“Estimation of De Facto Exchange Rate Regimes: Synthesis of The Techniques for Inferring Flexibility and Basket Weights”

Jeffrey Frankel, Harvard & Shang-Jin Wei, Columbia, 2008 and

“New Estimation Of China’s Exchange Rate Regime”

J. Frankel, Jan. 2009
Summary

- A synthesis of two techniques for statistically estimating de facto exchange rate regimes:
  1. A technique that we have used to estimate implicit de facto weights when the hypothesis is a basket peg with little flexibility.
  2. A technique used by others to estimate the de facto degree of exchange rate flexibility when the hypothesis is an anchor to the $, but with flexibility around that anchor.

- Many currencies today follow variants of Band-Basket-Crawl => We need a technique that can cover both dimensions: inferring weights and inferring flexibility.
• Frankel & Wei (2008) tried out the approach
  – monthly data on 20+ currencies,

• My current work tries it for the RMB & some other currencies for which weekly reserve data are available.
De jure regime ≠ de facto

1. Most “fixed” aren’t:
   Countries declaring a peg, often abandon it.

2. Most “floating” aren’t:
   “floaters” Var.of $E$ (vs. Res) not > fixers’

3. Most basket pegs aren’t.
   Weights are kept secret  =>  It takes more than 100 observations for an observer to distinguish a true basket peg statistically
   -- Frankel, Schmukler & Serven (2000)
It is harder to classify a country’s regime than one would think

• As is by now well-known, de facto ≠ de jure.

• But it is genuinely difficult to classify most countries’ de facto regimes, which are intermediate regimes and which change over time.
• Some currencies have basket anchors, often with some flexibility that can be captured either by a band or by leaning-against-the-wind intervention.

• Most basket peggers keep the weights secret. They want to preserve a degree of freedom from prying eyes, whether to pursue
  – a lower degree of de facto exchange rate flexibility, as China,
  – or a higher degree, as with others.

• The task of distinguishing de facto from de jure exchange rate regimes, has produced a lively literature.

• But inferring de facto weights and inferring de facto flexibility are equally important, whereas most authors have hitherto done only one or the other.
Dominant way to estimate de facto regimes: estimate degree of flexibility, typically presuming that $ = anchor currency


- Levy-Yeyati & Sturzenegger (2005): cluster analysis based on Variability of $E$ & $\Delta E$, and of $\Delta$ Reserves
But, the de facto classification schemes give very different answers among themselves.

Why?

• Different ways of quantifying flexibility
• The correct anchor currency may not always be the dollar
• Most currencies cannot be neatly categorized
  – In particular, countries switch parameters and regimes frequently.
Another branch of the de facto regime literature estimates implicit basket weights:
Regress $\Delta$ value of local currency against $\Delta$ values of major currencies.

- **First examples:**
  Frankel (1993) and Frankel & Wei (1994, 95).
- **More:**
- **Example of China, post 7/05:**
  - Finding: RMB still pegged, with 95% weight on $.$
Implicit basket weights method -- regress \( \Delta \) value of local currency against \( \Delta \) values of major currencies -- continued.

- Null Hypotheses: Close fit \( \Rightarrow \) a peg.
  - Coefficient of 1 on $ \Rightarrow $ peg.
  - Or significant weights on other currencies \( \Rightarrow \) basket peg.

- \textbf{But} if the test rejects tight basket peg, what is the Alternative Hypothesis?
A preliminary look at the data

• First set of countries examined:
  – 9 small countries that have been officially identified by the IMF as following basket pegs: Latvia, Papua New Guinea, Botswana, Vanuatu, Fiji, W.Samoa, Malta & the Seychelles.
  – 4 known floaters: Australia, Canada and Japan.
  – 3 peggers of special interest: China, Hong Kong & Malaysia.
• Within the period 1980-2007,
• variances of $\Delta E$ & $\Delta Reserves$ are computed for 7-year intervals
  – The aim in choosing this interval: long enough to generate reliable estimates of the parameters, and yet not so long as inevitably to include major changes in each country’s exchange rate regime.
• All changes are logarithmic.
• We try subtracting imputed interest earnings from reported $\Delta Reserves$ to get intervention.
Figure 1: Comparison of Reserve Variability Vs. Exchange Rate Variability

