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## ABSTRACT

Measuring the integration of world capital markets is notoriously difficult. For example, regulatory changes which appear comprehensive may have little impact on the functioning of the capital market if they fail to lead to foreign portfolio inflows. In contrast to the usual practice of documenting the timing of regulatory changes, we specify a reduced-form model for a number of financial time-series (for example, equity returns and dividend yields) and search for a common break in the process generating the data. In addition, we estimate a confidence interval for the break. Information on a variety of financial and macroeconomic indicators is employed to interpret the results and to identify the likely date the equity market becomes financially integrated with world capital markets. We find endogenous break dates that are very accurately estimated but do not always correspond closely to dates of official capital market reforms. After the break, stock markets are on average larger and more liquid than before; returns are more volatile and more highly correlated with the world market return, dividend yields are lower and credit ratings improve.

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## 1. Introduction

The concept of market integration is central to research in international finance, international economics and development economics. Financial market integration is associated with economies where domestic investors are able to invest in foreign assets and foreign investors in domestic assets. With the opening up of so many emerging markets in the last decade, history now offers a unique experiment to explore the economic and financial effects of market integration.

Needless to say the integration concept is central to the international finance literature. When markets are integrated, assets of identical risk command the same expected return, regardless of domicile. A large literature has developed testing for market integration (see the references in Bekaert and Harvey (1995)).

International economists on the other hand have focused more on the potential welfare gains of market integration. Cole and Obstfeld (1992), Lewis (1996) and van Wincoop (1994) all document how countries can benefit from sharing their consumption risks through trading equity claims on each other's output, but they also show these gains to be quite small.

Finance intuition suggests this literature may be missing an important dynamic factor. Consider the following example.[1] A corporation operating in a closed economy faces a high cost of capital. It is difficult to raise equity capital because domestic investors, not being allowed to invest abroad, are unable to diversify their portfolios. In order to attract capital, the corporation will have to offer a high expected rate of return. The corporation may even take steps to inefficiently diversify its operations to reduce the variance risk that the domestic investors bear.

When this particular market becomes financially integrated, the corporation is able to access a new pool of investors. Inefficient operations will be abandoned. The cost of

[1] See Obstfeld (1994) and Stulz (1997) and the references therein.

equity capital will likely decrease and more investment projects will become viable (have positive net present value). This could lead to an investment boom and higher economic growth (see Henry 1997b for an empirical analysis).

While originally primarily focusing on economic integration (no binding impediments to trade), development economists have recently more and more acknowledged the role of financial markets in general and market integration in particular, in part because of developments in growth theory (see Demurgüç-Kunt and Levine (1996) and references therein). There is now a burgeoning literature on the impact of stock market development on growth (see Levine and Zervos (1996), Rajan and Zingales (1997), Atje and Jovanovic (1993)), but formal empirical work on the growth benefits of financial market integration is only just beginning. Obstfeld (1994) provides a theoretical analysis demonstrating the benefits of financial market integration. Although his numerical examples suggest large welfare gains to market integration, no formal empirical analysis is conducted.

From the example given above, the key role of integration in international economics and development economics is clear. In addition on the financial side, moving from a segmented regime to an integrated regime will likely impact expected returns, volatilities and correlations with world factors all of which are important for both risk analysis and portfolio construction.[2]

But how do we measure market integration? Indeed, how do we test the equilibrium models of risk sharing? How do we measure the growth effects of market integration? A prerequisite is the date that a market becomes integrated. The dating question is the subject of our research.

[2] Not surprisingly, a literature has developed attempting to measure the macroeconomic and financial effects of market integration (see Bekaert and Harvey (1995, 1997, 1998a,b), Aggarwal, Inclan and Leal (1996), De Santis and İmrohoroğlu (1997), Richards (1996), Levine and Zervos (1996), Kim and Singal (1997), Henry (1997a,b) and Domowitz, Glen and Madhavan (1997)).

The dating of market integration is notoriously difficult. The capital market liberalization process is a complex process and it is unlikely that "dates" of capital market reforms will be informative of the true date of market integration. For example, there are often ways to circumvent capital controls. Investors may be able to access markets indirectly, such as via American Depositary Receipts (ADRs), though the market is technically closed to foreign investors. Liberalization may occur in stages and be a gradual process. Finally, some policy changes may be anticipated while others may lack credibility.

There are potential solutions to these problems. One option is to specify a tightly parameterized model of the process of dynamic integration. For example, Bekaert and Harvey (1995) use a regime-switching framework to model (potentially) gradual changes in market integration. However, these models are difficult to specify and are often statistically rejected. In addition, international asset pricing models typically fail to match the home asset preference that investors display, even when markets are seemingly perfectly integrated.[3]

In this paper, we offer an alternative approach. We provide estimates of market liberalization dates for 20 countries with 90% confidence intervals. Our methodology is new in two respects. First, in contrast to Bekaert and Harvey's (1995) focus on returns, we look at a series of financial and macroeconomic variables that are likely related to the integration process. For example, we consider net equity capital flows as well as variables such as dividend yields that may capture the permanent price effects that market integration entails. Indeed, returns are noisy in emerging markets and it is likely important to expand the scope of examination to other variables. Second, we do not take a stand on an asset pricing model, but simply assume that the variables before and after market integration follow a stationary process which is well described by a vector autoregression.

Our methodology uses the new technique of Bai, Lumsdaine and Stock (1998) to

[3] See, for example, Tesar and Werner (1995b, 1998).

find endogenous break points for the VAR parameters. Since the model is in reduced form, it is important to let all parameters change. The methodology also yields a break date with a 90% confidence interval. Interestingly, Bai, Lumsdaine and Stock show that the confidence intervals around break dates can be tightened considerably by adding different series which break at the same time. One of the unique aspects of our research is that we simultaneously examine a number of economic time series in our search for structural breaks.

The paper is organized as follows. In the second section, we describe the liberalization process and formulate formal hypotheses. Part of our discussion draws on a detailed time-line compiled by Bekaert and Harvey (1998b) that chronicles financial and economic reforms as well as substantial economic news in each of the 20 countries we examine. We use this information later to help interpret our break point results. This section also details a simple three period model of the integration process. This model largely motivates the use of price levels in some of the variables we examine in our dating of the integration process. The third section details the econometric methodology. The data are described in the fourth section. The fifth section contains our empirical results. We present both univariate and multivariate break points for the time-series that we examine. The sixth section provides an economic interpretation of the statistical break points and discusses the effects of financial market integration on a wide range of financial and economic indicators. Some concluding comments and caveats are offered in the final section.

## 2. The Capital Market Liberalization Process

### *2.1 The impact of liberalizations*

How does the liberalization process occur? This process is extremely complex and there is no established economic model that guides us. That is, while there are general

equilibrium models of economies in integrated states and segmented states, there is no model that specifies the economic mechanism that moves a country from segmented to integrated status.

To gain some intuition, we consider a simple model which traces the impact on security prices of market integration. The model is a straightforward extension of the standard static integration/segmentation model; see e.g. Alexander, Eun and Jankiramanan (1987) and Errunza, Senbet and Hogan (1996). Within the context of a simple quadratic utility specification, we examine a three period problem for the world market and an emerging market. We assume that there is one share outstanding of each asset. In period three, dividends are paid out and, hence, there are only two trading periods. In period two, the government may integrate the market with the world or it may not. Each market has a price-taking agent who only consumes in the third period. In period one, agents attach a probability, $\lambda$, to the government integrating the emerging market in the second period.

For simplicity, the risk-free rate is set equal to zero and currency considerations are ignored. Risky assets in the world market (emerging market) yield a random per capita payoff of $D_i^W (D_j^E)$, with $i = 1, \ldots, N_W$ ($j = 1, \ldots, N_E$) in the third period. Denote the aggregate, market payoff as $D_M^W = \sum_{i=1}^{N_W} D_i^W$ and $D_M^E = \sum_{j=1}^{N_E} D_j^E$.

Since the emerging market is assumed small relative to the world market, we focus on equity prices in the emerging markets. The second-period prices under perfect integration ($P^I$) or perfect segmentation ($P^S$) are well-known:

$$P^S = E[D_M^E] - \rho \text{Var}[D_M^E]$$
$$P^I = E[D_M^E] - \rho \text{Cov}[D_M^E, D_M^W]$$

where $\rho$ is the risk aversion coefficient and where we assumed the weight of the emerging market in the global world market to be negligible.

In period 1, agents know that prices in period 2 will either be $P^S$ or $P^I$. The

attraction of the quadratic utility framework is that in period 1, the price will be:

$$P = \lambda P^I + (1 - \lambda)P^S$$

It is important to realize that $P^S < P^I$, since the variability of local cash flows will be high whereas the covariance between local and world cash flows may be quite low.

Suppose the government announces a liberalization in period 1 to occur in period 2. The model predicts that prices will jump up and that the size of the jump is related both to the credibility of the government's announcement (and policies in general) as captured by the $\lambda$ parameter, and the diversification benefits to be gained from integrating the market, as reflected in $P^I$. Foreign capital flows in when the market finally liberalizes (in period 2) and the price rises again since all uncertainty is resolved. This last price rise may be small if the announcement was credible.

This simple model suggests that we may see breaks not only in returns, but maybe even more clearly in variables such as dividend yields and market capitalization to GDP that embed permanent price changes. Of course, this model is very stylized and ignores many interesting dynamic effects. As a result, we concentrate our discussion on a large set of factors that are likely consistent with integration. It may be the case that none of these factors when examined individually reveals market integration. However, considered as a group – or in subgroups – these factors may be useful in determining the degree of integration.

We already established that the integration process should impact a number of financial variables. The risk-sharing models and the above model suggest that expected returns (cost of capital) should decrease. The reason is that the volatility of emerging market returns is much higher than the covariances with world market returns. Holding the variances and covariances constant, this implies that prices should rise (expected returns decrease) when a market moves from a segmented to an integrated state. However, when a market is opened to international investors, it may become more sensitive to world events (covariances with the world may increase). Even with this effect, it is

likely that these covariances are still much smaller than the local variance, which would imply rising prices.

It also makes sense that the liberalization process may be reflected in activity in the local market. As foreigners are allowed to access the local market, liquidity may increase along with trading volume. We may be able to directly observe the interest of foreign investors by examining the net equity capital flows to these markets. In the model above foreign ownership of local shares is established in the second period after the price effects have taken place.

There could also be some structural changes in the market. For example, if the cost of capital decreases, new firms may present initial public offerings. The concentration may decrease as a result of these new entrants. In addition, individual stocks may become less sensitive to local information and more sensitive to world events. This may cause the cross-correlation of the individual stocks within a market to change.

The liberalization process is intricately linked with the macroeconomy. Liberalization of financial markets could coincide with other economic policies directed at inflation, exchange rates, and the trade sector (see Henry 1997a for details). Liberalization may also be viewed as a positive step by the international bankers that establish country risk ratings. Hence, these ratings may contain valuable information regarding the integration process as well as the credibility of reforms.

As mentioned earlier, one might be misled by examining any single or even a small group of these indicators. For example, capital flows may not reveal a substantial change because foreign investors are able to access the domestic market via ADRs and Country Funds. However, it makes sense that a comprehensive examination of a number of indicators will provide additional information.

There are of course important timing issues to be considered. Market prices could change upon announcement of the liberalization or as soon as investors anticipate a lib-

eralization may occur in the future. However, foreign ownership can only be established when allowed by the authorities. Although we will look at breaks in all of our variables, we will be careful in grouping them, taking into account such timing issues.

*2.2 Economic events and liberalization*

Bekaert and Harvey (1998b) provide a microscopic examination of the economic events that could impact the liberalization process for each of the twenty countries in our sample. In addition, a chronology of both Country Fund launchings and ADR issues is presented in Bekaert and Harvey (1998a). We use this information to give economic content to our statistical tests.

As an example, consider the information collected for Colombia. In early 1991 a series of regulatory moves were directed at easing the ability of foreign owned corporations to repatriate profits. There were significant economic reforms in mid-1991 that reduced tariffs in two steps. Much of the economy's external debt was refinanced in March 1991.

In October 1991, two important economic events occurred. The first involved the deregulation of the peso. The currency was allowed to float freely and exchange controls were eased. At the same time, Resolution 51 allowed foreigners to invest up to 10% in the local equity market. In November 1991, Resolution 52 eliminated the 10% cap on equity investment. By December 1991, the telecom industry was privatized.

In April 1992, the Colombian Investment Company (Country Fund) was listed in Luxembourg. The first ADR was offered in January 1993. In September 1993, a number of currency related reforms were passed: the exchange controls that required that Pesos be converted to U.S. dollars and then translated into other currencies were eliminated; local firms were given the ability to obtain short-term loans abroad; local firms could make peso loans to foreign owned corporations based in Colombia; the U.S. dollar could be used for domestic transactions; and the use of derivative securities on currencies was

approved.

What can structural break tests teach us about a process as complex as the capital market liberalization process in Colombia just described? Let us be clear about what the structural break tests provide us with. First, they can reject the null of no structural break. That is important in itself. Many believe that we are moving towards a globally integrated capital market, but there is no guarantee that the liberalizations that took place effectively integrated emerging markets into world capital markets. If we fail to reject the null of no structural break in our stock market variables, we must conclude that the liberalization process that took place over the last decade had little effect on the return-generating process.

Second, when there is a significant break, we can also investigate the break date with the associated confidence interval. Knowing that the return-generating process underwent a break is a necessary but not sufficient condition for concluding that capital market liberalizations actually served to integrate the capital market. We need to examine the timing of the break using the kind of information we assembled for every country in Bekaert and Harvey (1998b) to determine whether it was caused by a capital market liberalization or another major event such as the privatization of a major company. One may suspect that when the market integration is gradual and occurs in small increments, the confidence interval around the break may be large. However, it is also possible that gradual policy changes induce discrete and sudden changes in market prices and other financial variables, since agents may anticipate further policy changes. Our methodology allows us to distinguish between these cases on a country-by country basis. We may potentially also be able to shed light on what type of capital market reforms are most conducive to bring about market integration.

Third, since we estimate the reduced-form dynamics of the variables before and after the liberalization, we can examine what changes the break induced in the stochastic process governing our variables and investigate whether these changes are consistent with our intuition about the effects of market integration.

Finally, as recent events in Southeast Asia have amply shown, the market integration process can be reversed. For example, Thailand effectively suspended convertibility of its currency in late 1997. This is potentially quite damaging for our methodology. What is the value of our tests of the market integration if the process is better described as a regime-switching model (see e.g. Bekaert and Harvey (1995))? At this point, we do not have a full answer and this question merits more research. Nevertheless, our intuition is that if the regimes are persistent enough, a regime switch acts as a near permanent break and our tests will have power to detect when the switch occurred. If there are frequent switches, we suspect our confidence interval around the break to be wide. A severe problem may arise if there are exactly two or three switches, in which case our tests may be completely uninformative. We will come back to this issue in section 5.4 and discuss some robustness checks. One potential approach is to investigate the tests for multiple breaks in univariate time series, recently developed by Bai and Perron (1998); here we simply plot our Wald tests for the structural break over the whole period and assess the chance that there are multiple breaks informally.

## 3. Econometric Methodology

Our goal is to test for structural breaks in multiple time series that are potentially impacted by the integration process. The work of Banerjee, Lumsdaine, and Stock (1992) (BLS1) and Bai, Lumsdaine, and Stock (1998) (BLS2) is ideally suited for this purpose. These papers contain three key observations: (i) that tests can be constructed to determine whether or not a structural break occurred in the data, (ii) that precision with which a potential break date is estimated is a function not of the number of observations but of the number of series in a multivariate framework that experience the same break date, (iii) that confidence intervals can be computed enabling inference about the break date. They demonstrate this for both stationary vector autoregressions and cointegrated systems. We begin by sketching the intuition for these observations in a simple univariate model with a known break date and gradually generalize to the multivariate case with

an unknown break date that is relevant for our purposes.

*3.1 One known break, no regressors*

Consider the simple case where $y_t = C + e_t$ and consider estimating the following univariate model:

$$y_t = C_0 + C_1 \mathbf{1}(t > k) + \varepsilon_t, \tag{1}$$

where $\mathbf{1}(A)$ is an indicator function, equal to one if event A is true and zero otherwise. This model allows for a structural break at date $k$ under the alternative; under the null hypothesis there is no break. Assume that $k$ is known. The error term, $\varepsilon_t$ is a martingale difference sequence with $4 + \kappa$ moments (for example, the variance of $\varepsilon_t$ is $\sigma^2$). This model may be estimated by ordinary least squares, with the parameters computed as

$$\hat{C} = \begin{pmatrix} \hat{C}_0 \\ \hat{C}_1 \end{pmatrix} = \begin{pmatrix} \sum_{t=1}^{T} 1 & \sum_{t=k+1}^{T} 1 \\ \sum_{t=k+1}^{T} 1 & \sum_{t=k+1}^{T} 1 \end{pmatrix}^{-1} \begin{pmatrix} \sum_{t=1}^{T} y_t \\ \sum_{t=k+1}^{T} y_t \end{pmatrix}$$

so that

$$\begin{pmatrix} \hat{C}_0 - C_0 \\ \hat{C}_1 - C_1 \end{pmatrix} = \begin{pmatrix} T & T-k \\ T-k & T-k \end{pmatrix}^{-1} \begin{pmatrix} \sum_{t=1}^{T} \varepsilon_t \\ \sum_{t=k+1}^{T} \varepsilon_t \end{pmatrix}.$$

If we denote $\tau = \frac{k}{T}$ as the fraction of the sample at which the break occurs, then by the Central Limit Theorem $\frac{1}{\sqrt{T}} \sum_{t=1}^{T} \varepsilon_t \overset{d}{\Rightarrow} N(0, \sigma^2)$ and $\frac{1}{\sqrt{T}} \sum_{t=k+1}^{T} \varepsilon_t \overset{d}{\Rightarrow} N(0, (1-\tau)\sigma^2)$. It follows that $\sqrt{T}(\hat{C} - C) \overset{d}{\Rightarrow} Z$, where $Z$ is a bivariate Normal. As a result, tests of the hypothesis $H_0 : C_1 = 0$ can be conducted using a Wald-type test (equal to $\tau(1-\tau)\frac{\hat{C}_1^2}{\hat{\sigma}^2}$), with limiting distribution $\chi^2(1)$, where $\hat{C}_1$ is the relevant element from the vector of parameter estimates and $\hat{\sigma}^2$ is the estimate of $\sigma^2$.

*3.2 Unknown break date, no regressors*

Now suppose we were choosing between two dates, $k_1$ and $k_2$. We could estimate the model twice, allowing for breaks at the respective dates, and compute a $\chi^2$ statistic

testing the two separate hypotheses. To evaluate whether a break occurred at either $k_1$ or $k_2$, we might consider taking the maximum of these two $\chi^2$ test statistics; we would not be able to compare this maximum to a standard $\chi^2$ table, since the probability that *at least one* exceeds the 95% critical value is larger than 5%. To determine the correct critical value, we could simulate pairs of random $\chi^2(1)$ variables and take the maximum of each pair, sort them, and then look at the value associated with the 95th percentile.

