FUNDAÇÃO GETÚLIO VARGAS
ESCOLA DE ECONOMIA DE EMPRESAS DE SÃO PAULO

Joana Colarinha Vieira

International Portfolio Diversification: Evidence from Emerging Markets

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Dissertação apresentada à Escola de Economia de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre Profissional em Economia.

Campo do Conhecimento:
International Master in Finance

Orientador Prof. Dr. João Mergulhão (advisor)

Orientador Prof. Dr. Martijn Boons (advisor)

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ABSTRACT

Taking into account previous research we could assume to be beneficial to diversify investments in emerging economies. We investigate in the paper *International Portfolio Diversification: evidence from Emerging Markets* if it still holds true, given the assumption of larger world markets integration.

Our results suggest a wide spread positive time-varying correlations of emerging and developed markets. However, pair-wise cross-country correlations gave evidence that emerging markets have low integration with developed markets. Consequently, we evaluate out-of-sample performance of a portfolio with emerging equity countries, confirming the initial statement that it has a better a risk-adjusted performance over a purely developed markets portfolio.

Keywords: international portfolio diversification; pairwise correlation; dynamic conditional correlation; risk parity

RESUMO

Considerando estudos anteriores, podemos assumir ser benéfico diversificar os investimentos em economias emergentes. No estudo *Diversificação do Portfolio Internacional: evidência de mercados emergentes,* investigamos se o mesmo ainda se verifica, tendo em conta o pressuposto de uma maior integração global dos mercados.

Os nossos resultados sugerem correlações positivas ao longo do tempo de economias emergentes com mercados desenvolvidos. Contudo, as correlações entre países evidenciam que países emergentes ainda estão pouco integrados com os países desenvolvidos. Consequentemente, avaliamos o desempenho de um portfolio fora da amostra, com acções de país emergentes, confirmando o pressuposto inicial de que este apresenta um desempenho, ajustado ao risco, ligeiramente superior a um portfolio puramente constituído com acções de mercados desenvolvidos.

Palavras Chave: diversificação do portfolio internacional; correlação aos pares; correlação condicional dinâmica; igualdade de risco

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1. Introduction

One of the most important classical arguments in favor of international diversification is to benefit from the lower correlations among stocks in different markets. When correlations within equity returns are high, it is likely that when one stock loses other stocks may loose as well. Hence, potential gains from diversification are greater when correlation between stock returns is low. Solnik (1976) provided evidence that a globally diversified portfolio could half the risk of a diversified portfolio of U.S. stocks.

Furthermore, the potential diversification gains are substantial when developing countries are included in the set of investment opportunities. Literature on Emerging markets finance describes these markets as being highly volatile with impressive expected returns (Mullin 1993, Santis et al. 1997). Moreover, correlations of these equity returns with developed countries' equity returns are low. Consequently, it may be possible to decrease portfolio risk by diversifying into emerging markets.

In his seminal article Campbell R. Harvey (1995) provided the first comprehensive analysis of 20 new equity markets in emerging economies, claiming that given the low correlations among emerging with developed market returns (1986-1992), the inclusion of emerging market assets in a mean-variance efficient portfolio significantly reduces portfolio volatility and increases expected returns.

However, Shawky et al. (1997) point towards a reduction of the potential gains from international diversification (1990-1995), due to the increased worldwide integration of financial markets, which might have caused stronger co-movements among international equity markets.

Taking in consideration the debate motivated by the scope of previous research, this paper aims to analyze if it might still be interesting for investors in developed markets, in current days, to diversify their equity portfolios into developing economies.

For this purpose we begin by investigate the recent level of international stock market correlations for the elapsed time of 1995 until 2014, exploring an MSCI dataset of emerging and developed markets. We further evaluate if correlations are changing and increasing over the same period using the Dynamic Conditional Correlation model (DCC), with a particular focus on the behavior of returns correlations during the subprime crisis period. Lastly, we have an empirical analysis of Exchange Traded Funds (ETFs) portfolio performance, with and without emerging markets stocks.

Exchange Traded Funds are a relatively new product that became available in the early 1990s, providing an alternative method of investing indirectly in international equities. This new product has the same characteristics as index funds or mutual funds, but is traded like stocks. ETFs are commonly compared to mutual funds because their market value is also close to their net asset value; however, they differ from mutual funds in the sense that ETFs are baskets of securities that trade on exchanges like individual stocks. Moreover, ETFs are superior to active mutual funds due to lower fess, intraday liquidity, transparency and tax efficiency. (Huang et al. 2011). ETFs are both able to track a benchmark index (like open-end funds) as well as to be traded in equity markets (like closed-end funds) (Charteris et al 2014). Nowadays, ETFs are one of the fastest-growing segments of the investment management business. Its success is mainly associated with lower costs, simple access, transparency and liquidity.

In this project we analyze seventeen developed countries equity ETFs and sixteen emerging countries equity ETFs between 1996 and 2015. Given that ETFs are relatively new, the number of ETFs that we could choose from is limited.

The portfolios' allocations are based on the historical averages of the expected returns, and variances of the ETFs indices collected. For each case, two strategies are examined: (i) risk parity portfolio and (ii) equally weighted portfolio. The performance of each portfolio is evaluated on a 60-month rolling window, out-of-sample basis, over the 30/04/2001 to 27/02/2015 period. That is, the first allocation is based on data from 30/04/1996 to 30/03/2001. The portfolio is re-optimized at each point in time.

The study is organized as follows. In the first section is provided a review of some selected literature relevant to the study. The second section describes the data used in the study. Empirical results are discussed in the subsequent section. Finally, the last section provides a conclusion and a summary of the findings of this study.

2. Literature Review

Emerging stock markets are especially known for having higher average returns, due to a superior economic growth during economical expansionary cycles, and bigger volatilities, associated to more unstable political, economical and financial environments. Moreover, global risk factors are expected to have minimal, or even no influence in their performance, explaining the low returns correlations with other emerging markets and developed markets (Pajuste et al 2000).

Driessen et al. (2007) argued that the benefits of international portfolio diversification are larger for developing countries relative to developed countries. They show that

country risk is a good determinant of diversification benefits, with countries with greater country risk having the higher potential benefits coming from global diversification. However, their findings also show that diversification benefits have decreased over the sample period 1985-2002. The reduction in diversification benefits seems to be linked to an improvement in the country risk over time.

Also, Salomons et al. (2003) tested whether the perceived risk is reflected in larger equity risk premium (ERP) for emerging markets, finding that when comparing ex post ERP for emerging markets to developed markets, the ERP is significantly higher in emerging markets.

Given these results, developing markets appear to represent interesting investment opportunities for global investors improving expected return and lower risk.

However, in recent years, financial markets have become more integrated, which leads to greater correlations between stock markets in different countries and an implied reduction of benefits from international diversification. Eiling et al (2006) concluded that equity markets around the world are becoming increasingly interconnected. In a sample of 32 emerging markets, from Q3 1991 to Q2 2009, they found significant positive trends in cross-country correlations within regions, correlations across emerging regions and correlations between emerging markets and the rest of the world. The authors still traced increased average correlations among emerging market regions from less than 0,1 in the early 1990s to close to 0,8 in recent years.

In a different approach, when comparing emerging countries correlations with the MSCI World market return before and after 1990, 17 out of 20 markets experience increased correlations with the world (Harvey 2002).

Financial crisis are one of the main factors responsible for the variation of market correlations and consequent increase, discouraging then international diversification.

Moreover, literature documents that emerging countries are more vulnerable to crisis due to their underdeveloped financial markets, which are also not so good news for investors diversifying in these markets, although developed countries are also affected. Crisis as the Wall Street crash in 1987, the European monetary system collapse in 1992, the 1994 Mexican pesos crisis, the 1997 "Asian Flu", the 1998 "Russian Cold", the 1999 Brazilian devaluation, the 2000 Internet bubble burst, the Argentinian default crisis in July 2001, and the recent American mortgage market crisis, have affected financial markets worldwide and resulted in catastrophic losses. All starts with a country-specific shock, which spreads rapidly to other markets (Billio et al. 2009). Researchers as Forbes and Rigobon (2000), Bae et al. (2003), Eichengreen et al. (1995, 1996) have attempted to elucidate the rational for these financial setbacks and the mechanisms of their global spread. An international propagation phenomenon of shocks also referred as "contagion".

According to the World Bank's framework we can distinguish three distinctive definitions of contagion[1]:

1.Broad definition: whereby contagion is identified as a general process of shock transmission across countries. A process supposed to work during calm as well as in crisis periods. Accordingly, a contagion is associated not only with negative shocks but also with positive spillover effects;

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[1] See Billio, Monica. Caporin, Massimilian. 2010. "Market linkages, variance

2.Restrictive Definition: referring to contagion as a propagation of shocks between two countries (or group of countries) in excess of what should be expected by fundamentals and considering the co-movements triggered by ordinary shocks.

3.Very restrictive definition: in this case contagion should be interpreted as the change in the transmission mechanisms that takes place during turn oil period. For example, the latter can be inferred by a significant increase in the cross-market correlation. (This is the one adopted by Forbes and Rigobon (2000))

Many papers have gone deeper in the contagion conceptualization, testing its existence under different approaches. The methodology's choice varied according to the definition of contagion adopted. Syllignakis et al. 2011, used the Dynamic Conditional Correlations approach to investigate the existence of increased correlation patterns during the recent stock market crash (2007-2009), employing weekly stock-price data. They found evidence of contagion effects during this period of crisis, due to driving behavior in the financial markets of the Central and Eastern European emerging countries. Naoui (2010), also examined the financial contagion phenomenon during the American subprime crisis, applying the Dynamic Conditional Correlation model to a sample of daily returns of six developed countries and ten emerging countries, seriously affected by the subprime crisis, concluding that contagion was stronger between this markets sample and the US during the subprime crisis. Chiang et al. 2007 studied nine Asian daily stock-return data series from 1990 to 2003, also using the DCC model, and found two phases of the Asian crisis: in a first moment of an increase in correlation

(contagion)[2]; followed by a second one showing a continued high correlation (herding). Moreover, the authors' finding of contagion effects during the Asian financial crisis goes against Forbes and Rigobon (2002) conclusion of "no contagion".

The Dynamic Conditional Correlation analysis has then been widely used to measure the degree of financial contagion. As in these studies, we are applying the Dynamic Conditional Correlation Model (Engle 2002), to analyze the evolution of the correlations between the developed markets MSCI indices and twenty-one emerging countries. Moreover, as correlation coefficients across markets are likely to increase after a bad shock, we access if the same is verified between developed and emerging markets during the 2008 subprime crisis. This analysis more focused on the 2008 crisis was motivated by Valls Pereira et al. (2013) study. The authors state that the comparison of correlations, between the returns of the markets of interest, before and after the event theoretically responsible for triggering the financial crisis, is a very intuitive way of assessing the contagion presence. King and Wadhwani (1990) also employ this method to examine the 1987 American crisis (Wall Street Crash), finding superior correlations among markets of the United States, the United Kingdom and Japan after this event. However, we can also find authors providing evidence of no contagion across different economies, after crisis events (Lee and Kim (1993), Forbes

[2] Forbes and Rigobon (2002) define contagion as significant increases in cross market co-movement, while any continued high degree of market correlation suggests strong linkages between the two economies and is considered to be interdependent. So, the presence of contagion must involve a dynamic increase in correlation in the period following a crisis event.

and Rigobon (2002)).

This paper concludes with the evaluation of equity country ETFs. There are a few studies in the literature examining the performance of country equity ETFs portfolios. Huang et al., 2011 found that investors investing in ETFs of foreign markets (for the period 2003-2009) will have no performance difference from those who invest in a more direct way (only in the S&P500). In Petronio et al., 2014 we can find an analysis of the main ETF markets (U.S. and European), for the period 2006-2012, and examine the portfolio selection problem. A different study compares the performance of a portfolio consisting of exchange-traded funds (ETFs) with that of the overall market, exemplified by the Topix Index (2008-2009). Kono et al. 2011, concludes that an optimal ETF portfolio can outperform an overall market index when performance is measured using the Sharpe ratio.

In our study, we apply the "risk parity" and "equally weighting asset allocation approaches" to evaluate the out-of-sample performance of an international portfolio with emerging countries ETFs against one without emerging stocks. While for an equally weighted portfolio capital is distributed equally, for a risk parity portfolio the investment capital is allocated in way that all portfolio constituents have the same contribution to the total "risk" of the portfolio. Studies such as Maillard, Roncalli, and Teiletche (2009) allow for a better understanding on the properties of risk-parity portfolios. They offer evidence that for the RP portfolio to be efficient is necessary to have identical Sharpe ratios and identical correlations among all assets in the universe. Finnally DeMiguel, et al (2007), in their extensive study of fourteen different asset allocation models, demonstrated that equally-weighted portfolio is the best allocation

model across seven different empirical datasets of the global equities universe. The authors also emphasize that when evaluating the performance of a particular strategy for optimal asset allocation the 1/n rule, should serve at least as a first obvious benchmark. Supported by this discussion we propose the following research questions:

1st question: How have emerging countries' time-varying correlations with developed markets been changing in the last 15 years?

2nd question: What are the average historical correlations among international markets, for the same period, ranging from 1999 to 2014?

3rd question: Is a portfolio with emerging equity country ETFs outperforming a portfolio with only developed equity country ETFs, for the period 1996 to 2015?

The main contribution of the current paper should rely on the study of an innovative dataset, analyzing its correlations and benefits according to the type of portfolio combinations adopted, offering a first comparison for the selected sample in a recent period.

3. Data and Methodology

3.1 Data

The selected dataset utilized to study the recent levels of correlations across international markets, consists of the monthly last prices of 50 MSCI equity indices from, corresponding to 21 emerging countries, 23 developed countries, 5 regional indexes and one world market index. Each of the stock market indices is reported in U.S. currency and data was obtained from Bloomberg Database. Specifically, the collected

index values, corresponding to the emerging markets sample refer to the following indexes: MSCI Equity Indexes of Peru, Chile, Colombia, Mexico, Brazil, China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan, Thailand, Czech Republic, Egypt, Greece, Hungary, Poland, Russia, South Africa, Turkey. While the collected index values, corresponding to the developed markets sample refer to the MSCI indexes of Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, USA, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand. The country selection for both samples, emerging and developed markets, was done according to the constitution of the MSCI Emerging Markets Index and MSCI Developed Markets Index. Qatar and United Arab Emirates were excluded from the sample for not having enough data available for the period of this study. Considering the comparison of correlations between regions and the world index three MSCI indices were collected for the emerging markets of Latin America, Asia, Europe/Middle East/Africa; two MSCI indices for emerging and developed markets, and, finally, the MSCI world index.

