COMPARATIVE DETERMINANTS OF INTERNATIONAL EQUITY DIVERSIFICATION

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This dissertation is dedicated to my parents:

My mother, ShuLian Deng

My father, Professor ShuWen Zhang

and to my girl friend:

Fei Wang (Faye), CPA

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ABSTRACT

COMPARATIVE DETERMINANTS OF INTERNATIONAL EQUITY

DIVERSIFICATION

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This study provides a comprehensive, simultaneous comparison of the country and sector determinants of international diversification. Specifically, it bridges the theory between the cointegration methodology and diversification by linking market integration, cointegration and portfolio diversification. Cointegration tests are conducted to both analyze the stationarity of country and industry index covariances and to dissect the diversification contributions of each component. Portfolios comprised of market indices independent of cointegrating relations produce, on average, better risk-return profiles than those constructed from cointegrated market indices. Although country and sector allocations both contribute to independent market portfolio gains, the diversification determinants have differential impact on the components of portfolio risk. Additional tests affirm sector decisions provide stronger diversification gains than

country allocation decisions. Finally, tests suggest institutional fund flows differentiate the performance of the independent and cointegrated portfolios. Mixed evidence suggests institutional flows may contribute to cointegrating relations although the effect is not pervasive.

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CHAPTER 1

COMPARATIVE DETERMINANTS OF INTERNATIONAL EQUITY DIVERSIFICATION

1.1 Introduction

Since U.S. equities account for less than half of world equities, the quest for improved diversification has stimulated tremendous growth in global investment.[1] As supporting evidence, there was $7.94 billion invested in 43 U.S. based international mutual funds in 1985; by 2005, there were 838 international funds with $920 billion in assets. Approximately 70 percent of those international assets were invested in foreign (non-U.S.) funds that invest in companies domiciled outside the U.S. The remaining international mutual fund assets were directed to global (world) funds that include both foreign and domestic companies.[2] (Investment Company Institute, *2006 Mutual Fund Factbook*). International investment growth was particularly strong for institutional separately managed international portfolios where assets were 40 percent larger than mutual funds by 2005 (Pensions and Investments).[3] An estimated 58 percent of the

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[1] MSCI Global Investable Market Index Series Methodology, March 2007 (http://www.msci.com/gimi/MSCI_Mar07_GIMIMethod.pdf)

[2] During the period of this study, the SEC (Investment Company Act of 1940, 35-d, U.S.C.) required that at least 65% of total fund assets be invested in securities consistent with the fund's investment objective. Since 35% of the assets could be invested in other securities, there was potentially little difference between international and global fund portfolios. In 2003, the SEC criterion was increased to 80%.

[3] Separately managed accounts are portfolios managed for the benefit a single investor. Separate accounts require significantly higher initial investments than mutual funds

international SMA assets were invested outside the United States (Cerulli Associates, 2005).

Portfolio management entails both security selection and market timing decisions. Domestically, selection includes sector/industry and style allocation decisions that contribute to portfolio diversification gains (Vardharaj and Fabozzi, 2007). International management is inherently more difficult. First, international managers must choose from a significantly large universe of portfolio candidates. Second, country and exchange rate risks unique to international management greatly compound the domestic selection decisions.

Research comparing benefits of the country and sector dimensions of international diversification has produced mixed results. Early studies found the country factor provided the greatest risk reduction (Roll, 1992). Contemporary studies, however, indicate a greater role provided by the sector/industry factor [Baca, Garbe, and Weiss (2000), Caviglia, Brightman, and Aked (2000), Chen, Bennett, and Zheng (2007), Heston and Rouwenhorst (1994)].

This study provides a comprehensive, simultaneous comparison of the country and sector components of international diversification. I employ cointegration to analyze the stationarity of country and sector index covariances, and dissect the diversification contributions of each component. Cointegration is particularly adept for diversification testing for two reasons. One, stock index time series may be nonstationary (Roll, 1997) and cointegration is ideal to analyze the impact of country and sector nonstationarity on portfolio covariances (DeFusco, McLeavey, Pinto, and

Runkle, 2004). Two, countries or industrial sectors may share long term stochastic trends that can mitigate diversifying properties. Thus, the countries/sectors divergent of the cointegrating relationship make them more desirable candidates for portfolio inclusion (Gallo, Phengpis, and Swanson 2007). The cointegration methodology detects convergent long-term economic or financial relationships among the index time series and, therefore, separates the cointegrated and independent series. I find the cointegration methodology particularly adept at identifying independent markets among the various investable international capital markets that produce, on average, better risk-return profiles than those comprised of cointegrated markets.

This study is divided into seven sections. Section 2 contains the literature review. The theoretical basis of the research is provided in Section 3. The data is assessed in Section 4 and the presentation of the methodology comprises Section 5. The empirical results are summarized in Section 6. The conclusion and extensions of the study is discussed in Section 7.

1.2 Literature Review

1.2.1 International Diversification

Early global diversification studies emphasized the importance of country diversification in international portfolios [Levy and Sarnat (1970), Solnik (1976, 1995), Jorion (1985), Harvey (1991), Santis and Gerard (1997)]. Country diversification still provides important benefits [Heston and Rouwenhorst (1994), Hamelink, Harasty and Hillion (2001)] particularly in emerging markets [Puchkov, Stefak and Davis (2005)].

Researchers began to consider the impact of domestic sector diversification in the 1970s (Lessard, 1974). Although Roll (1992) found the sector composition of country indices accounted for 40 percent of country returns, sectors have provided increasingly large diversification benefits relative to countries [Baca, Garbe and Weiss (2000), Cavaglia, Brightman and Aked (2000), Brooks and Del Negro (2002), L'Her, Sy and Tnani (2002), Carrieri, Errunza and Sarkissian (2004)]. Notably, the combined benefits of country and sector diversification gains exceed gains provided by either source individually (Arshanapalli, Doukas and Lane, 1997).

1.2.1.1 Country Integration and Convergence

Neoclassical global growth models predict eventual economic convergence between poor and rich countries (Solow, 1956). The convergence is initially confined to developed countries with high output levels and low growth rates. Eventually, developing countries with improving economies join the global convergence trend. Although economic studies generally support the tenets of global convergence hypothesis [Baumol (1986), Maddison (1987), Abramovitz (1986, Mankiw, Romer and Weil (1992) Barro (1991), Barro and Sala-i-Martin (1991, 1992)], there is contention regarding the rate and degree of country convergence [Baumol (1986), Chatterji and Dewhurst (1996) and Quah (1996, 1997)]. In the view of proponents of the stratified convergence proposition, countries converge initially toward regional economic group leaders rather than toward a global mean [Bernard and Durlauf (1995), Nahar and Inder (2002)].

Global economic convergence studies have shown country capital market indices effectively reflect respective economic growth [King and Levine (1993), Atje and Jovanovich (1993), Demirguc-Kunt and Levine, (1996a, 1996b), Korajczyk (1996), Levine and Zervos (1996, 1998)]. For example, a strong relationship between stock market returns and GDP has been validated in many studies of the U.S. market [Fama (1981), Fischer and Merton (1984), Chen, Roll and Ross (1986), Barro (1990), Geske and Roll (1983), Fama (1990) and Schwert (1990)]. A strong linkage between capital market growth and economic output has also been shown for Canada (Cozier and Rahman 1988, Barro 1990), Japan and Korea (Kwon and Shin 1999), Germany and United Kingdom (Mullins and Wadhwani 1989), the G-7 countries (Choi, Hauser and Kopecky 1999), European countries (Wahlroos and Berglund 1986, Wasserfallen 1989, 1990 among others) and emerging countries (Mauro, 2000). Thus, country market indices can serve as effective proxies in convergence tests.

Studies have documented cointegrating relationships among developed countries but have reported variability in the number of cointegrating relationships, the countries sharing common trends, and the speed of the convergence process. For example, global studies find a single common stochastic trend between the U.S. and Japan (Campbell and Hamao, 1992), and among the U.S., Canada, Germany, Japan and the U.K (Kasa, 1992). Heimonen (2002) shows Finnish and Japanese markets divergent of a cointegration relationship among the U.S., the U.K. and German stock markets. In Europe, Apilado, Phengpis and Swanson (2004) find the U.K. cointegrated with EMU countries while Hardouvelis, Malliaropulos and Priestley (2006) found UK is independent of Eurozone cointegration. More recent evidence report multiple cointegrating relationships among developed countries [Arshanapalli and Doukas (1993), Byers and Peel (1993) and Corhay, Rad and Urbain (1993), Karolyi and Stulz (1996), Serletis and King (1997)].

The rate of the country convergence process appears to be increasing [Abramovitz 1986), Quah (1996, 1997)]. Chan, Gup and Pan (1997) find an expedited convergence rate initiated by the October 1987 market crash. Hardouvelis, Malliaropulos & Priestley (2006) argue the formation of the EMU in 1999 also contributed to an increase in the rate of economic convergence. Importantly, differences in the rate of convergence essentially demarcate countries into globally (co)integrated, regionally cointegrated, segmented (independent), or segmented but in the convergence process.

1.2.1.2 Industry/Sector Integration and Convergence

Interrelationships among industrial sectors play an increasingly important role in the degree and/or speed of global/regional convergence [Dowrick and Nguyen (1987, Dollar and Wolff (1993), Bernard and Jones (1996a-c), Gouyette and Perelman (1997), Garcia Pascual and Westermann (2002), Freeman and Yerger (2001), Funk and Strauss (2003), Caporale (1997), Christiano and Fitzgerald (1998), Horstein (2000)]. Although industry/sector cointegration research is relatively nascent, Norrbin (1995) documents industrial cointegration.

1.2.2 Comparative Diversification Benefits

Portfolio risk/return profiles will benefit most if managers allocate by rank order diversification determinant (Vardharaj and Fabozzi, 2007). Contemporary studies report the industry/sector diversification gains exceed those of geography [Dijk and Keijzer (2004), Lin, Kopp, Hoffman and Thurston (2004)].

1.2.3 Contribution of This Study

This study provides a comprehensive, simultaneous comparison of the geographical and industrial sector components of international diversification. I employ cointegration to analyze the stationarity of geographical (region/country) and industrial sector index covariances, and to dissect the diversification contributions of each determinant. First, this study bridges the theory between the cointegration metholology and diversification. The cointegration methodology is employed to evaluate interrelationships among the components of diversification (e.g., Johansen, 1988, 1991). This methodology can dissect and measure the contributions of the geographical and industrial sector components of international portfolio diversification. I contend cointegrated assets have high long run within-vector correlations and are, therefore, redundant diversifiers unneeded in portfolios. In contrast, international diversification gains are produced by less correlated assets independent of cointegrating relationships.

Second, this study analyzes the combined effects of the three dimensions of diversification during varying periods and trends of market performance. For instance, Butler and Joaquin (2002) and Campbell, Koedijk and Kofman (2002) both found correlation increases during Declining market periods when investors need diversification most. The heavy influence of downside risk during declining markets questions the traditional global investment strategy so I separate my portfolio performance test under varying market conditions.

1.3 Theory Background

1.3.1 Time-Varying Market Integration

Bekaert and Harvey (1995) offer a time-varying form of conditional CAPM model of Sharp (1964) and Lintner (1965) to measure the degree of integration. The aggregated market model for conditional mean return, with information set Z_{t-1}, takes the following form:

$$E_{t-1}[r_{i,t}] = \phi_{i,t-1}\lambda_{t-1}\,\mathrm{cov}_{t-1}[r_{i,t}, r_{w,t}] + (1-\phi_{i,t-1})\lambda_{i,t-1}\,\mathrm{var}_{t-1}[r_{i,t}] \qquad (1)$$

where $E_{t-1}[r_{i,t}]$ is the conditionally expected excess return on country i at time t-1, the $r_{w,t}$ is the return on a world portfolio, cov_{t-1} is the conditional covariance operator, and λ_{t-1} is the conditionally expected world price of covariance risk for time t. The var_{t-1} is the conditional variance operator for country risk and $\lambda_{i,t-1}$ is the conditionally expected price of country variance risk for time t. The risk-free rate has zero conditional variance because the return is determined at t-1. The ϕ, which falls in the interval [0, 1] is the time-varying assessment of the likelihood that the market is integrated where the ϕ=1 if fully integrated, ϕ=0 if fully segmented (independent), and 0<ϕ<1 if in the convergence process. This model is widely used in financial integration and asset pricing tests (for example, see Hardouvelis, Malliaropulos and Priestley, 2006).

