Multi-Market Asset Trading and ADR Return Spread Serial Correlation: Evidence of ADR Return Spread Speed of Adjustment

David L. Senteney*
California State University San Bernardino
Taewon Yang
California State University San Bernardino

ABSTRACT
This research investigates the relationship between the underlying equity-ADR share spread and home country institutional and macroeconomic factors for non-U.S. firms having ADR shares listed on the major U.S. stock exchanges. Toward this end, we utilize country-specific series of home country equity share and U.S. exchange listed ADR return differential series to measure departures from arbitrage parity. In second stage analyses, we employ country portfolio time series models to estimate the degree and persistence of departures from arbitrage parity for each country equity-ADR share spread series. In a third stage analysis, we investigate the association of speed of adjustment of the underlying equity-ADR return spread series with home country institutional and macroeconomic factors. The results of this research indicate that the divergence of equity-ADR share spread return from arbitrage parity is significantly related to home country institutional factors such as property rights, government integrity, and government fiscal health, as well as macroeconomic factors such as tariffs, tax rates, and government expenditures as a percentage of GNP. We believe our findings contribute to our understanding of reasons for the existence of pricing differentials arising when identical assets are traded in different markets.

Keywords: ADR; Speed of Adjustment; Return Lead-Lag; Multi-market Trading; Cross-listing; Price Discovery
JEL: M10, M41

*Contact author: Dsenteney@csusb.edu

1. INTRODUCTION

The American Depository Receipts (ADR) are financial instruments representing ownership of shares in a non-U.S. company but having the convenience of trading on U.S. national exchanges in the same manner as ordinary U.S. equity shares.[1] Consequently, ADR shares are convenient instruments by which U.S. investors may acquire international diversification risk reduction while avoiding the non-U.S. taxes and trading costs accompanying ownership of non-U.S. equity shares. However, the price pressures created by Law of One Price (LOOP) multiple market arbitrage forces suggest that the underlying equity and ADR shares must trade at the same price after adjusting for applicable exchange rate transaction and trading costs since both shares represent ownership of the essentially the same basic assets. Nonetheless, existing research results indicate that underlying equity-ADR share return differentials are frequently observed and that home country equity-ADR share premiums and discounts arise as a result of other relevant economic causes (e.g., Bin et al., 2003 and Dey and Wang, 2012). For these reasons, home country equity-ADR share premiums and discounts remain prevalent and arbitrage opportunities (although small) persist.

The global growth in capital markets over recent decades gives rise to an abundance of new opportunities for multiple market asset trading and provides ample motivation for us to contemplate the appropriate manner by which multi-market activities should be carried out. A considerable body of relevant research literature addressing equity-ADR share pricing has developed over recent years highlighting relevant issues and improving our understanding of the multiple-market traded asset pricing in an international financial market setting. A preponderance of this literature suggests that LOOP deviations arise as a result of applicable macroeconomic forces creating barriers to full economic integration of markets and LOOP Parity. For example, Gagnon and Karolyi (2010) report empirical evidence suggesting that ADR share premiums and discounts are the arise from the degree of the home country economic development and suggest that less developed countries manifest greater underlying equity-ADR share pricing disparity. Furthermore, Howe and Ragan (2002) report empirical evidence suggesting that home country equity share price discovery leads ADR share prices, and Kim et al. (2000) find that the speed of ADR LOOP deviation adjustment is associated with the underlying equity share home country market index, exchange rate, and share price. Investigating German underlying equity-ADR share pairs-trading, Grammig et al. (2005) report empirical results suggesting that the majority underlying equity-ADR share price discovery takes place in the home country equity market. Similarly, Eun and Sabherwal (2003) report that price discovery in Canadian equity-ADR shares is directly associated with order flow competition.

The purpose of this research is to investigate the association between international financial market integration and underlying equity-ADR Share Parity Deviations as viewed from LOOP. Following upon the "No Arbitrage" condition, LOOP dictates that two markets are integrated if and only if similar assets are priced similarly in the two markets. As a result, this study investigates the observed underlying equity-ADR share return differential serial correlation in order to illuminate the empirical magnitude and persistence of parity deviations speed of adjustment so as

[1] . ADRs were created as a mechanism to circumvent costly barriers arising from investing in equity shares of non-U.S. companies as well as the various difficulties arising from share prices denominated in currencies other than the U.S. Dollar. Guaranty Trust Co. (i.e., predecessor to J.P. Morgan) initiated trading in ADR shares in the U.S in 1927 when it began issuing and trading ADR shares of British retailer Selfridges. The ADR was first listed on the New York Curb Exchange and introduced the first sponsored ADR for British firm Electrical and Musical Industries (i.e., EMI) in 1931. In recent years J.P. Morgan and BNY Mellon are the U.S. Financial Institutions most actively involved with U.S. ADR shares.

to further our understanding of the functioning of multi-market asset trading. With greater financial market integration (i.e., absent significant barriers to investment), the underlying-ADR share return differential should dissipate rapidly and tend to zero after adjusting for exchange rate conversion and transaction costs. This research employs a "pairs-trading" zero-investment return models to investigate financial market integration and the serial dependence of LOOP deviations for underlying equity-ADR shares trading in the applicable home country equity market and the U.S. Level II and Level III ADR share markets[2]. Similar to extant research, we examine return cross-autocorrelations across underlying equity-ADR share markets employing the established methodology of comparative adjustment to market return indices.[3] We utilize well-established traditional linear market model aggregated coefficients approaches to measure the speed of adjustment (i.e., or lack thereof) of underlying equity-ADR share pricing disparity. Because the lagged response of underlying equity-ADR share return differential is a return-based surrogate for degree of financial market integration, we interpret faster adjustment as less LOOP deviation and greater degree of market integration.

Our results suggest that the underlying equity-ADR share return differential series exhibits significant and persistent degree of divergence from arbitrage parity resulting in significant return differential adjustment lags. Furthermore, we find that the underlying equity-ADR differential return series adjustment lags are related to home country economic institutional factors such as strength of property rights, judicial effectiveness, and tax burden, as well as home country macroeconomic variables such as corporate tax rates and taxes as a percentage of GNP. We believe our findings contribute to our understanding of reasons for the existence of pricing differentials arising when identical assets are traded in different markets.

The outline of the remaining sections is as follows: In the following section of this paper, we review the prior literature pertaining to this topic and establish foundation for statistical hypotheses. The sections following the literature review will describe the empirical methods and results of statistical hypotheses tests. The final section will contain the conclusion and any suggestions for further research.

2. PRIOR RESEARCH AND HYPOTHESES DEVELOPMENT

Prior years of financial markets research has produced an extensive body of empirical evidence addressing and assessing time series properties of short-term equity security returns. The observed autocorrelation in short-term equity share returns is well established in the extant relevant empirical research literature establishing that many equity share return series display significant serial correlation.[4] The observed empirical serial correlation of equity share return series presents somewhat puzzling evidence for finance researchers since the predictability of equity share returns

---

[2]. Level II and Level III ADRs require foreign private issuers to register and file annual reports with the United States Securities and Exchange Commission (SEC). The U.S. SEC reporting requirements applicable to Level III ADRs are more stringent than for Level II ADR shares because Level III shares have the added advantage of raising capital via initial public offering on major U.S. stock exchanges. Consequently, Level III ADRs must comply with strict investor protection disclosure requirements applicable to all other exchange listed shares as promulgated by the U.S. SEC.

