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Abstract

We study the evolution of global equity market integration using US dollar denominated iShares. Designed to mimic the movements of MSCI indices, these securities provide an easy pool of international diversification products for the investor. As such they allow us to conduct an analysis of the largest equity markets comovements devoid of problems associated with trading restrictions, exchange rates fluctuations and non-synchronous trading. In contrast to most of the previous studies, we apply time varying methodology for the analysis of both short-term and long-term comovements that provide detailed evidence on the pattern and dynamics of the equity market linkages. We find evidence in favour of increasing conditional correlations for all of the markets since 2001. Time-varying and recursive cointegration tests provide somewhat weak evidence in favour of the presence of bivariate cointegration relationships, but stronger evidence in the multivariate case, suggesting limited diversification opportunities for the U.S. based investor in the long run.

Keywords: Stock Market Integration, G7 Stock markets, Cointegration, GARCH

JEL Classification: G10, G15

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1. Introduction

The past decade has seen a dramatic growth in equity investing in passively managed index funds. It happened partly due to strong performance of S&P500 in the mid 1990's and partly due to ready access, particularly by U.S. investors, to a well diversified indexed portfolio at a low cost. The decade has also been marked by growing integration of equity markets worldwide resulting from financial liberalization measures and market oriented economic reforms, being actively pursued by developing economies, as well as improvements in technology. As Khorana et al. point out, "Given the rise in indexing and the interest in international investing, it is not surprising that a new financial security responding to both of these trends has been introduced" (1998, pp. 78). This new security is known as iShares (formerly known as World Equity Benchmark Shares (WEBS)). iShares, organized as exchange-traded funds (ETFs), are designed to track Morgan Stanley Capital International (MSCI) indexes in respective countries. They provide a product that tracks a portfolio designed explicitly to allow internationally comparable benchmark performances yet can be easily traded on organized exchanges. It thus combines the diversification benefits of an index fund with the flexibility of a common stock. The popularity of iShares has grown, with in excess of over $100b invested in this investment instrument by end 2004. Over 80% of investment in iShares is concentrated in the iShares of G7 countries (www.indexfunds.com).

Prior to the introduction of iShares, international investing by U.S. based investors occurred either via well-diversified MNC's, or via international index funds, which provided exposure to a basket of countries, or via closed-end single country funds. Given that closed-end country funds can only be traded in the secondary market, there is usually a discrepancy between their share prices and the underlying net asset value (NAV). On the contrary, iShares are created or redeemed only in kind and the resulting arbitrage opportunities ensure that the share prices do not diverge much from the underlying NAV of constituent shares. Thus iShares present the U.S. based investor with an opportunity to replicate the market portfolio of a foreign country without the risk of selling it at a discount. Against this background, it is not surprising that iShares have rapidly become an attractive alternative for investors seeking international equity exposure. As of October 2004, well in excess of $150 billion has already been invested in these products (indexfunds.com).

In view of the growing popularity of international iShares, the purpose of the present study is to use iShares prices to measure the extent of equity market comovements. While numerous studies have analyzed the issue of international equity market integration from an empirical standpoint (see for example Phylatkis and Ravazzolo (2002), Gilmore and McManus (2002) and Kearney and Lucey (2004), and the citations therein), most have used broad national stock indices as proxies for equity markets in their analysis. It has been noted, however, that stock market indices may not represent easily investible assets due to high costs of maintaining equivalent portfolios and due to entry barriers for foreign investors existing in a number of markets. The ETFs, on the other hand, appear to be more suitable for examining market linkages since their exposure to entire markets and easiness of trade make them accessible to investors with varying degrees of sophistication. From a technical point of view, iShares price series are devoid of a number of problems such as non-synchronous trading, exchange rates fluctuations and trading restrictions.

Despite the advantages of using iShares over national stock market indices, only a handful of studies have used iShares as proxies for foreign equity markets so far, reflecting partly the relative newness of some of these financial products. For example, see Miffre (2004), Phengpis and Swanson (2004), Durand and Scott (2003), Pennathur, Delcoure and Anderson (2002), Schwebach, Olienyk and Zumwalt (2002), Olienyk, Schwebach and Zumwalt (1999). In general, these studies focus on the international diversification benefits from holding iShares funds of different countries, in the short run and/or in the long run and compare their performance with the respective closed-end country funds (CECF), when possible. In this backdrop, the present study adds to the existing literature in a number of ways. First, it considers a very recent time period to measure equity market integration relying on iShares prices using daily data from March 1996 to January 2005. It is thus the longest time series of iShares prices analyzed in the literature so far. Second, by drawing on the work of Olienyk, Schwebach and Zumwalt (1999), we perform a more in-depth analysis of the long-term and short term interdependencies between iShares price series than has been previously done using very recently developed time series techniques. In particular, we use Gregory-Hansen (1996) test for cointegration that allows for an endogenously determined structural break of unknown timing. We also investigate the time-varying dynamics of the long-run relationships by using Hansen-Johansen (1999) recursive cointegration graphical procedure. Furthermore, we use the recently developed dynamic conditional correlation specification of multivariate GARCH models by Engle (2002) (DCC-GARCH) that allows for explicit time variation in the conditional covariance and correlation matrix between iShares returns.

Taking the U.S. based investor's perspective, we measure the status of integration between U.S. and the remaining Group of Seven (G7) markets: Canada, France, Germany, Italy, Japan and United Kingdom. In our empirical analysis, we utilize prices for the iShares MSCI Index Series for non-U.S. markets and Standard & Pours Depository Receipts (SPDRs) for the U.S. By using G7 markets, we cover well in access of 60 % of world equity market capitalization (www.world-exchanges.org/) and over 50 % of U.S. foreign equity holdings (US Department of Treasury (2003)).

Based on our findings, there is some evidence in favor of multivariate cointegration between U.S. and group of G7 markets, although evidence of bivariate cointegration is rather weak. Furthermore, there is evidence that the extent of interdependencies has been rising since 2001, possibly due to the launching of Euro and growing integration of the Euro area markets. Overall, our findings suggest limited diversification opportunities available to the U.S. based investor interested in investing in ETFs of the G7 markets.

