A TEST OF COINTEGRATION BETWEEN SECURITY MARKETS OF LATIN AMERICAN NATIONS, THE NYSE AND THE DOW JONES INDICES

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ABSTRACT

This study uses cointegration tests to examine the relationships among the stock markets of Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela and the NYSE and Dow Jones Indexes. The goal of this paper to test whether cointegration exists between the stock market index of each of the mentioned developing nations, and the US stock market. Previous studies have shown that unit roots occur in stock price series, in accordance with rational expectations and efficient markets under certain assumptions. Two-to-eight daily lags and two-to-twelve monthly lags are examined. Unit roots in stocks prices are found. Our results also show that there is monthly and daily cointegration between the NYSE and the Dow Jones Indices and the security markets of Mexico and Venezuela, and no cointegration with the stock markets of Argentina, Brazil, Chile, Colombia, and Peru.

KEYWORDS

Cointegration, Diversification, International Financial Markets, Market Efficiency

INTRODUCTION

Investors all around the world build portfolios that include shares of firms from different countries in trying to reduce systematic risk. Nevertheless, increased trade and financial flows among economies, as well as advances in technology and improved communication systems threaten the achievement of diversification. If the demand side of all the markets possesses the same information, can this result in a growing integration of the stock markets that results in a decrease of diversification? This paper is written with that question in mind. Other studies have investigated this subject. Nevertheless, we extend the discussion to the largest Latin American countries, and attempt to answer questions specific to these markets.

During the last decade, US investors have shown an increased interest on the Latin emerging economies evidenced by the number of new country funds that have come into existence. Some practitioners and researchers have argued that greater economic and financial integration among countries results in stock market's interdependencies. Given that these countries have strong economic ties of financial and trade flows with the United States, and that advances in technology and communication systems have improved the transfer of information, in order to answer the question posed in previous paragraph we need to examine the interdependencies of among the US and Latin stock markets.

The general hypothesis, is that the interdependencies among different economies cause markets to respond to news and behave in a more similar manner. Therefore, the degree of diversification achieved by a portfolio made up of stocks from these countries is, consequently, reduced. In addition, if a lead lag relationship is detected, a uni-directional causality would be proven to exist, meaning that one market would lead the other. This finding would affect investment strategies. If, on the other hand, no cointegration is to be found, then we could argue that no long-run relationship between these markets exists and, consequently, diversification benefits could be reaped by American investors who try to diversify purchasing into these markets.

If we could identify a series of conditions pertaining to each market with which there is cointegration and differentiate those from conditions pertaining to markets with which cointegration is not found to exist, we may be able to improve educated guesses about markets adopting these conditions. This educated guesses could help us make more appropiate inferences about the variance of retuns and diversification possibilities of the changing markets.

The following sections will include a summary of the literature review, the data and methodology used in this study, and the results and conclusions of this paper.

LITERATURE REVIEW

Integration of financial markets reflected in the interdependencies among national stock market indices has been focus of numerous studies. In 1974, Solnik represented the International Asset Pricing Model by two equations relating the price of a security to national and world factors. Studies produced during the seventies such as those by Agmon (1972), Lessard (1976), and Levy and Sarnat (1970) found little evidence of covariation among the financial markets of different countries. These studies used data from the 1960s and 1970s. Nevertheless, as countries deregulated their financial markets, and communications and technology improved globally, stock markets have become international. This internationalization has motivated another generation of studies on international stock market relationships, such as those by Eun and Shim (1989) and Fisher and Palasvirta (1990). The studies that examined index data from the 1980s found comovements of national stock indices.

Correlation is a simple way of testing whether country specific factors are diminishing over time. An increase in the correlation coefficients between the returns of the market portfolio would imply that the two stock markets have become more integrated. Nevertheless, this test does not allow for any short run dynamics. In the 1980s, the mathematical procedures that allow for testing of long-run relationships were refined. During this time, cointegration methods were perfected by different econometricians. Some researchers applied this technique to test for long-term relationships among markets.

In 1992, Kasa studied the common stochastic trend behind the co-movements of major equity markets. Kasa's study focused on the US, Canada, Japan, Germany and the UK during the years 1974 to 1990, and concluded that a stochastic trend was the force behind the stock markets' long-term upward trend. Weatley (1988) used a version of the consumption based asset pricing model to test international equity market integration. In order to reject cointegration, the model investigates whether foreign equities plot along the home country's asset pricing line. For this analysis Weatley used 1960 to 1985 monthly data and concluded that international cointegration was found to exist. Eun and Shim (1989) detected multilateral interaction across borders using data for 1979 to 1985. Stock market price movements in the US were found to be immediately transmitted to several foreign markets. Their results also indicated that the US stock markets are the most influential in the world.

Using 1973 to 1986 monthly data for the US, Netherlands, Japan, West Germany and the UK, Taylor and Tonks (1989) measured the impact of the abolition of the UK exchange rate control system on the cointegration between UK's stock market and other stock markets. With exemption of the US market, which was cointegrated for the whole period, the results showed that the UK and the foreign stock markets were cointegrated after the date of abolition (October 1979). Byers and Peel (1993) concluded that, with the exception of the UK and Japan, no cointegration existed in any other international stock market between October 1979 and October 1989. In 1995, Yuhn tested for cointegration in the present value model. His study included Canada, Germany, Japan, UK, and the US. Yuhn (1995) concluded that US and Canada follow a long-run equilibrium path. Cerchi and Havenner (1988) investigated the dynamic behavior of five stock prices over the period January 1972 though December 1979. Their conclusions where that while each individual stock price series followed a random walk, when modeled together, the five series share one common trend and three cyclic states. Their model produced a set of one-month-ahead forecasts for the 24 months immediately following the estimation period.

The findings by different authors, even over the same periods and markets, varied (i.e. Japan, Fang et al, 1991 and Chan et al., 1992). In other cases, for the same country (i.e. Mexico, Arellano, R. 1993) cointegration is not found in a certain period, but it is found using data from a later period. In conclusion, correlation and cointegration between stock markets has been tested numerous times using different mathematical procedures, countries, and periods. Most of the research in this subject can be characterized as falling into one of the following groups: the first group investigates correlations between national stock markets and the benefits from international diversification. The second investigates the extent to which equity returns can be explained by theories of international asset pricing. A third group has been concerned with the transmission of information and shocks between national markets. Lastly, a fourth branch has examined the extent to which equity returns in different countries appear to demonstrate predictability.

In this study we use cointegration tests to empirically investigate the relationship between the U.S. stock market (using the NYSE and Dow Jones Industrial Indices as proxies) and the stock market indices of the following Latin American developing countries: Mexico, Venezuela, Brazil, Peru, Argentina, Colombia and Chile. We also identify their lead-lag relationships. The short-term impact will be assessed including lags for two-to-eight days. The long-term impact will be assessed by including lags for two-to-thirteen months. This paper contributes as an extension of previous analyses by examining both short-term and long-term dynamic relationships among stock markets. The entire period should authenticate any claims of long-run equilibrium processes.

Together, these markets represent the economies of the most developed countries in Latin America. They also represent a sample of developing economies, each at a different stage of development. Our hypothesis is that several factors affect the aggregate demand for securities in each country. These factors are the same in each country. Therefore, since this paper observes countries with different macroeconomic idiosyncrasies and markets at different times of the life cycle, we expect to find cointegration in the cases of the most developed and efficient markets (Argentina, Brazil and Mexico) and no cointegration in the cases of the least developed and efficient markets (Chile, Colombia, Peru, and Venezuela).