I extend equation (1) to a more general form that reflects country and industrial sector diversification factors. Defining $E_{t-1}[R_{i,t}]$ as the conditionally expected excess return on index i at time t-1 (where index i can proxy either a country or sector), I have

$$E_{t-1}[R_{i,t}] = \phi_{i,t-1}\lambda_{t-1}\mathrm{cov}_{t-1}[R_{i,t}, R_{l,t}] + r_c(1-\phi_{i,t-1})\lambda_{i,t-1}\,\mathrm{var}_{t-1}[R_{i,t}] + r_i(1-\phi_{i,t-1})\lambda_{i,t-1}\,\mathrm{var}_{t-1}[R_{i,t}] \quad (2)$$

where, the γ is the mean conditional country/sector correlation (γ_c represents country and γ_i represents industrial sector). When R_i is a country index, $\gamma_c = corr(R_i, R_i) = 1$, the mean correlations between country index i and N number of industries is expected to be $\gamma_i = \sum_{k=1}^{N} corr(R_i, R_k)/N = 0$. In essence, γ is a dummy variable to be matched with index i, so that when i represents country index, [γ_c, γ_i] = [1,0] and the industrial vector [γ_c, γ_i] = [0,1]. From equation (1), I replace $r_{w,t}$ with the return of a leading index, $R_{l,t}$, which is the weakly exogenous variable (index) in a cointegration relation or common stochastic trend. The $r_{w,t}$ is a special case of $R_{l,t}$ when all countries share a single common trend. Thus, the $R_{l,t}$ is a more general form than $r_{w,t}$ since $R_{l,t}$ can represent a leading country inside a cointegrated vector [Baumol (1986), Chatterji and Dewhurst (1996) and Quah (1996, 1997)]. Specifically, when [γ_c, γ_i] = [1,0], $R_{l,t}$ represents the leading cointegrated country index and when [γ_c, γ_i] = [0,1], $R_{l,t}$ represents the leading cointegrated industrial index. Separating the diversification dimensions, equation (2) can be simplified into two representations that follow Bekaert and Harvey (1995):

$$\begin{aligned} &Country: E_{t-1}[R_{c_i,t}] = \phi_{i,t-1}\lambda_{t-1}\,\mathrm{cov}_{t-1}[R_{c_i,t}, R_{c_l,t}] + (1-\phi_{i,t-1})\lambda_{i,t-1}\,\mathrm{var}_{t-1}[R_{c_i,t}] \\ &Industry: E_{t-1}[R_{cI_i,t}] = \phi_{i,t-1}\lambda_{t-1}\,\mathrm{cov}_{t-1}[R_{I_i,t}, R_{I_l,t}] + (1-\phi_{i,t-1})\lambda_{i,t-1}\,\mathrm{var}_{t-1}[R_{I_i,t}] \end{aligned} \quad (3)$$

Establishing the general time-varying market integration asset price formula for countrt and industry, I measure the degree of integration (ϕ). I propose three possible regimes for integration at time t dependant on information set Z_{t-1}: fully integrated (ϕ=1), fully segregated or independent (ϕ=0), and converging or diverging (0<ϕ<1).[4]

When fully integrated (ϕ=1), the pricing model becomes: $E_{t-1}[R_{i,t}] = \lambda_{t-1} \operatorname{cov}_{t-1}[R_{i,t}, R_{l,t}]$, where the expected return of each completely integrated market is priced by the covariance of the leading index. If capital markets are integrated, financial assets trading in different markets should have the same risk/return characteristics regardless of country or industry (Campbell and Hamao, 1992). Thus, cointegrated indices sharing a common trend should co-move perfectly and have return and risk profiles ($E_{t-1}[R_{l,t}] = \lambda_{l,t-1} \operatorname{var}_{t-1}[R_{l,t}]$) similar to the leading vector index [Bernard and Durlauf (1995) and Heimonen (2002)]. Therefore, the model reduces to

$$E_{t-1}[R_{i,t}] = E_{t-1}[R_{j,t}] = E_{t-1}[R_{l,t}] = \lambda_{l,t-1} \operatorname{var}_{t-1}[R_{l,t}] \qquad (4)$$

Transforming returns to the natural logarithms of the price level, the relationship between integrated indices *I* and *J* become

$$E_{t-1}(\ln I_t) - \ln I_{t-1} = E_{t-1}(\ln J_t) - \ln J_{t-1} \qquad (5)$$

$$\Rightarrow E_{t-1}(\ln I_t) - E_{t-1}(\ln J_t) = \ln I_{t-1} - \ln J_{t-1} \qquad (6)$$

where ln*I* and ln*J* represent log price of index i and j, respectively. Equation (6) shows the linear combination between *I* and *J* is temporally stationary. Moreover, in a fully

[4] Bekaert and Harvey (1995) provide the solution for the regime probability measurement ϕ.

integrated regime, the correlation between any two index returns among $R_{i,t}$, $R_{j,t}$ and $R_{l,t}$ becomes unity

$$\rho_{t-1}[R_{i,t}, R_{l,t}] = \frac{\text{cov}(R_{i,t}, R_{l,t})}{\sigma_{R_{i,t}} \sigma_{R_{l,t}}} = \frac{\text{cov}(R_{i,t}, R_{l,t})}{\sigma_{R_{l,t}}^{2}} = 1 \qquad (7)$$

$$\rho_{t-1}[R_{i,t}, R_{j,t}] = \frac{\text{cov}(R_{i,t}, R_{j,t})}{\sigma_{R_{i,t}} \sigma_{R_{j,t}}} = \frac{\text{cov}(R_{i,t}, R_{j,t})}{\sigma_{R_{l,t}}^{2}} = 1 \qquad (8)$$

When completely segmented (ϕ=0), the index pricing model ($E_{t-1}[R_{i,t}] = \lambda_{i,t-1} \text{var}_{t-1}[R_{i,t}]$) implies expected return is determined solely by own variance so only own, unshared index risk matters $\rho_{t-1}[R_{i,t}, R_{j,t}] = \frac{\text{cov}(R_{i,t}, R_{j,t})}{\sigma_{R_{i,t}} \sigma_{R_{j,t}}} = 0$. The lack of cointegration suggests no long-run equilibrium among independent indices. In the long-run, therefore, I expect:

$$\begin{array}{c} E_{t-1}[R_{i,t}] \neq E_{t-1}[R_{j,t}] \neq E_{t-1}[R_{l,t}] \\ or\ \lambda_{i,t-1} \text{var}_{t-1}[R_{i,t}] \neq \lambda_{j,t-1} \text{var}_{t-1}[R_{j,t}] \neq \lambda_{w,t-1} \text{var}_{t-1}[R_{l,t}] \end{array} \qquad (9)$$

In the aggregate, the relationship between two completed independent indices I and J in level becomes

$$E_{t-1}(\ln I_t) - \ln I_{t-1} \neq E_{t-1}(\ln J_t) - \ln J_{t-1} \qquad (10)$$

$$\Rightarrow E_{t-1}(\ln I_t) - E_{t-1}(\ln J_t) \neq \ln I_{t-1} - \ln J_{t-1} \qquad (11)$$

so the difference between two segmented indices is not stationary through time.

Importantly, the inclusion of partially integrated indices (0<ϕ<1) does not affect the cointegration analysis since convergence (divergence) results from cointegrating with a negative (positive) trend component. Thus, it does not matter whether convergence begins from higher or lower level if the rate of convergence/divergence is constant. In that case, expected risk adjusted returns among the converging/diverging vector indices will be equal and the converging/diverging risk premium is derived from own risk $\lambda_{i,t-1}$. The long-run stable relation between converging/diverging indices takes the following form:

$$E_{t-1}[R_{l,t}] = \alpha * E_{t-1}[R_{i,t}] \qquad (12)$$

where $E_{t-1}[R_{l,t}]$ is the expected return of a leading index, $E_{t-1}[R_{i,t}]$ is converging/diverging index i expected return, and α represents the equilibrium relation between the two expected returns. The $(1-\alpha)$ is the risk premium for index i relative to the expected return of a leading index.

In the aggregate, the relationship between two converging/diverging indices I and J in level becomes:

$$E_{t-1}(\ln I_t) - \ln I_{t-1} = \alpha * (E_{t-1}(\ln J_t) - \ln J_{t-1}) \qquad (13)$$

$$\Rightarrow E_{t-1}(\ln I_t) - E_{t-1}(\ln J_t) = \alpha * (\ln I_{t-1} - \ln J_{t-1}) \qquad (14)$$

Equation (14) shows the difference between two converging/diverging indices is a function of time and is trend stationary. When converging, $0 < \alpha < 1$ and stable so the difference at time t is proportionally smaller than that at time t-1. Divergence is indicated when $\alpha > 1$ and stable. Scenario $\alpha < 0$ is discussed in Appendix B. Equations (12) and (13) imply the long-run correlation between any two indices of $R_{i,t}$ and $R_{j,t}$

when converging/diverging becomes non zero $\{ \rho_{t-1}[r_{i,t}, r_{j,t}] = \frac{\text{cov}(r_{i,t}, r_{j,t})}{\sigma_{r_{i,t}} \sigma_{r_{j,t}}} = A > 0 \}$. The three regimes (full, segmented, partial) can be detected using the cointegration methodology.[5]

1.3.2 Integration, Independent and Converging under Cointegration Framework

Correlation analysis is a common tool in diversification studies. However, Longin and Solnik (1995) found international covariance/correlation matrices unstable over time and Tarbert (1998) shows portfolio deficiencies result from the temporal instability of correlations. Tarbert advocates cointegration tests to improve long-run diversification benefits. Cointegration is an econometric technique used to test the long run correlation between non-stationary time series variables (Engle and Granger, 1987). A stationary linear combination of variables that are, individually, non-stationary and integrated of order 1, is cointegrated of order CI(1,1). A unit root is present in the series if the coefficient $|\beta| = 1$ in $Y_t = \beta Y_{t-1} + \varepsilon_t$, where Y_t is the variable in level at time t, and ε_t is the error component. Time series with a unit root have a stochastic trend, or I(1). The lack of a stationary linear combination means the time series are independent, or not cointegrated.

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[5] The inconsistency of cointegration and efficient markets is brought to researchers since earlier 1990 because the cointegration implies prediction power from the error correction representation. However, whether inconsistency hold or not depends on the definition of "efficient market" [Dwyer and Wallace (1992)] and many recent work support the view that cointegration or lack of cointegration has nothing to do with market efficiency, see Hodrick (1987). Sephton and Larsen (2002) claim that cointegration methodologies cannot be relied upon to provide reliable evidence on market efficiency.

I postulate both full and partial integration series are cointegrated in the long run with stable temporal convergence rates. The temporal implied multivariate price relation level is presented in Figure 1.1. Figure 1.2 provides the temporal bi-variate price relation level.

Each index in Figure 1.1 assumes the form of,

$$y_t = y_{t-1} + y_{t-1} * E_{t-1}(R_{y,t}) + \varepsilon_{y_t} = y_{t-1}(1 + E_{t-1}(R_{y,t})) + \varepsilon_{y_t} \qquad (15)$$

so at time t the index equals the index at time t-1 plus the lagged index return and a shock ε. Subtracting following equation (16) from (17), we have the difference between bivariate indices i and j:

$$y_{i,t} = y_{i,t-1}(1 + E(R_{y_i,t})) + \varepsilon_{y_{it}} \qquad (16)$$

$$y_{j,t} = y_{j,t-1}(1 + E(R_{y_j,t})) + \varepsilon_{y_{j,t}} \qquad (17)$$

at time period t is equal to the difference in the prior period t-1 plus two conditional components,

$$diff_{y_t} = diff_{y_{t-1}} + (E(R_{y_i}) * y_{i,t-1} - E(R_{y_j}) * y_{j,t-1}) + diff_{\varepsilon_t}. \qquad (18)$$

From equation (18), each regime state can be derived.

When full integration exists when two series y_i and y_j are parallel or merged ($diff_{y_t} - diff_{y_{t-1}} = 0$), since

$$(E(R_{y_i}) * y_{i,t-1} - E(R_{y_j}) * y_{j,t-1}) + diff_{\varepsilon_t} = 0 \qquad (19)$$

Fully integrated variables are cointegrated since the linear combination between the series is stationary of I(0).[6] When fully integrated, $E(R_{y_i}) = E(R_{y_j})$ so the following relation must hold:

$$(E(R_{y_i})*y_{i,t-1} - E(R_{y_j})*y_{j,t-1}) = E(R_y)*(y_{i,t-1} - y_{j,t-1}) = E(R_y)*diff_{y_{t-1}} = -diff_{\varepsilon_t} \quad (20)$$

Notably, $-diff_{\varepsilon_t}$ is the error correction term that ties two series together and prevents deviations from the long run cointegrating relation. Index L and A in Figure 1.1 presents the fully integrated case; the stable bi-variate difference is illustrated in Figure 1.2 with *diff(L, A)*. When partially integrated, $(E(r_{y_i})*y_{i,t-1} - E(r_{y_j})*y_{j,t-1}) + diff_{\varepsilon_t} < 0$, two series are converging because $diff_{y_t} - diff_{y_{t-1}} < 0$.

Similarly, if $(E(r_{y_i})*y_{i,t-1} - E(r_{y_j})*y_{j,t-1}) + diff_{\varepsilon_t} > 0$, the $diff_{y_t} - diff_{y_{t-1}} > 0$ so the two series are diverging [Baumol (1986), Barro (1991), Bernard and Durlauf (1995)]. Regardless of direction, the price difference between two series is a function of time so that the linear combination of the series is trend stationary. Figure 1.1 demonstrates convergence (between L and C) during time T1 and T2 as well as divergence (between L and B) during time T1. The bi-variate differences are presented in Figure 1.2.

When segmented, $(E(r_{y_i})*y_{i,t-1} - E(r_{y_j})*y_{j,t-1}) + diff_{\varepsilon_t}$ follows a random walk process so $diff_{y_t} - diff_{y_{t-1}}$ is not predictable at time t-1. Thus, segmented indices are independent of any cointegration relationship.

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[6] Whether series are parallel or merged depends on their initial level difference at time 0.

1.3.3. Implication of Cointegration on Equity Diversification

Cointegrated indices are covariance unstable (DeFusco, McLeavey, Pinto, and Runkle, 2004) and have time series that may not be stationary (Roll 1997). Gallo, Phengpis and Swanson (2007) find that cointegration mitigates diversifying properties of cointegrated assets.

As shown previously (Equation 4), cointegrated indices have equal expected returns. The relation between their long run returns is

$$\frac{\partial r_i}{\partial r_j} = \beta_{(r_i, r_{j,})} = \frac{Cov(r_i, r_j)}{\sigma_{r_j}{}^2} = \frac{Cov(r_i, r_j)}{\sigma_{r_l}{}^2} = 1 \qquad (21)$$

Thus, covariance will be positive $Cov(r_i, r_j) = \sigma_{r_l}{}^2 > 0$. From Markowitz (1952) modern portfolio theory,

$$\sigma_p^2 = \sum_{i=1}^{N}(w_i^2 * \sigma_i^2) + \sum_{i=1}^{N}\sum_{\substack{j=1 \\ j \neq i}}^{N} w_i w_j Cov(r_i, r_j)$$

$$= \frac{1}{N}(average\ unsystematic\ risk) + \frac{N-1}{N}(average\ systematic\ risk) \quad (22)$$

when $N \to \infty$, $\sigma_p^2 = average\ systematic\ risk = \sigma_l^2 > 0$. When the leading index 1 (weak exogenous index in the cointegration relation) has a (non-stationary) unit root, variance is time-dependent: $\sigma_p^2 = Var(y_l) = \sigma_l{}^2 * t$, and $t \to \infty$, $Var(y_l) \to \infty$. This implies cointegrated assets provide no long run diversification benefits. This same conclusion applies to converging/diverging indices since $\frac{\partial r_i}{\partial r_l} = \beta_{(r_i, r_{l,})} = \frac{Cov(r_i, r_l)}{\sigma_{r_l}{}^2} = \alpha > 0$, and $\sigma_p^2 = average\ systematic\ risk > 0$.