This same intuition applies when we do not have any *a priori* knowledge as to when the break might have occurred. In particular, suppose we wanted to choose between all possible break dates; we could analogously compute statistics at each possible date and then designate the maximum over this sequence of statistics as the date at which the break is most likely to have occurred. If this maximum exceeded some critical value, we would reject the null hypothesis of no break in favor of a break. As before, we could simulate the correct critical value by generating $T$-tuples of random $\chi^2$ variables (where $T$ is our sample size), taking the maximum, sorting, and using the value associated with the 95th percentile.

To find the break date, at each possible date, $k$, a test statistic is computed as in 3.1, resulting in a sequence of test statistics, which we denote by $F_T(k)$. BLS2 (theorem 1) applies the functional Central Limit Theorem to this sequence to show that its limiting distribution is

$$F^*(\tau) = \{\tau(1-\tau)\}^{-1} \left(W(\tau) - \tau W(1)\right)^2,$$

where $W$ is a standard Brownian motion process. Because Max is a continuous function, we can use the continuous mapping theorem to show that $\max_k F_T(k) \Rightarrow SupF^*(\tau)$. This test is called the Sup-Wald test. The observation $\hat{k}$ that maximizes $F_T(k)$ is our estimated break date. While the break date cannot be consistently estimated in this context, the estimate of the fraction of the sample at which the break occurs, $\hat{\tau} = \frac{\hat{k}}{T}$, is a consistent estimator for the true fraction, $\tau_0 = \frac{k_0}{T}$.

BLS2 further study the joint limiting distribution of $\hat{k}, \hat{C}(\hat{k})$, and $\hat{\sigma}^2(\hat{k})$, the maximum likelihood estimators of the break date, the vector $C$, and the variance, $\sigma^2$ (for

notational simplicity, we will supress dependence on $\hat{k}$ by writing $\hat{C}$ and $\hat{\sigma}^2$ from now on). They establish that $\frac{\hat{C}_1^2}{\hat{\sigma}^2}(\hat{k}-k_0)$ converges to $V^*$, which has a well-defined limiting distribution under the alternative that the true break occurs at $k_0$. In particular, $V^*$ is distributed as $argmax_\nu\ (W(\nu)-\frac{1}{2}|\nu|)$, with the limiting density of $V^*$ given in Picard (1985) as

$$\gamma(x)=\frac{3}{2}e^{|x|}\Phi(-\frac{3}{2}\sqrt{|x|})-\frac{1}{2}\Phi(-\frac{1}{2}\sqrt{|x|}), \tag{2}$$

where $\Phi(\cdot)$ is the cumulative normal distribution function and $W$ is now a one-dimensional two-sided Brownian motion on $(-\infty,\infty)$. A two-sided Brownian motion, $W(\cdot)$, on the real line is defined as $W(\nu)=W_1(-\nu)$ for $\nu<0$, and $W(\nu)=W_2(\nu)$ for $\nu\geq 0$, where $W_1$ and $W_2$ are two independent Brownian motion processes on $[0,\infty)$, with $W_1(0)=W_2(0)=0$. Confidence intervals of width $(1-\pi)$ can be constructed using

$$\hat{k}\pm\alpha_{\frac{1}{2}\pi}(\frac{\hat{\sigma}^2}{C_1^2}), \tag{3}$$

where $\alpha_{\frac{1}{2}\pi}$ is the $(1-\frac{1}{2}\pi)$th quantile of $V^*$.

*3.3 Multiple series, no regressors*

Now consider the case where $y_t$ is an $n\times 1$ vector, so that (1) is an n-dimensional system of equations. Consider the case where all $n$ elements of $y_t$ experience a break at the same unknown date $k$. Then the procedure for determining the break date in section 3.2 can be used and a test for structural breaks has a non-standard distribution as detailed above. Let $\hat{\Sigma}$ denote the estimator of the variance-covariance matrix of the $n\times 1$ vector $\varepsilon_t$. Then a test of the null hypothesis that a break occurred in all series at date $k$ can be constructed as a Wald-type test using $\hat{C}_1'[Var(\hat{C}_1)]^{-1}\hat{C}_1$. In addition, a confidence interval for the break date is computed as $(\hat{C}_1'\hat{\Sigma}^{-1}\hat{C}_1)(\hat{k}-k_0)$ with distribution given by $V^*$ above and confidence intervals analogous to equation (3) are constructed using

$$\hat{k}\pm\alpha_{\frac{1}{2}\pi}(\hat{C}_1'\hat{\Sigma}^{-1}\hat{C}_1)^{-1}. \tag{4}$$

From equation (4), it is apparent that the confidence interval shrinks with more series that have the same break date. In the simplest case where the elements of $\varepsilon_t$ are uncorrelated so that $\Sigma$ is a diagonal matrix, the confidence interval is

$$\hat{k} \pm \alpha_{\frac{1}{2}\pi}(\sum_{i=1}^{n} \frac{\hat{C}_{1i}^2}{\hat{\Sigma}_i})^{-1}$$

where $\hat{\Sigma}_i$ is the $i$-th diagonal element of $\hat{\Sigma}$ and $\hat{C}_{1i}$ is the $i$-th element in $\hat{C}_1$. Since each term in the summation is strictly positive, the addition of another equation will only decrease (and never increase) the width of the confidence interval. In particular, when the magnitude of the break ($C_{1i}$) and variance of $\varepsilon_{it}$ ($\Sigma_i$) are the same for each series, the confidence interval shrinks at the rate $\frac{1}{n}$. This differs from the usual case of constructing confidence intervals for regression coefficients that are the same across equations in which confidence intervals shrink at rate $1/\sqrt{(n)}$. In addition, even if some of the series do not contain a break, so that $C_{1i} = 0$ for some equations, the inclusion of the series does not result in a widening of the confidence intervals. In short, the precision with which the break date can be estimated increases with the number of series that have a common break. Also, for a fixed break magnitude, note that the confidence interval does not depend on the sample size, in particular, it does not shrink as the sample size increases. These two facts illustrate the importance of multiple series in identifying break dates.

*3.4 Multiple series, stationary regressors*

The results of BLS2 apply to general vector autoregressions among stationary variables and also among systems of cointegrated regressors. In this paper, we focus on the stationary case. Specifically, it is assumed that the errors in regressions have $4 + \kappa$ moments for some $\kappa > 0$. The general form of the regression is (equation 2.2 from BLS2):

$$y_t = (G_t' \otimes I_n)\theta + d_t(k)(G_t' \otimes I_n)S'S\delta + \varepsilon_t \tag{5}$$

where $y_t$ is $n \times 1$, $G_t'$ is a row vector containing a constant, lags of $y_t$, and row $t$ of the matrix of exogenous regressors, $X$, $I_n$ is an $n \times n$ identity matrix, $d_t(k) = 0$ for $t < k$ and

$d_t(k) = 1$ for $t \geq k$.[4] $\theta$ and $\delta$ are parameter vectors with dimension $r$. For example, for a first-order vector autoregression with a vector of constants $\mu$ and parameter matrix $A$ ($y_t = \mu + Ay_{t-1} + \epsilon_t$), $\theta = vec[(\mu, A)]$ and $r = n(n+1)$. $S$ is a selection matrix containing zeros and ones and having column dimension $r$ and full row rank (equal to the number of coefficients which are allowed to change). Note that $S'S$ is idempotent with non-zero elements only on the diagonal. If $S = I_r$, then model (5) is a full structural change model. For $S = s \otimes I_n$, where $s = (1, 0, \ldots, 0)$ a row vector, model (5) allows for a mean shift only (this is the case considered in the empirical examples of BLS2).

The model (5) allows any or all of the coefficients to change. We can write the system more compactly as

$$y_t = Z_t'(k)\beta + \varepsilon_t,$$

where $Z_t'(k) = \left((G_t' \otimes I_n), d_t(k)(G_t' \otimes I_n)S'\right)$ and $\beta = (\theta', (S\delta)')'$. If we let $R = (0, I)$ be the selection matrix associated with $\beta$, so that $R\beta = S\delta$ and $\Sigma$ is the covariance matrix of the errors $\epsilon_t$, then the F-statistic testing $S\delta = 0$ is

$$\hat{F}_T(k) = T\{R\hat{\beta}(k)\}'\{R(T^{-1}\sum_{t=1}^{T} Z_t\hat{\Sigma}_k^{-1}Z_t')^{-1}R'\}^{-1}\{R\hat{\beta}(k)\},$$

where $\hat{\beta}(k)$ and $\hat{\Sigma}_k$ denote the estimators of $\beta$ and $\Sigma$, respectively, evaluated at $\hat{k}$, obtained as described above. Analogous to the simple univariate case, BLS2 show that $\hat{F}_T(k)$ converges in distribution via the functional central limit theorem to $F^*$, where $F^* = \{\tau(1-\tau)\}^{-1}\|W(\tau) - \tau W(1)\|^2$, where $\|\cdot\|$ represents the Euclidean norm and now $W(\cdot)$ is a vector of independent standard Brownian motion processes whose dimension is equal to $q$, the rank of $S$. The corresponding distribution can easily be approximated by partial sums of normal random variables for each dimension; a table with corresponding critical values for the rank up to $q = 50$ is given in the appendix. Higher dimensions are available on request. By the continuous mapping theorem, the limiting distribution of

[4] The notation that we employ for $d_t(k)$ here represents a slight departure from the standard break literature; in particular, usually $d_t(k) = \mathbf{1}(t > k)$ where $\mathbf{1}(A) = 1$ when event $A$ is true (and therefore the date $k$ is the last date of the old regime). We choose to adopt the current convention because we believe it is a more intuitive representation of a "break date" (i.e., the date $k$ represents the first date of the new regime).

$\max_k F_T(k)$ converges to $\max F^*$. As noted above, we will focus on this test statistic in the empirical work.

The dimension of the test statistic increases with both the dimensionality of the system and with the number of regressors in the model whose coefficients are allowed to break. As an example, consider an $n \times 1$ vector autoregression. If the order of the VAR is $p$ and we allow for a break in all of the coefficients, the relevant dimension of the F-statistic will be $n(np+1)$.

To conduct inference about the break date, theorem 4 of BLS2 shows that

$$[\delta_T' S' S(Q \otimes \Sigma^{-1}) S' S \delta_T](\hat{k} - k_0) \stackrel{d}{\Rightarrow} V^*,$$

where $V^*$ is the same as in the univariate case (with limiting density given by equation 2 above) and $Q = plim\ \frac{1}{T} \sum_{t=1}^{T} G_t G_t'$. Thus we can similarly invert the limiting distribution to construct confidence intervals for the estimated break date, based on allowing any or all of the coefficients to experience a break. The confidence interval is

$$\hat{k} \pm \alpha_{\frac{1}{2}\pi} [(S\hat{\delta}_T)' S(\hat{Q} \otimes \hat{\Sigma}_{\hat{k}}^{-1}) S' (S\hat{\delta}_T)]^{-1},$$

where $\hat{Q} = \frac{1}{T} \sum_{t=1}^{T} G_t G_t'$ and $\hat{k}, \hat{\Sigma}_k$ are estimated values.

Finite sample properties of these test statistics are investigated in BLS2. The tests are shown to have good size and power properties under the null hypothesis of no break and the alternative of a breaking mean, respectively. In addition, simulations regarding confidence intervals confirm that, for fixed parameters, increasing the sample will not affect the precision of the MLE of $k_0$ but increasing the number of series that experience the same break does improve precision. In addition, this precision depends on the true value of the break magnitude.

## 4. Data

We consider a number of time-series for 20 emerging markets followed by the International Finance Corporation (IFC). It is best to think of our variables as comprising five groups: financial data linked to price levels, financial variables related to liquidity, financial flows, financial variables linked to the comovement of returns, and economic indicators.

The first group contains U.S. dollar index total returns reported by the IFC. Bekaert and Harvey (1998a) argue that expected returns may be better proxied by dividend yields. Our model of capital market integration also suggests the usefulness of price level information.

The second group tries to measure the liquidity in the local market. We measure both the dollar volume of trading (divided by GDP) as well as a measure of monthly turnover (volume of trading divided by capitalization). We also examine the size of the market relative to gross domestic product.

The third group is focused on capital flows to the market. We measure the cumulative net U.S. holdings in 17 of the 20 emerging markets. We link the net equity capital flows from the U.S. *Treasury Bulletin* to the realized returns in each of these markets to develop our measure of U.S. holdings. The interpretation of these data is explored in Tesar and Werner (1995a). The particular series we use are constructed in Bekaert and Harvey (1998b).

Our fourth group of variables details both the structure and comovement of returns in each market. The stock to stock comovement is proxied by the cross-sectional standard deviation of returns each month. If all stocks move together as would occur in a market with strong sector concentration, this value is low. Another market characteristic we examine is the concentration ratio computed using a Herfindahl index.

The fourth group also incorporates measures of comovement with world variables. Capital market integration may make local returns more dependent on world information. We examine the covariance with the Morgan Stanley Capital International world market return. We also examine three instruments that are correlated with movements in the world business cycle: the world dividend yield, the Baa-Aaa yield spread and the change in the slope of the U.S. term structure as measured by the difference between U.S. Treasury 10 year and three month yields to maturity.

Our final group of variables provides information on the local economic environment. We examine inflation rates, foreign exchange volatility and the size of the trade sector. As an ex ante measure of a country's prospects and of the credibility of policies, we also examine the Institutional Investor Country Credit Rating.

## 5. Empirical Results

### *5.1 Univariate analysis: Mean breaks*

Following BLS1, our univariate analysis begins with a country-by-country analysis of 11 time series. The estimation involves univariate autoregressions with the lag length determined by the Bayesian Information Criterion of Schwarz (1978). Initially, this analysis only allows for breaks in the mean of the series. That is, the autoregressive parameters are assumed to be constant across the break point. While this assumption is not particularly attractive, it is the only one estimated in the previous literature and it gives us a base case to work with.

Our results can be briefly summarized with three observations. First, with few exceptions, the break point for U.S. dollar returns has a wide confidence interval, often wider than the sample. Second, for all other series, between 50% to 75% of the countries show significant breaks at the 5% confidence level. This even occurs for the macro level

data and credit ratings which are not available at a monthly frequency.[5] Third, significant breaks may occur for only a few series for any particular country, reinforcing the need to examine multiple series simultaneously. For example, Venezuela, a country which did not show significant breaks with other economic series, presents a highly significant break in net U.S. holdings in March 1994. In multivariate analysis below, we will detect significant break points in financial series as well.

*5.2 Univariate analysis: Breaks in all parameters of autoregression*

While others have examined structural breaks in means, we are the first paper to empirically test for breaks in all of the parameters of the autoregression.[6] Figure 1 presents the country by country results visually. For each country, we graph the 90% confidence interval around the break date (horizontal axis) against the confidence that a break occurred (one minus the p-value from the statistical break test; vertical axis). In each graph, we present break information for the 11 economic and financial variables. Figure 2 presents the same information except that the breaks are grouped by each economic and financial variable. Hence, each graph in Figure 2 displays the breaks for the 20 countries in our analysis.

An examination of the test statistics (available on request) indicates that it is much more likely that the breaks are statistically significant when we consider breaks in all the parameters rather than the mean alone. To highlight this point, Table 1 presents the analysis of one financial series, U.S. dollar equity returns in 20 different markets. While it is extremely difficult to determine breaks in the mean of equity returns (in the first panel of Table 1), there are more countries with significant breaks when all the parameters are allowed to change (second panel of Table 1). For example, the second panel suggests a

[5] The credit rating series covers a short time span and has a semi-annual frequency. Therefore, the results for this series cover only 22 observations. Results may be sensitive to this very small sample - in particular, the break date is often identified very near one of the ends of the sample.

[6] We still assume a constant innovation covariance matrix across the break.

significant break for Chile and Mexico whereas the evidence in first panel provides weak or no support for the existence of these breaks.

The graphics provide a powerful way to view the information. Let us first focus on Figure 1 and revisit our example of Colombia. An analysis of the economic reforms suggests that integration occurred in the early 1990s. The analysis of the break in means provides inconclusive results for both returns and dividend yields (no significant break). In Figure 1, we see a significant break in U.S. dollar returns in February 1992. The analysis of dividend yields suggests a slightly earlier date, October 1991. Around this time we also observe a significant shift in market capitalization to GDP, turnover, and credit ratings. The grouping of this information should further help pin down the date of integration.

In Colombia, as in some other countries, the break dates for the various series appear clustered in time. This is consistent with a far-reaching event such as market integration driving the breaks in all series. For the majority of countries, this is not the case. In fact, for quite a few countries, there seem to be two focal points for the break dates. One of the series that often breaks early on is the credit rating series. It is likely that for countries such as Argentina, Brazil, Chile, Mexico and Venezuela, the first clustering represents the start of the debt crisis in 1982. The second clustering potentially reflects the onset of the market integration process.

The two-date clustering raises the possibility that there may be two breaks in some series. It is a limitation of our analysis that we identify only one break in each time series. However, it is possible to calculate the Wald statistic at every point in the time series. We provide a visual inspection of the Wald statistic and its critical value in Figures 3 and 4 for two countries.

Figure 3 presents the time series of Wald statistics for Portugal based on the analysis of U.S. dollar returns. The Wald statistic moves above its critical value in mid-1987 and peaks in February 1988 suggesting only one break in the returns series. Figure 4 presents

the Wald statistics for the analysis of dividend yields for Colombia. The Wald statistic moves above the critical value in late 1990 which coincides with a significant number of reforms taking place in that market. There is no evidence for Portugal or Colombia of a second break.[7]

Let's now turn to Figure 2 and consider the contrast between returns and dividend yields. Bekaert and Harvey (1998a) present simulation evidence which suggests that it is easier to detect a break in the cost of capital by examining dividend yields rather than returns. Figure 2 provides considerable supporting evidence for their simulations. The breaks for dividend yields are much more likely to be significant and the confidence intervals are tighter.

Strikingly, the market capitalization to GDP and value traded to GDP series show even more significant break points as do, but less dramatically, the turnover and capital flows series. Interestingly, the break dates for these variables are much more clustered in time across countries than the break dates for the other series. They also occur generally later than for most other series. One potential explanation for this phenomenon is that the capital flows (and the market integration they may bring about) are primarily driven by factors in the developed world, such as interest rates [see World Bank (1997) and Stulz (1997)]. Interest rates were unusually low in the U.S. in 1993, which coincided with a large capital outflow to emerging markets. We examine this issue in more detail in section 6.3.

*5.3 The importance of world factors*

The third panel of Table 1 brings world information into the univariate autoregres-

[7] Some caution needs to exercised in interpreting the Wald statistic plots. If the Wald statistic is twice as large in magnitude at some point in the time series, it does not mean that it is twice as likely that a break occurred at that point. In addition, our graphic discussion does not constitute a consistent statistical test for multiple breaks (instead, see Bai and Perron 1998).

sion analysis as specified in equation (5) with n=1. As in the other panels of Table 1, all parameters of the model are allowed to change permanently at the break point. The intuition for inserting the world variables and allowing for their coefficients to change is that after the market is integrated, it is more likely influenced by world events.

