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PREDICTABLE RISK AND RETURNS  
IN EMERGING MARKETS

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ABSTRACT

The emergence of new equity markets in Europe, Latin America, Asia, the Mideast and Africa provides a new menu of opportunities for investors. These markets exhibit high expected returns as well as high volatility. Importantly, the low correlations with developed countries' equity markets significantly reduces the unconditional portfolio risk of a world investor. However, standard global asset pricing models, which assume complete integration of capital markets, fail to explain the cross-section of average returns in emerging countries. An analysis of the predictability of the returns reveals that emerging market returns are more likely than developed countries to be influenced by local information.

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## 1. Introduction

In recent years, a number of new equity markets have emerged in Europe, Latin America, Asia, the Mideast and Africa. Little is known about these markets other than the fact that the expected returns can be impressive and these markets are highly volatile. Importantly, the correlations of these equity returns with developed countries' equity returns are low. As a result, it may be possible to lower portfolio risk by participating in emerging markets.

This paper has a number of goals. First, the average or unconditional risk of these equity returns is studied. While previous authors have documented low correlations of the emerging market returns with developed country returns, I test whether adding emerging market assets to the portfolio problem *significantly* shifts the investment opportunity set. I find that the addition of emerging market assets significantly enhances portfolio opportunities.

Second, I explore reasons why the emerging market equities have high expected returns. In the framework of asset pricing theory, high expected returns should be associated with large exposures to risk factors. However, I find that the exposures to the commonly used risk factors are low. The asset pricing model, as specified, is unable to explain the cross-section of expected returns. One possible reason for this failure is the implicit assumption of complete integration of world capital markets. Some evidence is offered that suggests that this assumption may be violated.

Third, the time-variation in the emerging market returns is studied. Emerging markets contrast with developed markets in at least two respects. I offer evidence that the emerging market returns are generally more predictable than the developed market returns. In addition, it is more likely that the emerging market returns are influenced by local rather than global information variables.

One interpretation of the influence of local information is that the emerging markets are segmented from world capital markets. A second interpretation is that there is important time-variation in the risk exposures of the emerging markets. For countries with stable, developed industrial structures, many researchers studying time-varying asset returns have assumed that risk loadings are constant.

This is a far less reasonable assumption for developing countries. The country risk exposure reflects the weighted average of the risk exposures of the companies that are included in the country index. As the industrial structure develops, both the weights and the risk exposures of the individual companies could change. This may induce time-variation in risk exposures. In addition, the risk exposures are likely influenced by local rather than global information variables.

I study a conditional asset pricing model where the expected returns are functions of global and local information variables, the world risk premiums are dependent only on global information and the conditional risk is a function of both global and local information. In contrast to the unconditional models, this specification allows for time-variation in the risk exposures and the expected returns.

Tests of the conditional asset pricing model suggest that the risk exposures significantly change through time for a number of the countries. An examination of the time-varying risk functions suggests that the exposures in some countries move with the time-varying conditional correlations of the countries' returns and a benchmark world return. However, the asset pricing model's restrictions are rejected which means that this formulation is unable to explain the predictability of the returns nor the cross-section of expected returns.

The paper is organized as follows. The second section provides a description of the data and some summary statistics for the 20 emerging market index returns. In the third section, an analysis of the cross-country correlations of the emerging and developed returns is presented. The section includes tests of whether adding emerging markets to the portfolio problem significantly changes portfolio opportunities. The average risk exposures to prespecified world economic risk factors are also presented and interpreted. The rejection of the asset pricing theory is characterized in mean-variance space. The fourth section details the predictability of the emerging market returns. Conditional asset pricing models are estimated with the goal of trying to explain the predictability and to understand the sources of model rejection. Some concluding remarks are offered in the final section.

## 2. Characterizing the returns and volatility of emerging markets

### 2.1 Data sources

Data on more than 800 equities in six Latin American markets (Argentina, Brazil, Chile, Colombia, Mexico, Venezuela), eight Asian markets (India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Taiwan, Thailand), three European markets (Greece, Portugal, Turkey), one Mideast market (Jordan) and two African markets (Nigeria, Zimbabwe) form the Emerging Market Data Base (EMDB) of the International Finance Corporation (IFC) which is part of the World Bank. Monthly value-weighted index returns are calculated, with dividend reinvestment, for these 20 countries. These markets are labeled “emerging” as a result their low or middle income status by the World Bank. In 1991, a per capita GNP of US\$635 or less implied low income and per capita GNP between US\$636 and US\$7,910 defined middle income status.

Table 1 provides some basic statistics regarding the composition of the indices. For each market in June 1992, the market capitalization in U.S. dollars is provided.<sup>1</sup> First, the emerging markets are small relative to the U.S., Japan and U.K. equity markets. However, some emerging markets are larger than one might think. For example, capitalizations of Mexico and Taiwan are similar to those of the markets in Italy and the Netherlands. There are ten emerging markets that are larger than the smallest European market (Finland US\$13.6 billion). The total capitalization of the emerging markets is US\$747.1 billion. This represents 8% of the Morgan Stanley Capital International (MSCI) world capitalization.

Similar to the MSCI method for calculating country equity indices, the IFC uses a subset of the stocks trading in the emerging market. Stocks are selected for inclusion in the index based on size, liquidity and industry. The IFC targets 60% of the total market capitalization of the country and 60% of the total trading volume.

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<sup>1</sup> For most markets, the exchange conversion is based on a rate quoted on the last day of the month in the *Wall Street Journal* or the *Financial Times*. When a number of exchange rates exist, the IFC uses the nearest equivalent “free market” rate or a rate that would apply to the repatriation of capital or income. In some cases, even the newspaper rates are not used and the IFC relies on their correspondents in the particular market. See IFC (1993).

The indices do not include stocks whose issuing company is headquartered in an emerging market but listed only on foreign stock exchanges. In addition, if several stocks meet the size and liquidity hurdle, the IFC selects stocks that represent industries which are not well represented in the index. A detailed description of the selection criteria and the index construction is contained in IFC (1993).

Table 1 contains the number of stocks used for each of the IFC country indices which ranges from 77 for Korea to 17 in Zimbabwe. These numbers seem small compared to the U.K., Japan and the U.S. However, these portfolio sizes are comparable to the MSCI portfolios for developing countries. For example, Harvey (1991) reports that 15 of the 20 MSCI developed markets have fewer than 77 companies included in their indices.

Naturally, one might be concerned with the possibility of some biases being introduced as a result of infrequent trading of the some of the index stocks. However, the trading activity of many of the emerging markets is impressive compared to the developed markets. For example, Harvey (1993a) reports that 5 emerging markets have higher turnover than the average turnover in the U.S., Japan and the U.K. and 10 emerging markets have higher turnover than the U.K. However, to mitigate the possible influences of infrequent trading, I concentrate the analysis on monthly rather than weekly data.

## *2.2 Analysis of monthly returns*

Some summary statistics of the 20 emerging market returns are presented in Table 1. In the first panel, all returns are calculated in U.S. dollar terms (translated using the effective rate on the last trading day of the month). Annualized arithmetic mean returns range from 71.8% for Argentina to -11.4% for Indonesia (whose sample only begins in February 1990). High average returns are often associated with high volatility. For example, both Argentina and Turkey have annualized standard deviations over 75%. Taiwan, whose average return is 40.9%, has a standard deviation of 53.9%.

Given the high volatility, there will be a sizable divergence between the geo-

metric and arithmetic average returns. The geometric mean represents the average return to a buy and hold strategy in the particular market with dividend reinvestment. The geometric mean return for the Latin American Index is 27.6% compared to the arithmetic mean of 35.7%. A less dramatic difference is found for the Asia index, 19.3% arithmetic and 15.7% geometric.

In the overall sample, the arithmetic average return on the emerging markets composite index is 20.4% with a standard deviation of 24.9%. The average returns are roughly 50% higher than the MSCI world composite index (13.9% arithmetic, same sample) and the standard deviation is about 80% higher than the MSCI world index (14.4%).

Although this study concentrates on U.S. dollar returns, it is informative to consider the magnitude of the local currency returns which are reported in the second panel of table 1. In many countries, especially in Latin America, these returns are dramatically different as a result of high inflation. For example, the average annual return in Argentina is 228.8% in local currency terms with a volatility of 155.2%. The average return in local currency for the Brazilian index is 155.5%.

Table 1 also reports the serial correlation of the monthly returns. In contrast to the developed markets, the first-order serial correlation coefficients are higher for the emerging markets. 12 of the 20 emerging markets have serial correlation coefficients greater than 10% and 8 of the markets have coefficients above 20%. The first-order autocorrelation in Colombia is an astonishing 49%. The approximate standard error for those countries whose data begins in 1976:02 is 7.1%. These statistics are in sharp contrast to the three developed markets reported at the end of table 1 whose first-order serial correlation averages less than 1%.<sup>2</sup>

To further investigate the properties of the data, the coefficients of skewness and excess kurtosis are reported. If the data are normally distributed, then these coefficients should be equal to zero. To test for normality, the following system of

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<sup>2</sup> Harvey (1993a) finds that some of the cross-section of serial correlation can be explained by measures of the asset concentration within each index.

equations is estimated for each asset  $i$ :

$$\begin{aligned}
 e_{1it} &= r_{it} - \mu_i \\
 e_{2it} &= (r_{it} - \mu_i)^2 - \mathcal{V}_i \\
 e_{3it} &= [(r_{it} - \mu_i)^3] / \mathcal{V}_i^{3/2} \\
 e_{4it} &= [(r_{it} - \mu_i)^4] / \mathcal{V}_i^2 - 3
 \end{aligned} \tag{1}$$

where  $\mu$  is the mean,  $\mathcal{V}$  is the variance,  $e = \{e_{1it} e_{2it} e_{3it} e_{4it}\}$  represents the disturbances and  $E[e] = 0$ . There are two parameters and four orthogonality conditions leaving a  $\chi^2$  test with two degrees of freedom. The test statistic results from setting the coefficient of skewness and excess kurtosis equal to zero in the third and fourth equations. This forms a joint test of whether these higher moments are equal to zero.<sup>3</sup>

The results suggest that null hypothesis normality can be rejected at the 5% level in 14 of the 20 emerging markets. However, normality cannot be rejected in any of the three developed markets reported. Multivariate tests [not reported in the table] suggest that the emerging markets are not normally distributed. For the eight emerging countries with data from 1976:02, the test statistic with 16 degrees of freedom is 68.52 (p-value<0.1%). For the three developed countries over the same sample period, the statistic with 6 degrees of freedom is 9.36 (p-value=15.4%). When the data are sampled from 1986:03, there are 18 emerging market indices and the test statistic is 75.79 (p-value<0.1%). Over the same period, the test statistic for the developing countries is 12.99 (p-value=4.3%).

The summary statistics provide a number of contrasts between emerging markets and developed markets. Emerging markets have higher average returns and volatility than developed markets. Many of the markets have serial correlation which is much higher than one would expect on the basis of developed markets. Finally, the returns in the emerging markets depart from the normal distribution. These findings will be important in later sections when interpreting both the cross-section of average returns and the predictability of the returns.

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<sup>3</sup> A related test is presented in Richardson and Smith (1993). Their system is contains parameters for the coefficients of skewness and excess kurtosis and the test statistic is analytically solved imposing the null distribution when calculating the asymptotic variance-covariance matrix of the estimators.



### *2.3 Survivorship bias in the emerging markets sample*

There are two potential sources of survivorship bias in the sample of emerging markets. The first concerns the general composition of the countries in the sample. The second source has to do with the way the indices are constructed.

In general, there are many possible countries that might have been included in the sample. Indeed, the World Bank considers any stock market in a developing country as an “emerging market.” However, the small number of countries that are included in the sample are the winners. While the survivorship problem has been extensively studied in biometrics [see, for example, Miller (1976)], the work in finance on this difficult problem is very recent. For example, Brown, Goetzmann, Ibbotson and Ross (1992) study the impact of survivorship on mutual fund performance.

The second source of bias has to do with the way the country indices are constructed. While the IFC does not explicitly select stocks on the basis of historical financial performance or expected future performance, their size and liquidity criteria implicitly reveal information about the past history of the company. This type of survivorship bias in the index stocks, however, will also hold for more conventional indices, such as the MSCI or FT-Actuaries. Kothari, Shanken and Sloan (1992) examine the impact of survivorship bias in asset pricing tests.

A more blatant problem is the backtracking of some of the indices. The EMDB was established in early 1981 and the initial indices were based on stocks selected in 1981. For a number of countries, these indices were backtracked to December 1975. The first sixty months of data are potentially plagued with a lookback bias. That is, to be selected in 1981, the companies had to be successful (or at least solvent). As a result, one might expect the first five years of data to reveal high average returns. Indeed, some firms that may have existed in December 1975 and that dropped out of the market by January 1981, are not included in the IFC index.

The backtracking problem is isolated to the pre-1981 data. In addition, it is not obvious that the problem is that severe. I compared the average returns for 1976–1980 to the average returns over 1981–1992. For the eight largest markets

that have data back to December 1975, five have mean returns in the first period that are greater than the second period (when measured in U.S. dollars). This is consistent with survivorship bias. However, if the average returns are computed in local currency terms, only two countries have mean returns in the first period that are greater than the second period. While the importance of survivorship bias is not clear, careful attention is paid later in the paper to separately analyzing the full sample (1976–1992) and a ‘no backtracking’ sample.

### 3. Average returns and risks

#### 3.1 Frontier intersection tests

A number of researchers have suggested that the low correlations between emerging markets and developed markets imply portfolio investment opportunities.<sup>4</sup> However, one obvious question arises: does the addition emerging markets to the portfolio problem *significantly* shift the investment opportunity set?

First, consider the cross-country correlations of the emerging market stock returns in table 2. The sample period is 1986:03–1992:06 (75 observations) for 18 markets and shorter samples are reported for Indonesia and Turkey. In contrast to the cross-country correlations of the developed market returns, most of the correlations are low and many are negative. Harvey (1991) reports that the average cross-country correlation in 17 developed markets is 41% over the 1970:02–1989:05 sample. The average cross-country correlation of the emerging country returns is only 12%. Argentina, Venezuela, Korea, India, Pakistan, Jordan, Nigeria and Zimbabwe have about zero average correlation with the other emerging countries. Surprisingly, Brazil has a negative correlation with Argentina, Venezuela and Mexico. Perhaps not surprisingly, India and Pakistan are negatively correlated.

Table 2 also reports the average correlation of each of the emerging country returns with the 18 MSCI developed market returns. Similar to the results among

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<sup>4</sup> For example, see Errunza (1983), Errunza and Padmanabhan (1988), Stone (1990), Divecha, Drach and Stefek (1992), Speidell and Sappenfield (1992) and Wilcox (1992).

the emerging markets, there are many low average correlations between developed and emerging markets. Argentina, Colombia, Venezuela, India, Pakistan, Nigeria and Zimbabwe have effectively zero average correlation with developed markets. The overall average correlation between emerging and developed markets is only 14%. The final line reports the correlation of the emerging country returns with the MSCI world market return. Similar to the results which equally-weight the correlations in the 18 developed markets, the average correlation of the emerging markets and the world market return is only 15%.

Figure 1 presents unconditional minimum standard deviation frontiers based on data from 1986:03–1992:06. In the first panel, the dotted curve is based on 18 MSCI country indices. The solid curve shows the effect of adding 18 emerging country indices to the problem. Indonesia and Turkey are not included in the sample because of their short histories. At the global minimum variance portfolio, the standard deviation is reduced by 6% (from 13% to 7%) by adding the emerging market assets.

The second panel of figure 1 repeats the minimum standard deviation analysis with the constraint of no short selling imposed. This may be a particularly appropriate constraint for the emerging market sample where it could be operationally difficult to short a basket of securities. Interestingly, the analysis does not substantially change. The minimum variance portfolio with 18 developed returns has a standard deviation of 14.5%. When the 18 emerging market returns are added, the minimum variance portfolio has a standard deviation of 7.5%.

