

# Hedging Currency Risk in Emerging Markets

Alexandra Horobet, Lucian Belascu, and Ana-Maria Barsan

**Abstract**—Emerging markets represent attractive investment opportunities for international investors in financial assets, due to their low correlations with assets in mature markets and between themselves. At the same time, investments in emerging markets are seen as riskier compared to investments in developed markets, and one particular source of concern is currency risk. Our paper investigates the risk-return profile of investments in emerging markets stocks from the perspective of a US dollar based investor and studies the benefits of hedging returns with forward contracts. The research focuses on a number of ten emerging markets from Asia and Latin America during a time interval between 2006 and 2010. We find that currency risk is a lesser contributor to the overall risk accepted by an American investor compared to the local market risk and that hedging local returns does not necessarily increase the set of investment opportunities for investors in emerging markets.

**Keywords**—Currency risk, emerging countries, hedging.

## I. INTRODUCTION

DECADES ago, as growing international investments started to give rise to problems regarding the correlation between the already established, functional and mature markets, a parallel phenomenon started to attract the interest of researchers and analysts alike: the emergence of new financial centers in Asia (Hong Kong, India, Indonesia, Malaysia, Singapore, South Korea, Taiwan and Thailand) in the eighties, and in South America (Argentina, Brazil, Chile, Mexico and Venezuela) in the nineties (countries now deemed as having developing markets). The attractiveness of these new markets laid in the fact that they seemed relatively uncorrelated to the developed markets, as well as among themselves.

A low and even negative correlation between the assets included in a portfolio is a critical factor for a better risk diversification. When international portfolios are created, including assets traded in different national environments, risk diversification effect might be important, if the various markets maintain low correlations between themselves. The timing of investment and the countries of choice are factors that influence the effect of diversification in both risk reduction and return augmentation, as the correlation of returns is state-dependent: the correlations change over time, but can

be predictable. According to Erb et al. [1], correlations are strongest when two analyzed countries are both in recession. The correlations decrease when both countries are in recovery and are lowest when the countries are in different phases of the business cycle. Therefore, according to Yavas [2] a shock also has an impact over correlations. An interesting point of view is presented by Chue [3], who shows that the benefits from international diversification tend to be higher at times when they are most needed, namely when a particular event or state of economy pushes the correlation of international stock returns to be high.

Nowadays, emerging markets constitute about 80% of the world's population, while representing about 20% of the world's economy. These are economies with low to middle per capita income, variable in size, but having one thing in common: reform programs meant to bring about economic development and performance, along with transparency and efficiency in their capital markets and a more stable currency. This last aspect is aimed in two directions: locally, a more stable currency reduces the desire for investors to send their capital abroad, and, internationally, it builds confidence in their economies and attracts a higher volume of foreign investments (either direct or portfolio). At the same time, investments in emerging economies are exposed to a series of specific risks: country risk - which refers to the risk that a country won't be able to honor its financial commitments, political risk - which represents the financial risk that a country's government will suddenly change its policies, market risk - also referred to as volatility, which represents the day-to-day fluctuations in a stock's price, and currency risk - that stems from unexpected changes in the exchange rate of the local currency against foreign currencies. All these specific risks can be counteracted by risk diversification, as a result of including emerging markets in international portfolios.

Our paper's goal is to provide evidence on the relevance of hedging returns provided by investments in emerging markets over a medium time span, from the perspective of a US dollar based investor. As our paper will show, although hedging leads to a significant risk reduction for portfolios of emerging markets, it might not always prove to be beneficial from the perspective of returns. The paper is structured as follows: Section II reviews the empirical evidences available in the literature regarding the links between stock market returns and exchange rates, Section III describes data and the research methodology, Section IV outlines the main results, while Section V concludes and draws directions for future research.

Alexandra Horobet is with the International Business and Economics Department, Bucharest University of Economic Studies, Romania (corresponding author's phone: +40-744304649; e-mail: alexandra.horobet@gmail.com).

Lucian Belascu is with the Department of Management, Marketing and Business Administration, Lucian Blaga University of Sibiu, Romania (e-mail: lucian\_belascu@yahoo.com).

Ana-Maria Barsan is with the Department of Political Science, University of Bucharest, Romania (e-mail: amybarsan@yahoo.com).