The rest of the paper is structured as follows. Section 2 provides a brief overview of exchange-traded funds with a particular focus on Standard & Poors Depositary Receipts (SPDRs) and iShares. Section 3 reviews recent findings in relation to equity market integration. Data and methodology are described in Sections 4 and 5. Section 6 provides empirical results and Section 7 provides conclusions.

2. Background

2.1. Exchange-traded funds (ETFs)

Exchange-traded funds are considered to be one of the major financial innovations of the past decade. ETFs are organized as funds or unit investment trusts that seek to track price and yield performance of the underlying sector, domestic, international indices (www.amex.com). ETFs allow investors to track a benchmark thus gaining an exposure to segments or entire domestic or foreign markets with relative ease. Purchasing and selling ETFs for both retail and institutional investors is easy due to similarities with trading stocks. This implies that buying on margin and short selling (even on a downstick) are allowed. In the secondary market ETFs are traded intradaily, like stocks or shares of close-end funds. In the primary market, when the fund itself is the party of the trade, transactions take form of in-kind creation (redemption) process through market specialists. This process involves depositing (receiving) a stock portfolio to receive (redeem) a pre-specified amount of ETF shares. The in-kind transfer process underlies some of the unique features of ETFs: one of the lowest expense ratios in the industry (Fuhr (2001), Gastineau (2002), Gastineau (2004a), Gastineau (2004b) and tax-efficiency (Poterba and Shoven (2002), Gastineau (2004a). The typical expense ratios on an ETF range between 0.35 and 0.50 %, which compares favourably with 0.73 % charged by index funds (Sills (2001), Simon (2004)). Such low expenses are explained by absence of active management and shareholder-level accounting. Furthermore, in-kind creation (redemption) gives rise to arbitrage opportunities and precludes significant deviations between ETF net asset value (NAV) and market price. All these features render ETFs an attractive investment vehicle.

Thus ETFs have aided in the development of ETF-based portfolio management where ETFs are used as portfolio components for the purposes of tax management, sector rotation strategies, hedging strategies, maintaining equity exposure during manager transition etc. (Gastineau (2004), Chamberlain and Jordan (2004)). The disadvantages of the ETFs lie in the risk of offsetting potential gains by brokerage commissions paid on every trade, and sensitivity of the ETF's price to a price of a single security due to possibility of high portfolio concentration of particular ETFs (Simon (2004)). In the U.S., first ETFs were introduced on AMEX in 1993 in forms of SPDRs (Standard & Poors Depository Receipts).[1] Since their introduction, ETFs have seen a remarkable growth; with their assets almost doubling each year since 1995 (see Table 1). There exists 152 ETFs in the U.S. today, comprising a variety of financial products, such as SPDRs, iShares, QQQs, VIPERs that are traded on AMEX, NYSE and CBOE (Ross (2005), Gastineau (2002) and Chamberlain and Jordan (2004)). In December 2004 combined assets of the U.S. exchange-traded funds amounted to $226 billion, having increased by almost 50 % over the

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[1] For a brief review of the history of ETFs' antecedents (portfolio trading, IPS, TIPS, Supershares) see Gastineau (2002).

previous year.[2] Among them, assets of International Equity Funds surged by almost 140 % during the last year, from $13.9 billion to $33.6 billion (Investment Company Institute, 2005). The two different types of ETFs, SPDRs and iShares, analysed in the present study are discussed below.

Table 1 about here

2.1.1. SPDRs

SPDRs were launched by State Street Global Advisors in 1993. SPDRs are exchange-traded funds that aim to track performance of various Standard & Poor's indices. They include SPDR Trust Series 1, referred as Spiders and Select Industry SPDRs. The former is designed as a unit investment trust that follows the S&P500 index. The latter is constructed as an open-end fund that tracks the performance of specific industry groups of S&P500 index (www.amex.com). SPDRs are the largest ETFs. As of 2004 they have attracted almost $56 billion of assets and their average daily trading amounts to $5 billion (Ross (2005)).

2.1.2. iShares

iShares, initially known as WEBS (World Equity Benchmark Securities), were launched by Morgan Stanley in May 1996 and re-branded as iShares MSCI Index Funds by Barclays Global Investors in May 2000. iShares have provided investors with access to markets that otherwise would have remained beyond their reach. Accounting for 42 % of the ETF market, iShares belong to one of the most popular ETFs today (Ross (2002)). As of January 2005, there exists 21

[2] For information about non-US ETFs see Fuhr (2001), Sills and Rutter (2001), Deville (2003).

series of iShares covering individual foreign equity markets; namely Australia, Austria, Belgium, Brazil, Canada, France, Germany, Hong Kong, Italy, Japan, Malaysia, Mexico, Netherlands, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom. iShares do not invest in a basket of securities closely representing the market. Developed (emerging) markets index funds would normally invest at least 95 % (60 %) of their assets in the securities from the underlying index and American Depository Receipts (Chamberlain and Jordan (2004)).

3. Literature Review

3.1. Earlier Studies of Equity Market Linkages

Grubel (1968) and Levy and Sarnat (1978) pointed to international diversification as a possible source of welfare gains for individual investors. These works made analysis of correlation the cornerstone of the portfolio analysis. Following their approach, earlier empirical studies analyzed international correlations to infer about the extent of internationalization and market interdependencies. For example, see Kaplanis (1988), Fisher and Palasvirta (1990), Ratner (1992), Wahab and Lashagari (1993), Longin and Solnik (1995), King and Wadhwani (1990), Bertero and Mayer (1990)). In particular, Longin and Solnik (1995), King and Wadhwani (1990) and Bertero and Mayer (1990)) found the correlations between the equity markets to be unstable and generally increasing during 1960-1990s.

Later research into market interdependencies relied on the cointegration methodology of Engel and Granger (1987) and its multivariate extension by Johansen (1988) due to its perceived relation with portfolio diversification (Alexander (1999), MacDonald (1995)). This branch of the literature is very ample and includes, among others, Kasa (1992), Richards (1995), Arshanapalli and Doukas (1996), Choudhry (1997), Francis and Leachman (1998), Phylaktis (1999), Manning

(2002), Arbeláez, Urrutia, and Abbas (2001), Chen, Firth, and Rui (2002). An excellent review of these studies is provided in Kearney and Lucey (2004). Although the results of these analyses do not always conform to each other, they predominantly testify in favor of increased degree of long run market relationships worldwide.