DATA

Daily and monthly closing prices for the stock market index of each country were obtained from the Datastream tapes. For the United States, the NYSE and Dow Jones Industrials Indices are used as the benchmark indices. For Argentina, the Merval Price Index; for Brazil the Bovespa Price Index; for Chile the General (IGPA) Price Index; for Colombia the Bogota SEIBB Price Index; for Mexico the IPC (Bolsa) Price Index; for Peru the Lima SE General IGBL Price Index; and for Venezuela the SE General Price Index. Due to data availability, the period of consideration for each country varies. Table 1 displays information regarding the data. From left to right the columns show the name of the country, the period for daily data, the number of daily observations, the period for monthly data, and the number of monthly observations.

Insert Table 1 about here

The main reason why prices, rather than returns, are used, is that the variances of indices do not behave in the same manner as the variances of the individual stock prices. Therefore, prices are expected to render more accurate results.

METHODOLOGY

The goal of this paper is to test whether a long-run equilibrium relationship persists between the stock market indices of Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela, and the NYSE and Dow Jones Industrial Indices. When no tendency to change a state exists, this is termed equilibrium. Stable systems return to equilibrium after disruptions occur. Long-run equilibrium is a relationship to which a system converges over time. These relationships may not hold over certain periods of time. Nevertheless, if the equilibrium system is stable, the relationship should eventually hold to some degree of accuracy. Over time, long-run links hold "on average".

Banerjee (1993) stated that "an equilibrium relationship holds between two variables X and Y if the amount by which actual observations deviate from this equilibrium is a media-zero stationary process: the difference between actual and predicted values has a fixed distribution around zero. In an equilibrium system, this error term can neither grow systematically nor indefinitely. The error term should not diminish over time since it portrays the continuously affected economic variables. With the absence of shocks the error term would disappear." This stationary process is the statistical concept on which equilibrium is based. The definition of equilibrium holds when utilizing variables which, by themselves, are stationary. Thus, if we have two stationary series Px and Py, the difference resulting from this equation: $P_y - b(P_x) - a = e_t$ must be a stationary series for any value of b. With respect to equilibrium, these series need not be stationary in first place, only the combination of the two series need to produce a stationary error. The application of the cointegration technique presupposes the nonstationarity of variables under consideration. The cointegration exists if deviations from the presumed relationship have bounded variability (Banerjee et al. 1986).

A prerequisite for testing for cointegration is that all variables are nonstationary. Therefore, we begin our analysis by examining for the order of integration of individual time series. The methodology used is the Phillips-Perron unit root test (Phillips-Perron, 1988, and Perron, 1988) that tests for the null hypothesis of a unit root in the series against the alternative of stationarity. This test is robust to a variety of serial correlation and time-dependent heteroskedasticity, which may be present in our data. Therefore, for our case, this test has an advantage over the test proposed by Fuller (1976) and Dickey and Fuller (1979 and 1981).

Unit Roots

Classical methods of estimation are based on the assumptions that means and variances are constants and not dependent upon time. However, unit root tests have shown that these assumptions are not followed by most macroeconomic time-series. Many macroeconomic time-series variables indicate that they are characterized by common trends or unit roots. If the variables possess one unit root, then these variables are said to be integrated of order one I(1). Many time series are represented by first differences. Unit root variables (non-stationary variables) are those in which the means and variances change over time.

Traditional estimation procedures, such as OLS, give misleading information when approximating relationships with unit root variables. This problem (the spurious regression problem) is important. Since the mean and variance of unit root variables change over time, the statistics computed with traditional methods do not converge to their true values as the sample size increases. In this case the regression statistics become time-dependent violating one of the main assumptions of the traditional tests. In many cases, the bias that exists results in the inappropriate rejection of the null hypothesis. We test whether stock prices contain unit roots using the tests proposed by Phillips (1987), Phillips and Perron (1988) and Perron (1988) which allow for a wide class of weakly dependent and heterogeneously distributed innovations. In essence, the Phillips-Perron unit root tests correct the serial correlation and autoregressive heteroskedasticity of the error terms in the regression model.

The Phillips-Perron Unit Root Test

The Phillips-Perron test for unit root is based upon one of three different time series processes:

$$Y_t = \hat{\alpha} Y_{t-1} + \hat{u}_t \quad (1)$$

$$Y_t = \mu^* + \alpha^* Y_{t-1} + u_t^* \quad (2)$$

$$Y_t = \tilde{\mu} + \tilde{\beta}(t - T/2) + \tilde{\alpha} Y_{t-1} + \tilde{u}_t \tag{3}$$

where T is the sample size, and $\hat{u}_t$, u_t^* and $\tilde{u}_t$ are the residuals.

We use OLS regression to estimate the coefficients and the t-statistics. In order to test for the significance of the alphas, the statistics are adjusted to reflect autocorrelation in the u_t series.

The regression equation (1), does not contain a constant or a trend as regressors. This is appropriate in the driftless case when the initial observation y_0 is equal to 0. In this case, the null hypothesis of a unit root, H_0^1: $\hat{\alpha} = 1$, is tested against the stationary alternative of no unit root, H_A^1: $\hat{\alpha} < 1$. For the null hypothesis an asymptotically valid test consists of the statistic

$$Z(t_{\hat{\alpha}}) = (S_u / S_{Tl}) t_{\hat{\alpha}} - 1/2 \left(S_{Tl}^2 - S_u^2\right)\left[S_{Tl}\left(T^{-2} \sum y_{t-1}^2\right)^{1/2}\right]^{-1} \tag{4}$$

where $t_{\hat{\alpha}}$ is equal to the regression t-statistic for testing the null hypothesis H_0^1: $\hat{\alpha} = 1$ obtained from the OLS regression in equation (1), S_u^2 and S_{Tl}^2 are the consistent estimators of σ_u^2 and σ^2 which are consistent under the null hypothesis.

The regression equation (2), incorporates a constant as a regressor and allows for a nonzero mean in the series. α^* and $t\alpha^*$ are univariate with respect to y_0. Two null hypotheses are tested with and without a constant: H_0^2: $\alpha^* = 1$ and H_0^3: $\mu^* = 0$, $\alpha^* = 1$, against the alternative stationary hypothesis. For the null hypothesis, H_0^2: $\alpha^* = 1$, the test consists of the statistic

$$Z\left(t_{a^*}\right) = (S_u / S_{Tl}) t_{\alpha^*} - (1/2\, S_{Tl})\left(S_{Tl}^2 - S_u^2\right)\left[T^{-2} \sum \left(y_{t-1} - \bar{Y}_{-1}\right)^2\right]^{-1} \tag{5}$$

For the joint null hypothesis of equation (2), H_0^3: $\mu^* = 0$, $\alpha^* = 1$, the F- test statistic is as follows:

$$Z(\Phi_1) = \left(S_u^2 / S_{Tl}^2\right)\Phi_1 - \left(1/2\, S_{Tl}^2\right)\left(S_{Tl}^2 - S_u^2\right) \left\{T\left(\alpha^* - 1\right) - 1/4\left(S_{Tl}^2 - S_u^2\right)\left[T^{-2}\left(\sum y_{t-1} - \bar{Y}_{-1}\right)^2\right]^{-1}\right\} \tag{6}$$

where $\Phi_1 = \left(2S^{*2}\right)^{-1}\left[TS_0^2 - TS^{*2}\right]$ and $t\alpha^*$ is the regression t-statistic for the null hypothesis $\alpha^*=1$ in equation (2), S_0^2 the variance under the appropriate null hypothesis, S^{*2} the sample variance of the estimated residuals from regression (2), S_u^2 and S_{Tl}^2 the consistent estimators of σ_u^2 and σ^2 under the null hypothesis, whereas $\overline{Y}_{-1}$ is the sample mean of y_{t-1}: $\overline{Y}_{-1} = (T-1)^{-1}\sum y_{t-1}$.