## II. EMPIRICAL EVIDENCES ON STOCK RETURNS AND EXCHANGE RATES

The relationship between stock market returns and exchange rates has been researched in a rather intensive manner, with various studies discussing the presence of a “legitimate” risk premium associated to investments in foreign markets that would compensate investors for exposure to higher risks than on home markets. In the case of emerging markets, acknowledged as having higher levels of instability compared to mature markets, the crises that affected them in the 1990s, but also the financial turmoil that emerged in 2007-2008, have demonstrated that the impact of exchange rate fluctuations might be seriously felt by international investors.

Whenever an investment is made abroad, in a different currency than the investor’s home or reference currency, there is an impact of currency fluctuations both the level of risk and return. Levy and Lim [4], Eun and Resnick [5] and Bugar and Maurer [6], among others, have shown that investors that do not control for the currency risk might find themselves in the difficult position of obtaining gains from international investments that do not surpass the costs attached to foreign investments. This stems from the fact that correlations between exchange rates are not sufficiently small to provide investors with better effects of diversification in an international portfolio.

When one considers the overall impact of currency risk on international investments, a few points are noteworthy. First, currency fluctuations affect both the return and risk of any foreign investment and, especially over short periods of time, the effects of currency fluctuations on the home currency return may exceed the capital gain or income. At the same time, empirical studies indicate that currency risk is generally smaller than the risk of the corresponding stock market. Second, the currency risk of an investment may be hedged for major currencies in foreign currency derivatives markets; therefore, currency risk can be easily eliminated in international investments and does not represent a major obstacle for international investments. Third, the contribution of currency risk should be measured for the total portfolio rather than for individual markets or securities, because currency risk might be diversified away by the mix of currencies represented in the portfolio, as Giovannini and Jorion [7] show. Fourth, the impact of currency risk decreases with the length of the investment horizon; an investor with a long time horizon should normally care less about currency risk than an investor who is concerned about daily or weekly fluctuations in his portfolio’s value.

Research on the links between stock market returns and exchange rate movements has developed since the beginning of the 1980s, with rather mixed results. Aggarwal [8] is among the first researchers that study stock prices and exchange rates; he finds a significant relationship between the US dollar and US stock prices, but Soenen and Hennigan [9] find an opposite relationship between the two variables. Jorion [10] examines the exposure of US multinational corporations to currency risk for a period of seventeen years and concludes that companies’ share prices were not systematically influenced by changes in nominal exchange rates. Gao [11] and Koutmos and Martin

[12] detect a more significant relationship between American companies share prices and changes in the nominal exchange rate of the dollar against various currencies. Dutch companies have been researched by De Jong et al. [13] that find more significant exposures in phases of the Dutch guilder depreciation, after investigating 117 companies over a 5-year period (1994-1998). British companies also display significant exposure, according to El-Masry [14], but depending to a large extent on the nature of their businesses. Kyimaz [15] investigates Turkish companies for the period 1991-1998 and finds significant exposures to currency risk, but also variable from one industry to another. Horobet and Dumitrescu [16] investigated the exposure of national stock markets from four countries in Central and Eastern Europe – Czech Republic, Hungary, Poland and Romania – to nominal and real exchange rate risk, and find that companies show contemporaneous and lagged exposure to nominal and real exchange rate risk and that these exposures are of the same type in all countries.

An analysis in the context of international portfolio investments is critical for the accurate assessment of currency risk impact, given the diversification effects that national capital and currency markets provide to any international investor. Hauser et al. [17] examine the role of currency risk in determining the benefits from international diversification in developed and emerging stock markets and find that under certain conditions currency risk hedging may not be beneficial. They indicate that the hedging of currency risk is an inferior policy because of the negative correlations between the exchange rate and stock returns when measured in the local currencies of emerging markets. On the same note, Shetty and Manley [18] find that hedging against currency risk does not help to improve the return outcome, but it lowers return volatilities for some investors. Although hedging currency risk is a common practice in developed financial markets, emerging markets have historically lacked derivatives markets as support for hedging decisions. As mentioned by Lien and Zhang [19], derivatives markets are able to support capital inflows to emerging economies, but they have also led to exacerbated volatility.