[3] . Studies based on stock market indices include, among many others, Cashin et al. (1995), Soydemir (2000), Masih and Masih (2001), Scheicher (2001), and Chen et al. (2002). Capital asset-pricing models to test for market integration have been applied by Bekaert and Harvey (1995), Bekaert et al. (2005), and Carrieri et al. (2007), among others.

[4]. A few examples of the extensive extant empirical research literature are Jagadeesh (1990), Lehmann (1990), Conrad, Kaul and Nimalendran (1991), Copper (1999), Gervais, Kaniel and Mingelgrin (2001), Avramov, Chordia and Goyal (2006), and Hendershott and Seasholes (2014).

is contrary to financial market informational efficiency. As a result, Finance researchers have devoted significant time and resources to identifying factors associated with serial correlation in equity share return series.[5]

One of the more prominent characteristics of observed equity security return behavior weighing heavily on the minds of financial market researchers is the observed positive cross-autocorrelation in lead-lag return series ordinarily believed to arise from illiquidity considerations. Among underlying factors driving this aspect of security return behavior are firm size (Lo and McKinlay (1990)), analysts following (Brennan, Jegadeesh, and Swaninathan (1993)), institutional ownership (Badrinath, Kale, and Noe (1995), and trading volume Chordia and Swaminathin (2000), asynchronous trading (Lo and McKinlay (1990b) and Boudoukh, Richardson, and Whitelaw (1994)), time-varying expected returns (Conrad and Kaul (1988; 1989) and Hameed (1997)), and delayed information processing (Chordia and Swaminathin (2000)).

2.1. MARKET INDICES COPARION APPROACH

The most important operational issue in endeavoring to measure the speed of adjustment of security returns is the question of which security return series to compare it with. The comparison might be, for example, a security's own past return series, the returns series of industry-based portfolios, or market index return series depending on whether one is investigating the return spend of adjustment to firm-specific, industry, or market wide information. One approach well-established in the relevant research literature examining the speed the of adjustment of prices to market-wide information is to employ market indices as the comparison return series as a surrogate for market-wide price-relevant information in time series models. Because ADR shares have two price relevant markets (i.e., the home country equity market and the U.S. ADR market), this study employs a Two-Index Longitudinal Market Model (TILMM) approach similar to Gagnon and Karolyi (2010) for each of the underlying equity-ADR share return series utilizing respective home country equity and U.S. NYSE market indices as the comparison return series with which to juxtaposition the underlying equity-ADR return spread series. Each TILMM includes contemporaneous as well as lagged values of home country and U.S. NYSE market indices for the comparison return series as independent explanatory variables in time series models estimating the serial correlation of those variables with the underlying equity-ADR return spread series. Estimation of time series models specified in this manner is a convenient way to estimate the speed of adjustment of the underlying equity-ADR return spread series to market-wide price relevant information by testing null hypotheses concerning the statistical significance of coefficients for the contemporaneous and lagged values of the reference market indices. Specifically, this research examines differences in the relative magnitude of the contemporaneous and lagged values of the reference market index coefficients in order to make inferences regarding differences in the speed of adjustment of the underlying equity-ADR return spread series to price-relevant market-wide information.[6] We use the TILMM time series model specification shown in Figure Equation No.1 below to test relevant null hypotheses regarding differences in the speed of adjustment of

[5]. Naturally, a negative serial correlation is consistent with mean reversion in equity share return series.

[6]. One advantage of this approach is that the model specification investigates the extent to which current returns are predicted (or granger caused) by lagged returns on return series. Using the time-series model specification shown above, the sum of the same return coefficients approximates the speed of price adjustment to new information. Furthermore, the sum of the cross-portfolio coefficients is the cross-autocorrelation (lead-lag relation) between the different return series. It is common in the extant literature for the sum of the own lag return coefficients to be interpreted as the speed of adjustment to the new information (Chordia and Swaminathin (2000), Fargher and Weigand, and McQueen et al. (1996)).

underlying equity-ADR return spread series to price-relevant market-wide information in the two markets applicable to ADR shares.

Equation No.1: Equity-ADR Share Return Spread R_t^{A-E}= R_{it}^{ADR}- R_{it}^{Equity} TILMM Regression - Speed of Return Spread Response To Two Market Information

$$R_t^{A-E} = \beta_{i,0}^{A-E} + \sum_{j=-5}^{j=0} \beta_{i,1-j}^{A-E:Equity} \cdot R_{M,t+j}^{Home} + \sum_{j=-5}^{j=0} \gamma_{i,6-j}^{A-E:ADR} \cdot R_{M,t+j}^{US} + \varepsilon_{it}^{A-E} \quad (1)$$

Definitions and Measurement of the Return Variables Employed in TILMM Spread Time Series Analyses

Name	Symbol	Variable Computation	Variable Description
ADR Share Daily Returns	R_{it}^{ADR}	$= \frac{P_{it}^{ADR} - P_{it-1}^{ADR} + Dividend_t^{ADR}}{P_{it-1}^{ADR}}$	The daily U.S. ADR share dividend adjusted return.
Equity Share Daily Returns	R_{it}^{Equity}	$= \Delta\,\gamma_{it} \cdot \left[\frac{P_{it}^{Equity} - P_{it-1}^{Equity} + Dividend_t^{Equity}}{P_{it-1}^{Equity}}\right]$	The U.S. Dollar home country equity share return after adjusting the equity share return for daily currency exchange rate changes ($\Delta\,\gamma_{it}$).
Return Spread	R_t^{A-E}	$= R_{it}^{ADR}$ - R_{it}^{Equity}	U.S. ADR and Home Country daily share return differential.
U.S. Market Daily Return	R_{Mt}^{US}	$= \frac{Index_t^{NYSE} - Index_{t-1}^{NYSE} + Dividend_t^{NYSE}}{Index_{t-1}^{NYSE}}$	Daily total dividend-adjusted and equally weighted U.S. NYSE Market share return for trading day t.
Home Market Daily Return	R_{Mt}^{Home}	$= \Delta\,\gamma_{it} \cdot \left[\frac{Index_t^{Home} - Index_{t-1}^{Home} + Dividend_t^{Home}}{Index_{t-1}^{Home}}\right]$	Respective U.S.-listed ADR share Home Country Market daily currency exchange rate adjusted ($\Delta\,\gamma_{it}$) total dividend-adjusted equally weighted return for trading day t.

2.2. INTERPRETATION OF EQUATION FOR HYPOTHESES TESTS

The first null hypothesis (i.e., **H_{01}**) derived from Equation No.1 addresses differences in the contemporaneous association of the underlying equity-ADR return spread series with home country (i.e., $\beta_{i,1}^{A-E:Equity}$) and U.S. NYSE (i.e., $\gamma_{i,1}^{A-E:ADR}$) market indices. The first hypothesis tests how well the underlying equity-ADR return spread series tracks each of the market return indices contemporaneously. Because the dependent variable is the difference in the underlying equity-ADR share return series (i.e., R_t^{A-E}= R_{it}^{ADR}- R_{it}^{Equity}) interpretation of the coefficients for the home country (i.e., $\beta_{i,1}^{A-E:Equity}$) and U.S. NYSE (i.e., $\gamma_{i,1}^{A-E:ADR}$) market returns series is interpreted as the difference between the contemporaneous association coefficients for each of the home country market returns series $\beta_{i,1}^{A-E:Equity} = \beta_{i,1}^{ADR} - \beta_{i,1}^{Equity}$ and the U.S. NYSE return series $\gamma_{i,1}^{A-E:ADR} = \gamma_{i,1}^{ADR} - \gamma_{i,1}^{Equity}$. Consequently, the first null hypothesis addresses the equality of the differences in the contemporaneous association coefficients (i.e., H_{01}: $\gamma_{i,1}^{A-E:ADR} = \beta_{i,1}^{A-E:Equity}$).