In contrast, equation (9) shows independent stock market indices will have unpredicted correlations and unequal returns in each period: $\frac{\partial r_i}{\partial r_j} = \beta_{(r_i,r_{j,})} = \frac{Cov(r_i,r_j)}{\sigma_{r_j}{}^2} = 0$. A zero slope coefficient (beta) between two independent index returns implies zero long run covariance: $Cov(r_i, r_j) = 0$. When $N \to \infty$, $\sigma_p^2 \to 0$, and diversification benefits ensue. Thus, diversified portfolios should be comprised of independent indices that will simultaneously produce higher returns and lower risk than portfolios of cointegrated indices as illustrated in the relative efficient frontiers in Figure 1.3.

1.4 Data

I examine 192 monthly returns of country equity market, industry sector proxies from the S&P/Citigroup Global Equity Indices (GEI) database over the period October 1, 1990 – September 30, 2006.[7] The database is designed to reflect components of the broad universe of institutionally investable international stocks. In total, the indices are comprised of over 10,000 companies from both the developed and emerging markets with a minimum market value of $1 billion.[8] All indices in the databases are float-adjusted and weighted by capitalization. To be eligible for inclusion, each company must have a minimum market value of $100 million with trading volume exceeding $25

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[7] The S&P/Citigroup actually begins October 1, 1989. However, construction of a momentum factor used in performance tests requires 12 prior months' returns.

[8] A detailed description of the database is provided in "S&P/Citigroup Global Equity Indices Index Methodology," August 2006, available at www.globalindices.standardandpoors.com.

million over the preceding twelve months. Constituents in the indices are reconstituted each September-end based on prior July-end values.

This study focuses on the Broad Market Indices (BMI) that measure the developed segment of the universe. At each level, the BMI is decomposed into the large capitalization Primary Market Index (PMI) and Emerging Market Index (EMI). The BMI includes the upper 80 percent of the BMI market value and, therefore, reflects the large capitalization sector of a respective market. The respective small capitalization EMI is computed from the remaining 20 percent of the BMI index. Geographically, indices are formed at the global, regional (n = 4), and local market levels (n = 21) as well as by industrial sectors (n = 10) and industrial groups (n=24).

Notably, the construction process of the indices is designed to alleviate various forms of undesirable sampling bias. First, the performance of firms subsequently removed or deleted from the indices is retained for all prior periods of inclusion, mitigating survivorship bias.[9] Second, only live contemporaneous data is utilized in construction assuring the indices have no look-ahead bias. Third, thinly traded companies, corporate holdings, private control blocks, government holdings, and legally restricted shares are eliminated from inclusion assuring that illiquid securities do not unduly inflate market performance.[10]

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[9] Survivorship bias in performance studies has been reported by Grinblatt and Titman (1989), Brown and Goetzmann (1995), Malkiel (1995), and Elton, Gruber and Blake (1996).

[10] For an excellent summary of the impact of sampling biases, see O'Shaughnessy, J.P., 2005, "What Works on Wall Street," McGraw-Hill.

Stocks are also classified by the Global Industry Classification Standard (GICS) industry classification structure. The indices provide geographic and economic balance across the 10 GICS Sectors. These sectors, now consistent across all Standard & Poors indices, are Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Telecommunication Services and Utilities. The GICS sectors are further decomposed into 24 industry groups, 64 industries and 139 sub-industries.

1.5 Methodolgy

1.5.1 Unit Root Test

Cointegration refers to a linear combination of nonstationary variables. To test stationarity of data series, economists often perform unit root tests on price level. This study conducts three unit root tests: Dickey-Fuller (1979), Augmented Dickey-Fuller (1981) and Zivot and Andrews (1992).

1.5.1.1. Dickey-Fuller Unit Root Test

Consider a simple AR(1) model is $Y_t = \beta Y_{t-1} + \varepsilon_t$, where Y_t is the equity price index, t is the time index, β is a slope coefficient, and ε_t is the error term. A unit root is present if $|\beta| = 1$. The regression model can be rewritten as $\Delta Y_t = (\beta - 1)Y_{t-1} + \varepsilon_t = \delta Y_{t-1} + \varepsilon_t$, where Δ is the first difference operator. This model testing for a unit root is equivalent to determining if $\delta = 0$. Since the test is performed on the residual term rather than raw data, it is not possible to use standard t-distribution to compute critical values. The test statistic τ is the Dickey Fuller (DF) statistic. There are three versions of the DF test: one, a test for a unit root ($\Delta Y_t = \delta Y_{t-1} + \varepsilon_t$); two, a test for a unit root with drift: ($\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \varepsilon_t$); and, three, a test for a unit root with drift around a stochastic trend ($\Delta Y_t = \alpha_0 + \alpha_1 * t + \delta Y_{t-1} + \varepsilon_t$). Each test version has its own critical value dependent on the sample size. In each case, the null hypothesis is that there is a unit root, δ = 0. A caveat of the DF tests is the low power that often cannot distinguish between true unit-root processes (δ = 0) and near unit-root processes (δ is close to zero).

1.5.1.2. Augmented Dickey-Fuller Unit Root Test

The Augmented Dickey-Fuller (ADF) procedure first removes all the structural effects (autocorrelation) in the time series and then tests using the DA procedure. The ADF and DF tests share the sampling process but the ADF test is applied to the model, $Y_t = \alpha_0 + \alpha_1 * t + \beta Y_{t-1} + \beta_1 \Delta Y_{t-1} + ... + \beta_p \Delta Y_{t-p} + \varepsilon_t$, where α_0 is a constant, the α_1 is the time trend coefficient, and p the lag order of the autoregressive process. Imposing the constraints $\alpha_0 = 0$ and $\alpha_1 = 0$ corresponds to modeling a random walk. Constraining $\alpha_1 = 0$ corresponds to modeling a random walk with drift. Incorporating lags of the order p, the ADF formulation allows for higher-order autoregressive processes. This means that the lag length p has to be determined in the testing process. This study uses Akaike information criterion (AIC) and the Schwartz Bayesian criterion (SBC) to determine the lag length(s) for both the single series and the system. The unit root test is performed under the null hypothesis $\beta = 1$ against the alternative hypothesis of $\beta < 1$. The computed test statistic $DF_\tau = (\hat{\beta} - 1) / SE(\beta)$ is computed, it is compared to the relevant critical value for the Dickey-Fuller test. If the test statistic is less than the critical value then the null hypothesis of no unit root is rejected ($\beta = 1$).

1.5.1.3. Zivot-Andrews Unit Root Test with Structure Break

The DF and ADF unit root test results assume there is no structural break in the systematic risk of the indices. A univariate test of non-stationary price series is therefore conducted to verify the DF and ADF test results.[11] I perform the Zivot and Andrews (ZA, 1992) unit root test on each index and portfolio price series. In contrast to other similar tests (e.g., Perron, 1989), the ZA test allows the break point to be endogenously determined by the test equation. To test the null hypothesis that one price series is $I(1)$ is without a structural break against the alternative hypothesis that it is $I(0)$ with a structural break, the unit root test equation is estimated for each possible break date, T_{PB}.

$$\Delta Y_t = \mu + \delta t + \theta DU_t + \gamma DT_t + \alpha Y_{t-1} + \sum_{i}^{k} \phi_i \Delta Y_{t-i} + e_t \qquad (23)$$

The ZA statistic under the null hypothesis is the smallest of the unit root test statistics calculated for all T_{PB} iterations. If the null hypothesis is rejected, the T_{PB} associated with the ZA statistic becomes the significant break date, T_B, on which a structural change occurred.

[11] Roll (1997) reports evidence the style returns may not be stationary.

1.5.2 Cointegration Test

Roll (1997) suggests stock index time series may not be stationary and, may have unstable covariances if the indices share a unit root or common trend (DeFusco, McLeavey, Pinto, and Runkle, 2004). Nonstationary indices may be redundant diversifiers so index stationarity has important implications for the composition of a diversified portfolio. I perform cointegration tests on the price series of the S&P/Citigroup indices to examine country and industrial sector, respectively, comovement. Each index price series first is converted to natural logarithms for cointegration rank tests that determine the number of long-run equilibrium relations or cointegrating vectors (CIVs) among non-stationary variables in the attainable set.[12] The augmented Dickey-Fuller (ADF) unit root tests (Dickey and Fuller, 1979, 1981) are employed to detect any non-stationarity in the index price series.[13]

The Johansen cointegration methodology (Johansen, 1988, 1991, 1992a, 1992b, 1994; and Johansen and Juselius, 1990) is based on the vector autoregressive (*VAR*) process for p non-stationary variables and yields a cointegration rank test. The test computes the λ_{trace} statistic for the null hypothesis of at most r CIVs against the alternative of p CIVs as in (23).

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[12] Conversion to natural logarithms makes the first differences of index prices, the percentage change or return, conceptually more meaningful in the vector autoregressive representation than the absolute changes of index prices.

[13] Previous literature (e.g., Masih and Masih, 2001; and Chen et al., 2002) provides consistent evidence index price series are non-stationary.

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{p} \ln(1-\lambda_i). \tag{24}$$

where λ_i is an eigenvalue. Cointegrated indices that share a common factor can be identified by significant λ_{trace} statistics while independent indices should produce insignificant λ_{trace} statistics.

Stock index prices are positively temporally biased so I must discern common linear trends among any of the indices. Hence, model specification tests must be conducted. Conditional on r CIVs, the test uses the G(r) statistic, asymptotically distributed as χ^2(r) (Johansen, 1994),

$$G(r) = -T\sum_{i=1}^{r}[\ln(1-\hat{\lambda}_i^*) - \ln(1-\hat{\lambda}_i)]\,. \tag{25}$$

where $\hat{\lambda}_i^*$ and $\hat{\lambda}_i$ are the VAR eigenvalues for CIVs with and without linear trends, respectively. Exclusion tests [likelihood ratio L-R tests of β restrictions, Johansen (1991) and Johansen and Juselius (1990)] further affirm independence from cointegrating relations with insignificant exclusion test statistics.

The asymptotic distribution of the rank test statistic differs depending on the deterministic model components. The assumed distribution used to calculate critical values of the rank test in the I(1) is often not valid so the reported p-values may be inaccurate, particularly for models with structural breaks. Although often ignored in cointegration studies, structural breaks can induce spurious rejections of cointegrating relationships. Since structural breaks have been documented in international market studies, their presence offers important implications for this study [Leybourne and

Newbold (2003), Goh, Wong and Kok (2005)]. Structural breaks are monitored with likelihood-ratio (L-R) tests (Johansen, Mosconi and Nielsen, 2000).

To address shock-induced non-normally distributed residuals, I include dummy variables that control extreme values of standardized residuals with t-statistics greater than 2.576.[14] The relatively small sample size (n = 192) over the 1990-2006 period can also produce estimation error. As a remedy for the sample size problem, I apply the Bartlett small sample correction technique to each cointegration test. Both the uncorrected Trace test statistic and Bartlett corrected Trace rank test statistic (Johansen, 2000, 2002) are reported.

1.5.3 Measure of the Portfolios Performance

Cointegrated indices represent some level of redundancy, or superfluous diversification, so their role in international diversification is unclear. To the extent that the vector requires portfolio inclusion, the one index with the best risk-return profile can represent the entire vector. In contrast, the entire vector may be redundant, in which case all cointegrated indices can be omitted from a diversified portfolio. To assess necessary indices, I create and compare equal-weighted portfolios of cointegrated indices and of independent indices constructed from GEI country returns. Separate tests are performed on country and industrial sector indices, respectively. The performance of the portfolios is evaluated with the four-factor model,

$$R_{it} = a_{i0} + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + \varepsilon_t \qquad (26)$$

[14] Residuals with a t equal to or greater than 2.576 are statistically significant at 1% level and, thus, treated as a large shock.

R_{it} is the monthly equity index return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. SMB and HML are returns on zero-investment factor mimicking portfolios (small minus big stocks and high BE/ME minus low BE/ME stocks, respectively). In the spirit of the Fama-French methodology, each month, SMB equals the difference between the average returns of the two EMI small-stock indices (EMI Growth and EMI Value) and the average returns of the two PMI large-stock indices (PMI Growth and PMI Value). Similarly, each month, HML equals the difference between the average returns of the two high-BE/ME stock indices (PMI Value and EMI Value) and the average returns of the two low-BE/ME stock indices (PMI Growth and EMI Growth).

Similar to Carhart (1997), I create a country momentum factor in which countries are sorted and classified into quartiles based on prior year 12-month (October – September) country index rate of return. UMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices (quartile 4) and short prior worst performing country indices (quartile 1).

The four-factor model measures performance as measured by systematic risk. I also examine total-risk adjusted performance with the Sharpe (1966) ratio,

$$SHP_{i,t} = (\overline{R}_i - \overline{R}_f) / \sigma_i. \qquad (27)$$

The $\overline{R}_i$ is the average country portfolio return and the $\overline{R}_f$ is the average U.S. Treasury bill rate. The Jobson-Korkie (1981) *Z*-statistic tests differences between Sharpe measures and the BMI Global Broad Market index (M),

$$Z = \frac{\overline{R}_i s_M - \overline{R}_M s_i}{\sqrt{\theta}}, \qquad (28)$$

where $\theta = \frac{1}{T}\left[2s_i^2 s_M^2 - 2s_i s_M s_{iM} + \frac{1}{2}\overline{R}_i^2 s_M^2 + \frac{1}{2}\overline{R}_M^2 s_i^2 - \frac{\overline{R}_i \overline{R}_M}{2s_i s_M}(s_{iM}^2 + s_i^2 s_M^2)\right]$. $\overline{R}_i$ and $\overline{R}_M$ are average respective excess returns on portfolio i and M, s_i and s_M are the respective standard deviations of returns on series i and M, and s_{iM} is the estimated return covariance between index i and the market index.

A priori, I expect the independent market portfolios to perform well (significant positive intercepts) while the cointegrated market portfolios perform poorly (significant negative intercepts).

