Trading Asian Crisis Country Systematic Risk like the Weather

What’s My Inspiration (What Led Me Here)?

- In Hull’s chapter about pricing non-financial risks, he says the underlying stochastic process “… could be something as far removed from financial markets as the temperature in New Orleans”
- Go the Chicago Mercantile Exchange website. You’ll see many different Weather derivative contracts being traded
- Zeng’s (2000) example: a snow mobile dealer in Colorado, worries about less than normal snowfall, and buys a snowfall put, that pays out when snowfall is less than the “strike” value

Quantifying Weather Risk

- First compute a weather index, like Heating Degree Day (HDD), or Cooling Degree Day (CDD)

$$HDD = \sum_{i=1}^{N} \max(0, 65°F - T_i)$$

$$CDD = \sum_{i=1}^{N} \max(0, T_i - 65°F)$$

$$T_i = \frac{temp(i)_{\max} + temp(i)_{\min}}{2},$$

Pricing Weather Derivatives

- Then you write a derivative contract on the weather index (like CDD or HDD), depending on the context

$$P_{call} = k \cdot \max(W - S, 0)$$

$$P_{put} = k \cdot \max(S - W, 0)$$

$$P_{swap} = k \cdot (W - S).$$

- Note there is a problem here: there is no Black-Scholes benchmark for weather

How About Hedging Against A Financial Crisis?

- After all, you can make the analogy between a crisis and an increase in temperature
- First, you’d want an index to quantify the risk
- Second, you’d want a methodology to price the risk
- Third, you’d want a methodology to guide trading strategies

Quantify Country Risk With Solnik's (1974) Single-Currency, Country CAPM

- I want to disentangle currency risk from equity risk, so I use the following model as a point of departure

The Constant of Proportionality

$$E(r_k) - r_{fk} = \boldsymbol{\beta_{kw}}[E(r_w) - r_{fk}]$$

Excess Return Above Risk Free Rate for Country *k*…

Should be Proportional to the Excess Return for the Global Index above the Risk Free Rate for Country *k*

Quantifying Financial Crisis Risk With Time-Varying, (Rolling) Country Betas

- A simplified Scholes-Williams (1977) estimator to correct country risk for the fact that trading does not occur synchronously across markets:

A Simplified SW Beta

$$b_{kw,t}^{S} = b_{kw,t}^{+} + b_{kw,t} + b_{kw,t}^{-}.$$

Estimate 250-Trading Day, Rolling Regressions

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-249} \end{pmatrix} = a^{+}_{kw,t} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + b^{+}_{kw,t} \begin{pmatrix} r_{w,t+1} \\ r_{w,t} \\ \vdots \\ r_{w,t-248} \end{pmatrix} + \begin{pmatrix} e^{+}_{k,t} \\ e^{+}_{k,t-1} \\ \vdots \\ e^{+}_{k,t-249} \end{pmatrix}$$

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-249} \end{pmatrix} = a_{kw,t} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + b_{kw,t} \begin{pmatrix} r_{w,t} \\ r_{w,t-1} \\ \vdots \\ r_{w,t-249} \end{pmatrix} + \begin{pmatrix} e_{k,t} \\ e_{k,t-1} \\ \vdots \\ e_{k,t-249} \end{pmatrix}$$

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-249} \end{pmatrix} = a^{-}_{kw,t} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + b^{-}_{kw,t} \begin{pmatrix} r_{w,t-1} \\ r_{w,t-2} \\ \vdots \\ r_{w,t-250} \end{pmatrix} + \begin{pmatrix} e^{-}_{k,t} \\ e^{-}_{k,t-1} \\ \vdots \\ e^{-}_{k,t-249} \end{pmatrix}$$

Instead of OLS, Try α-Trimmed Least Squares, (with α=10%)

- The idea is that in each window, you compute residuals, rank them from largest to smallest and trim out the 10% most positive, and 10% most negative
- Koenker and Bassett (1978) propose this estimator, a multi-variate analog to the trimmed mean
- Q: Why Do I Use this Here?

  A: Only to Show You that it's NOT the Most Extreme Values Driving the Results

By the Way, Why Not Use Conditional Betas?

- Estimate the Burns, Engle, Mezrich (or BEM), Journal of Derivatives (1998) model,

Conditional mean equation

$$\begin{pmatrix} r_{k,t} \\ r_{w,t} \end{pmatrix} = \begin{pmatrix} \mu_k \\ \mu_w \end{pmatrix} + \begin{pmatrix} \varepsilon_{k,t} \\ \varepsilon_{w,t} \end{pmatrix} + \begin{pmatrix} m_{kk} & m_{kw} \\ m_{wk} & m_{ww} \end{pmatrix} \begin{pmatrix} \varepsilon_{k,t-1} \\ \varepsilon_{w,t-1} \end{pmatrix}$$

Conditional covariance equation

$$H_t = \begin{pmatrix} \sigma_{k,t}^2 & \sigma_{k,w,t} \\ \sigma_{k,w,t} & \sigma_{w,t}^2 \end{pmatrix}$$

$$= \begin{pmatrix} a_{kk,0} & 0 \\ a_{kw,0} & a_{ww,0} \end{pmatrix} \begin{pmatrix} a_{kk,0} & a_{kw,0} \\ 0 & a_{ww,0} \end{pmatrix} +$$

$$\begin{pmatrix} a_{kk,1} & a_{wk,1} \\ a_{kw,1} & a_{ww,1} \end{pmatrix} \begin{pmatrix} \varepsilon_{k,t-1} \\ \varepsilon_{w,t-1} \end{pmatrix} \begin{pmatrix} \varepsilon_{k,t-1} & \varepsilon_{w,t-1} \end{pmatrix} \begin{pmatrix} a_{kk,1} & a_{kw,1} \\ a_{wk,1} & a_{ww,1} \end{pmatrix} +$$

$$\begin{pmatrix} a_{kk,2} & a_{wk,2} \\ a_{kw,2} & a_{ww,2} \end{pmatrix} \begin{pmatrix} \sigma_{k,t-1}^2 & \sigma_{k,w,t-1} \\ \sigma_{k,w,t-1} & \sigma_{w,t-1}^2 \end{pmatrix} \begin{pmatrix} a_{kk,2} & a_{kw,2} \\ a_{wk,2} & a_{ww,2} \end{pmatrix}$$