The equation (3) allows for a deterministic trend. We test the hypotheses H_0^4: $\widetilde{\alpha} = 1$, H_0^5: $\widetilde{\beta} = 0$, $\widetilde{\alpha} = 1$, and H_0^6: $\widetilde{\mu} = 0$, $\widetilde{\beta} = 0$, $\widetilde{\alpha} = 1$, against the stationary alternative. The test in the case of the null H_0^4: $\widetilde{\alpha} = 1$, is

$$Z(t_{\widetilde{\alpha}}) = (S_u/S_{Tl})t_{\widetilde{\alpha}} - \left(T^3/4\sqrt{3}D_x^{1/2}S_{Tl}\right)\left(S_{Tl}^2 - S_u^2\right) \quad (7)$$

In equation (3) we have two joint hypotheses to examine. In the first joint hypothesis, H_0^5: $\widetilde{\beta} = 0$, $\widetilde{\alpha} = 1$, the statistic is

$$\begin{aligned} Z(\Phi_2) = {} & \left(S_u^2/S_{Tl}^2\right)\Phi_2 - \left(1/3\,S_{Tl}^2\right)\left(S_{Tl}^2 - S_u^2\right) \\ & \left[T(\widetilde{\alpha}-1) - \left(T^6/48D_x\right)\left(S_{Tl}^2 - S_u^2\right)\right] \end{aligned} \quad (8)$$

where $\Phi_2 = \left(3\widetilde{S}^2\right)^{-1}\left[TS_0^2 - T\widetilde{S}^2\right]$.

For the second joint hypothesis, H_0^6: $\widetilde{\mu} = 0$, $\widetilde{\beta} = 0$, $\widetilde{\alpha} = 1$, the statistic is

$$\begin{aligned} Z(\Phi_3) = {} & \left(S_u^2/S_{Tl}^2\right)\Phi_3 - \left(1/2\,S_{Tl}^2\right)\left(S_{Tl}^2 - S_u^2\right) \\ & \left[T(\widetilde{\alpha}-1) - \left(T^6/48D_x\right)\left(S_{Tl}^2 - S_u^2\right)\right] \end{aligned} \quad (9)$$

where $\Phi_3 = \left(2\widetilde{S}^2\right)^{-1}\left[T\left\{S_0^2 - \left(\overline{Y} - \overline{Y}_{-1}\right)^2\right\} - T\widetilde{S}^2\right]$ and $t_{\widetilde{\alpha}}$, $\widetilde{S}^2$, S_0^2, S_u^2, and S_{Tl}^2 are the regression t-test, the OLS residual variance, the sample variance of the estimated residuals from regression (3), the variance under the null hypothesis, $S_0^2 = (T-1)^{-1}\sum(y_t - y_{t-1})^2$, and the consistent estimator of σ_u^2 and σ^2, respectively. D_x is the determinant of the inner product of the data matrix with itself for equation (3):

$$\begin{aligned} D_x = {} & \left(T^2\left(T^2-2\right)/12\right)\sum y_{t-1}^2 - T\left(\sum ty_{t-1}\right)^2 + T(T+1)\sum ty_{t-1}\sum y_{t-1} \\ & - \left(T(T+1)(2T+1)/6\right)\left(\sum y_{t-1}\right)^2 \end{aligned} \quad (10)$$

where summations are over all available elements of the vector. Also, $\overline{Y}_{-1}$ and $\overline{Y}_{-1}$ are the sample means of y_t and y_{t-1}, as represented by $\overline{Y} = (T-1)^{-1}\sum y_t$, $\overline{Y}_{-1} = (T-1)^{-1}\sum y_{t-1}$.

For all the t and F tests statistics we can find the critical values in Table 2.

Insert Table 2 about here

There is a relation ship between the tests for c ointegration and the tests for unit roots. Tests for unit roots are performed on univariate time-series whereas cointegration deals with the relationship among a group of variables each of which has a unit root. Tests for cointegration deal with linear long-run relationships among economic variables. Failure to find cointegration does not mean that there is no stable long-run relationship between the variables, but that there is no long-run linear relationship among them. It is possible that there are nonlinear relationships among integrated variables. At the same time, all variables must be integrated of the same ord er since, if th e variables are integrated of different orders, it is not possible to express a linear cointegrating partnership.

Cointegration Test

Many pairs of economic time-series are expected to behave in a way that they do not drift too far apart from each other. Cointegration can be thought of as a technique to estimate the equilibrium in a relationship with unit root variables. Cointegration of these variables is stationary even though individually they are not. Cointegration is the link between nonstationary processes and the concept of long-run equilibrium.

Let X_t be a px1 vector of ARI(1) variables:

$$X_t = \sum \pi_i X_{t-i} + \mu + \varepsilon_t \qquad (11)$$

where π_i *is an nxn matrix*, ε_t is an independently and identically distributed n-dimensional vector of random disturbances with a zero mean and variance matrix Λ, and μ is the vector of the means of X_t.

Equation (11) can be rewritten as:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} - \Pi X_{t-k} + \mu + \varepsilon_t \qquad (12)$$

where $\Gamma_l = -I+\pi_1+\pi_2+...+\pi_l$, $l=1,2,\dots,k-1$

$\Pi = I-\pi_1-\pi_2-...-\pi_k$

$\Delta = 1-L$ and L is the lag operator. All long-run information is contained in the level term ΠX_{t-k}. Since individual levels in X_{t-k} are means, the rank of Π is material in determining the number of cointegrating vectors. If Π has a rank of r, we can assume that there are r cointegrating relationships among the elements of X_t or p-r common stochastic trends. When rank (Π) = r and $0<r<p$, then we can write $\Pi = \alpha\beta'$, where α and β are nxr matrices, shown error correction coefficients, and cointegration parameters respectively. Under the hypothesis that there are r cointegrating vectors (i.e., $\Pi = \alpha\beta'$), we can rewrite equation (12) as:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} - \alpha\beta' X_{t-k} + \mu + \varepsilon_t \quad (13)$$

This equation is estimated by regressing ΔX_t and X_{t-k} and the constant term. The results from the regression are R_{0t} and R_{kt} respectively. The concentrated likelihood function is of the following form:

$$L(\alpha, \beta, \Lambda) = |\Lambda|^{-T/2} \exp\left\{-1/2 \sum \left(R_{0t} + \alpha\beta' R_{kt}\right)' \Lambda^{-1} \left(R_{0t} + \alpha\beta' R_{kt}\right)\right\} \quad (14)$$

Assuming that β is fixed, this concentrated likelihood function is maximized over α and Λ, by a regression of R_{0t} on $-\beta' R_{kt}$. This regression gives us the estimated values of α and Λ:

$$\hat{\alpha}(\beta) = S_{0k}\beta(\beta' S_{kk}\beta)^{-1} \quad (15)$$

and

$$\hat{\Lambda}(\beta) = S_{00} - S_{0k}\beta(\beta' S_{kk}\beta)^{-1}\beta' S_{k0} \quad (16)$$

where Sij are moment matrices of the residuals:

$$S_{ij} = T^{-1}\sum_{k=1}^{T} R_{it}R_{jt} \qquad \text{i,j = 0,k}$$

Since we estimate equation (13), now we have to minimize $\left|\hat{\Lambda}\right|^{-T/2}$:

$$\min\left|S_{00} - \hat{\alpha}(\beta)(\beta' S_{kk}\beta)\hat{\alpha}(\beta)\right| \quad (17)$$

We can minimize equation (13) by solving the eigenvalue problem:

$$\left|\lambda S_{kk} - S_{00}S_{00}^{-1}S_{0k}\right| = 0 \quad (18)$$

which yields to eigenvalues of $S_{00}S_{00}^{-1}S_{0k}$. The maximum likelihood estimates of β are the eigenvectors corresponding to the r largest eigenvalues.

