Mean Reversion in Stock Prices: Evidence from Emerging Markets*

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Abstract

This paper investigates whether stock-price indexes of emerging markets can be characterized as random walk (unit root) or mean reversion processes. We implement a panel-based test that exploits cross-sectional information from seventeen emerging equity markets during the period January 1985 to April 2002. The gain in power allows us to reject the null hypothesis of random walk in favor of mean reversion at the 5 percent significance level. We find a positive speed of reversion with a half-life of about 30 months. These results are similar to those documented for developed markets. Our findings provide an interesting comparison to existing studies on more matured markets and reduce the likelihood of earlier mean reversion findings as attributable to data mining.

JEL Codes: G15, G14, C22

Key Words: Emerging Markets, Mean Reversion, Panel Test

1. Introduction

Researchers in finance have long been interested in the long-run time-series properties of equity prices, with particular attention to whether stock prices can be characterized as random walk (unit root) or mean reverting (trend stationary) processes.[1] If stock price follows a mean reverting process, then there exists a tendency for the price level to return to its trend path over time and investors may be able to forecast future returns by using information on past returns. On the other hand, a random walk process implies that any shock to stock price is permanent and there is no tendency for the price level to return to a trend path over time. This suggests that future returns are unpredictable based on historical observations. The random walk property also implies that the volatility of stock price can grow without bound in the long run. These time-series properties are not only of interest by themselves but also have important implications for asset pricing.

The evidence of mean reversion is first documented for the U.S. market. Using U.S. individual firm-level data, DeBondt and Thaler (1985) first report that past losing stocks over the previous 3-5 years significantly outperform past winning stocks over a 3-5 years holding period. Their results indicate that stock prices do not follow a random walk, but contain a strong mean reverting component. Fama and French (1988) also report mean reversion in U.S. equity market using long-horizon regressions, and Poterba and Summers (1988) document evidence of mean reversion using the variance ratio test. Recently, researchers have also tested for mean reversion in equity prices using international data. For example, Richards (1997) reports evidence of long-term winner-loser reversals for equity indexes for sixteen countries. Balvers, Wu and Gilliland (2000) find significant evidence of mean reversion across eighteen developed equity markets and demonstrate that one can exploit the property of mean reversion to predict equity returns using a parametric contrarian investment strategy. Other researchers, however, report conflicting results again mean reversion. For example, Lo and MacKinlay (1988) report some evidence against mean reversion in weekly U.S. data. Kim, Nelson and Startz (1991) show that mean reversion exists only in pre-war U.S. data, while Richardson and Stock (1989) and Richardson (1993) argue that the results from Fama and French (1988) and Poterba and Summers (1988) are not robust because of small-sample biases.

Much of the controversy on the issue of mean reversion arises because the speed of reversion, if it exists, may be very slow and standard econometric tests do not have sufficient power to discriminate a mean reversion process from a random walk process. In this paper, we test for mean reversion in stock prices of seventeen emerging markets using monthly data from 1985.1 through 2002.4. Our results provide useful information from this independent sample, and complement the existing studies on developed markets.[2] To overcome the power deficiency problem, we conduct the test in a panel framework. We pool data of seventeen countries and utilize the information on the cross-sectional variations in equity returns to increase the power of the test so that mean reversion can be more easily detected. To further improve estimation efficiency, we estimate the system of equations using the seemingly unrelated regression (SUR) technique. We find that the null hypothesis of a random walk can be rejected at the five percent level in favor of mean reversion for seventeen emerging stock index prices. A transitory deviation reverses to the trend path at the speed of around two percent per month with a half-life of around 30 months.[3] These results are similar to the findings for developed markets as documented in Balvers, Wu and Gilliland (2000). They provide a useful comparison to existing studies on more mature markets and reduce the likelihood of earlier mean reversion findings as attributable to data mining.

The remainder of the paper is organized as follows. Section 2 presents the empirical methodology. Section 3 describes the data. The empirical results are reported in Section 4. Section 5 checks for the robustness of results while the final section concludes the paper.