BEM Betas:
You Combine the MA matrix with the Covariance matrix

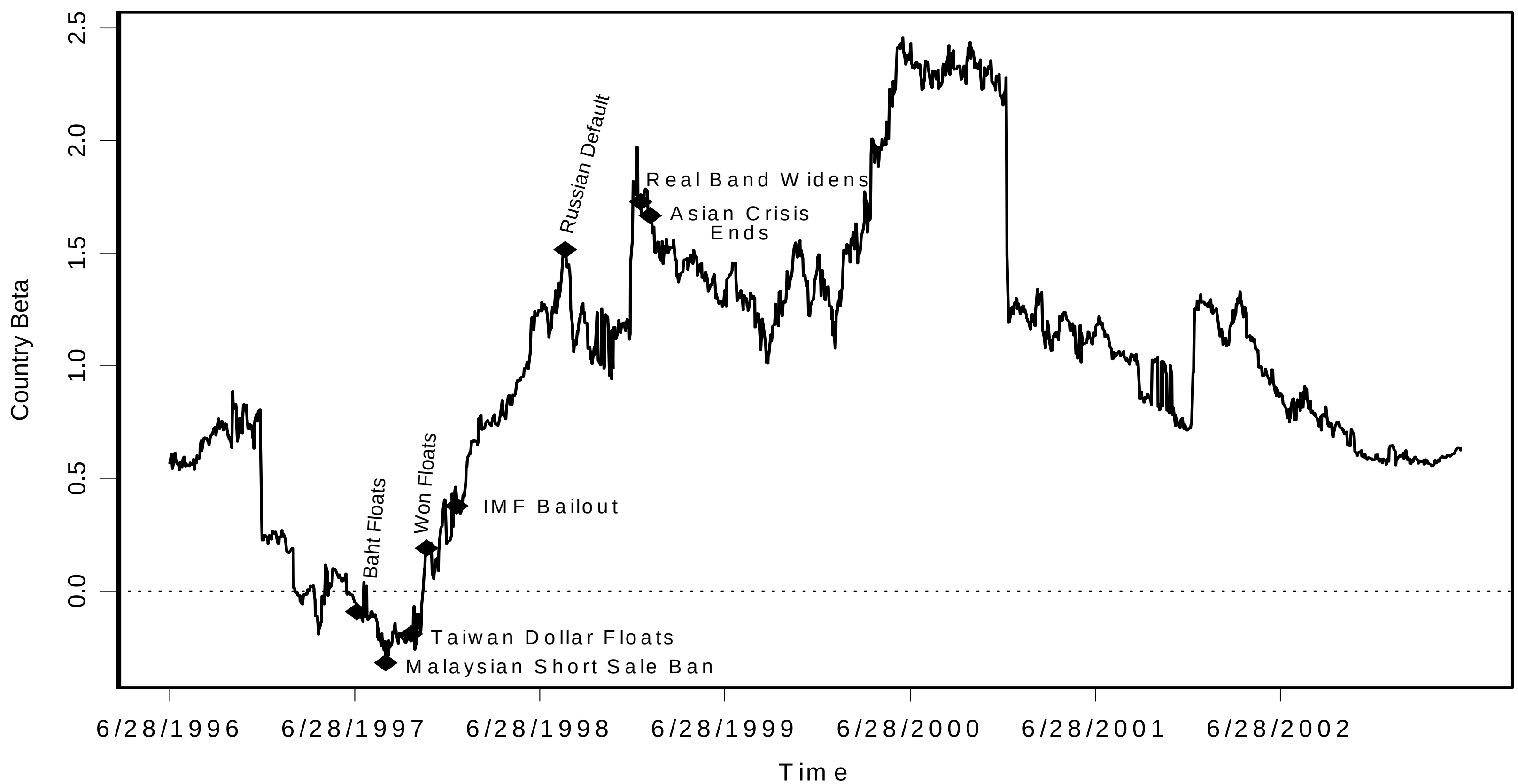
$$\beta_{k,t}^s = \frac{s_{k,w,t}}{s_{w,t}^2}$$

$$= \frac{\sigma_{k,t}^2 m_{wk}(1+m_{kk}) + \sigma_{k,w,t}\left[(1+m_{ww})(1+m_{kk}) + m_{wk}m_{kw}\right] + \sigma_{w,t}^2 m_{kw}(1+m_{kk})}{\sigma_{k,t}^2 m_{wk}^2 + 2\sigma_{k,w,t} m_{wk}(1+m_{ww}) + \sigma_{w,t}^2 (1+m_{ww})^2}.$$

