National Bureau of Economic Research
Asset Pricing Program Meeting
November 1994

Time-Varying World Market Integration

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- Increased awareness of the benefits of being global.
  - ⇒ Foreign assets enhance reward to risk profiles for portfolio managers.
  - ⇒ Better investment opportunities are being realized by corporations which are becoming more multinational.

- But how do we assess the expected returns for different countries?

- What are the risks and the risk premiums in international investment?

1. Introduction

Example:

Aguas Minerales S.A. and Cadbury Schweppes PLC, 1992

How do we value an asset in an emerging market?

Many investment bankers and consulting firms estimate the cost of capital as:

$$r_i = r_f + \beta_i(r_m - r_f) + factor\, to\, account\, for\, country\, risk$$

where r_m is the return on the U.S. market.

- Country "risk factor" is the spread between U.S Treasury bonds and Mexican Eurodollar bonds.

→ Is this the best way to do valuation?

1. Introduction

State of Asset Pricing Research in an Increasingly Global World

- Classic empirical asset pricing tests were applied to individual countries.

  ⇒ Implies complete market segmentation.

- International empirical studies use a world asset pricing model.

  ⇒ Implies complete market integration.

- Models of partial segmentation have also been proposed.

  ⇒ Allows for both integration and segmentation.

- The complete integration model is probably adequate to describe expected returns in many developed countries.

- The complete segmentation model makes sense in those countries where there are numerous investment restrictions that can not be easily bypassed.

- The partial integration model is not that useful because it *assumes that the degree of segmentation is fixed through time.*
  - Intuition would suggest that integration is a dynamic concept.

- Any of the above models could give misleading estimates of expected returns and risk premiums in national markets.

1. Introduction

We offer an empirical model which nests the three extreme cases: complete integration, complete segmention, and partial segmentation.

Importantly, our model allows the degree of integration to change through time.

This model has a good chance to explain both the time-series and cross-section of international returns.

While the model can be applied to any market, our paper mainly focusses on emerging markets.

1. Introduction

Why study emerging markets?

- ◦ Interest sparked by high average returns, high volatility and low correlations with developed country returns.

- ◦ Popular new markets – however, little research yet.

- ◦ Existing models likely to fail when applied to these markets.

- An ideal setting to investigate the influence of market integration on expected returns.

Goals of the research:

1. To characterize international equity returns with special emphasis on emerging markets.

2. Present and apply a conditional regime-switching model that allows for time-varying degree of integration of national capital markets.

3. Explore the predictability in these returns in terms of time-varying exposures, global risk premiums, and integration parameters.

4. To demonstrate how the model can be used to calculate the cost of capital in different national markets.

5. To show how our model can be used to measure the effects of regulatory changes on the cost of capital.

The Data

- 20 value-weighted emerging market indices provided by the International Finance Corporation (IFC).
  - → IFC selects stocks for country portfolio based on size and liquidity. There is also an industry consideration.
  - → Number of stocks included in each index range from 17 (Zimbabwe) to 77 (Korea).
  - → Harvey (1994) provides a description of the IFC methodology.

- 21 value-weighted developed market indices provided by Morgan Stanley Capital International (MSCI).
  - → MSCI also follows a portfolio approach for the national indices.
  - → Harvey (1991) provides a description of the MSCI methodology.

Are listed stocks freely available to foreign investors?	Repatriations of income	Repatriations of capital
Free entry		
Argentina	Free	Free
Brazil	Free	Free
Colombia	Free	Free
Jordan	Free	Free
Malaysia	Free	Free
Pakistan	Free	Free
Portugal	Free	Free
Turkey	Free	Free
Relatively free entry		
Chile	Free	After 1 year
Greece	Some restrictions	Some restrictions
Indonesia	Some restrictions	Some restrictions
Mexico	Free	Free
Thailand	Free	Free
Venezuela	Some restrictions	Some restrictions
Special classes of shares		
Korea	Free	Free
Philippines	Free	Free
Zimbabwe	Restricted	Restricted
Authorized investors only		
India	Some restrictions	Some restrictions
Taiwan	Free	Free
Closed		
Nigeria	Some restrictions	Some restrictions

2. Characterizing the returns

- Markets small but many are active.
- Capitalization of emerging markets is smaller than their contribution to world GDP.
- Tendency for market cap to grow as standard of living increases.
- High average returns and high volatility.

Our focus is on the class of asset pricing models which allow for time-variation in risks, risk premiums and returns.

Completely integrated markets:

World Conditional CAPM

$$E_{t-1}[r_{it}] = \lambda_{t-1}\text{Cov}_{t-1}[r_{it}, r_{wt}]$$

where

- r_i is the excess local market return in country i.
- r_w is the excess world market return.
- λ is the world price of covariance risk.
- Conditioning information should include both local and global information variables.