All of the aforementioned studies utilize broad stock market indices to analyze long-run market relations. As mentioned earlier, ETFs, by virtue of their very design and construction, appear to be more suitable for examining equity market linkages. The next sub-section focuses on the studies that considered closed-end country funds (CECFs) and iShares as instruments through which international integration may be traced.

3.2. iShares, International Diversification and Long Run Relationships between Equity Markets

One of the earliest studies using ETFs as diversification instruments was carried out by Olienyk, Schwebach and Zumwalt (1999). They tested for cointegration and Granger causality between SPDR and 17 WEBS and 12 respective country funds during 1996-1998. The authors find a surprisingly unanimous result that SPDR is pair-wise cointegrated with every WEBS. Cointegration is also found for WEBS and respective CECF. Furthermore, all 17 WEBS appear to Granger cause SPDR, thus indicating presence of short-term inefficiencies. Thus Olienyk et al. findings seem to suggest that there remains possibility of earning short run arbitrage profits using WEBS and SPDRS, though only limited potential for diversification benefits from index-linked securities in the long run.

Diversification benefits of iShares are also analysed in Pennathur, Delcoure and Anderson (2002), Durand and Scott (2003), Miffre (2004), Schwebach, Olienyk, et al. (2002). Pennathur, Delcoure and Anderson (2002) apply single- and two-factor models to the iShares prices for the earlier period 1996-1999. The two-factor model, which includes both home and US market index returns, indicates that iShares maintain a considerable exposure to the US market. The authors thus conclude that iShares do not represent a perfect international diversification vehicle.

A similar conclusion is reached by Durand and Scott (2003) in case of Australian iShares. Durand and Scott use a VAR framework to explain the dynamics of Australian iShares returns and volume due to movements in U.S. returns, volumes and exchange rates. Their findings suggest that U.S. based investors into Australian market tend to overreact to contemporaneous and past information from the U.S. equity market, exchange rates and past iShares returns.

Despite their imperfections, iShares appear to offer diversification potential superior to that of closed-end country funds. Miffre (2004) demonstrates that investing in iShares may generate efficiency gains over those achieved by country-specific funds. Relying on the analysis of optimal portfolios constructed on the basis of Sharpe ratio, the paper argues that a typical investor would benefit from investing on average half of her wealth in S&P500 and the rest in iShares tracking developed European markets (Spain, Italy, the U.K., Sweden, Canada and France). Based on our literature search, Miffre (2004) is the only paper to consider time-varying correlations between S&P500 and iShares returns. While acknowledging that the correlations are not stable over time, the author does not attempt to go further and discuss the dynamics of time-varying correlations and implications for the optimal asset allocation.

In another related paper, Schwebach, Olienyk, and Zumwalt (2002) draw attention to the impact of increased volatility on the efficacy of diversification. They evaluate performance and diversification benefits of both WEBS and CECF before and after the Asian crisis. Having analyzed simple correlations, the paper argues that both performance and extent of diversification benefits have changed drastically after the Asian crisis, the latter being reflected in increased correlations. As suggested by the results of the correlation analysis, WEBS offer better diversification opportunities after the Asian crisis than CECF.

Phengpis and Swanson (2004), on the other hand, discuss construction of optimal portfolios and in this context, use results from cointegration analysis to investigate whether or not incorporating information about long run relationships can help in improving diversification gains than relying exclusively on short-term information. The authors conclude that relying on national indices (as opposed to iShares) to evaluate diversification gains may overstate the actual benefits and moreover, including long term information as an additional input to portfolio construction can improve diversification benefits.

Olienyk et al. (1999) is the starting point of the present study. We begin by considering pairwise, bivariate cointegrating relation between various combinations of G7 markets using a more recent cointegration technique developed by Gregory and Hansen (1996) that allows for endogenously determined structural break and hence reflects significant improvement over prior cointegration techniques. Next, we extend Olienyk et al. (1999) study to investigate the existence of multivariate cointegrating relationship between G7 markets, since the absence of bivariate relation cannot rule out the existence of multivariate relationship between markets. Subsequently, we focus on the time varying dynamics of both long-term and short-term cointegrating relationship by using recursive cointegration procedure of Hansen and Johansen (1999), residual-based cointegration test of Gregory and Hansen (1996) and Dynamic Conditional Correlation GARCH (DCC-GARCH) of Engle (2000) respectively. The resulting graphs present a detailed picture of the time varying nature of the equity market linkages

4. Data and Methodology

4.1. Data

Our dataset consists of daily closing prices for SPDR for the U.S. market and six MSCI iShares Series for the remaining G7 stock markets, namely U.K., Germany, France, Italy, Japan and Canada. We concentrated on the iShares covering G7 countries as these represent the largest equity markets, covering in excess of 85% of market capitalization of all world markets over the period (www.world-exchanges.org/). The sample period spans almost ten years, from 18th March 1996 to 20th January 2005 and includes 2309 observations. The entire dataset is obtained from the DataStream. The beginning of the sample period coincides with the start date of trading of iShares, then WEBS. It is thus the longest time series of iShares prices analyzed in the literature so far. Such a long dataset is especially suitable for applying cointegration analysis to characterize the long term dependencies between the markets. Figure 1 below presents a graph of SPDR and iShares prices over the sample period.

[Figure 1 around here]

Next we present descriptive statistics of the SPDR and iShares sample daily returns in Table 2. The returns were calculated as continuously compounded returns, $R_t = \log P_t - \log P_{t-1}$, where P_t is the closing price of a respective iShares. With the exception of Japan, even allowing for the bear market of the early 2000's, all securities displayed positive return. iShares' returns are leptokurtic for all G7 countries and mostly negatively skewed, except for Japan.