The graphical analysis does not answer the question of whether the frontier significantly shifts when the emerging market assets are added to the problem. Following Shanken (1986), Huberman and Kandel (1987) and Jobson and Korkie (1989), let  $\mathbf{r} = \{\mathbf{r}_1, \mathbf{r}_2\}$  where  $\mathbf{r}_1$  is the matrix of returns in 18 developed markets and  $\mathbf{r}_2$  represents the returns in the 18 emerging markets. The test whether one set of assets (developed returns) spans the frontier of both developed and emerging markets by estimating the following moment condition:

$$\boldsymbol{\eta}_t = \mathbf{r}_{2t} - \boldsymbol{\alpha} - \boldsymbol{\beta}\mathbf{r}_{1t} - \delta r_{0t}, \quad (2)$$

where  $r_0$  is the return on the minimum variance portfolio constructed from  $\mathbf{r}$  (all

36 assets),  $\alpha$  and  $\delta$  are  $1 \times 18$  parameter vectors,  $\beta$  is a  $18 \times 18$  parameter matrix,  $\eta$  defines the disturbances and  $E[\eta|1, \mathbf{r}_1, r_0] = \mathbf{0}$ . Let the set of minimum-variance portfolios generated by  $\mathbf{r}_1$  be efficient with respect to the assets  $\mathbf{r}$ . From Roll (1977), we know that a regression of  $\mathbf{r}_2$  on  $\mathbf{r}_1$  and the global minimum variance portfolio return should yield zero intercepts if  $\mathbf{r}_2$  intersects the efficient set. The slope coefficients should also sum to unity.

The test statistic due to Shanken (1986) and Jobson and Korkie (1989) is

$$\phi_z = \frac{(T - N - 1)}{(N - N_1 - 1)} \frac{(\hat{a}_z - \hat{a}_{z1})}{(1 + \hat{a}_{z1})}, \quad (3)$$

where

$$\begin{aligned} \hat{a}_z &= (\bar{\mathbf{r}} - \bar{r}_z \boldsymbol{\iota})' \mathbf{V}^{-1} (\bar{\mathbf{r}} - \bar{r}_z \boldsymbol{\iota}) \\ \hat{a}_{z1} &= (\bar{\mathbf{r}}_1 - \bar{r}_{z1} \boldsymbol{\iota}_1)' \mathbf{V}_{11}^{-1} (\bar{\mathbf{r}}_1 - \bar{r}_{z1} \boldsymbol{\iota}_1) \\ \bar{r}_z &= (\hat{b} - \hat{b}_1) / (\hat{c} - \hat{c}_1) \\ \hat{b} &= \bar{\mathbf{r}}' \mathbf{V}^{-1} \boldsymbol{\iota} \\ \hat{c} &= \boldsymbol{\iota}' \mathbf{V}^{-1} \boldsymbol{\iota} \end{aligned}$$

and  $\bar{\mathbf{r}}$  represents the mean returns,  $\mathbf{V}$  is the variance-covariance matrix and  $\boldsymbol{\iota}$  is a vector of ones. The test statistic follows an F-distribution with  $(T - N - 1)$  and  $(N - N_1 - 1)$  degrees of freedom where  $T$  is the number of observations,  $N$  is the total number of assets and  $N_1$  are the assets in  $\mathbf{r}_1$ . The intuition behind the test is that a line originating from  $\bar{r}_z$  in mean-variance space should have the same slope when it is tangent to the frontier of  $\mathbf{r}_1$  assets and when it is tangent to the frontier of all  $\mathbf{r}$  assets. The test statistic essentially measures the difference in the slopes. A more detailed description can be found in Jobson and Korkie (1989).

Table 3 reports the results of the intersection tests. I report three different versions of the test statistic. The first is the statistic detailed in (3) with a heteroskedasticity-consistent variance-covariance matrix. The second and third versions correct for a moving-average process of 15 months using Bartlett weights [Newey and West (1987)] and Parzen weights [Andrews (1991)]. Given the evidence of nonnormality of the emerging market returns, it is important to assess the sensitivity of the intersection test to different assumptions on the error structure.<sup>5</sup>

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<sup>5</sup> An alternative version of the test involves estimating (2) with the generalized

The results in table 3 unambiguously reject the null hypotheses that the two frontiers intersect. The first version of the test statistic provides evidence against the null with a p-value  $<0.1\%$ . The correction for a possible moving-average structure has little effect on the inference. The p-values for the statistics are still  $<0.1\%$  which supports the evidence against the null hypothesis. The intersection tests tells us that the shift in the frontier in figure 1 is genuine rather than an artifact of sampling variation.<sup>6</sup>

The previous analysis assumes the portfolio manager had knowledge of the complete history of the returns in computing mean-variance efficient portfolios. Consider an alternative exercise. The investment in month  $t$  is determined by the weights of the unconditional minimum-variance portfolio estimated using five years of data ending in month  $t-1$ . The portfolio weights are updated each month and no short selling is allowed. Any survivorship bias in the pre-1981 data due to the backtracking of the indices is eliminated because the first investment occurs in March 1981.

If the investor is limited to the 18 MSCI developed markets, this portfolio strategy delivers a 16.6% average return with a 15.8% standard deviation. If the emerging markets are added to the sample, the strategy produces a slightly higher return, 17.4%, but the standard deviation is much less, 11.4%. This out-of-sample analysis suggests that the main benefit to emerging market investment is not the increasing of returns but the lowering of the portfolio volatility for minimum variance strategies.<sup>7</sup>

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method of moments. However, the dimension of the weighting matrix is over 300 which makes this method infeasible unless simplifying assumptions are made on the covariance structure. See the discussions in Ferson, Foerster and Keim (1993) and Ferson (1993).

<sup>6</sup> This consistent with recent results of De Santis (1993) who investigates whether the stochastic discount factor that prices the developed country returns also prices the emerging country returns.

<sup>7</sup> The minimum-variance portfolio strategy does not use the mean return vector [see Roll (1977, A.12–A.14)]. Harvey (1993c) considers alternative strategies that target 16% conditional volatility with information affecting all the moments. The results indicate that reward to risk ratios are greatly increased when emerging market investments augment developed market portfolios.

### *3.2 The issue of integration*

What is the risk of investing in emerging markets? How are these risks rewarded in equilibrium? Is it appropriate to consider emerging markets as additional assets that can be inserted into some well-known international asset pricing paradigm? These questions cannot be answered without some discussion of international capital market integration.

There are numerous international asset pricing models that take complete market integration as the null hypothesis. Stulz (1981) proposes a model where expected returns are linear in a measure of world consumption risk. Solnik (1974) pursues a global Sharpe (1964), Lintner (1965), and Black (1972) capital asset pricing model (CAPM) where investors in various countries differ in their consumption baskets and care about returns measured in their domestic currency. Adler and Dumas (1983) build on this model by incorporating stochastic national inflation. The single risk factor is the return on a value-weighted world equity market portfolio, hedged against currency risk. A final approach is a multi-beta specification in motivated by Merton (1973), Ross (1976) and Solnik (1983) in which expected returns are determined by sensitivities to many sources of risk.

All of these models, assume that capital markets are integrated. Rejections of model restrictions could be interpreted in many ways. The rejection could be a result of some fundamental problem in testing the model such as improperly specifying the factor mimicking portfolios. Inference is especially complicated by Roll's (1977) critique. Rejection could also be due to the incomplete integration of the national market into the global capital market.

There are reasons to doubt that some of the emerging markets are fully integrated into world capital markets. Complete integration means that two assets with the same risk in different markets have the same expected returns. Factors that contribute to market integration are free access by foreigners to domestic capital markets and free access by domestic investors to foreign capital markets. Potential barriers to integration come in the form of: access, taxes and information.

The appendix provides a country-by-country examination of the restrictions

that foreign investors face as of the Spring of 1993. The degrees of restrictions vary from completely closed to foreign investors (Nigeria) to 100% investable (nine countries). The appendix also provides some details on a new set of indices developed by the IFC called “investable” indices. While only a short history exists (since 1988), these new indices explicitly account for access restrictions on foreign participation.

There are many other factors that either enhance or decrease the chance that the market is integrated. These issues include taxes, the timeliness of trading information, foreign exchange regulations, the availability and accuracy of accounting information, the number of securities cross-listed on developed exchanges, political risk, and the institutional structures that protect investors. In general, there is a trend towards relaxing the factors that contribute to segmentation in many emerging markets.<sup>8</sup> However, the degree of integration likely varies across different countries. As such, it is unlikely that any asset pricing model which assumes complete integration of capital markets will be able to fully account for the behavior of security prices in these different markets.

### *3.3 Risk exposure*

In completely segmented markets where a one-factor model characterizes asset returns, expected returns are priced with respect to the covariance with the national market portfolio rather than the world market portfolio. In this case, the expected returns on the national index would be related to the volatility of the national market portfolio. In completely integrated capital markets with purchasing power parity, the covariance with the world portfolio determines the cross-section of expected returns. It is reasonable to expect that some of the emerging markets are segmented, however, the degree and effect of the segmentation is not obvious.

Even given this suspicion of some market segmentation, it is still informative to assess the exposure of these markets to known global risk factors. In a completely segmented capital market, covariance with a global risk factor may be

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<sup>8</sup> See Bekaert (1993) and Harvey (1993a).

important. It is unlikely that the national economy is completely independent of the world economy.

Table 4 provides two sets of linear factor model estimates. In panels A and B, both full sample and the most recent subperiod estimates of a single factor Sharpe-Lintner specification are presented. The single factor is the excess return on the MSCI world market portfolio. All returns are calculated in U.S. dollars in excess of an Eurodollar deposit with 30 days to maturity. This model is consistent with the world CAPM investigated in Cumby and Glen (1990), Harvey (1991) and one of the models in Dumas and Solnik (1993).

In the other panels, a two-factor specification, motivated by Adler and Dumas (1983), is presented adding the excess return on a trade-weighted portfolio of 10 currency deposits. Adler and Dumas' model allows for deviations from purchasing power parity. In their equation 14 with  $L$  countries, expected returns in a numeraire currency are generated by the covariance with the world portfolio and by the covariances of the asset returns and inflation rates in all the countries. The weights on these inflation covariances depend on the wealth-weighted risk aversion in each country. The usual way to implement this model is to follow the Solnik (1974) assumption that the asset covariance with the numeraire country's inflation is zero. Expected returns can then be written in terms of their covariance with the world portfolio and their  $L - 1$  covariances with exchange rate changes.<sup>9</sup>

Econometrically, this model is intractable unless a very small number of countries are examined. For example, Dumas and Solnik (1993) are able to estimate the model for only four countries. One possible simplification pursued in a number of papers<sup>10</sup> is to aggregate the exchange rate factor. Given that it is impossible to observe the wealth-weighted risk aversions of the  $L - 1$  countries, trade weights (exports plus imports) are used as an aggregation method.

The aggregation of the exchange risk factor departs from the asset pricing theory but provides tractability. One may also view this as the prespecification of

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<sup>9</sup> See the discussion in Dumas (1993).

<sup>10</sup> See Bodurtha (1990), Jorion (1991), Bailey and Jagtiani (1993), Brown and Otsuki (1993), Ferson and Harvey (1993, 1994a) and Harvey, Solnik and Zhou (1993).



factors in some general multibeta model. Empirically, Ferson and Harvey (1993, 1994a) and Harvey, Solnik and Zhou (1993) have found the aggregated exchange risk factor to be significant in both conditional and unconditional asset pricing tests. Indeed, Harvey, Solnik and Zhou show that the loadings from these first two factors are able to explain 50% of the cross-section of expected returns in developed markets.

In contrast to previous applications which use exchange rate changes, I calculate the excess return on the trade-weighted currency portfolio. The portfolio return is a trade-weighted sum of investments in 10 currencies (G-10 countries minus the U.S. and plus Switzerland). The investment includes both the change in the value of the currency *and* the country's 30-day Eurodeposit rate. While the measure does not include emerging markets, the trade-weight on these markets would be very small.<sup>11</sup> The foreign currency portfolio return is measured in excess of the 30-day Eurodollar deposit rate. This procedure ensures that the factor return is a traded asset and avoids the two-step estimation problem for factor mimicking portfolios inherent in the Ferson and Harvey (1993) approach.

In contrast to the results of Cumby and Glen (1990) and Harvey (1991) for developed countries, the world market portfolio beta has little influence on the expected returns in emerging countries. Only one country, Portugal, has a beta greater than one.<sup>12</sup> The world market portfolio is significant in only seven countries: Mexico, Korea, Philippines, Malaysia, Thailand, Greece and Portugal. Of the emerging markets sample, many conjecture that these countries are the most integrated in the world economy.

Looking across all the countries, the world CAPM is rejected. The inter-

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<sup>11</sup> Although some emerging markets have had very large exchange rate swings, the factor is intended to measure the return on a currency deposit in each country. Presumably, a large depreciation in currency, say in Brazil, would be offset by a large local deposit interest rate. Additional details of the construction and the data used are provided in Harvey (1993b).

<sup>12</sup> I also estimated [not reported] betas following Scholes and Williams (1977) using one lag and one lead of the world market return. In general, there is little difference between the Scholes-Williams betas (and intercepts) and the OLS parameters. However, three countries over the full sample have betas greater than one: Mexico, Philippines and Portugal.

cepts in five countries, Argentina, Chile, Colombia, Philippines and Pakistan, are significant at the 5% level and the correlation of the stock returns in these countries is low. The multivariate intercept restrictions of Gibbons, Ross and Shanken (1989) adjusted for conditional heteroskedasticity and tested on the 8 countries with data from 1976:02 provides convincing evidence against the null hypothesis that the intercepts are equal to zero.

The interesting finding is *not* just that the intercepts are significantly different from zero; the significant intercepts are *all* positive. Even if we use a different level of significance, say the one associated with t-ratios greater than 1.3 (10% level, one-sided), all 13 countries have positive intercepts. If the single factor CAPM describes world expected returns, this would imply that these countries' returns greatly exceeded expected levels of performance. Indeed, some of the pricing errors are massive. For example, Argentina's pricing error is 63.4% per annum with a t-ratio of 2.4 and Chile has an annualized error of 29.7% with a t-ratio of 2.9. Another possible interpretation is that the intercepts are telling us something about the survivorship bias problem. While the IFC started collecting data in 1981, the multivariate intercept tests reach back to 1976. However, an examination of the subperiod which does not include to lookback bias period, suggests that survivorship does not completely explain the findings.

Panel B of table 4 considers the most recent subperiod, 1986:03–1992:06. Five of the seven countries which had significant betas on the world index in the full sample have significant betas in the most recent sub-period.<sup>13</sup> Intercepts are significant at the 5% level in 7 of the 20 countries. 11 of the countries have intercepts with t-ratios greater than 1.3 and all of these intercepts are positive. Similar to the overall period, there are some countries with very large pricing errors. For example, Chile has an error of 43.9% per annum with a t-ratio of 3.9. The multivariate test of Gibbons, Ross and Shanken (1989) provides evidence against the null hypothesis that the intercepts are zero for 18 countries at the 0.1% level.

The multivariate tests suggest that the world market portfolio is not uncon-

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<sup>13</sup> For some of the countries, the full sample and the most recent subperiod sample are identical.

ditionally mean-variance efficient. This is in contrast to the findings of Cumby and Glen (1990) and Harvey (1991) who consider only developed market returns. The intercept tests suggest that the shift in the frontier documented in table 3 was large enough that mean-variance efficiency can be rejected. Another way of interpreting this finding is by examining the Kandel and Stambaugh (1989) critical rejection region.