1.5.4 Intertemporal Analysis

Tests of performance of mutual funds over varying market conditions have been prominent in the literature dating to the 1960s (e.g., Treynor and Mazuy 1966, Fabozzi and Francis 1977, 1979, Alexander and Stover 1980, Veit and Cheney 1982, Chang and Lewellen 1984, Henriksson 1984). Performance tests in this study are reconducted during periods of rising and declining markets to compare and contrast the performance of the independent and cointegrated portfolios in different market conditions. Rising (declining) markets are defined collectively as months in which the broad market index risk premium rose (declined), as specified by Fabozzi and Francis (1977, 1979) and Gallo, Lockwood and Rodriguez (2006). This procedure yields a mutually exclusive division of the total sample into rising (n = 119) and declining (n = 73) market sample subsets.

1.5.5 Attribution Analysis

1.5.5.1 Portfolio Risk Decomposition

I perform tests that decompose the risks of the portfolios that are subsequently compared statistically across portfolios. The portfolio risks employ a version of the two-pass tests of Fama and MacBeth (1973) to compute portfolio risk components. Using the first 60 monthly observations (October 1990 – September 1995), the returns of the independent and cointegrated portfolios are each regressed against the four-factor model. The country (industrial) portfolios use the country (industrial group) momentum variable as the fourth factor. For each portfolio, I record the intercept, R_m, SMB, HML, CUMD or IGUMD slope coefficients, mean square error (MSE), and standard deviation (SD) of returns for October 1995. The slope of R_m, MSE, and SD measures reflect systematic (market), unsystematic, and total risks, respectively. I then roll the 60-observation regression forward one month and compute the risk coefficients for the next month (November, 1995). Continuing the process, I ultimately have a cross-sectional time series of 132 coefficients for each risk measure over the period October 1995 through September 2006. The time series of coefficients are then compared with two sample t-tests between portfolios to assess differences in diversification profiles.

1.5.5.2 Comparison of Portfolio Diversification Determinants

Country diversification produces important gains [Heston and Rouwenhorst (1994), Hamelink, Harasty and Hillion (2001)] but recent studies suggest industrial sectors provide larger relative diversification benefits [Baca, Garbe and Weiss (2000), Cavaglia, Brightman and Aked (2000), Brooks and Del Negro (2002), L'Her, Sy and

Tnani (2002), Carrieri, Errunza and Sarkissian (2004)]. The two-pass total, systematic, and unsystematic risk coefficients afford an opportunity to compare the diversification gains provided by country and industrial sector allocation. The time series of risk coefficients of the country and industrial sector portfolios, within both the independent and cointegrated sets, are compared with t-tests to evaluate relative diversification gains of country and industrial sectors.

1.5.5.3 Institutional Flow Tests

Lee, Shleifer, and Thaler (1991) provide a model by which common factors are induced by traders such as institutional investors [Cohen, Gompers, and Vuolteenaho (2002), Gompers and Metrick, (2001), Goetzmann and Massa (2003), and Warther (1995)]. For example, Gallo, Phengpis and Swanson (2008) find a trading induced factor that explains, in part, the relationship among and between the cointegrated and the independent domestic equity styles.

I use monthly changes in money market mutual fund (MMMF) balances to proxy investor class fund flows. Monthly changes in MMMFs provide a snapshot of fund flows since money market funds are a liquidity source and a primary vehicle for funds awaiting reinvestment. The institutional MMMF data, collected by the Investment Company Institute (ICI) and provided to the Federal Reserve Board, is comprised of deposits greater than $100,000.[15]

[15] Retail flows for deposits less than $100,000 are also computed by the ICI. Retail MMMFs are included in M2; institutional MMMFs are included in M3. See http://www.stls.frb.org/fred/index.html for more information.

Three sets of tests are conducted to examine the influence of institutional flows on the global portfolios. First, I regress the independent and cointegrated portfolios on a five-factor model that adds the institutional flow series, INST, to the four-factor model,

$$R_{pt} = a_{i0} + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}INST_t + \upsilon_t \tag{29}$$

A significant INST coefficient indicates the influence of institutional flows on country and industrial style portfolio performance. Particular emphasis is placed on differences in the INST coefficient between the independent and cointegrated portfolios within the country and industrial sector portfolio sets.

Second, Barberis and Shleifer (2003) postulate that subsets of securities group on the basis of common factors. I use canonical correlation analysis to investigate differences between the independent and cointegrated indices. Canonical correlation is a multivariate technique that determines independent dimensions, or interrelationships, between sets of dependent and independent variables. The process produces multiple functions, or dimensions, that maximize the correlation between linear composites, or canonical variates, of the sets of dependent and independent variables. The general form of canonical analysis is specified as $Y[y_1, y_2, \ldots, y_n] = X[x_1, x_2, \ldots, x_m]$ where n (m) is the number of indices in the Y (X) vector (Hamilton, 1994). Canonical correlation decomposes the matrix,

$$C = R^{-1}_{yy'} R_{yx'} R^{-1}_{xx'} R_{xy} = U'\Lambda B \tag{30}$$

where the R are the returns for the cointegrated and independent index vectors and the diagonal matrix Λ contains the eigenvalues of C. A set of canonical coefficients (B) is produced for both the independent and dependent variables, defined as,

$$B_y = R^{-1/2}_{yy}\, B \tag{31}$$

$$B_x = \Lambda\, R^{-1}_{xx}\, R_{xy}\, B_y \tag{32}$$

that maximize the correlations between the indices in the independent and cointegrated groups. After computing the canonical correlation coefficients, I save the canonical variates for the independent ($u = B_y'Y$) and cointegrated ($v = B_x'X$) index vectors, for each dimension. For instance, u_1 and v_1 is a pair of canonical variates in the first function while u_2 and v_2 represent a pair of canonical variates in the second function. Under function i, the difference between two set of indices are calculated as $diff_i = u_i - v_i$. I propose the cumulative variance under n dimensions is computed as a mean square variance (MSV):

$$\text{MSV} = \frac{\sum_{i}^{n} (u_i - v_i)^2}{n} \tag{33}$$

I then regress MSVs derived at both the country ($MSV_{Country}$) and industrial sector (MSV_{Sector}) levels against the five-factor model to further compare the influence of institutional trading on independent and cointegrated portfolios.

Third, I analyze the cointegrated vector (CIV) residuals to examine whether institutional flows contributing to the long run cointegration equilibrium. The CIV residual, or deviation from long-run cointegration equilibrium is a stationary $I(0)$ process. Any deviation from long-run cointegration equilibrium will be corrected toward the equilibrium relation if a cointegration vector holds. The CIV residuals from each cointegrated vector, in both the country and industrial sets, are regressed on the five-factor model. A significant INST coefficient indicates an institutional trading contribution to cointegrating relations.

1.6 Empirical Results

1.6.1 Diversification at Country-level

Computational limitations prevent a direct cointegration test on the time series of all 21 country indices.[16] Therefore, I classify country indices into four geographical regions: North America (NA: US and Canada), Asian Pacific (AP: Japan, Singapore, Hong Kong, New Zealand, Australia) and Europe which is divided into EMU countries (EMU: Germany, Frances, Italy, Austria, Finland, Spain, Belgium, Netherlands, and Ireland) and non-EMU nations (NEMU: U.K., Norway, Denmark, Switzerland, and Sweden).[17] S&P/Citigroup GEI regional indices are available for the North American, EMU and Asian Pacific regions. However, since the EMU was not formally operational until 1999, I construct equally weighted indices of the EMU and non-EMU countries to use for full-period regional tests. Descriptive statistics of all country indices are presented in Table 1.1. Panel A of Table 1.1 contains country market returns while the industry return summaries, respectively, are provided in Panels B and C of Table 1.1.

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[16] The sample has a finite 192 observations. The 21 country time series plus their lags can consume almost half of the degrees of freedom, depending on lag length. The reduced degrees of freedom lower the power of the cointegration tests and increase sample size distortion.

[17] Similar regional definitions were employed by Baumol (1986), Chatterji and Dewhurst (1996), Quah (1996, 1997) Barro and Sala-i-Martin (1991, 1992), and Nahar and Inder (2002). Hardouvelis, Malliaropulos and Priestley (2006), Danthine, Giavazzi and Thadden (2000), Fratzscher (2002) and Bartram, Taylor and Wang (2007) all document different rates of integration between EMU and non-EMU countries.

Initial cointegration tests are performed to affirm the rationale of my regional classification. The inter-regional cointegration results are provided in Table 1.2. Panel A displays unit root test results and Panel B presents cointegration rank test results for the regional indices.

Cointegration refers to a linear combination of nonstationary variables. Insignificant Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Zivot-Andrews (ZA) test statistics in Panel A on all the regional indices fail to reject the hypothesis of a unit root, so each region has a unit root representation in price level and is nonstationary. Unit root tests merit the implementation of cointegration analysis to detect long-run equilibria among these non-stationary indices. Panel B evidences no significant CIVs (r=0) among four regional data series based on the Johansen Trace (57.62) and Bartlett Trace (57.04) statistics when compared to a 5% critical Trace value of 63.65. In sum, Table 1.2 suggests the four regional market indices possess heterogeneous risk characteristics with unequal long run expected returns. Thus, each region contributes to a diversified global portfolio. These results also affirm the rationale of my regional classification.

1.6.1.1 Unit Root Test on Country Level Indices

Intra-regional tests are performed on the countries within each region. The intra-regional unit root tests results are presented in Table 1.3. The intra-regional DF, ADF and ZA test statistics are all insignificant, indicative of unit roots present in each region.

1.6.1.2 Cointegration Test on Country Indices

I perform cointegration tests on the country indices within each region to identify intra-regional independent countries. Intra-regional country cointegration test results are provided in Table 1.4. Every region except North America has a significant G(r) test statistic [$G(r)_{AP}$ = 16.72 $G(r)_{EMU}$ = 8.31, $G(r)_{NEMU}$ = 5.83] suggesting the existence of a linear trend component in each regional cointegrating equilibrium model. AP, EMU, and NEMU regions all have significant CIVs ($\lambda_{trace,AP}$ = 104.57, $\lambda_{trace,EMU}$ = 240.02, $\lambda_{trace,NEMU}$ = 114.36), further confirmed by more conservative Bartlett Trace test statistics. Notably, the NA CIV is not statistically significant ($\lambda_{trace,NA}$ = 16.88).

Exclusion tests in Table 1.5 identify countries independent of (excluded from) regional CIVs. Countries with insignificant likelihood-ratio (L-R) test statistics at 5% level are independent of a CIV. Since North America has no significant CIV, exclusion tests are not performed on that region.

Results in Table 1.5 show Japan ($L\text{-}R_{JA}$ = 19.45) and Singapore ($L\text{-}R_{SI}$ = 17.01) cointegrated within the AP regional CIV. In contrast, insignificant test statistics for Australia ($L\text{-}R_{AU}$ = 0.05), Hong Kong ($L\text{-}R_{HK}$ = 0.14), and New Zealand ($L\text{-}R_{NZ}$ = 0.05) affirm their regional independence and need for representation in a diversified global portfolio.

In Europe, the non-EMU regional tests indicate Norway ($L\text{-}R_{NW}$ = 5.06), U.K. ($L\text{-}R_{UK}$ = 14.06), and Denmark ($L\text{-}R_{DM}$ = 10.00) are cointegrated while Sweden ($L\text{-}R_{SW}$ = 3.47) and Switzerland ($L\text{-}R_{SZ}$ = 0.05) are independent countries that provide diversifying benefits.[18] The EMU regional tests show cointegration among the Austria ($L\text{-}R_{AS}$ = 6.13), France ($L\text{-}R_{FR}$ = 6.31), Germany ($L\text{-}R_{GE}$ = 8.47), Italy ($L\text{-}R_{IT}$ = 6.92), and Finland ($L\text{-}R_{FI}$ = 8.31) markets. Hence, the independent Netherlands ($L\text{-}R_{NL}$ = 0.04), Spain ($L\text{-}R_{SP}$ = 0.84), Ireland ($L\text{-}R_{IR}$ = 0.30), and Belgium ($L\text{-}R_{BE}$ = 2.88) market indices will be portfolio representatives from the EMU region.

A graphical demonstration of country price levels for each region is shown in Figure 1.4. As seen, the plots for the cointegrated countries (either fully integrated or converging) move in tandem, consistent with cointegration test results. The independent country plots wander arbitrarily.

I run inter-regional cointegration test on the independent countries to further validate the regional classification. Independent countries should also not cointegrate across regions. As shown in Table 1.6, no independent country has a significant Trace or Bartlett Trace test statistic. Thus, the independent countries are cointegrated neither within nor among regions, further reflecting their diversifying properties.

1.6.1.3 Comparative Portfolio Diversification

Gallo, Phengpis and Swanson (2007) show portfolios of independent U.S. equity styles are better diversified than cointegrated style portfolios. I create equally-weighted portfolios, at both the regional and global level, of independent (CINDE) and cointegrated (CCOINT) countries to compare the risk return profiles of the two

[18] Sweden has a L-R statistic of 3.47 that is not significant at 5% level. However, a less conservative 10% level will suggest Sweden included. I therefore run a second step cointegration rank test among only UK, NW, DE and SW. Second step test result supports the exclusion of Sweden from the system and a cointegrating relation is found only among UK, NW and DE.

groups.[19] Total risk-adjusted portfolio performance test results are provided in Table 1.7. Although each regional independent portfolio has a higher Sharpe (SHP) ratio than its cointegrated counterpart, no regional Jobson-Korkie Z-statistics are significant against the BMI global market proxy. And only the Asian Pacific regional CINDE ($SHP_{AP,INDE}$ = 0.17, Z-statistic = 2.14) portfolio enjoyed regional superior performance over the CCOINT portfolio. The global CINDE portfolio ($SHP_{GLB,INDE}$ = 0.21, Z-statistic = 1.83), however, outperformed the BMI global benchmark. The superior global CINDE performance was produced by a combination of higher return and lower risk. The global CINDE also outperformed the global CCOINT ($SHP_{GLB,INDE}$ = 0.21, $SHP_{GLB,COINT}$ = 0.15, Z-statistic = 1.96). In sum, the independent portfolio also outperformed the cointegrated portfolio. The superior global performance of the CINDE portfolios evinces the potential benefits of effective global diversification.

Systematic risk-adjusted performance of the portfolios is assessed with the four-factor model. At the global and regional levels, I also create a zero-cost portfolio, CHEDGE, long the CINDE countries and short the CCOINT countries (CINDE – DCOINT). CHEDGE measures a risk premium for independent countries. Table 1.8 summarizes the four-factor performance of the portfolios.