1980-2007, in 7-year intervals

Variance of Δ log of Reserves*

Variance of Δ log Exchange Rate (in US$)

Country from year t to year t+6

Floating/Fix line

Shocks line
Lessons from Figure 1

1. The folly of judging a country’s exchange rate regime – the extent to which it seeks to stabilize the value of its currency – by looking simply at variation in the exchange rate.

E.g. \( \text{Var}(\Delta E) \) for 1980-86 A$ > 2001-07 ¥.
But not because the A$ more flexible.
It is rather because Australia was hit by much larger shocks.
One must focus on \( \text{Var}(\Delta E) \) *relative to* \( \text{Var}(\Delta Res) \).

2. Countries that specialize in mineral products tend to have larger shocks.
Lessons from Figure 1, continued

3. Even countries that float use FX reserves actively. E.g., Canada in the 1980s.

4. A currency with a firm peg (e.g., Hong Kong) can experience low variability of reserves, because it has low variability of shocks.
Distillation of technique to infer flexibility

• When a shock increases international demand for korona, do the authorities allow it to show up as an appreciation, or as a rise in reserves?

• We frame the issue in terms of Exchange Market Pressure (EMP), defined as % increase in the value of the currency plus % increase in reserves (or monetary base, or M1).

• EMP appears on the RHS of the equation and the % increase in the value of the currency appears on the left,
  – a coefficient of 0 signifies a fixed $E$ (no changes in the value of the currency),
  – a coefficient of 1 signifies a freely floating rate (no changes in reserves) and
  – a coefficient somewhere in between indicates a correspondingly flexible/stable intermediate regime.
A limitation of papers that estimate flexibility

• They sometimes choose arbitrarily the major currency in terms of which flexibility and stability are to be defined.
• The $ is the most common choice.
  – This is fine for some countries.
  – But for Europe, the € is more relevant.
  – And for others -- in Asia/Pacific, the Middle East & parts of Africa -- the relevant foreign currency is neither the $ nor the €, but some basket.
• It would be better to let the data tell us what is the relevant anchor for a given country, rather than making the judgment a priori.
The technique that estimates basket weights

- Assuming the value of the home currency is determined by a currency basket, how does one uncover the currency composition & weights? This is a problem to which OLS is unusually well suited.

We regress changes in the log of $H$, the value of the home currency, against changes in the log values of the candidate currencies.

- Algebraically, if the value of the home currency $H$ is pegged to the values of currencies $X_1, X_2, \ldots \& X_n$, with weights equal to $w_1, w_2, \ldots \& w_n$, then

\[ \Delta \log H(t) = c + \sum w(j) \left[ \Delta \log X(j) \right] \]  \hspace{1cm} (1)

- If the exchange rate is truly governed by a strict basket peg, then we should be able to recover the true weights, $w(j)$, precisely, so long as we have more observations than candidate currencies; and the equation should have a perfect fit.
The question of the numeraire

- Methodology question: how to define “value” of each currency.[1]

- In a true basket peg, the choice of numeraire currency is immaterial; we estimate the weights accurately regardless. [2]

- In practice, few countries take their basket pegs literally enough to produce such a tight fit. One must then think about non-basket factors in the regression (EMP, the trend term, error term): Are they better measured in terms of one numeraire or another?

- We choose as numeraire the SDR.

- F&Wei checked how much difference numeraire choice makes.
  - by trying the Swiss franc as a robustness check
  - and in Monte Carlo studies

[1] Frankel(1993) used purchasing power over a consumer basket of domestic goods as numeraire; Frankel-Wei (1995) used the SDR; Frankel-Wei (1994, 06), Ohno (1999), and Eichengreen (2006) used the Swiss franc; Bénassy-Quéré (1999), the $; Frankel, Schmukler and Luis Servén (2000), a GDP-weighted basket of 5 major currencies; and Yamazaki (2006), the Canadian $.