The solid hyperbola in first panel of figure 2 is the unconditional mean-variance frontier for 36 assets from 1986:03–1992:06. The dashed hyperbola is the critical rejection region for a 5% significance level. Notice that the world market portfolio is well to the right of the critical rejection region indicating that this benchmark portfolio is significantly off the efficient frontier. The exercise is repeated in the second panel of figure 2 imposing the no short-sales restriction. While this does not correspond to the multivariate tests in table 4, it demonstrates that even if short-sale restrictions are imposed the world market portfolio is nowhere near the efficient portion of the frontier.

The two-factor estimates over the full sample are presented in the right-hand columns of table 4. The world market beta remains significant at the 5% level in six countries: Mexico, Korea, Philippines, Malaysia, Thailand and Portugal. The foreign exchange risk factor has some explanatory power eight countries. It is especially important in explaining the aggregated index returns, Latin America, Asia and the emerging markets composite.

The addition of this second factor, however, does not affect the intercepts. Five of the intercepts are significant (and positive) at the 5% level. Eleven have t-ratios greater than 1.3 and all of these are positive. The multivariate test provides evidence against the null hypotheses at the 1.4% level of significance.

The currency risk factor appears to have more of an influence in the most recent sub-period. The right-hand columns of panel B show that this variable loads significantly into 7 countries' factor models: Chile, Mexico, Taiwan, Malaysia, Pakistan, Thailand and Zimbabwe. Both factors are important for the aggregated indices with 29% of the variance of the composite index explained. However, seven intercepts are significantly different from zero at the 5% level and 12 have t-ratios

greater than 1.3. All of these intercepts are positive. The multivariate intercept test provides evidence against the null hypothesis of zero intercepts at the .1% level of significance.

Figure 3 presents these results using the Kandel and Stambaugh (1989) critical rejection region for the two factor model. In the first panel, it is clear that portfolios of the world market return and the exchange rate return do not cross the critical rejection region drawn at the 5% significance level. With the short-sale restrictions imposed, the critical rejection region is intersected. However, as noted earlier, the asset pricing tests presented in table 4 allow for unrestricted short selling.

Two additional world risk factors were considered.<sup>14</sup> In contrast to developing countries, many of the emerging markets have undiversified industrial sectors. Given that many of these equities are resource based, the emerging market equities may have significant exposure to price fluctuations in an index of natural resources. Bivariate regressions are estimated using the percentage change in the Commodity Research Bureau's (CRB) industrial inputs index in excess of a risk-free rate. There was only one country, Indonesia, that had a significant exposure to this factor.

The emerging economies also have larger proportional agricultural sectors than the developed economies. Factor models were estimated using the percentage change CRB food price index in excess of a risk-free rate. Similar to the industrial input series, no country exhibited a significant sensitivity to this factor.

Although the tests indicate that world market portfolio is inefficient, what is the cross-sectional relation between the expected returns and the risk sensitivities? Roll and Ross (1993) and Kandel and Stambaugh (1993) have recently shown that a small degree of inefficiency could result in no relation between expected returns and risks. The first panel of figure 4 provides a scatter plot of the average

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<sup>14</sup> These factors were examined *after* the factor models were estimated in table 4, in response to a suggestion by a conference discussant, and, as such, should not be considered factor snooping. Other specifications of global risk factors are investigated by Ferson and Harvey (1994a,b). The general approach follows Chen, Roll and Ross (1986).

returns and the world market betas over the recent subperiod. The cross-sectional regression line is also plotted and is insignificant. None of the cross-sectional variation is explained. If the loadings from the second risk factor are added to the estimation, the regression is still insignificant at the 5% level.

The second panel of figure 4 presents the same average returns against their standard deviations. The cross-sectional regression line of the average returns on the volatilities is also presented with and without the influential Argentinian observation. The regression using all countries is significant at the 0.5% level. The own variance has more explanatory power than the beta with respect to the world portfolio. These results support the interpretation that many of the emerging markets are not fully integrated into world capital markets.<sup>15</sup>

There are other reasons why the unconditional CAPM could fail aside from the market integration issue. For example, the linear factor specification in table 4 assumes that the conditional risk exposures are constant over the estimation period. The differences in the magnitude of the some of the risk coefficients in the full and most recent subperiod suggest that exposures may be time varying. Indeed, a rejection of the unconditional CAPM does not imply a rejection of the conditional CAPM.

#### 4. Analysis of conditional risk

##### *4.1 Predictable returns in emerging markets*

Table 5 presents an analysis of the predictable variation in the emerging market returns. Linear regressions of the emerging market returns on three sets of information variables are detailed. The first set consists of common world information variables. The second includes only variables that are specific to the country being examined. The final set combines the local and country-specific information sets.

To provide a direct comparison to research on developed markets, the world

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<sup>15</sup> Bekaert and Harvey (1993) present a model where the time-series of expected returns is generated by both the covariance with the world return and the variance of the country return weighted by the probability that the market is integrated.

information set follows Harvey (1991).<sup>16</sup> The set includes lagged values of the MSCI world return, the return on the U.S. three-month Treasury bill minus the one-month return, the yield spread between Moody's Baa and Aaa rated bonds and the Standard and Poor's 500 dividend yield minus the one-month U.S. Treasury bill return. The only difference between this information set and Harvey's is the exclusion of the January dummy variable.

The first column of adjusted  $R^2$ s results from regressions on the world information variables. Notice that the sample periods are slightly different than the table 4 regressions. This due to the unavailability of some of the local information variables which will be used in later analysis. Heteroskedasticity-consistent tests of significance (p-values) are reported beneath the  $R^2$ . The expected returns in 9 of the 20 countries are significantly (5% level) affected by the world information variables. A multivariate heteroskedasticity-consistent test of predictability based on the Pillai trace [see Kirby (1993)] provides strong evidence against the hypothesis of constant expected returns.

The second column of adjusted  $R^2$ s is obtained from regressions on the local information variables. The local information set includes the lagged country U.S. dollar returns, the change in the foreign exchange rate versus the U.S. dollar, the dividend yield and a local short-term interest rate.<sup>17</sup>

Local information is important for 11 of the 20 regressions at the 5% level of significance. When the local information is combined with the world information, 12 regressions are significant at the 5% level and 14 at the 10% level. A heteroskedasticity-consistent exclusion test of the local information variables provides evidence against the null hypothesis in 10 countries at the 5% level. That

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<sup>16</sup> Harvey's (1991) selection of variables was motivated by Keim and Stambaugh (1986), Campbell (1987) and Fama and French (1988).

<sup>17</sup> I selected interest rates which were the 'most unregulated.' Deposit rates were used for Argentina, Chile, Colombia, Venezuela, Thailand, Greece, Jordan, and Nigeria. Call money rates were used in India, Indonesia, and Pakistan. Money market rates were used for Korea, Malaysia, and Turkey. Treasury bills were used for Mexico, Philippines, Portugal and Zimbabwe. The bank rate was used for Brazil. The U.S. three-month Treasury bill yield was used for Taiwan who is not a member of the International Monetary Fund.

is, in the 12 countries with significant regressions, 10 are importantly influenced by local information. The variance ratios in the far right-hand columns suggest that more than half of the predictable variance in these emerging market returns is induced by local information.

From the evidence of serial correlation presented in table 1, it may seem obvious that lagged country returns should predict future returns. Indeed, it is possible that this type of predictability could be induced by infrequent trading.<sup>18</sup> However, using a monthly frequency should diminish this influence. Interestingly, in the regressions with world and local information [not reported], only three countries, Colombia, Venezuela and the Philippines, have significant coefficients on the lagged country returns.

These results contrast with the results on developed countries in three respects. First, the degree of explanatory power is greater in emerging markets. Using the combined information set, 7 of the regression adjusted  $R^2$  exceed 10% and 3 exceed 20%. Over the same period, the predictability of the world market portfolio is limited to 5%. Over the 1970.02–1989.5 period, Harvey (1991) reports that only 2 of 18 developed countries have adjusted  $R^2$ s that exceed 10% using world information variables. Using various combinations of world and local information only three countries have  $R^2$ s that exceed 10%.

The second difference concerns the importance of local information variables. In almost all of the significant regressions, local information played an important role. In contrast, Harvey (1991) found that most of the variation was being driven by global information variables. Using a different sample and different instruments, Ferson and Harvey (1993) report that local information is important in only 6 of 18 developed markets.

Some are skeptical of the predictability in asset returns because of the collective data snooping by many researchers.<sup>19</sup> While most of the snooping is focussed

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<sup>18</sup> Serial correlation could be induced by persistence in country risk exposures or world risk premiums. It could also be induced by informational inefficiencies. Unfortunately, there is no way to separate these possible causes and hence no attempt has been made to filter the data.

<sup>19</sup> See, for example, Foster and Smith (1993).

on U.S. returns, the use of international returns does not provide ‘out-of-sample’ evidence of predictability because of the correlation between the international returns and the U.S. return. For example, in Harvey (1991) the rank-order correlation between the predictive  $R^2$  and the squared correlation of the country returns with U.S. returns is 57.9% which is significant at the 5% level (p-value 1.8%). That is, high correlation with the U.S. usually implies a high degree of predictability.

The final contrast with developed markets is that there is little or no relation between the predictability of emerging market returns and their unconditional correlations with the U.S. or the world market return. The rank-order correlation between the predictive  $R^2$  and the squared correlation with the U.S. return is only 29.5% (p-value 22.0%). A similar result is obtained when one considers the squared correlation with the world market return. In this case, the rank-order correlation drops to -3.7% (p-value 88.0%). While this evidence is informal, it suggests that the predictability may be genuine.

#### 4.2 Conditional asset pricing tests

Following the unconditional analysis in table 3, I examine the influences of two sources of risk, the world market return and the foreign exchange portfolio return, on conditionally expected returns. In this analysis, expected returns, risk premiums and betas change through time as a function of the information variables.

Let  $Z^w$ ,  $Z^\ell$ ,  $Z^{w,\ell}$  be the world information, local information and the combined information respectively. The following model is estimated:

$$\begin{aligned}
 u_{1it} &= r_{it} - Z_{t-1}^{w,\ell} \delta_i \\
 u_{2t} &= f_t - Z_{t-1}^w \theta \\
 u_{3it} &= [u'_{2t} u_{2t} (Z_{t-1}^{w,\ell} \kappa_i)' - f'_t u_{1it}]' \\
 u_{4it} &= \mu_i - Z_{t-1}^{w,\ell} \delta_i \\
 u_{5it} &= (-\alpha_i + \mu_i) - Z_{t-1}^{w,\ell} \kappa_i (Z_{t-1}^w \theta)'
 \end{aligned} \tag{4}$$

where  $r$  represents the return on asset  $i$ ,  $\delta$  are coefficients from a linear projection of the asset returns on the information,  $Z^{w,\ell} \kappa_i$  are the fitted conditional betas,  $f$



are the factor returns,  $\theta$  are the coefficients from a linear projection of the factor returns on the information,  $\mu$  is the mean asset return, and  $\alpha$  is the difference between the mean asset return and the model fitted mean asset return (pricing error). Conditioning  $u_1$  and  $u_3$  on  $Z^{w,\ell}$ ,  $u_2$  on  $Z^w$  and  $u_4$  and  $u_5$  on ones produces an exactly identified system of equations.<sup>20</sup>

The following is the intuition behind the system. The first two equations are regressions of the asset and factor returns on the information. These are ‘statistical’ models of expected returns. I let the country returns be influenced by both local and world information variables. However, the world risk premiums are strictly a function of world information variables. Next the definition of conditional beta is used:

$$\beta_{it} = (E[\mathbf{u}'_{2t}\mathbf{u}_{2t}|Z_{t-1}^{w,\ell}])^{-1}E[\mathbf{f}'_t u_{1it}|Z_{t-1}^{w,\ell}]. \quad (5)$$

The conditional beta in (4) is assumed to be a linear function of the combined world and local information.<sup>21</sup> The last two equations deliver the average pricing error. Parameter  $\mu_i$  is the average expected return from the statistical model. The parameter  $\alpha_i$  is the difference between the average ‘statistical’ model returns and the asset pricing model’s fitted returns. It is analogous to the  $\alpha_i$  reported in table 3. However, in this analysis, both the betas and the premiums are changing through time. Furthermore, the focus is on the predictable portion of the returns.

This complicated system of equations and can only be estimated one asset at a time. As such, not all the cross-sectional restrictions of asset pricing theory can be imposed. For example, it will not be possible to report a multivariate test of whether the  $\alpha_i$  parameters are equal to zero. However, one important cross-sectional restriction has been imposed. Because the system is exactly identified, the world risk premium function,  $Z_{t-1}^w\theta$ , is identical for every country examined.

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<sup>20</sup> For analysis of related systems, see Ferson (1990), Harvey (1992), Ferson and Korajczyk (1993) and Ferson and Harvey (1993). Importantly, I ask the model to explain the predictability induced by both local *and* world information whereas Ferson and Harvey (1993) only challenge the model to explain the predictability induced by the world information.

<sup>21</sup> The linear conditional beta formulation is used in Shanken (1990), Ferson and Harvey (1991, 1993) and Jagannathan and Wang (1993).

The conditional risk function is simply  $Z^{w,\ell}\kappa_i$ . Wald tests are conducted to test for the significance of the beta and to test whether the beta changes through time.

As this system is exactly identified, there is no general test of the model's restrictions in the form of Hansen's (1982) J-statistic. However, the asset pricing model implies that the coefficient  $\alpha_i$  should not be different from zero and this hypothesis can be tested. Another possible test involves analyzing the model disturbance:

$$u_{6it} = r_{it} - Z_{t-1}^{w,\ell}\kappa_i(Z_{t-1}^w\theta)'. \quad (6)$$

According to the asset pricing model,  $E[u_{6it}|Z_{t-1}^{w,\ell}]$  should be zero. Diagnostics are reported by regressing  $u_{6it}$  on the three sets of information variables and comparing the predictability of the model errors to the predictability of the asset returns.

Estimates of (4) are provided in table 6 for the subset of eight countries with data available from 1977:04 (there are 183 observations).<sup>22</sup> Panel A details the results of the one factor model. Consistent with the unconditional results in table 3, the annualized average pricing errors are more than two standard errors from zero for Chile and India and 1.5 standard errors from zero for Argentina, Mexico and Thailand. The average pricing errors are of the same magnitudes as the average returns indicating that allowing for time-varying betas and premiums is not enough to get the mean returns right.

The Wald tests show that, in four of the countries, the conditional betas are significantly different from zero. In three of these countries, the betas exhibit significant time-variation. However, the time-variation in the betas does not help explain the predictability in the asset returns. For the countries that have significant time-variation in their expected returns, not only are the pricing errors different from zero on average, they are correlated with the predetermined information. These correlations are sufficient to provide rejection of the asset pricing specification (4).

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<sup>22</sup> For some of the countries, the interest rate data was not available before 1977:03. Zimbabwe is not included because the interest rate data begins later.

The results of the two-factor estimation are presented in panel B. In six of the eight countries, the average pricing errors are worse with two factors rather than one. The betas are jointly significant in six of the countries. There is significant time-variation in the betas of five of these six countries. The addition of the extra factor reduces the residual  $R^2$  on the combined information in four of the five countries with time-varying betas. However, the correlation between the pricing errors and the combined information is still significant for three of the countries.

Figure 4 provides plots of the conditional betas from the single factor estimation along with 60-month rolling correlations calculated with and without the October 1987 observation. For most of the countries, the general movements in the conditional betas are reflected in the rolling correlation measure (which is smoother due to the overlapping samples). This is especially true in the countries with the most significantly time-varying betas, Argentina, Mexico, India and Thailand.

The behavior of the correlations and the relation between the correlations and market betas is important because some observers interpret increased correlation as evidence of increased market integration. From figure 4, the numerical magnitude of the correlation has increased in five countries: Brazil, Chile, Mexico, Korea and Thailand. However, there is no necessary link between correlation and integration. A country can have zero correlation with the world market and be perfectly integrated into world capital markets. The low correlation could be caused by the weighted average of the firm betas in the country index equalling zero.