The four-factor performance directly mirrors the implications of the Sharpe ratios. Intercepts are consistently higher for the CINDE portfolios at both the regional and global levels. Again, the only intra-regional significant performance difference is in

[19] Value-weighted strategies do not change our conclusions appreciably. Value-weighted portfolios results are reported in Appendix C.

the Asian Pacific region ($a_{CHEDGE,AP}$ = 0.62 percent, t-statistic = 2.10). And at the global level, the CINDE portfolio outperformed the model benchmark ($a_{CINDE,GLB}$ = 0.24 percent, t-statistic = 1.91) and the global COINT portfolio ($a_{CHEDGE,GLB}$ = 0.24 percent, t-statistic = 1.90). Thus, the systematic risk-adjusted superior performance of the independent countries further attests to the diversification benefits of global independent country diversification.

1.6.1.4 Market Varying Portfolio Performance

The correlation of global markets has been shown to increase during declining markets [Butler and Joaquin (2002), Campbell, Koedijk and Kofman (2002)]. Hence, global diversification has failed when diversifcation benefits are most needed. I perform intertemporal tests to ascertain the extent to which the superior performance of the INDE portfolio is an artifact of either rising or declining markets. Defining a rising (declining) market as one in which the BMI global market proxy increased (declined), I create two time series of 119 rising market returns and 73 declining market returns. I repeat the four-factor-model test on the two separate time series.

Table 1.9 summarizes the return and risk of the CINDE and CCOINT portfolios in both types of markets. Consistent with full period results, the CINDE portfolios superior performance is earned during periods of rising markets when CINDE had higher returns and lower risk at both the regional and global levels. Notably, the CINDE portfolios generally had higher risk, both total and systematic, during declining markets. For example, the total volatility of the global INDE portfolio ($r_{CINDE,DOWN}$ = -2.72 percent, $\sigma_{CINDE,DOWN}$ = 3.30 percent, $b_{1,CINDE,GLB,DOWN}$ = 1.05) slightly exceeded that of the COINT portfolio ($r_{CCOINT,DOWN}$ = -2.95 percent, $\sigma_{CCOINT,DOWN}$ = 3.19 percent, $b_{1,CCOINT,DOWN}$ = 1.01) in declining market months.

Table 1.10 presents four-factor performance results during the 119 rising months. Results are substantively identical to those of the full period as regional and global INDE intercepts are consistently higher than the COINT portfolio coefficients. Asia Pacific is the only region with significant performance difference ($a_{CHEDGE,AP,UP}$ = 1.80 percent, t-statistic = 2.70). The global CINDE portfolio also outperformed the market proxy ($a_{CINDE,GLB,UP}$ = 0.50 percent, t-statistic = 2.01) and the global CCOINT portfolio ($a_{CHEDGE,GLB,UP}$ = 0.87 percent, t-statistic = 3.15). In essence, the superior relative total period performance of the CINDE country portfolio was derived from rising markets.

The four-factor performance comparison of the portfolios in declining markets is presented in Table 1.11. The intercept of the CINDE portfolio is still higher at the global level and is also higher for most regions (the EMU is the exception). However, the performance differential at all levels is statistically insignificant. Thus, I conclude the superior performance of the CINDE strategy is largely produced during rising markets.

1.6.2 Diversification at Industrial Sector level

S&P/Citigroup stocks are also classified by the Global Industry Classification Standard (GICS®) industry classification structure. The indices provide geographic and economic balance across the 10 GICS Sectors. These sectors, now consistent across all Standard & Poors indices, are Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Information Technology, Materials, Telecommunication Services and Utilities. The GICS sectors are further decomposed into 24 industry groups. Summary statistics of all sector and industry group indices are presented in Panel B of Table 1.1. A graphical demonstration of country price levels for each industry sector is shown in Figure 1.5.

1.6.2.1 Cointegration Tests on Sector Level Indices

Cointegration tests are performed on the sector indices using the methodology applied to the country indices. First Panel A of Table 1.12 displays unit root test results for both 10 sectors. The sector cointegration results are provided in Panel B which presents cointegration rank test and exclusion test results for the 10 sector indices is displayed in Panel C.

The unit root tests fail to reject the hypothesis of a unit root, so the sector indices have unit root representation in price level and are nonstationary. The sector DF, ADF and ZA test statistics are all insignificant, indicative of unit roots present in the sector indices. Thus, sector rank and exclusion tests are warranted. The results of the sector cointegration rank tests, presented in Panel B of Table 1.12, indicates no more than two significant CIVs ($r = 2$) among the 10 sector data series based on the Johansen Trace (227.56) and more conservative Bartlett Trace (149.28) statistics when compared to a 5% critical Trace value of 188.74. The two significant CIVs are also along with significant G(r) test statistics [$G(r)_0 = 3.36$, $G(r)1 = 19.44$] which suggest a linear trend component is not eliminated by cointegrating relation.

I perform cointegration exclusion tests on the sector indices to identify sectors independent of the cointegrated sector vectors. Sectors with insignificant likelihood-ratio (L-R) test statistics at 5% level are independent of a CIV. Sector exclusion test results are provided in Panel C of Table 1.12.

Exclusion tests show the financial (FINA: $L\text{-}R_1 = 0.09$, $L\text{-}R_2 = 0.94$), consumer staple (CONS: $L\text{-}R_1 = 0.08$, $L\text{-}R_2 = 0.85$), and health care (HEAL: $L\text{-}R_1 = 0.25$, $L\text{-}R_2 = 0.43$) are independent of both cointegrated vectors. The other seven vectors share, to some extent, a common trend. The consumer discretionary (COND: $L\text{-}R_1 = 5.09$), energy (ENER: $L\text{-}R_1 = 5.15$), industrials (INDU: $L\text{-}R_1 = 4.67$), and materials (MATE: $L\text{-}R_1 = 4.95$), are cointegrated within the first vector. The three remaining sectors, information technology (INFO: $L\text{-}R_1 = 3.78$, $L\text{-}R_2 = 17.20$), telecommunications (TELE: $L\text{-}R_1 = 2.96$, $L\text{-}R_2 = 15.66$), and (UTIL: $L\text{-}R_1 = 1.18$, $L\text{-}R_2 = 13.18$), share the trend of only the second CIV.[20]

Similar to a country impact on the regional level, a cointegrated sector could be the artifact of undue influence by a particular industrial component of the sector. Therefore, I conduct cointegration tests on the 15 industrial groups that, in total, comprise the seven cointegrated sectors. Notably, four sectors (energy, materials, telecommunications, and utilities) have only one industry group making the sector and

[20] L-R test with 1 degree of freedom (DGF=1) shows the possible cointegration components in the first cointegration vector. L-R test with 2 degree of freedom (DGF=2) performs a joint test which shows all the possible cointegration components in all cointegration vectors. Therefore, significant components in the first cointegration vectors are also shown significant in the L-R test with DGF=2.

group one in the same. The industry group cointegration test results are provided in Table 1.13.

The industry group unit root tests, shown in Panel A, produce insignificant DF, ADF and ZA test statistics for 15 indices, indicative of unit roots present in the industry groups of the cointegrated sectors. The subsequent industry group cointegration rank test results, presented in Panel B, reveal two significant CIVs (r = 2) based on the Johansen Trace (424.14) and Bartlett Trace (371.66) statistics.

Industry group exclusion test results are presented in Panel C of Table 1.13. Findings show the retail (RETA: $L\text{-}R_1 = 0.33$ $L\text{-}R_2 = 3.19$) and semiconductor (SESE: $L\text{-}R_1 = 1.83$, $L\text{-}R_2 = 4.97$) industry groups independent of both cointegrated vectors. The other thirteen industry groups share, to some extent, a common trend. However, these exclusion tests may suffer from an insufficient degree of freedom problem, as demonstrated above, so the pool of 15 series based on 192 observations may not be statistically reliable or valid. To assess the exclusion test validity, I perform separate cointegration tests on the industry groups of each the three cointegrated sectors with more than one industry group component: consumer discretionary (n=5), industrials (n=3) and information technology (n=3). Robustness test results for the consumer discretionary (Panels A and B), information technology (Panels C and D) and industrials (Panels E and F) are provided in Table 1.14.

Panel A of Table 1.14 shows two significant cointegration vectors in the consumer discretionary (COND) industry groups (r = 2, Bartlett Trace = 31.78) while Panel B indicates only the retailing industry group, RETA, is independent of the cointegrated vectors from the rest of the consumer discretionary groups (RETA: L-R_1 = 0.57 L-R_2 = 0.65). Within the information technology (INFO) sector, there is one CIV (Panel C: r = 1, Bartlett Trace = 13.15) of which only the semiconductor (SESE) industry group is independent (SESE: L-R_1 = 1.51, L-R_2 = 0.22), as displayed in Panel D. The capital goods sector has one cointegrated vector (Panel E: r = 1, Bartlett Trace = 23.04) to which all three industry group components are related (Panel F).

In sum, the joint cointegration tests suggest the independent retailing and semiconductor industry groups should be components of independent portfolios. To verify, I perform cointegration tests on all the independent sectors (n=3) and industry groups (n=2). Independent series cointegration rank test results, presented in Table 1.15, confirm there is no cointegrating relationship (r = 0, Bartlett Trace = 61.98) among the five independent series.

1.6.2.2 Sector Portfolio Performance

The cointegration rank and exclusion tests suggest the composition of industrial portfolios categorized by independent and cointegrated industrial series. IGINDE is an equally-weighted portfolio of the 11 independent industry groups [RETA, SESE, and the groups of the independent financial (n=4), health care (n= 2) and consumer staples (n=3) series]. The equally weighted cointegrated industrial portfolio, IGCOINT, is comprised of the cointegrated industry groups in the consumer discretionary (n=3), energy (n=1), materials (n=1), industrials (n=3), information technology (n=3), telecommunications (n=1), and utilities (n=1) sectors. Results of four-factor model industrial portfolio performance tests are presented in Table 1.16.

As measured by total risk, the IGINDE industrial portfolio (SHP_{IGINDE} = 0.23) performed significantly better than the global benchmark (SHP_{BMI} = 0.16, Z-statistic = 2.72) and the IGCOINT portfolio ($SHP_{IGCOINT}$ = 0.15, Z-statistic = 2.21). Systematic risk-adjusted performance of the portfolios is then examined with a four-factor model that replaces the country momentum factor in the four-factor model (equation 26) with an industry group momentum factor (IGUMD) constructed from the S&P/Citigroup industry group indices in the same manner as the CUMD. A zero-cost portfolio, IGHEDGE, long the IGINDE industrial groups and short the IGCOINT groups (IGINDE – IGCOINT) is also created. IGHEDGE measures a risk premium for independent industrial groups. Table 1.17 summarizes the four-factor performance of the portfolios.

The four-factor performance tests reflect those implied by the Sharpe ratios. The intercept on the IGINDE portfolio is significant and positive ($a_{,IGINDE}$ = 0.30 percent, t-statistic = 2.97) as is that on the hedge portfolio ($a_{IGHEDGE}$ = 0.30 percent, t-statistic = 2.17). Thus, the IGINDE portfolio performance was superior to the benchmark and to the IGCOINT portfolio ($a_{IGCOINT}$ = 0.00 percent, t-statistic = -0.13) that matched the performance of the market proxy. Thus, the systematic risk-adjusted superior performance of the independent industrial groups illustrates the diversification benefits of global independent industrial sector diversification.

Similar to the country portfolio tests, I examine industrial portfolio performance in varying market conditions. Results for rising markets, contained in Panel B of Table 1.18, show the IGINDE (a_{IGINDE} = 0.10 percent, t-statistic = 0.30), IGCOINT ($a_{IGCOINT}$ =

0.10 percent, t-statistic = 0.57) and hedge ($a_{IGHEDGE}$ = -0.00 percent, t-statistic = -0.10) portfolios were unable to outperform the market benchmark. In contrast, the IGINDE portfolio performed well during declining months, Panel C, ($a_{IGCOINT}$ = 0.40 percent, t-statistic = 1.84) while the other portfolios maintained market comparable performance. I therefore conclude that the superior performance of the IGINDE strategy is generated in declining markets, directly counter to the CINDE country portfolio findings.

1.6.3 Combined Country and Sector Portfolio Performance

The independent country portfolio performance was pronounced in rising markets while the industrial independent portfolio performed best in declining markets. I created equally weighted portfolios that combine all the independent countries and industrial groups (INDE, n = 22) to examine the combined effects of country and sector diversification. A similar combined portfolio is created for the combined cointegrated countries markets and industrial groups (COINT, n = 23). The combined portfolios are evaluated with a five-factor model that includes country and industry group momentum factors. The combined performance summary is presented in Table 1.19.

The collective effects of country and sector diversification are illustrated by the superior performance of the INDE and hedge portfolios over the full period (a_{INDE} = 0.30 percent, t-statistic = 3.30; a_{HEDGE} = 0.30 percent, t-statistic = 2.68). Importantly, the combined INDE portfolio performance was invariant to market conditions, performing well in months when the market rose ($a_{INDE,RISING}$ = 0.30 percent, t-statistic = 1.75; $a_{HEDGE,RISING}$ = 0.40 percent, t-statistic = 1.85) as well as declining months ($a_{INDE,DECLINING}$ = 0.40 percent, t-statistic = 2.15; $a_{HEDGE, DECLINING}$ = 0.44 percent, t-statistic = 1.87). The combined COINT portfolio simply matched the market proxy in each period. These results indicate the significant contributions of both country and sector allocations in global portfolio diversification.

