Equity Integration in Times of Crisis

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Two Objectives:

1. Derive new methodology to assess integration of assets across instruments/borders/markets, etc.
2. Use methodology to illustrate technique empirically during periods of crisis
   - Integration inside NYSE drops during 10/'98
   - Seoul and Tokyo not integrated before or after Asia crisis, but worse during crisis

Definition of Asset Integration

- Assets are *integrated* if satisfy asset-pricing condition:

$$p_t^j = E_t(d_{t+1} x_{t+1}^j) \tag{1}$$

- Completely standard general framework

Paper Focus: $E_t(d_{t+1})$

- Marginal Rate of Substitution/Discount Factor ties together all intertemporal decisions
- Subject of much research (Hansen-Jagannathan, etc.)
- Prices all assets
- Unobservable, even *ex post* (but estimable)
- Should be identical for all assets *in an integrated market*

Empirical Strategy

Definition of Covariance:

$$p_t^j = E_t(d_{t+1} x_{t+1}^j) = COV_t(d_{t+1}, x_{t+1}^j) + E_t(d_{t+1}) E_t(x_{t+1}^j). \qquad (2)$$

Rearrange and substitute actual for expected (WLOG):

$$x_{t+1}^j = -[1/E_t(d_{t+1})] COV_t(d_{t+1}, x_{t+1}^j) + [1/E_t(d_{t+1})] p_t^j + e_{t+1}^j,$$

$$x_{t+1}^j = d_t (p_t^j - COV_t(d_{t+1}, x_{t+1}^j)) + e_{t+1}^j \qquad (3)$$

where $d_t = 1/E_t(d_{t+1})$

Impose Two (Reasonable?) Assumptions for Estimation:

1) *Rational Expectations*: e^{j}_{t+1} is assumed to be white noise, uncorrelated with information available at time t, and

2) *Factor Model*:

$COV_t(d_{t+1}, x^{j}_{t+1}) = b^{0}_{j} + \Sigma^{i} b^{i}_{j} f^{i}_{t}$, for the relevant sample.

Now we have an estimable Panel Equation:

$$x_{t+1}^{j} = d_t(p_t^j - COV_t(d_{t+1}, x_{t+1}^j) + e_{t+1}^j \qquad (3)$$

- Use *Cross-sectional* variation to estimate the coefficients of interest $\{d\}$ – the shadow discount rates
- Use *Time-series* variation to estimate nuisance coefficients {ß}
- Can estimate $\{d\}$ for two sets of assets and compare them
    - Should be equal if assets are integrated – priced with same shadow discount rate

Why this Strategy?

- Natural to look at first moment (of MRS) first
- Easy to estimate
- Insensitive in practice
- Confirm priors, previous research, but discriminating

Are Assumptions Reasonable?

Easier

- Rational expectations in financial markets at relatively high frequencies

Harder

- Portfolio-specific covariances (payoffs with discount rates) are either constant or have constant relations with small number of factors, *for short samples*
  - Standard assumption to make in literature
  - Use standard factor model (Fama-French)
    - Fama-French: 30 years; here for 1/2 months
  - Sensitivity Analysis for robustness

Strengths of Methodology

1. Tightly based on general theory
2. Do not need particular asset pricing model held with confidence *for long period of time*
3. Do not model discount rate directly
4. Relatively loose assumptions required
5. Requires accessible, reliable data

6. Can be used at many frequencies

7. Can be used for many asset classes (stocks, bonds, foreign)

8. Requires no special/obscure software (E-Views/RATS/TSP/STATA all work – just NLLS)

9. Focused on intrinsically interesting object

Differences with Literature

- We focus on first-moment of δ (estimated discount rate/MRS)
  - Standard: β (factor loadings), or second moment of δ
- The set-up is intrinsically non-linear
- Don't fixate on asset-pricing model

Most Importantly, don't impose bond market integration

- Consider risk-free gov't T-bill with price of \$1, interest i_t:

  $1=E_t(d_{t+1}(1+i_t)) \Rightarrow 1/(1+i_t)=E_t(d_{t+1})$

  - Do not use the T-bill rate *since the T-bill market may not be integrated with the stock market!*
  - Will test *(and reject!)* this assumption

- Do not violate replication/arbitrage since are testing for integration across markets where replication is impossible

Implementation

Estimate:

$$x_{t+1}^j / p_{t-1}^j = d_t((p_t^j / p_{t-1}^j) + b_j^0 + b_j^1 f_t^1 + b_j^2 f_t^2 + b_j^3 f_t^3) + e_{t+1}^j \quad (4)$$