We augment the autoregressions with the lagged world return and three additional instruments that contain information about the world business cycle: the lagged world dividend yield, the lagged Baa-Aaa yield spread, and the lagged change in the slope of the U.S. term structure of interest rates. Remarkably, the confidence intervals shrink quite dramatically. For example, the 90% confidence interval for the break date in Colombia (February 1992) is much tighter than in the second panel, spanning one month before and one month afterwards. Whereas for most countries the wide interval resulting from the returns analysis is simply shrunk by adding the world information, for some other countries the new date is outside the wide confidence interval (for instance Argentina and Zimbabwe).

*5.4 Multivariate analysis*

Table 2 contains results for two bivariate systems: the first set is returns and dividend yields and the second set is returns and market capitalization to GDP. Although both dividend yields and market capitalization to GDP may capture permanent price effects, they may not break at the same time (see also Figure 2).

As with the results in the final panel of Table 1, we include four world instruments in this analysis. In addition, we allow for all of the parameters in the VAR to break. This includes the parameters governing the relation between the returns, dividends and relative market size to the world instruments. Bekaert and Harvey (1997) provide evidence that world factors are more influential after capital market liberalizations.

The message of Table 2 is that the bivariate analysis allows us to more accurately

detect break points in the financial series. In the analysis of returns and dividends, 18 of the 20 countries have breaks that are significant at the 1% level.[8] A similar finding is presented in the analysis of returns and market capitalization to GDP. In 19 of the 20 countries, significant breaks are detected at the 1% level and one country has a break that is significant at the 5% level. Generally, the confidence intervals around the break dates are only two months wide. Interestingly, in 16 of the 20 countries, the break date in the system with market capitalization to GDP is later than in the system with dividend yields. We will come back to this below.

Figures 5 and 6 present the graphs of the Wald statistics for Columbia and Korea. For Colombia, there is one clear break that is obvious from the time series of Wald statistics, in October 1991. This month exactly coincides with major regulatory initiatives that impacted foreign exchange conversion and the ability of corporations to remit profits abroad. On the other hand, we know that Korea experienced multiple liberalizations. There are roughly four peaks in the graph of the Wald statistics. There is some correspondence between these peaks and economic events. For example, in September 1980 there was a liberalization of rules for foreign investment in Korea (first peak). This opened the market to foreign direct investment. In October 1984, the Korea Fund was launched. This gave foreign investors their first chance to make portfolio investments in Korea (second peak). In fact, when we drop the default and term spread instruments, the break date becomes November 1985, which is significant at the 5% level. It is possible that the early break in 1980 is caused by breaks in these two US instruments (see below). In September 1988 (third peak), sweeping liberalization plans were announced (that were not implemented until much later). For example, in September 1991, the government announced that the stock market would become 'open' to international investors in January 1992 (fourth peak). This meant that foreigners could own up to 10% of the capitalization of a company and no individual could own more than 3%. However, a number of companies had more than 10% foreign ownership. The government had to

[8] Examining Indonesia is problematic given the small sample we have. We ran into estimation problems and report results only for the case that does not allow the world instruments to break.

raise the total foreign ownership limit to 25% for 45 firms. In December 1994, the government raised the foreign ownership limit to 12% from 10%. They also announced their intentions of raising the limit to 15% some time in 1995. The announcement date for the 15% limit was July 1995.[9] While there is one significant break in late 1985, there is some evidence of multiple (insignificant) peaks which might be associated with multiple liberalizations.[10]

*5.5 A control experiment using world returns and world dividends*

The analysis in Table 2 assumes that there are breaks in the relationships between the country variates and the world information. One might conjecture that some of the breaks we detect are a result of spurious breaks in the process generating the world instruments themselves. In addition, structural breaks may occur for reasons that have nothing to do with market integration. For example, our specification captures time-variation in expected returns through a stable relation between returns and instruments such as dividend yields. Breaks in this relation may have occured across the world.[11]

As a control experiment, we tested whether there were any significant breaks in the world variables. These results are presented in Table 3. We fail to detect a significant break in the univariate return specifications, but we do detect a significant break in the dividend yield regression when world instruments are used as regressors. The same break materializes in the analogous bivariate specification that also includes world returns as an independent variable. Further analysis reveals that the break is in fact caused by a break

[9] For completeness, the ownership limit was raised to 18% in May 1996. In September 1996, the limit was raised to 20%. In May 1997, the ownership limit was further increased to 23%.

[10] We also conducted, but do not report, the analysis of the Wald statistics on the bivariate system of returns and market capitalization to GDP for Korea. The statistics are above their critical values between October 1987 and January 1991 with a spike in May 1988. The only other time that the statistic is above its critical value is January 1992 which coincides with the 'official' liberalization date.

[11] See Garcia and Ghysels (1998) and Bossaerts and Hillion (1998).

in the corporate bond spread and term to maturity spread instruments. The break date of mid-1980 likely reflects the change in the operating procedure of the Federal Reserve in the U.S. Given that this break occurs before all of the breaks we find in emerging markets (with one exception, Korea, see above) and even before many of our samples start, it will not affect our analysis.[12]

Overall, this analysis gives us some confidence that when we add the world variables to the analysis, we should be detecting breaks that result from changing relationships to the world variables rather than shifts in the world aggregates alone. Moreover, the significant breaks we find in emerging markets suggest structural changes that apparently did not occur in the developed world.

## 6. Interpretation

### *6.1 Did liberalization occur and what does it mean?*

Table 4 presents an analysis of the behavior of financial and economic aggregates five years before and five years after a break. For this analysis, we use the break points from the bivariate analysis of returns and dividend yields, reported in Table 2.

To begin with, we examine the behavior of the ex post returns and dividend yields (which the break estimation was based on). Bekaert and Harvey's (1998a) simulation evidence suggest that the dividend yield will be a powerful indicator of the change in the cost of capital. The results in Table 4 suggests that the dividend yield decreases in 13 of the countries we examine. The overall mean dividend yield falls from 4.95% to 2.93%.

We present four test statistics. The first tests are heteroskedasticity-consistent

[12] Of course, many countries contained in the world market (such as Japan and New Zealand) also experienced major changes in capital controls in the early 1980s. However, at the time, the world market portfolio was dominated by the capitalization of the U.S. equity market.

country-specific tests of the hypothesis of no change in each time series for each country, that is, we test $C_1 = 0$ in the model of equation (1). These tests also correct for a first-order moving average process in the residuals for all series that are available on a monthly basis. For those series which have components that are observed at an annual frequency, we correct for a 12th-order moving average process. The test statistics' p-values are denoted with asterisks.

The next tests are multivariate. The third from last line presents a simple difference in means test across the countries. This test allows for different variances in the pre and post data but imposes independence across countries and across time.

The second from last line involves a multivariate estimation with a single indicator variable that is activated after the break dates. The coefficient on this variable represents the average difference in the post-break period. We test whether this single coefficient is different from zero. This estimation is group-wise heteroskedasticity consistent (allows for different variances across the countries) and is robust to country-specific moving average processes in the residuals. We also allow for fixed country effects in the estimation.

The final line of the table presents another version of the multivariate test. In this test, we add country-specific indicator variables which pick up the country-specific difference between the pre and post break mean. We conduct a group-wise heteroskedasticity and moving-average-consistent Wald test that these coefficients jointly equal zero. As with the previous test, we allow for fixed country effects in the estimation.

Our multivariate analysis excludes five countries for which both dividend yields and mean returns increase after the break. Our logic is as follows. After a market is financially integrated, we would expect a permanent price increase. This increase leads to a decrease in the dividend yield. We would also expect to see a one shot higher return but lower returns, on average, afterwards. It is important to note that even when the dividend's permanent growth rate increases because of permanently better investment opportunities (endogenous growth theory) or because the companies' payout policies

change (lower dividends since better growth opportunities), we should see dividend yields decrease.[13] The returns are noisy because we may mix the 'return to integration' (one shot positive return) with the post-integration returns (which should be lower). Hence, we view the combination of increasing dividend yields and increasing mean returns as inconsistent with financial market integration.

There are five countries where both dividend yields and average returns increase. It is likely that the break for Chile is simply picking up the debt crisis. The sample is very short for Indonesia and we had difficulties estimating some of our models for this country. Nigeria and Zimbabwe are also in this group. It is not clear that Zimbabwe has experienced a market liberalization. The date for Nigeria is reasonable but there are so few observations after the break date that it is difficult to corroborate. Argentina is the most problematic. The date of February 1989 is close to the date that most consider the offical date of liberalization, November 1989 (see Bekaert and Harvey (1998b)). However, 1989 is an extremely volatile year so February looks much different from November. For example, the IFC Global Index for Argentina calculated in U.S. dollar terms stands at 161.3 in February 1989. It rises to 681.5 by June (a 322% increase), falls to 238.86 in July (one month loss of 64%) and rises to 544.3 by November. As a result, the high average return after the break would not necessarily look that high if the date was shifted by just a few months.

The results in Table 4 are intriguing. For the remaining 15 countries, the average size of the equity market (as measured by market capitalization to GDP) increases from 11% to 29% in the post break period. We also find that there is significantly more trading. The value traded to GDP ratio increases in all but one of the countries. There is an increase in trading, as measured by the turnover ratio, in more than half the countries examined.

In the post break period, we estimate that the average level of U.S. equity ownership in these markets rises from 2% to 3%. A heteroskedasticity consistent test of the

[13] See the discussion in Bekaert and Harvey (1998a).

difference in means suggests that the change in holdings is significant at the 5% level in 12 of the 14 countries that experienced increased ownership. Furthermore, credit ratings increase from an average of 46.8 to 47.3. In the seven countries with increased ratings, all but one increase is significant at the 5% level. We also examine two other financial measures: the concentration ratio and the cross-sectional standard deviation. While individual countries suggest some significant changes, there is no clear pattern in these measures across countries.

We examine a number of economic aggregates. We find little relation between inflation and the break points, though the results are heavily influenced by Argentina and Brazil. The size of the trade sector increases in most countries. On average, exports plus imports to GDP increases from 49% to 60% in the post break period. Henry (1997a) documents how trade and financial liberalization often occur simultaneously. We also find that on average the real exchange rate decreases implying a local currency appreciation. Kim and Singal (1997) do not find real exchange rate appreciations after stock market openings. Our results seem more in line with the conventional wisdom in international economics, that capital inflows may induce real exchange rate appreciations (see e.g. Reisen (1993)). A real exchange rate appreciation may be the by-product of an exchange rate stabilization program, which manages to abruptly reduce the volatility of exchange rate changes, but where inflation converges more slowly to a lower level (see Reinhart and Vegh (1995)). Hence, macroeconomic reform accompanying financial liberalization may be the driving force behind this result. Nevertheless, there are no clear patterns in exchange rate volatility before or after liberalizations. Moreover, there are very large cross-country differences in the change in the real exchange rate and quite a few countries experience real exchange rate depreciations. Finally, our results on per capita GDP growth suggest that real growth modestly increases from 2.57% to 2.82% after the break. The multivariate test which allows for country specific intercepts suggests that this change is significant.

Table 4 also presents some analysis of two additional measures: volatility and the

beta versus the world market return. Policy makers are often concerned that the opening up of a capital market may lead to excessive volatility. Our results suggest no particular pattern in volatility before and after the break points. In 11 countries the volatility decreases and in 8 countries the volatility increases. These results confirm the analysis in De Santis and İmrohoroğlu (1997), Bekaert and Harvey (1997), and Kim and Singal (1997). Consistent with the evidence in Bekaert and Harvey (1997) that world factors become more important after liberalizations, there is an increase in nine countries' betas. For example, the beta for Thailand increases from 0.41 to 0.80. However, the mean beta decreases from 0.42 to 0.35, a change that is not significant.[14]

*6.2 Integrated versus segmented portfolios*

To obtain an alternative view on the financial effects of market integration, we form equally weighted portfolios of countries before and after their break points. The pre-break point portfolio we call the "segmentation portfolio" and the post-break point portfolio we call the "integration portfolio." At the beginning of the sample, March 1980, there is only one country in the integrated portfolio. In March 1983, there are three countries and by April 1983 there are four countries in the integrated portfolio. The segmented portfolio begins with all the non-integrated countries. By August 1992, only two countries remain in the segmented portfolio. The portfolio drops to a single country in February 1993. The segmented portfolio ends in December 1993.

We present summary statistics on these portfolio returns in Table 5. We present panels that exclude the five countries whose returns and dividend yields after the break are inconsistent with market liberalization and another set of panels which examines all breaks. We focus on the five years beginning January 1990. During this period many of the countries experience a break.

[14] The panel-based regression tests of differences in betas and ex post volatilities are not feasible because there is only one observation in each of the pre and post samples.

The mean return of the integrated portfolio is higher than the segmented portfolio which may be ascribed to a revaluation after the break that leads to higher ex post returns but lower expected returns (see also Bekaert and Harvey (1998a)). In support of the revaluation hypothesis, we recalculated the portfolio returns and only included a country in the integrated portfolio six months after the break date. The six months of exclusion reduces the mean return on the integrated portfolio by 200 basis points. The standard deviation of the integrated portfolio is slightly lower than the segmented portfolio. Consistent with the results in Table 4, policy makers should not expect a decrease in volatility when markets are opened up.

Table 5 also presents two measures of the comovement of the portfolios and the world market portfolio: correlation and beta. In Table 4, we noticed that a number of countries experienced increased betas. The integrated/segmented portfolio results reinforce the idea that the emerging market returns are much more sensitive to world factors after a break. The correlation with the world market more than doubles moving from the segmented to the integrated portfolio. The beta also shows a dramatic increase - also more than doubling in both samples.

It is important to note that the increases in the comovement measures do not imply that the diversification benefit of investing in emerging markets disappears. The correlation increases from 17% to 43% which is still a low correlation.[15] These results do indicate that the market returns are much more sensitive to world factors. There are two potential sources for this increased correlation. In a world where discount rates vary through time, global pricing may induce higher correlations with the world market as opposed to local pricing. It is also possible that the local firm's cash flows become more sensitive to world factors. One potential channel is the increased trade flows occuring after financial and economic integration.

[15] The correlation of the integrated portfolio updated through December 1997 is 44%.

*6.3 When did integration occur?*

Table 6 presents an analysis of the break dates. In the three columns, we report dates presented in Bekaert and Harvey (1998a). These include official regulatory dates, the introduction of country funds and the introduction of American Depositary Receipts. We also report the break point in the U.S. equity holdings based on the univariate analysis with breaks in all the parameters of the autoregression. Finally, we present the breaks that result from the bivariate estimation.

There are many different approaches to determining when a liberalization occurs. One strategy is to date the liberalization by the official government decrees. The disadvantage of this approach is that investors can sometimes bypass regulations. The approach in our paper is to let the data speak for itself. However, it is also important to link our break dates to what is happening in each market. Bekaert and Harvey (1998b) provide a detailed, country-by-country history of important events related to liberalizations in 20 countries.

One country we have focused on is Colombia. Our chronology of the history in section 2.2 shows 1991 being a critical year for capital market reforms. In October 1991, the peso was deregulated, foreign firms were allowed to remit 100% of their profits and the broad reforms of Resolution 51 took effect. In December 1991, Resolution 52 came into effect which allowed foreigners to purchase up to 100% of locally listed companies. The median break date in the bivariate analysis of dividends and returns is November 1991. This suggests that these reforms led to an effective liberalization of the capital market.

However, Colombia is not the only country where there is a relation between the reforms and the break dates. For example, the bivariate break date for Argentina is February 1989. In March 1989, the Brady plan (an adjustment package that combined debt relief and market-oriented reforms) was announced. By November 1989, the New Foreign Investment Regime was put into place. All legal limits on foreign investment

were abolished. Capital gains and dividends could be repatriated freely with no need for previous approval of transactions. Legal limits regarding the type or nature of foreign investment were abolished. A free exchange regime (free repatriation of capital, remittance of dividends and capital gains) was introduced.

Not all countries have a close association of the break dates and reform dates. For example, in 1988 Article 15 of Decree 32 paved the way for foreigners to invest directly in Turkey. As a result, foreigners were no longer required to seek preapproval to purchase or sell securities listed on the Istanbul Stock Exchange. Our break analysis suggests the break occurred in October 1989 - a considerable period after the Decree. It is possible that the Decree was not effective until well after it became law. It is also possible that investors did not view the Decree as credible.

Table 6 also allows for a more general analysis of the clustering and timing of our break dates relative to official liberalizations, ADR and country fund introductions or the start of significant U.S. capital flows. First, the table clearly reveals that the dividend yield break date is earlier than the market capitalization break date. In particular, it is earlier in 16 of 20 countries. If we view each country date as an independent Bernoulli trial, this proportion would be highly significantly different from 0.5. This remains true when we restrict attention to the 15 countries for which dividend yields and returns do not simultaneously increase after the break date. The two dates are quite far apart: the average difference (in months) across all countries is 47.9, almost four years. The dividend yield is most closely associated with the country fund date, although the average absolute difference is still about 26 months for the 15 integrating countries. For the other three dates, the difference exceeds three years. The market capitalization date is most closely associated with the ADR date with an absolute difference of less than two years. The liberalization dates and capital flow dates are on average about 32 months away from the market capitalization date, but the country fund introductions are more than four years away.

The market capitalization dates seem to be clustered in 1993. This was the year

when capital flows to emerging markets really took off. In April 1993, the U.S. interest rate reached a trough and some believe that this triggered capital outflows from the U.S. to emerging (and other) markets. The market capitalization break dates are in fact much more closely associated with the April 1993 date (an average of only 21 months) than with the capital flow dates. Of course, 1993 also witnessed numerous ADR programs, sometimes coupled with large privatization programs which may have increased local market capitalization.

Taken together, these results confirm that actual liberalization may not be the prime drivers of changes in the return generating process. Although our results are at best suggestive, the role of country funds and ADRs seems critical (see Errunza, Senbet and Hogan (1997) and Miller (1997)).

## 7. Conclusions

We study structural breaks in a host of financial and economic time series in 20 emerging markets. The methodology, developed in BLS2, is quite novel and allows the determination of the break date with a 90% confidence interval. In contrast to previous empirical applications, we allow for all of the parameters in an autoregression to change at the break point. If the recent capital market liberalization process in emerging markets effectively integrated these markets into world capital markets, we expect the move from segmentation to integration to be accompanied by a significant break in a number of time series.

We find strong evidence of structural breaks in emerging equity markets but no evidence of structural breaks in the world equity market. The statistical significance of our results, and consequently, the precision of our dating exercise, is enhanced by allowing all parameters to break rather than only the mean, by examining variables which capture permanent price level changes (such as dividend yields) rather than only noisy returns data and by examining multiple time series simultaneously. The confidence

interval around our break dates is surprisingly tight given that the liberalization process is often complex and gradual. We find that integration brings about or is accompanied by an equity market which is significantly larger and more liquid than before, and stock returns which are more volatile and more correlated with world market returns than before. Integration is also associated with a lower cost of capital, an improved credit rating, a real exchange rate appreciation and increased real economic growth. These results are based on cross-sectional averages and the dispersion in the changes in financial and economic time-series across countries may be wide. One advantage of our approach is that it allows a country-by-country analysis and we have focused on only a few examples in the current paper.

Our dates should be useful for the rapidly growing body of literature studying the changes emerging markets undergo after liberalization. Consider four possible alternative measures of a break date: a date based on major regulatory reforms liberalizing foreign equity investments, the date of the announcement of the first ADR issue, the date of the first country fund launching, and the date based on changes in capital flows. Our endogenous structural break dates are mostly within two years of one of these dates, but the closeness and identity of the the closest exogenous break date varies greatly across countries.