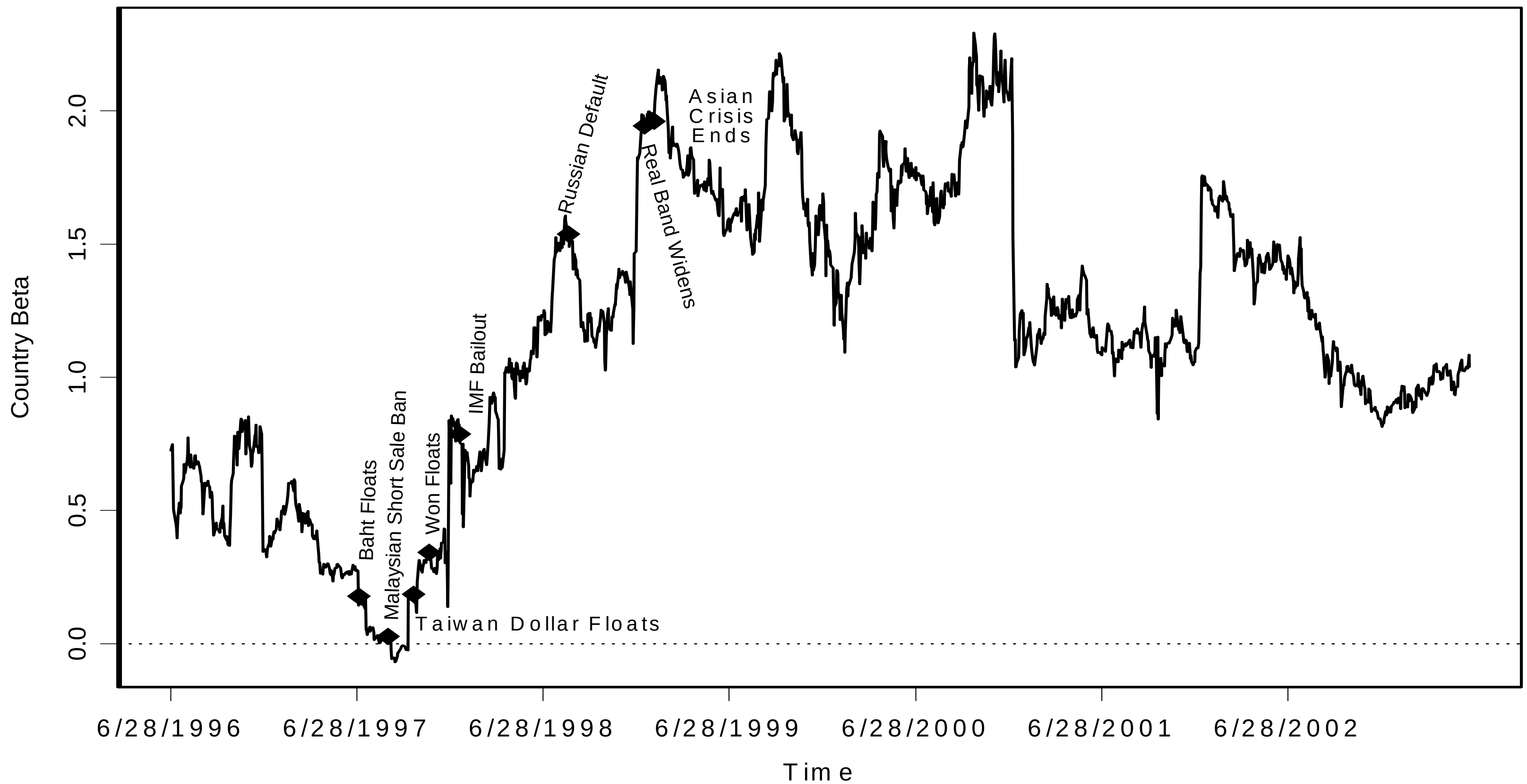
I'd Like the Same Values Across Samples, but I don't get that…

	Sample used to Estimate Conditional Betas	Conditional Beta on the first day of the Asian Crisis - July 2, 1997	Conditional Beta for the end of the Asian Crisis - February 1, 1999	Conditional Beta for date of last observation in first sample June 25, 2001
	7/3/95-6/25/01 observations: 1500	0.2734	0.4503	1.5251
China	8/1/95-7/24/01 observations: 1500	0.3469	0.5027	1.4729
	7/3/95-6/20/03 observations: 1995	0.2075	0.4789	1.3936
	7/3/95-6/25/01 observations: 1500	0.7960	0.8397	0.3005
Korea	8/1/95-7/24/01 observations: 1500	0.8232	0.8228	0.3230
	7/3/95-6/20/03 observations: 1995	0.8388	1.1696	0.3739
	7/3/95-6/25/01 observations: 1500	1.3796	5.1615	2.4477
Indonesia	8/1/95-7/24/01 observations: 1500	-0.2233	1.2093	0.0168
	7/3/95-6/20/03 observations: 1995	-0.0697	1.3506	0.1631
	7/3/95-6/25/01 observations: 1500	-0.2391 [a]	0.5134 [a]	0.2831 [a]
Thailand	8/1/95-7/24/01 observations: 1500	-0.2766	0.4464	0.2670
	7/3/95-6/20/03 observations: 1995	-0.6412 [a]	0.6521 [a]	0.2538 [a]
	7/3/95-6/25/01 observations: 1500	0.2793 [a]	-0.2896 [a]	0.3262 [a]
India	8/1/95-7/24/01 observations: 1500	0.2194 [a]	-0.2918 [a]	0.2807 [a]
	7/3/95-6/20/03 observations: 1995	-0.1419	-0.1191	0.2505
	7/3/95-6/25/01 observations: 1500	-1.7456	0.3796	1.1840
Turkey	8/1/95-7/24/01 observations: 1500	-1.6767	0.4877	1.3461
	7/3/95-6/20/03 observations: 1995	-1.7729	0.3211	1.4122
Argentina	7/3/95-6/25/01 observations: 1500	0.8103 [a]	1.6460 [a]	1.2007 [a]
	8/1/95-7/24/01 observations: 1500	0.7718	1.6244	1.1596
	7/3/95-6/20/03 observations: 1995	0.6096	1.2749	0.6759