The current financial crisis had a tremendous impact on global financial markets, regardless of the type of country, developed or emerging. Under these circumstances, it is critical to understand the national capital markets’ exposure to various risk factors and, in the context of our research, to currency risk. Mainly, the question is whether during crisis periods one may detect a significant increase in the exposure to currency risk and if such exposure is global or country specific. In their study of the 1997 Asian crisis Chakrabarti and Roll [20] found that covariances, correlations and volatilities increased from the pre-crisis to the crisis period in both European and East Asian countries. Kenourgios et al. [21] investigate financial contagion, during the period 1995–2006, in two developed markets (United States and United Kingdom) and four emerging markets (Brazil, Russia, India, China) and find the presence of contagion effects from the country where the crisis emerged to all others, for each of the examined financial crises, and also that emerging BRIC markets are more prone to financial contagion. Therefore, an

investment strategy centered only on international diversification might not work in practice during turbulent periods in financial markets. Niklewski and Rodgers [22] investigate whether the recent financial crisis has led to a long-term structural change in the conditional correlation relationship between returns in international equity markets. They conclude that there is not much confirmation of the hypothesis that economic structural adjustment has resulted in long-term changes in the correlation between US and developed markets, but they find that the conditional correlation between US and emerging or frontier markets was modified due to structural changes.

### III. DATA AND RESEARCH METHODOLOGY

Our research focuses on monthly returns of the stock market indices of a ten emerging markets from Asia and Latin America – Argentina, Brazil, China, Chile, Hong Kong, India, Korea, Malaysia, Singapore and Taiwan, of which three are members of the so-called BRIC countries (Brazil, India and China). The reason for including Latin American countries is their proximity to the United States, which translates into a slightly higher correlation with the American market.

The data was collected from the MSCI (Morgan Stanley Capital International) database, and all indices were extracted at “Typical price”, in local currencies, so that, after an analysis of their local returns, they can be transformed as a result of hedging in order to observe the impact of hedging over the investment possibilities offered to the American investors, and when is hedging necessary and helpful, which is the main purpose of this paper. Data on exchange rates was collected from PACIFIC Exchange Rate Service.

The period under analysis ranges from January 2006 until December 2010, which translates into 60 monthly observations. We have chosen this period because the medium term offers a higher representation power, and, in addition, the period also includes the financial crisis, which affects the behavior of markets and correlations between them.

Based on logarithmic returns for countries' indices ( $R_i$ ), we have calculated mean or expected returns ( $E(R_i)$ ) and the variance ( $Var(R_i)$ ) for each market. The next step was to calculate the percentage change in the exchange rate for the currency of each country ( $e_i$ ), along with the respective expected returns ( $E(R_{ei})$ ) and variances ( $Var(R_{ei})$ ).

The dollar rate of return provided by an investment in local markets,  $R_{\$/i}$ , was calculated as follows:

$$R_{\$/i} = R_i + e_i \quad (1)$$

Using these dollar rates of return we have computed the expected or mean returns –  $E(R_{\$/i})$  – and their variance, as in Equation (2):

$$Var(R_{\$/i}) = Var(R_i) + Var(e_i) + 2 \times cov(R_i, e_i) \quad (2)$$

Where,  $cov(R_i, e_i)$  shows the correlation between the returns on local stock markets' indices and the changes in the exchange rate between the local currency and the US dollar.

In order to test the necessity of hedging, we calculated the structure of the volatility to extract the contribution of currency risk, as follows:

$$U_1 = \frac{Var(R_i)}{Var(R_{\$/i})} \quad (3)$$

$$U_2 = \frac{Var(R_{ei}) + 2 \times cov(R_i, R_{ei})}{Var(R_{\$/i})} \quad (4)$$

Where,  $U_1$  shows the contribution of local market volatility to the overall volatility in US dollars, while  $U_2$  indicates the contribution of currency risk to the overall volatility felt by an investor with the US dollar as the reference currency. Equation (4) shows that Equation (3) shows that the proportion of emerging markets volatility explained by changes in the local currencies exchange rates against the US dollar depends not only on the volatility in the foreign exchange market, but also on the covariance of the European stock market returns and exchange rate changes. This implies that the exchange rate volatility will not necessarily induce more volatility in the returns available to foreign investors, due to the value and sign of the covariance.

We computed 1-month synthetic forward rates using Interest Rate Parity between local currencies and the US dollar, with interest rates collected from the OECD Statistics Database, CEIC Database, FRED and Central banks databases.

Using unhedged and hedged market returns we derive efficient frontiers that show whether the performance of diversified portfolios made up of emerging markets' stocks may be improved by hedging local returns against currency risk.

### IV. RESULTS

Tables I and II show the returns and variances of both hedged and unhedged portfolios made of emerging countries' stocks. For the unhedged portfolios, the returns range from 0.24% to 1.45%, the highest returns being offered by Argentina, followed closely by China, Chile and India. The majority of portfolios come with variances between 0.50% and 1.27%, the notable exceptions being Chile and Malaysia, and the highest variance being observed in Argentina. With the exception of Chile, these results are consistent with the assumption that reward comes with risk.