One pressing issue for further research is the robustness of our approach to the presence of multiple breaks or a reversal in the integration process, as we have witnessed recently in South-East Asia. We plan to investigate this in the future.

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**Table 1**

## Analysis of U.S. dollar returns: Break in mean, all parameters, all parameters with world information

| | Mean Break | | | All Parameters Break | | | All parameters break + 4 Instruments | | |
|---|---|---|---|---|---|---|---|---|---|
| **Country** | 5th Percentile | Median | 95th Percentile | 5th Percentile | Median | 95th Percentile | 5th Percentile | Median | 95th Percentile |
| Argentina | | Jun-85 | | Feb-84 | Jul-89 | Dec-94 | May-79 | Jun-79 | Jul-79 |
| Brazil | | Sep-83 | Aug-94 | | Sep-83 | Aug-94 | Dec-86 | Jan-88 | Feb-89 |
| Chile | Mar-78 | Jul-80 ** | Nov-82 | Jan-79 | Nov-79 *** | Sep-80 | Apr-80 | May-80 *** | Jun-80 |
| Colombia | Jun-90 | Apr-94 | | Aug-90 | Feb-92 ** | Aug-93 | Jan-92 | Feb-92 ** | Mar-92 |
| Greece | Aug-80 | Nov-85 * | Feb-91 | Nov-88 | Aug-90 * | May-92 | Apr-85 | May-86 ** | Jun-87 |
| India | Mar-85 | Apr-92 | | Oct-84 | Jun-90 | Feb-96 | Jul-90 | Aug-90 ** | Sep-90 |
| Indonesia | Jan-91 | Nov-91 ** | Sep-92 | Jan-91 | Nov-91 ** | Sep-92 | Sep-91 | Nov-91 | Jan-92 |
| Jordan | Oct-79 | Feb-82 * | Jun-84 | Oct-79 | Feb-82 * | Jun-84 | May-80 | Mar-82 | Jan-84 |
| Korea | Mar-81 | Apr-89 | | Mar-81 | Apr-89 | | Sep-91 | Oct-91 | Nov-91 |
| Malaysia | | Dec-87 | | Jul-91 | Jan-94 | | Dec-86 | Jan-87 ** | Feb-87 |
| Mexico | | Jan-83 | Oct-94 | Oct-85 | Oct-87 *** | Oct-89 | Mar-86 | May-86 * | Jul-86 |
| Nigeria | Apr-89 | Apr-93 | | Apr-89 | Apr-93 | | Dec-93 | Jan-94 *** | Feb-94 |
| Pakistan | Jul-91 | Mar-94 | | Jan-92 | Dec-93 | Dec-95 | Dec-91 | Jan-92 * | Feb-92 |
| Philippines | Oct-86 | Aug-87 ** | Jun-88 | Oct-86 | Aug-87 *** | Jun-88 | Dec-92 | Jan-93 | Feb-93 |
| Portugal | Jun-87 | Feb-88 ** | Oct-88 | Nov-87 | Jan-88 *** | Mar-88 | Nov-87 | Dec-87 *** | Jan-88 |
| Taiwan | Jul-86 | Jun-89 | May-92 | Jul-86 | Jun-89 | May-92 | Jun-92 | Feb-93 * | Oct-93 |
| Thailand | | Jun-86 | | Mar-85 | Oct-87 | May-90 | Mar-79 | May-79 | Jul-79 |
| Turkey | | Aug-90 | Oct-94 | | Aug-90 | Oct-94 | Dec-89 | Feb-90 | Apr-90 |
| Venezuela | Dec-85 | Feb-92 | | Jun-90 | Feb-92 ** | Oct-93 | Apr-89 | Feb-90 * | Dec-90 |
| Zimbabwe | | Jul-84 | | Aug-80 | Oct-84 | Dec-88 | Jul-91 | Aug-91 ** | Sep-91 |

Blank entries indicate that the confidence interval lies outside the sample dates.

*,**,*** Indicate significance levels of 10%, 5% and 1%, respectively.

**Table 2**

## Bivariate analysis with world instruments
## Break in world instruments

| Country | Break in World Instruments Returns + Dividend Yields | | | Break in World Instruments Returns + Mkt Capitalization/GDP | | |
|---|---|---|---|---|---|---|
| | 5th Percentile | Median | 95th Percentile | 5th Percentile | Median | 95th Percentile |
| Argentina | Jan-89 | Feb-89 *** | Mar-89 | Jul-91 | Aug-91 *** | Sep-91 |
| Brazil | Mar-90 | Apr-90 *** | May-90 | Dec-92 | Jan-93 *** | Feb-93 |
| Chile | Jan-83 | Feb-83 *** | Mar-83 | Dec-92 | Jan-93 *** | Feb-93 |
| Colombia | Sep-91 | Oct-91 *** | Nov-91 | Dec-92 | Jan-93 *** | Feb-93 |
| Greece | May-86 | Jun-86 *** | Jul-86 | Mar-90 | Apr-90 *** | May-90 |
| India | Oct-87 | Nov-87 *** | Dec-87 | Dec-91 | Jan-92 *** | Feb-92 |
| Indonesia[a] | Jul-92 | Aug-92 *** | Sep-92 | Jan-95 | Feb-95 ** | Mar-95 |
| Jordan | Mar-92 | Apr-92 *** | May-92 | Mar-88 | Apr-88 *** | May-88 |
| Korea | Jan-80 | Feb-80 *** | Mar-80 | Apr-88 | May-88 *** | Jun-88 |
| Malaysia | Dec-92 | Jan-93 *** | Feb-93 | Sep-93 | Oct-93 *** | Nov-93 |
| Mexico | Jan-83 | Feb-83 *** | Mar-83 | Dec-92 | Jan-93 *** | Feb-93 |
| Nigeria | May-89 | Jun-89 | Jul-89 | Dec-93 | Jan-94 *** | Feb-94 |
| Pakistan | Nov-90 | Dec-90 *** | Jan-91 | Sep-93 | Oct-93 *** | Nov-93 |
| Philippine | Sep-87 | Oct-87 *** | Nov-87 | Sep-93 | Oct-93 *** | Nov-93 |
| Portugal | Jul-88 | Aug-88 *** | Sep-88 | Nov-87 | Dec-87 *** | Jan-88 |
| Taiwan | Jul-88 | Aug-88 *** | Sep-88 | Dec-87 | Jan-88 *** | Feb-88 |
| Thailand | Dec-89 | Jan-90 ** | Feb-90 | Dec-92 | Jan-93 *** | Feb-93 |
| Turkey | May-89 | Jun-89 *** | Jul-89 | Jan-91 | Feb-91 *** | Mar-91 |
| Venezuela | Dec-93 | Jan-94 *** | Feb-94 | Dec-91 | Jan-92 *** | Jan-92 |
| Zimbabwe | Feb-83 | Mar-83 | Apr-83 | Oct-91 | Nov-91 *** | Dec-91 |

[a]Estimation for Indonesia does not allow for a break in the world instruments.

*,**,*** Indicate significance levels of 10%, 5% and 1%, respectively.

**Table 3**

## Control experiment with world variables

| System | Description | Break analysis | | |
|---|---|---|---|---|
| | | 5th Percentile | Median | 95th Percentile |
| World return | Coefficients on lags of world return allowed to break | Sep-87 | Oct-90 | Nov-93 |
| World return, lagged instruments (div, Baa-Aaa, 10yr-3mo) | Coefficients on lags of world return and the three instrumental variables allowed to break | Jul-84 | Oct-85 | Jan-87 |
| World dividend yield | Coefficients on lags of world dividend yield allowed to break | Nov-74 | Apr-80 | Sep-85 |
| World dividend yield, lagged instruments (world return, Baa-Aaa, 10yr-3mo) | Coefficients on lags of world dividend yield and the three instrumental variables allowed to break | May-80 | Jun-80 *** | Jul-80 |
| World returns + dividend yield | Coefficients on lags of world return and dividend yield allowed to break | Jul-82 | Aug-82 | Sep-82 |
| Returns, dividend yield and lagged instruments (Baa-Aaa, 10yr-3mo) | Coefficients on lags of world return, world dividend yield and the two instrumental variables allowed to break | May-80 | Jun-80 *** | Jul-80 |

*,**,*** Indicate significance levels of 10%, 5% and 1%, respectively.

**Table 4**

**Analysis of Financial and Economic Aggregates Before and After Break Based on Bivariate Estimation of Returns and Dividend Yields**

A. Primary time series

| | Ex Post Returns (annual) | | | Dividend yield | | | Market Cap to GDP | | | Turnover | | | Value Traded to GDP | | | Level of Equity Holdings | | | Concentration Ratio | | | Cross-Sectional Standard Deviation | | | Average Inflation (Annual %) | | | FX Volatility | | | Institutional Investor's Country Credit Rating | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. |
| Argentina | 33.74 | 99.54 | | 1.07 | 1.92 | ** | 0.01 | 0.06 | *** | 0.26 | 0.48 | *** | 0.34 | 2.56 | *** | -0.02 | -0.01 | ** | 0.22 | 0.30 | *** | 0.18 | 0.25 | | 384.89 | 1335.18 | ** | 0.14 | 0.37 | *** | 23.6 | 23.3 | |
| Brazil | 30.83 | 37.60 | | 3.91 | 3.07 | | 0.05 | 0.14 | *** | 0.41 | 0.41 | | 1.48 | 4.24 | *** | 0.01 | 0.07 | *** | 0.25 | 0.19 | *** | 0.24 | 0.23 | | 648.00 | 2064.62 | *** | 0.08 | 0.14 | *** | 30.9 | 27.9 | *** |
| Chile | 12.74 | 25.85 | | 4.97 | 5.21 | | 0.14 | 0.10 | *** | NA | 0.09 | ne | NA | 0.88 | ne | 0.00 | 0.00 | | 0.23 | 0.22 | | 0.14 | 0.14 | | 27.37 | 23.44 | | 0.03 | 0.05 | *** | 53.0 | 28.1 | *** |
| Colombia | 28.92 | 39.94 | | 6.44 | 2.06 | *** | 0.04 | 0.16 | *** | 0.05 | 0.09 | *** | 0.16 | 1.10 | *** | -0.01 | 0.01 | *** | 0.18 | 0.21 | *** | 0.11 | 0.13 | | 26.91 | 23.77 | *** | 0.01 | 0.02 | *** | 36.9 | 41.9 | *** |
| Greece | -15.39 | 54.68 | ** | 10.06 | 4.45 | *** | 0.02 | 0.08 | *** | 0.04 | 0.14 | *** | 0.04 | 1.23 | *** | -0.01 | -0.01 | * | 0.58 | 0.29 | *** | 0.08 | 0.14 | *** | 20.65 | 17.25 | *** | 0.04 | 0.04 | | 54.5 | 47.6 | *** |
| India | 14.50 | 26.76 | | 2.97 | 1.90 | *** | 0.02 | 0.06 | *** | 0.74 | 0.74 | | 1.33 | 3.36 | *** | 0.00 | 0.00 | *** | 0.23 | 0.19 | *** | 0.08 | 0.12 | *** | 8.62 | 10.08 | ** | 0.01 | 0.02 | *** | 49.4 | 47.0 | *** |
| Indonesia | -6.10 | 15.53 | | 0.35 | 1.50 | *** | 0.07 | 0.12 | *** | 0.44 | 0.37 | | 1.53 | 3.80 | *** | 0.01 | 0.05 | *** | 0.20 | 0.19 | | 0.13 | 0.10 | *** | 8.18 | 8.75 | | NA | 0.00 | ne | 45.6 | 41.6 | *** |
| Jordan | 2.61 | 8.93 | | 5.24 | 2.42 | *** | 0.34 | 0.50 | *** | 0.14 | 0.23 | ** | NA | NA | *** | NA | NA | | 0.52 | 0.42 | *** | 0.07 | 0.07 | ne | 11.82 | 4.01 | ne | 0.03 | 0.01 | ne | NA | NA | ne |
| Korea | 22.12 | 5.44 | | 7.58 | 6.26 | ** | 0.03 | 0.02 | *** | NA | 1.12 | ne | NA | 1.91 | ne | 0.00 | 0.01 | ne | 0.15 | 0.16 | *** | 0.14 | 0.10 | *** | 16.72 | 12.49 | ** | 0.00 | 0.02 | *** | 70.3 | 57.3 | *** |
| Malaysia | 19.40 | -6.06 | | 2.20 | 1.51 | *** | 0.73 | 1.88 | *** | 0.14 | 0.36 | *** | 8.89 | 61.37 | *** | 0.01 | 0.02 | *** | 0.19 | 0.18 | ** | 0.09 | 0.10 | | 3.30 | 4.14 | *** | 0.01 | 0.01 | *** | 34.4 | 44.8 | *** |
| Mexico | -3.19 | 56.19 | | 7.87 | 5.32 | ** | 0.00 | 0.04 | *** | NA | 0.94 | ne | NA | 2.43 | ne | 0.01 | 0.07 | *** | 0.19 | 0.18 | | 0.13 | 0.22 | *** | 30.95 | 89.72 | *** | 0.05 | 0.12 | *** | 72.3 | 63.8 | *** |
| Nigeria | -13.04 | 40.36 | * | 7.28 | 8.17 | | 0.02 | 0.04 | *** | 0.01 | 0.01 | | NA | NA | ne | NA | NA | ne | 0.17 | 0.17 | | 0.06 | 0.11 | * | 25.23 | 34.75 | | 0.24 | 0.12 | *** | NA | NA | ne |
| Pakistan | 11.54 | 19.30 | | 7.10 | 2.43 | *** | 0.02 | 0.12 | *** | 0.11 | 0.17 | *** | 0.21 | 2.02 | *** | 0.00 | 0.00 | *** | 0.18 | 0.15 | *** | 0.08 | 0.11 | *** | 6.64 | 11.30 | *** | 0.01 | 0.01 | *** | 30.3 | 28.7 | *** |
| Philippines | 97.66 | 16.53 | ** | 3.70 | 1.68 | *** | 0.03 | 0.12 | *** | 0.32 | 0.21 | ** | 1.29 | 1.93 | ** | 0.32 | 0.23 | *** | 0.28 | 0.34 | *** | 0.15 | 0.12 | ** | 17.97 | 12.39 | | NA | 0.02 | ne | 24.7 | 24.8 | |
| Portugal | 101.21 | -1.41 | * | 0.95 | 2.76 | *** | 0.07 | 0.10 | ** | 0.09 | 0.15 | *** | 0.67 | 1.36 | *** | 0.00 | 0.02 | *** | 0.31 | 0.23 | *** | 0.22 | 0.08 | *** | 17.53 | 10.94 | *** | NA | 0.03 | *** | 51.3 | 62.8 | *** |
| Taiwan | 74.77 | 10.39 | * | 1.57 | 0.68 | *** | 0.12 | 0.65 | *** | 2.83 | 2.51 | | 52.67 | 165.26 | *** | 0.00 | 0.00 | * | 0.21 | 0.18 | *** | 0.09 | 0.11 | | 0.28 | 3.81 | *** | 0.01 | 0.01 | *** | 72.2 | 77.5 | *** |
| Thailand | 43.02 | 24.22 | | 6.19 | 2.49 | *** | 0.07 | 0.34 | *** | 0.51 | 0.73 | ** | 3.42 | 20.46 | *** | 0.02 | 0.03 | *** | 0.28 | 0.19 | *** | 0.08 | 0.12 | *** | 3.19 | 4.88 | *** | 0.02 | 0.01 | *** | 54.7 | 61.7 | *** |
| Turkey | 66.50 | 30.47 | | 7.03 | 4.43 | *** | 0.02 | 0.12 | *** | 0.06 | 0.50 | *** | 0.16 | 3.13 | *** | -0.03 | 0.00 | *** | 0.21 | 0.27 | *** | 0.16 | 0.17 | | 49.88 | 67.21 | *** | 0.03 | 0.03 | | 37.6 | 43.2 | *** |
| Venezuela | 38.09 | 24.26 | | 1.40 | 2.54 | *** | 0.10 | 0.07 | *** | 0.33 | 0.18 | ** | 3.09 | 1.16 | *** | -0.01 | 0.01 | *** | 0.25 | 0.34 | *** | 0.16 | 0.12 | ** | 46.14 | 64.72 | *** | 0.04 | 0.09 | *** | 35.9 | 33.8 | ** |
| Zimbabwe | -4.54 | 42.04 | * | 11.10 | 11.74 | | 0.05 | 0.03 | *** | NA | 0.05 | ne | NA | NA | ne | NA | NA | ne | 0.27 | 0.31 | *** | 0.15 | 0.16 | | 18.50 | 15.55 | ** | 0.02 | 0.04 | *** | NA | NA | ne |
| Mean[a] | 35.51 | 23.15 | | 4.95 | 2.93 | | 0.11 | 0.29 | | 0.44 | 0.57 | | 6.12 | 19.35 | | 0.02 | 0.03 | | 0.27 | 0.23 | | 0.13 | 0.13 | | 60.57 | 160.09 | | 0.03 | 0.04 | | 46.81 | 47.34 | |
| P-value[a] | | 0.12 | | | 0.01 | | | 0.09 | | | 0.32 | | | 0.16 | | | 0.36 | | | 0.19 | | | 0.43 | | | 0.25 | | | 0.15 | | | 0.47 | |
| P-value[a], FE | | 0.75 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.79 | | | 0.58 | | | 0.00 | | | 0.00 | | | 0.32 | | | 0.39 | | | 0.10 | |
| P-value[a], JS | | 0.12 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.77 | | | 0.00 | |

[a]Excludes Argentina,Chile, Indonesia, Nigeria, and Zimbabwe (For these countries both returns and dividend yield increases after the break date)

Test Statistics are detailed below:

Sig. indicates the Newey-West corrected T-stats on the univariate regression: Series = B0 + (Indicator for Five Years After Break)*B1

FE indicates the T-stat significance on a panel estimation with fixed effects of the regression: Series[i,t] = B0[i] + (Indicator for Five Years After Break)[i,t]*B1

JS indicates the Chi-Square joint test that all of the coefficients are zero in the pooled time series regression: Series[i,t] = B0[i] + (Country Specific Indicator for Five Years After Break)[i,t]*B1[i]

*Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

**Table 4**

## Analysis of Financial and Economic Aggregates Before and After Break
## Based on Bivariate Estimation of Returns and Dividend Yields

