E C O N O M I C S   B U L L E T I N

The world is shrinking: Evidence for stock market convergence

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Abstract

The relationship between eleven emerging stock markets and the U.S. stock market is examined. The beta for each market is estimated under a GARCH model designed to account for time-varying and exchange rate volatility. Entire period as well as pre- and post-liberalization sub-period models are estimated. Most (nine) of the markets show evidence of stock market convergence; five markets have betas not distinguishable from unity. The two markets that exhibit divergence still show significant correlation with the U.S. market.

Citation: Jayasuriya, Shamila and William Shambora, (2008) "The world is shrinking: Evidence for stock market convergence." *Economics Bulletin,* Vol. 7, No. 14 pp. 1-12
Submitted: October 8, 2008. **Accepted:** October 14, 2008.
URL: http://economicsbulletin.vanderbilt.edu/2008/volume7/EB-08G10016A.pdf

The World is Shrinking: Evidence for Global Stock Market Beta Convergence

1. Introduction

Investment diversification has long been viewed as a way to improve risk adjusted returns. Financial liberalization has created the opportunity for increased diversification through global investment. Because of the expanded opportunities for domestic companies to spread operations out around the world and the cross-listing of foreign companies in domestic stock markets, some have theorized that global diversification can be achieved by investing at home. Errunza, Hogan and Hung (1999) call the phenomenon where domestic investors can achieve international diversification without going to foreign capital markets "home-made diversification." However, Arouri (2004) and Jayasuriya and Shambora (2008) find that gains from international diversification have been available to U.S. investors willing to invest in emerging markets. In this paper, we examine country betas for evidence of convergence. Our attack is somewhat different from those used in previous research. We estimate country betas with the U.S. market using a GARCH model that allows the exchange rate to affect the conditional variance. We find that some country betas have already converged with the market beta and others are working their way toward convergence, which suggests that "home-made diversification" is becoming more easily available and at some point may even be achievable by investing in assets such as U.S. index funds. This note is organized as follows: The remainder of this section takes a brief look at related research. Section 2 presents the model, the data and the model estimation methodology. The third section discusses the empirical results and the fourth section concludes.

Our paper shares close ties with that of Gangemi, Brooks and Faff (1999) on the topic of country beta convergence even though there are key differences between the two including the hypotheses of interest, target sample and estimation methodology. In particular, Gangemi et al (1999) examine the mean reversion property of country-level betas for a group of 18 developed markets. OLS country betas are first obtained for each country, which are then used in cross-sectional, mean reversion-based estimations of one period's beta coefficient on the previous beta. In general, the authors find considerable evidence of mean reverting country betas. The seminal work on mean reverting betas is in fact provided by Blume (1971) in a domestic market setting where individual asset betas for common stocks listed on the NYSE are found to display a regression tendency toward a value of unity, which by definition is the beta for the aggregate market.

Babetskii, Komarek and Komarkova (2007) investigate stock market convergence using two measures including the β and σ convergence methods that first originated in the economic growth literature. Specifically, these authors examine financial integration (both at the country and sector levels) for four recent European Union members with the Euro area. The emphasis, however, is on stock return convergence and not country beta convergence as a measure of integration. Evidence suggests that the Czech Republic, Hungary, and Poland have achieved convergence of stock returns relative to the Euro area with a high speed of convergence. Sy (2006) implements a similar approach to study the degree of financial integration in the West African Economic and Monetary Union using data from bank credit markets and finds no evidence of convergence in banks' spreads over time.

A paper by Shuetrim (2000) examines the convergence of betas for individual stocks listed on the NYSE. The author's findings reveal that company-level betas converge to unity over time. Measurement error is ruled out as a possible explanation for convergence. Instead, firm characteristics such as the size and age of a firm are found to be underlying reasons for the observed beta convergence. The methodology of this paper involves estimating a time series of equity betas using the Kalman Filter approach and then computing the laws of motion for the betas. In particular, the laws of motion are based on a first-order Markov process and they describe the density functions from which the next period's equity beta is drawn given the beta today.