Table 7 sheds some light on the relation between correlation and beta. Interestingly, the unconditional correlation is significantly different from zero in only three countries: Mexico, Korea, and Thailand. A test of whether this correlation is time-varying produces no evidence against the null hypothesis of constant correlation, however, the lowest p-values are found for Chile, Mexico, Korea, India and Thailand.<sup>23</sup>

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<sup>23</sup> The test measures whether the unconditional correlation is constant. A different and more complex test is whether the conditional correlation is constant. This is more complex because it is necessary to model the dynamics of the conditional

The correlation is related to beta by the ratio the world and country standard deviations. Table 7 tests whether the ratio of variances is constant in the following system:

$$\begin{aligned}
 u_{1it} &= r_{it} - Z_{t-1}^{w,\ell} \delta_i \\
 u_{2it} &= r_{wt} - Z_{t-1}^w \theta \\
 u_{3it} &= \phi_i u_{1it}^2 - u_{2it}^2
 \end{aligned}
 \tag{7}$$

where  $\phi_i$  is the ratio of the variance of the world to the variance of country  $i$ 's excess returns. Conditioning  $u_1$  and  $u_3$  on  $Z^{w,\ell}$  and  $u_2$  on  $Z^w$  produces a  $\chi^2$  test of whether this ratio is constant with 8 degrees of freedom.

This decomposition helps interpret the observation that correlations of the emerging market returns and the world market return are shifting through time. For three of the countries, Argentina, Chile and Thailand there is evidence in table 7 against the null hypothesis that the ratio of variances is constant. For two other countries, Mexico and India, the evidence in table 6 suggests that the conditional betas are changing through time. Each or both of these two effects could cause time-variation in correlations – or they could cancel each other out. But, importantly, the correlation measure, the ratio of volatilities, and the conditional betas, are not sufficient to make inference about the degree of integration in these capital markets.

#### *4.3 Future directions for asset pricing in emerging markets*

In contrast to the evidence in developed markets, the global unconditional asset pricing models are unable to explain the cross-section of expected returns in emerging markets. Also different from the evidence in developed markets, the analysis of conditional risk and risk premiums suggests that significant pricing errors persist and the standard asset pricing models do not account for the predictability in the emerging market returns. One likely factor contributing to the failure of these models is the lack of integration of the emerging markets into the world capital markets.

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variance processes for both the country and the world portfolio.

Indeed, there are significant barriers to free capital flows in many of the countries in the sample. For example, foreigners could not directly participate in the Korean equity market. While the strict controls were dismantled at the end of 1992 [see Chuppe and Atkin (1992)], the Korean market is effectively off limits throughout our sample.

There are other countries which have two classes of trading. For example, in Thailand, identical stocks trade on Main (for domestic investors) and Alien (for foreign investors) Boards. Foreigners are restricted to a certain proportion of the capitalization (which depends on the industry). Bailey and Jagtiani (1993) show that the Alien-Main premium is significantly different from zero and changes through time.

The segmentation of these markets make it unlikely that expected returns will adhere to a global asset pricing model. In a completely segmented market, own volatility (which is usually idiosyncratic in a global asset pricing model) may be priced.<sup>24</sup> Indeed, the evidence in figure 4 is suggestive of a relation between own volatility and the cross-section of expected returns. In a segmented market, covariance with global factors may appear to be priced to the extent that there is correlation between the local market volatility and global factors.

Empirical asset pricing research has either assumed complete segmentation [for example, Black, Jensen and Scholes (1972), Fama and MacBeth (1973), Gibbons (1982) and Stambaugh (1982)], complete integration [for example, Harvey (1991), Dumas and Solnik (1993) and this paper], or a combination – partial segmentation. None of these models accounts for time-varying integration. A reasonable prior (especially with emerging markets) is to expect a high degree of segmentation early in the market history and increasing integration with world capital markets as we approach present day.

An asset pricing specification that allows for time-varying integration should let both the covariance with the world market and the covariance with the local

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<sup>24</sup> See, for example, Errunza and Losq (1985) and Eun and Janakiramanan (1986) for models of partial segmentation.

market return to affect the conditional mean:

$$u_{ijt} = r_{ijt} - \phi_{it}\lambda_{t-1}^w \text{Cov}_{t-1}[r_{ijt}, r_{wt}] - (1 - \phi_{it})\lambda_{t-1}^i \text{Cov}_{t-1}[r_{ijt}, r_{it}] \quad (8)$$

where  $r_{ij}$  is the return on security  $j$  in country  $i$ ,  $r_i$  is the return on the local country index,  $\phi_{it}$  is the measure of time-varying integration (1= complete integration, 0=complete segmentation), and  $\lambda$  is a measure of risk aversion ( $w$ =global,  $i$ =country specific). The key to estimating this type of model is the specification of  $\phi_{it}$ . This research direction is being pursued in Bekaert and Harvey (1993).

## 5. Conclusions

This paper provides the first comprehensive analysis of 20 new equity markets in emerging economies. These markets have historically been characterized by high average returns and large volatility. However, given the low correlation with developed country returns, the evidence suggests that the emerging market returns are not spanned by the developed market returns. As a result, inclusion of emerging market assets in a mean-variance efficient portfolio will significantly reduce portfolio volatility and increase expected returns.

Next, the risk of emerging market equities is analyzed. Risk exposure is interlinked with asset pricing theory. That is, exposure is only meaningful if it is rewarded in equilibrium. However, equilibrium models of global asset pricing take, as given, the complete integration of world capital markets. Applying standard one and two-factor global asset pricing paradigms leads to large pricing errors. The betas are unable to explain any of the cross-sectional variation in expected returns.

Finally, the predictability of the emerging market returns is investigated. Both world and local information variables are used to forecast the returns. There are three important differences between the predictability in emerging and in developed markets. First, in developed markets, the market's correlation with the U.S. return is closely linked to the degree of predictability. In emerging markets, there is no significant association between correlation with the U.S. portfolio and predictability. Second, the amount of predictability found in the emerging markets

is greater than that found in developed markets. Third, local information variables play a much more important role in predicting emerging market returns. Indeed, over half of the predictable variance in the emerging market returns can be traced to local information.

Predictability can be induced by time-varying risk premiums, time-varying risk exposures or a combination of the two. Given the nature of the predictability, in that it is strongly influenced by local information, it is most likely driven time-varying risk exposures. When a model is estimated that allows for all of the moments to change through time, there is some evidence of time-varying risk exposures. However, the conditional asset pricing models fail to price the emerging market assets correctly on average and are unable to account for the time variation in expected returns.

The fact that much of the predictability is induced by local information is also consistent with the possibility that some of these countries are segmented from world capital markets. Future research will investigate an asset pricing framework that allows for the possibility of incomplete integration and for the degree of integration to change through time.

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## Appendix: IFC Indices and Restrictions on Foreign Investors

The International Finance Corporation (IFC) began calculating market indices in 1981. The indices, known as the IFC Global (IFCG) Indices, do not take into consideration restrictions on foreign ownership. While there is a trend towards reducing the barriers to foreign ownership, these constraints are binding in a number of countries.

Recently, the IFC has introduced a second set of indices, the IFC Investable (IFCI) Indices. The IFCI indices reflect restrictions on ownership limits. For example, if a firm had a market capitalization of US \$300 million and the national law restricts foreign ownership to 50% of any company, the IFC Global index uses the full \$300 million as the market capitalization while the IFC Investable index uses \$150 million.

Since my paper studies the integration of the emerging markets into world capital markets, I have chosen to use the IFC Global indices. An additional reason for using the Global indices is the limited availability of the Investable indices (data begins in 1988). However, it is important to understand the degree of restrictions in each market. The following is drawn from the International Finance Corporation (1993a).<sup>25</sup>

Argentina. The market is considered generally 100% investable; some corporate statute limitations apply.

Brazil. The market is considered generally investable. Since May 1991 foreign institutions may own up to 49% of voting common stock and 100% of non-voting participating preferred stock. Some corporate statute limitations (e.g., Petrobras common are off-limits) apply.

Chile. Foreign portfolio investment is considered to enter Chile through Law 18657 of 1987 regarding Foreign Capital Investment Funds, which limits aggregate foreign ownership to 25% of a listed company's shares.

Colombia. The market is considered 100% investable from February 1, 1991.

Greece. The market is generally 100% investable.

India. A press release issued by the Ministry of Finance of the Government of India on September 14, 1992 announced that foreign institutional investors (FIIs) could henceforth invest in all listed securities in both primary and secondary markets. FIIs are required to register with the Securities and Exchange Board of India before making any investment. The market is considered effectively open from November 1, 1992. Investments are subject to a ceiling of 24% of issued share capital for the total holdings of all registered FIIs and 5% for the holding of a single FII in any one company. The ceiling includes the conversion of fully and partly convertible debentures issued by the company.

Indonesia. Until December 1987, the market was closed to foreign investment. In December 1987, the government introduced deregulation measures that allowed foreigners to purchase shares in eight non-joint venture companies. On September 16, 1989, the Minister of Finance of the Republic of Indonesia issued Decree Number 1055/KMK.013/1989, which allowed foreigners to purchase up to 49% of all companies' listed shares, including

<sup>25</sup> Also see Castelin and Stone (1990). Gooptu (1993) provides a comprehensive analysis of portfolio investment flows to emerging markets.

foreign joint ventures but excluding banks. The Bank Act, 1992, enacted on October 30, 1992, allowed foreigners to invest in up to 49% of the listed shares in three categories of banks-private national, state and joint foreign. Currently only private national banks are listed. %In a few markets, such as Indonesia, companies do not %list all the shares outstanding. %For its indexes, IFC counts only the shares listed %at the stock exchange.

Jordan. The market is considered generally 49% investable.

Korea. Since January 1, 1992, authorized foreign investors have been allowed to acquire up to 10% of the capital of listed companies; some corporate statute limitations apply (e.g. POSCO and KEPCO 8%, and some are permitted up to 25%). The 10% limit applies separately to common and preferred stock. Under the revised regulations of June 22, 1992, effective in July 1992, companies whose foreign holdings already exceed 10% could apply to Korea's Securities and Exchange Commission to increase their limit to 25%. As of March 1993, four companies had received permission: Korea Electronic Parts, Korea Long-Term Credit Bank, Trigem Computer and Young Chang Akki. The ceiling automatically declines when foreign-held shares are sold to domestic investors.

Malaysia. The limit on foreign ownership of Malaysian stocks is subject to some debate. Bank Negara, the central bank, restricts the ownership of banks and financial institutions by foreigners to 30%. However, these limits do not appear to be strictly enforced. Under the Bankings and Financial Institutions Act, 1989, the approval of the Minister of Finance is required before foreign investors can buy or sell shares of a licensed bank of finance company amounting to 5% or more. Certain non-bank stocks have different foreign share holdings limits for tax and other reasons. These are MISC, Proton, Telekom, Tenaga Nasional, Tai Wah Garments and Yantzekiang. All other stocks are open to foreign portfolio investment without any limits. However, the approval of the Foreign Investment Committee is required for acquiring 15% or more of the voting power of a company by any one foreign interest and for acquiring the assets of interests of a company when they exceed M\$5 million, whether by Malaysian or foreign interests. Except for a few specific cases, IFC uses 100% for most stocks and 30% for banks and financial institutions.

Mexico. Foreign portfolio investment is permitted in designated classes of shares, and since May 1989 in most other shares through the use of the Nafinsa Trust arrangement. It is now considered generally 100% investable, except for banks, where foreign ownership is restricted to 30%.

Nigeria. Closed to foreign investment.

Pakistan. The market is considered 100% investable from February 22, 1991.

Philippines. National law requires that a minimum of 60% of the issued shares of domestic corporations should be owned by Philippine nationals. To ensure compliance, Philippine companies typically issued two classes of stock: "A" shares, which may be traded only among Philippine nationals, and "B" shares, which may be traded to either Philippine nationals or foreign investors and which usually amount to 40% of the total. Mass media, retail trade and rural banking companies are closed to foreign investors.

Portugal. The market is considered generally 100% investable; some corporate statute limitations apply, particularly regarding shares issued in privatization.

Taiwan. The market was opened to foreigners on January 1, 1991, though foreign investors must meet high registration requirements and total cash inflows must meet high registration requirements and total cash inflows from abroad cannot currently exceed an official ceiling of \$2.5 billion. There is a 10% limit on aggregate foreign ownership of issued capital. The domestic transportation industry is closed to foreign investors.

Thailand. Various Thai laws restrict foreign shareholdings in Thai companies engaged in certain areas of business. The Banking Law restricts foreign ownership in banks to 49%. The Alien Business Law, administered by the Ministry of Commerce, restricts foreign ownership of stocks in specified sectors to 49%. In addition, other laws provide similar restrictions on foreign ownership. Restrictions are also faced by foreign investors through limits imposed by company by-laws which range from 15% to 65%. The Foreign Board was established in 1988 to facilitate trading in shares registered in foreign names.

Turkey. The market is considered 100% investable from August 1989.

Venezuela. Non-financial stocks are considered generally 100% investable from January 1, 1990, but some restricted classes do exist. Bank stocks are currently not available.

Zimbabwe. Effectively closed to foreign investment by virtue of severe exchange controls.

Table 1

## Summary statistics for emerging and developed markets' returns through June 1992

Country	Sample	Market Cap. US\$ bill.	Firms in IFC index	Annualized mean		Annualized std. dev. %	Autocorrelation			Coefficient of		P-value test of normal
				arithmetic %	geometric %		$\rho_1$	$\rho_2$	$\rho_{12}$	skewness	of excess kurtosis	
<i>Latin America - U.S. \$ returns</i>												
Argentina	1976.02	25.5	27	71.79	26.93	105.06	0.05	0.06	-0.10	1.92	6.95	0.00
Brazil	1976.02	50.7	67	21.71	3.73	60.70	0.03	-0.03	0.03	0.53	0.99	0.00
Chile	1976.02	37.0	35	39.64	31.91	39.64	0.18	0.26	0.09	0.92	3.12	0.10
Colombia	1985.02	5.1	20	46.09	40.69	32.54	0.49	0.15	0.04	1.68	3.90	0.00
Mexico	1976.02	128.9	56	30.52	19.04	44.99	0.25	-0.08	-0.01	-0.83	3.60	0.05
Venezuela	1985.02	9.0	16	38.08	26.26	47.52	0.27	0.18	-0.07	0.08	3.18	0.00
Latin America	1985.02	256.2	221	35.67	27.59	39.39	0.25	-0.04	-0.10	-0.11	0.74	0.25
<i>East Asia - U.S. \$ returns</i>												
Korea	1976.02	85.9	77	18.52	13.80	31.38	0.01	0.07	0.11	0.99	2.26	0.00
Philippines	1985.02	15.8	30	49.90	42.00	38.64	0.34	0.02	0.06	0.37	2.07	0.01
Taiwan	1985.02	135.9	70	40.93	26.23	53.99	0.06	0.04	0.13	0.15	0.81	0.31
<i>South Asia - U.S. \$ returns</i>												
India	1976.02	69.9	60	20.45	16.94	26.56	0.09	-0.10	-0.09	0.74	2.65	0.01
Indonesia	1990.02	11.7	66	-11.40	-17.40	34.01	0.25	0.16	0.26	0.05	-0.38	0.73
Malaysia	1985.02	78.3	62	13.24	9.45	26.89	0.05	0.07	-0.10	-0.62	1.98	0.56
Pakistan	1985.02	8.3	54	25.86	23.40	22.37	0.27	-0.24	0.13	2.61	11.04	0.00
Thailand	1976.02	43.8	43	21.75	18.29	25.67	0.12	0.16	0.06	-0.12	3.42	0.00
Asia	1985.02	449.6	462	19.31	15.65	26.27	0.01	0.18	0.13	-0.74	1.26	0.20
<i>Europe/Mideast/Africa - U.S. \$ returns</i>												
Greece	1976.02	13.3	32	9.43	3.49	36.25	0.12	0.18	-0.05	1.87	7.37	0.01
Jordan	1979.02	2.8	25	10.29	8.66	18.03	0.00	0.03	-0.01	0.47	0.91	0.00
Nigeria	1985.02	1.1	24	2.44	-6.19	37.19	0.09	-0.13	-0.08	-1.76	10.90	0.00
Portugal	1986.03	11.6	30	40.71	28.72	51.43	0.28	0.03	0.03	1.50	4.59	0.07
Turkey	1987.02	11.6	25	44.32	18.50	76.25	0.24	0.10	-0.18	0.98	0.68	0.00
Zimbabwe	1976.02	0.9	17	9.74	3.90	34.25	0.13	0.15	-0.04	0.26	1.93	0.14
Composite	1985.02	747.1	836	20.36	17.11	24.70	0.15	0.07	0.08	-0.71	1.27	0.10
<i>Developed - U.S. \$ returns</i>												
United Kingdom	1976.02	1,030.1	145	18.69	16.00	22.80	-0.00	-0.08	-0.15	-0.02	0.80	0.25
Japan	1976.02	2,119.7	266	17.69	14.91	23.35	0.01	-0.03	0.12	0.22	0.80	0.14
United States	1976.02	3,707.3	332	13.63	12.39	15.24	-0.00	-0.07	-0.00	-0.48	2.91	0.17
<i>Benchmarks - U.S. \$ returns</i>												
MSCI World	1976.02	9,198.1	-	13.91	12.81	14.36	0.03	-0.07	0.02	-0.42	1.71	0.33
G-10 FX	1976.02	-	-	11.36	10.83	9.85	-0.05	0.12	-0.01	-0.02	0.29	0.63