Interpretation of Equation No.1: ADR Shares Respond More Rapidly to Market-Wide Information When:

$$\gamma_{i,1}^{A-E:ADR} > \beta_{i,1}^{A-E:Equity} \text{ and } \sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR} < \sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$$

$$\text{or alternatively, } \frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}} < \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$$

Testable Hypotheses Derived From TILLM Equation No.1:

H_{01}: Differences in Contemporaneous Association: The return spread series tracks the two market indices equally well.

H_{01}: $\gamma_{i,1}^{A-E:ADR} = \beta_{i,1}^{A-E:Equity}$

H_{02}: Differences in Association of Lagged Market Indices: The return spread series tracks the two market indices with a similar lagged response.

$$H_{02}: \sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR} = \sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$$

H_{03}: Differences in Comparison of Contemporaneous and Lagged Market Indices: The return spread series tracks the two market indices with a similar speed of adjustment to the market-wide information.

$$H_{03}: \frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}} = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$$

The second null hypothesis (i.e., **H_{02}**) tests how well the underlying equity-ADR return spread series tracks each of the two lagged market return indices (i.e., delayed adjustment to market-wide information). The second null hypothesis addresses the sums of the lagged response coefficients in order to test whether the differences in the speed of adjustment of the underlying equity-ADR return spread series vis-à-vis the two sources of information (i.e., the home country and U.S. NYSE market returns series) are statistically significant. Consequently, we test null hypothesis that the difference between the sums of the lagged coefficients for each of the home country equity and U.S. NYSE market return series are equal to zero (i.e., H_{02}: $\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR} = \sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$). The results of this hypothesis provide insight into whether the underlying equity-ADR return spread series exhibits differential delayed adjustments to the home country and U.S. NYSE market returns series.

The third null hypothesis (i.e., **H_{03}**) addresses differences in comparative speed of adjustment to the home country and U.S. NYSE market returns series using the respective market contemporaneous association as a base for comparison. Consequently, we compare the differences in the home country equity market sum of the lagged response coefficients with the home country equity market contemporaneous response coefficients (i.e., $\frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$) and the U.S. NYSE market sum of the lagged response coefficients with the U.S. NYSE market contemporaneous response coefficients (i.e., H_{03}: $\frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}} = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$) in order to make inferences regarding the speed of adjustment of the underlying equity-ADR return spread series to the two sources of price-relevant information (i.e., the home country equity and U.S. NYSE market return series). For this reason, we test the null hypothesis that there is no difference in the underlying equity-ADR return spread series between the speed of adjustment ratios (i.e., H_{03}: $\frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}} = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$) vis-à-vis the two sources of information (i.e., the home country and U.S. NYSE market returns series).

3. SAMPLE SELECTION AND EMPIRICAL MODELS

The firms used in this research are non-U.S. companies having ADR shares listed on major U.S. stock exchanges and are thereby subject to applicable U.S. SEC filing requirements. This research uses daily U.S. dollar denominated equity and ADR security returns and relevant home country and U.S. NYSE market return indices for a time period ranging from January 1, 2000 through December 31, 2015 from DataStream subscription. The list of ADR firms is obtained from the Bank of New York and the JP Morgan ADR Universe websites. These ADRs are traded on the NYSE, AMEX or NASDAQ exchanges. Narrowing the list of companies satisfying data availability requirements results in 354 non-U.S. firms from 38 countries are utilized in a time series of 4174 trading-days over the 15-year time period examined. Descriptive statistics for the return data used as variables in time series model estimation and statistical tests are shown in Table No.1. Table No.1 shows the distributional statistics for the data employed in the empirical analyses of the variables used in this research.

Table No.1: **Descriptive Statistics For The Daily Equity-ADR Share Return Spread Data Employed In Computation Of Country-Specific Return Series Portfolios For Estimation Of Zero-Investment Time Series Models**

Panel A: Location and Dispersion Statistics for Return Data Used in TILLM Estimation

Variable	Mean	Std Dev	t Value	Maximum	Minimum	Skewness [1]	Kurtosis [2]
R_{it}^{ADR}	0.000054	0.026844	2.45 †	0.693147	-2.740842	-2.031999	238.912284
R_{it}^{Equity}	0.000063	0.026897	2.87 †	0.693147	-3.217602	-4.006925	442.928713
R_{t}^{A-E}	0.000009	0.024112	0.47	1.785712	-3.229377	-2.626627	598.599251
R_{Mt}^{Home}	-0.006886	0.206644	-40.51†	0.693147	-10.680016	-23.801603	703.043521
$R_{Mt}^{US\ NYSE}$	0.000157	0.012479	15.29	0.109130	-0.093962	-0.206252	7.992271

†: Indicates that the variable specific null hypothesis is rejected at the α = 0.05 confidence level.

1: The null hypothesis that the mean data value is equal to zero under the null is tested using the Student's t Test. Student's t-Test : $t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{N}}}$, where $\bar{x}$ is the sample mean, N is the number of non-missing values for a variable x_i, and s is the sample standard deviation. The critical t-value for the α = 0.05 confidence level two-tailed test is 1.962.

1: **Sample Skewness:** Skewness is a measure of symmetry or the lack of symmetry of data. A distribution is symmetric if the left and right of the center point appear similar. Skewness = $\frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^3}{\left[\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right]^{3/2}} \cdot \frac{N\sqrt{N-1}}{N-2}$, with all variables defined as previously. To test the statistical significance of the computed skewness value, the skewness measure is converted to an appropriate Z statistic by dividing the skewness measure by its standard error, i.e., $Z_S = \left\{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^3}{\sum_{i=1}^{N}(x_i - \bar{x})^{3/2}} \cdot \frac{N\sqrt{N-1}}{N-2}\right\} \cdot \frac{1}{\sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}}$. The skewness statistic indicates substantial departure from normality for absolute skewness statistic values > 2.00.

2: **Sample Kurtosis**: Kurtosis measures whether the data are heavy-tailed or light-tailed when compared with the normal distribution. Data having high kurtosis tend to have heavy tails and outliers. Data having low kurtosis have light tails and no outliers. Kurtosis = $\frac{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N}}{\left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N}\right]^2} -$ 3, where all variables are defined as previously. To test the statistical significance of the kurtosis value, the computed kurtosis is converted to an appropriate Z statistic by dividing the skewness measure by its standard error, i.e., $Z_K = \left\{\left\{\frac{(N-1)}{(N-2)(N-3)}\right\} \cdot \left\{(N+1)\left[\frac{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N}}{\left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N}\right]^2} - 3\right] + 6\right\}\right\} \cdot \left\{\frac{2}{\sqrt{\frac{(N^2-1)}{(N-3)(N+5)}}\sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}}\right\}$. The kurtosis statistic indicates substantial departure from normality for absolute skewness statistic values > 2.00.