2. Methodology and data description

The capital asset pricing model (CAPM) originally derived by Sharpe (1964), Lintner (1965) and Mossin (1966) is widely used in the finance literature to estimate the beta coefficient for an individual stock. Researchers later developed the International CAPM (ICAPM) model, which is simply an extension of the CAPM model on an international setting, to study country betas. An investigation of country betas is meaningful in a world of globally integrated stock markets and it is especially useful for investors who search for international portfolio diversification benefits. We estimate a conditional ICAPM model as shown in equation (1) – (3).

$$(R_{it} - R_{ft}) = \alpha + \beta(R_{wt} - R_{ft}) + \varepsilon_t \tag{1}$$

$$\varepsilon_t = \sqrt{h_t}\,\upsilon_t \tag{2}$$

$$h_t = \lambda + \sum_{i=1}^{p} \kappa_i h_{t-i} + \sum_{j=1}^{q} \eta_j \varepsilon_{t-j}^2 + \gamma ExchangeRateVolatility_t \tag{3}$$

In equation (1), R_{it} is the return on country i's stock market index, R_{wt} is the return on a global index, and R_{ft} is the return on a world risk-free asset. Subsequently $(R_{it} - R_{ft})$ is the country risk premium and $(R_{wt} - R_{ft})$ is the world market risk premium. Equations (2) and (3) together model conditional volatility under the assumption that the error term, ε_t, follows a generalized autoregressive conditional heteroskedasticity (GARCH) process as described by Bollerslev (1986).

Exchange rate volatility is included as an exogenous variable when modeling volatility in equation (3). It is an important variable in the above estimation because foreign stock investments do entail exchange rate risk. For example, the U.S. dollar return of a foreign investment is invariably affected by the exchange rate movements between the local currency and the U.S. dollar. We hypothesize the γ coefficient to be positive since greater exchange rate volatility creates greater uncertainty in the foreign exchange markets that would result in more volatile stock returns if denominated in a currency other than the local currency. It is also possible for the γ coefficient to be negative in the event of a negative covariance between local-currency returns and exchange rate changes.[1] In a recent paper, Mun (2007) studies the extent to

[1] See Mun (2007) for more details.

which exchange rate fluctuations can affect stock market volatility and cross-market correlations for a group of mature markets and finds evidence that higher exchange rate volatility in fact increases local equity market volatility in most cases. In earlier work, Bartov et al (1996) finds a significant positive link between exchange rate and stock return volatilities for a sample of U.S. multinational firms. However, Bodart and Reding (1999) find no significant link between the two volatilities for the German stock market and a group of other European markets.

The coefficient α represents the country's excess return. The coefficient β represents the country beta, which is defined as the systematic risk for a country's stock market relative to the world market.[2] Given that the primary emphasis of our paper is on country beta convergence, much of the discussion will be based on the coefficient β. For country indices that have return premia that fluctuate less (more) than one-for-one with the global index, the country betas are less (more) than 1. Moreover, β equal to 1 would be evidence that country betas are converging with a global market beta.

We estimate a GARCH(*p*,*q*) model because the random disturbance term ε_t does not satisfy the property of homoskedasticity. In addition, ARMA terms are added to equation (1) as appropriate to account for serial correlation in the data. The κ and η coefficients capture the GARCH and ARCH effects respectively. A positive GARCH term indicates volatility clustering of stock returns. In addition, there would be evidence of volatility persistence in the data if $\kappa + \eta$ is close to 1.