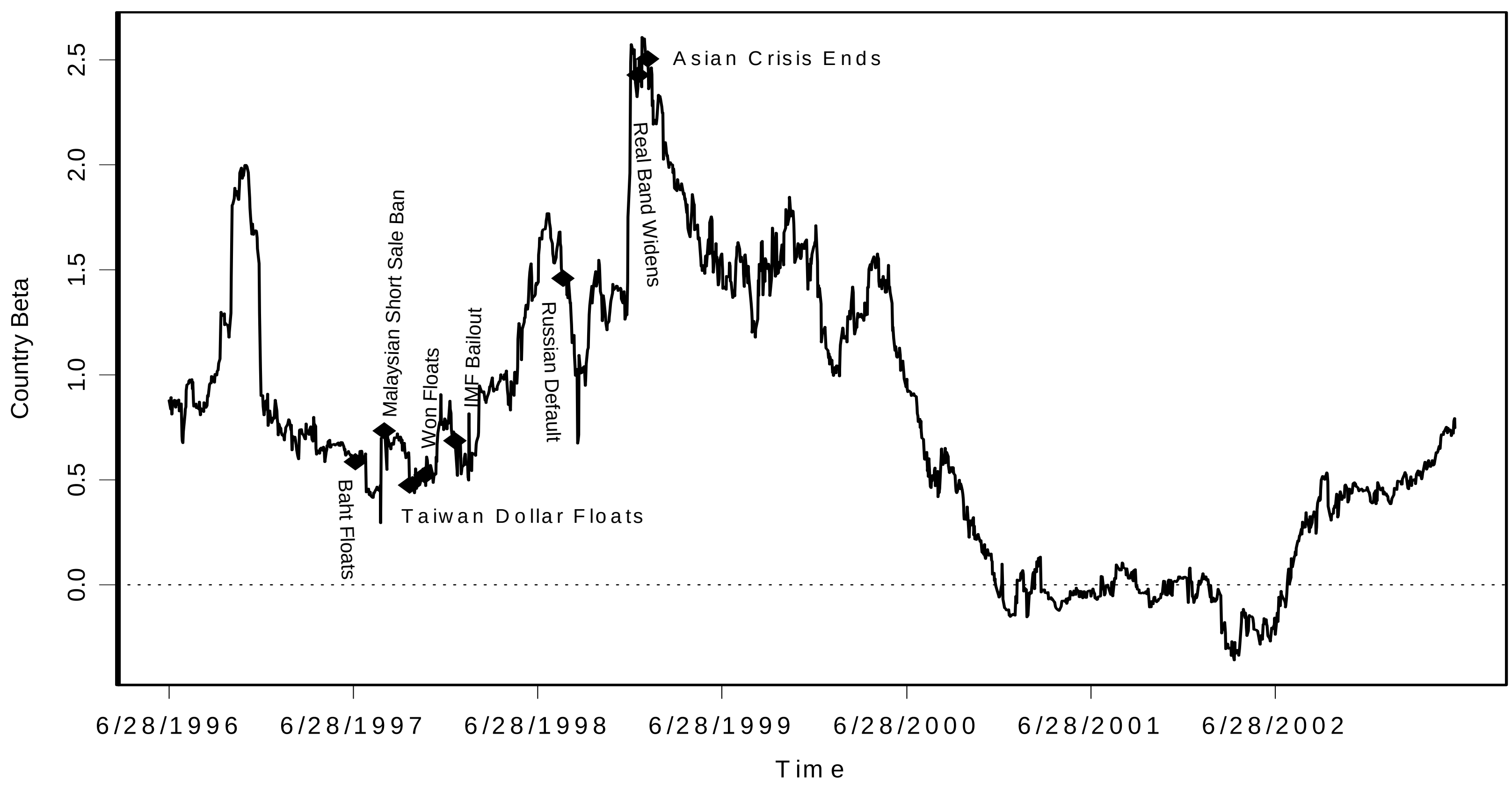
So, Here Are Some Crisis Risk Indices: Country Betas, China, 28/06/96-19/07/03