Table III, however, presents a very interesting situation when it comes to the analysis of the hedged portfolios. When returns have been hedged using forward contracts, we observe in the majority of cases, increases in returns accompanied by increases in variances. The increases in returns vary between 32.43% (China) and 87.38 (Taiwan), while increases in variance vary between 15.80% (Argentina) and 92.36% (Chile). At the same time, in the case of Hong Kong and Singapore, the returns of the hedged portfolios are actually significantly smaller than those of the unhedged ones, which suggest that the efficiency of hedging in terms of better returns is highly dependent on the market. Nevertheless, the variance of hedged returns is higher than the variance of unhedged returns for these two countries.

TABLE I  
UNHEDGED RATES OF RETURN AND VARIANCES

Country	Expected return (unhedged)	Variance of unhedged returns
Argentina	0.0145	0.0127
Brazil	0.0089	0.0054
Chile	0.0135	0.0020
China	0.0137	0.0090
Hong Kong	0.0070	0.0052
India	0.0125	0.0079
Korea	0.0070	0.0042
Malaysia	0.0089	0.0022
Singapore	0.0051	0.0052
Taiwan	0.0024	0.0052

TABLE II  
HEDGED RATES OF RETURN AND VARIANCES

Country	Expected return (hedged)	Variance of hedged returns
Argentina	0.0293	0.0150
Brazil	0.0180	0.0103
Chile	0.0216	0.0267
China	0.0203	0.0229
Hong Kong	0.0040	0.0191
India	0.0289	0.0180
Korea	0.0212	0.0147
Malaysia	0.0220	0.0088
Singapore	0.0024	0.0073
Taiwan	0.0193	0.0124

TABLE III  
CHANGES IN HEDGED VERSUS UNHEDGED RETURNS AND VARIANCES

Country	Change in return (%)	Change in variance (%)
Argentina	50.60	15.80
Brazil	50.58	48.19
Chile	37.50	92.36
China	32.43	60.80
Hong Kong	-75.99	72.94
India	56.67	56.18
Korea	67.15	71.23
Malaysia	59.62	75.29
Singapore	-109.80	29.11
Taiwan	87.38	58.53

There are two types of cases that are worth pointing out: the cases of the countries for which hedging actually decreases the expected return, increasing however the variance, and the cases in which the expected returns are modestly increased, but hedging brings about a higher increase in variance compared to the increase in expected returns (such is the case for Chile, China, Korea and Malaysia).

Table IV summarizes the expected local returns and the expected US dollar returns, as well as their variances, for the ten countries under analysis. We see here that, for most of the emerging countries, the expected dollar return is higher than the expected local return of the investment. This means that, for an American investor, there is a chance that the real gain from an investment to be higher than the expected one due to the currency gains.

TABLE IV  
LOCAL VERSUS DOLLAR EXPECTED RETURNS AND VARIANCES

Country	Expected local return	Variance of local return	Expected dollar return	Variance of dollar return
Argentina	0.0145	0.0127	0.0096	0.0143
Brazil	0.0089	0.0054	0.0147	0.0096
Chile	0.0135	0.0020	0.0152	0.0034
China	0.0137	0.0090	0.0171	0.0089
Hong Kong	0.0070	0.0052	0.0070	0.0051
India	0.0125	0.0079	0.0123	0.0095
Korea	0.0070	0.0042	0.0053	0.0069
Malaysia	0.0089	0.0022	0.0124	0.0030
Singapore	0.0051	0.0052	0.0091	0.0062
Taiwan	0.0024	0.0052	0.0041	0.0063

Another aspect that can be observed is that the variance in terms of dollars is smaller than the variance of local returns for all countries. This leads us to believe that, even if there is no real effect in terms of the expected return, the depreciation of the local currencies actually helps in decreasing the risk of the portfolio by creating something similar to insurance in dollar terms.

One of the most important elements that tells us whether or not hedging is necessary or is efficient in reducing risk is how much weight the currency risk has in the total risk of a portfolio. This is why risk was broken down in two elements:  $U_1$ , the influence of the volatility of the local returns in the total risk, and  $U_2$ , the influence of the volatility of the currency of each country in relation to the dollar on the total volatility. The results for each emerging country under analysis are shown in Table V.