Completely segmented markets:

Local Conditional CAPM

$$E_{t-1}[r_{it}] = \lambda_{i,t-1} \mathrm{Var}_{t-1}[r_{it}]$$

where

- ▷ r_i is the excess local market return.
- ▷ λ_i is the local price of covariance risk.

Mixture CAPM (Partial Segmentation)

Only tested in unconditional setting.

- Assumes a constant degree of integration.

Our empirical approach combines the two asset pricing models:

$$E_{t-1}[r_{it}] = \phi_{i,t-1}\lambda_{t-1}\text{Cov}_{t-1}[r_{it}, r_{wt}] \\ + (1-\phi_{i,t-1})\lambda_{i,t-1}\text{Var}_{t-1}[r_{it}]$$

- $\phi_{i,t-1}$ is the degree of integration.

  ⇒ Integration is allowed to be a function of the conditioning information.

Model for expected returns may be considered in the class of regime switching models.

- First Regime: Markets integrated. Expected returns adhere to *world* CAPM.

- Second Regime: Markets Segmented. Expected returns adhere to *local* CAPM.

Let S_t be a state variable which takes on the value

$$S_t = \begin{cases} 1, & \text{if markets integrated;} \\ 2, & \text{if markets segmented.} \end{cases}$$

Then we can interpret $\phi_{i,t-1}$ as the conditional probability of being in regime 1 (for country i), that is,

$$\phi_{i,t-1} = \text{Prob}[S_t = 1 | \mathcal{Z}_{t-1}]$$

A number of approaches are possible for estimating $\phi_{i,t-1}$.

Constant transition probabilities

- Pioneered by Hamilton (1988).
- S_t is assumed to follow a Markov process with constant transition probabilities.

Time-varying transition probabilities

- New work by Gray (1993), Ghysels (1992) and Diebold, Lee and Weinbach (1992).
- Transition probabilities are allowed to be functions of the conditioning information.

Transition probabilities:

The regime probabilility, $\phi_{i,t-1}$, is the probability of the integrated state at time t given the predetermined information, $\mathcal{Z}_{t-1}$.

$$\phi_{i,t-1} = \text{Prob}[S_t = 1 | \mathcal{Z}_{t-1}]$$

- P,Q are transition probabilities in the Markov regime switching model.

First Formulation

Gray (1993) derives the following recursive representation for the regime probability:

$$\phi_{i,t-1} = (1-Q)+(P+Q-1)\left[\frac{f_{1,t-1}\phi_{i,t-2}}{f_{1,t-1}\phi_{i,t-2} + f_{2,t-1}(1-\phi_{i,t-2})}\right]$$

and the transition probabilities are:

$$P = \text{Prob}[S_t = 1|S_{t-1} = 1]$$
$$Q = \text{Prob}[S_t = 2|S_{t-1} = 2]$$

- $f_{j,t}$ is the likelihood at time t conditional on being in regime j and time $t-1$ information, $\mathcal{Z}_{t-1}$

Second Formulation

Allow the transition probabilities P and Q to be time varying functions of the information:

$$P_t = \frac{\exp(\mathbf{B}_1' \mathcal{Z}_{t-1})}{1 + \exp(\mathbf{B}_1' \mathcal{Z}_{t-1})}$$

$$Q_t = \frac{\exp(\mathbf{B}_2' \mathcal{Z}_{t-1})}{1 + \exp(\mathbf{B}_2' \mathcal{Z}_{t-1})}$$

where $\mathbf{B}_1, \mathbf{B}_2$ are vectors of parameters.

Consider bivariate models for country i and the world and define the disturbance matrix $\mathbf{e}_t = [e_{i,t}, e_{w,t}]'$ and:

$$\text{Let} \begin{cases} \mathbf{e}^I, & \text{under integration} \\ \mathbf{e}^S, & \text{under segmentation} \end{cases}$$

As a result,

$$\mathbf{e}_t = \phi_{i,t-1}\mathbf{e}_t^I + (1-\phi_{i,t-1})\mathbf{e}_t^S.$$

The residuals are heteroskedastic,

$$\begin{aligned} E[\mathbf{e}_t^I \mathbf{e}_t^{I\prime} | \mathcal{Z}_{t-1}] &= \mathbf{\Sigma}_t^I \\ E[\mathbf{e}_t^S \mathbf{e}_t^{S\prime} | \mathcal{Z}_{t-1}] &= \mathbf{\Sigma}_t^S \end{aligned}.$$

Conditional variances

The conditional variance dynamics are parsimoniously modelled as ARCH(k) following Baba, Engle, Kraft and Kroner (1989).

$$\begin{aligned}\mathbf{\Sigma}_t^I &= \mathbf{C}^I + (\mathbf{A}^I)' \left[\sum_{k=1}^{K} w_k (\mathbf{e}_{t-k}\mathbf{e}'_{t-k}) \right] \mathbf{A}^I \\ \mathbf{\Sigma}_t^S &= \mathbf{C}^S + (\mathbf{A}^S)' \left[\sum_{k=1}^{K} w_k (\mathbf{e}_{t-k}\mathbf{e}'_{t-k}) \right] \mathbf{A}^S\end{aligned},$$

where

- $\mathbf{C}^I$ and $\mathbf{C}^S$ are symmetric 2×2 matrices
- $\mathbf{A}^I$ and $\mathbf{A}^S$ are 2×2 matrices

Advantages:

(1) Guarantees positive definite conditional variance matrices under weak conditions.