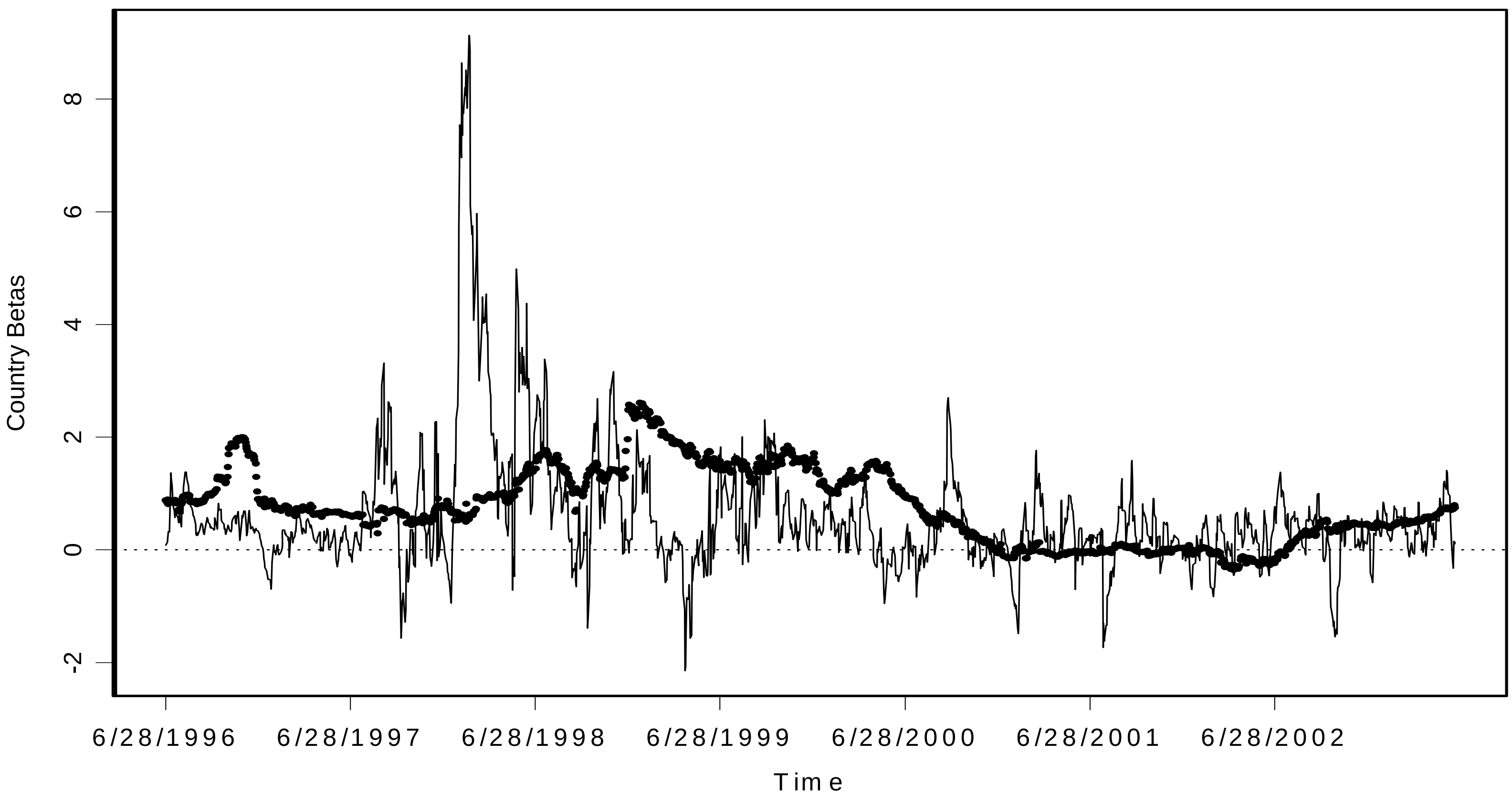
Country Betas, Korea, 28/06/96-19/07/03



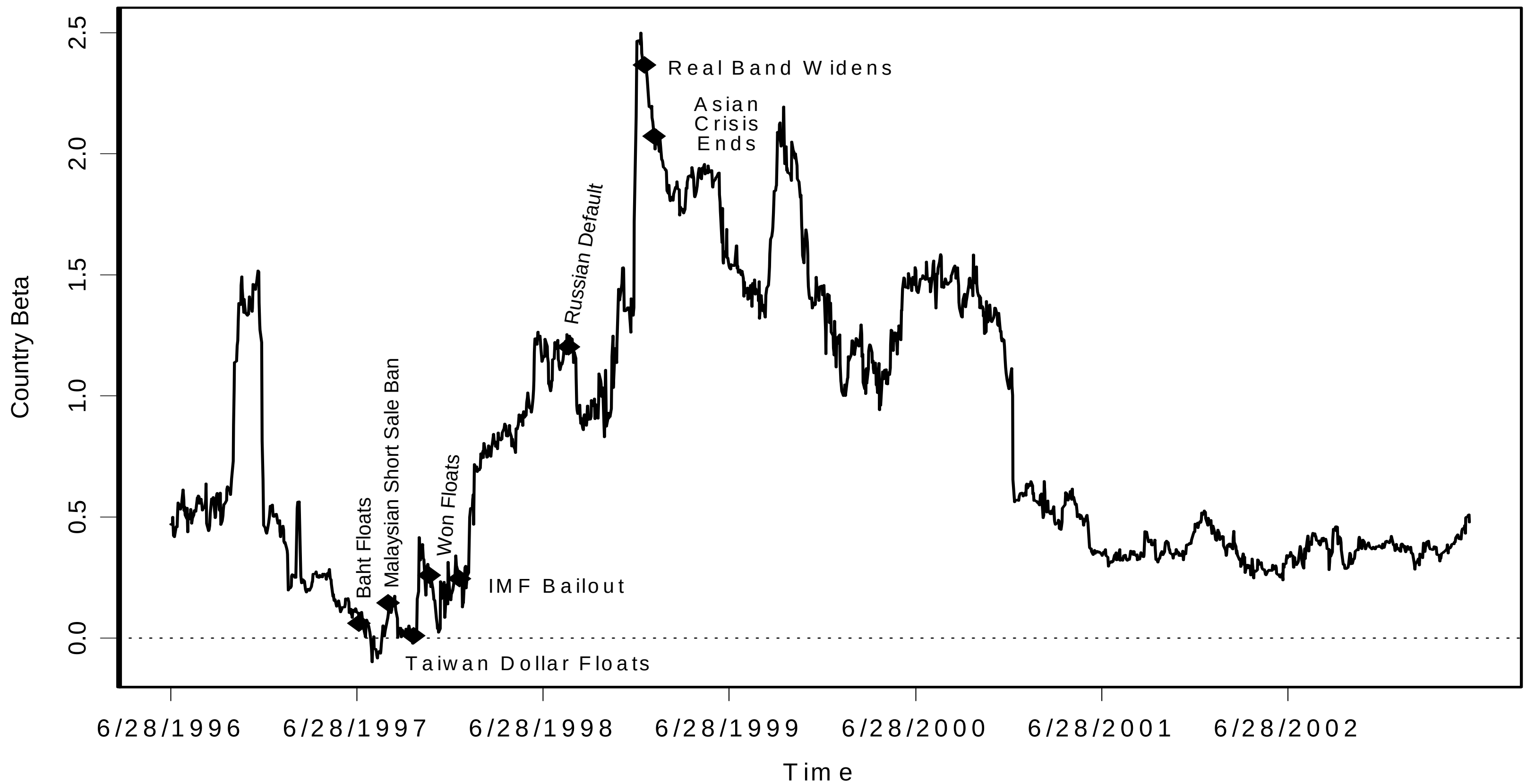
Country Betas, Indonesia, 28/06/96-19/07/03