Panel B: Descriptive Information Regarding Sample Composition By Country

Country Name	Country Market Index Name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Argentina	Buenos Aires Stock Exchange	14	3.95	14	3.95
Australia	Australian Stock Exchange	12	3.39	26	7.34
Belgium	Euronext Brussels	1	0.28	27	7.63
Brazil	Sao Paulo Stock Exchange	30	8.47	57	16.10
Chile	Santiago Stock Exchange	15	4.24	72	20.34
China	Shanghai Stock Exchange	63	17.80	135	38.14
Colombia	Bolsa de Valores de Colombia	2	0.56	137	38.70
Denmark	Copenhagen Stock Exchange	1	0.28	138	38.98

Finland	Helsinki Stock Exchange	2	0.56	140	39.55
France	Euronext Paris	11	3.11	151	42.66
Germany	XETRA Frankfurt	12	3.39	163	46.05
Greece	Athens Stock Exchange	4	1.13	167	47.18
Hong Kong	Hong Kong Stock Exchange	7	1.98	174	49.15
Hungary	Budapest Stock Exchange	1	0.28	175	49.44
India	Madrid Stock Exchange	14	3.95	189	53.39
Indonesia	Jakarta Exchange	2	0.56	191	53.95
Ireland	Irish Stock Exchange	9	2.54	200	56.50
Israel	Tel Aviv Stock Exchange	5	1.41	205	57.91
Italy	Milan Stock Exchange	9	2.54	214	60.45
Japan	JASDAQ Stock Exchange	23	6.50	237	66.95
Korea	KOSDAQ Stock Exchange	11	3.11	248	70.06
Luxembourg	Luxembourg Stock Exchange LuxSE	1	0.28	249	70.34
México	Bolsa Mexicana de Valores	22	6.21	271	76.55
Netherlands	Euronext Amsterdam	8	2.26	279	78.81
N Zealand	New Zealand Stock Exchange	1	0.28	280	79.10
Norway	Oslo Stock Exchange	2	0.56	282	79.66
Peru	Bolsa de Valores de Lima	1	0.28	283	79.94
Philippines	Philippines Stock Exchange	2	0.56	285	80.51
Portugal	Euronext Lisbon	1	0.28	286	80.79
Russia	MICEX	5	1.41	291	82.20
South Africa	Johannesburg Stock Exchange	8	2.26	299	84.46
Spain	Madrid Stock Exchange	4	1.13	303	85.59
Sweden	Stockholm Stock Exchange	2	0.56	305	86.16
Switzerland	Six Swiss Stock Exchange	4	1.13	309	87.29
Taiwan	Taiwan Stock Exchange	7	1.98	316	89.27
Turkey	Istanbul Stock Exchange	1	0.28	317	89.55
UK	London Stock Exchange	37	10.45	354	100.00

Table 2: Results of U.S. Listed ADR-Equity Share Return Spread Time Series Estimation: Estimation of Country Specific TILLM Times Series Portfolio Zero Cost Pairs Model For 38 Country Portfolios

Descriptive Statistics for Country Portfolio Longitudinal Time Series Models: The table below shows the mean coefficients estimates and respective null hypotheses tests that the respective time series coefficient estimates values take a value of zero. The mean and median values of the coefficient values are shown on the left and normality statistics are shown on the right side of the table.

Coefficient	Mean	Median	Std Dev	Maximum	Minimum	t Value [1]	Skewness [2]	Kurtosis [3]
$\beta_{i,1}^{Home}$	0.107094	0.067002	0.108704	0.357702	0.000000	5.99 †‡	0.827385	-0.524779
$\sum_{j=1}^{j=J} \beta_{i,k+j}^{Home}$	0.288643	0.087449	0.939867	5.648129	0.000331	1.87	5.512727	31.559606
$\frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{Home}}{\beta_{i,1}^{Home}}$	16.653356	1.105448	54.913311	302.547085	0.182556	1.79	4.626192	22.994163
$\frac{1}{1+e^{-x}}$ where $x = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{Home}}{\beta_{i,1}^{Home}}$	0.282555	0.288104	0.159788	0.499174	0.004161	10.46 †‡	-0.167737	-1.323039
$\gamma_{i,1}^{US}$	0.362088	0.340424	0.175273	0.834770	0.087557	12.57 †‡	0.575727	0.072963
$\sum_{j=1}^{j=J} \gamma_{i,k+j}^{US}$	0.019664	0.010412	0.019981	0.077760	0.001208	5.99 †‡	1.562051	1.940779
$\frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{US}}{\gamma_{i,1}^{US}}$	0.920933	0.846482	0.432944	3.085738	0.282513	12.94 †‡	3.591441	17.649510
$\frac{1}{1+e^{-x}}$ where $x = \frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{US}}{\gamma_{i,1}^{US}}$	0.233692	0.234808	0.067200	0.419684	0.028204	21.15 †‡	-0.307629	2.473205

Country Portfolio TILLM Time Series Equation No.1: $\bar{R}_{it}^{A-E} = \beta_{i,0}^{A-E} + \sum_{j=-5}^{j=0} \beta_{i,1-j}^{A-E:Equity} \cdot \bar{R}_{Mi,t+j}^{Home} + \sum_{j=-5}^{j=0} \gamma_{i,6-j}^{A-E:ADR} \cdot \bar{R}_{M,t+j}^{US} + \varepsilon_{it}^{A-E}$

†: **Student's t-Test** : The null hypothesis that the mean data value is equal to zero under the null is tested using the Student's t Test. Student's t-Test : $t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{N}}}$, where $\bar{x}$ is the sample mean, N is the number of non-missing values for a variable x_i, and s is the sample standard deviation. The critical t-value for the α = 0.05 confidence level two-tailed test is 1.686.

‡: **Non-Parametric Tests**: Indicates that the null hypothesis of no difference from zero is rejected at the α = 0.05 confidence level under the null hypothesis that the mean data variables values are equal to zero using the Wilcoxon Sign Rank Test. The Wilcoxon Sign Rank Test: $S = \sum r_i^+ - \frac{n_t(n_t+1)}{4}$, where r_i^+ is the rank of $|x_i - \mu_0|$ after discarding values of x_i equal to μ_0, n_t is the number of x_i values not equal to μ_0, and the sum is calculated for values of $x_i - \mu_0$ greater than 0. The Wilcoxon rank sum, Kendall's S and Mann-Whitney U test are exactly equivalent tests.

2: **Sample Skewness:** Skewness is a measure of symmetry or the lack of symmetry of data. A distribution is symmetric if the left and right of the center point appear similar. Skewness = $\frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^3}{\left[\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right]^{3/2}} \cdot \frac{N\sqrt{N-1}}{N-2}$, with all variables defined as previously. To test the statistical significance of the computed skewness value, the skewness measure is converted to an appropriate Z statistic by dividing the skewness measure by its standard error, i.e., $Z_S = \left\{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^3}{\sum_{i=1}^{N}(x_i - \bar{x})^{3/2}} \cdot \frac{N\sqrt{N-1}}{N-2}\right\} \cdot \frac{1}{\sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}}$. The skewness statistic indicates substantial departure from normality for absolute skewness statistic values > 2.00.

3: **Sample Kurtosis**: Kurtosis measures whether the data are heavy-tailed or light-tailed when compared with the normal distribution. Data having high kurtosis tend to have heavy tails and outliers. Data having low kurtosis have light tails and no outliers. Kurtosis = $\frac{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N}}{\left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N}\right]^2} - 3$, where all variables are defined as previously. To test the statistical significance of the kurtosis value, the computed kurtosis is converted to an appropriate Z statistic by dividing the skewness measure by its standard error, i.e., $Z_K = \left\{\left\{\frac{(N-1)}{(N-2)(N-3)}\right\} \cdot \left\{(N+1)\left[\frac{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N}}{\left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N}\right]^2} - 3\right] + 6\right\}\right\} \cdot \left\{\frac{2}{\sqrt{\frac{(N^2-1)}{(N-3)(N+5)}}\sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}}\right\}$. The kurtosis statistic indicates substantial departure from normality for absolute skewness statistic values > 2.00.