[2] assuming weights add to 1, and no error term, constant term, or other non-currency variable.
Synthesis equation

\[
\Delta \log H(t) = c + \sum w(j) \Delta \log X(j, t) \\
+ \beta \left\{ \Delta \log EMP(t) \right\} + u(t)
\]  \hspace{1cm} (2)

where \( \Delta \log EMP(t) \equiv \Delta [\log H(t)] + [\Delta \log Res(t)] \).

We impose \( \sum w(j) = 1 \), implemented by treating £ as the last currency.

4-year sub-samples estimated for each country.
Findings
First we test out the synthesis technique on some known $ peggers

• RMB (Table 2.5):
  – a perfect peg to the dollar during 2001-04 ($ coefficient =.99, flexibility coefficient insignificantly different from 0, & R2=.99).
  – In 2005-07 the EMP coefficient suggested that only 90% of increased demand for the currency shows up in reserves, rather than 100%; but the $ weight & R2 were as high as ever.

• Hong Kong $ (Table 2.8):
  – close to full weight on US$, 0 flexibility, & perfect fit.
A commodity-producing pegger

- **Kuwaiti dinar** shows a firm peg throughout most of the period: a near-zero flexibility parameter, & $R^2 > .9$
  (IV estimates in Table 3.5; IV= price of oil).
- A small weight was assigned to other currencies in the 1980s basket,
- but in the 2\textsuperscript{nd} half of the sample, the anchor was usually a simple $\$$ peg.
A first official basket pegger which is on a path to the €

• The Latvian lat (Table 2.10)
  – Flexibility is low during the 1990s, and has disappeared altogether since 2000. R2 > .9 during 1996-2003.
  – The combination of low flexibility coefficient and a high R2 during 2000-03 suggests a particularly tight basket peg during these years.
  – Initially the estimated weights include
    $-weight .4
    ¥-weight .3; though both decline over time.
    DM-weight .3 until 1999,
  – then transferred to €: .2 in 2000-03 and .5 in 2004-07.
A 2nd official basket pegger also on a path to the €

- **The Maltese lira** (Table 2.12)
  - During 1980-2003, weight on the $ is .2 -.4.
  - During 1980-1995, the European currencies garner .3-.4, the £ .2-.3 & the ¥ .1.
  - At the end of the sample period, the weight on the € rises almost to .9.
3rd official basket pegger

- **Norwegian kroner** (Table 2.14)
  - The estimates show heavy intervention.
  - Weights are initially .3 on the $ and .4 on European currencies (+ perhaps a little weight on ¥ & £).
  - But the weight on the European currencies rises at the expense of the $, until the latter part of the sample period shows full weight on the € and none on the $.
4th official basket pegger

- **Seychelles rupee** (Table 2.17)
  - confirms its official classification, particularly in 1984-1995: not only is the flexibility coefficient essentially 0, but $R^2 > .97$.
  - Estimated weights: .4 on the $, .3 on the European currencies, .2 on the ¥ and .1 on the £.
  - After 2004, the $ weight suddenly shoots up to .9.
2 Pacific basket peggers

• **Vanuatu** (Table 2.19)
  – low exchange rate flexibility and a fairly close fit.
  – roughly comparable weights on the $, ¥, €, and £.

• **Western Samoa** (Table 2.20)
  – heavy intervention during the first 3 sub-periods,
  – around a basket that weights the $ most, and the ¥ 2nd.
  – Weights in the reference basket during 2000-2003 are similar, except the € now receives a large significant weight (.4).
A BBC country, rare in that it announced explicitly the parameters:
basket weights, band width and rate of crawl.