For a U.S. investor, global diversification benefits are maximized if foreign country betas with respect to the U.S. market are far from unity since fully integrated markets would all have the same β of 1. We estimate the ICAPM model from equations (1) – (3) to obtain estimates of country betas for several time periods. First, we estimate for the entire period, January 1985 through April 2008. Next, we estimate the model for two sub-periods, one before the Bekaert and Harvey (2000) liberalization date and one after that date for each country. Finally, we estimate a rolling β over a series of 36 month windows to produce a graphic depiction of the evolution of the beta for each country. In a completely segmented market, the β coefficient would not be significant to the model. However, integration implies a significant β and full integration would result in a value close to 1.

The individual countries that we study are major emerging markets of the world that have also generated much foreign investor interest in the past. In particular, we focus on six Asian (India, Korea, Malaysia, Philippines, Taiwan, and Thailand) and five Latin American (Argentina, Brazil, Chile, Colombia, and Mexico) emerging markets. Also, as conventional in the literature, the "world market" in our study is proxied by the S&P 500. This allows us to compute the country betas and address the question of convergence from the perspective of a U.S. investor.

[2] Several studies in the existing literature, including Harvey (1991), Harvey and Zhou (1993), and Erb, Harvey, and Viskanta (1996) to name a few, model country betas as a function of local and global market risk factors in order to identify the key determinants of country risk. Some recent studies that estimate time-varying country betas are Andrade and Teles (2006), Gangemi, Brooks and Faff (2000), Lin and Lin (2000), and Verma and Soydemir (2006). This is not the focus of our paper, however, and we model a constant beta using the standard ICAPM model.

As a robustness check for β, we consider two other possibilities as well. The first is a regional index, which would be an appropriate choice if an equity market is integrated more with regional stock markets than with world markets in general. The third is a world index excluding the U.S. Monthly equity prices for the individual markets and the global indices are collected from the Datastream database for the time period from January 1985 through April 2008. The equity prices are all denominated in U.S. dollars. Stock returns are computed as the log difference of equity prices. In addition, the world risk-free interest rate is measured by the U.S. Eurodollar deposit rate. Also, exchange rate volatility is computed as the percentage change of the exchange rate between the local currency and the U.S. dollar which is appropriate given that the stock prices are denominated in U.S. dollars. The monthly risk-free interest rate and the exchange rate data are both gathered from the International Monetary Fund's International Financial Statistics database.

3. Empirical results

Table 1 presents the ICAPM estimation results for the entire data set where the global market return is the U.S. return.[3] A parsimonious GARCH(1,1) model is sufficient for all the estimations based on relevant information criteria. Also, diagnostic tests reveal no further serial correlation in the standardized and squared standardized residuals confirming the validity of the GARCH(1,1) specification. The estimated ARCH and GARCH effects are reasonable and indicate a high persistence of shocks for many markets. Also the GARCH terms indicate high volatility clustering for many. The alpha coefficient is significant for approximately half the countries of the sample indicating the presence of excess country returns especially for the Latin American emerging markets. All the betas are highly significant and the magnitudes appear to suggest low country risk relative to the U.S. for many of the markets. However, a two-sided hypothesis test conducted at the 5 percent significance level showed that the null hypothesis of β equal to 1 cannot be rejected for five markets including Argentina, Korea, Mexico, Taiwan, and Thailand. On the other hand, there is significant evidence that β is less than 1 for Chile, Colombia, India, Malaysia, and Philippines. For Brazil, β is in fact significantly greater than 1. Based on these country betas, we have initial evidence that a U.S. investor has the potential to achieve diversification benefits in select markets.