The sample period goes from 29 of January 1999 to 21 of November 2014, using 191observations for each index. The time frame was defined in a way that it could be used the largest amount of data as possible, regarding the availability of prices for each index. The selected Markets follow the categorization of Emerging Markets or Developed Markets according to the MSCI classification, as of October 2013.

For the purpose of comparing the performance of different international portfolios, thirty-three equity country ETFs (monthly last prices), were collected allowing for a

period of study ranging from 29/03/96 until 27/02/15. The table below provides the description of the ETFs indexes collected.

Table 1: ETF Universe

Developed Countries Indices	ETF Symbol	Description	Inception Date	Index being tracked
Singapore	EWS US	iShares MSCI Singapore ETF	29/03/96	SIMSCI
Spain	EWP US	iShares MSCI Spain Capped ETF	29/03/96	M1ES2550
Sweden	EWD US	iShares MSCI Sweden ETF	29/03/96	MXSE
Switzerland	EWL US	iShares MSCI Switzerland Capped ETF	29/03/96	M1CH2550
UK	EWU US	iShares MSCI United Kingdom	29/03/96	MXGB
Australia	EWA US	iShares MSCI Australia ETF	29/03/96	MXAU
Austria	EWO US	iShares MSCI Austria Capped ETF	29/03/96	M1AT5IM
Belgium	EWK US	iShares MSCI Belgium Capped ETF	29/03/96	MIMUBELN
Canada	EWC US	iShares MSCI Canada ETF	29/03/96	MXCA
France	EWQ US	iShares MSCI France ETF	29/03/96	MXFR
Germany	EWG US	iShares MSCI Germany ETF	29/03/96	NDDUGR
Hong Kong	EWH US	iShares MSCI Hong Kong ETF	29/03/96	MXHK
Italy	EWI US	iShares MSCI Italy Capped ETF	29/03/96	M1IT2550
Japan	EWJ US	iShares MSCI Japan ETF	29/03/96	MXJP
Netherlands	EWN US	iShares MSCI Netherlands ETF	29/03/96	MXNL
USA	DIA US	Dow Jones Industrial Average Index	30/01/98	DJITR
Israel	EIS US	iShares MSCI Israel Capped ETF	31/03/08	MISCNU
Emerging Countries Indices	ETF Symbol	Description	Inception Date	Index being tracked
Mexico	EWW US	iShares MSCI Mexico Capped	29/03/96	M1MX5IM
Malaysia	EWM US	iShares MSCI Malaysia ETF	29/03/96	MXMY
Korea	EWY US	iShares MSCI South Korea Capped ETF	31/05/00	M1KR2550
Taiwan	EWT US	iShares MSCI Taiwan ETF	30/06/00	TAMSCI
Brazil	EWZ US	iShares MSCI Brazil Capped ETF	31/07/00	M1BR2550
China	2801 HK	iShares MSCI China Index ETF	30/11/01	NDEUCHF
South Africa	EZA US	iShares MSCI South Africa ETF	28/02/03	MXZA
Turkey	DJIMT TI	Dow Jones Islamic Mkt Turkey	28/02/06	DJIMTR
India	INDIA SP	Ishares MSCI India Index ETF	31/05/06	MXIN
Russia	LYRUS SW	Lyxor ETF Russia USD	30/06/06	DJRUSGD
Chile	ECH US	iShares MSCI Chile Capped ETF	30/11/07	M1CL5IM
Indonesia	R/LQ45X IJ EQUITY	INDO PREMIER-ETF LQ-45	31/12/07	LQ45
Thailand	THD US	iShares MSCI Thailand Capped ETF	31/03/08	M1TH5IM
Colombia	GXG US	Global X MSCI Colombia ETF	27/02/09	M1ACOCP
Peru	EPU US	iShares MSCI All Peru Capped	30/06/09	M1PECAPD
Poland	PLND US	Market Vectors Poland ETF	30/11/09	MVPLNDTR

The benchmark being used is the MSCi World Index (MXWD). The risk-free rate considered in our study is the US three-month Treasury Bill obtained from the Federal Reserve Economic Data web database. All strategies are developed and implemented in U.S. dollar terms. This assumes that no currency hedging takes place.

3.2 Methodology

As previously mentioned, this paper addresses three different questions, with distinctive methods for each one.

3.2.1 Dynamic Conditional Correlation (DCC) model

The 1st research question refers to the analysis of time-varying correlations changes, between developed and emerging markets, in the last 15 years. The fluctuations of the correlations are modeled according to the DCC Model, as proposed by Engle (2002) and Tse and Tsui (2002) as an extension to the CCC model. The DCC model is preferred to the Constant Conditional Correlation model because it corrects its main defect on assuming constant correlations over time, which is not supported by empirical evidence. Both models belong to the family of multivariate GARCH models. To describe the DCC model as proposed by Engle (2002) we start by specifying the multivariate conditional variance:

$$H_t = D_t R_t D_t \quad (1)$$

Where D_t is the (n x n) diagonal matrix of time-varying standard deviations from univariare GARCH models with $\sqrt{h_{ii,t}}$ on the ith diagonal, i = 1,2, …, n; R_t is the (n x n) time-varying correlation matrix. According to the DCC model the conditional covariance matrix H_t is estimated in two steps. Firstly, univariate volatility models are fitted for each of the stock returns and are obtained the estimates of $\sqrt{h_{ii,t}}$. Secondly, stock-return residuals are transformed by their estimated standard deviations from the first stage $u_{i,t} = \varepsilon_{i,t} / \sqrt{h_{ii,t}}$ and $u_{i,t}$ is then used to estimate the parameters of the conditional correlation. The evolution of the correlation in the DCC model is given by:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1} \quad (2)$$

Where $Q_t = (q_{ij,t})$ is the *n x n* time-varying covariance matrix of u_t, $\bar{Q} = E[u_t u'_t]$ is the *n x n* unconditional variance matrix of u_t, and α and β are nonnegative scalar parameters satisfying $(\alpha + \beta) < 1$. Because Q_t does not generally have ones on the diagonal, we scale it to obtain a proper correlation matrix R_t. Therefore,

$$R_t = (diag(Q_t))^{-1/2} \, Q_t (diag(Q_t))^{-1/2} \quad (3)$$

Where $(diag(Q_t))^{-1/2} = diag\,(1/\sqrt{q_{11,t}}, \ldots, 1/\sqrt{q_{nn,t}})$.

In Equation 3, R_t is a correlation matrix with ones on the diagonal and off-diagonal elements less than one in absolute value, as long as Q_t is positive definite. The DCC model can be estimated by maximum likelihood breaking the log-likelihood function into two parts. First we estimate the parameters that determine the univariate volatilities and in a second phase we estimate the parameters that determine the correlations. Let θ denote the parameters in D_t, and ϕ the parameters in R_t, then the log-likelihood fund is:

$$l_t(\theta, \phi) = \left[-\frac{1}{2} \sum_{t=1}^{T} (n \log(2\pi) + log|D_t|^2 + \varepsilon'_t D_t^{-2} \varepsilon_t) \right] + \quad (4)$$

$$\left[-\frac{1}{2} \sum_{t=1}^{T} (\log|R_t| + u'_t R_t^{-1} u_t - u'_t u_t) \right].$$

The volatility can then be found in the first part of the likelihood function in Equation (4), obtained by the sum of individual GARCH likelihoods. The log-likelihood function can be maximized in the first step over the parameters in D_t. Once we have the estimated parameters from the first stage, the correlation component of the likelihood function in the second part of Equation (4) can be maximized to estimate correlation coefficients.

3.2.2 Pairwise unconditional correlations

Assuming the theoretical model of portfolio selection, the degree to which diversification can reduce risk depends upon the correlations among security returns and consequently diversification could eliminate risk if the returns are not correlated.

Motivated by the fact that equity markets around the world are becoming increasingly interconnected we are studying the cross-country correlations. This way, to attend the question on what are the levels of correlation among international markets, for a more recent period, we calculated two different matrices containing the pairwise Pearson's linear correlation coefficient between each pair of indices in order to measure the co-movements between each two returns series. The period under analysis goes from January 29th, 1999 to November 21st, 2014. In first place come the correlation coefficients for 27 MSCI Emerging Countries indices with regional indices and the world index (Table 14.1 in appendix). Follows the correlations between 27 MSCI Emerging Countries indices and 23 MSCI Developed Countries indices (table 15.1 in appendix). The respective p-values for Pearson's correlation were computed as well. Testing the null of no correlation, using a Student's t distribution for a transformation of the correlation. Additionally, we complement the cross-country correlations analysis with a particular focus on the 2008 subprime crisis. We employ a sub-sample analysis to the unconditional cross-market correlation coefficients in the pre- and post-crisis periods. If the correlation coefficient increases significantly during the crisis, this may imply a statistically higher degree of cross-market linkages (Kim et al. 2015).

3.2.3 Mean-Variance Model

The efficient frontier, for the MSCI data, was obtained following Robert C. Merton

paper (1972) methodology. When deriving efficient frontiers, we choose the weights that would minimize the portfolio variance $\sigma^2 \equiv \omega'\Omega^{-1}\omega$, subject to the budget constraint $\omega'e = 1$ (e unit vector) and a given level of expected portfolio return $\omega'ER = \mu p$. The optimal weights were obtained using the (n x n) covariance matrix of returns Ω, the expected returns on the risky assets ER (n x 1) and the chosen mean portfolio return ERp≡ μp. The minimum variance portfolio has: var(Rp)= $\omega'\Omega^{-1}\omega$, where ω is the (n x1) vector of optimal proportions held in the risky assets calculated as follows:

$$\omega = \Omega^{-1}\left[\frac{ER(\,C\mu p - B) + e(A - B\mu p)}{(AC - B^{2})}\right] \tag{5}$$

$$A = (ER')\Omega^{-1}\,(ER) \tag{6}$$

$$B = (ER')\Omega^{-1}\,e \tag{7}$$

$$C = e'\Omega^{-1}\,e \tag{8}$$

To answer all the proposed questions, monthly index returns are calculated based on the following logarithmic difference:

$$Rt = \log(Pt/Pt - 1) \tag{9}$$

In order to dimension the risk level, volatility is calculated through the standard deviation of the returns given by:

$$s = \sqrt{(\frac{1}{n}\sum_{i=1}^{n}(xi - \overline{x})\text{^}2)} \tag{10}$$

3.2.4 The Naive Portfolio

One of the weighting methodologies under analysis on this study refers to the naive strategy. As described in DeMiguel, the "ew" or "1/N" strategy gives the weight of 1/N to each of the N risky assets. Moreover, this strategy does not imply any optimization or estimation and totally ignores the data.

3.2.5 The Risk Parity Portfolio

The portfolios are also being weighted according to the risk parity strategy, in order to evaluate which method allows to a superior risk-adjusted performance.

This weighting methodology aims to equalize risk contributions from the different components of the portfolio, so that no asset contributes more than its peers to the total risk of the portfolio.[3]

So, the analytic solution under which we find the weight allocated to each component *i* is given by:

$$x_i = \frac{{\sigma_i}^{-1}}{\sum_{j=1}^{n} {\sigma_j}^{-1}} \ , \tag{11}$$

Consequently, as higher the volatility of a component is, the lower its weight in the ERC portfolio. We are taking the constraint of no short selling, $0 \leq x \leq 1$.

3.2.6 Out of Sample evaluation

The analysis of the aforementioned models follows a "rolling-sample" approach. As in DeMiguel, we choose an estimation window of length M = 60 for a T – month-long

[3] The risk measure being considered is the volatility of the portfolio. The Equal-weighted Risk Contribution principle can also be applied to other risk measures.

dataset of asset returns. [4]So, in each month t, and starting from t = M + 1, we take the data from the previous M months to estimate the parameters needed to determine the relative portfolio weights for each strategy. These weights are then used to compute the return for the month t +1. Then, we repeat this procedure for the next period, by including the data for the new date and dropping the data for the earliest period. We continue doing this until the end of the data set is reached. At the end we have a series of T – M monthly out-of-sample returns generated by each of the portfolio strategies.

Moreover, both strategies are *unconditional* due to how we choose expected returns, and variances. By using the average returns over the previous 60 months, although the mean returns change through time as the 60-month window moves, we are assuming that the best forecast of the equity returns are its past average. This implies that there is no other relevant information to forecast the next month stock price besides the previous price. In what refers to the variances, these are assumed to be unconditional over the previous 60 months. All strategies are developed and implemented in U.S. dollar terms, no currency hedging is taking place.

3.2.7 Performance Measures

For each strategy and each dataset we compute four different performance measures.

First we measure the out-of-sample Sharpe ratio of strategy *k*, defined by Sharpe (1994) as:

$$\text{Sharpe} = \frac{Rp - Rf}{\sigma p}, \tag{12}$$

where Rp is the annualised return, Rf is the annualized risk-free rate and σP is the

[4] in DeMiguel, the insights from the results for the case of M = 60 are not very different from those for the case of M = 120

volatility of the returns.

Second we calculate the Modified Sharpe ratio (MSR) as defined by Gregoriou and Gueyie (2003):

$$\text{Modified Sharpe Ratio} = \frac{Rp-Rf}{|MVaRp|} \tag{13}$$

This measure allows to take into account the higher moments of the distribution skewness (S) and excess kurtosis (K). So the MSR increases the complexity of the Sharpe ratio in the sense that it captures higher moments in the risk measure of the denominator, by using the Cornish-Fisher expansion.