B.Other time series

| | Ex Post Volatility (annual) | | Betas | | Per capita GDP growth (%) | | | Average (Exp. + Imp.)/GDP (%) | | | Real Exchange Rate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | 5 yrs before | 5 yrs after | 5 yrs before | 5 yrs after | 5 yrs before | 5 yrs after | Sig. | 5 yrs before | 5 yrs after | Sig. | 5 years before | 5 years after | Sig. |
| Argentina | 91.20 | 116.35 | 0.17 | -0.56 | -1.06 | 1.99 | ** | 0.16 | 0.21 | *** | 111.63 | 85.90 | *** |
| Brazil | 77.67 | 63.12 | 0.72 | 0.82 | 1.91 | -0.30 | ** | 0.16 | 0.21 | *** | 168.22 | 118.82 | *** |
| Chile | 47.56 | 31.21 | -0.21 | 0.54 | -12.10 | 2.83 | *** | 0.62 | 0.56 | *** | 53.08 | 94.90 | *** |
| Colombia | 21.37 | 40.34 | 0.14 | 0.09 | 2.09 | 2.94 | *** | 0.31 | 0.44 | *** | 93.02 | 83.42 | *** |
| Greece | 24.39 | 55.07 | 0.05 | 0.58 | 0.79 | 0.89 | | 0.42 | 0.60 | *** | 136.99 | 112.10 | *** |
| India | 25.08 | 38.10 | -0.04 | -0.40 | 2.93 | 3.36 | | 0.15 | 0.15 | | 73.51 | 98.61 | *** |
| Indonesia | 34.37 | 26.54 | 0.13 | 0.91 | 5.86 | 5.68 | | 0.42 | 0.47 | *** | 100.86 | 134.55 | *** |
| Jordan | 17.79 | 13.77 | 0.25 | 0.13 | NA | NA | ne | NA | NA | ne | NA | NA | ne |
| Korea | 37.35 | 31.51 | 0.49 | 0.07 | NA | 6.92 | ne | NA | 0.65 | ne | 97.83 | 108.95 | ne |
| Malaysia | 21.26 | 32.17 | 0.71 | 1.16 | 5.96 | 6.26 | ** | 1.47 | 1.88 | *** | 98.19 | 96.11 | |
| Mexico | 42.69 | 56.16 | 0.77 | 0.88 | -3.34 | -2.25 | * | 0.34 | 0.31 | *** | 73.04 | 81.49 | *** |
| Nigeria | 40.92 | 59.30 | 0.28 | 0.76 | NA | NA | ne | NA | NA | ne | NA | NA | ne |
| Pakistan | 10.56 | 10.56 | 0.00 | -0.02 | 2.57 | 1.65 | ** | 0.32 | 0.33 | *** | 92.05 | 102.84 | *** |
| Philippines | 44.61 | 32.31 | 0.15 | 0.75 | -3.63 | 1.00 | *** | 0.47 | 0.62 | *** | 96.42 | 97.87 | |
| Portugal | 73.42 | 24.19 | 1.89 | 0.86 | 2.62 | 3.18 | | 0.61 | 0.80 | *** | 145.23 | 100.52 | *** |
| Taiwan | 52.87 | 51.07 | 0.92 | 0.40 | 9.28 | 4.09 | ** | 0.86 | 0.77 | *** | NA | NA | ne |
| Thailand | 27.88 | 33.92 | 0.41 | 0.80 | 6.70 | 7.85 | * | 0.59 | 0.84 | *** | 102.06 | 97.00 | *** |
| Turkey | 79.19 | 73.57 | 0.90 | -0.01 | 2.99 | 2.21 | | 0.32 | 0.40 | *** | 133.11 | 104.56 | *** |
| Venezuela | 50.84 | 48.23 | -0.45 | 0.61 | 0.21 | -2.56 | ** | 0.47 | 0.50 | *** | 93.46 | 79.42 | *** |
| Zimbabawe | 38.43 | 35.82 | 0.27 | -0.08 | NA | NA | ne | NA | NA | ne | NA | NA | ne |
| Mean[a] | 43.70 | 44.29 | 0.42 | 0.35 | 2.57 | 2.82 | | 0.49 | 0.60 | | 110.90 | 98.93 | |
| P-value[a] | | 0.49 | | 0.48 | | 0.46 | | | 0.24 | | | 0.15 | |
| P-value[a], FE | | NA | | NA | | 0.02 | | | 0.00 | | | 0.07 | |
| P-value[a], JS | | NA | | NA | | 0.23 | | | 0.00 | | | 0.97 | |

[a]Excludes Argentina,Chile, Indonesia, Nigeria, and Zimbabwe (For these countries both returns and dividend yield increases after the break date)

Test Statistics are detailed below:

Sig. indicates the Newey-West corrected T-stats on the univariate regression: Series = B0 + (Indicator for Five Years After Break)*B1

FE indicates the T-stat significance on a panel estimation with fixed effects of the regression: Series[i,t] = B0[i] + (Indicator for Five Years After Break)[i,t]*B1

JS indicates the Chi-Square joint test that all of the coefficients are zero in the pooled time series regression: Series[i,t] = B0[i] + (Country Specific Indicator for Fi

*Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

**Table 5**

## Integration/Segmentation portfolio analysis

**January 1990-December 1994**

**Countries with significant breaks***

| Moment | Segmented portfolio | Integrated portfolio |
|---|---|---|
| Annualized Mean % | 15.13 | 20.88 |
| Annualized Volatility % | 21.26 | 18.82 |
| Correlation with World | 0.175 | 0.428 |
| Beta with World | 0.259 | 0.533 |

**All Countries**

| Moment | Segmented portfolio | Integrated portfolio |
|---|---|---|
| Annualized Mean % | 11.16 | 23.01 |
| Annualized Volatility % | 20.64 | 16.91 |
| Correlation with World | 0.170 | 0.427 |
| Beta with World | 0.245 | 0.478 |

*Significant countries includes all countries in the analysis except for Argentina, Chile, Indonesia, Nigeria, Zimbabwe.

**Table 6**

## The opening of equity markets in emerging countries

| Country | Official liberalization date | ADR introduction | Country Fund introduction | Break in net US equity flows to mcap | Break in returns + dividend yields | Break in returns + mcap to GDP |
|---|---|---|---|---|---|---|
| Argentina | Nov-89 | Aug-91 | Oct-91 | May-93 | Feb-89 | Aug-91 |
| Brazil | May-91 | Jan-92 | Oct-87 | Jun-92 | Apr-90 | Jan-93 |
| Chile | Jan-90 | Mar-90 | Sep-89 | Apr-93 | Feb-83 | Jan-93 |
| Colombia | Feb-91 | Dec-92 | May-92 | May-94 | Oct-91 | Jan-93 |
| Greece | Dec-87 | Aug-88 | Sep-88 | Dec-86 | Jun-86 | Apr-90 |
| India | Nov-92 | Feb-92 | Jun-86 | May-93 | Nov-87 | Jan-92 |
| Indonesia | Sep-89 | Apr-91 | Jan-89 | Feb-95 | Aug-92 | Feb-95 |
| Jordan | Dec-95 | n/a | n/a | n/a | Apr-92 | Apr-88 |
| Korea | Jan-92 | Nov-90 | Aug-84 | Mar-93 | Feb-80 | May-88 |
| Malaysia | Dec-88 | Aug-92 | Dec-87 | Feb-93 | Jan-93 | Oct-93 |
| Mexico | May-89 | Jan-89 | Jun-81 | Jan-92 | Feb-83 | Jan-93 |
| Nigeria | Aug-95 | n/a | n/a | n/a | Jun-89 | Jan-94 |
| Pakistan | Feb-91 | n/a | Jul-91 | Oct-94 | Dec-90 | Oct-93 |
| Philippines | Jun-91 | Mar-91 | May-87 | Jan-90 | Oct-87 | Oct-93 |
| Portugal | Jul-86 | Jun-90 | Aug-87 | Sep-94 | Aug-88 | Dec-87 |
| Taiwan | Jan-91 | Dec-91 | May-86 | May-94 | Aug-88 | Jan-88 |
| Thailand | Sep-87 | Jan-91 | Jul-85 | Jul-88 | Jan-90 | Jan-93 |
| Turkey | Aug-89 | Jul-90 | Dec-89 | Mar-94 | Jun-89 | Feb-91 |
| Venezuela | Jan-90 | Aug-91 | n/a | Feb-94 | Jan-94 | Jan-92 |
| Zimbabwe | Jun-93 | n/a | n/a | n/a | Mar-83 | Nov-91 |

Source: The first three columns are from Bekaert and Harvey (1998a).
Mcap refers to equity market capitalization.

Appendix Table A

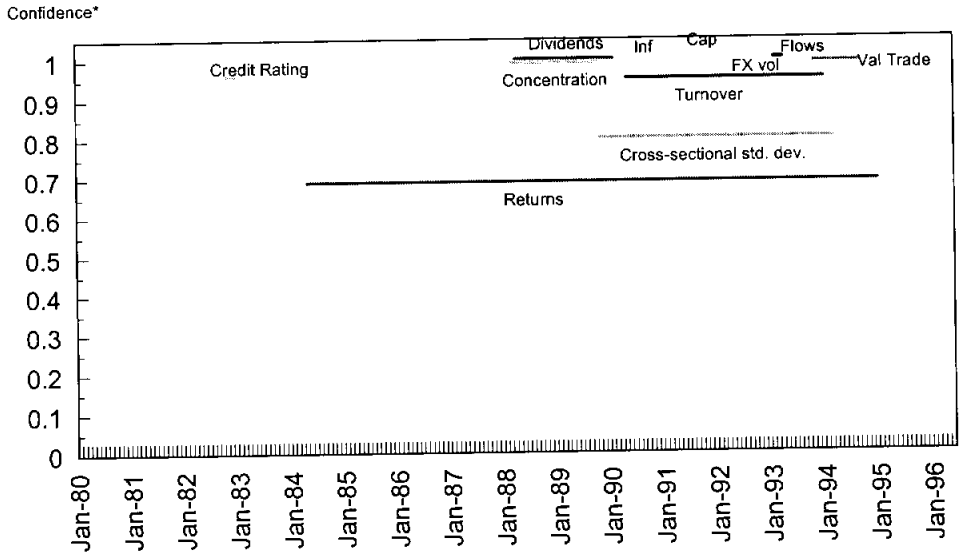
## Asymptotic critical values for $\max_k F(k)$ test statistic (with 15% trimming): Tests for a simultaneous break in q parameters.

| Dimension q | 15% | 10% | 5% | 1% |
|---|---|---|---|---|
| 1 | 6.34 | 7.15 | 8.69 | 11.81 |
| 2 | 9.06 | 10.23 | 11.78 | 16.37 |
| 3 | 11.36 | 12.46 | 14.33 | 17.87 |
| 4 | 13.13 | 14.03 | 15.65 | 19.38 |
| 5 | 15.10 | 16.56 | 18.44 | 23.06 |
| 6 | 16.84 | 18.45 | 20.42 | 24.68 |
| 7 | 18.31 | 19.52 | 22.21 | 27.02 |
| 8 | 20.19 | 21.93 | 24.32 | 28.89 |
| 9 | 21.45 | 23.12 | 25.42 | 30.85 |
| 10 | 23.33 | 24.65 | 27.52 | 32.41 |
| 11 | 24.62 | 25.96 | 28.36 | 33.74 |
| 12 | 26.40 | 27.94 | 30.40 | 36.18 |
| 13 | 27.85 | 29.65 | 32.13 | 36.83 |
| 14 | 29.44 | 31.18 | 33.38 | 39.06 |
| 15 | 30.66 | 32.52 | 34.88 | 39.63 |
| 16 | 32.33 | 33.93 | 36.62 | 41.64 |
| 17 | 33.49 | 35.50 | 38.58 | 44.29 |
| 18 | 35.30 | 37.04 | 40.11 | 45.27 |
| 19 | 36.45 | 38.53 | 41.76 | 47.98 |
| 20 | 37.94 | 39.60 | 42.82 | 47.75 |
| 21 | 39.63 | 41.39 | 44.19 | 50.41 |
| 22 | 40.61 | 42.12 | 44.81 | 50.40 |
| 23 | 42.02 | 43.87 | 46.86 | 52.21 |
| 24 | 43.13 | 45.11 | 48.49 | 55.50 |
| 25 | 44.98 | 46.82 | 49.68 | 56.87 |
| 26 | 46.41 | 48.41 | 51.35 | 56.93 |
| 27 | 47.33 | 49.44 | 52.13 | 58.90 |
| 28 | 48.52 | 50.45 | 53.55 | 61.37 |
| 29 | 50.11 | 51.93 | 55.47 | 61.65 |
| 30 | 51.67 | 53.39 | 56.99 | 63.82 |
| 31 | 53.09 | 55.77 | 59.52 | 65.64 |
| 32 | 53.44 | 55.69 | 59.50 | 66.64 |
| 33 | 55.30 | 58.01 | 61.44 | 67.58 |
| 34 | 56.43 | 58.33 | 61.42 | 67.67 |
| 35 | 57.91 | 60.38 | 63.75 | 69.47 |
| 36 | 59.36 | 61.43 | 64.39 | 72.99 |
| 37 | 60.62 | 63.13 | 66.59 | 74.53 |
| 38 | 61.09 | 63.34 | 67.08 | 75.31 |
| 39 | 62.72 | 65.29 | 69.71 | 76.52 |
| 40 | 64.72 | 67.33 | 70.77 | 76.73 |
| 41 | 65.57 | 67.92 | 71.62 | 78.90 |
| 42 | 66.45 | 68.86 | 72.27 | 80.18 |
| 43 | 58.73 | 61.14 | 64.69 | 71.38 |
| 44 | 59.50 | 61.96 | 65.86 | 76.04 |
| 45 | 60.86 | 63.04 | 66.85 | 74.99 |
| 46 | 62.82 | 64.93 | 68.80 | 77.61 |
| 47 | 64.02 | 66.49 | 70.67 | 79.63 |
| 48 | 65.35 | 67.62 | 71.60 | 79.08 |
| 49 | 65.93 | 68.55 | 72.37 | 80.14 |
| 50 | 67.22 | 69.69 | 74.18 | 82.84 |

q represents the dimension of the test statistic, $F_T(k)$ (the dimension of $S\delta'$ in (5)). Values in this table are based on 2,000 Monte Carlo replications of a discrete approximation to the limiting representation ($F^*$) of these statistics as functionals of a q-dimensional Brownian motion, with a discretization grid of 5000. See section 3.4 in the text for details.

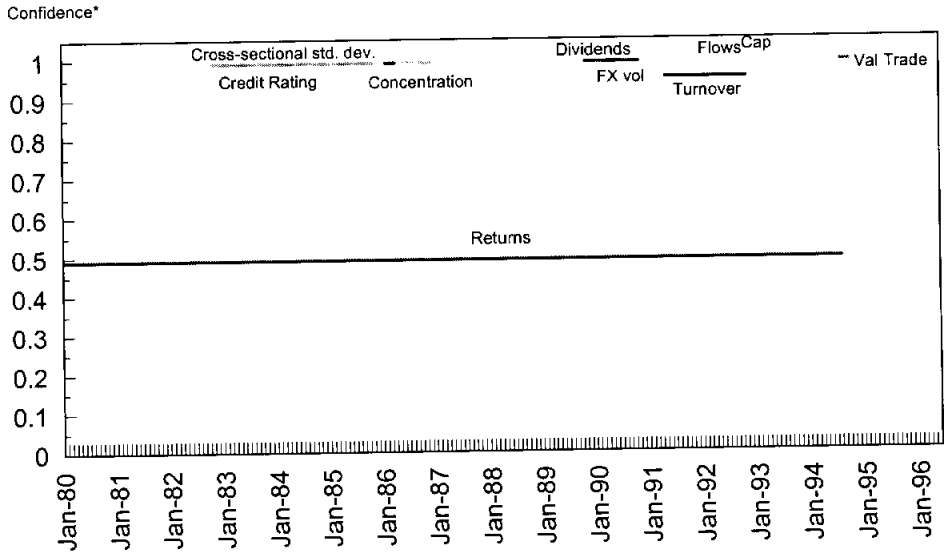
# Figure 1

## All Parameters Break in VAR
## Argentina




*Calculated as 1 minus the p-value.

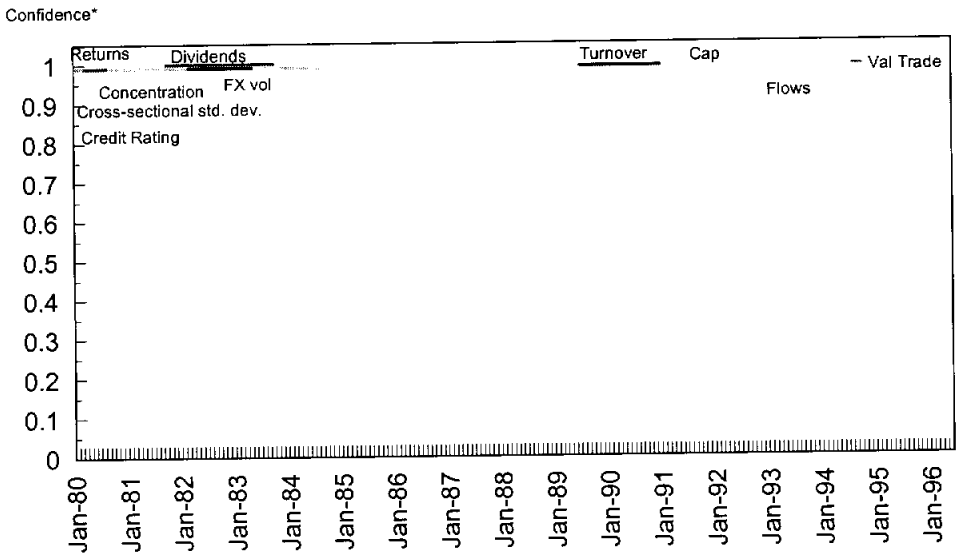
## All Parameters Break in VAR
## Brazil




*Calculated as 1 minus the p-value.

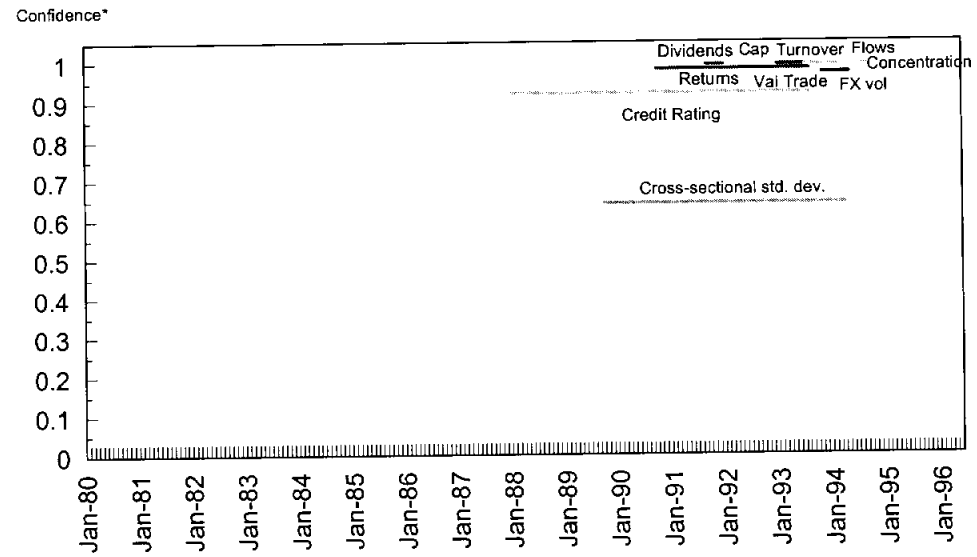
# Figure 1

## All Parameters Break in VAR
## Chile




*Calculated as 1 minus the p-value.