---

4. DISCUSSION OF RESULTS OF TIME SERIES MODELS AND RELEVANT STATISTICAL HYPOTHESES TESTS

In order to test the statistical hypotheses for time series Equation No.1 discussed earlier, we group firms into country portfolios consisting of average daily return series for each of the following five return series: (1) average daily home country market returns, (2) average daily U.S. NYSE market returns, (3) average daily home country equity share returns, (5) average daily U.S. ADR share returns, and (5) the average daily underlying equity-ADR return spread $\bar{R}_{it}^{A-E}$. Using the five daily average return series for each of 38 country portfolio time series we estimate Equation No.1 for each of the 38 country portfolios. Table No.2 shows the summary statistics for the parameter estimates for Equation No.1 for those 38 country portfolios.

As shown in Table No.2, the average contemporaneous association of the underlying equity-ADR return spread with the home country equity market is significantly different from zero at the α=0.05 confidence level. Furthermore, the average contemporaneous association of the underlying equity-ADR return spread with the U.S. NYSE equity market is significantly different from zero at the α=0.05 confidence level. Although the association of the underlying equity-ADR return spread with both the home country equity market and U.S. NYSE equity market is significantly different from zero at the α=0.05 confidence level, Null Hypothesis No.1 H_{01}: $\gamma_{i,1}^{A-E:ADR} = \beta_{i,1}^{A-E:Equity}$ that the magnitude of the association of underlying equity-ADR return spread with both market indices is similar is rejected at the α=0.05 confidence level since $\beta_{i,1}^{Home}$ = 0.107094 < $\gamma_{i,1}^{A-E:US}$ = 0.362088. As a result, we conclude that the contemporaneous association of underlying equity-ADR return spread with the U.S. NYSE equity market is greater than the contemporary association with home country equity market. This result suggests that the underlying equity-ADR return spread adjusts more rapidly to information conveyed by the U.S. NYSE equity market than information conveyed by the ADR share home country equity market.

Testable Hypotheses Derived From Country Portfolio Equation No.1:		
H_{01}: Differences in Contemporaneous Association: The return spread series tracks the two market indices equally well.		**H_{01}**: $\gamma_{i,1}^{A-E:ADR} = \beta_{i,1}^{A-E:Equity}$
Kruskal-Wallis Test	Chi-Square Statistic: 54.7608 †	Result of Hypothesis Test **H_{01}:**
	Pr > Chi-Square: 0.0001	Reject at α = 0.05 Confidence Level

Furthermore, Table No.2 also indicates that the average lagged association of the underlying equity-ADR return spread with the home country equity market (i.e., $\sum_{j=1}^{j=J}\beta_{i,k+j}^{A-E:Equity}$= 0.288643) is significantly different from zero at the α=0.05 confidence level as well. In addition, Table No.2 also indicates that the average lagged association of the underlying equity-ADR return spread with the U.S. NYSE equity market (i.e., $\sum_{j=1}^{j=J}\gamma_{i,k+j}^{A-E:ADR}$= 0.019664) is significantly different from zero at the α=0.05 confidence level. Even though the underlying equity-ADR return spread is significantly associated with lagged values of both home country equity market and U.S. NYSE equity market returns, the magnitude of the association is significantly greater for the home country equity market vis-à-vis the U.S. NYSE equity market (i.e., $\sum_{j=1}^{j=J}\beta_{i,k+j}^{A-E:Equity}$ = 0.288643 > $\sum_{j=1}^{j=J}\gamma_{i,k+j}^{A-E:ADR}$= 0.019664). For this reason, the null hypothesis that the underlying equity-ADR return spread series is equally associated with lagged home country equity market and U.S. NYSE equity market returns is rejected at the α = 0.05 confidence level. Consequently, we conclude that the persistence of the underlying equity-ADR return spread series is associated with delayed adjustment to price-relevant information conveyed by the home country equity market.

H02: Differences in Association of Lagged Market Indices: The return spread series tracks the two market indices with a similar lagged response.

H02: $\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR} = \sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$

Kruskal-Wallis Test	Chi-Square Statistic: 32.0295 †	Result of Hypothesis Test **H02:**
	Pr > Chi-Square Statistic: 0.0001	Reject at α = 0.05 Confidence Level

Table No.2 also shows that the ratio of the delayed association of the underlying equity-ADR return spread series with the home country equity market return series to the contemporaneous association of the underlying equity-ADR return spread series with the home country equity market return series (i.e., $\frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$ = 16.653356) is significantly greater than zero at the α = 0.05 confidence level. This value of the delay ratio taking a value greater than unity indicates that the lagged adjustment (i.e., $\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$) of the underlying equity-ADR return spread series to the home country equity market return series demonstrates the dominates the contemporary adjustment (i.e., $\beta_{i,1}^{A-E:Equity}$) and, thereby, inducing a lagged adjustment in the underlying equity-ADR return spread series to the information conveyed by the home country equity market return series. In contrast, Table No.2 also indicates that the ratio of the delayed association of the underlying equity-ADR return spread series with the U.S. NYSE equity market returns series to the contemporaneous association of the underlying equity-ADR return spread series with the U.S. NYSE equity market returns series takes a value which is less than unity (i.e., $\frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}}$ = 0.920933) but nonetheless is significantly greater than zero at the α = 0.05 confidence level. The value of the delay ratio being less than unity indicates that the contemporary association of the underlying equity-ADR return spread series with the U.S. NYSE equity market returns series dominates the delayed adjustment to the U.S. NYSE equity market returns series and suggests that the underlying equity-ADR return spread series does not exhibit delayed adjustment to information conveyed by the U.S. NYSE equity market returns series.

H03: Differences in Ratio of Contemporaneous and Lagged Market Indices: The return spread series tracks the two market indices with a similar speed of adjustment to the market-wide information.

H03: $\frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}} = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$

Kruskal-Wallis Test:	Chi-Square Statistic: 10.2022 †	Result of Hypothesis Test **H03:**
	Pr > Chi-Square Statistic: 0.0014	Reject at α = 0.05 Confidence Level

Estimation of Equity-ADR Spread Time Series Model No.1 For 38 Country-Specific Daily Return Portfolios: Summary of Results of Hypotheses Tests

Hypothesis Number	Coefficient Values	Signed Rank Test P-Value	Result
Hypothesis No.1 (Table No.2)	**H01**: $\gamma_{i,1}^{A-E:US} = \beta_{i,1}^{A-E:Equity}$	0.0001 ‡	Reject (α = 0.05)
Hypothesis No.2 (Table No.2)	**H02**: $\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:US} = \sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}$	0.0001 ‡	Reject (α = 0.05)

Hypothesis No.3 (Table No.2)	**H03**: $\frac{\sum_{j=1}^{j=J}\gamma_{i,k+j}^{A-E:US}}{\gamma_{i,1}^{A-E:US}} = \frac{\sum_{j=1}^{j=J}\beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$	0.0001 ‡	Reject (α = 0.05)

5. HOME COUNTRY INSTITUTIONAL INFRASTRUCTURE INDICES AND MACROECONOMIC VARIABLES

The final stage of this research we present analyses with the goal of identifying country-specific infrastructure indices and macroeconomic variables associated with lagged underlying equity-ADR return spread series adjustment to price-relevant information conveyed by home country equity market and U.S. NYSE equity market returns series. Toward this end, we utilize country-specific indices obtained from the Heritage Foundation website (https://www.heritage.org/index/explore) ranking countries of the world on dimensions of market-based economy supportive institutional infrastructure and macroeconomic statistics as surrogates for degree of market integration. We reason that countries ranked as having a greater degree of integration with world financial markets will exhibit smaller delay in the adjustment of underlying equity-ADR return spread series adjustment to price-relevant information conveyed by home country equity market and U.S. NYSE equity market returns series. On the other hand, we expect that countries ranked as having a lesser degree of integration with world financial markets will exhibit greater delay in the adjustment of underlying equity-ADR return spread series adjustment to price-relevant information conveyed by home country equity market and U.S. NYSE equity market returns series. Summary statistics and a description for the Heritage Foundation Indices and Macroeconomic measures can be found in Appendix A.