There are two tests determining the number of cointegrating vectors, r. These tests are based on the significant eigenvalues found from equation (14). The first test is the trace test statistic. This statistic tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to q (restricted model, r≤q) against a general alternative r=p (general unrestricted model). If r≤1 cannot be rejected and k=0 can be rejected, we conclude that there is one cointegrating vector.

$$\lambda_{Trace}(q) = -T\sum_{i=q+1}^{n}\ln\left(1-\hat{\lambda}_i\right) \quad (19)$$

The second test is the maximal eigenvalue test. This statistic tests the null hypothesis that, at most, q cointegrating vectors exist, $r \leq q$, under the alternative that only one additional cointegrating vector exist $r \leq q+1$. If $r=0$ is rejected and $r=1$ is accepted, there is cointegration.

$$\lambda_{\max}(q, q+1) = -T \ln\left(1 - \hat{\lambda}_{q+1}\right) \qquad (20)$$

Where $\hat{\lambda}_i$ represents the estimated eigenvalues and T represents the number of observations. Johansen and Juselius (1990) provide the critical values of λ_{Trace} and $\lambda_{\max}$ statistics. These critical values are reported in Table 3.

Insert Table 3 about here

If several I(1) variables are cointegrated, then one or more linear combinations of them will have a finite variance.

RESULTS

In order to test for unit roots we used the Phillips-Perron test. The test involves the estimation of the OLS regressions shown by equations (1), (2) and (3). The test with the most significant results of the three processes pertains to the following process:

$$Y_t = \tilde{\mu} + \tilde{\beta}(t - T/2) + \tilde{\alpha} Y_{t-1} + \tilde{u}_t \qquad (3)$$

The null hypothesis is that there is a unit root in the time-series process represented by equation (3). We consider three types of the null:

H_0^4: $\tilde{\alpha} = 1$

H_0^5: $\tilde{\beta} = 0$, and $\tilde{\alpha} = 1$

H_0^6: $\tilde{\mu} = 0$, $\tilde{\beta} = 0$ and $\tilde{\alpha} = 1$

The test statistic for H_0^4 is given by $Z(t\alpha)$, for H_0^5 by $Z(\Phi_2)$ and for H_0^6 by $Z(\Phi_3)$.

Thus, the $Z(t\alpha)$ statistic tests for a unit root in the univeriate time series representation of each stock price index.

Table 4 presents the results for the unit root tests of each country: monthly and daily. In the US, we used two proxies for the market index: the NYSE and the Dow Jones Industrial Indices.

The results show that the stock prices of all the markets analyzed, both with daily and monthly data, have unit roots. In reference to daily data: Argentina, Brazil, Chile, Colombia, Mexico and Peru contain a unit root without a mean and a trend since we were able to reject the joint hypothesis (H_0^6) at 5% level of significance. The NYSE, Dow Jones, and Venezuela, have a unit root and find significant results about the null hypothesis at 5%, 5%, and 1% respectively.

In reference to monthly data: the NYSE, Dow Jones, Venezuela, Argentina, Brazil, Chile, Colombia, Mexico, and Peru contain a unit root with a mean and trend and we reject the joint hypothesis (H_0^6) at the 5% level of significance.

In conclusion, the Phillips-Perron unit root tests indicate that the null hypothesis of unit roots in both daily and monthly prices is not rejected. Each of the stock price index series are integrated of order I(1), and, therefore, we can proceed with the cointegration tests for these countries.

Insert Table 4 about here

Cointegration results

Tables 5, 6, and 7 show the results of the cointegration tests. Where needed, the Akaike Information Criteria (AIC) is displayed[1]. Lower values of the AIC statistic are preferred to higher values. The appropriate lag is highlighted. Table 5 shows the daily and monthly results for Argentina, Chile, and Peru. Eight daily lags, and thirteen monthly lags are tested. None of the findings for these countries are significant. As a result, the security markets of these countries are not cointegrated with the US stock market as measured by the proxies in this paper.

Table 6, shows the daily and monthly results of the cointegration tests for Colombia and Brazil. In reference to Brazil, daily and monthly cointegration is found to be significant only in the last lag. Since the Akaike Information Criteria is increasing, the second lag is determined to be the relevant daily and monthly lag for both the NYSE and the Dow

[1] The AIC allows us to deal with the model specification problem: as more variables (or lagged terms) are included in the regression equation, the R^2 increases. R^2 values, which have a range from zero to one, show the proportion of a change in the dependent variable that is explained by a regression. However, the penalty with increasing the number of variables is that the standard errors of estimation become larger. In other worlds, these estimates become less precise. The AIC takes the increasing R^2 statistic in association with the increasing standard errors into account to produce a result indicating the best combination.

Jones. This AIC shows that there is not cointegration with Brazil. In reference to Colombia, eight daily lags were tested none of which were significant. Thirteen monthly lags are tested and significance is found for both the NYSE and the Dow Jones Indices. An observation that can be made in looking at the monthly results is that the cointegration between the Colombian stock market and the NYSE is only significant at the 5% level in one period. Nevertheless, the cointegration between the Colombian market and the Dow Jones is significant in three different periods at the 1%, 2.5% and 5% level of significance. In order to determine the appropiate lag, the Akaike Information Criterion was tested finding that in reference to both markets the appropiate lag was the 6th lag. Therefore, there is no long-run equilibrium between the US and Colombian stock markets.

Insert Table 5 about here

Insert Table 6 about here

Insert Table 7 about here

Table 7 shows the daily and monthly results of the cointegration tests for Mexico, and Venezuela. Once more, each country is tested for eight daily lags and thirteen monthly lags. In reference to Mexico, significance is found for each of the eight daily lags as well as some of the monthly lags. For both, the NYSE and the Dow Jones, the Akaike Information criterion selected the eighth daily lag and the second monthly lag as the significant ones. Therefore, the Mexican stock market follows the US markets after a week. In reference to Venezuela, significance is found in both the daily and monthly cases. The Akaike Information Criterion selected the first daily lag as the significant one for both US indices. Nevertheless, in reference to the monthly data, the sixth lag was selected for the NYSE and the first for the Dow Jones. Therefore, the Venezuelan market follows the US market after one day.

Interpretation of results

Several of the tested daily and monthly variables are found to be cointegrated. Therefore, one or more linear combinations of them have a finite variance. Nevertheless, the key question is what is the relevance of such finding in terms of finance.