(2) Imposes restrictions across equations and thereby economizes on parameters relative to other multivariate ARCH models.

Additional restrictions:

$$\mathbf{C}^I(2,2) = \mathbf{C}^S(2,2); \mathbf{A}^I(j,j) = \mathbf{A}^S(j,j) \text{ for } j = 1,2 \quad (1)$$

Interpretation

Conditional variance of the world market return is independent of the regime.

$$\mathbf{A}^I(1,2) = \mathbf{A}^S(1,2) = 0 \quad (2)$$

Interpretation

Country-specific shocks do not affect the conditional variance of the world market return.

$$\mathbf{A}^S(2,1) = 0. \quad (3)$$

Interpretation

World market shocks do not affect the conditional variance of the country return when markets are segmented.

We proceed in two steps.

- Estimate variance and price of risk parameter for the world market return using the world information variables, $\mathbf{Z}$.

- Estimate country by country imposing the parameter estimates from the first stage.

Advantage

This procedure imposes the restriction that the price of world market risk is the same in each country, which leads to more powerful tests.

Disadvantage

Usual standard errors are likely to be understated since we ignore the sampling error in the first-stage parameter estimates.

Price of Risk

Assume that the price of risk is linear in the information:

$$\lambda_{t-1} = exp(\mathbf{D}'\mathbf{Z}_{t-1})$$

$$\lambda_{i,t-1} = exp(\mathbf{D}_i'\mathbf{Z}_{t-1}^i)$$

where

$\mathbf{Z}$ represents global information variables

$\mathbf{Z}^i$ represents local information variables.

Time variation in expected returns generated by three sources:

1. Changes in the price of risk
2. Time-variation in the risk exposure
3. Evolution of the market integation measure.

Likelihood ratio tests

LR1: imposes restriction of constant prices of risk.

LR2: imposes restriction of constant conditional variances (no ARCH).

LR3: imposes restriction of constant degree of integration.

Hamilton vs. time-varying transition

Likelihood ratio tests are also calculated.

Other diagnostics

1. Project residuals, e_{it}, on three information sets, $\mathbf{Z}$, $\mathbf{Z}^i$, $\mathcal{Z}$ and report R^2 and heterskedasticity-consistent Wald tests.

2. Estimate alternative specification which includes a time-varying intercept

$$\mathbf{A}_i' \mathcal{Z}_{t-1}$$

Lagrange Multiplier test of restriction: $\mathbf{A}_i = 0$.

Alternative approaches [1]

A third version of the regime switching model allows the regime probabilities to be modelled directly as:

$$\phi_{i,t-1} = \frac{\exp(\mathbf{G}_i'\mathbf{Z}_{t-1}^i)}{1 + \exp(\mathbf{G}_i'\mathbf{Z}_{t-1}^i)},$$

where

$\mathbf{G}_i$ is a vector of coefficients.

- Condition the regime probabilities on local information variables – maybe even lagged $\phi_{i,t-1}$.

Alternative approaches [2]

Given the regime probability model, estimate with GMM:

$$u_{it} = r_{it} - \phi_{i,t-1}\varepsilon_{it}\varepsilon_{wt}(\mathbf{D}'\mathbf{Z}_{t-1}) - (1-\phi_{i,t-1})\varepsilon_{it}^2(\mathbf{D}_i'\mathbf{Z}_{t-1}^i)$$

where

$\varepsilon_{it}, \varepsilon_{wt}$ are unexpected returns on country i's national index and the world index, respectively.

- World price of risk is $\mathbf{D}'\mathbf{Z}_{t-1}$
- Local price of risk is $\mathbf{D}_i'\mathbf{Z}_{t-1}^i$.

- Multiple assets must be examined to get the system identified.

Alternative approaches–High Capitalization Countries

We follow Chan, Karolyi and Stulz (1992) and make the assumption that the world market return, $r_{w,t+1}$, is the weighted sum of the U.S. and Japanese market return:

$$r_{w,t+1} = \omega_{US,t} r_{US,t+1} + (1 - \omega_{US,t}) r_{JP,t+1}$$

- Assume U.S. market is integrated,
- Allow Japan to display time-varying integration.