In order to identify home country institutional and macroeconomic factors which are associated with measures of underlying equity-ADR return spread series adjustment delay we employ a second-stage regression analysis positioning the measures of underlying equity-ADR return spread series adjustment delay as the dependent variable and the home country institutional and macroeconomic factors as independent variables in the model. Identifying the home country institutional and macroeconomic factors relevant to measures of underlying equity-ADR return spread series adjustment delay becomes a question of linear regression model specification and the appropriate selection of the independent variables (i.e., home country institutional and macroeconomic factors) producing the model having the highest explanatory power for measures of underlying equity-ADR return spread series adjustment delay.

The dependent variable we use in identifying the best set of home country institutional and macroeconomic factor regressors is the ratio of the delay in the response to home country market-wide information to delay in the response to U.S. ADR market-wide information. Each delay measure (Delay1 and Delay2) transforms the ratio of the respective home country and U.S. ADR sums of lagged coefficients divided by the contemporaneous coefficient using a logit function transformation in order to reduce the scale of the data into measures better aligned with the Heritage Foundation home country institutional and macroeconomic factors index regressors. The Logit function transformation produces data observations ranging between 0 and 0.5, and, as a result, the Delay dependent variable will take values greater than zero and be monotonic increasing in relation to delay. The regression equation employed is shown below.

Dependent Variable for Home Country Institutional and Macroeconomic Factors Model Specification and Selection of Best Explanatory Model Regressors

Regression Equation No.2: $\text{Delay}_i = \delta_0 + \delta_1 \bullet \text{Property Rights}_i + \delta_2 \bullet \text{Judicial Effectiveness}_i + \delta_3 \bullet \text{Tax Burden}_i + \delta_4 \bullet \text{Fiscal Health}_i + \delta_5 \bullet \text{Corporate Tax Rate}_i + \delta_6 \bullet \text{Tax As \% of GNP}_i + \nu_i$

(1) Delay in the Response to Home Country Market-Wide Information	$\text{Delay1} = \frac{1}{1+e^{-x}}$ where $x = \frac{\sum_{j=1}^{j=J} \beta_{i,k+j}^{A-E:Equity}}{\beta_{i,1}^{A-E:Equity}}$
(2) Delay in the Response to U.S. ADR Market-Wide Information	$\text{Delay2} = \frac{1}{1+e^{-x}}$ where $x = \frac{\sum_{j=1}^{j=J} \gamma_{i,k+j}^{A-E:ADR}}{\gamma_{i,1}^{A-E:ADR}}$
Dependent Variable: Ratio of (1)/(2)	$\text{Delay} = \frac{\text{Delay1}}{\text{Delay2}}$

The results for regression Equation No.2 are shown in Table No.3 below. The goal of using Regression Equation No.2 is to identify from a range of possible institutional and macroeconomic factors those most associated with measures of delayed adjustment of the equity – ADR share return spread. Our criterion for selection of independent variables Regression Equation No.2 is the combination of regressors which produced the largest adjusted R-square for Regression Equation No.2. Table No.3 shows the subset of institutional and macroeconomic factor regressors satisfying that criterion. As shown in Table No.3, the Property Rights Institution coefficient (δ_1) is significantly less than zero at the $\alpha = 0.05$ confidence level. This result suggests that countries having stronger property rights institutions have smaller equity – ADR share return spread adjustment delay and, consequently, the equity and ADR shares traded in the home country and U.S. markets at prices closer to parity. Table No.3 also shows that the regression coefficient for Judicial Effectiveness (δ_2) is significantly greater than zero at the $\alpha = 0.05$ confidence level. This result is a bit puzzling as it suggests that delayed equity – ADR share return spread increases in relation to Judicial Effectiveness. However, interpretation of this result depends on how to a specific country utilizes its judiciary, and whether it uses the Judicial Effectiveness is to strengthen market supportive laws such as investor protection regulations. To the extent that countries do not use Judicial Effectiveness to strengthen market support of infrastructure, we expect that the effective judiciary will serve to increase the equity – ADR share return spread adjustment delay. We also see from Table No.3 that the regression coefficient for a country's Tax Burden (δ_3) is significantly greater than zero at the $\alpha = 0.05$ confidence level. We interpret this result as indicating that country Tax Burden increases the delay of adjustment of the ADR share return spread and, as a result, increases the disparity between the equity and ADR share return. We also see that the regression coefficient for country Fiscal Health (δ_4) does not significantly different from zero at the $\alpha = 0.05$ confidence level. Therefore, we draw no conclusion regarding the impact of country Fiscal Health on the delay on disparity between the equity and ADR share return. Following up on Table No.3 we note that Corporate Tax Rate (δ_5) produces a regression coefficient from Equation No.2 which is significantly greater than zero at the $\alpha = 0.05$ confidence level. We conclude that equity – ADR share return spread adjustment delay increases in relation to country Corporate Tax Rates which is consistent with intuition that taxes generally act as a barrier to economic integration. We infer that the overall level of taxation in the economy increases the equity – ADR share return spread adjustment delay as a result of the regression coefficient for Tax % of GNP (δ_6) being significantly greater than zero at the $\alpha = 0.05$ confidence level as indicated in Table No.3.

Summarizing the results produced for regression Equation No.2, we have identified six institutional and macroeconomic factors variables from a potential array of 14 factors which maximize the regression R-square. Five of the six institutional and macroeconomic variables are significantly different from zero at the $\alpha = 0.05$ confidence level. Of the five variables which significantly differ from zero at the $\alpha = 0.05$ confidence level, four are consistent with intuition underlying our prior reason to believe they ought to have any impact on equity – ADR share return spread adjustment delay. Our overall conclusion from these results is that country-specific barriers to economic integration appear to be the same factors driving equity – ADR share return spread disparity. We may further say that equity – ADR share return spread parity is more likely as barriers to economic integration are reduced.

Table 3: Results for Regression Equation No.2: Dependent Variable for Home Country Institutional and Macroeconomic Factors Model Specification and Selection of Best Explanatory Model Regressors

Parameter Estimate Results for Regression Equation No.2

Variable	Estimate	Standard Error	t Value	Pr > |t|	**Null Hypothesis**
Intercept Term: δ_0	-29.896900	13.949810	-2.14 †	0.0406	**NA**
Property Rights: δ_1	-0.746170	0.301920	-2.47 †	0.0196	**Reject**
Judicial Effectiveness: δ_2	0.840750	0.296230	2.84 †	0.0082	**Reject**
Tax Burden: δ_3	0.983380	0.281880	3.49 †	0.0016	**Reject**
Fiscal Health: δ_4	0.290620	0.161570	1.80	0.0825	**Not Reject**
Corporate Tax Rate: δ_5	0.409200	0.181470	2.25 †	0.0319	**Reject**
Tax % of GNP: δ_6	0.704820	0.269130	2.62 †	0.0139	**Reject**
Regression F-Statistic: 3.38 †		**R-Square**: 0.4114		**Adjusted R-Square** 0.2896	
F-Statistic P-Value: 0.0119					

Regression Equation No.2: $Delay_i = \delta_0 + \delta_1 \bullet \text{Property Rights}_i + \delta_2 \bullet \text{Judicial Effectiveness}_i + \delta_3 \bullet \text{Tax Burden}_i + \delta_4 \bullet \text{Fiscal Health}_i + \delta_5 \bullet \text{Corporate Tax Rate}_i + \delta_6 \bullet \text{Tax As \% of GNP}_i + \nu_i$

†: Indicates that the variable specific null hypothesis that the regression coefficient is zero valued is rejected at the $\alpha = 0.05$ confidence level.