2. Empirical Methodology

Our primary interest in this study is to test whether stock prices in emerging markets follow random walk or mean-reverting processes. Let p_t^i be the natural logarithm of country i's stock-price index with dividends reinvested at time t, and $r_t^i = p_t^i - p_{t-1}^i$ be its continuously compounded return. Let T be the sample size. Consider the following process:

$$p_t^i = \mu^i + \lambda^i o_{t-1}^i + \varepsilon_t^i \, , \qquad (1)$$

where μ^i is a constant parameter and ε_t^i is a stationary process which is allowed to be serially correlated, $i = 1, 2, \ldots, N; \; t = 1, 2, \ldots, T$. If $\lambda^i = 1$, equity price follows a random walk; while if $\lambda^i < 1$, equity price is mean reverting.

The most popular tests for the random walk hypothesis are the augmented Dickey and Fuller (1979, 1981, ADF) tests and the Phillips and Perron (1988, PP) tests. For the ADF tests, one estimates the following regressions:

$$r_t^i = \mu^i + (\lambda^i - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i \qquad (2)$$

$$r_t^i = \mu^i + \beta^i t + (\lambda^i - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i \qquad (3)$$

Equation (2) tests for the null hypothesis of a random walk against a mean stationary alternative, while equation (3) tests for the same null hypothesis against a trend stationary alternative. In both cases, the k extra regressors, r_{t-j}^i, are added to eliminate possible nuisance-parameter dependencies in the asymptotic distributions of the test statistics caused by serial correlation in the error terms. For a given sample, if the estimate of λ^i is not significantly different from unity, then the null hypothesis of a random walk cannot be rejected. On the other hand, if one finds that $\lambda^i < 1$, then the alternative hypothesis of mean reversion is supported. The PP tests work in a similar way except that the extra regressors, r_{t-j}^i, are not included in the regressions, but the serial correlation of the residuals is corrected via a non-parametric approach.

One significant drawback of the popular ADF and PP tests is that they have low power against the alternative of slow-speed mean reversion in small samples (see Campbell and Perron (1991), Cochrane (1991), and DeJong *et al*. (1992), among others). Therefore, failure to reject the null hypothesis may not be interpreted as decisive evidence against mean reversion. Because of this inherent problem, researchers have advocated pooling data and testing the hypothesis in a panel framework to gain test power.[4] Our study follows this approach. We pool data of seventeen emerging markets to estimate the common speed of reversion $\lambda^i = \lambda$, $i = 1, 2, \ldots, 17$. To further improve estimation efficiency and gain statistical power, we exploit the information in the cross-country correlation of returns and estimate the system using the seemingly unrelated regression (SUR) technique.

The panel-based test for the null hypothesis of no mean reversion ($\lambda = 1$) is based on the following two statistics: $z_{\lambda} = T(\hat{\lambda} - 1)$ and $t_{\lambda} - (\hat{\lambda} - 1)/s(\lambda)$, where $\hat{\lambda}$ is the panel estimate of λ from either OLS or SUR, $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$, and T is the sample size.

It is well known that under the null hypothesis of $\lambda = 1$, the above two statistics do not follow limiting normal distributions. We will therefore generate appropriate critical values for our exact sample size through Monte-Carlo simulations. The experiment is described in the Appendix.

3. The Data

The data used in this paper are obtained from International Finance Corporation's *Emerging Market Database* (IFC-EMDB). The sample is monthly from January 1985 to April 2002 with 208 observations and contains U.S. dollar denominated stock-price indexes for the following seventeen countries: Argentina, Brazil, Chile, Colombia, Greece, India, Jordan, Korea, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Taiwan, Thailand, Venezuela, and Zimbabwe. These indexes include dividends and capital gains and are end-of-month quotes.[5] We choose to use the IFC indexes rather than other local stock price indexes for several reasons. First, these indexes are constructed on a consistent basis by the IFC, making cross-country comparison more meaningful. Second, these indexes include the most active traded stocks in the respective local markets and cover at least 60 percent of market capitalization (see International Finance Corporation, 1997). Third, the IFC-EMDB has been used in numerous recent studies. This makes our results directly comparable with existing studies.