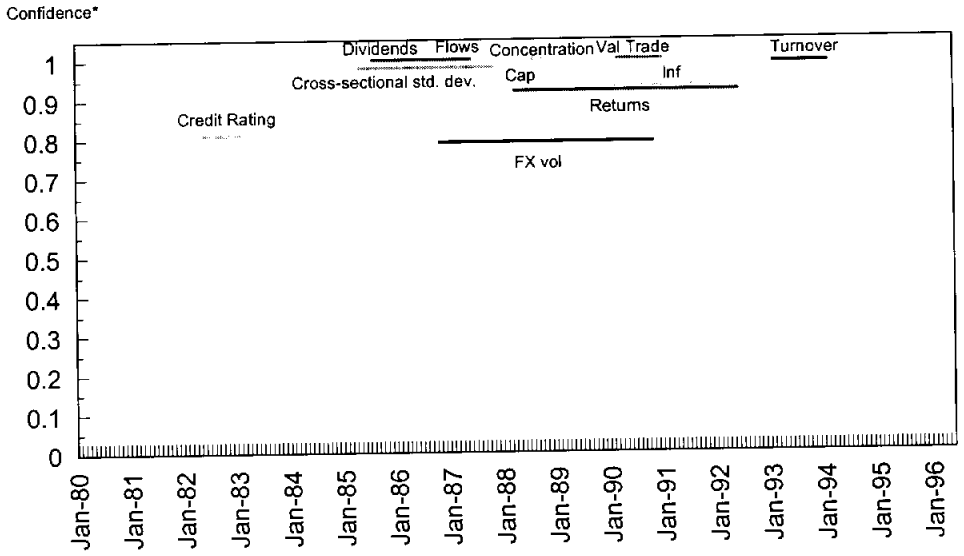
## All Parameters Break in VAR
## Colombia




*Calculated as 1 minus the p-value.

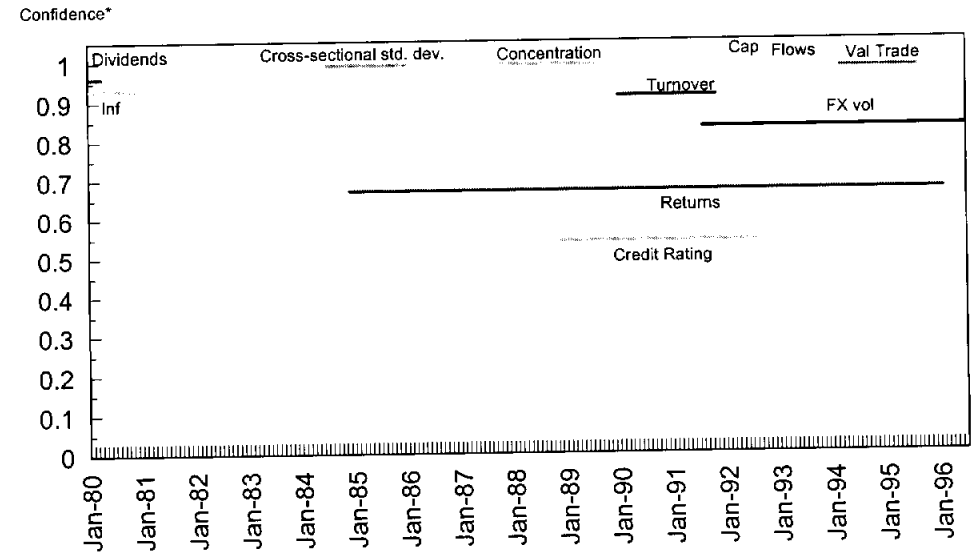
# Figure 1

## All Parameters Break in VAR
## Greece




*Calculated as 1 minus the p-value.

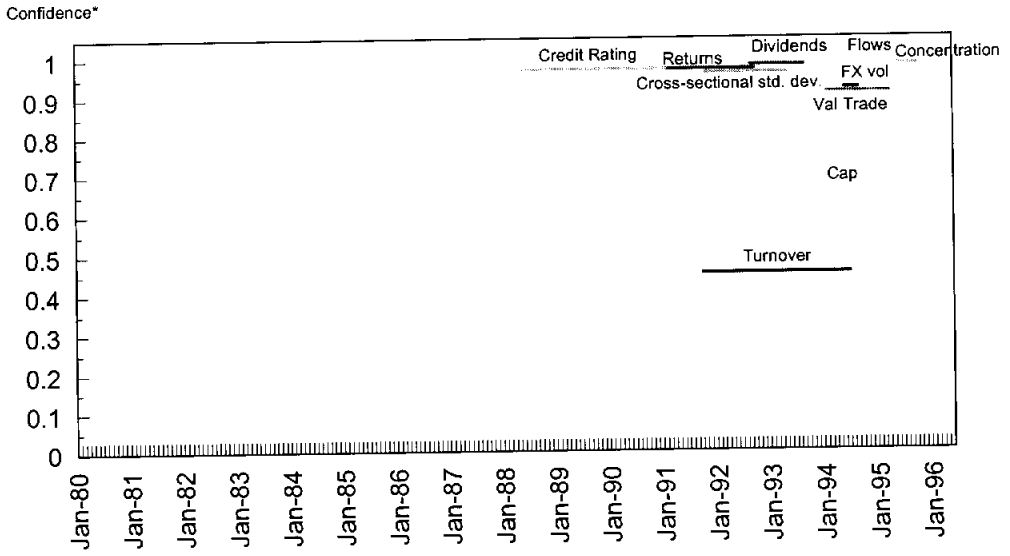
## All Parameters Break in VAR
## India




*Calculated as 1 minus the p-value.

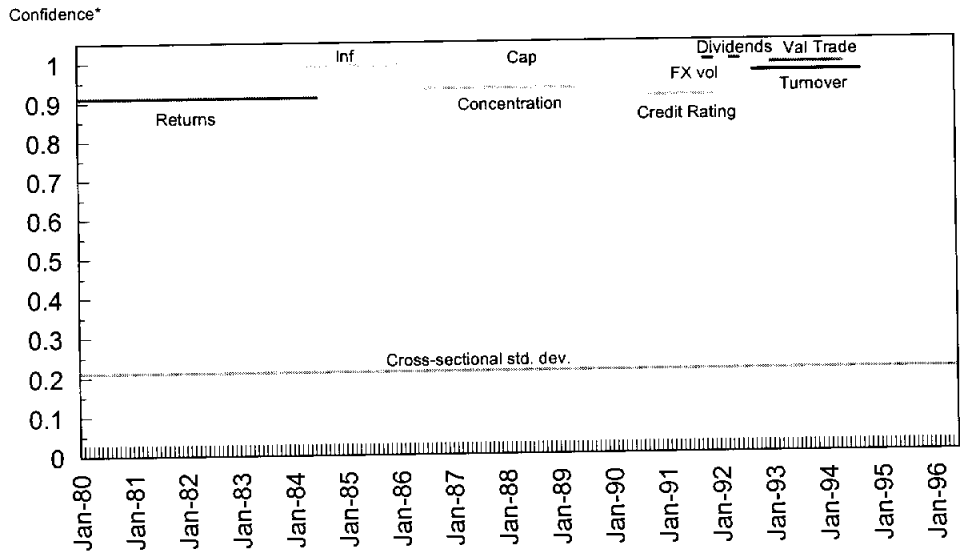
# Figure 1

## All Parameters Break in VAR
## Indonesia




*Calculated as 1 minus the p-value.

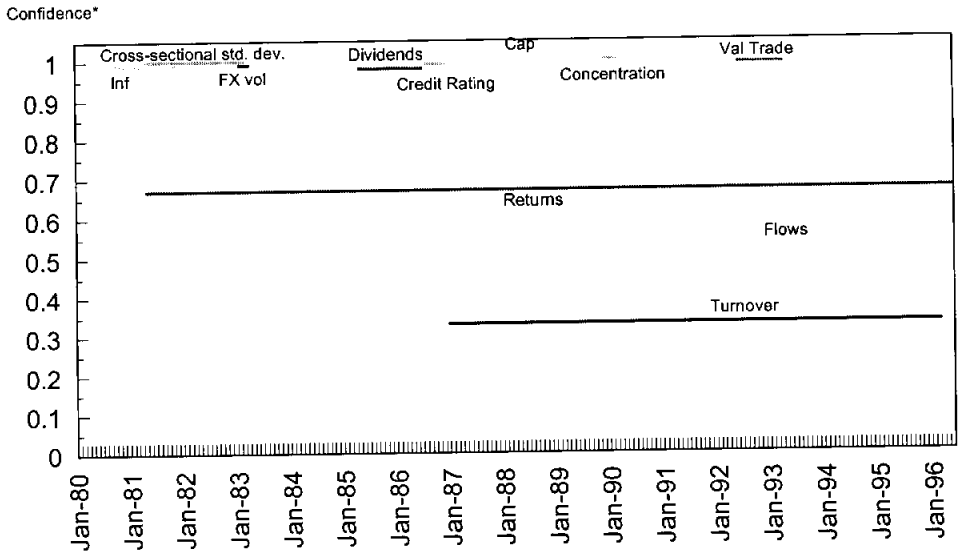
## All Parameters Break in VAR
## Jordan




*Calculated as 1 minus the p-value.

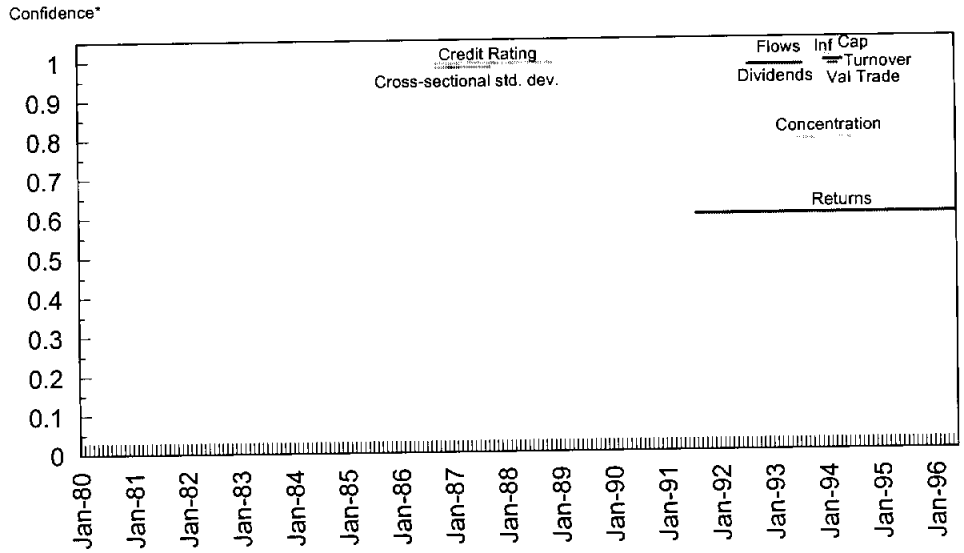
# Figure 1

## All Parameters Break in VAR
## Korea




*Calculated as 1 minus the p-value.

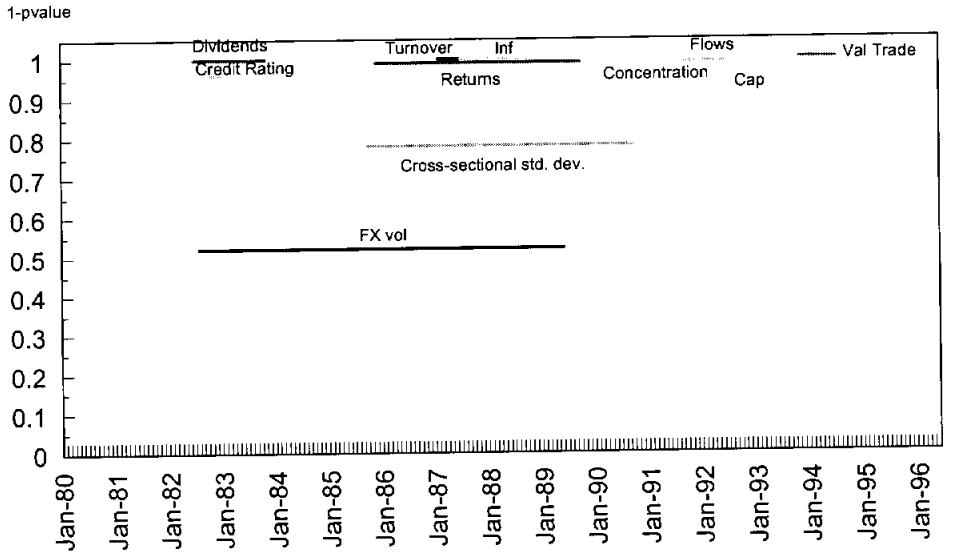
## All Parameters Break in VAR
## Malaysia



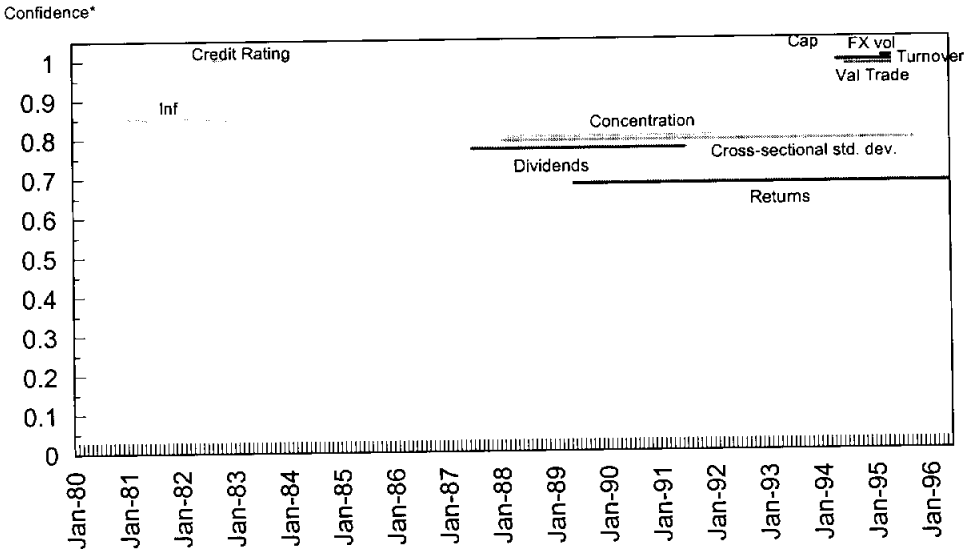

*Calculated as 1 minus the p-value.

# Figure 1

## All Parameters Break in VAR
## Mexico



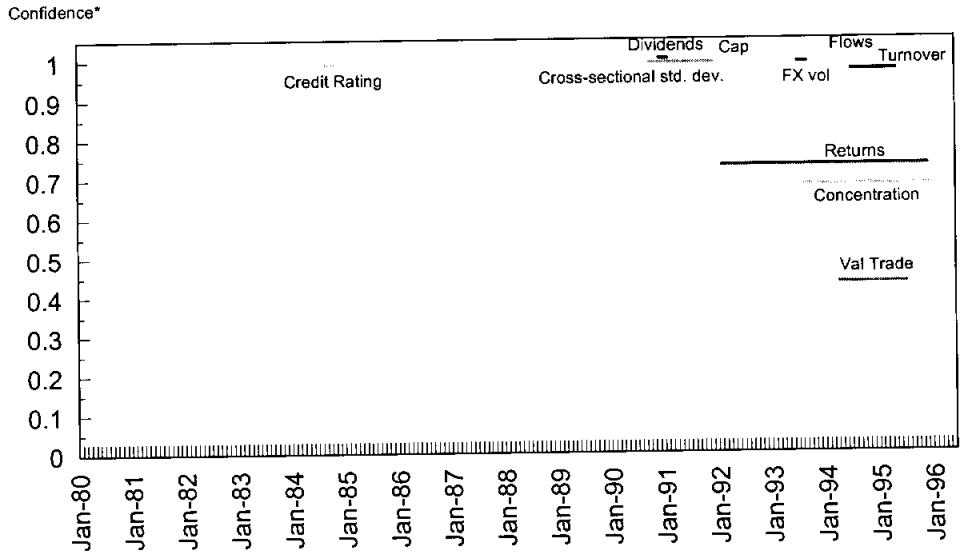

## All Parameters Break in VAR
## Nigeria




*Calculated as 1 minus the p-value.

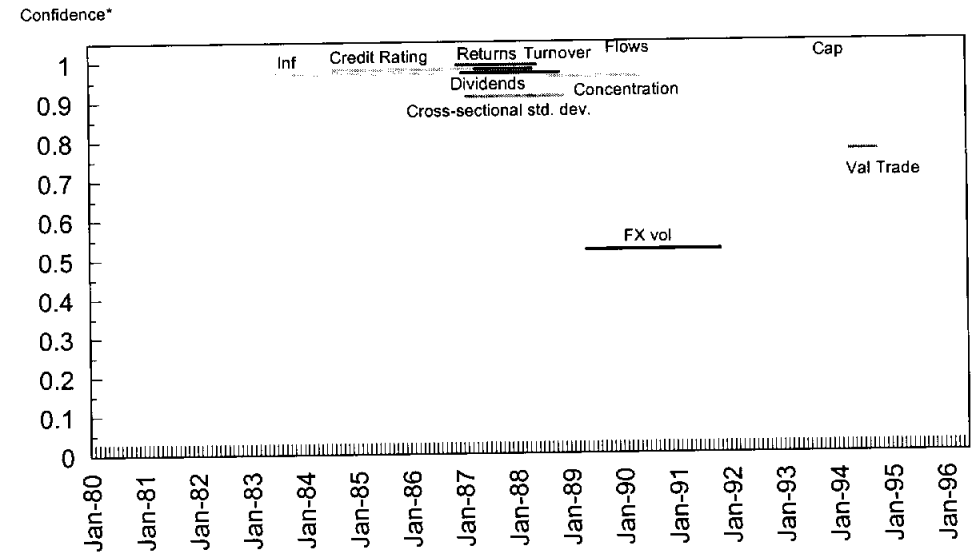
## Figure 1

## All Parameters Break in VAR
## Pakistan




*Calculated as 1 minus the p-value.

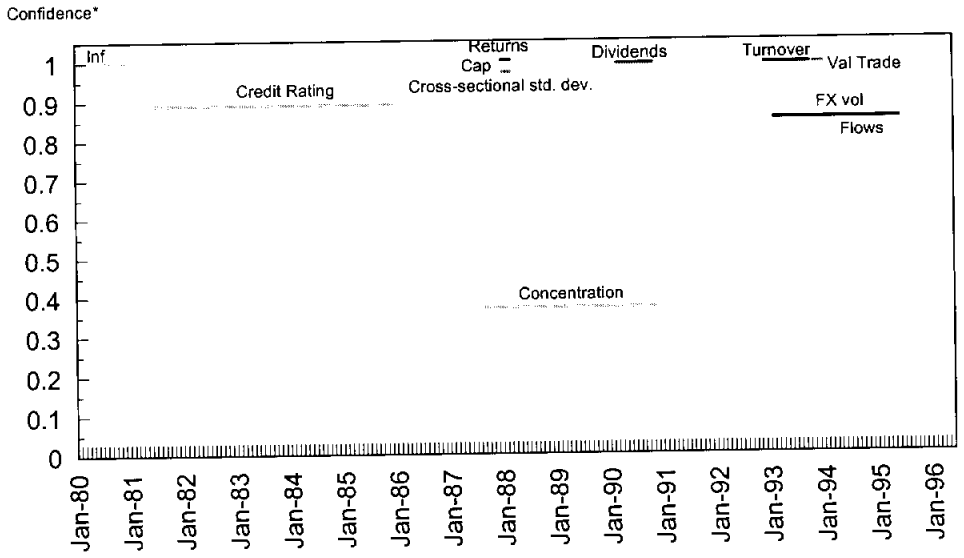
## All Parameters Break in VAR
## Philippines




*Calculated as 1 minus the p-value.