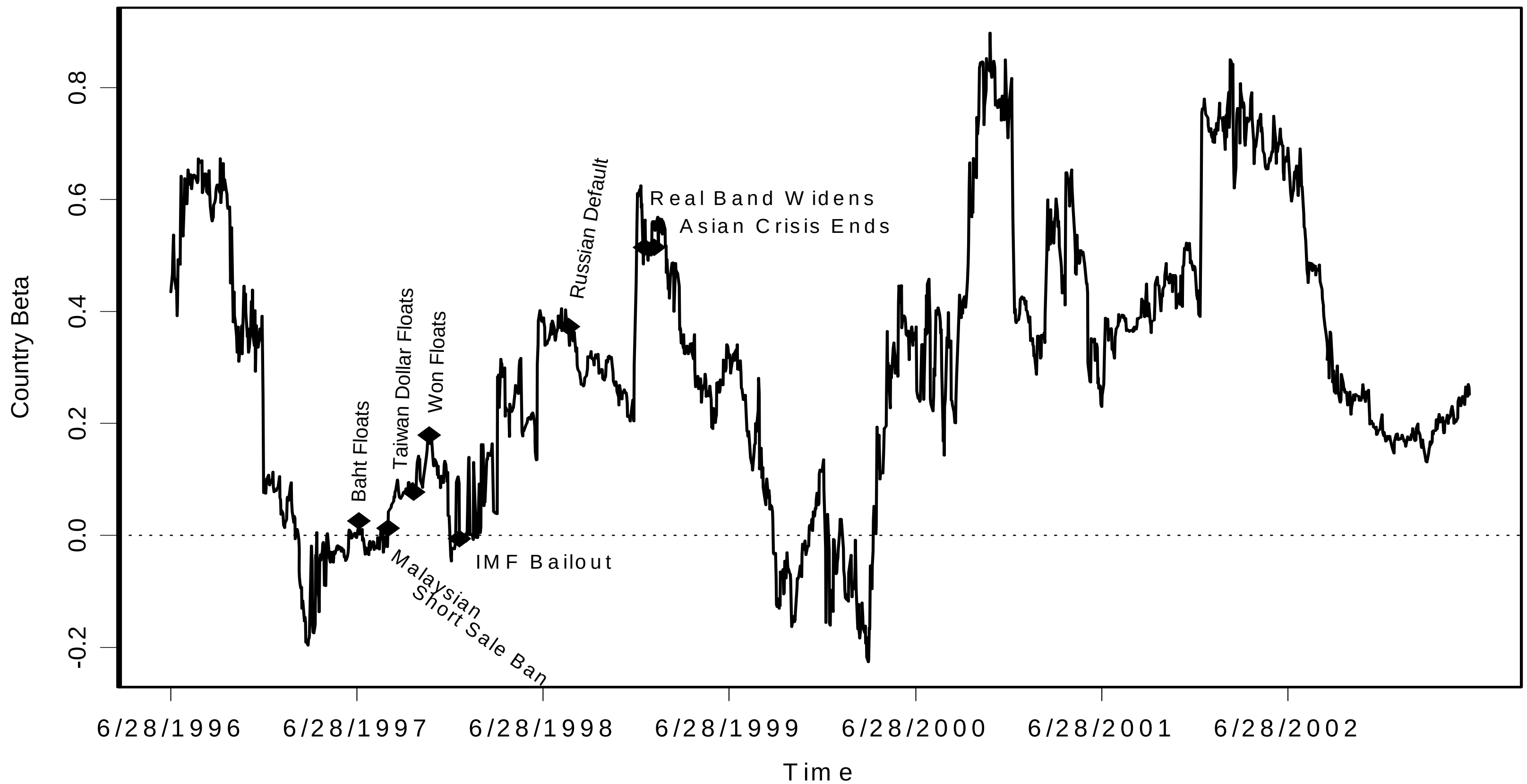
TLS (dots) vs. BEM (straight lines) Betas: Indonesia