Cointegrated vectors can be thought of as arising from a constraint that an economic structure imposes on the long-run relationship among the jointly variables, that is, on the movement of the variables in the system in the long-run. Consequently, the more cointegrating vectors there are, the more stable the system. The meaning in this scenario is that, if stability increases and markets become more alike in their behavior, diversification decreases.

As mentioned previously, it appears that correlation and, in the long-run cointegration, among the stock markets of different countries increases with time. These effects appear to be a recent phenomenon taking place in the early 1990s, although previous papers also find evidence of feed back effects during international crises.

The finding of cointegration between markets has been explained as the result of improved communications and technology, as well as the reduction or disappearance of barriers to capital movements. Presumably, the relaxation of capital controls has meant that previously unexploited arbitrage opportunities have now been filled. Therefore, this increased cointegration is subject to both constraints: communications, and free capital float; in general, other things equal, countries where there are constrains in one of these areas would not follow the same degree of cointegration.

We also need to consider that, although the individual's demand for the shares of a particular company is a utility function, the total (aggregate) demand of a market is not. Every national stock market is affected by expectations of the performance of the economy (national, regional, and global), expectations of inflation, national and international interest rates, the nominal income level, and so on. Also, another important factor relevant to the demand function of different stock markets is the moment in the life cycle or developmental stage of these markets. Small markets and markets with a short life history seem to be less cointegrated than older and larger stock markets. Therefore, the aggregate demand function in every market is a function of the expectations of national and international economic variables as well as a function of the level of development of the country and its stock market.

In accordance with the findings of prior studies, our results show that the NYSE and Dow Jones stock market indices are cointegrated with the indices of some Latin markets but not cointegrated with others. Nevertheless, contrary to our original hypothesis of cointegration wigh Argentina, Brazil and Mexico, and no cointegration with Chile, Colombia, Peru, and Venezuela, the results show cointegration with Mexico and Venezuela exclusively. An explanation for both findings can be formulated.

In the cases where no cointegration was found, we can conclude that, in general, the movements in these markets do not resemble those of the US. This could be explained by local factors which are more important than international factors (as could be the case of Peru), market imperfections such as restrictions in capital movements (as could be the case of Chile), economic isolation or stronger economic relation to countries other than US (as could be the case of Argentina and Brazil), and market efficiency. The conclusion is that in reference to such countries, the diversification benefits have not diminished over time.

In reference to the cases where cointegration was found to exist, it has been argued that from the lead-lag structure identified, an investor in the US could anticipate the stock price changes in the Mexican market by observing the NYSE or Dow Jones and perhaps derive abnormal returns. I do not agree with this interpretation. The mere fact that there is a lead-lag relationship does not mean investors can devise a trading strategy that can favor them with abnormal returns on a regular basis.

It has also been argued that the presence of a lead-lag relationship suggests the market is inefficient. Again, I do not agree with this assertion. To the extent that the stock markets reflect internal economic conditions, if two countries present similar conditions, there will be a systematic variation in the stock prices of both countries. Countries with similar economic cycles, or close commercial relationships may be the ones with similar security market movements. No restrictions to capital movements and national firms traded in the international stock markets will facilitate this relationship. These conditions could explain the relationship between the US and Mexican stock markets.

In the case of Venezuela, full integration implies simultaneus adjustment to new information coming into markets, thereby eliminating any opportunities for abnormal profits associated with lagged information processing. In order to try to find a rational explanation for the findings related to this market, the characteristics of the Caracas Stock Exchange were examined to find the factors that differentiated Venezuela from the rest of the countries in this study. Some of the factors studied were: time in existence of the market, volume, number of stocks traded, growth, international participation, accounting laws, taxes, restriction to capital movements, performance, share of market concentration by largest stocks, liquidity, capital repatriation, size, easiness of entry, withholding taxes for institutional investors, among others. None of these factors differentiate this stock exchange from any of the other ones studied.

The only factor found to be significant, and a possible rational explanation for the mentioned results, is related to the Venezuelan ADRs traded in US. The ADRs of Venezuelan companies that are traded in the US stock market represent approximately sixty percent of the Caracas market and eighty percent of the Index. In this case, cointegration could be the direct result of the inefficiencies of the Venezuelan market such as small number of stocks, lack of liquidity, and concentration of the ADRs traded in the US.

Some areas of study for future research suggested by the results of this study are further tests of cointegration among the South American markets, transmission mechanisms within these countries (since they have a very specific problematic such as hyperinflation), and further investigate the role of ADRs in the market efficiency of developing nations.

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Table 1. Daily and monthly data collected for each country.

Country	Period	# of Daily Observations	# of Monthly Observations
United States NYSE	01.01.86/09.22.97	3076	140
United States DJI	01.01.86/09.22.97	3076	140
Argentina	08.02.93/09.22.97	1080	49
Brazil	12.20.89/09.22.97	2022	91
Chile	01.02.87/09.22.97	2796	127
Colombia	01.02.92/09.22.97	1493	67
Mexico	01.04.88/09.22.97	2535	115
Peru	01.02.91/09.22.97	1753	79
Venezuela	01/01/86/09.22.97	971	42

Table 2. Critical Values for Phillips-Perron's Unit Root Test

	1 percent	5 percent
$Z(t_\alpha)$: ZTALPHAH	-2.58	-1.95
$Z(t_\alpha)$: ZTALPHAS	-3.43	-2.86
$Z(t_\alpha)$: ZTALPHAT	-3.96	-3.41
$Z(\Phi_1)$:ZPHI1	6.43	4.59
$Z(\Phi_2)$:ZPHI2	6.09	4.68
$Z(\Phi_3)$:ZPHI3	8.27	6.25

Source: Wayne A. Fuller (1976), Introduction to Statistical Time Series, New York: John Wiley & Sons.

Table 3. Distribution of the Maximal Eigenvalue and Trace of the Stochastic Matrix

	95%	97.5%	99%	Mean	Var
			Trace		
r=0	17.84	19.61	21.96	9.87	18.01
r≤1	8.08	9.65	11.57	3.03	7.02
			Maximal eigenvalues		
r=0	14.59	16.40	18.78	8.03	12.56
r≤1	8.08	9.65	11.57	3.03	7.02

Source: Johansen, S. and Juselius, K. (1990)

Table 4. Phillips-Perron Unit Root Tests

United States- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	NYSE - Daily					
2 Lags	4.0022748	2.7326993	9.4524369	0.2921077	6.5538977	4.1058458*
3 Lags	4.0104581	2.75113864	9.4943382	0.3147267	6.5797235	4.1492732*
4 Lags	4.0123466	2.7643677	9.5040209	0.3325777	6.5856941	4.179721*
	DOW JONES - Daily					
2 Lags	3.9352071	2.4082947	8.4480417	-.163169*	6.1916431	3.7296959*
3 Lags	3.9798984	2.4555399	8.6528192	-.124221*	6.3177076	3.8246177*
4 Lags	4.0077754	2.4891397	8.7817839	-.095153*	6.3973247	3.8939156*
	NYSE - Monthly					
2 Lags	2.8195953	1.3773216	4.2414038*	-1.217083*	4.7522338**	3.3126383*
3 Lags	2.6698071	1.398173	3.7854256*	-1.110166*	4.5072814*	3.3338049*
4 Lags	2.5904797	1.4952368	3.5559861*	-0.941908*	4.393743*	3.4442113*
	DOW JONES - Monthly					
2 Lags	2.7747963	1.0372884	3.9418644*	-1.611704*	4.8689753**	3.2177687*
3 Lags	2.6135765	1.0625729	3.5042462*	-1.540712*	4.6485623*	3.2329071*
4 Lags	2.5595333	1.2150194	3.3645187*	-1.385328*	4.5853432*	3.3605785*