- Normalize to make Cov() more plausibly time-invariant (with factors)
- Use Fama-French (1996) 3 factors
- Estimate with NLLS, Newey-West covariances
  - Degree of non-linearity low

Notes

- Similar in nature to Roll and Ross (1980)
- Subsumes static CAPM through $\{ß^0\}$
- Add three time-varying factors from Fama-French (their data!)
  - o Market return less T-bill return
  - o Small minus large return
  - o High minus low book/market returns

The NYSE during the LTCM Crisis

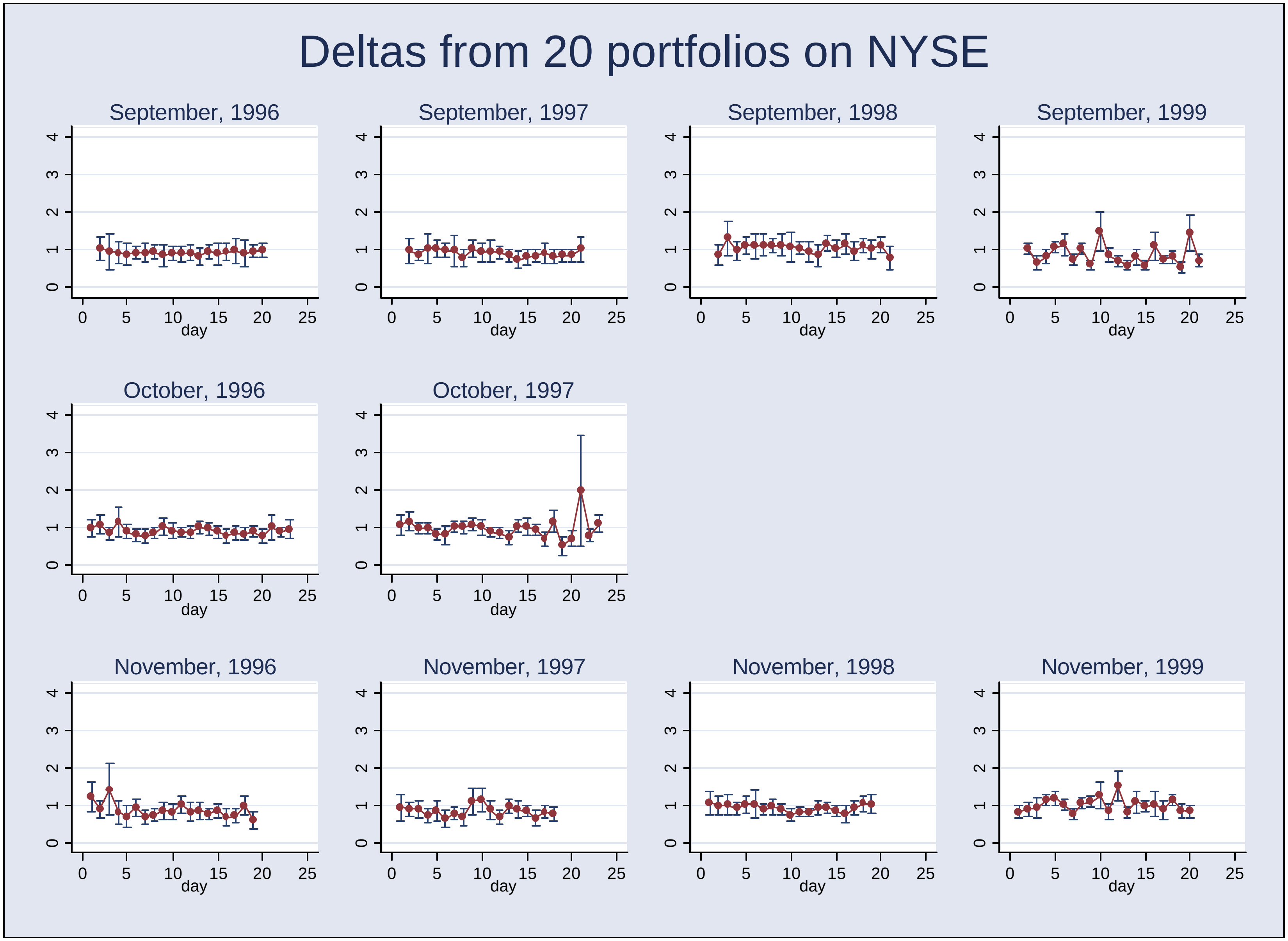
- Use moderately high-frequency approach
  - Daily data for 1-month span
  - September through November (each month separately)
  - 1996 through 1999
- Total of 12 samples of 1 month each

Portfolios

- Have 120 firms for each sample
- Group into 20 portfolios of 6 firms each (no dividends)
- Equally weighted

Shadow Discount Rates

- Can easily estimate from sets of 20 portfolios (along with confidence intervals)
  - Estimated under assumption of integration (!)