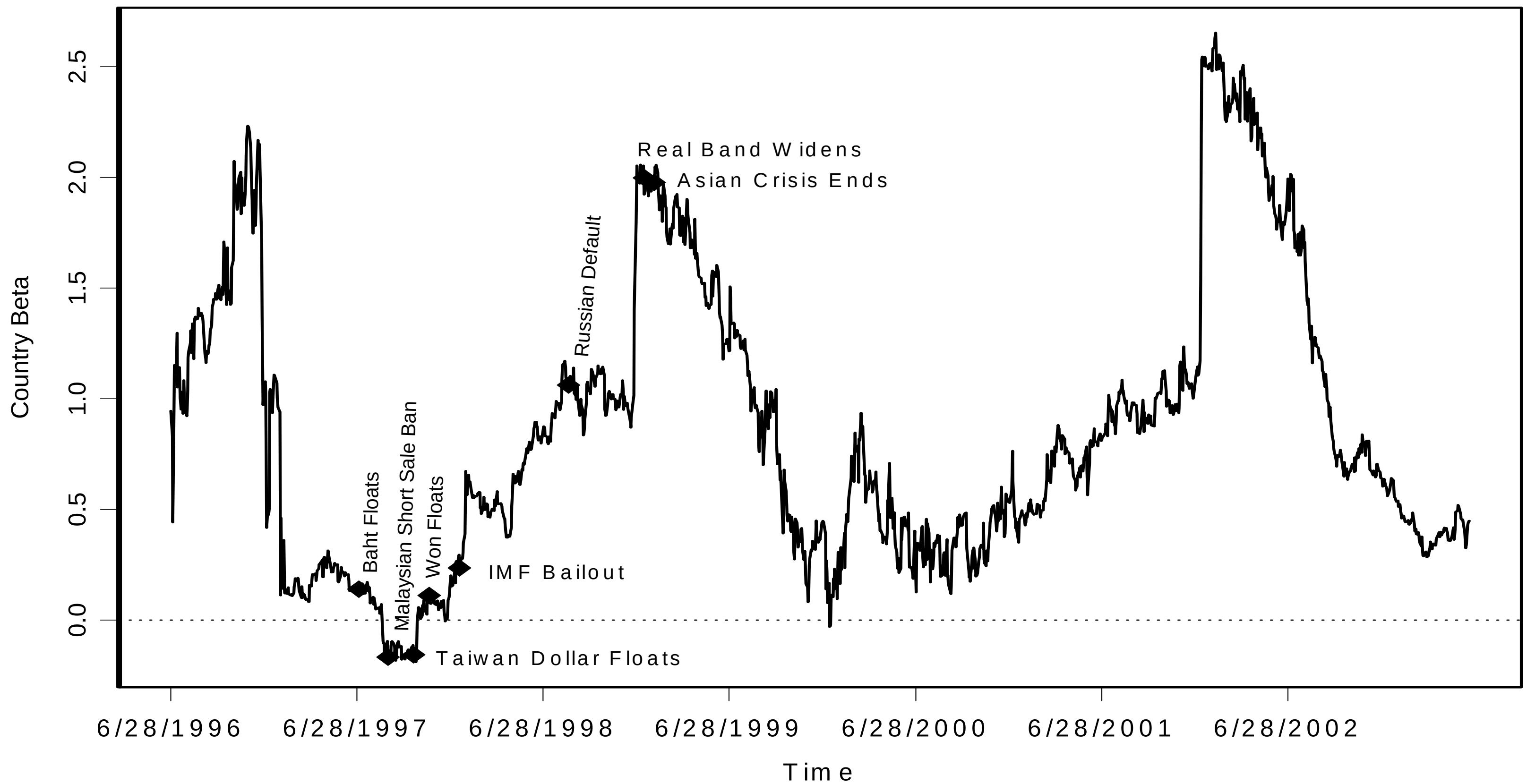
Country Betas, Thailand, 28/06/96-19/07/03