Source: Estimated values

* Significance at 5%

** Significance at 1%

Argentina- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	.9189274	-.954414*	1.1191852*	-1.162948*	1.2427277*	1.1992593*
3 Lags	.9245361	-.946167*	1.1173789*	-1.454282*	1.2396317*	1.1880801*
4 Lags	.9247421	-.944675*	1.1173145*	-1.452517*	1.2395197*	1.1860678*
	Monthly					
2 Lags	.9322676	-0.884605*	1.147416*	-1.34677*	1.2981971*	1.1713856*
3 Lags	.9862584	-0.781272*	1.1325563*	-1.228199*	1.2757007*	1.0586013*
4 Lags	.9536307	-0.803373*	1.1403419*	-1.238825*	1.2882649*	1.0814599*

Brazil- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	2.8710472	1.6961877	4.5619191*	-.802677*	4.2072085*	3.1800735*
3 Lags	2.9244502	1.7429264	4.717803**	-.76876*	4.30095*	3.2433178*
4 Lags	2.9861072	1.7963771	4.90151**	-.73082*	4.412359*5	3.3195585*
	Monthly					
2 Lags	1.5019325	.5944041	1.8004057*	-1.543959*	2.9532208*	2.6663096*
3 Lags	1.4230629	.5751642	1.6823552*	-1.522127*	2.9046124*	2.6673436*
4 Lags	1.3286102	.5332073	1.5505303*	-1.52392*	2.8479808*	2.6724832*

Chile- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	2.2509184	-0.261855*	4.5499831*	-1.746018*	4.0498783*	1.5490365*
3 Lags	2.17716113	-0.276923*	4.3161941*	-1.723057*	3.9352536*	1.6114009*
4 Lags	2.12868	-0.286873*	4.1374041*	-1.806251*	3.8646718*	1.6540584*
	Monthly					
2 Lags	1.4540858	-0.447219*	2.5367476*	-2.144893*	3.3402596*	2.3530065*
3 Lags	1.482892	-0.42266*	2.5978329*	-2.073672*	3.3475334*	2.208987*
4 Lags	1.4757588	-0.410283*	2.582213*	-2.038208*	3.3455179*	2.139519*

Colombia- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	2.5531033	.4368388	3.3261415*	-0.636428*	2.6423625*	0.727144*
3 Lags	2.3861439	.3198369	2.9423877*	-0.759035*	2.4392701*	0.7594036*
4 Lags	2.2877391	.2499184	2.7328162*	-0.833659*	2.3348306*	0.7897067*
	Monthly					
2 Lags	1.5840264	-0.058746*	1.4680047*	-1.276933*	1.9181937*	1.2955991*
3 Lags	1.486956	-0.124347*	1.3647945*	-1.346746*	1.9137314*	1.3631269*
4 Lags	1.3910183	-0.197453*	1.2800995*	-1.476151*	1.9299476*	1.4481574*

Mexico- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	3.5453541	1.8298629	6.325556**	-0.391803*	4.5383919*	2.1455652*
3 Lags	3.5115642	1.8101122	6.20825**	-0.416071*	4.47933*	2.1317629*
4 Lags	3.4733687	1.7866708	6.077099**	-0.445849*	4.4144116*	2.1167031*
	Monthly					
2 Lags	2.312222	0.7430382	3.0680698*	-1.914084*	4.1542496*	2.9669185*
3 Lags	2.30975	0.8023146	3.0626624*	-1.791895*	4.1544353*	2.8435865*
4 Lags	2.2924909	0.8481207	3.0251012*	-1.69536*	4.1561168*	2.7581933*

Peru- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	2.0833127	-0.142598*	3.4855521*	-2.062753*	3.8328889*	2.2544848*
3 Lags	2.0559292	-0.151143*	3.4187725*	-2.078314*	3.8123344*	2.2849033*
4 Lags	2.0353705	-0.157176*	3.3692762*	-2.089348*	3.7977791*	2.3066988*
	Monthly					
2 Lags	1.2737276	-0.480891*	2.0521087*	-2.497812*	3.7546158*	3.2922109*
3 Lags	1.3297501	-0.415713*	2.1359986*	-2.351703*	3.7267131*	2.9848694*
4 Lags	1.3558371	-0.36636*	2.1766557*	-2.246959*	3.7171557*	2.7781763*

Venezuela- Daily and Monthly

	$Z(t_{\hat{\alpha}})$	$Z(t_{\alpha^*})$	$Z(\Phi_1)$	$Z(t_{\tilde{\alpha}})$	$Z(\Phi_2)$	$Z(\Phi_3)$
	Daily					
2 Lags	5.6375312	3.8656531	15.966215	.5679409	11.126034	7.8122775**
3 Lags	5.3833697	3.6029848	14.555169	.5913496	10.204676	7.2365385**
4 Lags	5.1766857	3.4711748	13.456396	.529318	9.4902821	6.791741**
	Monthly					
2 Lags	1.2711732	0.395994	1.1403282*	-1.792338*	4.6185239*	5.7341779*
3 Lags	1.5940555	0.8444536	1.5322768*	-1.349329*	5.2269472**	6.8642445**
4 Lags	1.6118451	0.9502473	1.5578884*	-1.205579*	5.2677639**	7.2322364**

* Significance at 5%

** Significance at 1%

Table 5 Johansen Cointegration Test Results

ARGENTINA

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
Trace Test-NYSE							
r=0	8.653	8.528	9.452	9.485	9.664	10.017	10.478
r ≤	1.869	1.878	1.721	1.757	1.805	1.704	1.718
Maximum Eigenvalues Test-NYSE							
r=0	6.784	6.853	7.731	7.728	7.859	8.313	8.760
r ≤ 1	1.869	1.878	1.721	1.757	1.805	1.704	1.718
Trace Test-Dow Jones							
r=0	7.174	6.865	7.674	7.877	7.701	7.599	7.523
r ≤ 1	0.531	0.445	0.490	0.491	0.482	0.432	0.496
Maximum Eigenvalues Test-Dow Jones							
r=0	6.643	6.521	7.184	7.485	7.219	7.167	7.027
r ≤ 1	0.531	0.445	0.490	0.491	0.482	0.432	0.496

2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
Trace Test-NYSE											
7.836	8.634	9.185	14.700	10.442	13.895	11.349	10.861	15.230	14.679	11.273	12.452
0.810	0.316	0.518	1.438	0.337	0.520	1.470	4.274	5.971	5.111	4.217	2.010
Maximum Eigenvalues Test-NYSE											
7.025	8.519	8.666	13.263	10.106	13.375	9.879	6.587	9.259	9.468	7.056	10.442
0.810	0.316	0.518	1.438	0.337	0.520	1.470	4.274	5.971	5.111	4.217	2.010
Trace Test-Dow Jones											
7.823	7.847	6.651	14.878	12.085	14.181	12.040	7.818	9.681	11.819	10.491	7.896
0.670	0.141	0.279	1.554	0.626	0.164	0.754	2.509	2.185	2.779	2.397	0.015
Maximum Eigenvalues Test-Dow Jones											
7.153	7.706	6.371	13.324	11.460	14.017	11.286	5.309	7.496	9.040	8.094	7.882
0.670	0.141	0.279	1.554	0.626	0.164	0.754	2.509	2.185	2.779	2.387	0.015