4. Empirical Results

Table 1 panel A reports the mean, standard error, correlation with the world equity return, and five serial correlations for each country's index return. The world equity return data is obtained from Morgan Stanley Capital International (MSCI). Both monthly mean returns and standard errors vary vastly across countries. Over the 18-year period, the highest monthly mean return is 1.89 percent for Chile, while the lowest mean return is 0.33 percent for Malaysia. Argentina has the highest standard error of 19.93 percent per month, while Jordan has the lowest monthly standard error of 4.35 percent. The average correlation with the world equity return amounts to 22 percent. The first-order serial correlations are quite large for a number of countries. For example, Colombia has the first-order autocorrelation of 0.386, the Philippines has 0.316, and Mexico has 0.285. Higher-order serial correlations are in general smaller in magnitude. Panel B of Table 1 lists the estimates of cross correlations of monthly returns among the seventeen markets. Most of the cross correlations are positive and indeed some of them are as high as over 30 percent (e.g., Chile with Mexico (43 percent), Philippines with Malaysia (52 percent), Taiwan with Thailand (42 percent), and Korea with Thailand (47 percent)). These relatively high cross-sectional correlations motivate the use of SUR estimation.

For the purpose of comparison, we first apply the standard ADF and PP tests to each country and report the results in Table 2. The model is estimated both with and without a time trend. For the ADF tests, the lag length, k, is chosen using the optimal sequential procedure suggested by Campbell and Perron (1991), with the maximum lag length, k_{max}, set to *12*, while for the PP tests, the fixed truncation lag is set to *12*. It is apparent that the choice of lag length, k, can affect the test results. Note that other procedures to select the lag length are also available. Through extensive Monte-Carlo simulations, Ng and Perron (1995) demonstrate that a too parsimonious model can have large size distortions, while an over-parameterized model may result in reduction of test power. Nevertheless, the size problem is in general more severe than the power loss. Ng and Perron (1995) show that methods based on sequential tests have an advantage over information-based rules such as the Akaike information criterion and the Schwartz Bayesian information criterion because the former have smaller size distortions while maintaining similar power. The procedure adopted here falls into the category of the general-to-specific sequential procedures.

For both types of tests, since the distribution of the test statistics is non-normal, we compute critical values for the exact sample size ($T=208$) using Monte-Carlo simulation with *10,000* replications under the null hypothesis of no mean reversion ($\lambda=1$) with iid normal innovations. Based on the ADF test, the null hypothesis of random walk can be rejected in favor of mean reversion at the 5 percent significance level for only 5 markets out of 17. These markets are Chile, Korea, Philippines, Taiwan and Venezuela. Similarly, based on the PP test, the null can be rejected at the 10 percent level for 5 out of 17 markets (Chile, India, Korea, Philippines and Taiwan). In both cases, adding the time trend does not seem to improve the power of the test. These results suggest that most of the emerging market equity indexes do not have mean reversion. However, it is also possible that emerging market equity indexes have slow-speed mean reversion, but the power of the test based on single equation estimation is not sufficient to discriminate it from a random walk process.

We now apply the panel-based test to improve the power. First, we estimate the system of 17 equations using OLS, while restricting the slope coefficients to be the same, $\lambda^i = \lambda$, $i = 1, 2, \ldots, 17$.[6] We estimate the panel with various lag lengths k and report all results to check for robustness. Table 3 displays the test results. Based on the z_λ test statistic, we find that the null hypothesis of no mean reversion in seventeen markets can be rejected at the 10 percent level with $k = 6$, and at the 5 percent level with $k = 9$ and 12. On the other hand, the null hypothesis can be rejected at the 1 percent level for all lag length k based on the t_λ test statistic. The slope coefficient estimates are very similar, implying a half-life of between 31 and 36 months.[7] Interestingly, these half-lives are very similar to those for developed equity markets documented by Balvers, Wu and Gilliland (2000).