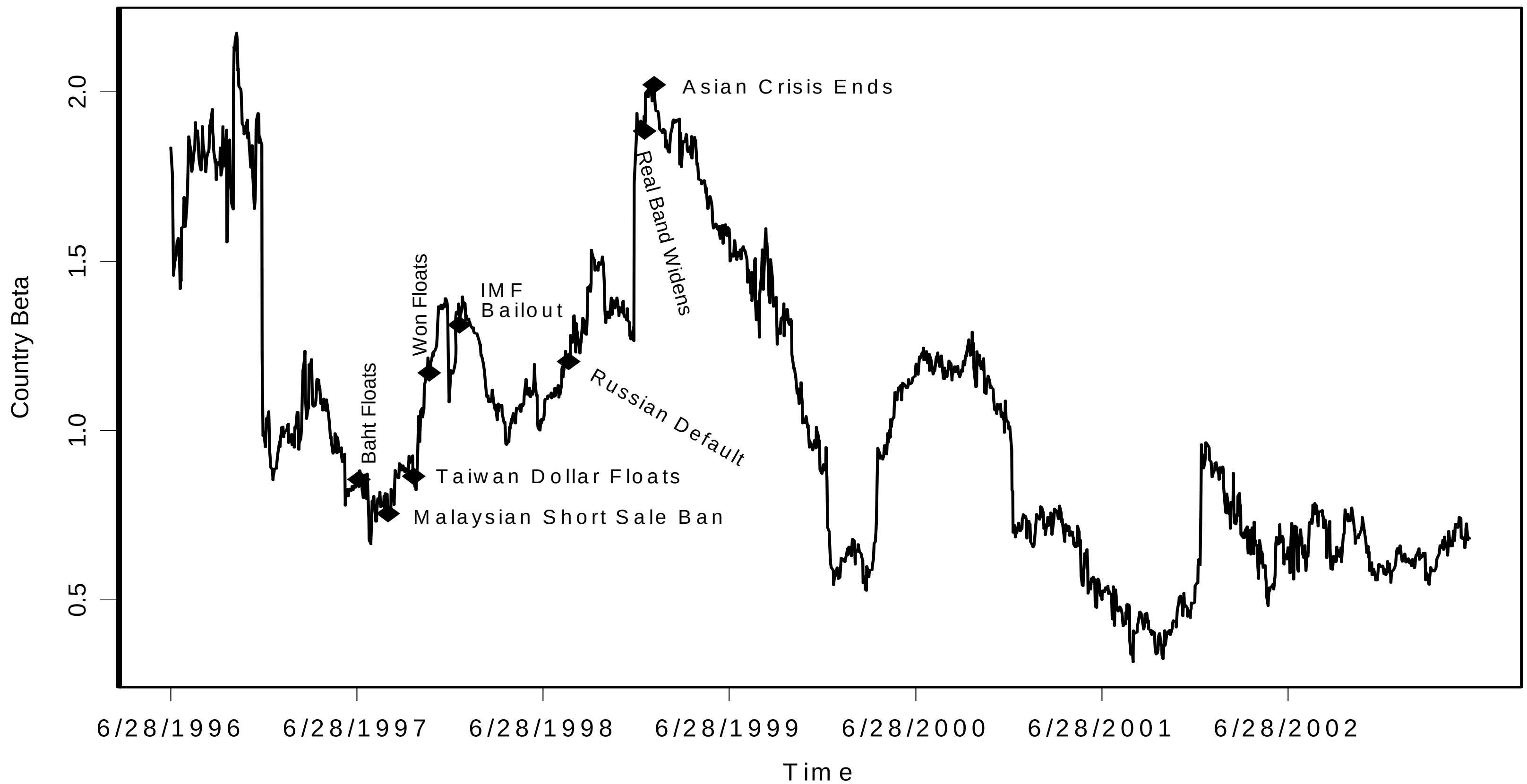
Country Betas, India, 28/06/96-19/07/03



Country Betas, Turkey, 28/06/96-19/07/03



Country Betas, Argentina, 28/06/96-19/07/03



How Would I Price This?

- I don’t really know, since I’m not really sure what kind of distribution the country comes from
- I do know there’s lots of dependence, though
- Zeng (2000) says that’s exactly the problem with weather; lot’s of dependence

Here's a Non-Methodological Answer (i.e., Any Other Thoughts?)

- Here's a formula for call prices (the option pays out for country betas above the strike value) $P_{call} = k \cdot \max(\beta_{i,t+125} - S_{i,t},\ 0)$
- I then compute the strike as

$$S_{i,t} = \beta_{i,t-1} + IQR\left(\beta_{i,t-1,t-125}\right)/2$$
$$= \beta_{i,t-1} + \left[\beta^{0.75}_{i,t-1,t-125} - \beta^{0.25}_{i,t-1,t-125}\right]/2 .$$

so

$$P_{call,t+125} = \$10{,}000 \cdot \max\left(\beta_{i,t+125} - S_{i,t},\ 0\right)$$
$$= \$10{,}000 \cdot \max\left(\beta_{i,t+125} - \beta_{i,t-1} - \left[\beta^{0.75}_{i,t-1,t-125} - \beta^{0.25}_{i,t-1,t-125}\right]/2,\ 0\right).$$

Here Are Some Results (Big Deal)

	July 2, 1997	January 2, 1998	July 2, 1998	December 31, 1998	July 2, 1999	December 31, 1999	July 3, 2000	January 2, 2001	July 2, 2001	January 2, 2002	July 2, 2002	January 2, 2003	Asian Crisis	Post Crisis	Total
Philippines	0	0	$6,597	$15,509	0	0	0	0	0	0	$2,290	0	$22,106	$2,290	$24,396
Thailand	0	$370	$9,563	$11,209	0	0	0	0	0	$650	0	0	$21,141	$650	$21,791
South Africa	0	0	$4,584	$13,754	0	0	0	$2,457	0	0	0	0	$18,339	$2,457	$20,796
Malaysia	0	$4,306	$4,668	$8,259	0	0	0	0	0	0	$1,741	0	$17,233	$1,741	$18,974
Indonesia	0	$1,322	$7,807	$7,528	0	0	0	0	0	$266	0	$4,569	$16,657	$4,834	$21,492
Turkey	0	0	$5,735	$10,779	0	0	0	$628	$1,611	$1,783	$7,279	0	$16,514	$11,300	$27,814
China	0	$2,132	$9,127	$3,592	0	$424	$7,680	0	0	0	$263	0	$14,851	$8,367	$23,218
South Korea	0	$5,721	$1,698	$4,905	0	0	0	$2,710	0	0	$2,794	0	$12,324	$5,503	$17,827
Brazil	$193	$8,673	0	$2,872	$2,266	0	0	0	0	0	$2,406	0	$11,738	$4,672	$16,410
Argentina	0	$2,399	0	$7,051	0	0	$961	0	0	0	0	0	$9,450	$961	$10,411
Chile	$2,920	0	$328	$5,768	0	0	$625	0	0	0	$3,635	0	$9,015	$4,260	$13,276
Taiwan	0	0	$1,223	$5,757	0	0	$394	0	0	$2,444	$3,236	0	$6,980	$6,074	$13,054
India	0	0	$3,071	$1,684	0	0	$679	$3,545	0	$630	$1,744	0	$4,755	$6,598	$11,353

Lots of Positives During the Crisis

Lots of Zeroes After the Crisis

I’m Thinking to Try Look Back Options

- Even though Betas Are not Monetary Values, I may try to make them so, by multiplying by a cash value. Why?

- If you didn’t see the presentation I gave on replicating financial crises with exchange options, the idea is that during a crisis investors simultaneously seem to exercise options to leave one country for investments elsewhere…

Problem

- Exchange Options are typically more expensive to price than plain vanilla's because the correlations, and hence the country betas tend to be more volatile than pure volatility estimates

- So, a supplier of such insurance might benefit if they can hedge that risk, thereby perhaps lowering the costs of such insurance

Conclusion

- I've come full circle
  - First, I thought this was the key idea
  - Then, I discovered that you could replicate a crisis with exchange options
  - Now, to knock the price down, it may be useful to hedge country betas with call options
- It will be useful to think about forecasting country betas