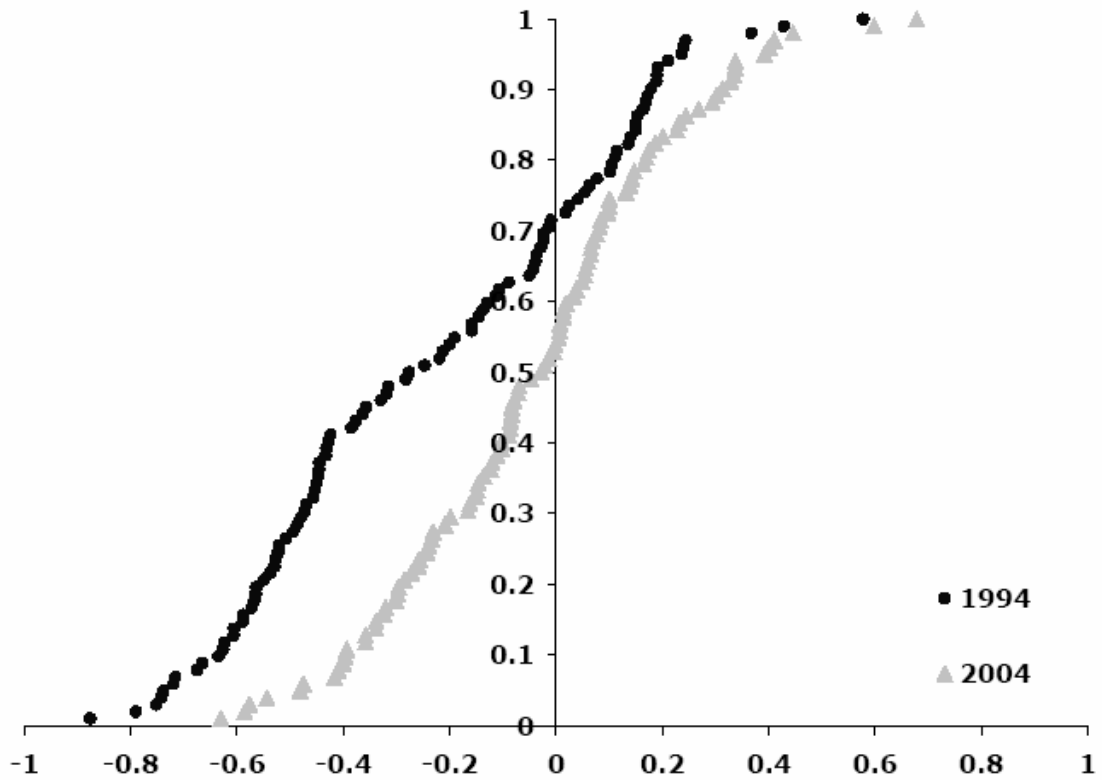



Bangladesh




- Benin: trade and finance moving differently ($ vs euro).
- Bangladesh: L starting to flatten
- IN GENERAL: Trade weighted index is not a good summary of what is going on financially

# $FX^{AGG}$ in 1994 and 2004




- The number of countries with negative positions has gone down from 71% to 54%.
- The number of countries below -.5 has gone down from 30% to <10%

# Aggregate Foreign Currency Exposure

Table 4

| | 1994 | | 2004 | |
|---|---|---|---|---|
| | mean | median | mean | median |
| | | $FX^{agg}$ | | |
| All | -0.24 | -0.26 | -0.04 | -0.03 |
| Advanced | 0.04 | 0.08 | 0.11 | 0.09 |
| Dev. & Emging | -0.31 | -0.43 | -0.08 | -0.10 |
| Developing | -0.42 | -0.47 | -0.15 | -0.18 |
| Emerging | -0.11 | -0.07 | 0.04 | 0.06 |
| | | $NETFX$ | | |
| All | -0.31 | -0.22 | 0.11 | -0.04 |
| Advanced | 0.17 | 0.08 | 0.51 | 0.36 |
| Dev. & Emging | -0.45 | -0.36 | 0.00 | -0.13 |
| Developing | -0.73 | -0.52 | -0.21 | -0.22 |
| Emerging | 0.06 | -0.08 | 0.38 | 0.06 |

- Bulk of developing countries are not hedged against depreciation. Shift towards positive position over time.
- SIZE of exposure growing in industrial countries

# Selected Emerging Markets

| | 1996 | 2000 | 2004 |
|---|---|---|---|
| | | FXAGG | |
| Brazil | -0.13 | -0.19 | -0.05 |
| Mexico | -0.25 | -0.15 | -0.06 |
| India | -0.42 | -0.21 | 0.07 |
| Korea | -0.05 | 0.15 | 0.24 |
| Russia | 0.06 | 0.17 | 0.23 |
| China | 0.19 | 0.38 | 0.43 |
| | | NETFX | |
| Brazil | -0.06 | -0.17 | -0.06 |
| Mexico | -0.27 | -0.14 | -0.05 |
| India | -0.16 | -0.09 | 0.04 |
| Korea | -0.02 | 0.15 | 0.25 |
| Russia | 0.05 | 0.36 | 0.35 |
| China | 0.10 | 0.27 | 0.34 |