- **Chile in the 1980s & 1990s** (Table 2.4)
  - $R^2 > .9$.
  - The $ weight is always high, but others enter too.
- **Estimates qualitatively capture Chile’s**
  - shift from $ anchor alone in the 1980s, to a basket starting in 1992.
  - move to full floating in 1999.
Chile, continued

• But the estimates do not correspond perfectly to the policy shifts of 1992 & 99

• Possible explanations for gap between official regime and estimates include:
  – De facto ≠ de jure
  – Parameter changes more frequent than the 4-year sub-periods.
    • The Chilean authorities announced 18 changes in regime parameters (weights, width, and rate of crawl) during the 18-year period 1982 -1999.
    • The difficulty is that we have only monthly data on reserves, for most countries => it is not possible to estimate meaningful parameter values if they change every year or so.
Floaters

- **Australian $ (Table 2.1)**
  - The coefficient on EMP shows less flexibility than one would have expected, given that the currency is thought to have floated throughout this period.
  - Perhaps the problem is endogeneity of EMP.
    - World commodity prices are a natural IV. (Table 3.1)
    - For each sub-period, the estimated flexibility coefficient is indeed higher than it was under OLS, but still far below 1.
Extensions

• Allow coefficients to vary over time, even within the 4-year sub-samples (Tables 4.1-4.10);

• Relax constraint that $[\Delta \log H]$ and $[\Delta \log Res]$ enter with the same coefficient (Tables 5.1-5.8);

• Insert $\Delta$ Interest rate alongside $\Delta$ Reserves & $\Delta E$ (Tables 6.1-6.5);

• Check for robustness with respect to the numeraire unit used to define currency values: Sw.franc vs. SDR (Table 7);

• Alternate definition of Exchange Market Pressure, using Monetary Base
Current applications using higher-frequency data


• Not yet written up: results for 13 countries that offer weekly data on reserves.
Updated estimation of the RMB with daily data

• This approach reveals that by mid-2007, the RMB basket had switched a substantial part of the $ weight onto the €.

• Implication is that the appreciation of the RMB against the dollar during this period was due to the appreciation of the € against the $, not to any upward trend in the RMB relative to its basket.
Table 1: Evolution of RMB Basket Weights from 10-22-2006, 3-month windows of daily data, ending on the month shown

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<td>0.814***</td>
<td>0.878***</td>
<td>0.992***</td>
<td>0.971***</td>
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<td>(0.035)</td>
<td>(0.041)</td>
<td>(0.027)</td>
<td>(0.039)</td>
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<td>0.019</td>
<td>0.049**</td>
<td>0.070**</td>
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<td>(0.017)</td>
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<td>0.001***</td>
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<td>0.96</td>
<td>1.00</td>
<td>1.00</td>
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<td>krw</td>
<td>0.011</td>
<td>0.098</td>
<td>0.059</td>
<td>-0.011</td>
<td>-0.019</td>
</tr>
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</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Table 2: Rolling 12-month regressions of value of RMB

$\Delta (\text{EMP})$ defined as $[\text{res}(t)-\text{res}(t-1)]/\text{mb}(t-1) + [\text{exr}(t)-\text{exr}(t-1)]/\text{exr}(t-1)$

12-month windows, ending on the month shown

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<th>07M2</th>
<th>07M3</th>
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<th>08M5</th>
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<td>0.756***</td>
<td>0.613***</td>
<td>0.597***</td>
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<td>(0.096)</td>
<td>(0.068)</td>
<td>(0.143)</td>
<td>(0.105)</td>
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<td>0.290***</td>
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<td>(0.047)</td>
<td>(0.029)</td>
<td>(0.076)</td>
<td>(0.097)</td>
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<td>-0.004***</td>
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<td>R-squared</td>
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<td>-0.024</td>
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Results for 13 countries that offer weekly data on reserves (1991-2008):

- Argentina, Brazil, Canada, Chile, Colombia, India, Indonesia, Mexico, Peru, Russia, Thailand, Turkey & Venezuela.