Next, we further exploit the information on the cross-country correlations of returns and estimate the system of seventeen equations using SUR. Table 4 reports the estimation and testing results. In general SUR does increase estimation efficiency and improves the test power. Based on the z_λ test, the null hypothesis can be rejected at the 10 percent level with $k = 3$, at the 5 percent level with $k = 6$, and at the 1 percent level with $k = 9$ and 12. The t_λ test is more powerful in that the null hypothesis can be rejected at the 1 percent level for all lag lengths k. The implied half- lives range between 25 and 33 months, which are somewhat shorter than the corresponding half-lives estimated from OLS.

Overall, our panel-test results suggest that there is significant evidence of mean reversion in seventeen emerging equity markets. The speed of reversion is about 2 percent per month, which implies a half-life of around 30 months. These results compare well with those found for developed markets.

5. Robustness of Results

In this section, we conduct several further tests to check for the robustness of results on mean reversion. First, we test for mean reversion of the seventeen emerging markets relative to the world market index, following Balvers, Wu and Gilliland (2000). Test results are reported in Table 5. Based on the z_λ test, the null hypothesis of no mean reversion relative to the world market can be rejected at the 10 percent level for $k = 0$ and 3, and at the 5 percent level for other lag lengths. Using the t_λ test, the null can be rejected at the 5 percent level for all lags. The estimated half lives are slightly shorter than those reported in Table 4, where tests are conducted on country indexes themselves.

The panel approach assumes $\lambda^i = \lambda$ for all seventeen emerging equity markets. But in reality, the speeds of reversion can be different for countries with different geographical locations and different institutional and cultural backgrounds. To check whether our results are robust, we conduct our test for two more homogenous groups of countries. The first group consists of seven Asian countries: India, Korea, Malaysia, Pakistan, Philippines, Taiwan and Thailand; while the second group consists of six Latin American countries: Argentina, Brazil, Chile, Colombia, Mexico and Venezuela. It is more reasonable to assume that the speed of reversion is similar within each of these country groups.

Table 6 presents the results for the group of seven Asian countries. We can see that the null hypothesis of no mean reversion can be rejected at the 1 percent significance level in all cases except one with k = 0 based on the z_λ test. Furthermore, the speed of reversion is in general faster than the case with seventeen countries pooled together, with the average half life of around 20 months.

The results for the group of six Latin American countries are shown in Table 7. Test results are sensitive to which test statistic is used for inference. The null hypothesis can be rejected at the 5 percent level using the t_λ test, but cannot be rejected even at the 10 percent level using the z_λ test. The speed of reversion is substantially slower than the group of seven Asian countries, with the average half life of over 3 years.

6. Conclusion

Economists have shown considerable interest in the mean reversion property in equity prices because whether equity prices follow random walk or mean reversion processes has important implications for market efficiency and asset pricing. Most existing studies use data from developed markets to test for mean reversion, and researchers report conflicting evidence. The purpose of this paper has been to test for mean reversion using an independent data set of seventeen emerging markets.

It is known that traditional tests, such as Dickey and Fuller (1979, 1981) and Phillips and Perron (1988), for a random walk in stock prices have insufficient power against the alternative hypothesis of mean reversion in small samples. Given the fact that there are only 18 years of data in our sample, the power problem is especially serious. We therefore pool data of seventeen countries and implement a panel-based test. The test exploits the cross-country information and greatly enhances estimation efficiency. This helps us to identify a slow mean reverting component in equity prices and substantially increases the power. The gain in test power allows us to reject the random walk hypothesis in favor of mean reversion at conventional significance levels. We estimate the half-lives to be about 30 months, which are close to those found for developed markets. For the first time, we document strong evidence of mean reversion of equity prices in seventeen emerging markets. Our results are also interesting and useful as they add to the controversial evidence of mean reversion first provided for U.S. stock prices by Fama and French (1988) and Poterba and Summers (1988). As our data set is different from other data sets previously examined in this context, the uncovering of a strong relation reduces the likelihood of earlier mean reversion findings as attributable to data mining.