CHILE

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
Trace Test-NYSE							
r=0	7.903	8.571	9.121	9.492	8.369	9.157	9.469
r ≤ 1	0.234	0.168	0.141	0.105	0.072	0.081	0.031
Maximum Eigenvalues Test-NYSE							
r=0	7.669	8.402	8.980	9.388	8.297	9.077	9.438
r ≤ 1	0.234	0.168	0.141	0.105	0.072	0.081	0.031
Trace Test-Dow Jones							
r=0	8.024	8.754	9.310	9.583	8.290	8.543	8.754
r ≤ 1	0.359	0.295	0.267	0.202	0.162	0.173	0.090
Maximum Eigenvalues Test-Dow Jones							
r=0	7.665	8.459	9.043	9.381	8.128	8.370	8.663
r ≤ 1	0.359	0.295	0.267	0.202	0.162	0.173	0.090

2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
Trace Test-NYSE											
6.406	6.516	8.250	11.428	10.163	10.284	9.377	8.639	7.303	6.222	11.427	13.179
0.013	0.000	0.067	0.037	0.230	0.065	0.005	0.263	1.783	1.734	5.110	6.013
Maximum Eigenvalues Test-NYSE											
6.394	6.516	8.184	11.440	9.833	10.219	9.372	8.376	5.519	4.487	6.316	7.167
0.013	0.000	0.067	0.037	0.230	0.065	0.005	0.263	1.783	1.734	5.110	6.013
Trace Test-Dow Jones											
8.722	8.341	10.140	15.887	14.014	15.288	13.770	11.415	10.081	7.620	10.966	11.925
0.070	0.076	0.334	0.139	0.507	0.266	0.053	0.052	0.869	0.676	3.965	4.951
Maximum Eigenvalues Test-Dow Jones											
8.651	8.265	9.806	15.749	13.507	15.022	13.716	11.363	9.213	6.944	6.982	6.974
0.070	0.076	0.334	0.139	0.507	0.266	0.053	0.052	0.869	0.676	3.965	4.951

PERU

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
Trace Test-NYSE							
r=0	6.160	6.187	6.411	6.443	6.197	6.953	7.628
r ≤ 1	1.688	1.445	1.348	1.300	1.250	1.201	1.253
Maximum Eigenvalues Test-NYSE							
r=0	4.472	4.742	5.064	5.144	4.947	5.752	6.374
r ≤ 1	1.688	1.445	1.348	1.300	1.250	1.201	1.253
Trace Test-Dow Jones							
r=0	5.693	5.695	6.016	6.159	5.556	5.881	6.373
r ≤ 1	1.802	1.575	1.454	1.361	1.282	1.221	1.214
Maximum Eigenvalues Test-Dow Jones							
r=0	3.891	4.120	4.562	4.798	4.275	4.660	5.159
r ≤ 1	1.802	1.575	1.454	1.361	1.282	1.221	1.214

2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
Trace Test-NYSE											
8.657	10.527	13.272	15.480	11.880	14.694	14.330	10.287	9.880	13.300	17.069	14.138
2.663	2.564	2.423	1.670	1.760	2.227	2.796	3.916	4.049	2.832	5.405	4.482
Maximum Eigenvalues Test-NYSE											
5.974	7.963	10.850	13.810	10.120	12.466	11.533	6.371	5.831	10.468	11.664	9.656
2.663	2.564	2.423	1.670	1.760	2.227	2.796	3.916	4.049	2.832	5.405	4.482
Trace Test-Dow Jones											
9.337	9.775	11.334	17.384	13.731	16.058	14.393	10.045	11.513	14.981	15.649	15.473
2.329	2.479	2.382	1.614	1.641	1.876	2.171	3.262	3.959	3.197	4.715	5.966
Maximum Eigenvalues Test-Dow Jones											
7.008	7.296	8.952	15.770	12.091	14.182	12.222	6.783	7.554	11.765	10.934	9.507
2.329	2.479	2.382	1.614	1.641	1.878	2.171	3.262	3.959	3.197	4.715	5.657

*** Significant at 5% level   ** Significant at 2.5% level   * Significant at 1% level

Table 6 Johansen Cointegration Test Results

BRAZIL

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
	Trace Test-NYSE						
r=0	13.671	14.802	15.978	15.015	15.510	16.285	18.408***
r≤ 1	4.428	4.533	4.074	3.573	3.377	2.932	2.857
	Maximum Eigenvalues Test-NYSE						
r=0	9.243	10.269	11.904	11.442	12.133	13.352	15.548***
r≤ 1	4.428	4.533	4.074	3.573	3.377	2.932	2.857
	Akaike Information Criterion						
	1489600	1490900	1492400	1493800	1495300	1496700	1498200
≤	Trace Test-Dow Jones						
r=0	13.988	15.168	15.920	15.272	15.549	15.878	18.006***
r≤ 1	5.181	5.508	5.163	4.591	4.442	3.979	3.894
	Maximum Eigenvalues Test-Dow Jones						
r=0	8.807	9.660	10.756	10.681	11.108	11.899	14.113
r≤ 1	5.181	5.508	5.163	4.591	4.442	3.979	3.894
	Akaike Information Criterion						
	1153600	1154700	1155900	1157000	1158200	1159300	1160400

2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
Trace Test-NYSE											
9.571	15.517	22.179*	19.982**	17.892**	24.705*	21.135**	20.148**	28.280*	26.422*	24.916*	19.611**
1.804	6.586	9.641***	6.339	5.574	4.555	4.592	6.118	11.597*	10.568**	9.552***	6.189
Maximum Eigenvalues Test-NYSE											
7.768	8.931	12.538	13.644	12.318	20.150*	16.543**	14.030	16.683**	15.854**	15.364***	13.423
1.804	6.586	9.641***	6.339	5.574	4.555	4.592	6.118	11.597*	10.568**	9.552***	6.189
Akaike Information Criterion											
1691000	1720800	1756200	1794800	1825000	1864400	1905500	1945900	1976700	2004200	2027700	2061400
Trace Test-Dow Jones											
10.878	16.514	24.449*	26.611*	25.668*	27.174*	23.057*	20.673**	31.980*	25.149*	22.901*	20.467**
3.068	7.547	11.453**	7.551	7.133	4.048	3.682	5.119	11.317**	8.589***	8.343***	6.262
Maximum Eigenvalues Test-Dow Jones											
7.810	8,966	12.996	19.060*	18.536**	23.127*	19.375*	15.554**	20.643*	16.580**	14.558	14.205
3.068	7.547	11.453**	7.551	7.133	4.048	3.682	5.119	11.317**	8.589***	8.343***	6.262
Akaike Information Criterion											
1301800	1328100	1357300	1386600	1413800	1444900	1477000	1508500	1534200	1558600	1585500	1614000

COLOMBIA

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
	Trace Test-NYSE						
r=0	11.755	12.431	13.241	13.210	13.480	14.748	15.527
r≤ 1	1.999	2.275	2.331	2.334	2.001	1.793	1.494
	Maximum Eigenvalues Test-NYSE						
r=0	9.775	10.155	10.909	10.878	11.471	12.953	14.033
r≤ 1	1.999	2.275	2.331	2.334	2.001	1.793	1.494
	Trace Test-Dow Jones						
r=0	9.789	10.204	10.671	10.645	10.517	11.288	11.698
r≤ 1	0.854	1.136	1.170	1.171	0.992	0.872	0.662
	Maximum Eigenvalues Test-Dow Jones						
r=0	8.916	9.068	9.501	9.474	9.524	10.416	11.037
r≤ 1	0.854	1.136	1.170	1.171	0.992	0.878	0.662