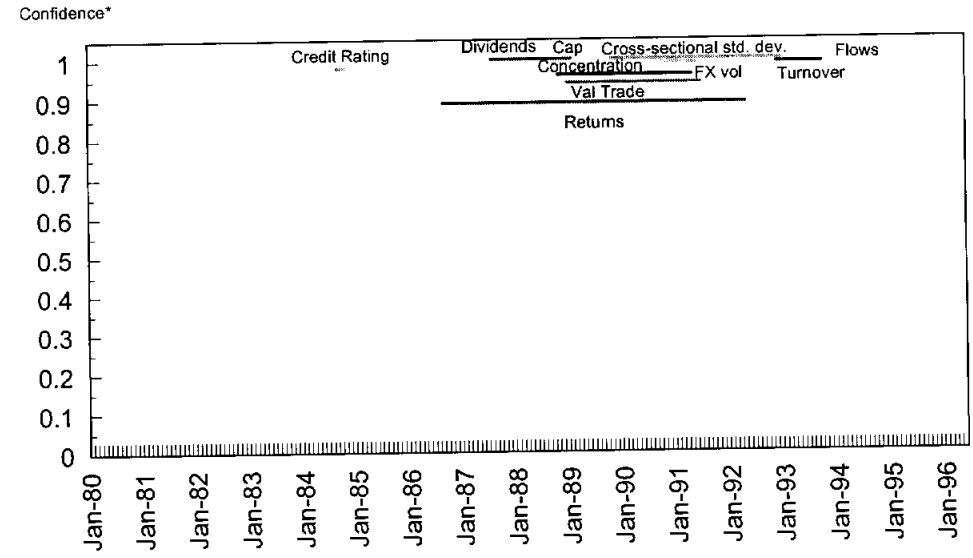
# Figure 1

## All Parameters Break in VAR
## Portugal




*Calculated as 1 minus the p-value.

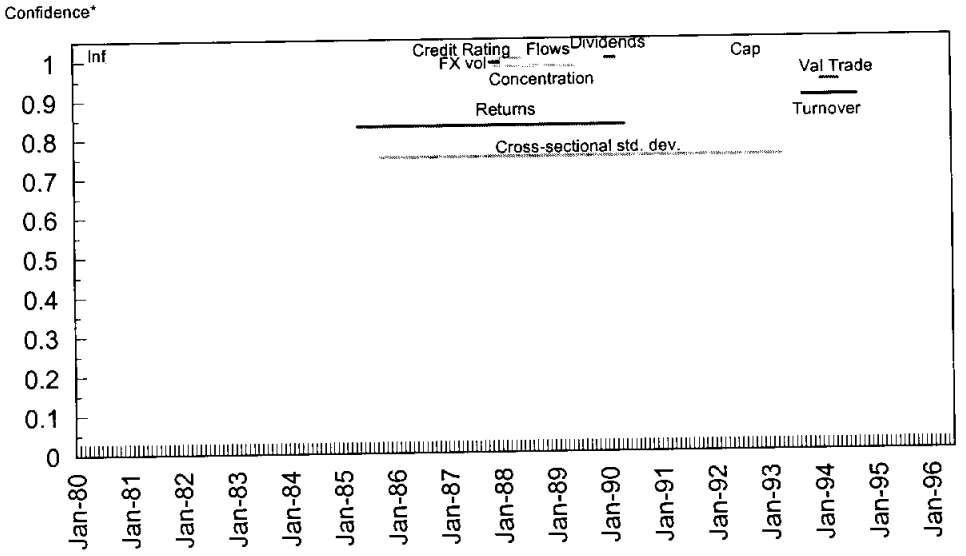
## All Parameters Break in VAR
## Taiwan




*Calculated as 1 minus the p-value.

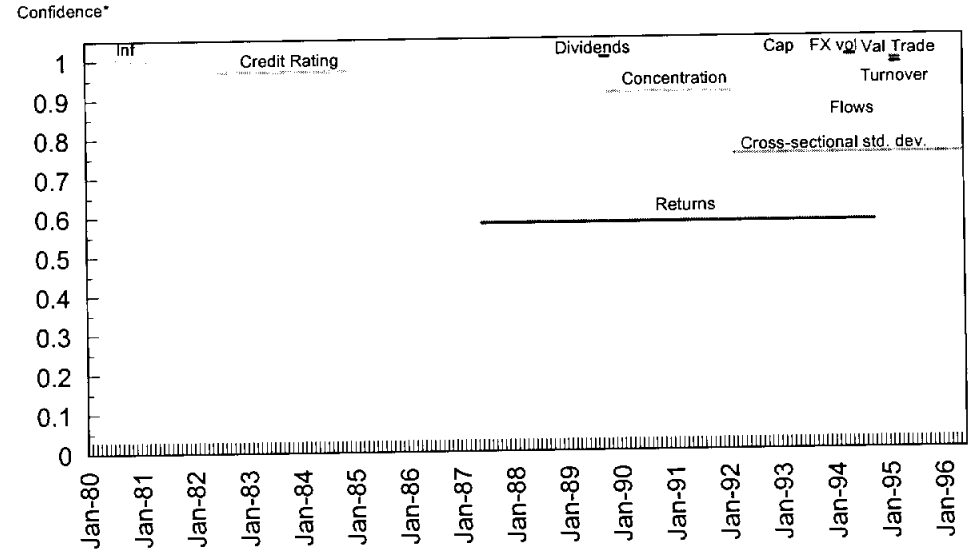
# Figure 1

## All Parameters Break in VAR
## Thailand




*Calculated as 1 minus the p-value.

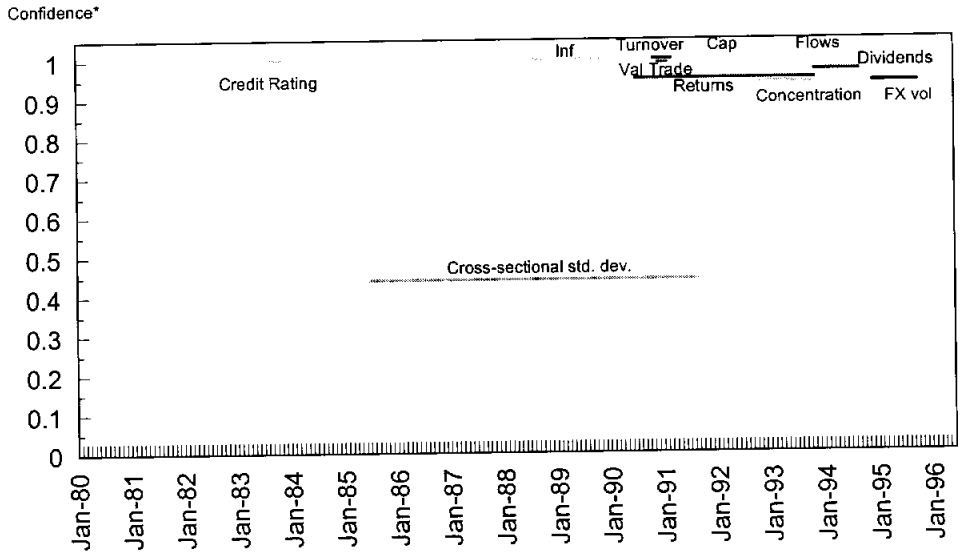
## All Parameters Break in VAR
## Turkey




*Calculated as 1 minus the p-value.

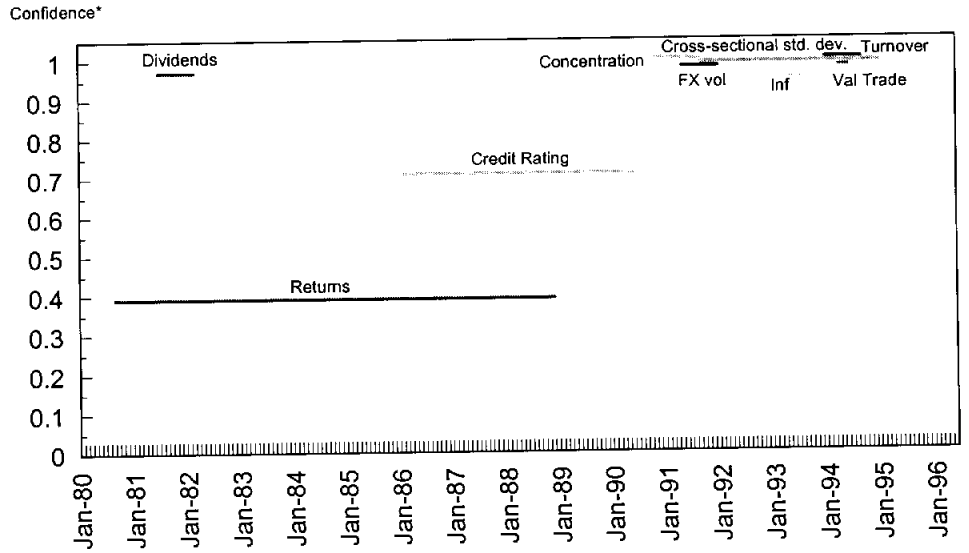
# Figure 1

## All Parameters Break in VAR
## Venezuela




*Calculated as 1 minus the p-value.

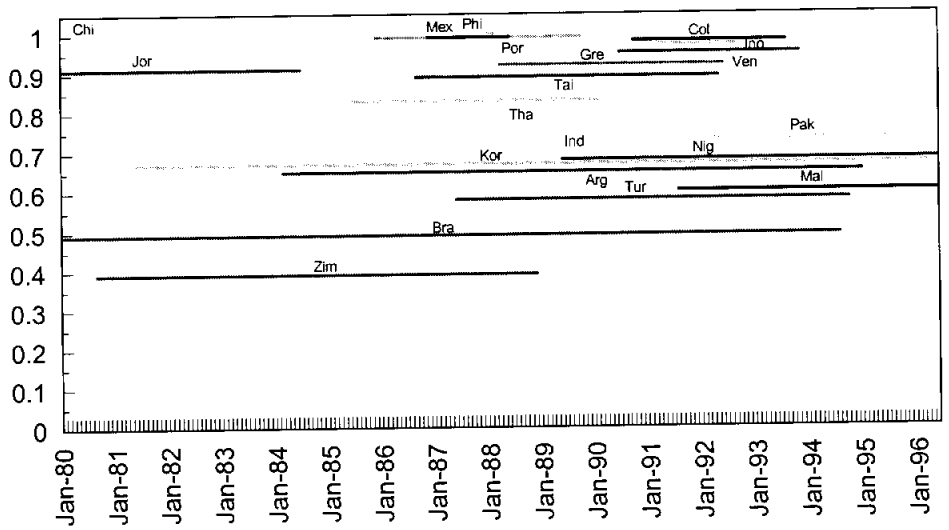
## All Parameters Break in VAR
## Zimbabwe



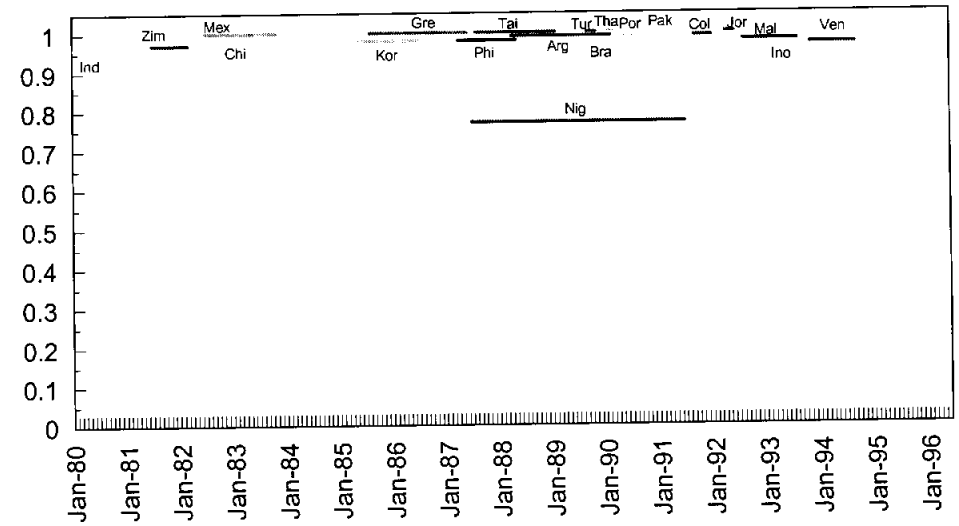

*Calculated as 1 minus the p-value.