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Endnotes

1. We use the term “random walk” in a loose sense to simply mean that price index is a non-stationary process with a unit root. Therefore, we will use the terms “random walk” and “unit root” interchangeably. Similarly, we will use the terms “mean reversion” and “trend stationarity” interchangeably throughout this paper.

2. Recent researchers have paid an increasing attention to the study of stock price behavior in emerging markets. See, for example, Harvey (1995), Claessens *et al*. (1995), Cheung and Lai (1995), Bekaert and Harvey (2000), Bekaert, Harvey and Lumsdaine (2000), and Chaudhuri and Wu (2002), among others.

3. Chaudhuri and Wu (2002) also test for mean reversion for emerging market stock prices. They find that the null hypothesis of no mean reversion cannot be rejected in general using the standard unit-root test. But they argue that emerging markets may be subject to structural changes, and if a structural break is explicitly taken into account in the regression, mean reversion can be detected in 14 out of 17 countries. The results reported in the current paper complement those of Chaudhuri and Wu (2002) with a different motivation and methodology.

4. For applications of the panel test to financial data, see, for example, Abuaf and Jorion (1990), Wu (1996), and Balvers, Wu and Gilliland (2000), among others.

5. We have also done the same analysis using stock price indexes without dividends reinvested and obtained similar results. Those results are not reported but are available upon request.

6. We test the hypothesis that $\lambda^i = \lambda$ for i = 1, 2, …, 17, using a Wald-type test with critical values simulated, and obtain the p-value of 0.087. Therefore, this hypothesis can be rejected at the 10 percent significance level but not at the 5 percent level. In the next section, we impose this restriction for two more homogenous subgroups of countries to examine the robustness of results.

7. The half life is computed as $\ln(0.5) / \ln(\hat{\lambda})$. Note that the OLS estimate of λ is downward biased.

Appendix

This appendix describes the steps to calculate the critical values for the test statistics for the panel of N countries with T observations.

Step 1: Simulate N random walk processes with T price observations each, where the innovations are generated from a multivariate normal distribution with mean zero. The covariance matrix is either diagonal with the main diagonal elements equal to unity (in the case of OLS estimation) or is set equal to the historic cross-country covariance matrix (in the case of SUR estimation).

Step 2: Estimate the system with the simulated observations with the restriction that all slope coefficients are equal, and calculate the two statistics, z and t.

Step 3: Repeat steps 1 and 2 for 5,000 times to yield the empirical distribution of the test statistics under the null of $= 1$. The p-values reported in Tables 3-7 are defined as the percentage of the Monte-Carlo distribution having values greater than the corresponding historical test statistics computed with the data.

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Table 1 Summary Statistics of Emerging Stock Market Returns

This table reports summary statistics of stock index returns for 17 emerging markets. The data covers the period from 1985.1 to 2002.4 with 208 monthly observations. Panel A presents the mean, standard error, correlation with world market returns (from MSCI) and serial correlation coefficients for each country. Panel B reports the cross correlation coefficients among the 17 markets.