Cornish-Fisher expansion:

$$\tilde{z}_\alpha = z_\alpha + \frac{1}{6}(z_\alpha^2 - 1)\text{S} + \frac{1}{24}(z_\alpha^3 - 3z_\alpha)(\text{K} - 3) - \frac{1}{36}(2z_\alpha^3 - 5z_\alpha)S^2 \tag{14}$$

where the Modified VaR (MVARp) measure is given by:

$$\text{Modified VaRp } (1-\alpha) = \text{abs } (-(\mu + \tilde{z}_\alpha \sigma)) \tag{15}$$

where z_α is the *z-statistic* corresponding to a one-sided standard normal PDF for $1 - \alpha$ confidence, where α *is 5%.*

The Maximum Drawdown ratio (DD ratio) is given by:

$$\text{Maximum Drawdown Ratio} = \frac{Rp-Rf}{|\max DD|} \tag{16}$$

The Maximum Drawdown ratio is also another enhanced version of the Sharpe ratio but the measure of risk in the denominator is the absolute value of the maximum historical

drawdown. The maximum drawdown corresponds to the maximum amount lost from the highest preceding high to the lowest low, during the period that the portfolio has not recuperated its value to that above the last highest high. When the portfolio value recuperates from its losses and achieves a net new high it is said to be out of its drawdown. The input range in this case are the Value Added Monthly Indexes constructed from the monthly returns.

Finally, the Sortino ratio uses the concept of the Minimum Acceptable Return (MAR) in the denominator and in this case it is fixed at 5%. By setting a minimum acceptable rate of return for the investor, the returns are being split into two categories: returns greater than or equal to MAR and returns less than MAR. This measure only uses the downside returns in the calculation so, the higher the Sortino ratio, the better the control of the downside returns, while not being penalized by upside returns.

$$\text{Sortino} = \frac{R_P - MAR}{\sqrt{\frac{1}{T}\sum_{\substack{t=0 \\ Rp<MAR}}^{T} (R_{P,t} - MAR)^2}} \quad (17)$$

4. Results

4.1 Descriptive Statistics of returns

In this section it is initially presented the descriptive statistics of monthly U.S. dollar stock returns: mean, median, variance, standard deviation, minimum, maximum, skewness and kurtosis. Statistic information was generated for two distinctive samples, respectively the MSCI equity indices (table 2) and ETFs equity indices in full (table 3)

and out-of-sample period (table 4). The reason why we are analyzing the returns statistics in the full and out-of-sample period is because when constructing the ETFs portfolios we are only allocating the out-of-sample returns.

Concerning the MSCI equity indices being studied, the results for the jarque-bera test show that empirical return distributions are far from a normal distribution, except for Taiwan and Japan MSCI indices. In general terms, all markets have kurtosis higher than 3 (the benchmark value for a normal distribution), suggesting that the series is characterized by leptokurtosis. Hence the distributions of the returns in the markets considered have a greater number of observations in the tails, than what it should be found in a normal distribution.

For the considered period all the average returns revealed to be negative except for Greece (1,04%), Portugal (0,48%) and Italy (0,23%), although the indices for these countries didn't have the highest levels of volatility, as it would be expected. For example, both Turkey and Russia have standard deviations of 14,64% and 11,52% respectively, while Portugal has a standard deviation of just 6,85%.

Looking to the Emerging Markets MSCI Index the value for average returns is -0,65% and the standard deviation is 6,77%, while the Developed Markets MSCI index has an average return of -0,21%, with a volatility of 4,60%. Resulting that emerging markets seem to have a lower return combined with a larger volatility.

When juxtaposing regional indices among themself, Latin America is the one that reports the lowest level of average returns (-0,84%), combined with the highest volatility associated to it (8,02%). Therefore, suggesting to be the least attractive of all regional markets.

Table 2: Descriptive Statistics for monthly MSCI equity indexes returns.

MSCI	Nr of Observs.	Mean	Median	Variance	Stand. Dev.	Min.	Máx.	Skew.	Kurt.	Jarque-Bera (p-value)
Emerging countries										
Americas										
Peru	191	-1,15%	-1,50%	0,73%	8,55%	-23,68%	44,70%	0,87	6,53	0,1%
Chile	191	-0,62%	-0,70%	0,42%	6,46%	-18,29%	29,65%	0,76	5,64	0,1%
Colombia	191	-1,39%	-2,08%	0,78%	8,85%	-24,20%	33,62%	0,49	4,17	0,3%
Mexico	191	-1,01%	-1,65%	0,52%	7,18%	-16,83%	36,71%	0,91	6,14	0,1%
Brazil	191	-0,90%	-1,23%	1,10%	10,49%	-31,12%	39,08%	0,57	4,74	0,1%
Asia										
China	191	-0,49%	-0,86%	0,75%	8,65%	-38,19%	25,84%	0,11	5,08	0,1%
India	191	-0,93%	-1,63%	0,80%	8,92%	-31,49%	33,22%	0,41	3,99	0,8%
Indonesia	191	-1,08%	-1,59%	1,20%	10,95%	-34,18%	48,77%	0,41	5,21	0,1%
Korea	191	-0,79%	0,00%	0,93%	9,66%	-30,54%	39,09%	0,21	4,54	0,3%
Malaysia	191	-0,67%	-0,81%	0,37%	6,08%	-32,86%	19,18%	-0,47	6,74	0,1%
Philippines	191	-0,42%	-0,80%	0,57%	7,54%	-21,86%	27,94%	0,30	3,72	3,2%
Taiwan	191	-0,18%	-0,39%	0,62%	7,85%	-25,64%	24,53%	0,07	3,55	22,7%
Thailand	191	-0,78%	-1,38%	0,91%	9,55%	-35,97%	39,93%	0,41	5,53	0,1%
Europe/ Middle East/ Africa										
Cz Repub	191	-0,85%	-0,98%	0,70%	8,38%	-26,91%	34,01%	0,42	4,58	0,1%
Egypt	191	-0,82%	-0,82%	0,91%	9,54%	-35,51%	39,64%	0,22	4,63	0,2%
Greece	191	1,04%	0,24%	1,08%	10,41%	-26,10%	45,56%	0,74	4,96	0,1%
Hungary	191	-0,10%	-0,78%	1,11%	10,53%	-24,23%	56,82%	1,14	7,11	0,1%
Poland	191	-0,28%	-0,71%	0,98%	9,88%	-23,38%	40,49%	0,56	4,15	0,2%
Russia	191	-1,18%	-2,15%	1,33%	11,52%	-47,71%	43,50%	0,11	5,15	0,1%
South Africa	191	-0,77%	-1,06%	0,57%	7,56%	-15,81%	29,39%	0,65	3,73	0,4%
Turkey	191	-0,77%	-3,09%	2,14%	14,64%	-54,06%	52,94%	0,32	4,62	0,2%
Developed Countries										
Norway	191	-0,53%	-1,08%	0,66%	8,11%	-16,47%	40,53%	1,30	7,53	0,1%
Portugal	191	0,48%	-0,17%	0,47%	6,85%	-13,23%	30,24%	0,85	4,83	0,1%
Singapore	191	-0,54%	-0,99%	0,50%	7,04%	-21,40%	34,09%	0,91	6,76	0,1%
Spain	191	-0,13%	-0,75%	0,54%	7,38%	-19,50%	29,24%	0,60	4,55	0,1%
Sweden	191	-0,45%	-0,60%	0,62%	7,90%	-21,54%	30,92%	0,58	4,76	0,1%
Switzerland	191	-0,34%	-0,76%	0,22%	4,69%	-10,99%	13,14%	0,70	3,81	0,2%
UK	191	-0,04%	-0,33%	0,24%	4,87%	-12,91%	21,14%	0,62	4,94	0,1%
USA	191	-0,24%	-0,95%	0,20%	4,46%	-10,28%	18,93%	0,74	4,37	0,1%
Australia	191	-0,49%	-1,00%	0,42%	6,46%	-15,56%	28,98%	0,87	5,13	0,1%
Austria	191	-0,07%	-0,94%	0,68%	8,26%	-21,54%	46,53%	1,63	9,57	0,1%
Belgium	191	0,04%	-0,77%	0,50%	7,05%	-16,27%	45,29%	2,05	12,52	0,1%
Canada	191	-0,62%	-1,29%	0,38%	6,13%	-20,12%	30,72%	0,91	6,36	0,1%
Denmark	191	-0,77%	-1,79%	0,38%	6,20%	-16,83%	29,45%	1,06	6,20	0,1%
Finland	191	-0,02%	-0,67%	0,93%	9,66%	-28,46%	37,93%	0,40	4,54	0,2%
France	191	-0,12%	-0,72%	0,40%	6,33%	-14,36%	25,18%	0,69	4,11	0,1%
Germany	191	-0,16%	-0,80%	0,54%	7,34%	-20,32%	27,92%	0,76	4,69	0,1%
Hong Kong	191	-0,49%	-0,85%	0,42%	6,45%	-19,92%	24,16%	0,40	4,38	0,3%
Ireland	191	0,48%	-0,78%	0,50%	7,08%	-17,40%	29,78%	1,12	5,38	0,1%
Israel	191	-0,45%	-0,95%	0,47%	6,88%	-23,86%	20,93%	0,50	4,33	0,2%
Italy	191	0,23%	-0,21%	0,51%	7,11%	-17,02%	26,73%	0,52	3,72	0,8%
Japan	191	-0,09%	0,05%	0,26%	5,05%	-13,27%	15,96%	0,20	3,12	43,8%
Netherlands	191	-0,11%	-0,86%	0,40%	6,35%	-13,68%	28,78%	1,06	5,57	0,1%
New Zealand	191	-0,22%	-1,11%	0,41%	6,43%	-14,22%	25,36%	0,87	4,35	0,1%
Regional Indices										
Latin Americ	191	-0,84%	-1,55%	0,64%	8,02%	-18,54%	38,28%	0,84	5,50	0,1%
Asia	191	-0,58%	-0,89%	0,49%	6,97%	-17,98%	27,65%	0,46	4,00	0,6%
EMEA	191	-0,57%	-1,44%	0,53%	7,28%	-16,70%	35,84%	1,02	5,80	0,1%
Developed	191	-0,21%	-0,92%	0,21%	4,60%	-10,35%	21,13%	0,90	5,05	0,1%
Emerging	191	-0,65%	-0,88%	0,46%	6,77%	-15,41%	32,16%	0,83	5,31	0,1%
World	191	-0,22%	-0,85%	0,22%	4,72%	-10,87%	22,20%	0,92	5,27	0,1%

Looking at the results with ETFs sample for the full period (table 3), the jarque-bera test

outputs reject the null hypothesis of the returns for a normal distribution in most of the data sample, except for the ETF indexes tracking Japan, Israel, Taiwan, Colombia, Peru and Poland. However, when evaluating this data in the out-of-sample period (table 4) the ETFs indices of Japan, Israel, Taiwan, Turkey, India, Russia, Chile, Taiwan, Colombia, Peru and Poland don't reject the null of coming from a normal distribution.

Going through each index average returns, comparing both periods (table 3 and 4), it is observable that 7 out of 17 developed countries have higher mean returns in the full sample period. Moreover, when looking to the out-of-sample period we can find 7 emerging countries exhibiting negative average returns, but only Italy, among developed countries, had negative average returns. In general terms we can state that out-of-sample and full-period sample have distinctive characteristics where returns and volatilities are concerned. To state a definitive view on the dissimilarities identified, we should annul some bias in the sample construction, as it is the case of the number of observations by country. In the emerging markets for out-of-sample and full-period (table 3 and table 4) the number of observations shrink considerably in some countries.

Besides having higher average returns for the full sample period, most of emerging markets also have superior volatilities for the same period. Meaning that the marginal return increase came associated with higher risk for investors in emerging markets during the full sample period. Against this trend we found examples such as China, South Africa and Colombia with lower volatilities in the full sample period when compared to the out-of-sample. Also, Mexico, Turkey, Thailand and Malaysia have lower returns for the full sample period.

Table 3: Descriptive Statistics for monthly ETFs equity indexes returns, for the full sample period.

ETFs	Nr of Observs.	Starting Date	Mean	Median	Variance	Stand. Dev.	Min.	Máx.	Skew.	Kurt.	Jarque-Bera (p-value)
Developed Countries Indices											
Singapore	227	30/04/96	0,24%	0,81%	0,65%	8,06%	-32,61%	33,65%	-0,47	6,51	0,1%
Spain	227	30/04/96	0,71%	1,42%	0,52%	7,24%	-27,07%	21,51%	-0,60	4,62	0,1%
Sweden	227	30/04/96	0,40%	0,87%	0,63%	7,94%	-29,51%	21,03%	-0,62	4,40	0,1%
Switzerland	227	30/04/96	0,43%	1,18%	0,29%	5,35%	-27,83%	16,32%	-1,04	6,56	0,1%
UK	227	30/04/96	0,49%	0,81%	0,24%	4,90%	-22,01%	15,74%	-0,59	5,11	0,1%
Australia	227	30/04/96	0,68%	1,47%	0,45%	6,74%	-31,50%	17,68%	-0,88	5,43	0,1%
Austria	227	30/04/96	0,17%	0,58%	0,58%	7,65%	-44,33%	19,71%	-1,34	8,91	0,1%
Belgium	227	30/04/96	0,47%	1,14%	0,43%	6,54%	-41,16%	15,30%	-1,73	10,63	0,1%
Canada	227	30/04/96	0,70%	1,14%	0,40%	6,34%	-31,72%	20,92%	-1,10	6,68	0,1%
France	227	30/04/96	0,31%	1,22%	0,42%	6,45%	-26,61%	15,94%	-0,76	4,35	0,1%
Germany	227	30/04/96	0,54%	1,43%	0,53%	7,28%	-27,42%	22,11%	-0,83	4,97	0,1%
Hong Kong	227	30/04/96	0,45%	0,94%	0,56%	7,51%	-33,01%	32,49%	-0,26	6,22	0,1%
Italy	227	30/04/96	0,04%	0,58%	0,55%	7,39%	-26,84%	17,77%	-0,45	3,74	0,8%
Japan	227	30/04/96	-0,02%	0,14%	0,32%	5,66%	-17,97%	19,14%	-0,15	3,32	35,3%
Netherlands	227	30/04/96	0,19%	1,10%	0,41%	6,44%	-29,65%	14,27%	-1,03	5,41	0,1%
USA	205	27/02/98	0,58%	0,98%	0,19%	4,38%	-16,52%	9,84%	-0,77	4,58	0,1%
Israel	83	30/04/08	-0,03%	0,15%	0,42%	6,50%	-20,56%	13,54%	-0,49	3,60	6,4%
Emerging Countries Indices											
Mexico	227	30/04/96	0,76%	1,98%	0,72%	8,49%	-47,50%	18,71%	-1,51	9,02	0,1%
Malaysia	227	30/04/96	0,22%	0,88%	1,01%	10,07%	-42,04%	75,52%	1,32	18,54	0,1%
Korea	177	30/06/00	0,68%	1,25%	0,80%	8,97%	-33,57%	26,66%	-0,33	3,91	1,8%
Taiwan	176	31/07/00	0,10%	0,20%	0,60%	7,71%	-22,26%	23,62%	-0,12	3,57	18,8%
Brazil	175	31/08/00	0,59%	0,89%	1,10%	10,49%	-40,23%	24,94%	-0,69	4,46	0,1%
China	159	31/12/01	0,88%	1,84%	0,58%	7,63%	-25,31%	18,35%	-0,68	4,34	0,2%
South Africa	144	31/03/03	1,11%	1,59%	0,61%	7,79%	-35,15%	19,43%	-0,85	5,55	0,1%
Turkey	108	31/03/06	0,24%	1,68%	0,41%	6,39%	-20,75%	13,48%	-0,83	3,80	0,6%
India	105	30/06/06	0,63%	0,86%	0,88%	9,37%	-36,39%	29,13%	-0,48	5,10	0,2%
Russia	104	31/07/06	-0,42%	0,83%	1,11%	10,54%	-34,05%	29,42%	-0,39	3,98	3,3%
Chile	87	31/12/07	-0,21%	-0,32%	0,52%	7,20%	-27,03%	17,94%	-0,79	5,55	0,1%
Indonesia	86	31/01/08	0,25%	1,29%	0,74%	8,61%	-29,40%	28,48%	-0,45	5,75	0,1%
Thailand	83	30/04/08	0,81%	2,29%	0,82%	9,06%	-42,87%	18,65%	-1,50	8,24	0,1%
Colombia	72	31/03/09	0,88%	1,09%	0,52%	7,19%	-17,64%	17,23%	-0,14	3,05	50,0%
Peru	68	31/07/09	0,42%	0,78%	0,44%	6,67%	-17,32%	16,19%	-0,06	2,99	50,0%
Poland	63	31/12/09	-4,70%	-3,38%	0,60%	7,77%	-13,06%	2,32%	-0,30	1,50	39,4%
MSCi World	227	30/04/96	0,37%	1,08%	0,22%	4,69%	-22,20%	10,87%	-1,00	5,39	0,1%