# What shifted as $FX^{AGG}$ moved ?

| Quartile | obs | mean | min | max | $\Delta s_{it}^{A}$ | $\Delta \omega_{it}^{A}$ | $\Delta \omega_{it}^{L}$ | EMU | Non-EMU |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 25 | -0.09 | -0.34 | 0.04 | -0.07 | -0.15 | -0.17 | 0.28 | 0.12 |
| 2 | 25 | 0.12 | 0.06 | 0.19 | 0.05 | -0.06 | -0.08 | 0.12 | 0.12 |
| 3 | 26 | 0.26 | 0.19 | 0.34 | 0.07 | 0.01 | -0.21 | 0.00 | 0.15 |
| 4 | 26 | 0.48 | 0.34 | 0.92 | 0.16 | -0.02 | -0.29 | 0.04 | 0.04 |
| All | 102 | 0.20 | -0.34 | 0.92 | 0.06 | -0.05 | -0.19 | | |
| Advanced | 22 | 0.08 | -0.14 | 0.50 | 0.03 | -0.25 | -0.24 | | |
| EMU | 11 | -0.001 | -0.14 | 0.41 | 0.01 | -0.52 | -0.42 | | |
| Non-EMU | 11 | 0.15 | -0.04 | 0.50 | 0.06 | 0.02 | -0.07 | | |
| Dev. & Emging | 80 | 0.23 | -0.34 | 0.92 | 0.06 | 0.00 | -0.17 | | |
| Developing | 52 | 0.27 | -0.26 | 0.92 | 0.08 | 0.00 | -0.17 | | |
| Emerging | 28 | 0.15 | -0.34 | 0.63 | 0.03 | 0.00 | -0.18 | | |

- Change in NFA position (change in $s^{A}$) is crucial for improvement
- Change in share of liabilities that are foreign is also important
- Drop in A and L foreign currency shares comes from EMU

# What shifted as $FX^{AGG}$ moved ?

| | | $\Delta Res/\Delta A$ | | $\Delta NFA^{priv}$ | | $\Delta(\lambda_{Lit}^{PEQ}+\lambda_{Lit}^{FDI})$ | | $\Delta DebtL^{FC}$ | |
|---|---|---|---|---|---|---|---|---|---|
| quartile | obs | Mean | Median | Mean | Median | Mean | Median | Mean | Median |
| 1 | 25 | 0.21 | 0.05 | -0.18 | -0.18 | 0.09 | 0.08 | -0.13 | -0.01 |
| 2 | 25 | 0.30 | 0.36 | 0.08 | 0.02 | 0.02 | 0.03 | -0.08 | 0.00 |
| 3 | 26 | 0.42 | 0.46 | 0.14 | 0.03 | 0.21 | 0.20 | -0.01 | 0.00 |
| 4 | 26 | 0.50 | 0.58 | 0.43 | 0.37 | 0.27 | 0.26 | -0.03 | 0.00 |
| All | 102 | 0.37 | 0.41 | 0.12 | 0.04 | 0.15 | 0.15 | -0.06 | 0.00 |
| Advanced | 22 | 0.02 | 0.00 | 0.03 | 0.05 | 0.07 | 0.05 | -0.27 | -0.20 |
| EMU | 11 | -0.02 | -0.01 | -0.01 | 0.01 | 0.07 | 0.04 | -0.53 | -0.51 |
| non-EMU | 11 | 0.07 | 0.03 | 0.08 | 0.09 | 0.08 | 0.05 | -0.01 | -0.02 |
| Dev. & Emging | 80 | 0.47 | 0.52 | 0.15 | 0.04 | 0.17 | 0.16 | 0.00 | 0.00 |
| Developing | 52 | 0.51 | 0.54 | 0.28 | 0.15 | 0.17 | 0.16 | 0.00 | 0.00 |
| Emerging | 28 | 0.40 | 0.46 | -0.07 | -0.06 | 0.18 | 0.18 | -0.01 | 0.00 |

- Reserves went up, Private NFA improved in developing countries, FDI & Equity grew, but not “sin” going away.