Furthermore, we observe that exchange rate volatility and model error [ε from equation (1)] volatility are significantly correlated with each other for all the markets except India and Colombia. Interestingly, the β coefficients observed for these two countries are also the two lowest reported for the sample. In other words, exchange rate volatility appears not to be a significant determinant of excess model return volatility for markets that are relatively less integrated. This finding implies that a U.S. investor is less subject to variations induced by fluctuations in the foreign exchange markets when their dollar denominated returns are based in markets that are less correlated with the U.S. market. The impact of exchange rate volatility appears to be similar for Korea, Malaysia, Mexico, and Philippines with an average coefficient estimate of 3.448. This is the case for Argentina and Chile as well with an average coefficient estimate of 5.933. Taiwan, alone, has a negative coefficient indicating that higher market

[3] The ARMA coefficients that account for serial correlation in the model are not reported to conserve space, but are available upon request.

volatility is associated with lower exchange rate volatility. This is not unexpected in light of the fact that over the last decade Taiwan's U.S. dollar exchange rate has been relatively stable, while its stock market, which is highly correlated with the U.S. market, has not. The exchange rate stability over that period is most likely due in part to the stability of the U.S. dollar exchange rates of Taiwan's other two biggest trading partners, China and Hong Kong.[4]

The overall results are similar for the ICAPM estimations where the global market return proxy is either the regional or the world index return excluding the U.S. The ARCH and GARCH effects are also reasonable and volatility clustering still prominent. The choice of proxy for the world market return does not appear to make any difference in the direction of beta, but there are some differences in magnitude. See Table 2 for a comparison of β estimates obtained from the different world market measures. Importantly, the country betas are all significantly different than zero. Hypothesis tests at the 5 percent significance level indicated that β is consistently equal to 1 only for Korea and Argentina.

How important is the choice of global market return for our sample? Mean equality tests conducted on the average country betas suggest that it does not matter much. For example, the *p*-value of the mean equality test for the betas obtained from a regional (world index excluding the U.S.) versus the U.S. index return is 0.839 (0.979) implying that, on average, there is no correct selection of global market among the three possibilities. Nevertheless, given the focus we have on the U.S. investor, the U.S. index becomes a clear option for us. Consequently, the remaining analysis examines the country betas relative to the U.S. market return.

The above findings are based on country betas estimated for the entire time period under investigation. Rolling estimates of country betas or a subperiod analysis of betas, on the other hand, allows us to examine the evolving behavior of country betas. To achieve a graphical representation of this beta evolution, we estimate the ICAPM model in equations (1) - (3) for each country for a rolling window of 36 months and obtain 245 evolving betas from December 1987 to April 2008. These are plotted in Figure 1. The rolling estimates are not available for Argentina and Malaysia because, for both countries, the national currency was fixed to the U.S. dollar for at least some duration of the time period of study.[5] For the remaining countries, however, there is visual evidence that the βs have increased over time and approached (and sometimes even surpassed) a value of 1. Particularly good examples are Chile, Colombia, India, Korea, and Taiwan. These graphs provide some preliminary evidence of growing market integration between the U.S. and several emerging markets of the world.

Many emerging markets liberalized their equity markets to foreign investors in the mid 1980s or thereafter. These countries typically opened up their domestic markets via official decree, country fund introductions, or even American Depository Receipts (ADRs). Bekaert and Harvey (2000) provide a list of such opening dates for a group of twenty emerging markets that we utilize in our subperiod analysis. In particular, we use the official liberalization date for each country to divide the sample into pre- and post-liberalization periods. The liberalization date in

[4] China (PRC) is number one, the U.S. is number two and Hong Kong is number three.

[5] For example, from December 1994 to December 2001, the Argentinean Peso was pegged one for one with the U.S. dollar. Also, the Malaysian Ringgit was fixed at 3.8 Ringgits to a U.S. dollar for the time period from December 1998 to June 2005.

fact provides a good basis for our subperiod analysis because markets would be expected to be relatively segmented prior to liberalization and integrated with world markets at least to some extent following liberalization. This implies significant and relatively higher expected values for the βs after the market opening date. Our main focus therefore is on the subsample β coefficients. See Table 3 for the relevant estimates. A clear observation is that the betas are all significant for the post-liberalization period. This suggests the existence of some market integration following opening even though the degree of integration varies by country as evidenced by the magnitude of β. For example, β is not significantly different than 1 for Argentina, Korea, Taiwan, and Thailand suggesting complete integration with the U.S. market. For Brazil and Mexico, however, β is significantly greater than 1 and for the remaining markets β is less than 1. These results also support our earlier finding that diversification benefits have been available to the U.S. investor in select markets, even though liberalization policies that result in greater correlation among markets is likely to reduce such benefits over the course of time.