Note: the full sample period goes from each variable's starting date until February 27th 2015.

Table 4: Descriptive Statistics for monthly ETFs equity indexes returns, for the out-of-sample period.

ETFs	Nr of Observs.	Starting Date	Mean	Median	Variance	Stand. Dev.	Min.	Máx.	Skew.	Kurt.	Jarque-Bera (p-value)
Developed Countries Indices											
Singapore	167	30/04/01	0,79%	1,53%	0,44%	6,66%	-32,61%	24,15%	-0,92	7,53	0,1%
Spain	167	30/04/01	0,54%	1,42%	0,55%	7,44%	-27,07%	21,51%	-0,52	4,30	0,3%
Sweden	167	30/04/01	0,57%	0,81%	0,61%	7,79%	-29,51%	21,03%	-0,53	4,53	0,2%
Switzerland	167	30/04/01	0,52%	1,60%	0,24%	4,95%	-15,80%	11,13%	-0,73	4,04	0,2%
UK	167	30/04/01	0,40%	0,68%	0,26%	5,12%	-22,01%	15,74%	-0,53	5,23	0,1%
Australia	167	30/04/01	0,98%	1,82%	0,49%	7,01%	-31,50%	17,68%	-1,02	5,79	0,1%
Austria	167	30/04/01	0,43%	1,18%	0,67%	8,16%	-44,33%	19,71%	-1,35	8,58	0,1%
Belgium	167	30/04/01	0,54%	1,53%	0,48%	6,90%	-41,16%	15,30%	-1,80	10,93	0,1%
Canada	167	30/04/01	0,69%	1,14%	0,39%	6,23%	-31,72%	20,92%	-1,00	7,06	0,1%
France	167	30/04/01	0,16%	0,92%	0,44%	6,65%	-26,61%	15,94%	-0,78	4,45	0,1%
Germany	167	30/04/01	0,50%	1,13%	0,57%	7,57%	-27,42%	22,11%	-0,86	4,91	0,1%
Hong Kong	167	30/04/01	0,65%	1,12%	0,37%	6,12%	-23,73%	17,78%	-0,59	4,95	0,1%
Italy	167	30/04/01	-0,16%	0,59%	0,54%	7,32%	-26,84%	17,25%	-0,57	3,70	0,9%
Japan	167	30/04/01	0,20%	0,20%	0,26%	5,08%	-16,93%	11,29%	-0,35	3,20	11,2%
Netherlands	167	30/04/01	0,17%	1,28%	0,45%	6,67%	-29,65%	14,27%	-1,01	5,41	0,1%
USA	145	28/02/03	0,76%	1,12%	0,15%	3,81%	-14,58%	9,29%	-0,87	4,95	0,1%
Israel	23	30/04/13	0,23%	-0,84%	0,12%	3,40%	-4,58%	9,27%	0,97	3,59	5,2%
Emerging Countries Indices											
Mexico	167	30/04/01	0,87%	1,99%	0,54%	7,36%	-41,23%	16,22%	-1,44	8,70	0,1%
Malaysia	167	30/04/01	0,87%	1,15%	0,29%	5,39%	-19,17%	15,11%	-0,41	4,09	0,8%
Korea	117	30/06/05	0,57%	0,85%	0,73%	8,56%	-33,57%	26,66%	-0,51	5,06	0,2%
Taiwan	116	29/07/05	0,48%	0,75%	0,50%	7,04%	-20,37%	23,62%	-0,15	3,95	6,5%
Brazil	115	31/08/05	0,55%	0,73%	0,96%	9,79%	-40,23%	21,42%	-0,72	5,09	0,1%
China	99	29/12/06	0,36%	1,97%	0,71%	8,40%	-25,31%	18,35%	-0,68	4,08	1,0%
South Africa	84	31/03/08	0,45%	0,82%	0,68%	8,25%	-35,15%	19,43%	-0,88	6,23	0,1%
Turkey	48	31/03/11	0,48%	1,62%	0,24%	4,91%	-10,47%	9,73%	-0,66	2,73	8,1%
India	45	30/06/11	0,22%	0,52%	0,55%	7,42%	-18,73%	18,36%	-0,24	3,62	44,3%
Russia	44	29/07/11	-1,41%	-1,82%	0,88%	9,41%	-21,62%	22,49%	-0,01	3,13	50,0%
Chile	27	31/12/12	-1,39%	-1,67%	0,30%	5,47%	-15,64%	8,06%	-0,37	3,29	50,0%
Indonesia	26	31/01/13	-0,09%	1,29%	0,41%	6,39%	-20,64%	9,07%	-1,37	5,47	0,5%
Thailand	23	30/04/13	-0,26%	0,41%	0,38%	6,17%	-12,67%	10,93%	-0,25	2,18	49,4%
Colombia	12	31/03/14	-2,61%	-1,73%	0,73%	8,54%	-17,64%	14,35%	0,11	2,77	50,0%
Peru	8	31/07/14	-2,11%	-1,52%	0,11%	3,36%	-7,13%	1,42%	-0,31	1,50	27,5%
Poland	3	31/12/14	-4,70%	-3,38%	0,60%	7,77%	-13,06%	2,32%	-0,30	1,50	50,0%
MSCi World	167	30/04/01	0,25%	1,03%	0,26%	5,10%	-22,20%	10,87%	-1,11	5,94	0,1%

Note: the out-of-sample period goes from each variable's starting date until February 27th 2015. The out-of-sample starting date was then obtained subtracting a window of 60 months to the full period initial date.

The cross analysis of results with MSCI data and EFTs is limited by some methodological difficulties. Among others we would emphasize the different nature of variable construction, but especially distinctive time frame adopted in each case, or still the number of countries in each regional segment. However, although this unavoidable bias we still found a common trend between MSCI sample and EFTs out-of-sample,

where developed markets suggest on average better returns than emerging markets, contrarily to what we would from the literature. A plausible explanation could be that out-of-sample ETFs have a too short number of observations in some countries and are close to the 2008 financial crisis in world markets.

4.2 Dynamic Conditional Correlations

At this point in the paper we proceed to investigate a possible worldwide tendency for more integrated markets (emerging and developed), looking at markets' time-varying correlations. Lower correlations suggest less integrated markets (emerging vs developed). On the other hand, superior correlations imply a closer performance among markets, which decreases investor's incentive for risk dispersion.

We use the Dynamic Conditional Correlation (DCC) model developed by Engle (2002), to investigate the movement of correlations of stock market indices between Developed and Emerging Markets over the last 15 years. For this purpose we initially plot the dynamic conditional correlations between the MSCI Developed Markets Index and four emerging regional MSCI indices, so that we can have an overall view on the correlation evolution within markets. Then we proceed with a more detailed analysis of the time-varying correlations between the MSCI Developed Markets and sixteen Emerging Countries from Asia (figs. 2,3,4), Europe (figs. 5,6), Middle East and Africa (fig. 7), and South America (figs. 8,9). [5]

[5] Additionally, we have computed the annual average of the conditional coefficients relative to each figure, which can be found in the Appendix section.

Emerging Regional Markets

In a preliminary analysis we access the current correlation levels between developed markets and the three emerging regions under consideration on this study. It is clear from the diagrams that significant variations in the correlation structure occurred within the sample period. It can be seen that until 2004 Asian returns show the lower correlation with developed markets, while Latin America and EMEA had similar correlation levels. However, after 2004 the correlation of emerging Asia has grown above the other emerging regions, with exception of a particular day in October 2007 where it suffered the sharpest decrease. This decay didn't last too long, since emerging regions quickly recovered to the previous high correlation levels. Furthermore, we see from figure 1 that all the emerging regions seem to reach their highest correlation levels during the 2008 crisis period.

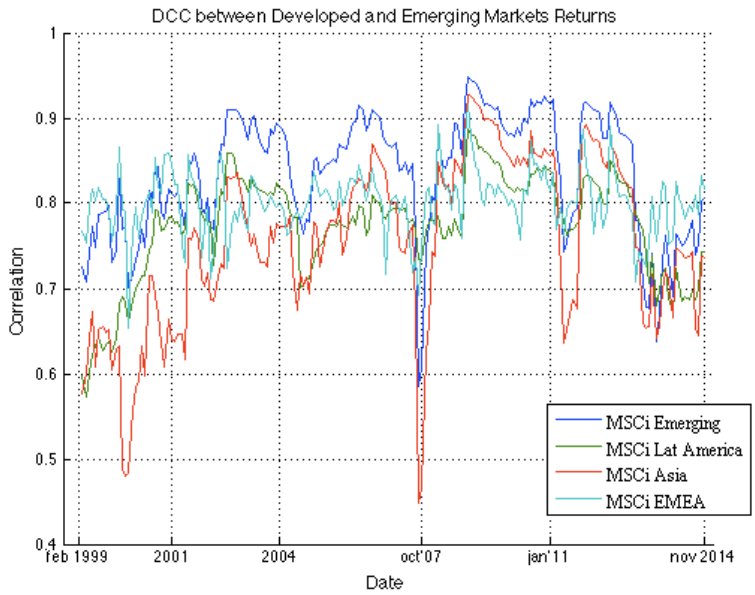

Figure 1: Dynamic Conditional Correlation between the MSCI Developed Markets Equity Index returns and the MSCI regional Equity Indexes returns (Emerging; Emerging Latin America; Emerging Asia; Emerging EMEA)

From the data in analysis we find consistent high correlation values, with a plausible

larger integration[6] of emerging markets with developed markets. We also reckon a growing correlation between emerging markets and developed markets over time that should be separated from the dramatic events of 2008. The world financial crises apparently gave a major contribution to a general disruption in returns observed.

To better understand the correlation behavior in each region we should embark in a more detailed analysis on a country based correlation with developed markets in the sample.

Emerging Asian Countries

Focusing first on countries belonging to emerging Asian economies, it can be seen that China and Korea are those exhibiting the highest correlation over time. India (figure 2), exhibits the sharpest increase from 1999-2001, coming closer to the Taiwan's correlation levels afterwards. Indonesia, Malaysia and Thailand (figure 3) do not show such high conditional correlations, however they have also suffered an increase of the correlation with developed markets until 2009. From this group Malaysia presents the most constant increase. Finally Philippines' correlation with developed markets (figure 4) assumes values between 0,4 and 0,6 having a much lower correlation when compared to Korea. It is interesting to notice that for all the considered Asian countries, the correlations became significantly higher throughout 2008-2009 and persisted at the

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[6] . as in Billio et al. 2009 we interpret market correlation as a measure of integration among financial markets. Also Cmpbell and Hamao (1992) take the high correlation as an indirect measure of market integration

higher levels, before declining at the end of 2009.