Table 1 (continued)

Country	Sample	Annualized mean		Annualized std. dev. %	Autocorrelation			Coefficient		P-value test of normal
		arithmetic %	geometric %		$\rho_1$	$\rho_2$	$\rho_{12}$	of skewness	of excess kurtosis	
<i>Latin America - Local currency returns</i>										
Argentina	1976.02	228.80	155.22	147.93	0.18	0.20	-0.02	3.03	12.90	0.00
Brazil	1976.02	155.52	123.82	79.53	0.16	0.23	0.20	1.26	1.87	0.00
Chile	1976.02	61.61	53.48	39.06	0.17	0.29	0.15	1.06	4.10	0.20
Colombia	1985.02	72.38	65.94	32.49	0.48	0.14	0.05	1.70	4.15	0.00
Mexico	1976.02	62.60	52.65	42.34	0.34	0.00	0.06	0.03	1.65	0.00
Venezuela	1985.02	64.23	55.43	40.24	0.37	0.20	-0.03	0.69	2.32	0.00
<i>East Asia - Local currency returns</i>										
Korea	1976.02	21.41	16.79	30.98	-0.05	0.06	0.12	1.03	2.43	0.00
Philippines	1985.02	54.44	46.02	40.40	0.28	-0.03	0.04	0.91	3.45	0.01
Taiwan	1985.02	33.38	19.86	52.72	0.05	0.03	0.13	0.13	0.92	0.26
<i>South Asia - Local currency returns</i>										
India	1976.02	27.91	24.02	27.93	0.11	-0.09	-0.01	1.25	5.39	0.22
Indonesia	1990.02	-6.22	-12.25	34.30	0.25	0.16	0.27	0.02	-0.32	0.81
Malaysia	1985.02	13.19	9.51	26.46	0.06	0.07	-0.06	-0.72	2.45	0.50
Pakistan	1985.02	32.47	29.84	22.49	0.27	-0.25	0.13	2.49	10.19	0.00
Thailand	1976.02	23.00	19.61	25.35	0.12	0.16	0.05	-0.15	3.76	0.00
<i>Europe/Mideast/Africa - Local currency returns</i>										
Greece	1976.02	19.03	13.59	34.75	0.11	0.15	-0.06	2.08	8.40	0.01
Jordan	1979.02	16.12	14.59	17.35	0.08	0.05	-0.01	0.88	1.45	0.00
Nigeria	1985.02	36.20	35.02	12.00	0.12	-0.05	0.11	2.65	15.33	0.00
Portugal	1986.03	38.38	26.45	51.29	0.29	0.03	0.08	1.55	5.55	0.31
Turkey	1987.02	85.65	59.07	76.59	0.18	0.08	-0.18	0.98	0.72	0.00
Zimbabwe	1976.02	21.79	16.33	33.01	0.10	0.14	-0.05	0.37	2.98	0.05

The monthly returns for emerging markets are from the International Finance Corporation. The developed market returns are from Morgan Stanley Capital International (MSCI). The world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio. G-10 FX is the U.S. dollar return to holding a trade-weighted portfolio of Eurocurrency deposits in 10 countries (G-10 countries plus Switzerland) [details of construction are found in Harvey (1993b)]. Normality tests of the country returns are conducted using the generalized method of moments by imposing the restriction that the coefficients of skewness and excess kurtosis are jointly equal to zero. The chi-square test statistic has two degrees of freedom. The probability values from the test statistic are reported in the final column. Multivariate tests were also conducted and are reported in the text.



Table 2

Correlations of the emerging market returns based on monthly data from March 1986 to June 1992 (75 observations).

	ARG	BRA	CHI	COL	MEX	VEN	KOR	PHI	TAI	IND	INO	MAL	PAK	THA	GRE	JOR	NGR	POR	TUR	ZIM	L-A	Asia	Comp	
ARG	-.15																							
BRA	.15	-.15																						
CHI	.11	-.02	-.15																					
COL	.00	.31	-.02	-.10																				
MEX	.00	.31	-.02	.11	-.10																			
VEN	.03	.24	-.05	.11	.20	-.09																		
KOR	.05	.03	-.03	.09	.16	.16	-.16																	
PHI	.14	.15	.13	.09	.34	.22	.02	.04																
TAI	.07	.30	.11	.34	.04	.22	.02	.04	-.13															
IND	.24	.04	.04	.12	.06	.04	.01	.00	.30	.07														
INO	.29	.06	.09	.25	.04	.01	.00	.50	.30	.07														
MAL	.04	.12	.26	.06	.46	.13	.17	.35	.25	.05	.46													
PAK	.02	-.03	-.13	.44	-.05	.01	-.03	-.01	-.07	-.12	.05	.08												
THA	.05	.07	.27	.14	.39	.19	.03	.28	.43	.07	.42	.52	.01											
GRE	.07	.02	.12	.22	.13	-.04	-.13	.12	.10	.02	.36	.08	-.10	.30										
JOR	-.10	-.10	.01	.11	-.02	-.05	-.14	.17	.16	-.01	.20	.08	-.12	.15	.10									
NGR	.13	.00	-.03	.14	-.11	.12	.05	.09	-.15	-.16	-.10	-.17	.01	-.12	.12	-.03								
POR	-.02	.10	.21	.14	.35	-.07	.10	.02	.39	-.11	.24	.24	.03	.35	.41	-.03	.20							
TUR	.15	.07	.02	.13	.17	-.10	.02	.12	.17	.09	.28	.26	.04	.29	.28	-.12	.08	.27						
ZIM	-.19	-.05	-.09	-.16	-.02	.11	-.03	-.02	-.01	-.24	.04	-.04	-.11	-.10	.03	.00	.05	.12	.01					
L-A	-.03	.11	.33	.05	.44	-.26	.27	.20	.90	.05	.32	.48	-.07	.49	.05	.13	-.14	.29	.24					
Asia	.02	.81	.38	.07	.38	-.22	.14	.09	.23	.06	-.08	.27	-.04	.20	.02	-.12	-.02	.27	.13	-.14	.28			
Comp	.00	.39	.42	.09	.47	-.30	.26	.16	.82	.06	.31	.45	-.06	.46	.07	.08	-.11	.40	.27	-.16	.90	.63		
Average	.03	.12	.15	.12	.20	-.04	.08	.15	.22	.04	.20	.22	.04	.24	.15	.07	.02	.20	.17	.00	.26	.19	.29	
Developed	.01	.14	.15	.07	.24	-.09	.15	.24	.15	-.06	.26	.44	.04	.36	.15	.12	.06	.25	.10	-.06	.22	.24	.28	
MSCI world	-.06	.18	.14	.08	.33	-.10	.33	.31	.21	-.21	.07	.55	.02	.41	.15	.13	.11	.40	.05	-.02	.30	.31	.36	

The monthly returns for emerging markets are from the International Finance Corporation (IFC). L-A is the composite index for Latin American countries. Asia is the composite for Asian countries and Comp is the IFC emerging markets composite index. Average denotes the average cross-correlation between the country and the other emerging markets. Developed is the average cross-correlation between the country and 18 Morgan Stanley Capital International (MSCI) developed market returns. MSCI world is the correlation with the MSCI value-weighted world market portfolio return. All returns are calculated in U.S. dollars.

**Table 3**

**Frontier intersection tests**

Errors	Moving average structure	F-statistic {p-value}
Heteroskedastic 1	none	6.943 {<0.001}
Heteroskedastic 2	15 lags Barlett	8.0128 {<0.001}
Heteroskedastic 3	15 lags Parzen	8.183 {<0.001}

The test statistic due to Shanken (1986) and Jobson and Korkie (1989) is

$$\phi_z = \frac{(T - N - 1)}{(N - N_1 - 1)} \frac{(\hat{a}_z - \hat{a}_{z1})}{(1 + \hat{a}_{z1})}$$

where

$$\hat{a}_z = (\bar{r} - \bar{r}_z \iota)' V^{-1} (\bar{r} - \bar{r}_z \iota)$$

$$\hat{a}_{z1} = (\bar{r}_1 - \bar{r}_z \iota_1)' V_{11}^{-1} (\bar{r}_1 - \bar{r}_z \iota_1)$$

$$\bar{r}_z = (\hat{b} - \hat{b}_1) / (\hat{c} - \hat{c}_1)$$

$$\hat{b} = \bar{r}' V^{-1} \iota$$

$$\hat{c} = \iota' V^{-1} \iota$$

and  $\boldsymbol{r} = \{\boldsymbol{r}_1, \boldsymbol{r}_2\}$ ,  $\boldsymbol{r}_1$  are the returns in 18 developed markets,  $\boldsymbol{r}_2$  are the returns in the 18 emerging markets,  $\boldsymbol{V}$  is the variance-covariance matrix,  $\boldsymbol{\iota}$  is a vector of ones and  $r_0$  is return on minimum variance portfolio constructed from  $\boldsymbol{r}$ . The statistic follows an F-distribution with  $(T - N - 1)$  and  $(N - N_1 - 1)$  degrees of freedom where  $T$  is the number of observations,  $N$  is the total number of assets and  $N_1$  are the number of assets represented in  $\boldsymbol{r}_1$ . The monthly returns for emerging markets are from the International Finance Corporation. The developed market returns are from Morgan Stanley Capital International (MSCI). The sample is 1986:03–1992:06.

Table 4

## Unconditional factor model tests

Country	Sample	One factor model			Two factor model			$\bar{R}^2$
		Intercept (annualized)	$\beta$ world return	$\bar{R}^2$	Intercept (annualized)	$\beta_1$ world return	$\beta_2$ FX return	
<i>Latin America</i>								
Argentina	1976.02	63.42 [2.40]	-0.17 [-0.40]	-0.00	64.06 [2.43]	-0.03 [-0.06]	-0.60 [-0.96]	-0.01
Brazil	1976.02	10.71 [0.73]	0.39 [1.20]	0.00	11.38 [0.78]	0.53 [1.59]	-0.63 [-1.41]	0.01
Chile	1976.02	29.66 [2.94]	0.17 [0.81]	-0.00	29.41 [2.91]	0.11 [0.47]	0.23 [0.77]	-0.00
Colombia	1985.02	37.34 [3.01]	0.15 [0.80]	-0.01	35.41 [2.84]	0.11 [0.60]	0.23 [0.72]	-0.01
Mexico	1976.02	17.60 [1.60]	0.79 [3.18]	0.06	18.70 [1.76]	1.03 [3.94]	-1.03 [-2.67]	0.10
Venezuela	1985.02	34.19 [1.86]	-0.38 [-1.12]	0.01	30.33 [1.68]	-0.46 [-1.31]	0.46 [1.31]	0.01
Latin America	1985.02	22.54 [1.60]	0.64 [2.08]	0.06	31.84 [2.42]	0.84 [3.07]	-1.10 [-2.89]	0.14
<i>East Asia</i>								
Korea	1976.02	6.93 [0.93]	0.51 [3.55]	0.05	7.23 [0.97]	0.58 [3.84]	-0.29 [-1.20]	0.05
Philippines	1985.02	35.69 [2.58]	0.76 [2.75]	0.09	37.92 [2.77]	0.80 [2.85]	-0.26 [-0.85]	0.09
Taiwan	1985.02	27.17 [1.34]	0.71 [1.67]	0.04	39.58 [2.01]	0.97 [2.51]	-1.47 [-3.42]	0.11
<i>South Asia</i>								
India	1976.02	11.53 [1.73]	-0.05 [-0.41]	-0.00	10.96 [1.68]	-0.18 [-1.30]	0.54 [2.70]	0.03
Indonesia	1990.02	-16.65 [-0.78]	0.21 [0.51]	-0.02	-12.97 [-0.57]	0.27 [0.66]	-0.41 [-0.56]	-0.05
Malaysia	1985.02	-0.81 [-0.09]	0.74 [3.51]	0.20	5.38 [0.65]	0.87 [4.61]	-0.73 [-3.01]	0.27
Pakistan	1985.02	18.01 [2.14]	0.05 [0.37]	-0.01	13.58 [1.76]	-0.04 [-0.27]	0.52 [2.28]	0.01
Thailand	1976.02	10.67 [1.63]	0.40 [2.06]	0.05	10.80 [1.67]	0.43 [1.83]	-0.12 [-0.46]	0.04
Asia	1985.02	7.76 [0.77]	0.46 [1.98]	0.07	14.63 [1.59]	0.61 [2.86]	-0.81 [-3.33]	0.17
<i>Europe/Mideast/Africa</i>								
Greece	1976.02	-1.57 [-0.18]	0.38 [2.09]	0.02	-2.30 [-0.26]	0.22 [1.05]	0.68 [2.47]	0.04
Jordan	1979.02	-0.29 [-0.06]	0.17 [1.67]	0.02	-0.23 [-0.05]	0.08 [0.78]	0.37 [2.38]	0.05
Nigeria	1985.02	-6.97 [-0.49]	0.23 [1.05]	-0.00	-9.98 [-0.64]	0.16 [0.83]	0.36 [1.21]	-0.00
Portugal	1986.03	26.79 [1.44]	1.20 [4.84]	0.15	27.12 [1.41]	1.21 [5.07]	-0.05 [-0.12]	0.14
Turkey	1987.02	36.95 [1.13]	0.10 [0.22]	-0.02	35.02 [1.07]	0.05 [0.10]	0.38 [0.40]	-0.03
Zimbabwe	1976.02	-0.43 [-0.05]	0.21 [1.11]	0.00	-1.13 [-0.13]	0.06 [0.29]	0.65 [2.62]	0.03
Composite	1985.02	8.44 [0.92]	0.50 [2.30]	0.10	15.71 [1.94]	0.66 [3.58]	-0.86 [-3.84]	0.23
<i>Developed markets</i>								
United Kingdom	1976.02	4.26 [1.06]	1.11 [14.78]	0.49	3.97 [1.00]	1.05 [11.89]	0.27 [2.29]	0.50
Japan	1976.02	2.92 [0.73]	1.18 [11.02]	0.53	2.46 [0.64]	1.08 [9.90]	0.43 [3.43]	0.56
United States	1976.02	0.47 [0.20]	0.84 [13.94]	0.63	0.98 [0.48]	0.95 [17.00]	-0.47 [-7.19]	0.71
<i>Multivariate intercept tests</i>								
	Model	F-statistic {p-value}						
8 countries	1 factor	2.449 {0.015}						
8 countries	2 factor	2.493 {0.014}						