## Figure 2

### Equity Returns
### All Parameters Break in VAR

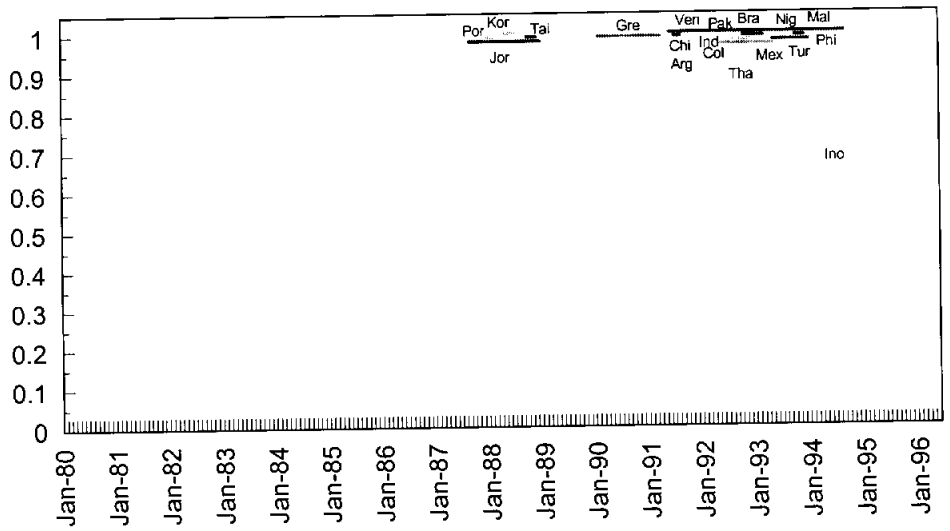



### Dividend Yields
### All Parameters Break in VAR

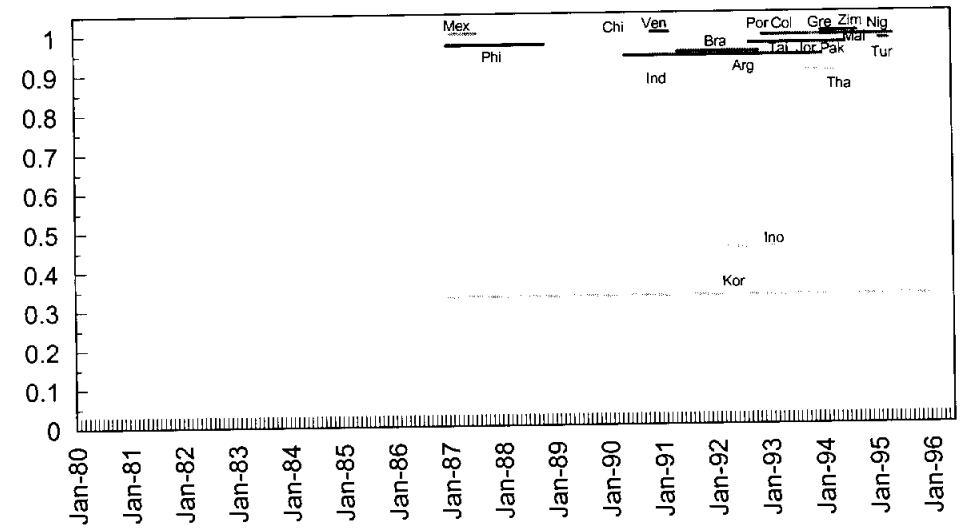


## Figure 2

### Market Capitalization to GDP
### All Parameters Break in VAR

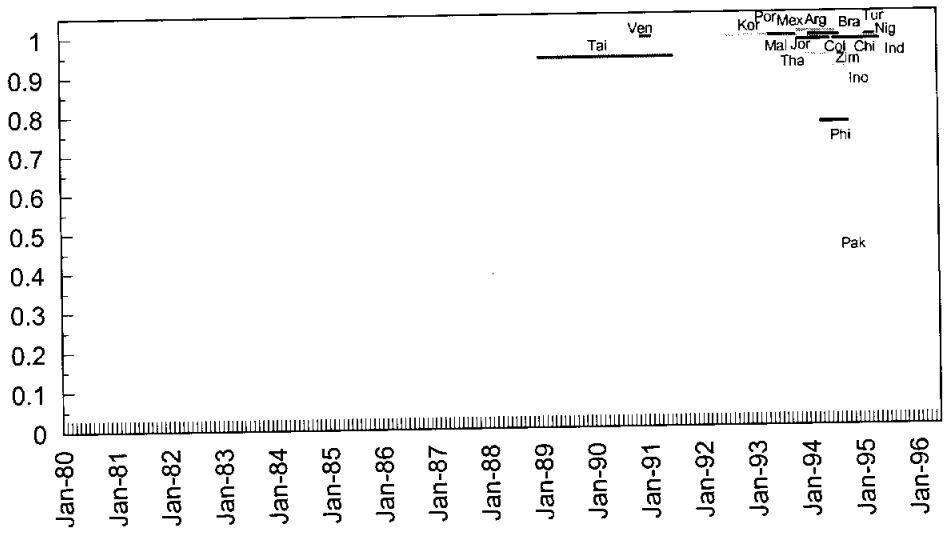



### Turnover
### All Parameters Break in VAR

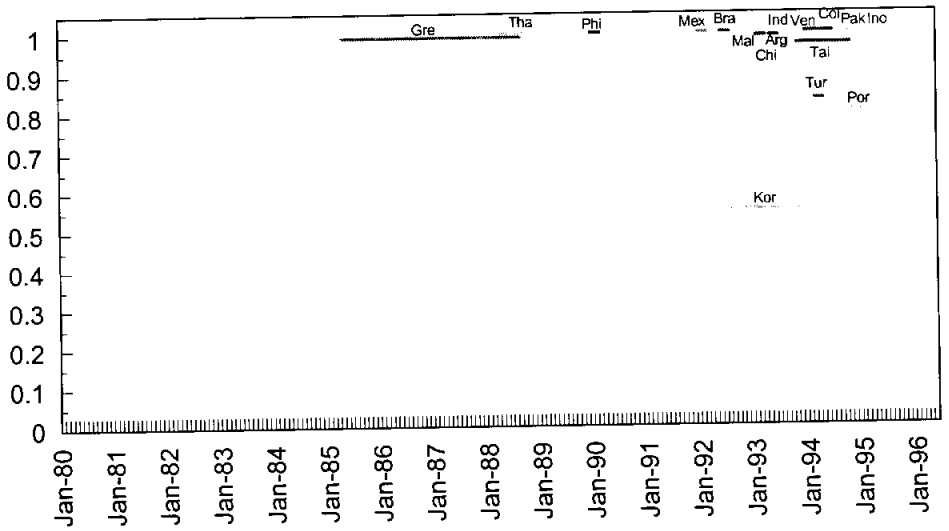


## Figure 2

### Value Traded
### All Parameters Break in VAR

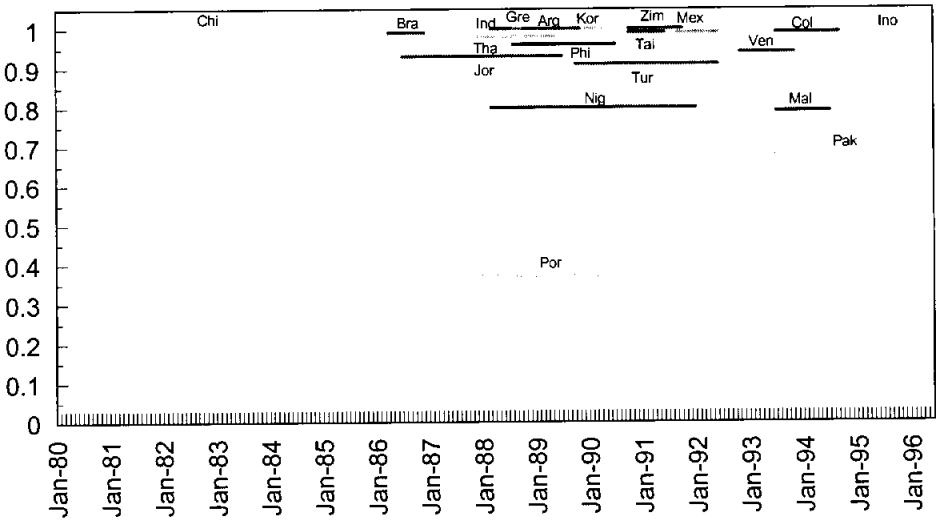



### Cumulative U.S. Net Equity Flows to Market Capitalization
### All Parameters Break in VAR

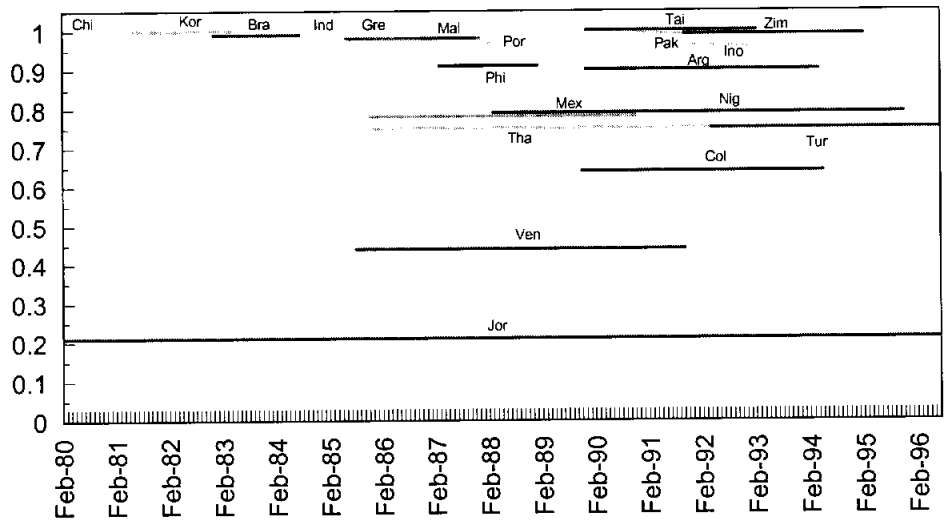


## Figure 2

### Concentration Ratios
### All Parameters Break in VAR

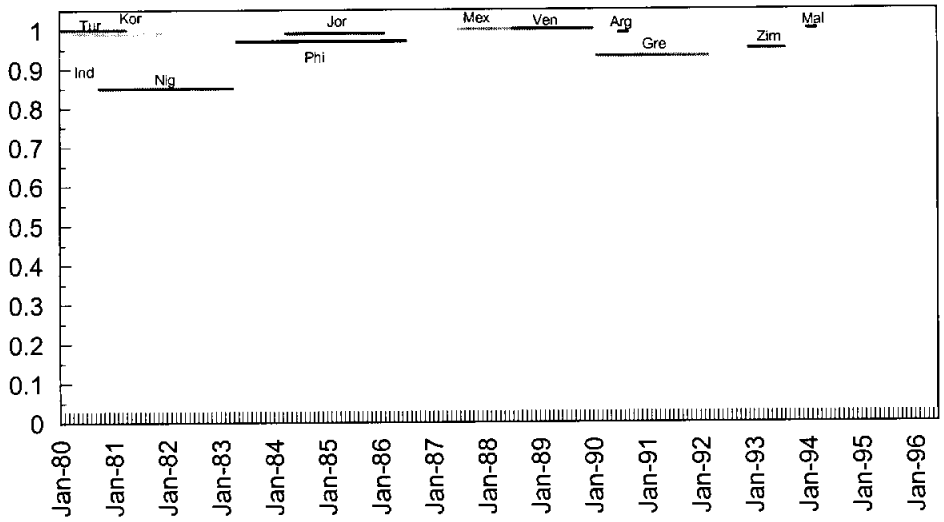



### Cross-Sectional Standard Deviation
### All Parameters Break in VAR



## Figure 2

### Inflation
### All Parameters Break in VAR




### FX Volatility
### All Parameters Break in VAR

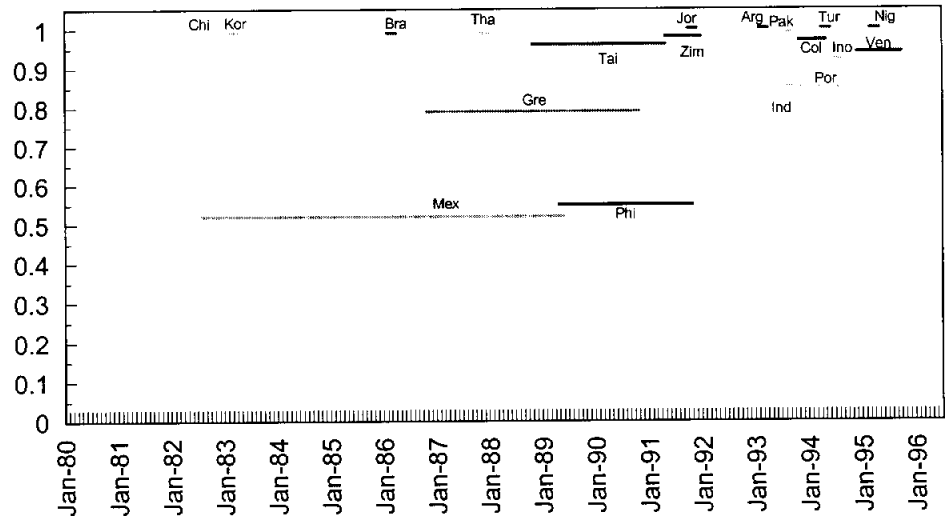


Figure 3

# Time-Series of Wald Statistics: Univariate Estimates:
## All Parameters Break in Equity Returns Autoregression: Portugal

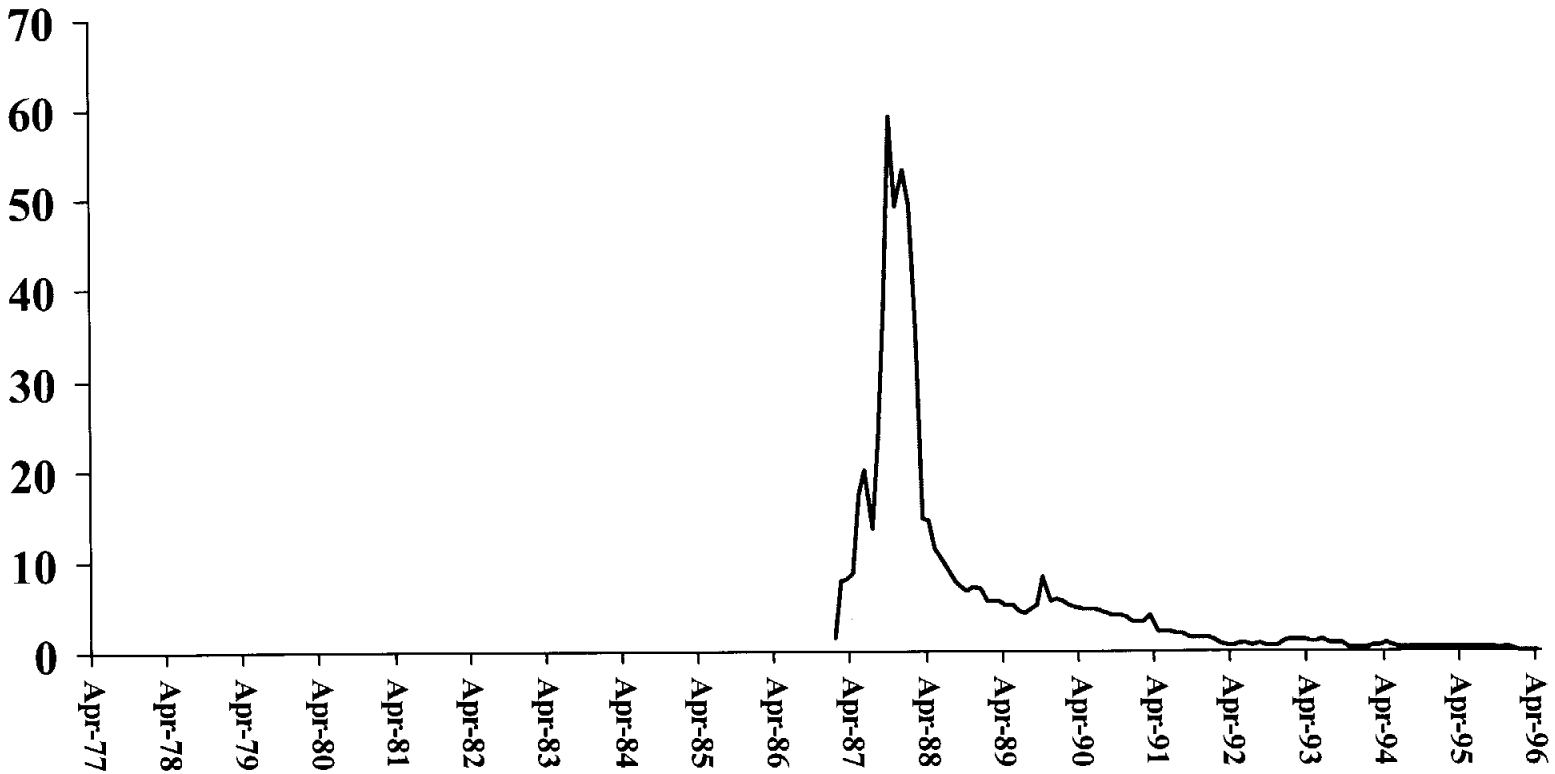


Figure 4

# Time-Series of Wald Statistics: Univariate Estimates

## All Parameters Break in Dividend Yield Autoregression: Colombia

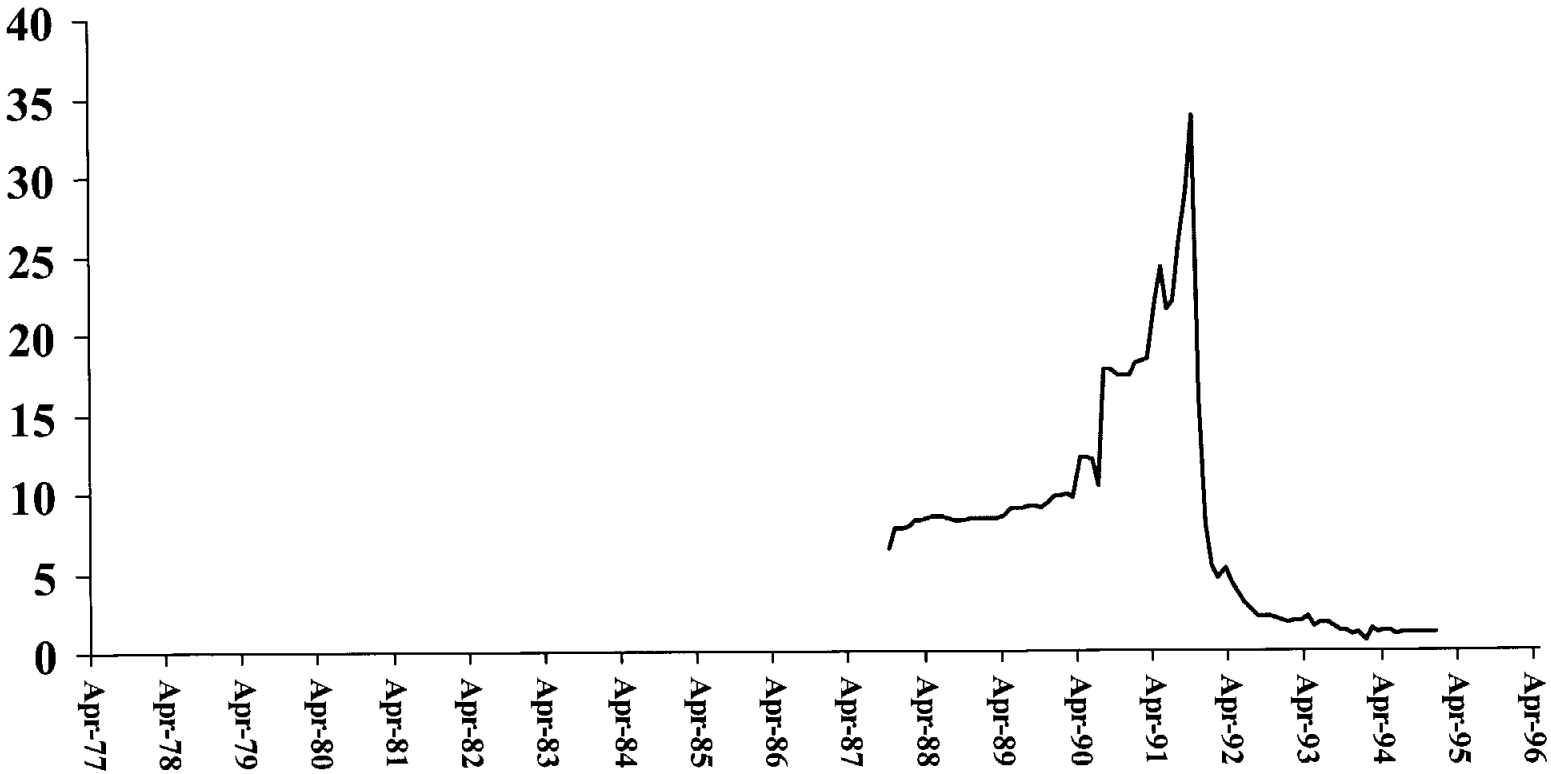


Figure 5

# Time-Series of Wald Statistics: Bivariate Estimates

## Returns and Dividend Yields

## All Parameters Break in VAR: Colombia

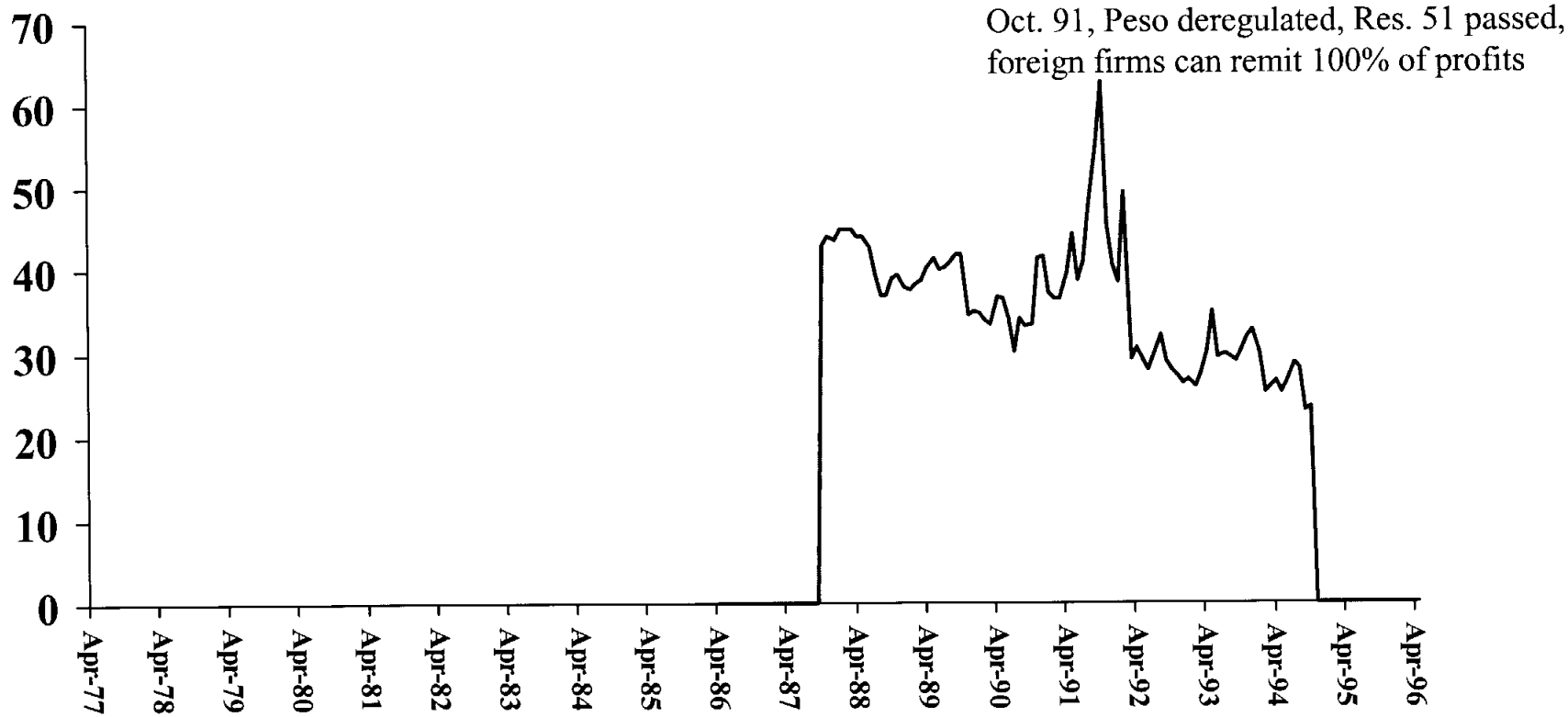


Figure 6

# Time-Series of Wald Statistics: Bivariate Estimates
## Returns and Dividend Yields
## All Parameters Break in VAR: Korea