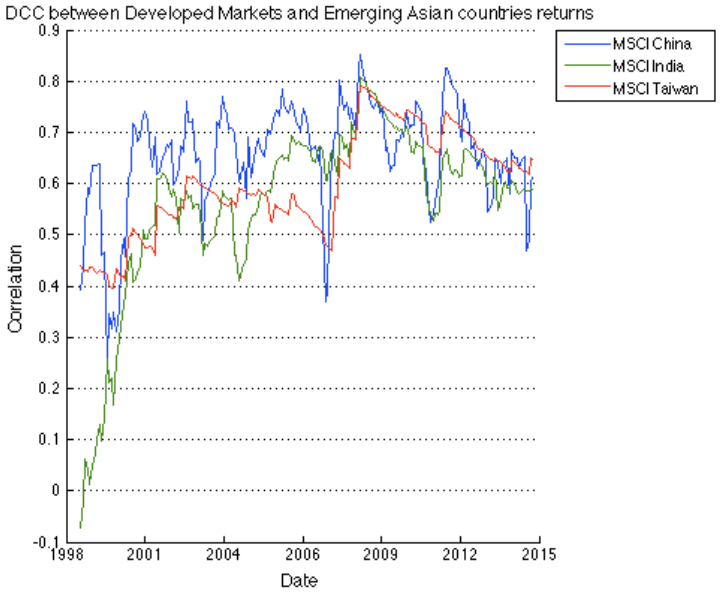


Figure 2: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi China, India, Taiwan Equity Indexes returns

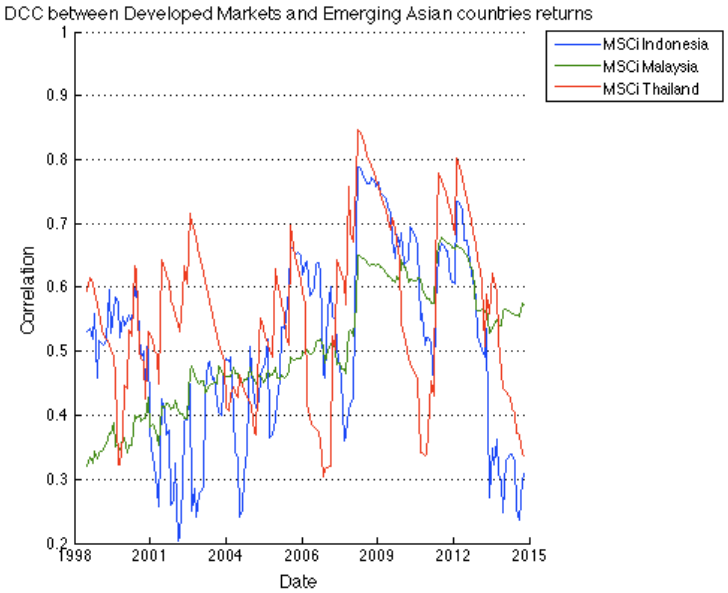


Figure 3: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi Indonesia, Malaysia, Thailand Equity Indexes returns

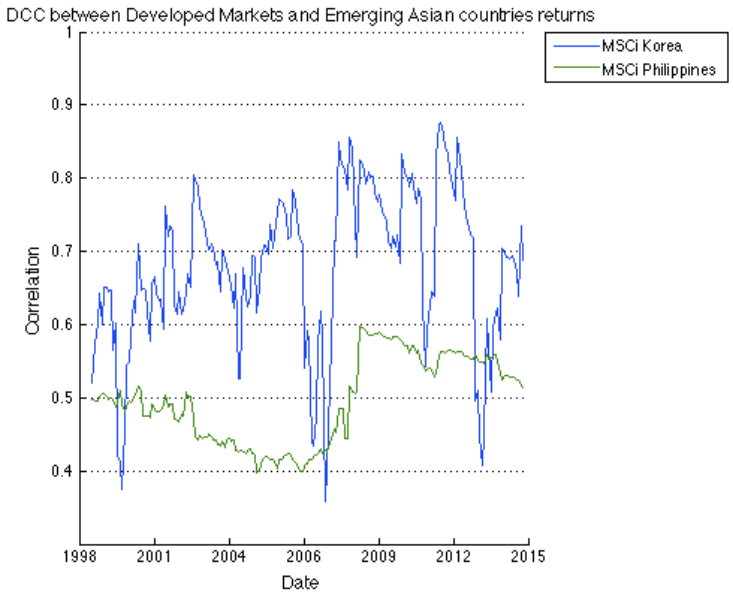


Figure 4: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi Korea, Philippines Equity Indexes returns

Emerging European Middle East and African (EMEA) countries

Relatively to emerging European and Middle East countries we find that Poland shows the highest correlation with developed markets over time (Fig. 6). Greece and Hungary had a gradual increase of the correlation over time with developed markets until 2009 (Fig. 5). All the five emerging European countries being considered exhibit a correlation decrease since 2012.

For emerging African countries, Egypt has substantial high-correlations over the 15-year period, reaching its highest correlation level (above 0,9) during the early stages of the sub-prime crisis. However, unusually high correlations were short-lived as they quickly moved back to the previous lower levels. DCC estimates in South Africa and Turkey exhibited more gradual increases around the crisis period (Figure 7).

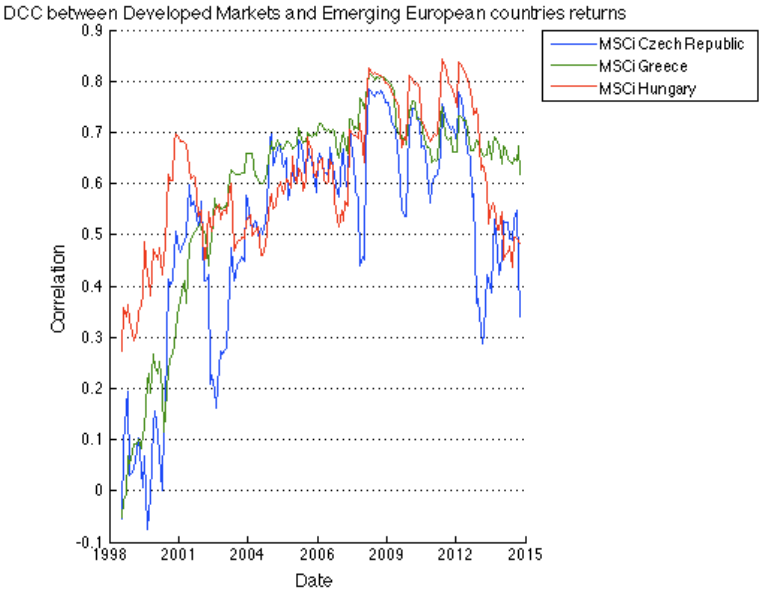


Figure 5: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi Czech Republic, Greece, Hungary Equity Indexes returns

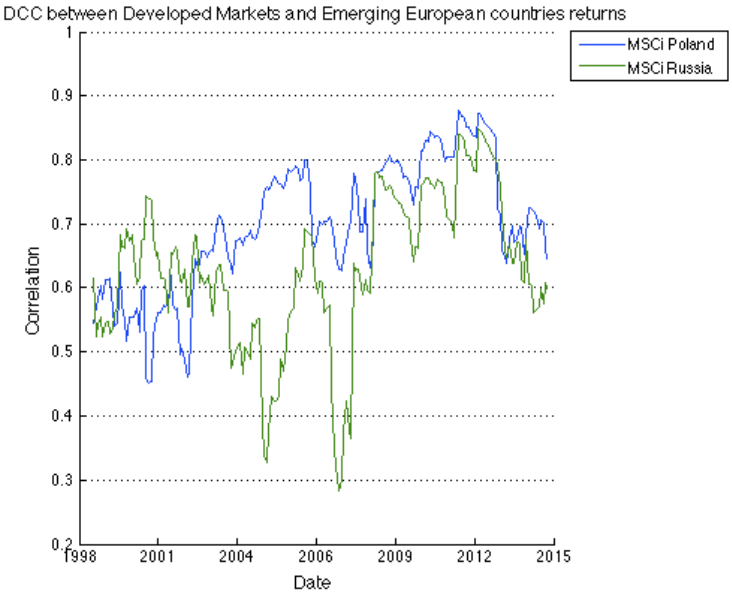


Figure 6: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi Poland, Russia Equity Indexes returns

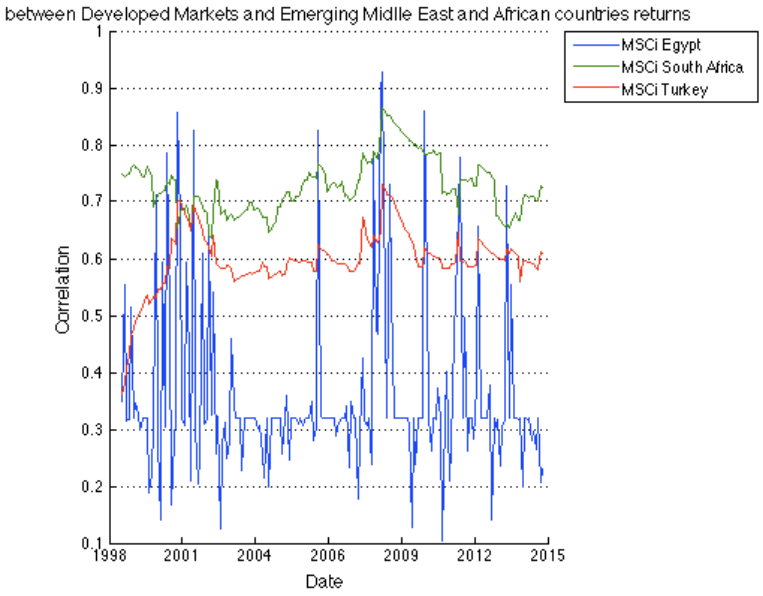


Figure 7: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and five MSCi Egypt, South Africa and Turkey Equity Indexes returns

Emerging South American Countries

Looking to the correlation of South American emerging economies with the developed markets, it can be seen that Mexico (fig. 8) has the highest correlation over time but also the sharpest decrease around 2007, lowering its correlation level from 0,8 to 0,5.

Brazil, on the other side, had a sudden rise in the correlation until 2001 (fig. 8), which lasted more persistently through the whole period. Also, Brazil exhibits relatively weaker response to the Lehman failure compared with the other countries reported earlier, showing a no changes around the crisis.

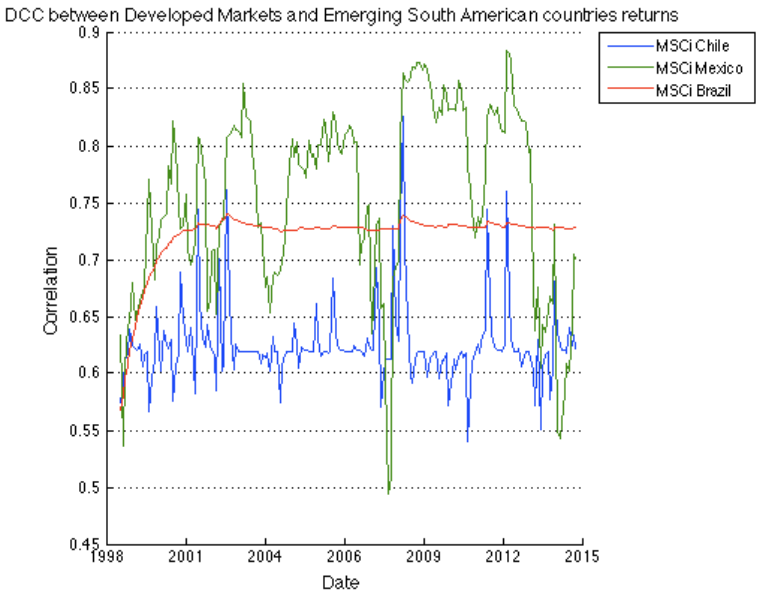


Figure 8: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and MSCi Chile, Mexico and Brazil Equity Indexes returns

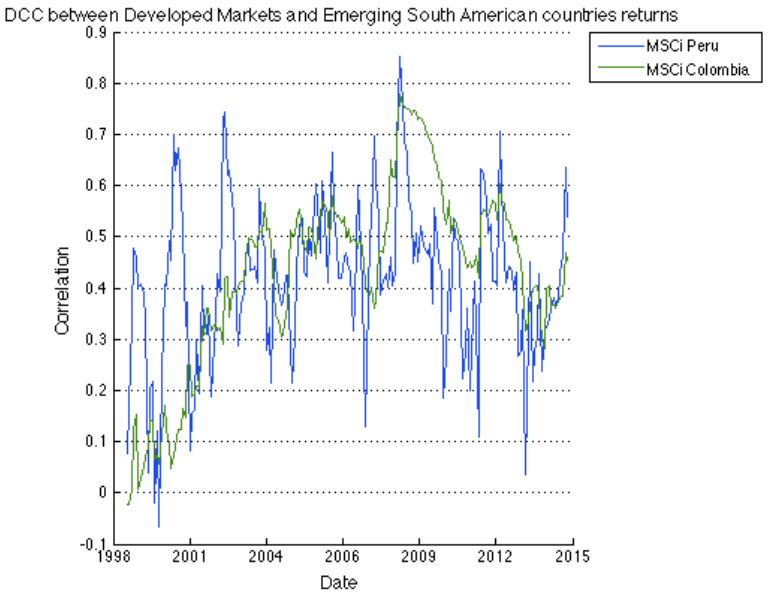


Figure 9: Dynamic Conditional Correlation between the returns of the MSCi Developed Markets Equity Index, and five MSCi Peru and Colombia Equity Indexes returns

In sum, from our results it is not clear a general trend in the correlations of asset returns across markets. In general terms we can notice a wide spread positive correlations with developed countries, among the emerging markets studied. However, this inference comes with the perception that there is not a common tendency in emerging markets, with occasional dramatic variations in correlations. Perhaps, the only clear exception should be European emerging markets (Greece; Hungary and Czeck Republic) where a curve in the graph over time allow us to infer a fast marginal gains in correlations with developed countries until 2009, after which the marginal gains came close to zero. Accordingly, we believe that for these countries we should assume a bigger integration with developed countries over time, decreasing as such the opportunity to spread risk by investors. In complementary research to this paper, we would investigate whether these European countries should be instead considered more like a developed market, rather than an emerging market.

Additionally we need to isolate the exogenous effect of the 2008 sub-prime financial crisis, because it is believed that financial crisis of such magnitude could in the short-term provide an environment for fast alignment of world markets generating an undesirable bias.

In order to provide an informational discussion to control the impact of the financial crisis, next we conduct a further analysis specifically about the events around 2008 crisis.

To examine this question we break the 15-year sample period of 1999-2014 into three sub-periods: before, during and after the crisis of 2008 (table 13). As expected, results suggest increasing correlations for the period after-crisis, when compared to the period

before-crisis. Moreover, the correlations from the period that incorporates the global financial crisis of 2008 are higher when compared to the complete sample.