Table 4 (continued)

Country	Sample	One factor model			Two factor model			$\bar{R}^2$
		Intercept (annualized)	$\beta$ world return	$\bar{R}^2$	Intercept (annualized)	$\beta_1$ world return	$\beta_2$ FX return	
<i>Latin America</i>								
Argentina	1986.03	77.06 [1.77]	-0.37 [-0.56]	-0.01	86.07 [2.04]	-0.16 [-0.27]	-1.48 [-1.60]	-0.00
Brazil	1986.03	20.36 [0.66]	0.82 [1.56]	0.02	25.04 [0.81]	0.93 [1.80]	-0.77 [-0.94]	0.01
Chile	1986.03	43.89 [3.94]	0.23 [0.90]	0.01	48.42 [4.57]	0.34 [1.52]	-0.74 [-2.45]	0.07
Colombia	1986.03	43.78 [3.20]	0.16 [0.81]	-0.01	41.46 [3.05]	0.11 [0.56]	0.38 [1.02]	-0.01
Mexico	1986.03	47.87 [2.49]	0.96 [2.55]	0.10	61.33 [3.73]	1.28 [3.83]	-2.21 [-3.89]	0.30
Venezuela	1986.03	43.18 [2.25]	-0.28 [-0.82]	-0.00	39.59 [2.13]	-0.37 [-1.04]	0.59 [1.43]	0.00
Latin America	1986.03	21.12 [1.42]	0.69 [2.18]	0.08	28.66 [2.08]	0.87 [3.24]	-1.24 [-2.84]	0.17
<i>East Asia</i>								
Korea	1986.03	7.95 [0.71]	0.57 [3.26]	0.09	11.66 [1.04]	0.66 [3.26]	-0.61 [-1.81]	0.12
Philippines	1986.03	36.96 [2.41]	0.71 [2.54]	0.08	39.24 [2.60]	0.77 [2.66]	-0.37 [-1.11]	0.08
Taiwan	1986.03	31.23 [1.37]	0.72 [1.58]	0.03	41.36 [1.90]	0.96 [2.38]	-1.66 [-3.34]	0.11
<i>South Asia</i>								
India	1986.03	10.45 [0.75]	-0.43 [-2.00]	0.03	10.11 [0.71]	-0.43 [-1.98]	0.06 [0.16]	0.02
Indonesia	1990.02	-16.65 [-0.78]	0.21 [0.51]	-0.02	-12.97 [-0.57]	0.27 [0.66]	-0.41 [-0.56]	-0.05
Malaysia	1986.03	7.75 [0.84]	0.87 [4.27]	0.30	13.03 [1.57]	0.99 [5.63]	-0.86 [-3.64]	0.40
Pakistan	1986.03	19.54 [2.04]	0.04 [0.24]	-0.01	15.71 [1.81]	-0.05 [-0.34]	0.63 [2.20]	0.05
Thailand	1986.03	24.30 [2.05]	0.74 [2.47]	0.16	29.74 [2.79]	0.87 [3.19]	-0.89 [-2.81]	0.24
Asia	1986.03	10.20 [0.92]	0.48 [1.97]	0.08	16.64 [1.68]	0.64 [3.03]	-1.05 [-3.99]	0.22
<i>Europe/Mideast/Africa</i>								
Greece	1986.03	31.03 [1.56]	0.43 [1.43]	0.01	28.77 [1.43]	0.37 [1.14]	0.37 [0.68]	0.00
Jordan	1986.03	-4.85 [-0.70]	0.13 [0.96]	0.00	-5.83 [-0.82]	0.11 [0.80]	0.16 [0.74]	-0.00
Nigeria	1986.03	-7.64 [-0.47]	0.23 [1.04]	-0.00	-10.32 [-0.60]	0.17 [0.84]	0.44 [1.25]	-0.00
Portugal	1986.03	26.79 [1.44]	1.20 [4.84]	0.15	27.12 [1.41]	1.21 [5.07]	-0.05 [-0.12]	0.14
Turkey	1987.02	36.95 [1.13]	0.10 [0.22]	-0.02	35.02 [1.07]	0.05 [0.10]	0.38 [0.40]	-0.03
Zimbabwe	1986.03	7.68 [0.72]	-0.05 [-0.26]	-0.01	4.28 [0.42]	-0.13 [-0.72]	0.56 [2.04]	0.02
Composite	1986.03	8.92 [0.89]	0.53 [2.34]	0.11	15.45 [1.78]	0.69 [3.89]	-1.07 [-4.28]	0.29
<i>Developed markets</i>								
United Kingdom	1986.03	5.08 [0.91]	1.06 [13.83]	0.63	3.94 [0.71]	1.04 [11.68]	0.19 [1.26]	0.63
Japan	1986.03	-2.12 [-0.30]	1.39 [7.51]	0.66	-5.06 [-0.81]	1.32 [7.44]	0.48 [2.30]	0.69
United States	1986.03	2.73 [0.55]	0.74 [6.58]	0.53	6.31 [1.63]	0.82 [9.05]	-0.59 [-5.15]	0.64
Multivariate intercept tests		Model	F-statistic {p-value}					
18 countries		1 factor	2.625 {0.001}					
18 countries		2 factor	3.012 {0.001}					

The monthly returns for emerging markets are from the International Finance Corporation. The developed market returns are from Morgan Stanley Capital International (MSCI). All returns are calculated in U.S. dollars and are in excess of the 30-day Eurodeposit rate. In the one factor model, the factor is the world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio in excess of the 30-day Eurodollar deposit rate. In the two factor model, the excess MSCI world return is used along with the U.S. dollar return to holding a trade-weighted portfolio of Eurocurrency deposits in 10 countries (G-10 countries plus Switzerland) [details of construction are found in Harvey (1993b)] in excess of the 30-day Eurodollar deposit rate. Heteroskedasticity-consistent t-statistics in brackets. Heteroskedasticity-consistent multivariate tests are conducted with 8 assets over the full sample (Argentina, Brazil, Chile, Mexico, Korea, India, Thailand and Greece). In the subsample from 86:03, 18 countries are used (all emerging markets except Indonesia and Turkey).

Table 5

## Analysis of predictable returns in emerging markets

Country	Sample	$\bar{R}^2$ world information	$\bar{R}^2$ local information	$\bar{R}^2$ combined information	$\chi^2$ exclude local	Proportion of variance due to world	Proportion of variance due to local	Proportion of variance due to covariance
<i>Latin America</i>								
Argentina	1977.04	0.003 [0.184]	-0.001 [0.638]	-0.000 [0.376]	2.499 [0.645]	0.551	0.456	-0.007
Brazil	1977.04	0.006 [0.196]	0.076 [0.000]	0.078 [0.000]	46.210 [0.000]	0.235	0.830	-0.065
Chile	1977.04	0.098 [0.000]	0.088 [0.000]	0.127 [0.000]	18.054 [0.001]	0.441	0.349	0.211
Colombia	1986.02	0.001 [0.200]	0.213 [0.001]	0.212 [0.001]	13.852 [0.008]	0.214	0.856	-0.070
Mexico	1977.04	0.110 [0.000]	0.072 [0.053]	0.145 [0.000]	12.021 [0.017]	0.652	0.361	-0.014
Venezuela	1985.02	-0.010 [0.422]	0.062 [0.039]	0.033 [0.064]	9.698 [0.046]	0.263	0.883	-0.115
<i>East Asia</i>								
Korea	1977.04	-0.011 [0.711]	0.036 [0.013]	0.021 [0.040]	11.837 [0.019]	0.110	0.856	0.034
Philippines	1985.02	0.150 [0.005]	0.121 [0.000]	0.201 [0.000]	15.016 [0.005]	0.427	0.512	0.061
Taiwan	1985.02	0.018 [0.081]	-0.019 [0.679]	-0.018 [0.242]	1.246 [0.871]	1.251	0.213	-0.464
<i>South Asia</i>								
India	1977.04	-0.011 [0.546]	-0.003 [0.740]	-0.003 [0.405]	3.677 [0.451]	0.607	0.794	-0.401
Indonesia	1990.02	0.105 [0.002]	0.010 [0.341]	0.227 [0.000]	7.118 [0.130]	0.948	0.711	-0.659
Malaysia	1985.02	-0.014 [0.240]	0.046 [0.053]	0.045 [0.067]	10.888 [0.028]	0.346	0.889	-0.236
Pakistan	1985.02	0.018 [0.478]	0.134 [0.258]	0.114 [0.369]	5.842 [0.211]	0.144	0.719	0.138
Thailand	1977.04	0.067 [0.000]	0.003 [0.528]	0.055 [0.000]	1.371 [0.849]	0.795	0.117	0.088
<i>Europe/Mideast/Africa</i>								
Greece	1977.04	0.026 [0.004]	-0.002 [0.288]	0.018 [0.006]	3.343 [0.502]	0.754	0.230	0.016
Jordan	1979.02	0.003 [0.336]	-0.024 [0.978]	-0.020 [0.649]	0.868 [0.929]	0.990	0.114	-0.103
Nigeria	1985.02	-0.018 [0.853]	-0.026 [0.804]	-0.056 [0.937]	1.378 [0.848]	0.587	0.391	0.023
Portugal	1986.03	0.125 [0.003]	0.111 [0.005]	0.150 [0.001]	6.919 [0.140]	0.456	0.421	0.124
Turkey	1987.02	0.080 [0.033]	0.101 [0.001]	0.094 [0.000]	10.589 [0.032]	0.278	0.467	0.255
Zimbabwe	1978.01	0.051 [0.016]	0.038 [0.016]	0.159 [0.000]	24.384 [0.000]	0.946	0.803	-0.749
<i>Global variables</i>								
World return	1977.04	0.051 [0.002]	-	-	-	-	-	-
FX return	1977.04	0.063 [0.004]	-	-	-	-	-	-

Multivariate test of predictability	F-statistic
8 countries world information	2.1523 [0.000]

The monthly returns for emerging markets are from the International Finance Corporation. The developed market returns are from Morgan Stanley Capital International (MSCI). All returns are calculated in U.S. dollars and are in excess of the 30-day Eurodeposit rate. The world information variables are: the MSCI world return, the U.S. three-month bill return minus the one-month return, the spread between Moody's Baa rated bonds and Aaa bonds, and the Standard and Poor's 500 dividend yield minus the 30-day Treasury bill rate. The local information variables include: the local U.S. dollar return, the change in the foreign currency rate versus the U.S. dollar, the local local dividend yield and a local interest rate. Heteroskedasticity-consistent p-value are in brackets. The proportion of variance explained by the world information is the variance of the fitted values generated from the world information variables in the regression which includes both world and local information divided by the variance of the fitted values using both world and local information variables. A similar variance ratio is calculated using the local information in the numerator. The first two variance ratios do not sum to one because of the covariance between the local and world information.

The global variables include the U.S. dollar return on the MSCI value-weighted world market portfolio in excess of the 30-day Eurodollar deposit rate and the U.S. dollar return to holding a trade-weighted portfolio of Eurocurrency deposits in 10 countries (G-10 countries plus Switzerland) [details of construction are found in Harvey (1993b)] in excess of the 30-day Eurodollar deposit rate.

Multivariate tests are conducted with 8 assets over the full sample (Argentina, Brazil, Chile, Mexico, Korea, India, Thailand and Greece). The heteroskedasticity-consistent test is based on Pillai's trace. The F-statistic has degrees of freedom of 32 and 676.

Table 6

An analysis of the conditional risk of emerging market returns

Country	Average Excess Return	Average Pricing Error $\alpha_i$	$\chi^2$ betas=0	$\chi^2$ constant betas	$\bar{R}^2$ returns on $Z^{w,t}$	$\bar{R}^2$ pricing errors on $Z^w$	$\bar{R}^2$ pricing errors on $Z^l$	$\bar{R}^2$ pricing errors on $Z^{w,l}$
A: 1 factor model								
Argentina <sup>a</sup>	45.956	41.858 (27.426)	11.678 [0.166]	11.566 [0.116]	0.005	0.011	0.003	0.014
Brazil	13.863	8.755 (16.020)	6.391 [0.700]	6.090 [0.637]	0.078	-0.000	0.073	0.075
Chile	24.436	26.971 (10.724)	10.462 [0.314]	10.357 [0.241]	0.127	0.096	0.150	0.150
Mexico	24.624	23.593 (12.028)	55.854 [0.000]	32.981 [0.000]	0.145	0.087	0.077	0.137
Korea	7.609	9.998 (8.325)	21.509 [0.011]	9.655 [0.290]	0.021	-0.015	0.024	0.010
India	11.513	15.760 (7.324)	19.714 [0.020]	19.380 [0.013]	-0.003	-0.015	0.002	-0.003
Thailand	11.874	12.340 (7.391)	47.419 [0.000]	45.730 [0.000]	0.055	0.064	0.045	0.053
Greece	0.716	-1.599 (9.337)	9.366 [0.404]	3.143 [0.925]	0.018	0.025	0.002	0.018
B: 2 factor model								
Argentina <sup>a</sup>	45.956	47.300 (27.580)	44.891 [0.000]	44.446 [0.000]	0.005	0.008	0.003	0.011
Brazil	13.863	6.072 (16.967)	19.723 [0.349]	16.201 [0.439]	0.078	0.016	0.078	0.097
Chile	24.436	31.307 (9.638)	26.842 [0.082]	26.112 [0.052]	0.127	0.075	0.132	0.123
Mexico	24.624	27.365 (12.552)	114.147 [0.000]	64.523 [0.000]	0.145	0.091	0.081	0.131
Korea	7.609	6.351 (8.433)	74.269 [0.000]	28.267 [0.029]	0.021	-0.009	0.032	0.023
India	11.513	16.806 (7.554)	65.568 [0.000]	32.691 [0.008]	-0.003	-0.015	0.003	-0.003
Thailand	11.874	12.683 (7.197)	120.290 [0.000]	104.588 [0.000]	0.055	0.058	0.039	0.042
Greece	0.716	3.405 (10.030)	32.248 [0.021]	12.953 [0.676]	0.018	0.016	-0.002	0.007

The monthly returns for emerging markets are from the International Finance Corporation. All returns are calculated in U.S. dollars and are in excess of the 30-day Eurodeposit rate. The world information variables,  $Z^w$ , are: the MSCI world return, the U.S. three-month bill return minus the one-month return, the spread between Moody's Baa rated bonds and Aaa bonds, and the Standard and Poor's 500 dividend yield minus the 30-day Treasury bill rate. The local information variables,  $Z^l$ , include: the local U.S. dollar return, the change in the foreign currency rate versus the U.S. dollar, the local local dividend yield and a local interest rate. The first factor is the U.S. dollar return on the MSCI value-weighted world market portfolio in excess of the 30-day Eurodollar deposit rate. The second factor is the U.S. dollar return to holding a trade-weighted portfolio of Eurocurrency deposits in 10 countries (G-10 countries plus Switzerland) [details of construction are found in Harvey (1993b)] in excess of the 30-day Eurodollar deposit rate.