[Table 2 around here]

Prior to testing for the presence of cointegration, iShare price series data are checked for non-stationarity using conventional unit root tests, namely Augmented Dickey-Fuller (ADF; Said and Dickey (1984)) and Phillips-Perron (PP; Phillips and Perron (1988)). All series were found to be non-stationary in levels and stationary in differences.[3]

5. Methodology

5.1 Gregory-Hansen Residual Based Cointegration Test

Engle and Granger (1987) suggested that two non-stationary variables might converge to a common equilibrium in the long run. Then a stationary combination of the two non-stationary variables should exist. Such variables are then called cointegrated and the vector that transforms the two non-stationary variables into a stationary one is called cointegration vector. Test for cointegration, suggested by Engle and Granger (1987) was extended by Johansen (1988) to a multivariate case. Both tests rely on the assumption that stability of cointegration vector is stable over time. However, it is highly likely that during longer periods a fundamental or non-fundamental shock may disrupt the equilibrium, which would result in a change in the parameters of cointegration vector.

Results of Monte Carlo experiments (Campos, Ericcson, and Hendry, 1996; Gregory and Hansen, 1996) demonstrate that standard tests for cointegration may lose power when a shift in parameters takes place and in fact, falsely signal the absence of equilibrium in the system. Gregory and Hansen (1996) test assumes the null hypothesis of no cointegration against the alternative hypothesis of cointegration with a single structural break of unknown timing. The

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[3] The critical values are from MacKinnon (1991). For the purposes of brevity tables are not reported here, but they are available upon request.

timing of the structural change under the alternative hypothesis is estimated endogenously. Gregory and Hansen suggest three alternative models accommodating changes in parameters of the cointegration vector under the alternative. A *level* shift model allows for the change in the intercept only (C):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha' y_{2t} + e_t, \ t = 1, \ldots\ldots, n \quad (1)$$

The second model accommodating a trend in data also restricts shift only to the change in *level with a trend* (C/T):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta t + \alpha' y_{2t} + e_t, \ t = 1, \ldots\ldots, n \quad (2)$$

The most general specification allows for changes both in the *intercept and slope* of the cointegration vector (R/S):

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1' y_{1t} + \alpha_2' y_{2t} \varphi_{t\tau} + e_t, \ t = 1, \ldots\ldots, n \quad (3)$$

The dummy variable, which captures the structural change, is represented as:

$$\varphi_{t\tau} = \begin{cases} 0, \ t \le [n\tau] \\ 1, \ t > [n\tau] \end{cases}, \quad (4)$$

where $\tau \in (0,1)$ is a relative timing of the change point. The trimming interval is usually taken to be (0.15*n,* 0.08*n*), as recommended in Andrews (1993). The models (1)-(3) are estimated sequentially with the break point changing over the interval $\tau \in (0.15n, 0.85n)$. Non-stationarity of the obtained residuals, expected under the null hypothesis, is checked by ADF test. Setting the test statistics (denoted as ADF*) to the smallest value of the ADF statistics in the sequence, we select the value that constitutes the strongest evidence against the null hypothesis of no cointegration.

5.2. Recursive Cointegration Tests

Hansen and Johansen (1993) provide a method to analyze not only the extent but also the dynamics of the long run relationships. Their recursive cointegration approach relies on Johansen and Juselius (1990) cointegration test. Recursive analysis is performed for an initial period and thereafter updates as new data are added are added to the initial sample. Consequently, the statistic of interest is calculated over the chosen sample, say t_0 to t_n. This sample is then extended by j periods and the statistic is re-estimated for the period from t_0 to t_{n+j}.. Eventually, the estimation procedure reaches the end of the data, producing the test statistic results equivalent to the standard static Johansen and Juselius (1990) estimation over the entire time period. The relevant trace statistic is then plotted and examined for interpretation. For ease of interpretation, the calculated trace statistic is rescaled to a critical value, usually 90 % or 95 %. Rescaled values above 1 of the trace statistic for the null hypothesis of τ cointegration relationships against k cointegration relationships indicate against the null hypothesis. In case of the null hypothesis of no cointegration relationships, an upward trend indicates either increased integration and/or a move toward integration; a downward trend indicates decreased integration and/or a move away from integration.

5.3. Dynamic Conditional Correlations GARCH (DCC-GARCH)

We also use the recent dynamic conditional correlation specification of multivariate GARCH models (DCC-GARCH; Engle, 2002) to model our time series. Analysis of correlations between international asset markets has been a cornerstone for making inferences about the short-term interdependencies between the markets and presence of diversification benefits (Grubel (1968), Longin and Solnik (1995)). Earlier studies relied on analysis of simple correlation coefficients (see for example Panton, Lessig and Joy (1976) and Watson (1980) whereas later studies utilized rolling correlation coefficients and correlation coefficients adjusted for the presence of different regimes in volatility (Forbes and Rigobon (1999)). This paper makes a step forward and suggests to analyze time varying conditional correlation between international stock markets by utilizing the recent methodology by Engle (2002), a multivariate GARCH dynamic conditional correlation analysis (DCC-GARCH).

A DCC-GARCH class of models encompasses the parsimony of univariate GARCH models of individual assets volatility with a GARCH-like time varying correlations. The estimation of the DCC-GARCH model is a two-step procedure. In the first step, univariate GARCH models are estimated for each time series, in the second step transformed residuals from the first stage are used to obtain conditional correlation estimator. The model assumes that returns from the *k* series are multivariate normally distributed with zero mean value and covariance matrix H_t:

$$r_t \left| F_{t-1} \sim N(0, H_t) \right. \tag{5}$$

$$H_t \equiv D_t R_t D_t , \tag{6}$$

where D_t is a *kxk* matrix of time varying standard deviations from univariate GARCH models with $\sqrt{h_{it}}$ on the i^{th} diagonal, following a univariate GARCH model. The proposed dynamic correlation structure is:

$$R_t = (Q_t^*)^{-1} Q_t (Q_t^*)^{-1} , \tag{7}$$

where Q_t^* is a diagonal matrix composed of the of the square root of the diagonal elements of the Q_t and Q_t follows a GARCH type of process:

$$Q_t = (1 - \sum_{m=1}^{M} \alpha_m - \sum_{n=1}^{N} \beta_n) \overline{Q} + \sum_{m=1}^{M} \alpha_m (\varepsilon_t^{'} \varepsilon_t) + \sum_{n=1}^{N} \beta_n Q_{t-n} , \tag{8}$$

where $\overline{Q}$ is an unconditional covariance matrix of the standardized residuals from the first-stage estimation.