Table 13: Summary of unconditional correlations for the regional MSCI' indices

	Full sample						Periods before, during and after the crisis					
	Emerging	*Lt. America*	*Asia*	*EMEA*	*Developed*	*World*	*Emerging*	*Lt. America*	*Asia*	*EMEA*	*Developed*	*World*
Emerging	1						1					
Lt. America	0,918	1					0,886 0,956 0,933	1				
Asia	0,953	0,791	1				0,926 0,981 0,973	0,704 0,892 0,846	1			
EMEA	0,916	0,853	0,784	1			0,865 0,966 0,925	0,780 0,932 0,877	0,662 0,913 0,839	1		
Developed	0,862	0,814	0,786	0,836	1		0,813 0,937 0,844	0,792 0,895 0,791	0,690 0,909 0,794	0,756 0,933 0,842	1	
World	0,890	0,838	0,815	0,858	0,998	1	0,841 0,953 0,890	0,812 0,911 0,832	0,721 0,927 0,843	0,778 0,945 0,875	0,999 0,999 0,996	1

Note: The left side of the table represents the correlations calculated from the complete sample, for the period going from 29 of January 1999 to 21 of November 2014. The entries on the right side of the table represent the correlations for the period before the crisis (on the top); for the period during the crisis (on the middle); for the period after-crisis (the ones below). The period (1) before crisis spans from February 1999 to October 2007; the period (2) of crisis spans from November 2007 to December 2010; the period (3) after crisis spans from 2011 to November 2014. All the data is in U.S. dollars and refers to monthly returns.[7]

This last analysis raises the issue whether the apparent increase of the time-varying

[7] these three diferente scenarios, under which we analyze the correlations, were determined taking Valls Pereira et al. (2013) as reference.

correlations might have been solely driven by the global financial crisis, questioning if markets are in fact more integrated. Given this, we continue this study with a non-dynamic approach, which allows us to examine if in fact emerging countries are already as integrated as developed countries.

4.3 Pairwise Correlations

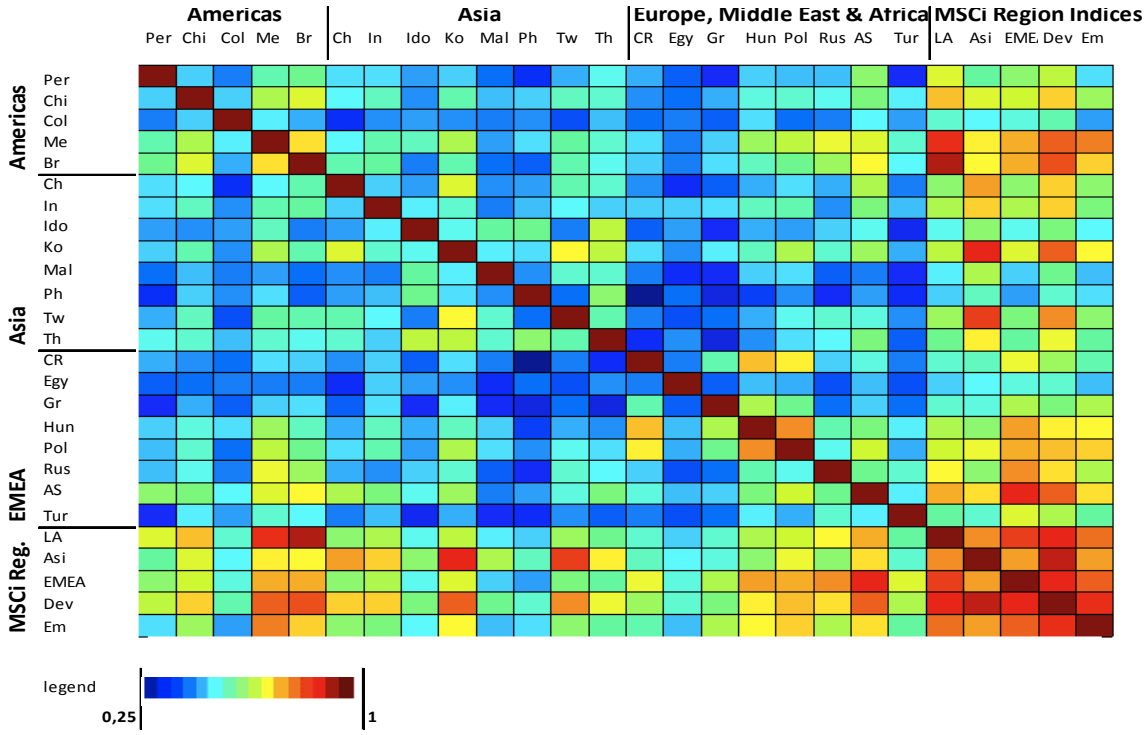
In this section we intend to study the degree of association within all global stock markets in our sample for the period going from January 1999 to November 2014. Running correlations within the general sample, among every county, we generate a correlation matrix that provides a possible existence of clusters of countries with higher correlation, differentiating those from the rest of the sample. As such, like previously, we assume where higher degrees of correlation are found (closer to 1), larger integration of markets exist, diminishing the gain for risk dispersion.

Looking first to the correlations between emerging countries, based on MSCI indexes, values range from 0,25 to 0,79 (see table 14.1 in appendix). Czech Republic, Greece and Turkey, with values of correlation going from 0,25 to 0,35, reveal the lowest correlation coefficients with the other emerging countries. The countries with higher correlation, over 0,7, are those more close geographically, as it would be expected since they are influenced by the risk of their neighbor countries. This is the case for Poland with Hungary, for example, with a correlation of 0,79. There are more six pairs of countries with correlations coefficients above 0,7.

In order to get a general idea of the correlations level we can look to the pseudocolor matrix created (table 14) of the cross-country correlation coefficients presented in table 14.1 (in appendix). So, in table 14 a scale of blue represents the lower values, closer to

0,25, while an orange color scale represents the higher values. Values of correlation equal to one are represented on the diagonal matrix with a brown color. So, from the pseudocolor matrix created, we may see that the predominant correlation values that take place between emerging countries are with correlations values going from 0,25 to 0,5, represented by a blue scale. In what refers to the correlations of the emerging countries with the developed markets index, there are twelve countries, out of twenty-one, with values between 0,7 and 0,84, being Brazil the one with the highest value from this group. (See table 14.1 in appendix).

Table 14: Heat color map of the cross-country correlations between 21 MSCI Emerging Countries indices and 5 MSCI regional indices



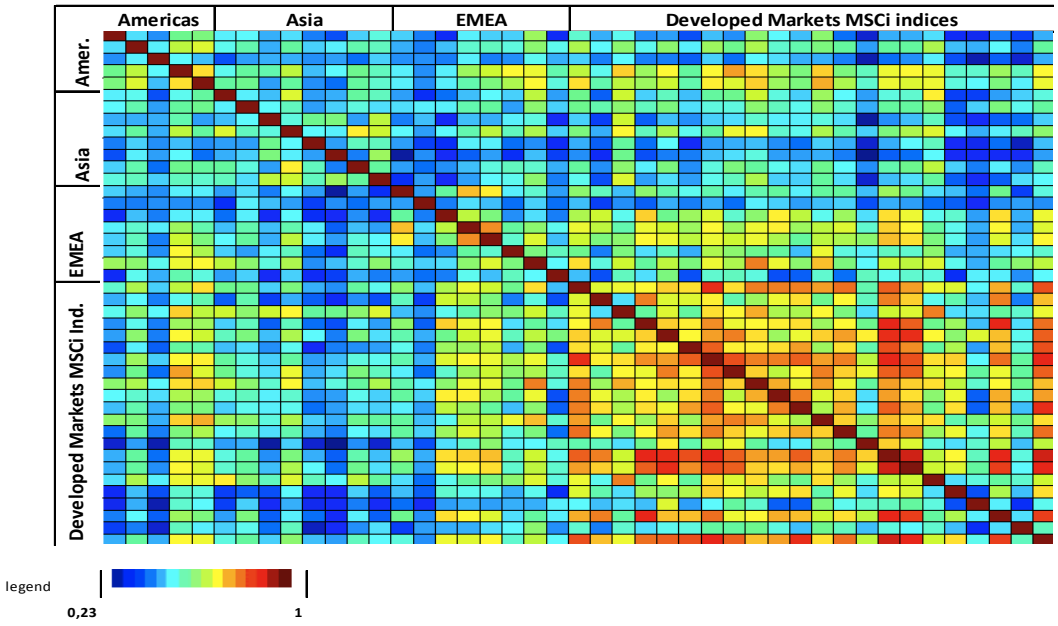
Note: this table is a matlab output that provides a pseudocolor plot of table 14.1 in appendix

[Insert Table 14.1 here]

From table 15.1 (in appendix) we can get complementary information on the correlations among 21 MSCI Emerging Countries indices with 23 MSCI Developed

Countries indices. It can be seen that developed countries have higher correlations among them (mostly above 0,7), when compared to the correlations between emerging countries. When analyzing correlations between pairs of emerging with developed countries indices, these tend to range from 0,4 and 0,6. However some emerging countries reveal correlations above 0,7 with several developed countries, being the case of Mexico, Brazil, Korea, Greece, Hungary, Poland and South Africa. Table 15 allows for an overall overview on the correlations between emerging and developed countries. It can be clearly seen that developed countries have higher correlations between them, represented by orange and yellow cells, than with emerging countries, mainly represented by blue cells.

Table 15: Heat color map of the cross-country correlations between 21 MSCI Emerging Countries indices and 23 MSCI Developed Countries



Note: this table is a matlab output that provides a pseudocolor plot of table 15.1 in appendix

[Insert Table 15.1 here]

In conclusion, correlation matrices do report high correlations among developed countries, and between the emerging regional indices with the developed markets index.

However, when compared to developed markets, emerging equity returns aren't yet reaching the same correlation levels among them and, with the developed equity returns.[8] Thus, emerging countries integration is still weak among them, and among these countries and countries with developed markets. Concluding, these results lead us to believe that there might still be potential benefits from diversification in developing markets due to their weak market integration when compared to develop economies.

4.4 Mean-variance model

We provide next a different approach, to the analysis we conducted in the previous section. Although, the above mentioned markets correlation analysis provides an overall picture of the historical performance of individual international markets it is not provided enough information on how returns and risks must be considered in combination. With the MSCI database collected, we essay if in a standard mean variance framework, the set of emerging assets adds substantial diversification benefits by shifting the mean-variance frontier. As the results suggest (fig. 10), the inclusion of emerging market assets in a mean-variance efficient portfolio still contribute to the reduction of the portfolio's volatility and the increase of expected returns. The blue curve is based on 23 MSCI developed country indices. The red curve reflects the consequence of adding 21 emerging country indices to the problem.

[8] All coefficients have been tested for significance (at the 1% level) and most have been found significant (results are not reported for sake of simplicity).

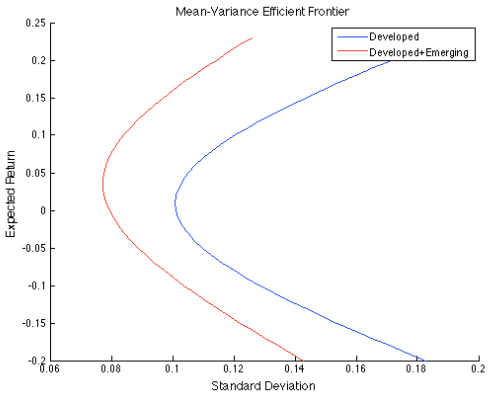


Figure 10 – Mean Variance Efficient Frontier for 21 Emerging Countries and 23 Developed Countries Equity Indices, January 29, 1999 to November 21, 2014

4.5 International ETFs Portfolios

So far we have been using MSCI data to study the performance of global equity markets and examine if there is evidence that it might still be interesting for the investor to invest in emerging markets stocks. However, in order to access if in fact investors may still expect to achieve superior gains by investing in developing countries we propose a different approach using a new dataset. We employ two different asset allocation strategies, to answer a final research question. Is it still possible to obtain a risk reduction, with no compromise of return, assuming a regional dispersion of investment spreading across developed and emerging markets?

For this purpose we are now using Exchange Traded Funds data. MSCI indices are a useful tool used by investors and financial managers to describe the market but these indices may not be invested directly. On the other hand exchange-traded funds, which were designed to "track" an index, are traded like stocks. Therefore, in this section, we access the potential gains that may come from investing in emerging economies. The assessment is made through the comparison of a portfolio with seventeen Developed countries ETFs with a second one, with the same data, plus sixteen Emerging countries

equity ETFs. The two portfolios were computed according to the risk parity and the equally weighted out-of-sample asset-allocation strategy. Since the ETFs indices have different sample periods they are added to the portfolios when they get available. Table 4 allows for a better comprehension of all the indices being allocated to both portfolios.
Looking first to the sharpe ratio results, on table 7, it can be seen that the portfolios with developed and emerging markets data outperform the ones with only developed markets ETFs, for both asset allocation strategies. In what refers to the performance measures Modified Sharpe Ratio (MSR) and Maximum Drawdown the results also favor the portfolio with emerging markets data.The analysis of the MSR comes relevant since the assets being considered don't follow a normal statistical distribution, and the standard Sharpe ratio is not sensitive to skewness and kurtosis. When looking only at the Sharpe ratio one can be underestimating potential big losses. However, when looking to the Sortino ratio results these are negative, don't favoring international diversification in both cases. Also, when comparing the two different asset-allocation strategies the results confirm what is argued in theory, the risk parity strategy leads to better results over the equally weighted one. Relatively to the portfolio's risk measures, both portfolios' returns have a negatively skewed distribution. This metric, known as a measure of "pain", is showing that the returns' distributions are not symmetrical, having a long tail on its left side, translated into many small gains with a few extreme losses.

Regarding the kurtosis, this is a measure for the "fatness" of tails of a distribution, measuring the likelihood of extreme events (both positive and negative). The results show that all the portfolios have a kurtosis higher than three, and so the distribution of the returns is said to be leptokurtic. From a risk averse investor's perspective, lower kurtosis would be preferred (other moments equal) since it would reduce the probability

of incurring in extreme events, limiting the risk of a severe loss. In the following analysis, it is being considered a "normalized" kurtosis, since we reported the deviation from the Standard Normal value of 3.