Interestingly, the two lowest β coefficients are once again documented for Colombia and India. For these two countries, it is clear that the markets were segmented until the early 1990s and they remain relatively less integrated even today. For several other markets, we observe that β is significant both before and after the official liberalization date. A closer look at the first country fund and ADR introduction dates reveals that these markets were open to some extent even prior to the official liberalization date, meaning that some limited U.S. investment in those markets was possible, which explains the significant correlation with the U.S. market even prior to the date listed.[6] For Malaysia and Philippines, correlation with the U.S. market has decreased somewhat following liberalization. This is most likely related to the capital flight that has taken place in those countries during the 1990's and 2000's, particularly over the last ten years, indicating a reluctance of U.S. investors to participate in their markets.[7]

4. Conclusion

We estimated country betas from a U.S. perspective for eleven countries, taking into account GARCH errors and exchange rate changes. We made these estimates for the entire period under study, a pre-liberalization period, a post-liberalization period, and a rolling window. The rolling windows show a general tendency for the country betas to move from lower to higher levels. Beta comparisons before and after liberalization also indicate a tendency for country betas to increase with liberalization. In fact, after liberalization, five of the eleven countries had betas indistinguishable from unity. Nine of the betas increased with liberalization and two countries, which have been experiencing continuing capital flight, saw decreases in beta. We did not find much difference in these outcomes when alternative "world market" proxies were used.

There appears to be some room in the emerging stock markets for diversification benefits for U.S. investors; however, these opportunities are shrinking. Following market liberalization

[6] Looking at market volatilities for many of these same countries, Nguyen (2008) finds that structural breaks in volatility coincide more with ADR and country fund introductions rather than liberalization dates.
[7] See Beja (2005) for case studies and implications of this phenomenon.

policies that facilitate greater integration, country betas have generally increased reducing the potential for diversification benefits. Some markets have already converged with the U.S. market while others appear to be headed in that direction. This speaks to the global nature of today's stock markets where "home-made diversification" is fast becoming the rule.

On a final note, we observed a significant link between exchange rate volatility and the variability of the model error for many of the markets. This is not surprising and has been suggested by previous research. It implies that a major factor in the difference between β-predicted returns and actual market returns when measured in a standard currency is the exchange rate. However, this appears to be true only in highly integrated markets as evidenced by the absence of such a link for the less integrated markets of Colombia and India. This finding would indicate that U.S. investors in low-β markets may achieve benefits that go beyond greater diversification potential because such benefits appear be independent of exchange rate fluctuations.

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Table 1. ICAPM estimation results using the U.S. index as the global market

Emerging Market (EM)	Alpha	Beta	ARCH	GARCH	Exchange Rate Volatility
Asia					
India	0.704	0.335**	0.137**	0.362	1.037
	(0.565)	(0.135)	(0.064)	(0.374)	(2.369)
Korea	1.017*	0.804***	0.089**	0.851***	3.048***
	(0.531)	(0.111)	(0.040)	(0.056)	(1.020)
Malaysia	0.721**	0.687***	0.149***	0.781***	3.558***
	(0.327)	(0.076)	(0.055)	(0.058)	(1.151)
Philippines	0.778	0.641***	0.082***	0.836***	3.306***
	(0.596)	(0.109)	(0.031)	(0.045)	(1.012)
Taiwan	0.631	0.841***	0.064***	0.932***	-2.482***
	(0.581)	(0.129)	(0.015)	(0.011)	(0.682)
Thailand	0.928	0.778***	0.065*	0.872***	2.628*
	(0.621)	(0.118)	(0.036)	(0.054)	(1.526)
Latin America					
Argentina	0.630	1.070***	0.005	0.846***	5.948***
	(0.701)	(0.164)	(0.014)	(0.015)	(1.216)
Brazil	1.936***	1.322***	0.122**	0.768***	1.749*
	(0.717)	(0.140)	(0.058)	(0.085)	(0.912)
Chile	2.073***	0.608***	0.020	-0.091	5.917***
	(0.474)	(0.077)	(0.076)	(0.170)	(1.149)
Colombia	1.200*	0.289**	0.137**	0.621***	1.357
	(0.663)	(0.121)	(0.065)	(0.182)	(0.943)
Mexico	1.765***	1.025***	0.160**	0.660***	3.881***
	(0.403)	(0.101)	(0.074)	(0.101)	(1.076)