1.6.4 Portfolio Attribution Tests

Portfolio performance tests indicate independent countries and sectors perform better, on a risk-adjusted basis, than their cointegrated counterparts. To assess differences in diversifying properties between the portfolios I conduct two sets of attribution tests. In the first set I decompose the total risk of the portfolios into their systematic (market coefficient) and unsystematic (mean squared error) components that are subsequently compared statistically within the independent and cointegrated sets at both the country and industrial sector levels. The second set of tests examines the influence of institutional trading on the portfolios. One, I add an institutional flows variable to the performance model. Two, I use canonical variates extracted from the independent and cointegrated index sets to assess any heterogeneity in institutional flows between the independent and cointegrated portfolios. Third, I conduct homogeneity test on the cointegrated vector residuals to identify whether institutional flows contribute to cointegrating relations.[21]

The portfolio risk decomposition tests employ a two-pass version of the Fama-MacBeth (1973) to compute risk components. Using the first 60 monthly observations

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[21] As described by Engle and Granger (1987), the CIV of the property market indices, I_{it}, takes a long-run equilibrium form $\beta_1^* I_{1t} + \beta_2^* I_{2t} + \ldots + \beta_n^* I_{nt} + \delta * D = 0$, where $I_{1t} \ldots I_{nt}$ are market indices price levels, $\beta_1 \ldots \beta_n$ are the Eigenvector coefficients and D is the deterministic component (i.e., constant, linear time trend, etc). The CIV residual, or deviation from long-run equilibrium is a $I(0)$ process which is equal to β^* I_t where β and I_t denote the vectors $(\beta_1, \beta_2, \ldots, \beta_n)$ and $(I_{1t}, I_{2t}, \ldots, I_{nt})$' respectively.

(October 1990 – September 1995), the returns of the independent and cointegrated portfolios are each regressed against the four-factor model. The country (industrial) portfolios use the country (industrial group) momentum variable as the fourth factor. For each portfolio, I record the intercept, R_m, SMB, HML, CUMD or IGUMD slope coefficients, mean square error (MSE), and standard deviation (SD) of returns for October 1995. The slope of R_m, MSE, and S.D. measures reflect systematic (market), unsystematic, and total risks, respectively. I then roll the 60-observation regression forward one month and compute the risk coefficients for the next month (November, 1995). Continuing the process, I ultimately have a cross-sectional time series of 132 coefficients for each risk measure over the period October 1995 through September 2006. The time series of coefficients are then compared with two sample t-tests between portfolios to assess differences in diversification profiles. The risk decomposition test results are presented in Table 1.20.

Findings in Panel A show the superior relative performance advantage of the country independent portfolios (a_{CINDE} = 0.186 percent, a_{CCOINT} = 0.044 percent, t –statistic = 8.67) was attained with lower levels of systematic ($b_{1,CINDE}$ = 1.056, $b_{1,CCOINT}$ = 1.069, t –statistic = -2.43), unsystematic (MSE_{CINDE} = 0.00028, MSE_{CCOINT} = 0.00033 , t-statistic = -10.81), and total (SD_{CCNDE} = 0.044 , SD_{CCOINT} = 0.045, t-statistic = -7.18) risks. These findings are further evidence independent countries provide greater diversification gains than cointegrated countries.

As shown in Panel B, the independent industrial relative portfolio performance advantage (a_{IGINDE} = 0.188 percent, $a_{IGCOINT}$ = 0.002 percent, t –statistic = 14.65) was also earned with lower systematic ($b_{1,IGINDE}$ =0.922 , $b_{1,IGCOINT}$ = 1.106, t –statistic = -12.20) and total risk (SD_{IGCNDE} = 0.037, $SD_{IGCOINT}$ = 0.042, t-statistic = -9.89). Surprisingly, the unsystematic risk of the independent industrial portfolios, although much lower than the country counterpart, was higher than that of the industrial cointegrated portfolio (MSE_{CINDE} = 0.00009, MSE_{CCOINT} = 0.00007 , t-statistic = 12.96). Thus, even though independent industrial sector portfolios have less risk than their cointegrated counterparts, they are less diversified.

As expected, the collective benefits of country and industrial sector allocation enhance the performance of the combined independent portfolio with lower systematic and unsystematic risk (Panel C). The combined INDE had better performance (a_{INDE} = 0.188 percent, a_{COINT} = 0.038 percent, t –statistic = 16.59) with less risk at the total (SD_{INDE} = 0.039 , SD_{COINT} = 0.042, t-statistic = -12.01), systematic ($b_{1,INDE}$ = 0.988, $b_{1,CCOINT}$ = 1.040, t –statistic = -9.47), and unsystematic (MSE_{INDE} = 0.00010, MSE_{COINT} = 0.00011 , t-statistic = -4.83) levels. Collectively, the combined INDE portfolio reflects less risk at every level and better performance than the COINT counterpart.

The diversifying power of the country and industrial sector allocations is then compared with t-tests on the series of risk coefficients within the independent and cointegrated portfolio sets. Results are presented in Table 1.21.

Findings show industrial sector portfolio risk is lower than that of the country portfolios in both the independent and cointegrated index sets. For the independent portfolios, the industrial portfolios reflect lower total (SD_{CINDE} = 0.04428 , SD_{IGINDE} =

0.03656, t-statistic = 28.88), systematic ($b_{1,CINDE}$ = 1.05624, $b_{1,IGINDE}$ = 0.92226, t –statistic = 23.43), and unsystematic (MSE_{CINDE} = 0.00028, MSE_{IGINDE} = 0.00009 , t-statistic = 26.02). A similar pattern is shown within the cointegrated set (SD_{CCOINT} = 0.04509, $SD_{IGCOINT}$ = 0.04175, t-statistic = 29.45; $b_{1,COINT}$ = 1.06872, $b_{1,IGCOINT}$ = 1.01636, t –statistic = 10.56; MSE_{CCOINT} = 0.00033, MSE_{ICOINT} = 0.00007 , t-statistic = 11.22). These results are consistent with studies that indicate industrial diversification benefits outweigh those produced by countries [Baca, Garbe and Weiss (2000), Cavaglia, Brightman and Aked (2000), Brooks and Del Negro (2002), L'Her, Sy and Tnani (2002), Carrieri, Errunza and Sarkissian (2004)].

Institutional investor flows have been shown to be an important determinant in return formation [Cohen, Gompers, and Vuolteenaho (2002), Gompers and Metrick, (2001), Goetzmann and Massa (2003), and Warther (1995)] and Gallo, Phengpis and Swanson (2008) find a trading induced factor that explains, in part, the relationship among and between the cointegrated and the independent domestic equity styles. Thus, I conduct three additional tests to examine the role of institutional flows in differentiating independent and cointegrated portfolios and as a contributing factor to cointegrating relations.

First, I add the monthly changes in institutional flows series, INST, to the four-factors and regress the portfolio returns on the five factors. The five-factor models results, provided in Table 1.22, shows institutional flows detract from the performance of the cointegrated country portfolios ($b_{5,CCOINT}$ = -0.141, t-statistic = -2.55) and is significant in differentiating the performance of the country independent and cointegrated portfolios ($b_{5,CHEDGE}$ = 0.124, t-statistic = 2.42). In contrast, at the industrial sector level, the flows enhance the performance of the independent portfolio ($b_{5,IGINDE}$ = 0.082, t-statistic = 2.37) but do not explain differences between the industrial portfolios ($b_{5,IGHEDGE}$ = 0.053, t-statistic = 1.06). When combined, the influence of institutional flows reflects the country results ($b_{5,COINT}$ = -0.056, t-statistic = -1.78; $b_{5,HEDGE}$ = 0.088, t-statistic = 2.26). In sum, there is mixed evidence that institutional flows do impact independent and cointegrated portfolios differently.

I then use canonical variates extracted from the independent and cointegrated index sets to assess heterogeneities between the independent and cointegrated portfolios. I propose the cumulative canonical variance under n dimensions is computed as a mean square variance (MSV) shown in equation (33). The MSV represents the net differences between the pair of independent and cointegrated portfolios at both the country ($MSV_{Country}$) and industrial sector (MSV_{Sector}) levels. I run MSV at each level against the five-factor model that combines the traditional 4 factors with the INST series. Results are shown in Table 1.23.

Panel A indicates the country ($Mean_{MSVCountry}$ = 1.147, $SD_{MSVCountry}$ = 0.690) and industrial sector ($Mean_{MSVSector}$ = 1.154, $SD_{MSVSector}$ = 0.703) canonical vectors share similar characteristics. Findings in Panel B indicate institutional flows contribute to differences in the performance of the independent and cointegrated portfolios at both the country ($b_{5,MSVcountry}$ = 3.481 , t –statistic = 1.67) and industrial sector ($b_{5,MSVsector}$ = 4.273, t –statistic = 2.00). Since the INST coefficient is positive at both levels, institutional flows are beneficial to the independent portfolios to the detriment of the respective cointegrated portfolio. Thus, the canonical tests evidence a role of institutional fund flows in demarcating the performance of the independent and cointegrated portfolio sets.

Finally, I employ the cointegrated vector (CIV) residuals to assess the role of institutional flows in contributing to the long run cointegration equilibrium for all the cointegrated vectors. The CIV residual, or deviation from long-run cointegration equilibrium is a stationary *I*(0) process. Any deviation from long-run cointegration equilibrium will be corrected toward the equilibrium relation if a cointegration vector holds. Table 1.24 presents the results of CIV residuals for each cointigrated vector regressed against the five-factor model.

Although prior tests suggest institutional flows contribute to cointegrating relations, the CIV tests in Table 1.24 show their impact is not consistent across CIV vectors. At the country level, the INST variable is significant only for the non-EMU vector ($b_{5,nonEMU}$ = 309.200, t –statistic = 2.05) and only for the first CIV vector at the industrial sector ($b_{5,IG1}$ = -766.934, t –statistic = -2.54). In sum, the influence of institutional funds as a cointegrating factor does not appear to be pervasive.

1.7 Conclusions

This study provides a comprehensive, simultaneous comparison of the geographical and industrial sector components of developed market global diversification. This paper examines global equity diversification benefits provided by 21 developed countries, 10 industry sectors with 24 industry subgroups over the 1990-2006 periods. First, this study bridges the theory between the cointegration methodology and diversification. Second, the cointegration methodology is employed to evaluate interrelationships among the components of diversification (e.g., Johansen, 1988, 1991). Cointegration can dissect and measure the contributions of the geographical and industrial sector components of international portfolio diversification. For each diversification determinant (country and sector), I find a portfolio of global markets independent from cointegrating relationships performs better during the period. I contend the high long run within-vector correlations of cointegrated assets make them redundant diversifiers. In contrast, global diversification gains are largely produced by less correlated markets independent of cointegrating relationships. Third, this study analyzes the combined effects of the two dimensions of diversification during varying periods and trends of market performance. I find the relative performance superiority of the country independent portfolio was derived from rising markets while that of an independent sector portfolio is generated in declining markets. Jointly, independent portfolios diversified across countries and industrial sectors have even better performance that is largely invariant to market conditions.

Fourth, risk decomposition tests show country and sector allocations both contribute to independent market portfolio gains, although the diversification determinants have differential impact on the components of portfolio risk. Additional tests affirm sector decisions provide stronger diversification gains than country allocation decisions. Finally, tests suggest institutional fund flows help differentiate the performance of the independent and cointegrated portfolios. Mixed evidence also suggests institutional flows may contribute to cointegrating relations although the effect is not pervasive.

The results of this study are important for both academic researchers and investment practitioners, particularly institutional investors. My results document the deterioration of global diversification benefits that result from increased market convergence. Studies examining the impact of the rate of market convergence on portfolio diversification and extending the analysis to emerging markets are fruitful areas of future academic research. Practitioners should emphasize markets independent of cointegrating relationships that mitigate diversifying benefits. Investors should also emphasize industrial sector allocation over the country decision. My strategy reduces the range of equity market allocations, improves portfolio performance, and reduces market search/monitoring costs. This strategy should be particularly attractive to institutional investors who are acutely aware of the importance of fund cost containment in an increasingly sluggish market environment.[22]

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[22] Remarks by John C. Bogle, Founder and Former Chairman, The Vanguard Group Before the 25th Annual Conference of The Association of Investment Management Sales Executives Boca Raton, FL, April 29, 2002