Table 16: International Portfolios (ex-post)

	starting date 1996 - Out of Sample - 60 month rolling window				
	Portfolio of Only Developed Markets		Portfolio of Developed and Emerging Markets		MSCI World
	Risk Parity	1/N	Risk Parity	1/N	
Annualized Return	5,75%	5,60%	5,96%	6,08%	3,85%
Annualized Volatility	19,31%	19,98%	19,39%	20,08%	16,40%
Sharpe Ratio	0,2221	0,2072	0,2325	0,2305	0,1458
Modified Sharpe Ratio	0,1293	0,1204	0,1357	0,1345	0,0838
Maximum Drawdown	0,0472	0,0445	0,0502	0,0503	0,0290
Sortino Ratio	-0,9910	-0,9904	-0,9909	-0,9903	-0,9935
Max. Monthly Return (%)	13,52%	14,06%	13,32%	13,82%	10,87%
Min. Monthly Return (%)	-25,91%	-27,34%	-26,89%	-28,37%	-22,20%
Skewness	-1,0451	-1,0525	-1,0663	-1,0815	-1,0366
Kurtosis	5,8450	6,0083	6,1959	6,3912	5,7749

5. Conclusion

Several authors have documented in the pass the topic of international diversification (Levy and Sarnat 1970; Lessard 1973; and Solnik 1974a) and historically, globally diversified portfolios, on the efficient frontier, have dominated over domestic portfolios. Therefore, there seems to be large potential gains from diversifying abroad associated with low correlation of stocks from different countries. Hence, emerging equity stocks have greatly attracted international investors' attention due to its low correlations with global markets. Though markets correlations are increasing, not only in consequence of increasing market integration and globalization, but also in result to recent financial crisis events. Hence the rationale for international diversification has been undermined. We are driven by the purpose to investigate whether it might still be attractive for the investment community to diversify abroad their securities portfolio, with a special focus on emerging market stocks. One critical aspect affecting the diversification gains in

emerging markets is the changing correlations over time. Consequently we evaluate if time-varying correlation between developed and non-developed markets have indeed been changing in the last fifteen years and if it is possible to confirm an upward trend. Although we find a wide spread positive correlation of emerging economies with developed markets, together with occasional dramatic variations in correlations, our findings suggest an inexistent common tendency in emerging markets. Nevertheless, our results indicate that markets suffered the impact of the global 2008 crisis with increased correlations, which signals a sudden closer market integration between emerging and developed markets. On a second level we want to examine if emerging markets are reaching the same integration levels as verified for developed markets. We extend this analysis to the comparison of the pairwise cross-country correlations. Our correlations suggest that developed markets establish a cluster that maximizes within integration. Contrarily, among emerging countries, and between emerging and developed countries, there are low correlation levels in both cases, implying a lesser integration. Thus, we can infer that investors might still be able to realize gains from a rational segmentation of the portfolio with integration of assets from emerging markets. We illustrate graphically, in a standard mean variance framework that the inclusion of twenty-one emerging market assets in a mean-variance efficient portfolio contributes to the reduction of the portfolio's volatility and the increase of expected returns. The study of global markets performance has been done based on MSCI data. These indices are the tools commonly used by investors to describe markets, even though they aren't truly assets to be invested directly. On the other hand, most of exchange-traded funds were designed to "track" these indexes, with the advantage of being traded like stocks. Given all this, to further investigate whether benefits may come from diversifying into

emerging economies, we evaluate if with the addition of sixteen developing equity ETFs to an international portfolio, it is still possible to enrich its return to risk. Our results indicate that the benefits of international portfolio diversification are better off when investor diversifies into developing countries, instead of investing only into developed countries. However, the potential gains are not so much superior anymore. There is ground to suspect a bias induced by the 2008 financial crisis, which remains to be demonstrated in this paper, requiring a supplementary analysis in a latter study.

We hope to have contributed to the existing literature by providing a broad analysis of the recent relations across global markets. This research serves as a starting point to a deeper investigation of potential benefits from diversifying into economies with lower market integration. A further analysis should take in consideration some observational problems depicted, especially with emerging markets. Also, a deeper and more detailed investigation in the dynamics of correlations between emerging and developed countries over time might come closer to a clear-cut picture of the overall trend where markets integration is concerned.

6. References

(1) **Harvey, C.R.** 1995. Predictable Risk and returns in Emerging Markets. *The Review of Financial Studies* 8 (3): 773-816.
(2) **Yang, Sheng-Yung** 2005. A DCC analysis of international stock market correlations: the role of Japan on the Asian Four Tigers. *Applied Financial Economics Letters,* 1, 89–93
(3) **Harvey, Campbell R.** 1994. Conditional Asset Allocation in Emerging Markets. NBER Working Paper Series
(4) **Driessen, Joost and Laeven, Luc**. 2007. International Portfolio Diversification Benefits: Cross-country evidence from a local perspective
(5) **Wang, Ping and Moore, Tomoe**. 2011. The integration of the credit default swap markets during the US subprime crisis: Dynamic correlation analysis
(6) **Engle et al.** 2002. Theoretical and empirical properties of dynamic conditional correlation multivariate Garch
(7) **Eiling, Esther and Gerard, Bruno**. 2006. Emerging Equity Market Comovements:

Trends and Macro-Economic Fundamentals
(8) **Eiling et al**. 2006. International Diversification of Investment Portfolios
(9) **Levy, Haim and Sarnat, Marshall** 1970.
(10) **Merton, Robert** 1972. An Analytic Derivation of the Efficient Portfolio Frontier
(11) **Huang, Mei-Yueh. Lin, Jun-Biao**. 2011. "Do ETFs provide effective international diversification?" *Research in International Business and Finance,* 25 334-344.
(12) **Santis, Giorgio**. Imrohoroglu, Selahattin. 1997. "Stock returns and volatility in emerging financial markets" Journal of International Money and Finance, Vol. 16, No 4: 561 - 579
(13) **Petronio, Filomena. Lando, Tommaso. Biglova, Almira. Ortobelli, Sergio**. 2014. "Optimal portfolio performance with exchange-traded funds." *EKONOMICKÁ REVUE,* Volume 17: 5-12.
(14) **Kono, Pedro. Yatrakis, Pan. Segal, Sabrina**. 2011. "An Empirical Study of Japanese Market Efficiency: Comparing the Risk-Adjusted Performance of an ETF Portfolio Versus the Topix Index." *Global Journals Inc.,* Volume 11 Issue 5: 49-54.)
(15) **Maillard, Sébastien. Roncalli, Thierry. Teiletche, Jérôme, Teiletche**. 2009. "On the properties of equally-weighted risk contributions portfolios."
(16) **Daly, Donnacha. Rossi, Sebastiano. Herzog, Florian**. "Methodology for the Construction and Enhancement of Risk-Parity Portfolios."
(17) **DeMiguel, Victor. Garlappi, Lorenzo. Uppal, Raman**. 2009. "Optimal Versus Naïve Diversification: How Inefficient is the 1/N Portfolio Strategy?." *The Review of Financial Studies,* v 22 n 5: 1915 - 1953.
(18) **Salomons, Roelof. Grootveld, Henk.** 2003. "The equity risk premium: emerging vs. developed markets" *Emerging Markets Review,* 4: 121 - 144.
(19) **Billio, Monica. Caporin, Massimiliano**. 2010. "Market linkages, variance spillovers, and correlation stability: Empirical evidence of financial contagion" *Computational Statistics and Data Analysis* 54: 2443-2458
(20) **Arruda, Bruno. Pereira Valls, Pedro**. 2013. "Analysis of the volatility's dependency structure during the subprime crisis" *Applied Economics* Vol. 45, No. 36: 5031-5045
(21) **Syllignakis, Manolis. Kouretas, Georgios**. 2009. "Dynamic correlation analysis of financial contagion: Evidence from the Central and Eastern European markets" *International Review of Economics and Finance* 20: 717-732
(22) **Chiang, Thomas. Jeon, Bang. Li, Huimin**. 2007. "Dynamic correlation analysis of financial contagion: Evidence from Asian markets" *Journal of International Money and Finance* 26: 1206-1228
(23) **Naoui, Kamel. Liouane, Naoufel. Brahim, Salem**. 2010. "A Dynamic Conditional Correlation Analysis of Financial Contagion: The Case of the Subprime Credit Crisis" International Journal of Economics and Finance Vol. 2, No.3
(24) **Mullin, John.** 1993. "Emerging Equity Markets in the Global Economy" *FRBNY*

7. Appendix

Table 5: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi China, India, Taiwan Equity Indexes returns, for each year

Years	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI China	0,54	0,44	0,68	0,67	0,63	0,68	0,68	0,74	0,60	0,76	0,72	0,71	0,66	0,71	0,62	0,60
MSCI Dev_MSCI India	0,06	0,32	0,51	0,58	0,51	0,50	0,58	0,67	0,65	0,71	0,75	0,69	0,59	0,64	0,60	0,59
MSCI Dev_MSCI Taiwan	0,43	0,44	0,50	0,56	0,59	0,57	0,57	0,55	0,51	0,68	0,76	0,73	0,69	0,70	0,65	0,63

Table 6: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi Indonesia, Malaysia, Thailand Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Indonesia	0,53	0,56	0,40	0,31	0,39	0,39	0,44	0,60	0,58	0,52	0,76	0,67	0,57	0,66	0,45	0,30
MSCI Dev_MSCI Malaysia	0,34	0,37	0,39	0,42	0,45	0,46	0,46	0,48	0,51	0,53	0,63	0,62	0,61	0,66	0,56	0,56
MSCI Dev_MSCI Thailand	0,56	0,47	0,53	0,61	0,58	0,44	0,50	0,60	0,37	0,68	0,77	0,57	0,50	0,74	0,60	0,40

Table 7: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi Korea, Philippines Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Korea	0,61	0,55	0,66	0,68	0,71	0,63	0,70	0,71	0,52	0,80	0,77	0,76	0,72	0,79	0,55	0,68
MSCI Dev_MSCI Philippines	0,50	0,50	0,48	0,48	0,44	0,43	0,41	0,41	0,43	0,50	0,59	0,57	0,55	0,56	0,55	0,53

Table 8: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi Czech Republic, Greece, Hungary Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Czech Republic	0,07	0,09	0,49	0,37	0,38	0,54	0,64	0,64	0,63	0,61	0,75	0,66	0,65	0,70	0,41	0,48
MSCI Dev_MSCI Greece	0,06	0,20	0,38	0,51	0,60	0,63	0,67	0,69	0,69	0,74	0,79	0,72	0,68	0,69	0,67	0,65
MSCI Dev_MSCI Hungary	0,33	0,46	0,65	0,53	0,52	0,51	0,59	0,63	0,58	0,70	0,80	0,75	0,74	0,79	0,62	0,48

Table 9: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi Poland, Russia Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Poland	0,58	0,56	0,55	0,57	0,67	0,68	0,77	0,75	0,68	0,72	0,79	0,80	0,83	0,85	0,69	0,69
MSCI Dev_MSCI Russia	0,55	0,67	0,65	0,62	0,58	0,50	0,44	0,64	0,43	0,63	0,74	0,72	0,76	0,82	0,69	0,60

Table 10: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and five MSCi Egypt, South Africa and Turkey Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Egypt	0,36	0,38	0,44	0,36	0,32	0,29	0,31	0,36	0,30	0,50	0,36	0,38	0,41	0,33	0,36	0,28
MSCI Dev_MSCI South Africa	0,75	0,73	0,69	0,69	0,68	0,67	0,71	0,74	0,72	0,79	0,83	0,79	0,72	0,75	0,67	0,71
MSCI Dev_MSCI Turkey	0,46	0,55	0,67	0,61	0,57	0,58	0,59	0,60	0,59	0,65	0,67	0,60	0,59	0,61	0,61	0,59

Table 11: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and MSCi Chile, Mexico and Brazil Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Chile	0,61	0,61	0,64	0,64	0,62	0,61	0,63	0,63	0,63	0,66	0,61	0,61	0,63	0,64	0,60	0,63
MSCI Dev_MSCI Mexico	0,64	0,74	0,75	0,73	0,80	0,70	0,79	0,81	0,74	0,69	0,86	0,84	0,78	0,84	0,70	0,63
MSCI Dev_MSCI Brazil	0,63	0,70	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73	0,73

Table 12: average of the DCC coefficients, between the returns of the MSCi Developed Markets Equity Index, and five MSCi Peru and Colombia Equity Indexes returns, for each year

	99'	00'	01'	02'	03'	04'	05'	06'	07'	08'	09'	10'	11'	12'	13'	14'
MSCI Dev_MSCI Peru	0,30	0,35	0,31	0,48	0,43	0,37	0,46	0,50	0,43	0,53	0,52	0,42	0,37	0,47	0,29	0,41
MSCI Dev_MSCI Colombia	0,06	0,10	0,23	0,35	0,46	0,42	0,50	0,54	0,45	0,58	0,73	0,58	0,48	0,55	0,39	0,39

Table 14.1 Correlation Coefficient Matrix for the 21 emerging countries monthly returns with 6 Msci region indexes for Latin America, Asia, Europe/MidEast/Africa, developed and World monthly returns, data from 29 of January 1999 to 21 of November 2014, U.S. dollar returns