Panel A				Serial correlations				
Country	Mean	Standard Error	Correlation with world	$\rho(1)$	$\rho(3)$	$\rho(6)$	$\rho(9)$	$\rho(12)$
Argentina	0.0106	0.1993	0.075	-0.069	0.053	0.104	0.091	-0.082
Brazil	0.0098	0.1724	0.270	0.009	-0.096	0.005	0.161	0.004
Chile	0.0189	0.0776	0.299	0.209	-0.112	0.008	0.043	0.083
Colombia	0.0134	0.0849	0.107	0.386	0.005	0.115	-0.060	0.011
Greece	0.0120	0.1085	0.239	0.079	0.015	0.086	-0.024	-0.100
India	0.0058	0.0913	0.017	0.100	-0.058	0.142	-0.054	-0.077
Jordan	0.0056	0.0435	0.108	-0.002	0.134	0.105	0.062	0.156
Korea	0.0080	0.1162	0.377	0.075	0.013	0.139	0.100	-0.047
Malaysia	0.0033	0.1008	0.418	0.128	-0.105	-0.111	0.167	-0.097
Mexico	0.0178	0.1315	0.381	0.285	-0.163	-0.083	0.060	-0.057
Nigeria	0.0067	0.1460	0.061	-0.002	-0.100	0.001	0.094	0.016
Pakistan	0.0057	0.0957	0.090	0.049	-0.037	0.030	-0.030	-0.038
Philippines	0.0111	0.1074	0.407	0.316	0.013	0.028	0.100	0.116
Taiwan	0.0104	0.1289	0.306	0.052	-0.064	-0.117	0.092	0.072
Thailand	0.0048	0.1213	0.428	0.089	-0.072	0.015	0.112	0.075
Venezuela	0.0065	0.1393	0.049	-0.005	-0.005	0.001	0.060	0.014
Zimbabwe	0.0147	0.1115	0.140	0.199	0.183	0.105	0.078	-0.063

Panel B

Country	Argentina	Brazil	Chile	Colombia	Greece	India	Jordan	Korea	Malaysia	Mexico	Nigeria	Pakistan	PhilippineS	Taiwan	Thailand	Venezuela	Zimbabwe
Argentina	1.00																
Brazil	0.08	1.00															
Chile	0.19	0.29	1.00														
Colombia	0.05	0.13	0.24	1.00													
Greece	0.10	0.07	0.25	0.20	1.00												
India	0.18	0.13	0.24	0.04	0.15	1.00											
Jordan	-0.11	0.01	0.05	0.07	0.09	0.12	1.00										
Korea	0.03	0.13	0.26	0.11	0.07	0.13	0.00	1.00									
Malaysia	0.09	0.15	0.35	0.11	0.12	0.15	0.03	0.28	1.00								
Mexico	0.25	0.18	0.43	0.11	0.18	0.14	0.00	0.21	0.35	1.00							
Nigeria	0.01	0.07	0.05	0.14	0.02	0.00	0.02	0.03	-0.06	-0.01	1.00						
Pakistan	0.04	0.13	0.20	0.32	0.06	0.23	0.13	0.13	0.22	0.16	0.07	1.00					
Philippines	0.09	0.20	0.38	0.21	0.16	0.08	0.02	0.31	0.52	0.24	0.01	0.12	1.00				
Taiwan	0.11	0.17	0.38	0.15	0.11	0.06	0.06	0.22	0.37	0.35	-0.06	0.12	0.30	1.00			
Thailand	0.15	0.15	0.39	0.14	0.16	0.17	0.09	0.47	0.64	0.34	-0.02	0.25	0.57	0.42	1.00		
Venezuela	0.15	0.02	0.07	0.21	0.07	0.11	0.07	0.03	0.19	0.09	0.09	0.09	0.09	-0.02	0.06	1.00	
Zimbabwe	0.01	0.12	0.21	0.13	0.09	0.14	0.04	0.27	0.19	0.12	0.08	0.11	0.20	0.09	0.19	0.21	1.00

Table 2 ADF and PP Tests for Random Walk in Emerging Stock Market Prices

This table reports augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for the random walk hypothesis for emerging market stock prices. The optimal lag length for the ADF tests is selected as suggested by Campbell and Perron (1991), with the maximum lag set to 12. For the PP tests, the truncation lag is set to 12.

The one, five and ten percent critical values are -3.529, -2.896 and -2.592, respectively for the model without a time trend; and -4.094, -3.467 and -3.158 for the model with a time trend. They are computed using Monte-Carlo simulation with 10,000 replications.