APPENDIX A

FIGURES AND TABLES

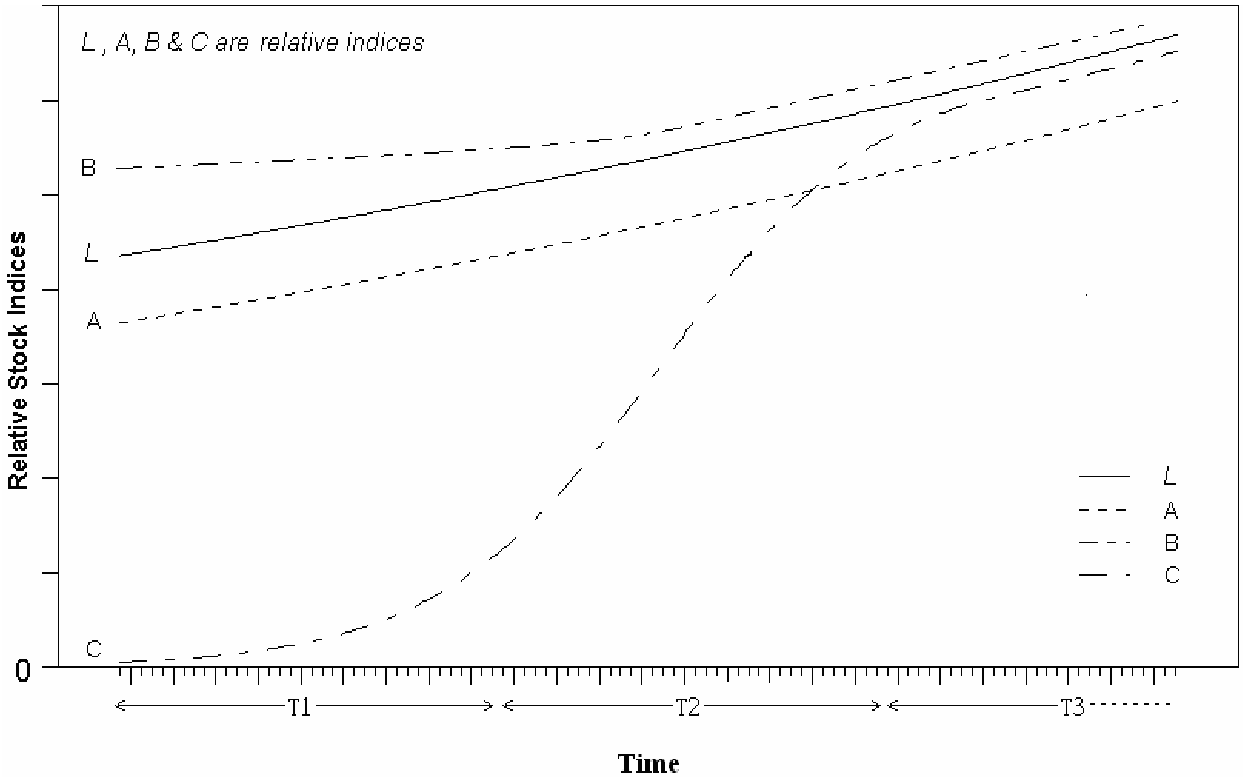

Figure 1.1 Long Run Convergences

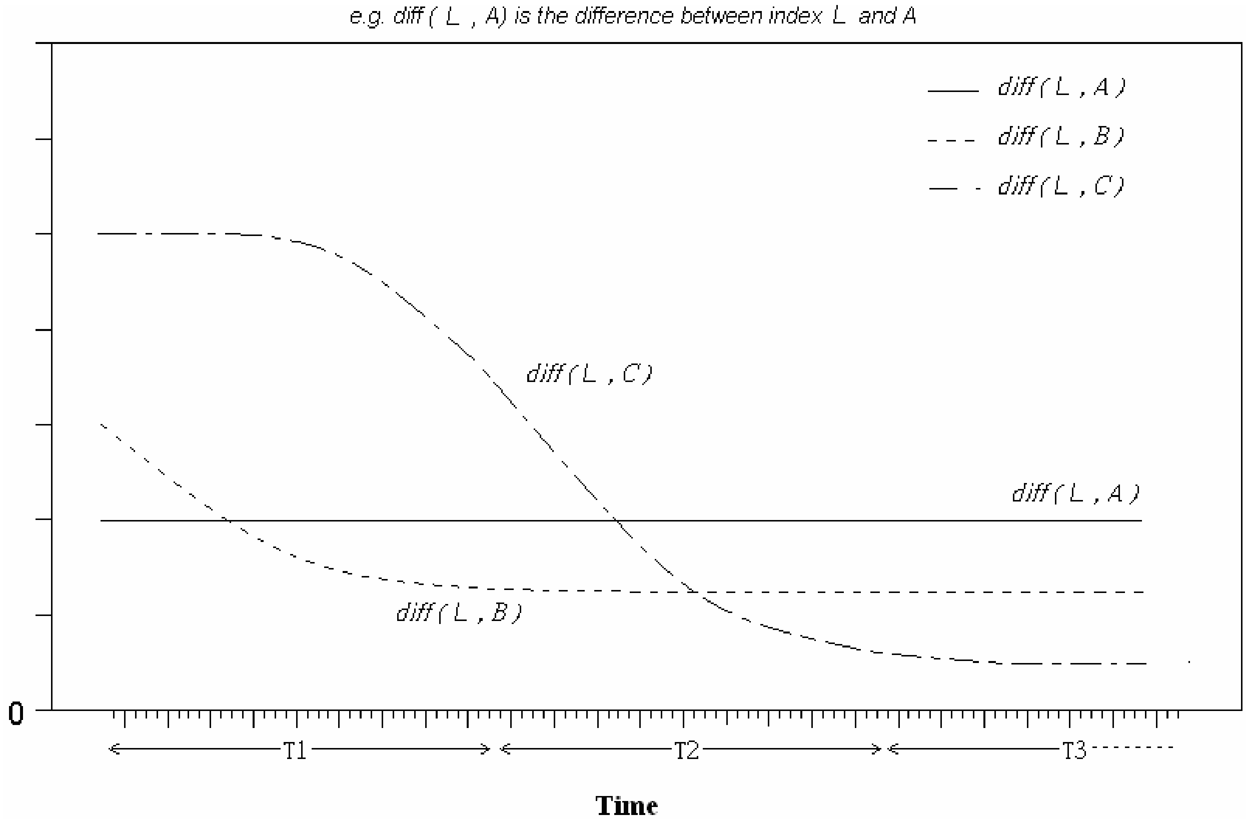

Figure 1.2 Differences between Two Indices

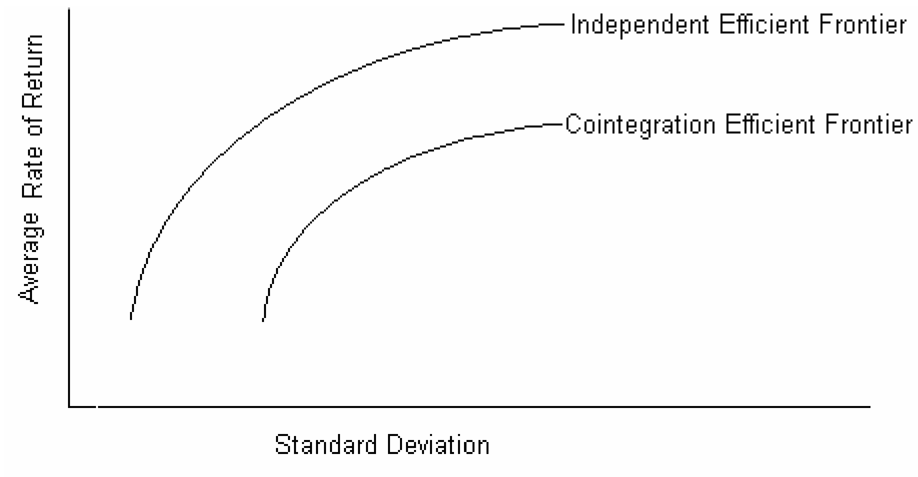

Figure 1.3 Efficient Frontiers between INDE and COINT

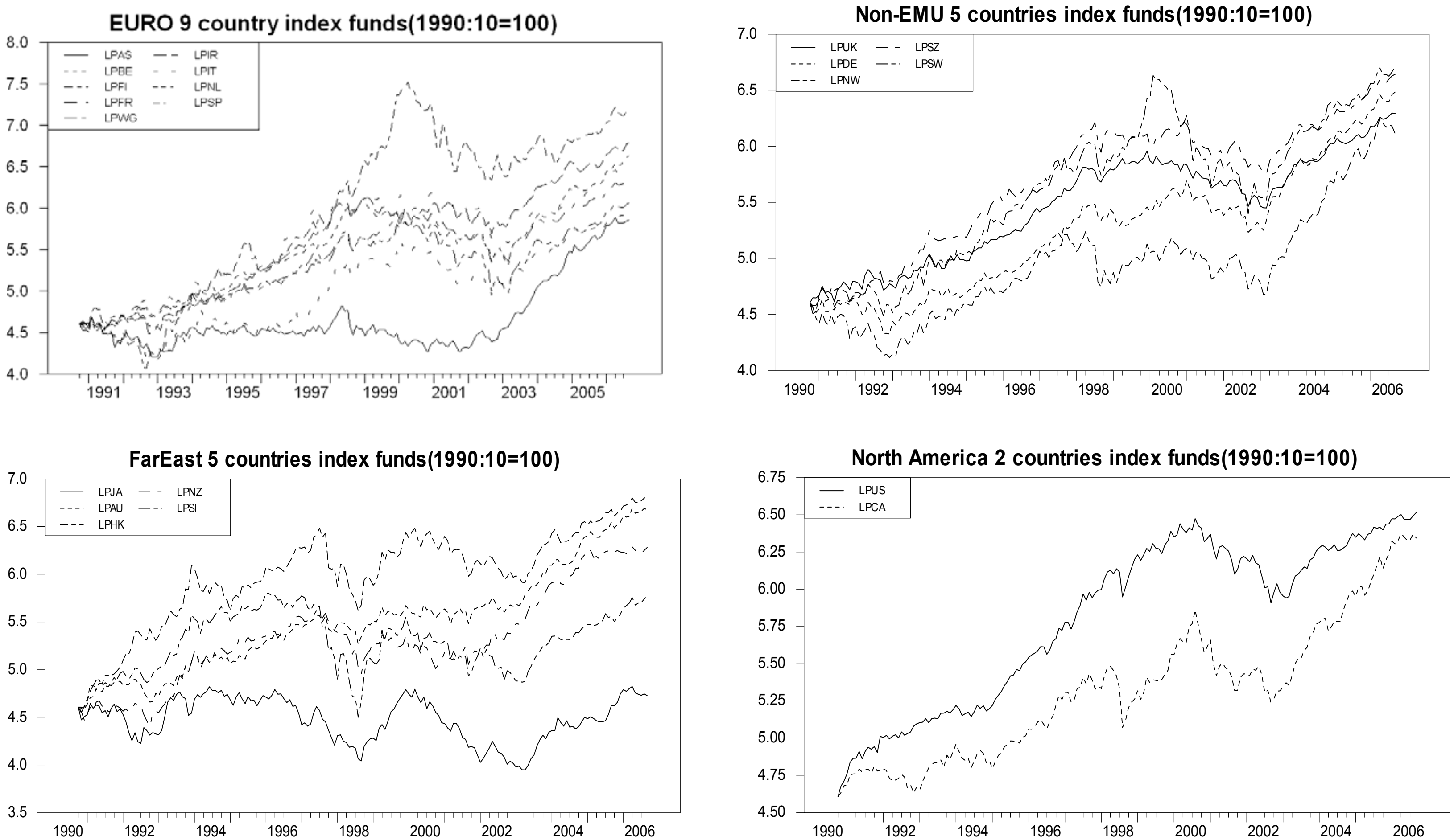

Figure 1.4 Country Indices Plot under Each Region from 09/1990 to 10/2006

Test period is from October 1990 to September 2006 which includes 192 monthly observations. LP represent log price of a index. LPAS—Austria, LPBE—Belgium, LPFI—Finland, LPFR—France, LPGE—Germany, LPIR—Ireland, LPIT—Italy, LPNL—Netherlands, LPSP—Spain, LPDE—Denmark, LPNW—Norway, LPSW—Sweden, LPSZ—Switzerland, LPUK—United Kingdom, LPAU—Australia, LPHK—Hong Kong, LPJA—Japan, LPNZ—New Zealand, LPSI—Singapore, LPCA—Canada, LPUS—United States.

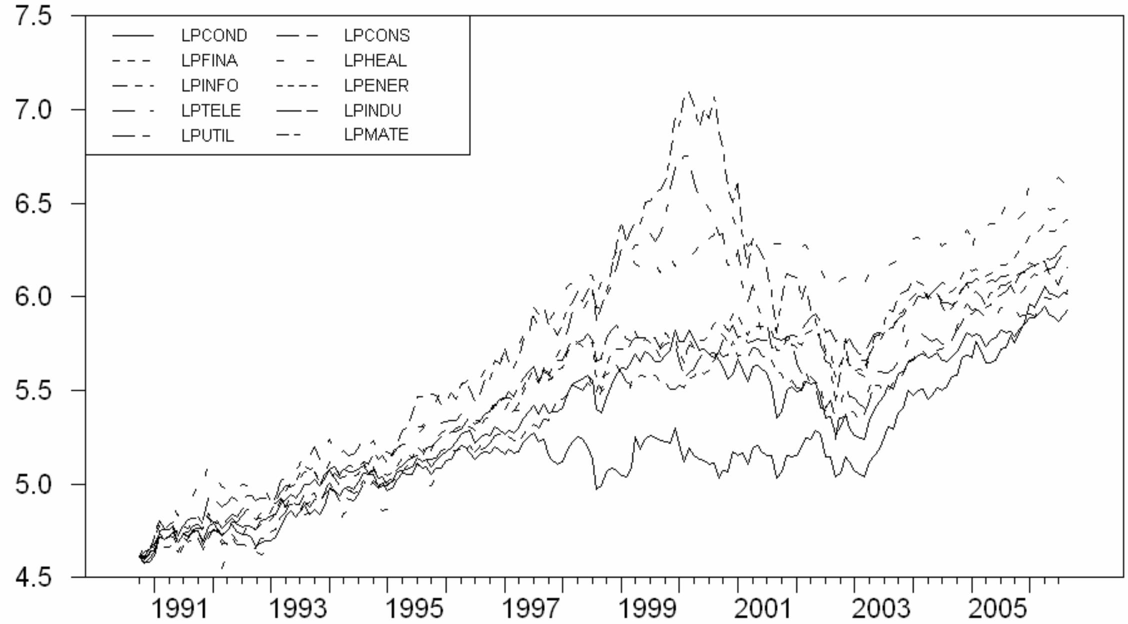

Figure 1.5 Ten Industry Sector Indices Plot from 09/1990 to 10/2006

LPCOND- Log price of Consumer Discretionary Sector; LPFINA- Log price of Financials Sector; LPINFO- Log price of Information Technology Sector; LPTELE- Log price of Telecommunication Services Sector; LPUTIL- Log price of Utilities Sector; LPCONS- Log price of Consumer Staples Sector; LPHEAL- Log price of Health Care Sector; LPENER- Log price of Energy Sector; LPINDU- Log price of Industrials Sector; LPMATE- Log price of Materials Sector.

Table 1.1 Descriptive Statistics

All indices are constructed by S&P/Citigroup. Data is from October 1990 to September 2006 which includes 192 monthly observations. Raw return is the average monthly return and excess return is the difference between raw return and Citigroup 3M T-bill. Sharp Ratio is shown in equation 26 as excess return divided by standard deviation.