2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
Trace Test-NYSE											
12.581	14.018	13.820	21.147**	12.769	17.322	14.644	10.567	10.714	15.299	17.531	17.372
1.254	2.525	2.389	3.329	2.921	3.845	4.303	3.658	3.697	4.281	5.955	4.990
Maximum Eigenvalues Test-NYSE											
11.327	11.493	11.431	17.818**	9.848	13.478	10.340	6.909	7.017	11.018	11.576	12.383
1.254	2.525	2.389	3.329	2.921	3.845	4.303	3.658	3.697	4.281	5.955	4.990
Akaike Information Criterion											
32140	32010	31785	31310	30739	30818	31196	31490	31795	31763	31405	30963
Trace Test-Dow Jones											
13.036	12.012	10.830	21.999*	15.161	20.660**	19.137	14.541	12.799	14.783	18.728***	17.524
1.317	2.745	3.054	4.776	4.748	5.833	5.864	3.271	3.798	4.180	5.609	5.492
Maximum Eigenvalues Test-Dow Jones											
11.718	9.267	7.778	17.223**	10.412	14.827	13.273	11.271	9.001	10.603	13.037	12.032
1.317	2.745	3.054	4.776	4.748	5.833	5.864	3.271	3.798	4.180	5.609	5.492
Akaike Information Criterion											
30488	30287	30052	29766	29372	29579	30090	32058	30896	31044	30696	30700

*** Significant at 5% level
** Significant at 2.5% level
* Significant at 1% level

Table 7 Johansen Cointegration Test Results

MEXICO

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
	Trace Test-NYSE						
r=0	22.228*	22.877*	24.017*	23.285*	22.719*	22.717*	25.066*
r≤ 1	2.532	2.370	2.538	2.314	2.424	2.448	2.426
	Maximum Eigenvalues Test-NYSE						
r=0	19.696*	20.607*	21.473*	20.971*	20.295*	20.270*	22.640*
r≤ 1	2.532	2.370	2.538	2.314	2.424	2.448	2.426
	Akaike Information Criterion						
	116130	116040	115940	115860	115810	115760	**116740**
	Trace Test-Dow Jones						
r=0	18.531**	19.323***	20.504**	20.298**	19.297***	18.980***	20.597**
r≤ 1	1.875	1.675	1.790	1.623	1.740	1.752	1.705
	Maximum Eigenvalues Test-Dow Jones						
r=0	16.656**	17.648**	18.713**	18.674**	17.558**	17.228**	18.891*
r≤ 1	1.875	1.675	1.790	1.623	1.740	1.752	1.705
	Akaike Information Criterion						
	144970	144810	144660	144500	144380	144220	**144120**

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
	Trace Test-NYSE											
r=0	17.344	16.062	16.416	22.751*	17.994***	18.246**	18.114***	13.287	14.322	11.519	10.396	12.786
r≤ 1	3.125	3.306	3.167	3.937	3.451	2.530	3.192	4.521	5.134	5.126	3.828	4.344
	Maximum Eigenvalues Test-NYSE											
r=0	14.220	12.757	13.229	18.814*	14.543	15.716***	14.922*	8.766	9.188	6.393	6.568	8.442
r≤ 1	3.125	3.306	3.167	3.937	3.451	2.530	3.192	4.521	5.134	5.126	3.828	4.344
	Akaike Information Criterion											
	120330	**120280**	121010	121870	122910	124420	125560	126830	128100	128710	130460	132213
	Trace Test-Dow Jones											
r=0	15.589	14.959	14.313	23.448*	20.601**	21.962*	18.929***	12.085	14.756	13.759	11.594	13.158
r≤ 1	3.384	3.580	3.263	3.731	3.740	2.452	2.638	2.960	3.317	3.875	2.822	2.946
	Maximum Eigenvalues Test-Dow Jones											
r=0	12.205	11.379	11.060	19.717	17.061**	19.510*	16.291***	9.125	11.438	9.884	8.772	10.212
r≤ 1	3.384	3.580	3.263	3.731	3.740	2.452	2.638	2.960	3.317	3.875	2.822	2.946
	Akaike Information Criterion											
	149020	**148790**	149370	149740	150220	151060	151700	152550	153920	154780	155640	158150

VENEZUELA

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
	Trace Test-NYSE						
r=0	19.064***	20.918**	17.678	15.431	14.908	16.227	12.841
r≤ 1	2.320	2.256	1.819	1.854	2.047	1.397	0.921
	Maximum Eigenvalues Test-NYSE						
r=0	16.744**	18.664**	15.859***	13.578	12.861	14.830***	11.919
r≤ 1	2.320	2.256	1.819	1.854	2.047	1.397	0.921
	Akaike Information Criterion						
	594390	595460	596590	597760	598930	600090	601180
	Trace Test-Dow Jones						
r=0	16.588	18.276***	15.426	13.738	13.208	14.859	11.953
r≤ 1	0.945	0.926	0.593	0.673	0.966	0.589	0.348
	Maximum Eigenvalues Test-Dow Jones						
r=0	15.643***	17.350**	14.833***	13.065	12.241	14.270	11.605
r≤ 1	0.945	0.926	0.593	0.673	0.966	0.589	0.348
	Akaike Information Criterion						
	614290	615460	616620	617840	619050	620210	621270

	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags	9 lags	10 lags	11 lags	12 lags	13 lags
	Trace Test-NYSE											
r=0	26.097*	28.773*	34.231*	33.377*	17.778	31.895*	63.655*	65.777*	49.248*	30.425*	64.592*	53.663*
r≤ 1	2.966	4.900	9.169***	5.484	3.447	0.367	13.230*	23.604*	18.578*	12.563*	15.686*	3.085
	Maximum Eigenvalues Test-NYSE											
r=0	23.131*	23.873*	25.061*	27.893*	14.331	31.528*	50.425*	42.173*	30.672*	17.862*	48.905*	50.578*
r≤ 1	2.966	4.900	9.169***	5.484	3.447	0.367	13.230*	23.604*	18.578*	12.563*	15.686*	3.085
	Akaike Information Criterion											
	4054900	3636000	3264670	2881500	2303200	**1828100**	1996500	2056800	2138500	2227000	2317500	2391600
	Trace Test-Dow Jones											
r=0	21.516**	13.133	13.904	23.056*	11.583	30.961*	26.467*	12.471	18.424***	26.627*	20.903**	70.109*
r≤ 1	4.162	1.080	0.537	0.001	0.080	2.836	2.844	1.284	2.984	2.192	1.027	4.734
	Maximum Eigenvalues Test-Dow Jones											
r=0	17.354**	12.053	13.137	23.055*	11.503	28.125*	23.623	11.187	15.440***	24.435*	19.876*	65.375*
r≤ 1	4.162	1.080	0.537	0.001	0.080	2.836	2.844	1.284	2.984	2.192	1.027	4.734
	Akaike Information Criterion											
	1299100	1341300	1405400	1473870	1545200	1598800	1668400	1747100	1809900	1881600	1958100	2035800

*** Significant at 5% level ** Significant at 2.5% level * Significant at 1% level

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