Country	ADF Tests		PP Tests	
	No Trend	With Trend	No Trend	With Trend
Argentina	-1.533	0.039	-2.050	-1.080
Brazil	-1.336	-3.815**	-1.715	-3.158*
Chile	-3.158**	-1.541	-3.621***	-1.032
Colombia	-2.338	-1.119	-2.060	-0.802
Greece	-2.109	-2.910	-1.956	-2.006
India	-1.902	-2.232	-3.055**	-3.169*
Jordan	-0.372	-3.207*	-1.506	-2.907
Korea	-3.214**	-3.194*	-2.700*	-2.536
Malaysia	-2.252	-2.108	-1.925	-1.913
Mexico	-2.458	-2.144	-2.331	-2.064
Nigeria	-0.823	-3.762**	-0.797	-2.848
Pakistan	-1.860	-1.519	-1.957	-1.723
Philippines	-3.597***	-3.009	-3.054**	-1.893
Taiwan	-3.214**	-2.924	-2.611*	-2.084
Thailand	-2.312	-2.105	-1.822	-1.426
Venezuela	-2.907**	-2.995	-2.084	-2.299
Zimbabwe	-2.380	-2.940	-2.535	-2.849

“*”, “**”, and “***” denote statistical significance at the ten, five, and one percent levels, respectively.

Table 3 Panel Tests for Mean Reversion of Stock Prices
Based on OLS Estimation

This table presents panel-based estimation results for stock price indexes for 17 emerging markets. The model is specified as:

$$r_t^i = \mu^i + (\lambda - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i$$

where $i = 1,..., N$. "N" is the panel size. The null hypothesis is H_0: $\lambda = 1$, and the alternative hypothesis is H_1: $\lambda < 1$. The test statistics are defined as: $z_\lambda = T(\hat{\lambda} - 1)$ and $t_\lambda = (\hat{\lambda} - 1)/s(\hat{\lambda})$, where T is the time periods in the sample, and $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$. The model is estimated by OLS under the assumption that the error terms are uncorrelated across countries. The p-values are computed from 5,000 Monte-Carlo replications.

	Lag length k=0	Lag length k=3	Lag length k=6	Lag length k=9	Lag length k=12
λ	0.981	0.981	0.979	0.978	0.978
z_λ	-3.887	-4.014	-4.321	-4.534	-4.551
p-value	0.169	0.136	0.078	0.049	0.047
t_λ	-8.793	-8.923	-9.172	-9.175	-8.675
p-value	0.000	0.000	0.000	0.000	0.000
Implied Half Life	36 months	36 months	33 months	31 months	31 months

Table 4 Panel Tests for Mean Reversion of Stock Prices
Based on SUR Estimation

This table presents panel-based estimation results for stock price indexes for 17 emerging markets. The model is specified as:

$$r_t^i = \mu^i + (\lambda - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i$$

where $i = 1,..., N$. "N" is the panel size. The null hypothesis is H_0: $\lambda = 1$, and the alternative hypothesis is H_1: $\lambda<1$. The test statistics are defined as: $z_\lambda = T(\hat{\lambda} - 1)$ and $t_\lambda = (\hat{\lambda} - 1)/s(\hat{\lambda})$ where T is the time periods in the sample, and $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$. The model is estimated by SUR under the assumption that the error terms are correlated across countries. The p-values are computed from 5,000 Monte-Carlo replications.

	Lag length k=0	Lag length k=3	Lag length k=6	Lag length k=9	Lag length k=12
λ	0.979	0.978	0.976	0.973	0.973
z_λ	-4.359	-4.560	-5.079	-5.697	-5.612
p-value	0.101	0.069	0.020	0.004	0.005
t_λ	-7.828	-8.117	-8.648	-9.234	-8.523
p-value	0.003	0.000	0.000	0.000	0.000
Implied Half Life	33 months	31 months	29 months	25 months	25 months

Table 5 Panel Tests for Mean Reversion of Stock Prices Relative to the World Market Index