6. CONCLUSION AND SUGGESTIONS FOR FUTURE RESREARCH

The goal of this study is to empirically investigate the underlying equity-ADR share return adjustment delay in order to shed light upon parity deviations speed of adjustment so as to advance our understanding of the correctly functioning of multi-market asset trading. The underlying equity-ADR share return spread should tend to zero after adjusting for exchange rate conversion and transaction costs. We employ a zero-investment return model to estimate the adjustment lag of LOOP deviations for underlying equity-ADR shares trading in the applicable home country equity market and the U.S. ADR share markets. Toward this end, we utilize well-established two country index linear market model aggregated coefficients approaches to measure the speed of adjustment of underlying equity-ADR share pricing disparity. Our results suggest that the underlying equity-ADR share return spread series displays statistically significant divergence from arbitrage parity resulting in significant return spread adjustment lags. Furthermore, we find that the underlying equity-ADR differential return series adjustment lags are related to home country economic institutional factors such as strength of Property Rights, Judicial Effectiveness, home country Tax Burden, as well as home country macroeconomic variables such as Corporate Tax Rate and Tax as a Percentage of GNP. We believe our findings contribute to our understanding of reasons for the existence of pricing differentials arising when identical assets are traded in different markets. Future research may seek to identify additional country-specific macroeconomic factors contributing to departures from parity for multiple market traded assets.

Appendix A: Description of Country Specific Institutional and Macroeconomic Indices

The Heritage Foundation: The Heritage Foundation is an American 501(c)3 foundation think-tank located in Washington, D.C.and geared mainly towards analyzing public policy issues relating to functioning of market-based economic systems. Heritage Foundation acted as a leader conservative movement during the presidency of Ronald Reagan and a number of it's analyses served as the basis policies implemented under that administration. The Heritage Foundation continues to make input on in U.S. public policy making and is considered to be one of the most influential market-based economics policy organizations.

Heritage Foundation National Economic Indices: The Heritage Foundation Economic Freedom Index is an annual index and ranking countries of the world according to the degree to which their economic and legal institutions support a market-based economic system. The Economic Freedom Index was created in 1995 by The Heritage Foundation and The Wall Street Journal to measure the degree of economic openness toward integration in global economic and legal systems. The Index employs a multiple criteria approach in assessing national institutions which support market-based economic systems as well as individuals acting in pursuit of their own economic interests and prosperity for the larger society.

National Indices Methodology: The national indices are ranking scores for various dimensions of market supportive institutions and ranging between 0 and 100 and with 0 indicating no market supportive infrastructure and 100 meaning strong market supportive institutions. There are grouped into four broad categories.

Twelve Dimensions Of Market Supportive Institutional Infrastructure

Rule Of Law

Property Rights: Degree of a country's legal protection of private property rights and degree of enforcement of those laws. It is comprised of the following components:

1. physical property rights
2. intellectual property rights
3. strength of investor protection
4. risk of expropriation
5. quality of land administration

Judicial Effectiveness: Degree of the judiciary's efficiency and fairness, especially dealing with property laws. It is comprised of the following components:

1. judicial independence
2. quality of the judicial process
3. likelihood of obtaining favorable judicial decisions

Government Integrity Analyzes how prevalent are forms of political corruption and practices such as bribery, extortion, nepotism, cronyism, patronage, embezzlement, and graft. It is comprised of the following components:

1. public trust in politicians
2. irregular payments and bribes
3. transparency of government policymaking
4. absence of corruption
5. perceptions of corruption
6. governmental and civil service transparency

Government Size	**Tax Burden:**	Analyzes marginal tax rates on personal and corporate income and the overall taxation level (including direct and indirect taxes imposed by all levels of government) as a percentage of the GDP. It is comprised of the following components: 1. top marginal tax rate on individual income 2. top marginal tax rate on corporate income 3. total tax burden as a percentage of GDP
	Government Spending:	Quantifies the burden of government expenditures, including consumption by the state and all transfer payments related to various entitlement programs. The ideal level varies from country to country, but zero expenditure is used as a benchmark.
	Fiscal Health:	Analyzes how well a country manages its budget by quantifying the growing debt and deficit. It is divided into the following sub-factors: 1. average deficits as a percentage of GDP for the most recent three years (80 percent of score) 2. debt as a percentage of GDP (20 percent of score)
Regulatory Efficiency	**Business Freedom:**	Analyses the cost, time and freedom to open, operate and close a business, taking into consideration factors like electricity. It is divided into thirteen sub-factors: 1. starting a business - procedures (number); 2. starting a business - time (days); 3. starting a business - cost (% of income per capita); 4. starting a business - minimum capital (% of income per capita); 5. obtaining a license - procedures (number); 6. obtaining a license - time (days); 7. obtaining a license - cost (% of income per capita); 8. closing a business - time (years); 9. closing a business - cost (% of estate); 10. closing a business - recovery rate (cents on the dollar); 11. getting electricity - procedures (number); 12. getting electricity - time (days); and 13. getting electricity - cost (% of income per capita).
	Labor Freedom:	Quantifies the intrusiveness of labor rights such as minimum wage, laws inhibiting layoffs, severance requirements, and measurable regulatory restraints on hiring and hours worked, plus the labor force participation rate as an indicative measure of employment opportunities in the labor market. It is divided into the following sub-factors: 1. ratio of minimum wage to the average value added per worker 2. hindrance to hiring additional workers 3. rigidity of hours 4. difficulty of firing redundant employees 5. legally mandated notice period 6. mandatory severance pay 7. labor force participation rate
	Monetary Freedom:	Analyses how stable are prices and how much microeconomy intervenes. It is divided into the following sub-factors:

		1. weighted average inflation rate for the most recent three years 2. price controls
Market Openness	**Trade Freedom:**	Quantifies the extent to which tariff and nontariff barriers affect imports and exports of goods and services into and out of the country. Its sub-factors are: 1. trade-weighted average tariff rate 2. nontariff barriers (NTBs)
	Investment Freedom:	Analyses how free or constrained is the flow of investment capital of individuals and firms.
	Financial Freedom:	Indicates banking efficiency as well as how independent the government is from the financial sector. This aspect looks at five broad areas: 1. extent of government regulation of financial services 2. degree of state intervention in banks and other financial firms through direct and indirect ownership 3. government influence on the allocation of credit 4. extent of financial and capital market development 5. openness to foreign competition

Appendix A Table A: Descriptive Statistics for Heritage Foundation Country-Specific Indices of Market Supportive Institutional Infrastructure and Macroeconomic Variables Employed in Econometric Analyses