The following system is estimated for each asset  $i$ :

$$\begin{aligned}
 & \text{Disturbance} && \text{Orthogonal to} \\
 u_{1it} &= r_{it} - Z_{t-1}^{w,l} \delta_i && Z_{t-1}^{w,l} \\
 u_{2it} &= f_t - Z_{t-1}^w \theta && Z_{t-1}^w \\
 u_{3it} &= [u_{2it}' u_{2it} (Z_{t-1}^{w,l} \kappa_i)' - f_t' u_{1it}]' && Z_{t-1}^{w,l} \\
 u_{4it} &= \mu_i - Z_{t-1}^{w,l} \delta_i && 1 \\
 u_{5it} &= (-\alpha_i + \mu_i) - Z_{t-1}^{w,l} \kappa_i (Z_{t-1}^w \theta)' && 1
 \end{aligned}$$

where  $r$  represents the excess return on asset  $i$ ,  $Z$  is the predetermined information,  $\delta$  are coefficients from a linear projection of the asset returns on the information,  $Z \kappa_i$  are the fitted conditional betas,  $f$  are the factor excess returns,  $\theta$  are the coefficients from a linear projection of the factor returns on the information,  $\mu$  is the mean asset return and  $\alpha$  is the difference between the mean asset return and the model fitted mean asset return (pricing error). The standard error of the pricing error parameter is reported in parentheses. Heteroskedasticity-consistent Wald tests (with p-values in brackets) are reported for two hypotheses: the conditional betas equal zero and the conditional beta is constant. The last three columns report model diagnostics in the form of linear regressions of the pricing errors on the three information sets: world, local and combined world and local. The sample is 1977:04-1992:06 (183 observations).

<sup>a</sup> Results are reported for a local information set that excludes the local short-term interest rate.

Table 7

## The relation between emerging market returns and the world market return

Country	Correlation with world	Test of time-varying correlation	Test of time-varying variance ratio
Argentina	-0.013 (0.062)	4.330 [0.826]	15.578 [0.035]
Brazil	0.094 (0.077)	7.337 [0.501]	12.701 [0.123]
Chile	0.052 (0.084)	11.741 [0.163]	20.275 [0.009]
Mexico	0.241 (0.087)	10.072 [0.260]	11.349 [0.183]
Korea	0.235 (0.064)	11.637 [0.168]	12.494 [0.130]
India	-0.044 (0.072)	9.080 [0.336]	14.882 [0.061]
Thailand	0.236 (0.110)	12.134 [0.145]	16.933 [0.031]
Greece	0.153 (0.081)	7.476 [0.486]	11.833 [0.159]

The monthly returns for emerging markets are from the International Finance Corporation. All returns are calculated in U.S. dollars and are in excess of the 30-day Eurodeposit rate. The world information variables,  $Z^w$ , are: the MSCI world return, the U.S. three-month bill return minus the one-month return, the spread between Moody's Baa rated bonds and Aaa bonds, and the Standard and Poor's 500 dividend yield minus the 30-day Treasury bill rate. The local information variables,  $Z^l$ , include: the local U.S. dollar return, the change in the foreign currency rate versus the U.S. dollar, the local local dividend yield and a local interest rate. Correlation is measured against the U.S. dollar return on the MSCI value-weighted world market portfolio in excess of the 30-day Eurodollar deposit rate.

The test for constant correlation is estimated for each asset  $i$ :

Disturbance	Orthogonal to
$u_{1it} = r_{it} - \mu_i$	1
$u_{2it} = u_{1it}^2 - \sigma_i^2$	1
$u_{3it} = r_{wt} - \mu_w$	1
$u_{4it} = u_{3it}^2 - \sigma_w^2$	1
$u_{5it} = \rho\sigma_w\sigma_i - u_{1it}u_{3it}$	$Z_{t-1}^{w,l}$

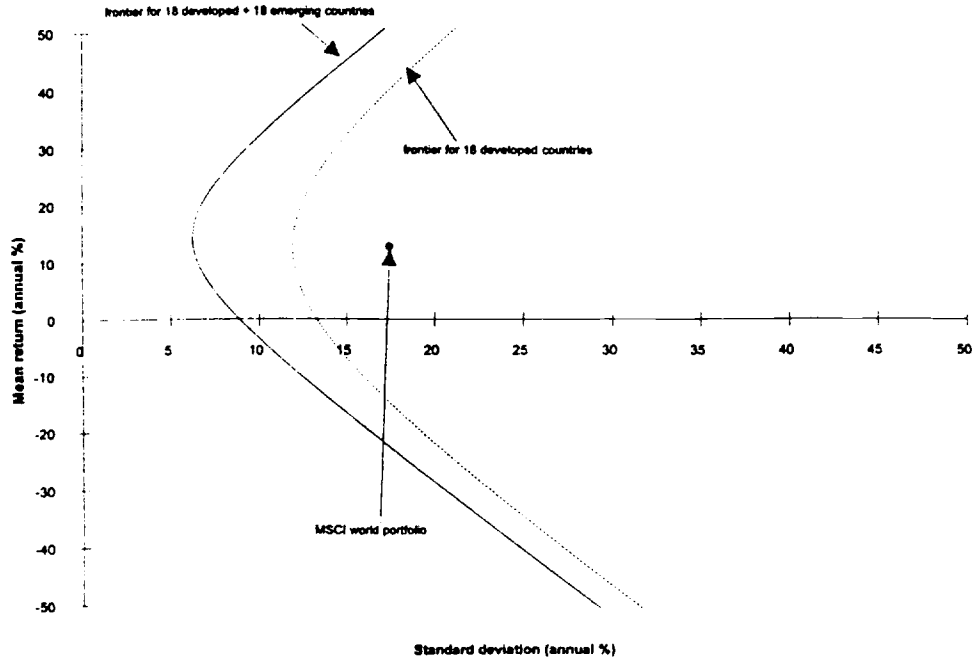
where  $r_i$  represents the excess return on asset  $i$ ,  $r_w$  represents the excess return on the world market portfolio.  $Z$  is the predetermined information,  $\mu_i$  is the mean asset return,  $\sigma_i^2$  is the variance of the asset return,  $\mu_w$  is the mean world return,  $\sigma_w^2$  is the variance of the world return and  $\rho$  is the correlation. The correlation parameter reported in the first column is based on an exactly identified version of the above system of equations where the fifth equation is conditioned only on a vector of ones. The heteroskedasticity-consistent standard error of the correlation is in parentheses. The test of the constant correlation, in the second column, is based on the overidentified system. The  $\chi^2$  statistic has 8 degrees of freedom.

The test for constant ratio of world variance to country  $i$  variance

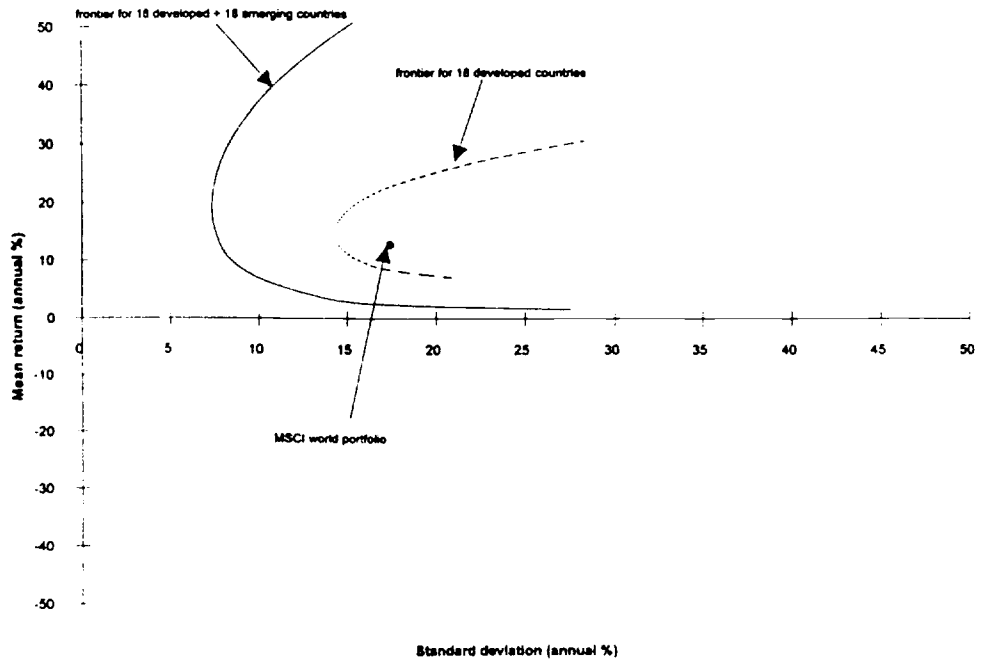
Disturbance	Orthogonal to
$u_{1it} = r_{it} - Z_{t-1}^{w,l}\delta_i$	$Z_{t-1}^{w,l}$
$u_{2it} = r_{wt} - Z_{t-1}^w\theta$	$Z_{t-1}^w$
$u_{3it} = \phi_i u_{1it}^2 - u_{2it}^2$	$Z_{t-1}^{w,l}$

where  $\phi_i$  is the ratio of the variance of the world to the variance of country  $i$ 's excess returns. The  $\chi^2$  test of whether this ratio is constant has 8 degrees of freedom. The sample is 1977:04-1992:06 (183 observations).

**Figure 1**  
**Minimum standard deviation frontier 1986.03 to 1992.06**  
A Short sales allowed



B No short sales

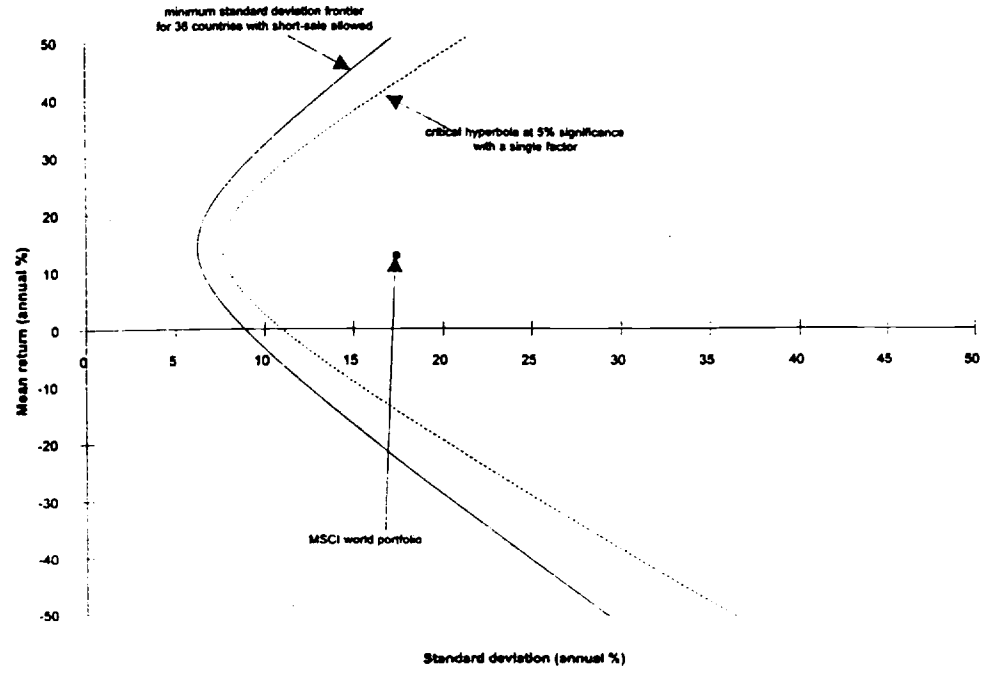




**Figure 1**  
**Minimum standard deviation frontier**

The monthly returns for 18 emerging markets are from the International Finance Corporation. The 18 developed market returns are from Morgan Stanley Capital International (MSCI). The world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio. The sample is 1986:03–1992:06.

**Figure 2**  
**Minimum standard deviation frontier with critical rejection region for 1 factor model**  
**A Short sales allowed**



**B. No short sales**

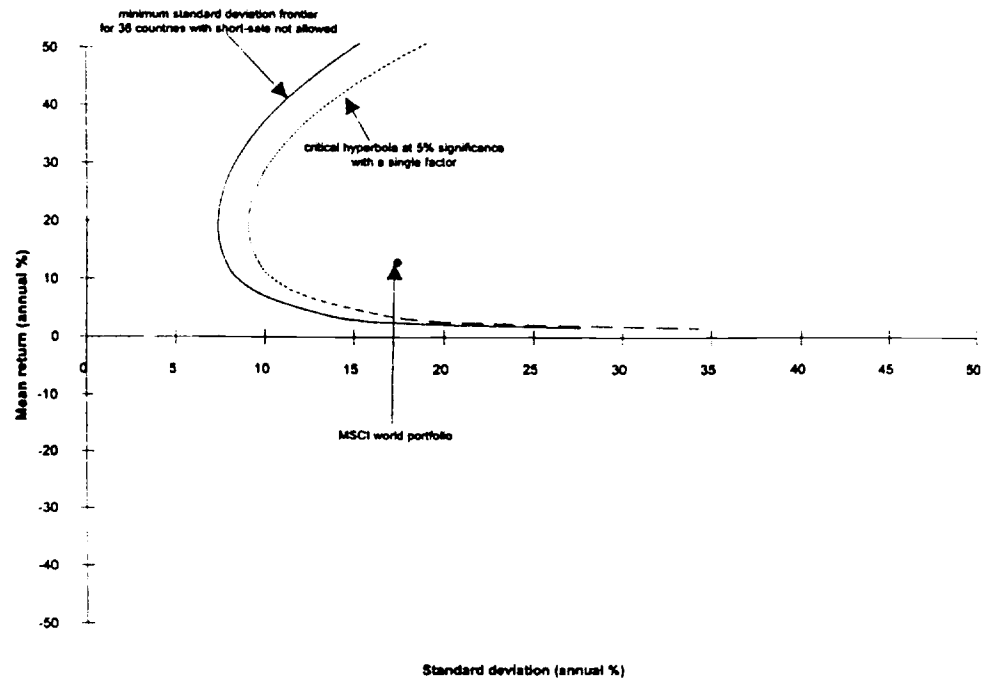


Figure 2

Minimum standard deviation frontier with critical rejection region for one factor model

The monthly returns for 18 emerging markets are from the International Finance Corporation. The 18 developed market returns are from Morgan Stanley Capital International (MSCI). The world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio. The sample is from 1986:03–1992:06. The critical hyperbola follows Kandel and Stambaugh (1989). Define the efficient set constants  $a = \bar{r}'V^{-1}\bar{r}$ ,  $b = \bar{r}'V^{-1}\iota$ ,  $c = \iota'V^{-1}\iota$ , and  $d = ac - b^2$  where  $\bar{r}$  are the expected returns,  $V$  is the variance matrix and  $\iota$  is a vector of ones. Let  $\hat{\mu}_p$  be a target expected return and  $\hat{\sigma}^{2*}(\hat{\mu}_p)$  be the minimum variance for expected return  $\hat{\mu}_p$ . Hence,  $(\hat{\mu}_p, \hat{\sigma}^{2*}(\hat{\mu}_p))$  is a point in the expected return–minimum variance space. Let  $w^*$  be a central-F variate at a given significance level. Kandel and Stambaugh prove that  $w(p) > w^*$ , i.e. portfolio  $p$ 's efficiency is rejected if and only if

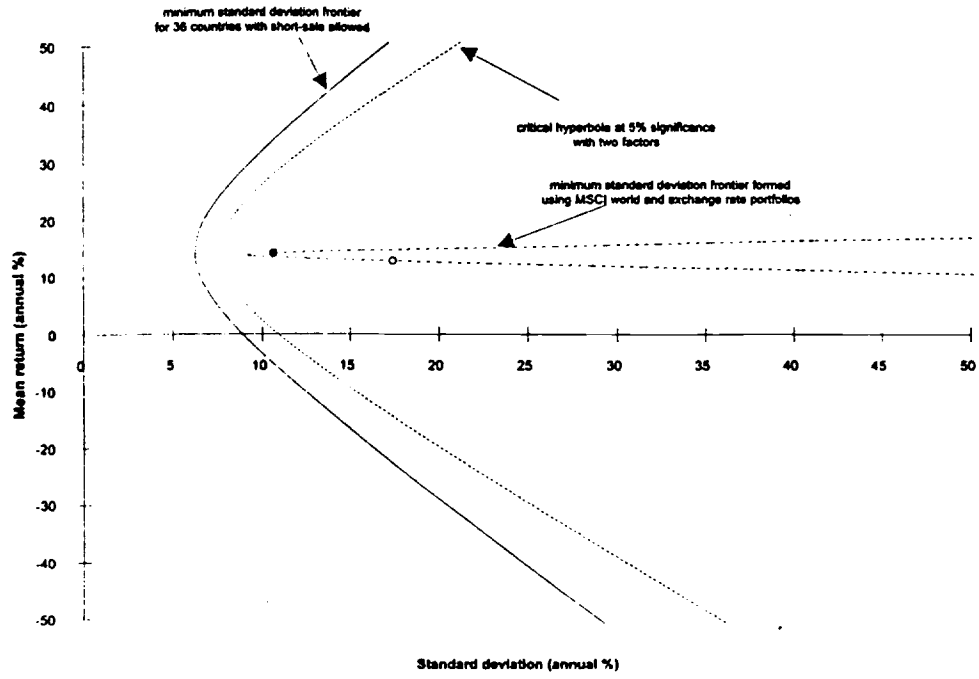
$$\hat{\sigma}_p^2 > \delta_1(w^*) + \delta_2(w^*)\sigma^{2*}(\hat{\mu}_p)$$

where  $\hat{\sigma}_p^2$  is the variance of  $p$  and

$$\delta_1(w) = \frac{w(w+1)}{cw-d} \quad \delta_2(w) = \frac{-d(w+1)}{cw-d}.$$

Thus,  $\hat{\sigma}^2 = \delta_1(w^*) + \delta_2(w^*)\sigma^{2*}(\hat{\mu})$  defines a critical hyperbola in mean-standard deviation space. If the given portfolio is to the right of the hyperbola, efficiency can be rejected at the significance level  $\alpha$ . The critical hyperbola with short-sale restrictions uses the same method except the assets in the minimum variance portfolios are must have nonnegative weights.