Deltas from 20 portfolios on NYSE
September, 1996
September, 1997
September, 1998
September, 1999
October, 1996
October, 1997
November, 1996
November, 1997
November, 1998
November, 1999
day
0 5 10 15 20 25
0 1 2 3 4

- Lots of time-series variation (Hansen-Jagannathan)
- Can reject hypothesis that δ = Treasury bill return (sluggish at almost zero => MRS should be 1)

Likelihood-Ratio (Joint) Test for Asset Integration

- Easy to compute by splitting sample into two sets of ten portfolios each
- Table 1:
  - Reject integration for October 1998
  - Bizarre, sensitive rejection for October 1999
  - Results insensitive to factor model
  - Bootstrapping (leptokurtosis!) to avoid assuming normality

A: Fama-French-Factor Model (intercepts, 3 time-varying factors)

	September	**October**	**November**
1996	34.7 (.33)	26.6 (.83)	32.3 (.40)
1997	39.7 (.17)	37.5 (.39)	32.2 (.05)
1998	34.4 (.40)	55.5 (.02)	27.6 (.56)
1999	16.6 (.97)	57.1 (.00)	30.3 (.43)

B: One-Factor Model (intercepts, market return factor)

	September	**October**	**November**
1996	24.2 (.55)	25.9 (.64)	41.2 (.05)
1997	29.6 (.34)	36.3 (.26)	29.7 (.19)
1998	25.4 (.49)	53.1 (.01)	22.6 (.61)
1999	15.9 (.95)	24.7 (.65)	26.3 (.42)

C: Model without Time-Varying Factors (intercepts only)

	September	**October**	**November**
1996	20.0 (.67)	25.8 (.59)	28.1 (.31)
1997	21.1 (.66)	38.3 (.66)	28.5 (.22)
1998	25.1 (.42)	54.2 (.01)	21.4 (.55)
1999	12.9 (.95)	26.4 (.50)	23.6 (.47)

D: Model without Asset-Specific Covariances

	September	**October**	**November**
1996	20.0 (.65)	24.8 (.61)	27.8 .25)
1997	20.6 (.59)	36.8 (.17)	31.1 (.10)
1998	20.9 (.60)	52.3 (.00)	22.4 (.43)
1999	10.9 (.98)	28.5 (.34)	22.2 (.47)

Table 1: Integration inside the American S&P 500

Likelihood-ration test statistics (bootstrap P-value)