Hence:

$$\begin{aligned} r_{US,t} &= \lambda^I_{t-1} \mathrm{Cov}^I_{t-1}[r_{US,t}, r_{w,t}] + e_{US,t} \\ r_{JP,t} &= \phi_{t-1} \lambda^I_{t-1} \mathrm{Cov}^I_{t-1}[r_{JP,t}, r_{w,t}] \\ &\quad + (1 - \phi_{t-1}) \lambda_{JP,t-1} \mathrm{Var}^S_{t-1}[r_{JP,t}] + e_{JP,t} \end{aligned}$$

We will let

$$\mathbf{e}_t = (\, e_{US,t}, e_{JP,t} \,)' .$$

- λ^I_{t-1}, $\lambda^S_{JP,t-1}$, are specified as exponentiated linear function of the information.

High Cap Countries

Conditional covariances explicitly account for the market capitalization weights, ω,

$$\begin{aligned} \text{Cov}^I_{t-1}[r_{US,t}, r_{w,t}] &= \omega_{US,t-1}\text{Var}^I_{t-1}[r_{US,t}] \\ &\quad + (1-\omega_{US,t-1})\text{Cov}^I_{t-1}[r_{US,t}, r_{JP,t}] \\ \text{Cov}^I_{t-1}[r_{JP,t}, r_{w,t}] &= \omega_{US,t-1}\text{Cov}^I_{t-1}[r_{US,t}, r_{JP,t}] \\ &\quad + (1-\omega_{US,t-1})\text{Var}^I_{t-1}[r_{JP,t}] \end{aligned} .$$

- The conditional variance is modelled as before using a BEKK model.

High Cap Countries

We impose the following additional restrictions on the model parameters:

$$
\begin{aligned}
\mathbf{A}^I(j,1) &= \mathbf{A}^S(j,1) \qquad \text{for } j = 1,2, \\
\mathbf{C}^I(1,1) &= \mathbf{C}^S(1,1), \\
\mathbf{A}^I(2,1) &= \mathbf{A}^S(2,1), \\
&\text{and} \\
\mathbf{A}^S(1,2) &= 0.
\end{aligned}
$$

Interpretation

- The first three restrictions guarantee that the conditional variance process for the U.S. is identical in both regimes.

- The fourth restriction ensures that the conditional variance of the Japanese returns only depends on past Japanese shocks in the segmented regime.

→ The full model with time-varying transition probabilities has 26 parameters.

5. Results

We follow previous research in the specification of information variables.

World Information

- World dividend yield in excess of short rate
- Default spread, Baa-Aaa yields
- Change in U.S. term structure
- Change in 30-day Eurodollar yield

Local Information

- Local dividend yield
- Local lagged return
- Change in U.S.$ exchange rate
- Equity capitalization as a percentage of GDP

Local Information for Transition Probabilities

- Local dividend yield
- Equity capitalization as a percentage of GDP

World Price of Risk

The model estimated is:

$$r_{w,t} = \lambda_{t-1} \mathrm{Var}_{t-1}[r_{w,t}] + \epsilon_{w,t}$$

$$\lambda_{t-1} = exp(\mathbf{D}'\mathbf{Z}_{t-1})$$

and

$$\mathrm{Var}_{t-1}[r_{w,t}] = c^2 + \alpha^2 \sum_{k=1}^{K} w_k \epsilon^2_{w,t-k}$$

A: Full model

δ_1	δ_2	δ_3	δ_4	δ_5
0.217 (0.930)	-0.280 (0.112)	0.291 (0.116)	1.564 (0.494)	-0.123 (0.202)

c	α
0.039 (0.003)	0.345 (0.161)

B: Constant variance model

δ_1	δ_2	δ_3	δ_4	δ_5
0.154 (0.712)	-0.351 (0.124)	0.343 (0.163)	1.656 (0.474)	-0.063 (0.176)

c	χ^2
0.042 (0.003)	2.078 [0.149]

C: Constant price of risk

λ	c	α	χ^2
1.876 (1.535)	0.040 (0.004)	0.361 (0.152)	11.166 [0.025]

- Market integration is difficult to measure.
  - → Measures such as correlation are incorrect.
  - → Impossible to aggregate investment restrictions into a meaningful measure. Besides, investors can get around many investment restrictions.
- We offer an empirical alternative.
  - ◦ Degree of integration measured directly from returns data.
  - ◦ Integration is allowed to change through time.

7. Research direction

- Apply the integration measure to a two beta model to get the cost of capital for emerging market equity issues.

- Do changes in the degree of market integration make the volatility process in emerging markets different than in developed markets?

- Condition the regime probability on indicator variables representing policy changes.
  - Measure the effect of policy on integration.
  - Measure the effect of policy on the cost of capital.
  - Provide some guidance to those markets considering changes in the regulatory environment as to what are the most effective routes to follow.