**Figure 3**  
**Minimum standard deviation frontier with critical rejection region for 2 factor models**  
**A. Short sales allowed**



**B. No short sales**

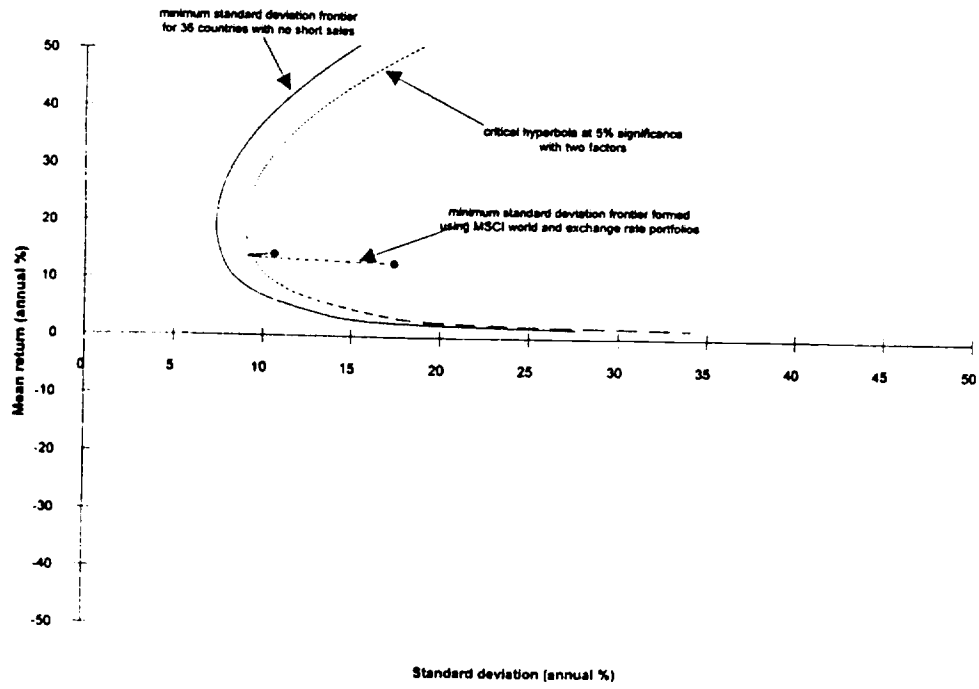


Figure 3

Minimum standard deviation frontier with critical rejection region for two factor model

The monthly returns for 18 emerging markets are from the International Finance Corporation. The 18 developed market returns are from Morgan Stanley Capital International (MSCI). The world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio. G-10 FX is the U.S. dollar return to holding a trade-weighted portfolio of Eurocurrency deposits in 10 countries (G-10 countries plus Switzerland). The sample is from 1986:03–1992:06. The critical hyperbola follows Kandel and Stambaugh (1989). Define the efficient set constants  $a = \bar{r}'V^{-1}\bar{r}$ ,  $b = \bar{r}'V^{-1}\iota$ ,  $c = \iota'V^{-1}\iota$ , and  $d = ac - b^2$  where  $\bar{r}$  are the expected returns,  $V$  is the variance matrix and  $\iota$  is a vector of ones. Let  $\hat{\mu}_p$  be a target expected return and  $\hat{\sigma}^{2*}(\hat{\mu}_p)$  be the minimum variance for expected return  $\hat{\mu}_p$ . Hence,  $(\hat{\mu}_p, \hat{\sigma}^{2*}(\hat{\mu}_p))$  is a point in the expected return–minimum variance space. Let  $w^s$  be a central-F variate at a given significance level. Kandel and Stambaugh prove that  $w(p) > w^s$ , i.e. portfolio  $p$ 's efficiency is rejected if and only if

$$\hat{\sigma}_{2p}^{2*} > \delta_1(w^s) + \delta_2(w^s)\sigma^{2*}(\hat{\mu}_p)$$

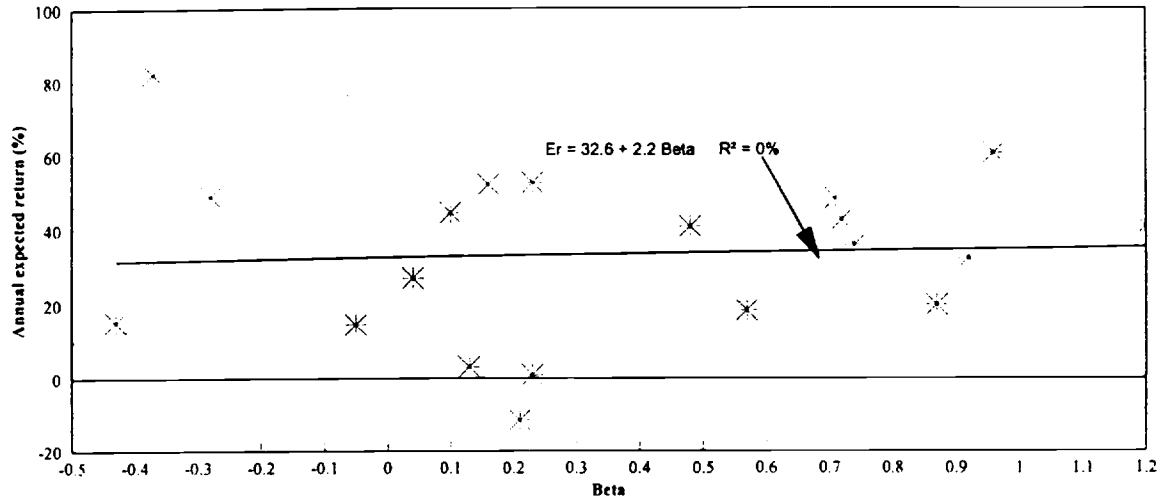
where  $\hat{\sigma}_{2p}^{2*}$  is the minimum variance achieved using the two factors

$$\delta_1(w) = \frac{w(w+1)}{cw-d} \quad \delta_2(w) = \frac{-d(w+1)}{cw-d}.$$

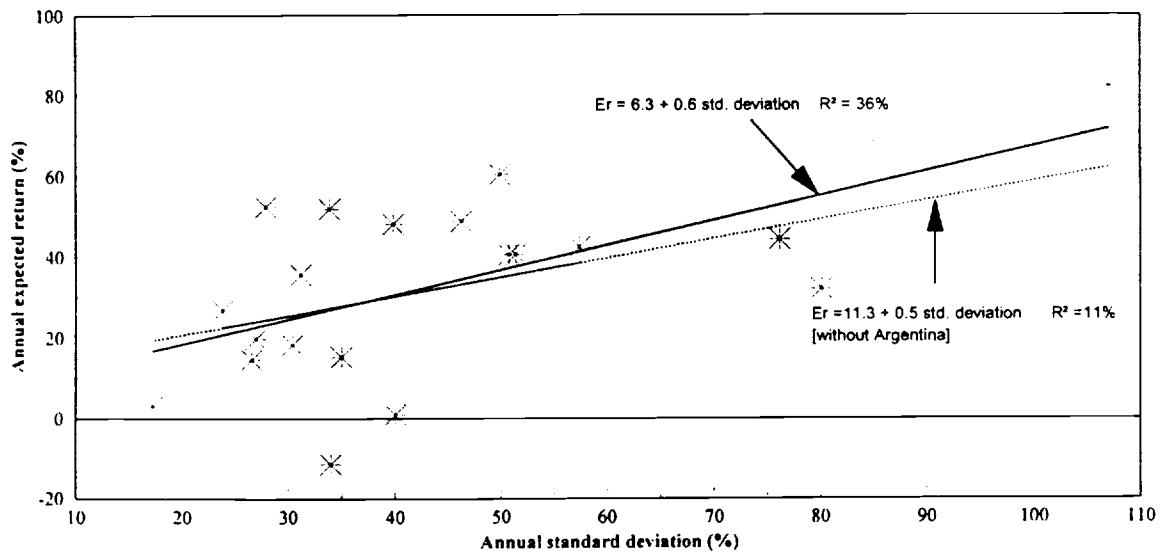
Thus,  $\hat{\sigma}^2 = \delta_1(w^s) + \delta_2(w^s)\sigma^{2*}(\hat{\mu})$  defines a critical hyperbola in mean-standard deviation space. If the given portfolio is to the right of the hyperbola, efficiency can be rejected at the significance level  $s$ . The critical hyperbola with short-sale restrictions uses the same method except the assets in the minimum variance portfolios are must have nonnegative weights.

**Figure 4**  
**The cross-section of expected returns, betas, and standard deviations**

**A. Annual expected return vs. beta**



**B. Annual expected return vs. standard deviation**

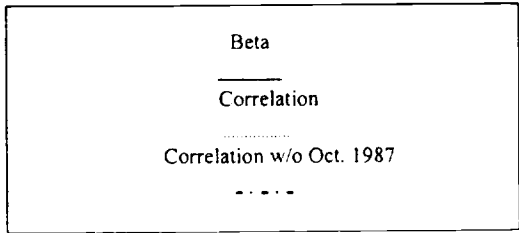
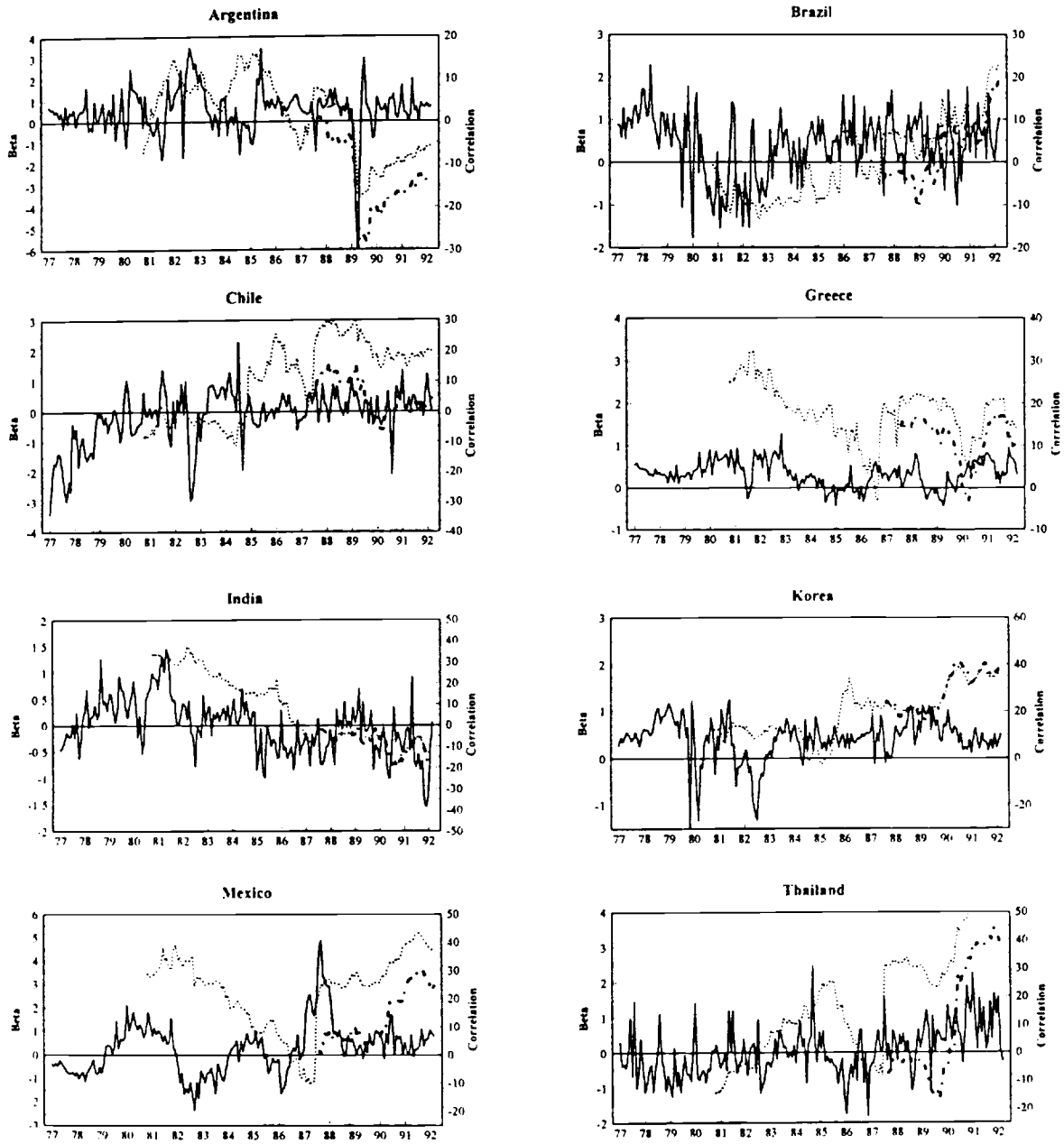


**Figure 4**

**The cross-section of expected returns, betas, and standard deviations**

The monthly returns for 20 emerging markets are from the International Finance Corporation. The 18 developed market returns are from Morgan Stanley Capital International (MSCI). The world market return is the U.S. dollar return on the MSCI value-weighted world market portfolio. The sample is from 1986:03–1992:06 for all countries except Turkey and Indonesia. In panel A, the betas result from the least squares regression of the average returns on the world market return. The fitted line is a regression of the average returns on the estimated betas. In panel B, the fitted line is a regression of the average returns on the estimated standard deviations. The second line excludes the influential Argentinian observation from the regression.

**Figure 5**  
**Time-varying conditional betas and correlations with the world market return**





**Figure 5**

**Time-varying conditional betas and correlations with the world market return**

The monthly returns for 8 emerging markets are from the International Finance Corporation. The world market return is the U.S. dollar return on the Morgan Stanley Capital International value-weighted world market portfolio. The sample is from 1977:04–1992:06. Correlations are rolling unconditional correlations using a 60-month window. Correlations are also reported without the October 1987 observation. The conditional betas result from the estimation of (6). The betas are assumed to be linear in the information variables.