TABLE V  
OVERALL DOLLAR RISK DECOMPOSITION

Country	$U_1$ (%)	$U_2$ (%)
Argentina	88.66	11.34
Brazil	56.10	43.90
Chile	59.76	40.24
China	100.73	-0.73
Hong Kong	100.55	-0.55
India	83.26	16.74
Korea	61.74	38.26
Malaysia	72.81	27.19
Singapore	83.88	16.12
Taiwan	81.82	18.18

One may observe in the above table that the local market return volatility has a significantly higher contribution to the total dollar return volatility compared to currency volatility. Nevertheless, for some countries, the impact of currency risk on dollar volatility is rather high: Brazil (43.90%), Chile (40.24%) or Korea (38.26%). Furthermore, there are certain countries where the influence of currency risk is negative. In these countries (China and Hong Kong), not only is hedging unnecessary, but it also decreases the returns that those investments bring to the American investor. For these countries, the depreciation of the local currency in relation to the dollar creates an "umbrella effect" on the investment, so that American investors are actually less exposed to risk than local investors. Still,  $U_2$  values for China and Hong Kong are small; therefore this result should be taken with caution.

The most obvious way of demonstrating the relevance of currency risk hedging is, however, by comparing the efficient frontiers of hedged and unhedged set of portfolios made of the ten emerging countries under consideration in our paper. The efficient frontiers plotted in Figure I were generated using Matlab and by not allowing short-selling.

As we may observe, the efficient frontier using hedged returns is almost entirely situated below and to the left compared to the efficient frontier generated using unhedged returns. The hedged portfolios limit the investment opportunities, bringing significantly lower returns (between 0.01 and 0.015) than the unhedged ones (ranging from little under 0.01 to 0.3). This means that investing in emerging economies is suitable only for investors with a high risk tolerance, as a better economic performance comes at a certain cost, even in the case of using hedging to minimize the risks.

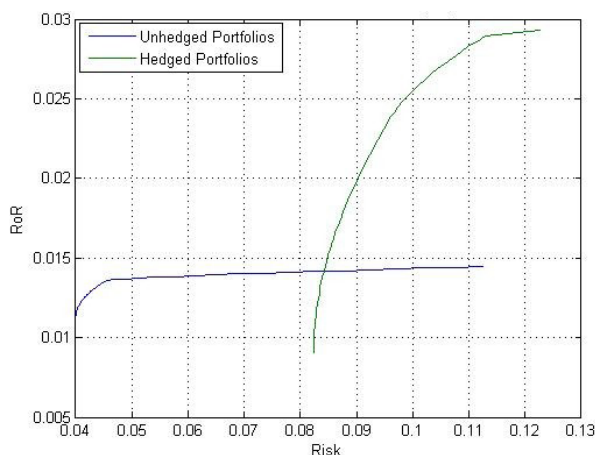


Fig. 1 Efficient frontiers for hedged and unhedged portfolios

## V. CONCLUSIONS AND FURTHER RESEARCH

A few noteworthy conclusions emerge out of the work presented in this paper: (1) the contribution of currency risk to an investment made by a US dollar based investor in emerging countries is variable from one country to the other; (2) in general, the currency risk contribution was positive during the time frame covered in the analysis, thus indicating that currency risk adds to the local market risk; (3) hedging does not necessarily lead to better risk-return profiles of investments made in emerging countries, at least when forward hedging is considered.

Further research is needed on this topic, in order to properly understand the relevance of hedging currency risk for international portfolios. Among the possible lines of research one may mention including developed markets in the set of portfolios that is used to generate efficient frontiers, using different hedging instruments, extending the time frame of the analysis and increasing the frequency of returns' observation.

## REFERENCES

[1] C. B. Erb, C. R. Harvey, and T. E. Viskanta, "Forecasting International Equity Correlations", *Financ. Anal. J.*, vol. 50, no. 6, pp. 32-45, Nov./Dec. 1994  
<http://dx.doi.org/10.2469/faj.v50.n6.32>

[2] B. F. Yavas, "Benefits of International Portfolio Diversification", *Graziadio Business Review*, Vol. 10, no. 2, 2007

[3] T. K. Chue, "Correlation of International Stock Returns and the Benefits from Diversification", Working Paper, Hong Kong University of Science & Technology, Apr. 2000

[4] H. Levy, K. C. Lim, "Forward Exchange Bias, Hedging and the Gains from International Diversification of Investment Portfolios", *J. of Int. Money and Finance*, vol.13, no. 2, pp. 159-170, Apr. 1994  
[http://dx.doi.org/10.1016/0261-5606\(94\)90013-2](http://dx.doi.org/10.1016/0261-5606(94)90013-2)