We use a parsimonious approach, modeling data are as a DCC-GARCH (1,1) process, within bivariable system of each iShare return versus the U.S. An asymmetric GARCH process of Glosten, Jaganathan and Runkle (1993) with t-distribution is assumed. The extraction of the conditional time varying correlations allows us to examine the short-run dynamics of the series. It also allows us to monitor the effects attributed to the sequence of crisis events that took place throughout the sample.

6. Empirical Findings

6.1. Gregory-Hansen Residual Based Cointegration Test Results

6.1.1 Bivariate cointegration: US SPDRS vs. G7 iShares

To analyze long-term relationships between SPDR and the G7 iShares return series, we perform Gregory-Hansen (1996) test that allows for a single break of unknown timing in the coefficients of the cointegration vector as given by equations (1)-(3) above. Since Gregory-Hansen tests are sensitive to the direction of causality, we apply the test using U.S. SPDR series first as dependent and then as independent variable. Since the results of both specifications turn out to be virtually identical, we choose to report only the results with SPDR as the dependent variable in Table 3 below.

[Table 3 around here]

Results of the bivariate Gregory-Hansen tests fail to reject the null hypothesis of no cointegration for all three alternative models as applied to the six pairs of markets. At a first sight, such a finding seems to be at odds with that of Olienyk, Zumwalt and Schwebach (1999). These authors, using conventional Engle-Granger testing methodology, found cointegration relations between SPDR and every iShare series in their sample. However, their dataset included only two and a half years of data, 18/03/1996-31/10/1998. It appears that equilibrium relations that might have existed during 1996-1998 have not persisted in time. Our findings suggest that there may still exist viable diversification opportunities for the US based investors over sufficiently long time periods.

6.1.2 Bivariate Cointegration: Between G7 excluding US

From the results for the group excluding US market it follows that UK, Italy and Japan remain segmented from other major stock markets throughout the sample period, since the null of no cointegration cannot not rejected for these markets. Somewhat weaker evidence of cointegration is found in the case of France – Germany (at 10 % level) and France – Canada (at 5% level). The break in the intercept occurred on 01/05/2000 for the former and on 22/05/1998 for the latter. The may 1998 period is congruent with the final notification of rates and members for the Euro, but why only France –Canada should show a change in the relationship is puzzling. It also comes at the time when a major Canadian purchase of French robotics technology was reported. The 2000 period comes immediately after the resolution to a dispute between a major French (Credit Lyonnaise) and German (Dresdner) banks regarding crossholdings. While important, these elements however would seem to be unlikely to change market dynamics fundamentally.

6.1.3 Multivariate Cointegration Tests' results

To account for the influence of other markets on the returns of a single market, we turn to the multivariate setting and employ Gregory-Hansen methodology for the group of US and European equity markets as well as for the group of the European equity markets only. We find evidence of cointegration between the US and European equity markets group at the 5 % level with the break in both trend and intercept occurring on 31/12/1999. This of course reflects the final transition to the euro, with the introduction of notes and coins and the withdrawals and demonetization of the national currencies. Somewhat weaker evidence of cointegration, at 10 % level, can also be found for the group of the three European markets (Germany, France and Italy) with the break in the entire vector occurring on 12/07/2000.

Summing up our findings, there is little evidence in favor of bivariate cointegration relationships between the G7 markets using SPDR and iShares returns. Our results in this respect lend support to the existing cointegration literature for G7 countries based on analysis of broad market indices. While Kasa (1992) found the strongest evidence in favour of cointegration between the world largest stock markets (US, UK, Germany, Japan and Canada) using both monthly and quarterly prices of market series over the period 1974-1990, his findings were later questioned by Richards (1995) who pointed out the need to apply small sample critical values to avoid over-rejection of the null hypothesis of no cointegration. Using adjusted critical values, Richards found very weak evidence of bivariate cointegration for the dataset of sixteen developed stock markets during 1969-1994 and argued that substantial risk-reduction benefits may arise from investing abroad.

Our findings with respect to presence of multivariate cointegration suggest somewhat limited diversification benefits available to US investors investing in iShares of other developed equity markets. It is worth noting that using broader market indexes for eighteen developed and emerging markets during 1961-1992, Chan, Benton and Pan (1997) also found somewhat weaker evidence of cointegration in case of the four European markets (UK, Germany, France, and Italy).

6.2. Recursive Cointegration Test Results

6.2.1. G7 countries

Results of Gregory-Hansen test indicate that the system of the world's largest markets has fluctuated around a common trend in the long run. To explore the dynamics of the equilibrium relationship in further detail, we turn to the multivariate recursive cointegration methodology by Hansen and Johansen (1999). Figures 2 present values of the recursive trace statistics for the null hypothesis of no cointegration (r=0) for the group of G7 markets.

[Figure 2 about here]

The results are presented for the whole sample period. Figure 2 suggests that there is instability in the group dynamics, reflected in large variations of the trace statistics. It appears that roughly four distinct periods could be separated out, indicated by shading on the graph. The first period ranges from March 1996 till September 1997. It is considered an unstable period with the minimum number of cointegration relations fluctuating between 1 and 4. In the second period ranging form October 1997 till September 2000, we notice stabilized convergence. The second period in turn may be further divided into two sub periods, before and after September 1998. These sub periods "separates out" the time of the Asian and Russian financial crises, suggesting that crisis events had repercussions not only for the emerging financial markets, but also influenced the dynamics of the interrelationships between the world's largest financial markets. The number of cointegration relations between 1997 and 1999 is 2 or 3; but the convergence processes slow down between 1999 and 2000 with minimum number of cointegration vectors being 2 and 1. It is noteworthy that during the period of 1996-1998 there were several common trends in the sample and this was the period analyzed in Olienyk, Zumwalt and Schwebach

(1999) study that discovered a number of cointegration relations in their sample. By focusing on underlying dynamics of the relationship as reflected in the recursive cointegration test, we infer that Olienyk et. al (1999) findings could have been driven by the choice of their sample period. The third period ranges from October 2000 to March 2001 and indicates disruption of long-run equilibrium with the minimum number of cointegration relations falling to 1. Finally the fourth period ranges from April 2001 to January 2005 and reflects increasing convergence with the minimum number of cointegration relations rising to 2.