		Americas					Asia								Europe, Middle East & Africa								MSCi Region Indexes					
		Peru	Chile	Colombia	Mexico	Brazil	China	India	ndonesia	Korea	Malaysia	hilippines	Taiwan	Thailand	Cz Rep	Egypt	Greece	Hungary	Poland	Russia	uth Africa	Turkey	Lat Am	Asia	Emea	Devel	Em	World
Americas	Peru	1,00																										
	Chile	0,49	1,00																									
	Colombia	0,43	0,50	1,00																								
	Mexico	0,59	0,65	0,52	1,00																							
	Brazil	0,61	0,68	0,47	0,73	1,00																						
Asia	China	0,50	0,52	0,38	0,52	0,59	1,00																					
	India	0,51	0,58	0,44	0,58	0,60	0,50	1,00																				
	Indon.	0,45	0,45	0,45	0,57	0,44	0,46	0,51	1,00																			
	Korea	0,49	0,58	0,45	0,66	0,59	0,68	0,56	0,54	1,00																		
	Malaysia	0,42	0,48	0,43	0,46	0,43	0,44	0,44	0,60	0,52	1,00																	
	hilippines	0,37	0,50	0,44	0,51	0,41	0,46	0,48	0,61	0,50	0,44	1,00																
	Taiwan	0,47	0,57	0,40	0,59	0,58	0,59	0,53	0,44	0,71	0,56	0,42	1,00															
	Thailand	0,53	0,56	0,48	0,56	0,54	0,56	0,49	0,66	0,67	0,56	0,63	0,59	1,00														
Europe/MidEast/Africa	Cz Rep	0,47	0,45	0,42	0,51	0,50	0,44	0,49	0,41	0,51	0,43	0,25	0,43	0,36	1,00													
	Egypt	0,41	0,42	0,43	0,43	0,43	0,36	0,49	0,46	0,45	0,36	0,42	0,40	0,44	0,44	1,00												
	Greece	0,34	0,47	0,41	0,50	0,51	0,41	0,51	0,34	0,51	0,35	0,32	0,43	0,32	0,59	0,41	1,00											
	Hungary	0,50	0,55	0,50	0,64	0,58	0,46	0,57	0,46	0,57	0,50	0,39	0,47	0,44	0,75	0,48	0,65	1,00										
	Poland	0,48	0,56	0,42	0,66	0,61	0,51	0,58	0,46	0,66	0,50	0,44	0,54	0,51	0,72	0,47	0,60	0,79	1,00									
	Russia	0,47	0,54	0,43	0,70	0,64	0,47	0,44	0,50	0,56	0,41	0,35	0,57	0,53	0,50	0,40	0,42	0,58	0,54	1,00								
	S.Africa	0,64	0,62	0,52	0,69	0,71	0,65	0,62	0,54	0,65	0,43	0,46	0,55	0,62	0,55	0,48	0,49	0,62	0,68	0,61	1,00							
	Turkey	0,34	0,52	0,45	0,57	0,53	0,44	0,48	0,33	0,47	0,34	0,36	0,45	0,41	0,44	0,40	0,42	0,52	0,47	0,57	0,52	1,00						
MSCi Region Indx	Lat Am	0,69	0,76	0,56	0,87	0,96	0,63	0,66	0,54	0,67	0,51	0,50	0,65	0,61	0,56	0,49	0,56	0,66	0,67	0,71	0,77	0,60	1,00					
	Asia	0,60	0,69	0,53	0,73	0,71	0,78	0,75	0,63	0,89	0,65	0,58	0,85	0,73	0,58	0,53	0,55	0,63	0,70	0,63	0,73	0,56	0,79	1,00				
	Emea	0,63	0,68	0,55	0,78	0,78	0,64	0,66	0,54	0,69	0,49	0,46	0,63	0,60	0,70	0,55	0,65	0,79	0,78	0,79	0,89	0,69	0,85	0,78	1,00			
	Devel	**0,67**	**0,75**	**0,58**	**0,83**	**0,84**	**0,75**	**0,75**	**0,62**	**0,83**	**0,61**	**0,56**	**0,79**	**0,71**	**0,64**	**0,56**	**0,62**	**0,72**	**0,76**	**0,74**	**0,83**	**0,65**	0,92	0,95	0,92	1,00		
	Em	0,50	0,65	0,46	0,80	0,75	0,63	0,62	0,53	0,72	0,48	0,50	0,64	0,60	0,58	0,48	0,65	0,72	0,74	0,66	0,74	0,60	0,81	0,79	0,84	0,86	1,00	
	World	0,53	0,67	0,48	0,81	0,77	0,66	0,65	0,54	0,74	0,51	0,52	0,66	0,62	0,60	0,50	0,66	0,73	0,75	0,68	0,76	0,61	0,84	0,82	0,86	0,89	1,00	1,00

Table 15.1 Correlation Coefficient Matrix for the 21 emerging countries monthly returns with the 23 developed countries monthly returns, data from 29 of January 1999 to 21 of November 2014, U.S. dollar returns

		Americas					Asia								Europe, Middle East & Africa								Developed Markets MSCi indices																						
		PER	CH	COL	MEX	BRA	CH	IN	INDO	KO	MAL	PH	TAIW	THAI	CR	EGY	GR	HUN	POL	RUS	S A	TUR	NOR	POR	SING	SPAI	SWE	SWIT	UK	USA	AUSTL	AUST	BEL	CAN	DEN	FIN	FRAN	GER	HK	IR	ISR	IT	JAP	NET	NZ
Americas	PER	1,00
	CH	0,49	1,00
	COL	0,43	0,50	1,00
	MEX	0,59	0,65	0,52	1,00
	BRA	0,61	0,68	0,47	0,73	1,00
Europe, Middle East & Af Asia	CH	0,50	0,52	0,38	0,52	0,59	1,00
	IN	0,51	0,58	0,44	0,58	0,60	0,50	1,00
	INDO	0,45	0,45	0,45	0,57	0,44	0,46	0,51	1,00
	KO	0,49	0,58	0,45	0,66	0,59	0,68	0,56	0,54	1,00
	MAL	0,42	0,48	0,43	0,46	0,43	0,44	0,44	0,60	0,52	1,00
	PH	0,37	0,50	0,44	0,51	0,41	0,46	0,48	0,61	0,50	0,44	1,00
	TAIW	0,47	0,57	0,40	0,59	0,58	0,59	0,53	0,44	0,71	0,56	0,42	1,00
	THAI	0,53	0,56	0,48	0,56	0,54	0,56	0,49	0,66	0,67	0,56	0,63	0,59	1,00
	CR	0,47	0,45	0,42	0,51	0,50	0,44	0,49	0,41	0,51	0,43	0,25	0,43	0,36	1,00
	EGY	0,41	0,42	0,43	0,43	0,43	0,36	0,49	0,46	0,45	0,36	0,42	0,40	0,44	0,44	1,00
	GR	0,34	0,47	0,41	0,50	0,51	0,41	0,51	0,34	0,51	0,35	0,32	0,43	0,32	0,59	0,41	1,00
	HUN	0,50	0,55	0,50	0,64	0,58	0,46	0,57	0,46	0,57	0,50	0,39	0,47	0,44	0,75	0,48	0,65	1,00
	POL	0,48	0,56	0,42	0,66	0,61	0,51	0,58	0,46	0,66	0,50	0,44	0,54	0,51	0,72	0,47	0,60	0,79	1,00
	RUS	0,47	0,54	0,43	0,70	0,64	0,47	0,44	0,50	0,56	0,41	0,35	0,57	0,53	0,50	0,40	0,42	0,58	0,54	1,00
	S A	0,64	0,62	0,52	0,69	0,71	0,65	0,62	0,54	0,65	0,43	0,46	0,55	0,62	0,55	0,48	0,49	0,62	0,68	0,61	1,00
	TUR	0,34	0,52	0,45	0,57	0,53	0,44	0,48	0,33	0,47	0,34	0,36	0,45	0,41	0,44	0,40	0,42	0,52	0,47	0,57	0,52	1,00
Developed Markets MSCi indices	NOR	0,55	0,65	0,48	0,65	0,73	0,60	0,60	0,48	0,60	0,46	0,43	0,58	0,53	0,62	0,46	0,65	0,69	0,67	0,60	0,73	0,46	1,00
	POR	0,45	0,51	0,42	0,53	0,58	0,39	0,57	0,37	0,45	0,39	0,34	0,42	0,38	0,56	0,37	0,66	0,66	0,60	0,41	0,53	0,38	0,69	1,00
	SING	0,53	0,62	0,52	0,74	0,66	0,67	0,63	0,67	0,70	0,59	0,60	0,62	0,69	0,47	0,43	0,52	0,57	0,62	0,61	0,67	0,55	0,70	0,49	1,00
	SPAI	0,43	0,53	0,41	0,64	0,63	0,47	0,56	0,39	0,56	0,40	0,38	0,51	0,43	0,62	0,39	0,74	0,69	0,70	0,49	0,59	0,49	0,71	0,81	0,58	1,00
	SWE	0,44	0,62	0,42	0,70	0,67	0,56	0,61	0,46	0,65	0,51	0,42	0,60	0,49	0,57	0,46	0,59	0,67	0,69	0,56	0,66	0,61	0,74	0,68	0,68	0,75	1,00
	SWIT	0,38	0,51	0,40	0,59	0,57	0,47	0,49	0,43	0,53	0,33	0,42	0,43	0,44	0,53	0,42	0,64	0,63	0,66	0,45	0,61	0,38	0,72	0,69	0,58	0,72	0,71	1,00
	UK	0,47	0,63	0,47	0,71	0,72	0,59	0,54	0,48	0,59	0,44	0,46	0,54	0,53	0,58	0,46	0,68	0,71	0,69	0,64	0,69	0,55	0,86	0,71	0,73	0,79	0,78	0,83	1,00
	USA	0,42	0,59	0,41	0,78	0,68	0,59	0,54	0,48	0,70	0,45	0,49	0,61	0,56	0,50	0,41	0,54	0,63	0,67	0,62	0,65	0,56	0,72	0,58	0,70	0,70	0,80	0,72	0,84	1,00
	AUSTL	0,62	0,64	0,51	0,73	0,75	0,67	0,62	0,55	0,71	0,46	0,53	0,59	0,64	0,57	0,50	0,62	0,69	0,70	0,59	0,80	0,54	0,80	0,63	0,76	0,70	0,73	0,71	0,80	0,74	1,00
	AUST	0,52	0,55	0,49	0,64	0,63	0,53	0,56	0,50	0,55	0,43	0,44	0,52	0,48	0,58	0,48	0,72	0,72	0,64	0,59	0,69	0,38	0,80	0,69	0,64	0,72	0,63	0,72	0,80	0,66	0,76	1,00
	BEL	0,47	0,58	0,45	0,61	0,61	0,48	0,53	0,50	0,52	0,40	0,44	0,49	0,48	0,50	0,43	0,66	0,63	0,59	0,47	0,62	0,39	0,80	0,73	0,65	0,73	0,70	0,78	0,83	0,71	0,69	0,81	1,00
	CAN	0,63	0,61	0,45	0,74	0,77	0,63	0,62	0,53	0,65	0,48	0,46	0,60	0,59	0,59	0,47	0,53	0,66	0,65	0,69	0,75	0,54	0,78	0,59	0,71	0,63	0,74	0,63	0,78	0,80	0,78	0,69	0,65	1,00
	DEN	0,40	0,58	0,42	0,60	0,64	0,51	0,54	0,48	0,57	0,45	0,41	0,51	0,49	0,59	0,48	0,63	0,69	0,65	0,54	0,61	0,41	0,81	0,71	0,61	0,70	0,78	0,73	0,80	0,74	0,69	0,74	0,77	0,74	1,00
	FIN	0,28	0,44	0,26	0,56	0,55	0,44	0,46	0,24	0,47	0,28	0,23	0,42	0,28	0,47	0,39	0,48	0,55	0,62	0,49	0,51	0,56	0,57	0,56	0,48	0,60	0,72	0,58	0,65	0,69	0,59	0,49	0,50	0,62	0,59	1,00
	FRAN	0,45	0,59	0,41	0,69	0,70	0,54	0,59	0,43	0,61	0,46	0,39	0,57	0,46	0,63	0,45	0,73	0,74	0,75	0,56	0,67	0,53	0,82	0,80	0,67	0,88	0,86	0,84	0,88	0,82	0,77	0,78	0,82	0,76	0,80	0,74	1,00
	GER	0,45	0,58	0,42	0,71	0,69	0,55	0,59	0,47	0,65	0,52	0,41	0,60	0,49	0,59	0,44	0,69	0,70	0,73	0,54	0,65	0,55	0,77	0,74	0,68	0,82	0,86	0,79	0,84	0,83	0,74	0,73	0,76	0,73	0,78	0,68	0,94	1,00
	HK	0,49	0,64	0,50	0,69	0,69	0,71	0,63	0,56	0,68	0,57	0,51	0,65	0,59	0,49	0,40	0,52	0,58	0,61	0,62	0,69	0,53	0,70	0,52	0,80	0,59	0,71	0,59	0,73	0,68	0,73	0,62	0,60	0,73	0,63	0,54	0,66	0,67	1,00
	IR	0,34	0,47	0,39	0,55	0,53	0,37	0,39	0,37	0,51	0,32	0,32	0,48	0,39	0,47	0,39	0,55	0,52	0,53	0,46	0,52	0,35	0,68	0,58	0,48	0,63	0,62	0,64	0,74	0,71	0,65	0,70	0,73	0,58	0,69	0,49	0,70	0,68	0,49	1,00
	ISR	0,31	0,45	0,26	0,55	0,51	0,37	0,48	0,31	0,45	0,31	0,34	0,42	0,32	0,41	0,32	0,43	0,45	0,44	0,45	0,45	0,51	0,51	0,46	0,49	0,46	0,68	0,44	0,51	0,59	0,54	0,39	0,40	0,61	0,52	0,54	0,56	0,58	0,54	0,38	1,00
	IT	0,41	0,52	0,39	0,63	0,60	0,43	0,60	0,39	0,50	0,40	0,33	0,49	0,39	0,60	0,43	0,73	0,70	0,68	0,49	0,59	0,51	0,76	0,80	0,58	0,88	0,76	0,75	0,81	0,70	0,71	0,76	0,75	0,67	0,73	0,65	0,91	0,85	0,59	0,65	0,50	1,00
	JAP	0,36	0,42	0,29	0,56	0,50	0,47	0,53	0,40	0,56	0,27	0,32	0,42	0,49	0,37	0,44	0,45	0,45	0,48	0,51	0,63	0,43	0,55	0,42	0,54	0,49	0,53	0,54	0,59	0,58	0,59	0,54	0,46	0,60	0,56	0,47	0,54	0,51	0,55	0,47	0,36	0,48	1,00
	NET	0,45	0,59	0,45	0,70	0,69	0,53	0,59	0,48	0,62	0,46	0,44	0,56	0,51	0,54	0,42	0,69	0,68	0,71	0,54	0,66	0,51	0,84	0,75	0,70	0,82	0,83	0,83	0,88	0,82	0,75	0,77	0,86	0,73	0,82	0,65	0,93	0,89	0,67	0,73	0,53	0,85	0,56	1,00
	NZ	0,45	0,50	0,52	0,58	0,55	0,49	0,48	0,51	0,58	0,44	0,52	0,51	0,60	0,39	0,44	0,56	0,56	0,57	0,49	0,62	0,49	0,62	0,55	0,68	0,57	0,62	0,63	0,66	0,60	0,77	0,67	0,62	0,59	0,59	0,46	0,63	0,61	0,63	0,55	0,37	0,59	0,51	0,65	1,00