NYSE is not integrated after LTCM/Russa Crisis

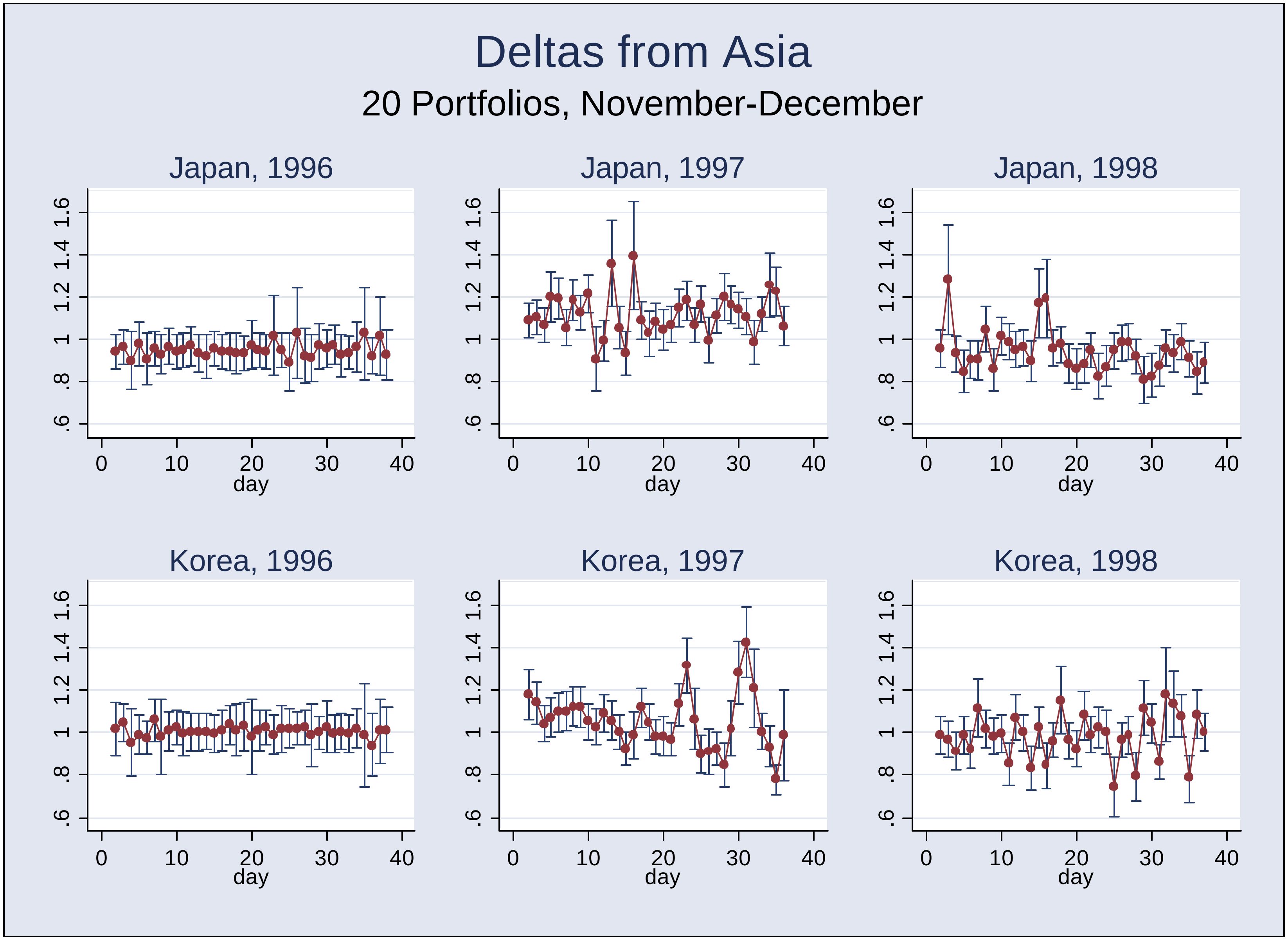
- Robust result

The Asian Crisis of 1997

- Focus on Korea, and financial integration with Japan
  - November and December (separately/combined)
  - 1996 through 1998
- Use domestic market return as factor (foreign too)

Portfolios

- 400 TSE stocks in 20 portfolios
- 360 Korean stocks in 20 portfolios
    - Converted into yen
- Equally weighted


Deltas from Asia
20 Portfolios, November-December
Japan, 1996
Japan, 1997
Japan, 1998
Korea, 1996
Korea, 1997
Korea, 1998
.6
.8
1
1.2
1.4
1.6
0
10
20
30
40
day

Again:

- Lots of time-series variation

Likelihood-Ratio (Joint) Test for Asset Integration

- Easy to compute by comparing Japanese and Korean MRSs
- Table 3-4:
    - Reject integration throughout
    - Worse in December 1997
    - Doesn’t depend on factor model
- Table 2 shows that cause is NOT lack of integration inside Seoul stock exchange

	November	December	November-December
1996	32.8 (.19)	27.3 (.32)	50.8 (.26)
1997	33.3 (.20)	27.0 (.29)	51.6 (.23)
1998	54.1 (.13)	10.5 (.97)	31.7 (.92)

Table 2: Integration inside the Korean Stock Exchange
One-Factor Model (intercepts, market return factor)
Likelihood-ration test statistics (bootstrap P-value)

	November	December	November-December
1996	389.9	259.2	640.3
1997	639.1	1716.2	2480.5
1998	269.3	591.3	876.3

Table 3: Integration between Korea and Japan
One-Factor Model (intercepts, domestic market return factor)
Likelihood-ration test statistics (all p-values =.00)

	November	December	November-December
1996	439.0	261.8	645.6
1997	626.5	1595.1	2401.1
1998	284.7	519.0	814.3

Table 4: Integration between Korea and Japan
Two-Factors Model (intercepts, domestic and foreign market return factors)
Likelihood-ration test statistics (all p-values =.00)

Tokyo and Seoul are never integrated

- Integration worsens during Asian crisis

Future Work

- Monte Carlo work for small samples

- Higher frequencies

Most Importantly

- Causes of low integration?