	Variable Name	Mean	Median	Std Dev	t-Statistic	Maximum	Minimum	Skewness	Kurtosis
12 Heritage Indices	**Property Rights:**	4.287230	4.378826	0.203173	130.08 †	4.579852	3.830813	-0.55024	-1.08595
	Judicial Effectiveness:	4.144915	4.241317	0.295542	86.45 †	4.508659	3.339322	-1.06453	0.42821
	Government Integrity:	4.196976	4.310799	0.317206	81.56 †	4.576771	3.591818	-0.47787	-1.29872
	Tax Burden:	4.194254	4.218035	0.181643	142.34 †	4.532600	3.775057	-0.53908	0.24303
	Government Spending:	3.909784	4.058716	0.579013	41.63 †	4.544358	1.840550	-1.64473	3.38429
	Fiscal Health:	4.295895	4.453854	0.539813	49.06 †	4.601162	1.667707	-3.79715	16.16784
	Business Freedom:	4.333585	4.361589	0.142652	187.27 †	4.547541	4.060443	-0.41541	-0.86538
	Labor Freedom:	4.094661	4.074090	0.205752	122.68 †	4.516339	3.720863	0.26463	-0.73750
	Monetary Freedom:	4.363028	4.397526	0.128988	208.51 †	4.464758	3.735286	-3.36453	14.92427
	Trade Freedom:	4.395291	4.430817	0.086751	312.33 †	4.553877	4.136765	-1.32470	1.92842
	Investment Freedom:	4.217255	4.317488	0.318972	81.50 †	4.553877	2.995732	-2.13443	5.47130
	Financial Freedom:	4.141618	4.248495	0.291983	87.44 †	4.499810	2.995732	-2.10118	6.09848
Macro Variables	**Tariff Rate (%):**	1.311745	1.098612	0.484773	16.46 †	2.617396	0.587787	1.04422	0.53657
	Income Tax Rate (%):	3.609857	3.725621	0.368813	60.34 †	4.043051	2.442347	-1.87508	3.47108
	Corporate Tax Rate (%):	3.125711	3.198465	0.314614	61.24 †	3.526361	2.140066	-1.63361	3.04839
	Tax As % of GNP:	3.265827	3.419203	0.490495	41.04 †	3.830813	2.186051	-0.93320	-0.32091

References

Badrinath, S.G., J.R. Kale, and T.H. Noe (1995). Of Shepherds, Sheep, and the Cross-autocorrelations in Equity Returns. The Review of Financial Studies, Volume 8, Issue 2, Pages 401–430.

Bekaert, G., Harvey, C., 1995. Time-Varying World Market Integration. Journal of Finance 50, 403-444.

Bekaert, G., Harvey, C., Ng, A., 2005. Market Integration and Contagion. Journal of Business 78, 39-70, previous version appeared as NBER Working Paper 9510.

Bin, F., Morris, G. B., & Chen, D. (2003). Effects of exchange-rate and interest-rate risk on ADR pricing behavior. The North American Journal of Economics and Finance, 14(2), 241-262.

Boudoukh, J., Matthew P. Richardson, and Robert F. Whitelaw. 1994. A Tale of Three Schools: Insights on Autocorrelations of Short-Horizon Stock Returns. The Review of Financial Studies. Vol.7, No.3 pp. 539-573.

Brennan, M., N. Jegadeesh, and B.Swaminathan. (1993). Investment Analysis and the Adjustment of Stock Prices to Common Information. Review of Financial Studies, vol. 6, issue 4, 799-824.

Carrieri, F., Errunza, V., Hogan, K., 2007. Characterizing World Market Integration through Time. Journal of Financial and Quantitative Analysis 41, 511-540.

Cashin, P., Kumar, M., McDermott, C., 1995. International Integration of Equity Markets and Contagion Effects. IMF Working Paper 95/110.

Chen, G., Firth, M., Rui, O., 2002. Stock Market Linkages: Evidence from Latin America. Journal of Banking and Finance 26, 1113-1141.

Chordia, Tarun, and Avanidhar Subrahmanyam, 2004. Order imbalance and individual stock return:
Theory and evidence, Journal of Financial Economics 72, 485–518.

Chordia, T. & Swaminathan, B. (2000). Trading Volume and Cross-Autocorrelations in Stock Returns. The Journal of Finance, 55, 913–935.

Conrad, Jennifer, Allaudeen Hameed, and Cathy Niden, 1994. Volume and autocovariances in short-horizon individual security returns, Journal of Finance 49, 1305–1329.

Conrad, Jennifer, and Gautam Kaul. 1988. Time-Variation in Expected Returns. The Journal of Business, vol.61, issue 4, 409-25.

Conrad, Jennifer, and Gautam Kaul. 1989. Mean Reversion in Short-Horizon Expected Returns. The Review of Financial Studies, Volume 2, Issue 2, April 1989, Pages 225–240.

Conrad, Jennifer, Gautam Kaul, and M. Nimalendran, 1991. Components of short-horizon individual security returns, Journal of Financial Economics 29, 365-384.

Cooper, Michael, 1999. Filter rules based on price and volume in individual security overreaction, Review of Financial Studies 12, 901–35.

Dey, M. K., & Wang, C. (2012). Return spread and liquidity: Evidence from Hong Kong ADRs. Research in International Business and Finance, 26(2), 164-180.

Eun, C. S., & Sabherwal, S. (2003). Cross-Border Listings and Price Discovery: Evidence from U.S.-Listed Canadian Stocks. The Journal of Finance, 58(2), 549-575.

Fargher, N. and R.A. Weigand. (1998). Changes in the stock price reaction of small firms up to common information. Journal of financial research, 21, 105-121.

Gagnon, L., & Karolyi, G. A. (2010). Multi-market trading and arbitrage. Journal of Financial Economics, 97(1), 53-80.

Gervais, Simon, Ron Kaniel, and Dan H. Mingelgrin, 2001. The high-volume return premium, Journal of Finance 56, 877–919.

Grammig, J., Melvin, M., & Schlag, C. (2005). Internationally cross-listed stock prices during overlapping trading hours: Price discovery and exchange rate effects. Journal of Empirical Finance, 12(1), 139-164.

Howe, J. S., & Ragan, K. P. (2002). Price discovery and the international flow of information. Journal of International Financial Markets, Institutions and Money, 12(3), 201-
215.

Hameed, Allaudeen. 1997. Time-varying factors and cross-autocorrelations in short-horizon stock returns. The Journal of Financial Research, Volume20, Issue 4 Pages 435-458.

Jagadeesh, Narasimhan, 1990. Evidence of predictable behavior of security returns, Journal of Finance 45, 881–898.

Kim, M., Szakmary, A. C., & Mathur, I. (2000). Price transmission dynamics between ADRs and their underlying foreign securities. Journal of Banking & Finance, 24(8), 1359-1382.

Lehmann, Bruce N., 1990. Fads, martingales, and market efficiency, Quarterly Journal of Economics 105, 1–28.

Lo, A.W. and A.C.MacKinlay. (1990). When Are Contrarian Profits Due To Stock Market Overreaction? Review of Financial Studies 3(2):175-20

Masih, R., Masih, A. 2001. Long and Short Term Dynamic Causal Transmission amongst International Stock Markets. Journal of International Money and Finance 20, 563-587.

McQueen, G., A.M. Pinegar, and S. Thorley. (1996). At the lady reaction to good news and the cross-autocorrelation of portfolio returns. The Journal of Finance 51, 889-920.

Richardson, T., and D.R. Peterson. (1999). The Cross-Autocorrelations of size-based portfolio returns is not an artifact of portfolio autocorrelation. Journal of Financial Research 22, 1-13.

Scheicher, M., 2001. The Comovements of Stock Markets in Hungary, Poland, and the Czech Republic. International Journal of Finance and Economics 6, 27-39.

Soydemir, G., 2000. International Transmission Mechanism of Stock Market Movements: Evidence from Emerging Equity Markets. Journal of Forecasting 19, 149-176.