- E.g.,
  - Colombia: during 2008, $ weight fell & flexibility increased.
  - Turkey during 2008 & 2008 moved from high euro weight with low flexibility to low euro weight with high flexibility.
### Colombia: Evolution of Basket Weights, Monthly Regressions with Daily data, 2008

<table>
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<tr>
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<td>EUR</td>
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<td>(0.277)</td>
<td>(0.180)</td>
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<tr>
<td>Δ(emp)</td>
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<td>0.447***</td>
<td>0.688***</td>
<td>0.931***</td>
<td>0.858***</td>
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<td>(0.110)</td>
<td>(0.049)</td>
<td>(0.091)</td>
<td>(0.062)</td>
<td>(0.076)</td>
<td>(0.203)</td>
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Observations | 21 | 22 | 14 | 15 | 20 | 21 |

GBP | -0.054 | 0.121 | 0.528 | 0.270 | 0.183 | 0.089 |

Robust standard errors in parentheses  *** p<0.01, ** p<0.05, * p<0.1
Turkey: Evolution of Basket Weights,
Quarterly Regressions with Weekly data

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<td>(0.056)</td>
<td>(0.204)</td>
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Observations 10 14 13 10
GBP 0.357 -0.644 0.281 1.151
Bottom line(s)

• The new synthesis technique is necessary to discern exchange rate regimes where both the anchor weights and the flexibility parameter are unknown.

• Weekly data are necessary to capture the frequency with which many countries’ exchange rate regimes evolve.
Appendix 1: Correlations Among Regime Classification Schemes

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<th>GGW</th>
<th>LY-S</th>
<th>R-R</th>
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<td>R-R</td>
<td>0.33</td>
<td>0.34</td>
<td>0.41</td>
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</table>

(Frequency of outright coincidence, in %, given in parenthesis.)

GGW = Ghosh, Gulde & Wolf. LY-S = Levy-Yeyati & Sturzenegger. R-R = Reinhart & Rogoff
Sample: 47 countries. From Frankel (2004).
Appendix 2: Monte Carlo study on fabricated currency regimes

- Two kinds of flexibility
  - Leaning ½-way against the wind of EMP fluctuations (Table 8.1)
  - Or else constrained to remain in a 5% band (Table 8.2)

- Two anchors
  - $ peg
  - Basket: $1/3, €1/3, ¥1/3

- The synthesis technique generally gives the right answer.
Monte Carlo exchange rate under simulated basket+band regime
(with parameters from Papual New Guinea)
Appendix 3 -- One concern: endogeneity of the exchange market pressure variable

- One would prefer to observe changes in the international demand for the home currency known to originate in exogenous shocks.
- In the case of countries that specialize in the production of mineral or agricultural commodities, there is a ready-made IV: changes in the price of the commodity on world markets.
- Accordingly, Tables 3 repeat the synthesis estimation technique, but for the commodity producers it uses changes in the world price of the commodity in question as an IV for changes in EMP.
To address endogeneity of EMP, we use commodity prices as IV

- **Malaysian ringgit** (Table 2.11) OLS.
  - Only in 1996-99 is there evidence of exchange rate flexibility (Asia crisis).
  - During 2000-03 there is a perfect peg to the $ (coefficient $ R^2$ both =1).
  - In 2004-07 the peg is still fairly strong, but here the weight of the US$ falls to .6, partially replaced by the Singapore $ (weight = .4).

- **IV = prices of tin & semiconductors** (Table 3.6)
  - Again, a perfect $ peg during 2000-03,
  - followed by shift to a basket consisting of an average of the US $ + the Singapore $.
Recurrent finding: IV estimate on EMP is higher than OLS estimate (but lower in significance)

- Floaters: IV estimates for Canadian $, as with A$, show flexibility parameters in each sub-period higher than they were under OLS, but surprisingly insignificant statistically.
- IV also raises flexibility coefficient for Intermediate regimes:
  - Thailand (Table 3.11) IV = price of rice
  - W.Samoa (Table 3.12) IV = price of coconuts.