# Changes in NETFX

| | obs | mean | min | max | $\Delta FX_{it}^{AGG}$ | $\Delta IFI$ |
|---|---|---|---|---|---|---|
| All | 96 | 0.41 | -0.52 | 3.11 | 0.20 | 0.57 |
| Advanced | 22 | 0.30 | -0.52 | 1.40 | 0.07 | 2.18 |
| EMU | 11 | 0.14 | -0.52 | 0.91 | 0.00 | 2.89 |
| Non-EMU | 11 | 0.46 | 0.11 | 1.40 | 0.15 | 1.47 |
| Dev. & Emging | 74 | 0.45 | -0.25 | 3.11 | 0.23 | 0.09 |
| Developing | 48 | 0.52 | -0.14 | 3.11 | 0.27 | -0.21 |
| Emerging | 26 | 0.32 | -0.25 | 2.53 | 0.15 | 0.64 |

- Developing countries are both increasing $FX^{AGG}$ and reducing scale.
- Advanced are rapidly increasing scale (especially EMU)

# Characteristics of $VAL^{XR}$

- $VAL^{XR}$ is sizable:
  - $75^{th}$ percentile abs value is 4.3% of GDP, $90^{th}$ is 11.2%
- $VAL^{XR}$ moves with VAL (not fully offset)
- $VAL^{XR}$ effects do not reverse
  - slight positive autocorrelation
  - Only a handful of countries show reversals in individual country regressions

# Size of $VAL^{XR}$

| | Mean | Median | 75% | 90% |
|---|---|---|---|---|
| All | 5.0 | 1.7 | 4.3 | 11.2 |
| Advanced | 2.4 | 1.2 | 2.8 | 5.0 |
| Dev. & Emging | 5.7 | 1.8 | 4.7 | 12.6 |
| Developing | 6.8 | 2.3 | 5.3 | 15.8 |
| Emerging | 3.4 | 1.2 | 3.8 | 10.0 |

- $VAL^{XR}$ as a share of GDP (in percentage points)

# VAL and $VAL^{XR}$

| | (1) All | (2) Adv. | (3) Dev. | (4) Eme. |
|---|---|---|---|---|
| VALxr | 1.071 (0.05)** | 0.574 (0.14)** | 1.095 (0.05)** | 0.982 (0.12)** |
| Constant | 0.724 (0.15)** | -0.969 (0.07)** | 2.529 (0.25)** | -1.745 (0.18)** |
| N | 1496 | 304 | 802 | 390 |
| $R^2$ | 0.65 | 0.09 | 0.72 | 0.51 |
| $R^2$ (no FE) | 0.54 | 0.06 | 0.61 | 0.42 |

- VAL and $VAL^{XR}$ are positively correlated. $VAL^{XR}$ is not entirely offset by price movements

# VAL, $VAL^{XR}$ over time

| | $\rho(VAL)$ | | $\rho(VAL^{xr})$ | | $\rho(VAL^{mp})$ | |
|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median |
| All | 0.02 | -0.01 | 0.12 | 0.09 | 0.01 | 0.01 |
| Advanced | -0.01 | -0.06 | 0.15 | 0.15 | -0.05 | -0.04 |
| EMU | -0.02 | -0.04 | 0.20 | 0.16 | -0.01 | -0.04 |
| Non-EMU | 0.01 | -0.08 | 0.10 | 0.14 | -0.09 | -0.03 |
| Developing | 0.02 | -0.001 | 0.11 | 0.06 | 0.02 | 0.03 |

- Crucial point is that the exchange rate effects do not disappear a year later

# A Dollar Crash

Table 11: Effects of a 20 percent Depreciation of the US Dollar

| | Trade | | Net Financial | | $VAL^{xr}$ | |
|---|---|---|---|---|---|---|
| Group | mean | median | mean | median | mean | median |
| All | -2.6 | -1.5 | 1.2 | 0.2 | 0.5 | 0.5 |
| Advanced | -1.3 | -1.3 | -0.7 | -0.7 | -3.3 | -1.7 |
| EMU | -1.3 | -1.2 | -0.3 | -0.2 | -1.9 | -0.5 |
| Non-EMU | -1.2 | -2.0 | -1.1 | -1.6 | -4.8 | -5.1 |
| Developing | -2.8 | -1.2 | 2.7 | 3.0 | 3.5 | 3.1 |
| Emerging | -3.2 | -2.5 | -0.5 | -0.7 | -2.9 | -0.8 |

Percentage change in Trade and Net Financial indices in the case of a 20 percent across the board depreciation of the US dollar, plus the implied valuation changes.

- See Warnock (2006) for a similar exercise on assets only
- Developing countries benefit (in purely financial terms)

# Summary

- First dataset on cross-country cross-time currency exposure by country.
- We are able to show:
  - Trade and Finance weights look different
    - Trade weighted index not a good summary of valuation impact of currency movements
  - Some (especially especially developing countries) have reduced exposure by:
    - Increasing reserves and changing composition of liabilities
  - Valuation shocks are substantial as a share of GDP, and the exchange rate channel is important