Note: Standard errors are given in parenthesis. The significance at the 1, 5, and 10 percent levels are indicated by ***, **, and * respectively.

Table 2. Country beta estimates for different global markets

Emerging Market (EM)	Regional Index	US Index	World Index excluding US
Asia			
India	0.559***	0.335**	0.387***
	(0.061)	(0.135)	(0.099)
Korea	0.899***	0.804***	0.866***
	(0.064)	(0.111)	(0.104)
Malaysia	0.632***	0.687***	0.572***
	(0.052)	(0.076)	(0.072)
Philippines	0.601***	0.641***	0.646***
	(0.070)	(0.109)	(0.103)
Taiwan	1.364***	0.841***	0.883***
	(0.057)	(0.129)	(0.100)
Thailand	0.905***	0.778***	0.713***
	(0.066)	(0.118)	(0.096)
Latin America			
Argentina	0.927***	1.070***	1.143***
	(0.063)	(0.164)	(0.150)
Brazil	1.337***	1.322***	1.621***
	(0.028)	(0.140)	(0.122)
Chile	0.523***	0.608***	0.603***
	(0.034)	(0.077)	(0.073)
Colombia	0.193***	0.289**	0.198*
	(0.053)	(0.121)	(0.108)
Mexico	0.777***	1.025***	0.724***
	(0.041)	(0.101)	(0.093)
P-values for mean equality tests of the average betas			
Average beta of the regional index versus the US index			0.839
Average beta of the world index versus the US index			0.979
Average beta of the regional index versus the world index			0.835

Note: Standard errors are given in parentheses. The significance at the 1, 5, and 10 percent levels are indicated by ***, **, and * respectively.

Table 3. Country beta estimates before and after the official stock market liberalization

Emerging Market (EM)	Official liberalization date	Pre-liberalization	Post-liberalization
Asia			
India	92.11	0.003	0.545***
		(0.388)	(0.151)
Korea	92.01	0.406**	1.130***
		(0.203)	(0.178)
Malaysia	88.12	0.864***	0.623***
		(0.198)	(0.114)
Philippines	91.06	0.804***	0.648***
		(0.250)	(0.147)
Taiwan	91.01	0.386*	0.848***
		(0.217)	(0.287)
Thailand	87.09	-0.490*	0.977***
		(0.289)	(0.159)
Latin America			
Argentina	89.11	-0.595	1.162***
		(1.339)	(0.167)
Brazil	91.05	0.167	1.477***
		(0.467)	(0.144)
Chile	92.01	0.471***	0.808***
		(0.162)	(0.086)
Colombia	91.02	0.060	0.463***
		(0.043)	(0.167)
Mexico	89.05	0.775***	1.079***
		(0.282)	(0.010)

Note: The official liberalization dates are based on Bekaert and Harvey (2000). Standard errors are given in parentheses. The significance at the 1, 5, and 10 percent levels are given by ***, **, and * respectively.

Figure 1. Rolling estimates for country betas using the U.S. Index as the global market (roll function width = 36 months)