This table presents panel-based estimation results for stock price indexes for 17 emerging markets relative to the world stock index (obtained from MSCI). The model is specified as:

$$r_t^i - r_t^{world} = \mu^i + (\lambda - 1)\, p_{t-1}^i - p_{t-1}^{world} + \sum_{j=1}^{k} \phi_j^i (r_{t-j}^i - r_{t-j}^{world}) + \varepsilon_t^i$$

where $i = 1,..., N$. "N" is the panel size. The null hypothesis is H_0: $\lambda = 1$, and the alternative hypothesis is H_1: $\lambda < 1$. The test statistics are defined as: $z_\lambda = T(\hat{\lambda} - 1)$ and $t_\lambda = (\hat{\lambda} - 1)/s(\hat{\lambda})$, where T is the time periods in the sample, and $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$. The model is estimated by OLS under the assumption that the error terms are uncorrelated across countries. The *p*-values are computed from 5,000 Monte-Carlo replications.

	Lag length k=0	Lag length k=3	Lag length k=6	Lag length k=9	Lag length k=12
λ	0.977	0.977	0.973	0.967	0.964
z_λ	-4.499	-4.661	-5.409	-6.535	-6.825
p-value	0.073	0.054	0.011	0.003	0.002
t_λ	-7.224	-7.380	-8.334	-9.634	-9.438
p-value	0.021	0.014	0.001	0.000	0.000
Implied Half Life	30 months	30 months	25 months	21 months	20 months

Table 6 Panel Tests for Mean Reversion of Seven Asian Stock Prices

This table presents panel-based estimation results for stock price indexes for seven Asian countries. The model is specified as:

$$r_t^i = \mu^i + (\lambda - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i$$

where $i = 1,..., N$. "N" is the panel size. The null hypothesis is H_0: $\lambda = 1$, and the alternative hypothesis is H_1: $\lambda < 1$. The test statistics are defined as: $z_\lambda = T(\hat{\lambda} - 1)$ and $t_\lambda = (\hat{\lambda} - 1)/s(\hat{\lambda})$, where T is the time periods in the sample, and $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$. The model is estimated by OLS under the assumption that the error terms are uncorrelated across countries. The *p*-values are computed from 5,000 Monte-Carlo replications.

	Lag length k=0	Lag length k=3	Lag length k=6	Lag length k=9	Lag length k=12
λ	0.967	0.966	0.963	0.957	0.957
z_λ	-6.800	-6.968	-7.690	-8.895	-8.969
p-value	0.011	0.007	0.004	0.001	0.001
t_λ	-6.474	-6.409	-6.681	-7.308	-6.940
p-value	0.001	0.001	0.001	0.000	0.000
Implied Half Life	21 months	20 months	18 months	16 months	16 months

Table 7 Panel Tests for Mean Reversion of Six Latin American Stock Prices

This table presents panel-based estimation results for stock price indexes for six Latin American countries. The model is specified as:

$$r_t^i = \mu^i + (\lambda - 1)\, p_{t-1}^i + \sum_{j=1}^{k} \phi_j^i r_{t-j}^i + \varepsilon_t^i$$

where $i = 1,..., N$. "N" is the panel size. The null hypothesis is H_0: $\lambda = 1$, and the alternative hypothesis is H_1: $\lambda < 1$. The test statistics are defined as: $z_\lambda = T(\hat{\lambda} - 1)$ and $t_\lambda = (\hat{\lambda} - 1) / s(\hat{\lambda})$, where T is the time periods in the sample, and $s(\hat{\lambda})$ is the standard error of $\hat{\lambda}$. The model is estimated by OLS under the assumption that the error terms are uncorrelated across countries. The p-values are computed from 5,000 Monte-Carlo replications.

	Lag length k=0	Lag length k=3	Lag length k=6	Lag length k=9	Lag length k=12
λ	0.983	0.983	0.981	0.978	0.977
z_λ	-3.587	-3.585	-3.983	-4.522	-4.833
p-value	0.407	0.408	0.331	0.214	0.154
t_λ	-5.235	-5.211	-5.504	-5.979	-6.000
p-value	0.012	0.012	0.005	0.000	0.000
Implied Half Life	40 months	40 months	36 months	31 months	30 months