Overall, our graphical plots based on recursive cointegration test suggest a trend towards increasing integration since 2001. In an earlier study, Rangvid (2001) analyzed dynamics of integration between the major European equity markets using quarterly data on IFS indices from 1960 to 1999 and found single cointegration relationship. Having applied the recursive cointegration test of Hansen and Johansen, Rangvid also pointed to increasing degree of European financial markets integration as reflected in the upward trend of recursive lambda trace statistics, though the convergence did not occur until 1982.

6.3. Dynamic Conditional Correlations (DCC-GARCH) Analysis Results

Dynamic conditional correlations between SPDR and iShares returns, calculated as described in Section 4.2.3, are presented in Figure 3. The graph shows the evolution of the dynamic conditional correlations over time. A number of regimes can be distinguished.

In the first regime, prior to 1997, conditional correlations are found to be generally declining. The second regime that coincides with the financial turmoil of 1997-1999 is characterized by a drastic increase in the value of the conditional correlations. For example, in case of German iShares, conditional correlations with SPDR exhibit an increase from 0.25 to 0.7 during this period. This finding is in line with the classical work of Longin and Solnik (1995) demonstrating that comovements between markets increase during volatile periods. Our findings also support Schwebach, Olienyk and Zumwalt (2002) study in this context that found increase in correlation and volatility after the Asian crisis for 11 foreign markets that included five of the seven G7 markets. Another peak in correlations follows in the mid of 1998. The third regime is characterized by volatile correlations during 2000. which from 2001 onwards are characterized by generally rising conditional correlations between SPDR and iShares of the G7 countries, with the correlations levels fluctuating around 0.6.

[Figure 3 about here]

7. Conclusions

Our study examines the extent of long and short-term interdependencies between the US and other developed equity markets. Contrary to most of the published studies in international financial integration that use data on broad stock market indices, our study utilizes price series of US and other G7 exchange traded funds, namely SPDR and iShares, to provide empirical evidence on diversification opportunities. Furthermore, our study provides an in-depth analysis of the status of integration of G7 markets by drawing from a number of advanced econometric techniques focusing on the time varying nature of both short term and long term market relationships.

Our findings suggest that the extent of short-term interdependencies has been increasing since 2001, as reflected in the increased conditional correlation between daily international returns. The evidence in favor of bivariate cointegration is somewhat weak. However, multivariate recursive cointegration test shows an increase in the number of significant common equilibrium relationships since 2001 that appears to have stabilized at two for the G7 ETFs. We thus conclude that there are somewhat limited diversification opportunities available to US based investor interested in investing in the ETFs of the large equity markets over the long run.

A number of potential implications emerge from our study. First, given the evidence that iShares suggests a somewhat different degree of integration of G7 markets than is currently known based on other indices there is clearly an issue regarding the microstructure of these shares. The iShares data indicates that dependent on the time period over which one is measuring, evidence in favour or against cointegration, and the diversification benefits which this implies, may emerge. Second, the extent to which iShares track the existing integration measures may also provide some evidence as to the real portfolio diversification benefits from holding iShares. Third, following Alexander (1999) and Phengpis and Swanson (2004), information provided by our cointegration tests using iShares can be used in future in designing efficient portfolios.

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Table 1. Assets and Number of ETFs by Type of Fund

Year	Total	Domestic Equity	Global/International Equity	Bond
Panel A: Asses, million of dollars, end of the year				
1993	$464	$464	–	–
1994	424	424	–	–
1995	1,052	1,052	–	–
1996	2,411	2,159	$252	–
1997	6,707	6,200	506	–
1998	15,568	14,542	1,026	–
1999	33,873	31,881	1,992	–
2000	65,585	63,544	2,041	–
2001	82,993	79,977	3,016	–
2002	102,143	92,904	5,324	$3,915
2003	150,983	132,332	13,984	4,667
Panel B: Number of Funds, end of the year				
1993	1	1	–	–
1994	1	1	–	–
1995	$2	$2	–	–
1996	19	2	17	–
1997	19	2	17	–
1998	29	12	$17	–
1999	30	13	17	–
2000	80	55	25	–
2001	102	68	34	–
2002	113	66	39	8
2003	119	72	41	6

Source: Investment Company Institute Fact Book 2004.

Table 2. Descriptive Statistics for SPDR and iShares Returns, 18/03/1996-20/01/2005

	Canada	**France**	**Germany**	**Italy**	**Japan**	**UK**	**USA**
Mean	0.000310	0.000252	0.000112	0.000264	-0.00016	0.000146	0.000254
Maximum	0.056	0.065	0.084	0.085	0.123	0.058	0.065
Minimum	-0.087	-0.090	-0.111	-0.093	-0.069	-0.075	-0.064
Std. Deviation	0.014	0.015	0.017	0.016	0.017	0.012	0.014
Skewness	-0.356	-0.160	-0.265	-0.336	0.390	-0.066	-0.058
Kurtosis	5.879	5.117	6.358	6.076	6.554	5.822	4.851
Jarque-Bera	845.988	440.90	1111.35	953.26	1273.12	767.64	330.68
Prob (Jarque-Bera)	0.00	00.00	0.00	0.00	0.00	0.00	0.00
Observations	2308	2308	2308	2308	2308	2308	2308