[5] C. S. Eun, B. G. Resnick, "International diversification of investment portfolios, US and Japanese perspective", *Man. Science*, vol. 40, no. 1, pp.140-60, Jan. 1994  
<http://dx.doi.org/10.1287/mnsc.40.1.140>

[6] G. Bugar, and R. Maurer, "International Equity Portfolios and Currency Hedging: The View Point of German and Hungarian Investors" Goethe University Working Paper Series: Finance and Accounting no. 67, 2001

[7] A. Giovannini, and P. Jorion, "The Time-Variation of Risk and Return in the Foreign Exchange and Stock Markets", *J. of Fin.*, vol.44, no.2, pp. 307-325, Jun. 1989  
<http://dx.doi.org/10.1111/j.1540-6261.1989.tb05059.x>

[8] R. Aggarwal, "Exchange rates and stock prices: a study of the US capital markets under floating exchange rates", *Akron Bus. and Econ. Rev.*, vol.12, pp. 7-12, 1981

[9] L. A. Soenen, and E. S. Henningan, "An Analysis of Exchange Rates and Stock Prices: the U.S. Experience between 1980 and 1986", *Akron Bus. and Econ. Rev.*, vol.19, pp.7-16, 1988

[10] P. Jorion, "International Portfolio Diversification with Estimation Risk", *J. of Bus.*, vol.58, no.3, pp. 259-278, Jul. 1985  
<http://dx.doi.org/10.1086/296296>

[11] T. Gao, "Exchange rate movements and the profitability of U.S. multinationals", *J. of Int. Mon. and Fin.*, vol. 19, no. 1, pp. 117-134, Feb. 2000  
[http://dx.doi.org/10.1016/S0261-5606\(99\)00038-8](http://dx.doi.org/10.1016/S0261-5606(99)00038-8)

[12] G. Koutmos, and A. Martin, "First- and Second-Moment Exchange Rate Exposure: Evidence from U.S. Stock Returns", *Fin. Rev.*, vol. 38, no. 3, pp. 455-471, Aug. 2003  
<http://dx.doi.org/10.1111/1540-6288.00055>

[13] A. De Jong, J. Ligterink, V. Macrae, "A Firm-Specific Analysis of Exchange-Rate Exposure of Dutch Firm", Erasmus Research Institute of Management Working Paper, 2002

[14] A. El-Masry, "The Exchange Rate Exposure of UK Nonfinancial Companies: Industry-Level Analysis", Manchester Business School Working Paper, 2003

[15] H. Kyimaz, "Estimation of foreign exchange exposure: an emerging market application", *J. of Mult. Fin. Man.*, vol.13, no. 1, pp. 71-84, Feb.2003

[16] A. Horobet, and S.Dumitrescu, "Insights into Central and Eastern European countries competitiveness: on the exposure of capital markets to exchange rate risk", *Rev. of Econ. and Bus. St.*, no.2, pp.107-126, 2008

[17] S. Hauser, M. Marcus, and U. Yaari, "Investing in emerging stock markets: is it worth while hedging foreign exchange risk?", *J. of Port. Man.*, vol. 20, no. 3, pp. 76-81, Spring 1994  
<http://dx.doi.org/10.3905/jpm.1994.76>

[18] A. Shetty, and J. Manley, "Analysis of currency impact on international investment", *Man. Fin.*, vol. 32, no. 1, pp. 5-13, 2006

[19] D. Lien, and M. Zhang, "A Survey of Emerging Derivatives Markets", *Em. Mark. Fin. and Trade*, vol.44, no.2, pp. 39-69, Mar/Apr 2008  
<http://dx.doi.org/10.2753/REE1540-496X440203>

[20] R. Chakrabarti, and R. Roll, "East Asia and Europe during the 1997 Asian collapse: a clinical study of a financial crisis", *J. of Fin.Mark.*, vol. 5, no.1, 2002, pp. 1-30, Jan 2002

[21] D. Kenourgios, A. Samitas, and N. Paltalidis, "Financial crises and stock market contagion in a multivariate time-varying asymmetric framework", *J. of Int. Fin. Mark., Inst. and Mon.*, vol. 21, no.1, pp. 92-106, Feb.2011

[22] J. Niklewski and T. Rodgers T. "International portfolio diversification and the 2007 financial crisis: will structural change in equity market correlations have a lasting impact on optimal portfolio selection?", Economics, Finance and Accounting, Applied Research Working Paper Series, 2011