Table 3. Results of the Gregory-Hansen Test for 18/03/1996-20/01/2004

	Model C		Model C/T		Model C/S	
SPDR - iShares	**ADF**	**Break Date**	**ADF**	**Break Date**	**ADF**	**Break Date**
USA - Canada	-2.50	16.12.1997	-3.89	27.07.1998	-3.22	29.04.1998
USA - France	-3.62	13.08.1997	-3.90	13.08.1997	-3.81	23.06.1997
USA - Germany	-4.33	29.12.1998	-4.20	29.12.1998	-2.99	27.07.1998
USA - Italy	-3.03	29.12.1998	-4.42	21.05.1999	-2.99	29.12.1998
USA - Japan	-4.08	17.10.1997	-4.04	17.10.1997	-3.58	17.10.1997
USA – United Kingdom	-4.06	22.09.1999	-4.29	22.09.1999	-2.70	27.07.1998
USA – France, Germany, Italy, UK	-5.67**	13.08.1997	-6.30**	04.08.1997	-6.49**	31.12.1999
United Kingdom - France	-3.97	01.11.1999	-4.31	01.11.1999	-2.41	30.08.2000
United Kingdom - Germany	-3.29	30.11.1999	-4.36	30.11.1999	-2.39	19.10.2000
United Kingdom - Italy	-3.62	22.07.2002	-3.92	11.03.1999	-3.27	10.04.1998
United Kingdom - Canada	-2.52	01.03.2000	-3.18	22.10.1997	-2.40	30.03.2001
United Kingdom - Japan	-2.64	18.08.1997	-3.23	18.08.1997	-2.34	02.03.2001
France - Germany	-4.34*	12.07.2000	-4.17	01.05.2000	-3.24	16.06.1998
France - Italy	-2.93	12.07.1999	-5.03	09.08.1999	-2.93	22.03.1999
France - Canada	-3.56	21.04.1998	-5.38**	22.05.1998	-5.28**	15.04.1998
France - Japan	-4.13	14.01.1998	-4.13	15.01.1998	-4.23	02.06.1998
Germany – Italy	-3.18	14.08.2002	-4.43	16.09.1999	-3.36	30.03.1998
Germany – Canada	-2.39	14.08.2002	-4.25	20.04.1998	-2.39	15.10.1997
Germany – Japan	-3.05	18.08.1997	-3.71	22.10.1997	-2.74	08.08.1997
Italy – Canada	-2.49	01.10.1997	-3.51	16.02.1998	-2.41	01.10.1997
Italy – Japan	-2.92	24.10.1997	-3.60	02.04.2001	-2.47	01.08.1997
Canada – Japan	-2.90	23.09.2003	-3.67	19.01.2001	-3.65	27.12.1999
Germany – UK, France, Italy	-4.55	12/07/2000	-4.48	12/07/2000	-5.36	12/07/2000
Germany – France, Italy	-4.57	12.07.2000	-4.52	12.07.2000	-5.37*	12.07.2000

Notes. Model specifications for the bivariate cointegration relationship: C – level shift (change in constant); C/T – level shift with trend (model with a linear trend and change in constant only); C/S – regime shift (model with change in both constant and slope). Critical values are taken from Gregory and Hansen (1996). ***, **, * - denotes significance at the 1, 5 and 10 % levels respectively.

Figure. MSCI iShares Indices for G7 Countries, 18/03/1996-20/01/2005

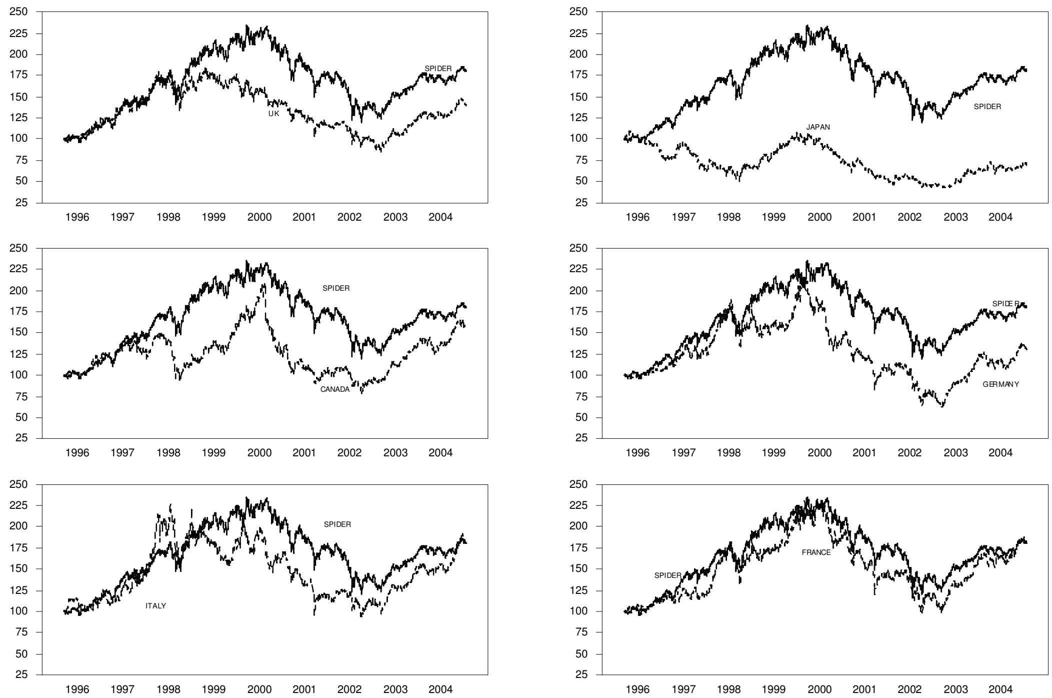
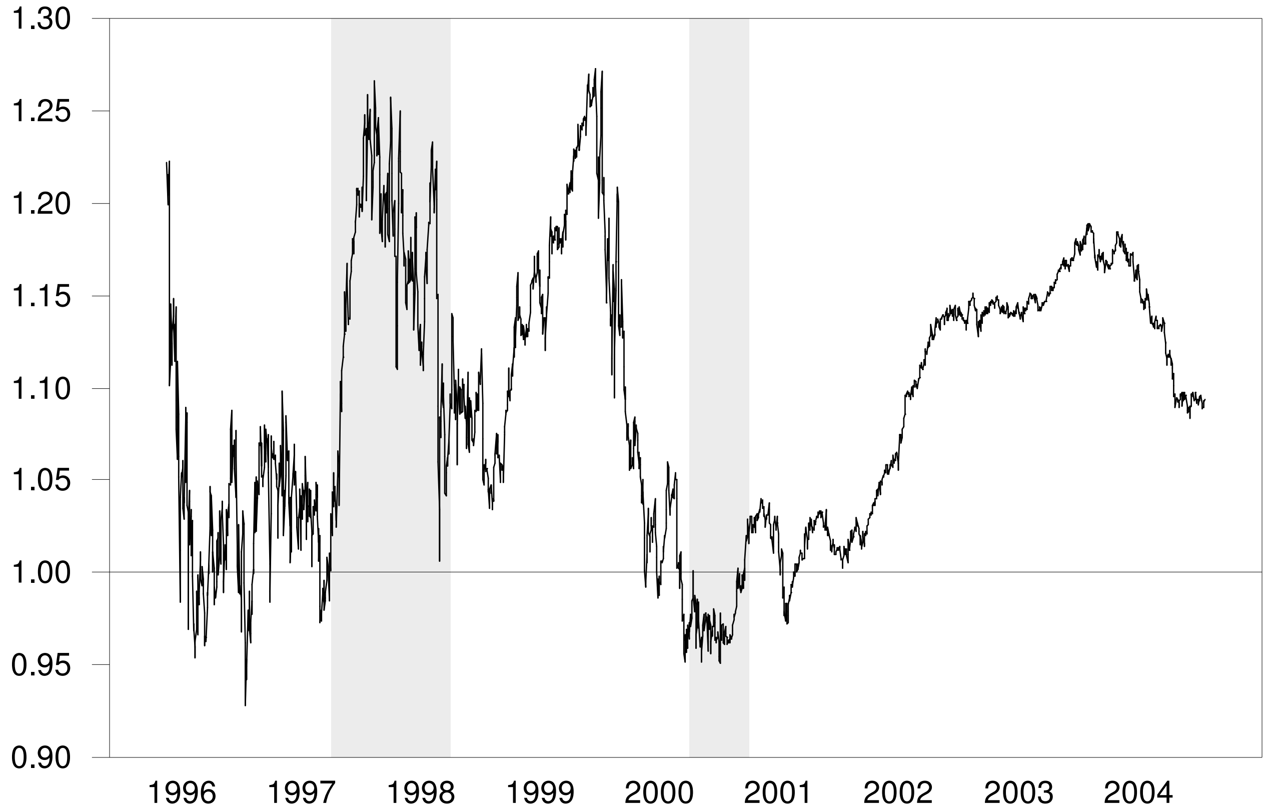
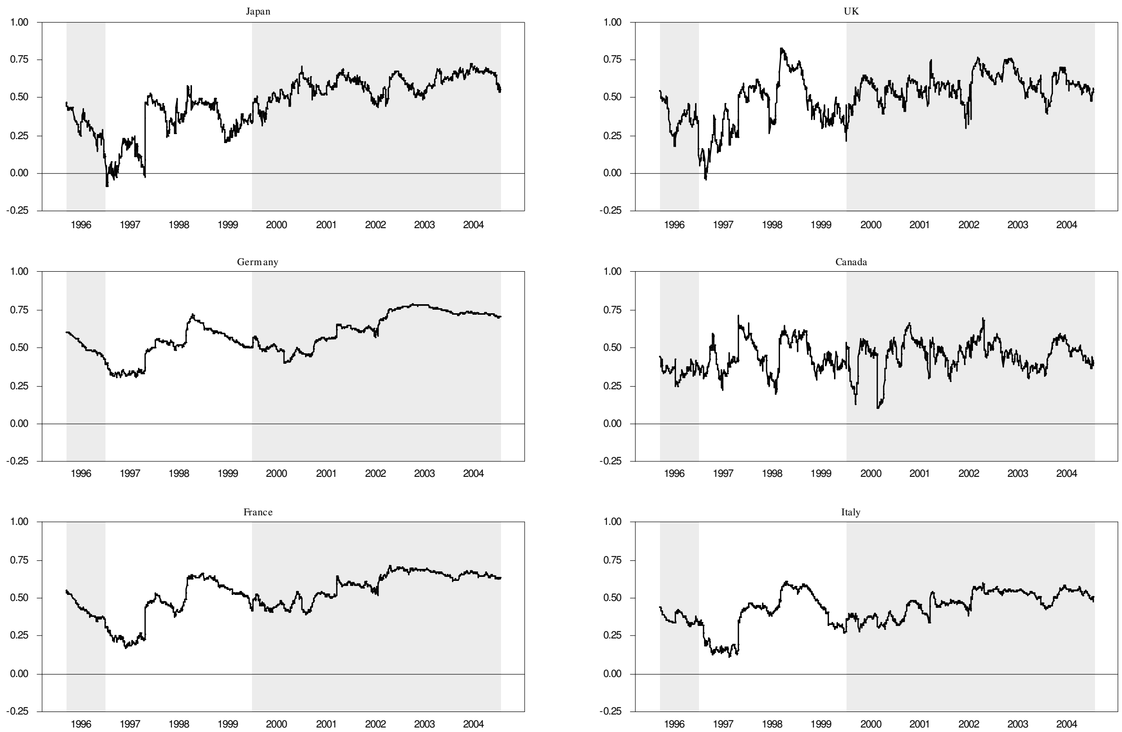


Figure 2. Recursive Normalized Trace Statistic for G7 Countries, 18/03/1996-20/01/2005



Notes. The figure shows values of the rescaled recursive trace statistic of Hansen and Johansen (1993) for H_o: r=0 (no cointegration) against H_1: r=1 (one cointegration relation in the system), rescaled by the 10 % critical value. The values of the statistic above one (above the horizontal line) indicate presence of a cointegration relationship.

Figure 3. Dynamic Conditional Correlation between SPDR and iShares returns



Notes. The figure shows conditional correlation coefficients between between SPDR and respective iShares, extracted from the DCC-GARCH(1,1) specification of the DCC-GARCH model of Engle (2002), with t-distributed errors. See Section 5.3. for the details of the model.

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