Panel A. Country Level Descriptive Statistics

	Raw Rt	S.D.	Median	Maximum	Minimum	Excess Rt	Sharp Ratio
North America							
Canada	1.02%	4.99%	1.62%	11.36%	-23.21%	0.69%	0.14
United States	1.07%	4.01%	1.50%	11.49%	-15.46%	0.74%	0.19
EMU							
Austria	0.86%	5.29%	0.96%	14.20%	-18.08%	0.52%	0.10
Belgium	1.22%	4.75%	1.27%	18.86%	-17.07%	0.89%	0.19
Finland	1.75%	9.35%	1.20%	31.79%	-29.89%	1.42%	0.15
France	1.09%	5.00%	1.22%	15.42%	-15.49%	0.75%	0.15
Germany	0.99%	5.75%	1.14%	22.72%	-23.30%	0.66%	0.11
Ireland	1.36%	5.47%	1.93%	19.32%	-16.38%	1.03%	0.19
Italy	0.94%	6.62%	0.73%	20.46%	-19.85%	0.61%	0.09
Netherlands	1.14%	4.76%	1.51%	12.70%	-17.03%	0.81%	0.17
Spain	1.32%	5.99%	1.15%	20.24%	-20.30%	0.99%	0.16
NON-EMU							
Denmark	1.14%	4.76%	1.35%	13.61%	-13.48%	0.81%	0.17
Norway	0.98%	6.41%	0.96%	16.73%	-27.87%	0.64%	0.10
Sweden	1.40%	7.10%	1.56%	21.40%	-21.23%	1.07%	0.15
Switzerland	1.20%	4.53%	1.13%	15.71%	-15.99%	0.87%	0.19
United Kingdom	1.00%	4.07%	0.79%	13.31%	-10.30%	0.67%	0.17
Asian Pacific							
Australia	1.16%	4.95%	1.12%	14.15%	-12.95%	0.83%	0.17
Hong Kong	1.48%	7.66%	1.32%	30.25%	-30.42%	1.15%	0.15
Japan	0.39%	6.50%	-0.24%	25.14%	-16.22%	0.05%	0.01
New Zealand	1.00%	5.94%	1.09%	17.48%	-19.29%	0.67%	0.11
Singapore	0.98%	8.01%	0.92%	33.91%	-21.89%	0.65%	0.08
Citigroup 3m T-Bill (R_f)	0.33%	0.14%	0.37%	0.62%	0.07%	0.00%	0.00
Broad Market Index (R_m)	0.93%	3.83%	1.34%	9.19%	-14.26%	0.59%	0.16

Table 1.1 – continued

Panel B. Industry/Sector Level Descriptive Statistics

10 Sector	Raw Rt	S.D.	Median	Maximum	Minimum	Excess Rt	Sharp Ratio
Energy	1.14%	4.92%	0.97%	17.26%	-12.98%	0.80%	0.16
Industrials	0.82%	4.21%	0.84%	12.34%	-13.82%	0.49%	0.12
Consumer Staples	0.97%	3.32%	1.34%	12.30%	-10.64%	0.64%	0.19
Financials	1.10%	4.42%	1.33%	12.82%	-19.30%	0.76%	0.17
Information Technology	1.15%	7.75%	1.05%	22.26%	-28.08%	0.82%	0.11
Materials	0.88%	4.72%	0.94%	18.71%	-14.67%	0.55%	0.12
Consumer Discretionary	0.83%	4.26%	1.21%	11.45%	-15.55%	0.49%	0.12
Health Care	1.11%	3.84%	1.60%	14.82%	-9.91%	0.78%	0.20
Utilities	0.97%	3.37%	0.97%	12.74%	-10.76%	0.64%	0.19
Telecommunication Services	0.93%	5.50%	0.83%	19.68%	-17.73%	0.60%	0.11

24 Industrial Group (Sector It Belongs)							
Energy (Energy)	1.14%	4.92%	0.97%	17.26%	-12.98%	0.80%	0.16
Capital Goods (Industrials)	0.86%	4.51%	1.02%	13.53%	-13.60%	0.53%	0.12
Commercial Services & Supplies (Industrials)	0.75%	4.12%	0.97%	9.68%	-15.42%	0.42%	0.10
Transportation (Industrials)	0.76%	3.94%	1.04%	13.64%	-12.77%	0.43%	0.11
Food & Staples Retailing (Consumer Staples)	0.75%	3.41%	0.91%	8.78%	-10.27%	0.42%	0.12
Food, Beverage & Tobacco (Consumer Staples)	1.02%	3.56%	1.25%	12.59%	-11.34%	0.68%	0.19
Household & Personal Products (Consumer Staples)	1.20%	4.45%	1.42%	23.51%	-12.26%	0.87%	0.20
Banks (Financials)	1.10%	4.59%	1.36%	14.42%	-20.84%	0.77%	0.17
Diversified Financials (Financials)	1.28%	5.56%	1.35%	14.73%	-21.01%	0.95%	0.17
Insurance (Financials)	1.02%	4.43%	1.07%	18.18%	-16.69%	0.68%	0.15
Real Estate (Financials)	1.02%	4.25%	1.24%	18.01%	-13.64%	0.69%	0.16
Telecommunication Services (Telecommunication Services)	1.41%	7.85%	2.10%	28.18%	-23.79%	1.08%	0.14
Software & Services (Information Technology)	1.14%	8.00%	1.06%	19.83%	-30.81%	0.81%	0.10
Technology Hardware & Equipment (Information Technology)	1.95%	10.28%	1.32%	27.30%	-30.11%	1.62%	0.16
Semiconductors & Semiconductor Equipment (Information Technology)	0.88%	4.72%	0.94%	18.71%	-14.67%	0.55%	0.12
Materials (Materials)	0.88%	4.89%	0.92%	12.41%	-18.99%	0.55%	0.11
Automobiles & Components (Consumer Discretionary)	0.67%	4.78%	1.23%	13.95%	-17.76%	0.34%	0.07
Consumer Durables & Apparel (Consumer Discretionary)	0.98%	4.35%	1.17%	14.00%	-17.24%	0.65%	0.15
Consumer Services (Consumer Discretionary)	0.86%	5.11%	1.20%	16.21%	-16.87%	0.53%	0.10
Media (Consumer Discretionary)	0.98%	4.76%	1.34%	13.75%	-14.07%	0.65%	0.14
Retailing (Consumer Discretionary)	1.10%	4.23%	1.41%	14.91%	-17.48%	0.77%	0.18
Health Care Equipment & Services (Health Care)	1.12%	4.08%	1.58%	14.81%	-8.55%	0.78%	0.19
Pharmaceuticals & Biotechnology (Health Care)	0.97%	3.37%	0.97%	12.74%	-10.76%	0.64%	0.19
Utilities (Utilities)	0.93%	5.50%	0.83%	19.68%	-17.73%	0.60%	0.11

Table 1.2 Inter-Regional Unit Root and Cointegration Rank Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Each data series has three different unit root tests: Dicky-Fuller (DF), Augmented Dicky-Fuller (ADF) and Zivot-Andrews (ZA), which have the null hypothesis of a unit root and nonstationary against the alternative hypothesis that no unit root is presented in the data series and stationary. DF test uses 1 lag based on Box-Ljung Q-statistic, ADF test allows for maximum 12 lags and ZA test use AIC criteria to decide the lag length from maximum 12 lags. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. AP represents Asian Pacific region, NA represents for North America region, EMU represents EMU countries and NON-EMU represents European countries but not in the Eurozone. To ensure normality of residual, large standardized residual as found on 1998:08 and 2001:09, are controlled by dummy variables. Possible structural breaks, such as 1997 Asian financial crisis and 2000 U.S. internet bubble burst, are monitored by using likelihood-ratio exclusion test. Trace is a standard Johansen trace statistics and Bartlett Trace is a small sample correction for each cointegration rank test. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics.

Panel A. Unit Root Test

	AP	NA	EMU	NON-EMU
Dickey-Fuller	-1.51	-1.81	0.02	0.03
ADF Z-test	-4.42	-2.06	0.12	0.19
Zivot-Andrew	-3.55	-3.35	-3.80	-3.99

Panel B. Cointegration Rank Test

I(1)-Analysis	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
	4	0	0.14	57.62	57.04	63.65	0.15	0.16
	3	1	0.09	29.15	28.95	42.77	0.56	0.57

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Dickey-Fuller Unit Root Test Critical values: 1%= -3.466 and 5%= -2.877 and 10%= -2.575
Augmented Dickey-Fuller Z-test Critical values: 1%= -20.3 and 5%= -14.0 and 10%= -11.2
Zivot-Andrews Unit Root Test Critical Values are 1% -5.57 and 5% -5.08 and 10% -4.82

Table 1.3 Country Unit Root Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Each data series has three different unit root tests: Dicky-Fuller (DF), Augmented Dicky-Fuller (ADF) and Zivot-Andrews (ZA), which have the null hypothesis of a unit root and nonstationary against the alternative hypothesis that no unit root is presented in the data series and stationary. DF test uses 1 lag based on Box- Ljung Q-statistic, ADF test allows for maximum 12 lags and ZA test use AIC criteria to decide the lag length from maximum 12 lags. AS—Austria, BE—Belgium, FI—Finland, FR—France, GE—Germany, IR—Ireland, IT—Italy, NL—Netherlands, SP—Spain, DE—Denmark, NW—Norway, SW—Sweden, SZ—Switzerland, UK—United Kingdom, AU—Australia, HK—Hong Kong, JA—Japan, NZ—New Zealand, SI—Singapore, CA—Canada, US—United States.

EMU 9 Countries	AS	BE	FI	FR	GE	IR	IT	NL	SP
Dickey-Fuller	1.64	-0.14	-0.89	-0.45	-0.63	-0.35	-0.01	-1.20	0.10
ADF Z-test	2.64	0.11	-1.38	-0.48	-1.32	-0.21	-0.28	-1.46	0.17
Zivot-Andrew	-3.86	-2.58	-3.87	-3.62	-3.98	-2.72	-3.39	-2.79	-3.08

Non-EMU 5 Countries	DE	NW	SW	SZ	UK
Dickey-Fuller	0.88	0.50	-0.86	-1.07	-0.60
ADF Z-test	1.13	1.04	-1.02	-1.03	-0.86
Zivot-Andrew	-3.88	-3.43	-4.63	-3.21	-2.88

Asian Pacific 5 Countries	AU	HK	JA	NZ	SI	North America 2 Countries	CA	US
Dickey-Fuller	0.31	-2.42	-1.95	-0.33	-2.31	Dickey-Fuller	0.35	-1.20
ADF Z-test	0.17	-4.89	-12.78*	-0.58	-2.12	ADF Z-test	0.86	-1.21
Zivot-Andrew	-4.03	-3.61	-3.77	-3.42	-3.43	Zivot-Andrew	-4.48	-3.27

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Dickey-Fuller Unit Root Test Critical values: 1%= -3.466 and 5%= -2.877 and 10%= -2.575
Augmented Dickey-Fuller Z-test Critical values: 1%= -20.3 and 5%= -14.0 and 10%= -11.2
Zivot-Andrews Unit Root Test Critical Values are 1% -5.57 and 5% -5.08 and 10% -4.82

Table 1.4 Intra-Regional Cointegration Rank Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. Significant large G(r) tests confirm the present of deterministic trend component. Insignificant G(r) leads to cointegration rank tests without a trend component. To ensure normality of residual, large standardized residual as found on 1998:08 and 2001:09, are controlled by dummy variables. Possible structural breaks, such as 1997 Asian financial crisis and 2000 U.S. internet bubble burst, are monitored by using likelihood-ratio exclusion test. Trace is a standard Johansen trace statistics and Bartlett Trace is a small sample correction for each cointegration rank test. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics. G(r) test statistic has a $\chi 2$ distribution with r degrees of freedom.

I(1)-Analysis	G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
North America (2 countries)	N/A	2	0	0.07	16.88	16.81	25.73	0.43	0.44
	N/A	1	1	0.02	3.58	3.57	12.45	0.80	0.80
Asian Pacific (5 countries)	N/A	5	0	0.22	104.57	103.24	97.95	0.02**	0.02**
	16.72***	4	1	0.11	56.82	56.26	71.65	0.41	0.43
EMU (9 countries)	N/A	9	0	0.27	240.02	234.13	228.15	0.01**	0.03**
	8.31***	8	1	0.23	179.58	175.70	187.25	0.12	0.17
Non-EMU (5 countries)	N/A	5	0	0.21	114.36	112.89	96.99	0.00***	0.00***
	5.83**	4	1	0.15	68.43	67.75	71.87	0.09	0.10

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.5 Intra-Regional Exclusion Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. L-R test is the likelihood-ratio test with the null hypothesis that the variable is independent and therefore can be excluded from the cointegration relation. Corresponding p-value is shown under the L-R test statistics. AS—Austria, BE—Belgium, FI—Finland, FR—France, GE—Germany, IR—Ireland, IT—Italy, NL—Netherlands, SP—Spain, DE—Denmark, NW—Norway, SW—Sweden, SZ—Switzerland, UK—United Kingdom, AU—Australia, HK—Hong Kong, JA—Japan, NZ—New Zealand, SI—Singapore. Countries are suggested to be excluded from its cointegration vector are in bold. L-R test statistic has a $\chi 2$ distribution with a degrees of freedom equal to the number of restrictions in the system.

Asian Pacific (5 countries)	r	DGF	JA	SI	**AU**	**HK**	**NZ**				
L-R test	1	1	19.45***	17.01***	0.05	0.14	0.05				
P-Value			0.00***	0.00***	0.83	0.71	0.82				
Non-EMU (5 countries)	R	DGF	NW	UK	DE	**SW**	**SZ**				
L-R test	1	1	5.06**	14.06***	10.00***	3.47	0.51				
P-Value			0.02**	0.00***	0.00***	0.06	0.48				
EMU (9 countries)	R	DGF	AS	FR	GE	IT	FI	**NL**	**SP**	**IR**	**BE**
L-R test	1	1	6.13***	6.31**	8.47***	6.92***	8.31***	0.04	0.84	0.30	2.88
P-Value			0.01**	0.01**	0.00***	0.00***	0.00***	0.84	0.36	0.58	0.09

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.6 Independent Countries Cointegration Rank Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. G(r) tests are not available due to no significant r is found. BE—Belgium, IR—Ireland, NL—Netherlands, SP—Spain, SW—Sweden, SZ—Switzerland, AU—Australia, HK—Hong Kong, NZ—New Zealand, CA—Canada, US—United States. To ensure normality of residual, large standardized residual as found on 1998:08 and 2001:09, are controlled by dummy variables. Possible structural breaks, such as 1997 Asian financial crisis and 2000 U.S. internet bubble burst, are monitored by using likelihood-ratio exclusion test. Trace is a standard Johansen trace statistics and Bartlett Trace is a small sample correction for each cointegration rank test. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics.

I(1)-Analysis	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
North America (CA and US)	2	0	0.07	16.88	16.81	25.73	0.43	0.44
Asian Pacific (HK, NZ and AU)	3	0	0.06	17.56	17.44	29.80	0.61	0.62
Non-Euro(SW and SZ)	2	0	0.04	7.84	7.81	15.41	0.49	0.49
Euro (SP,NL,BE and IR)	4	0	0.13	46.16	45.71	63.66	0.60	0.62
All Independent countries	11	0	0.317	368.92	339.69	372.60	0.07	0.42

* significant at 10 percent leve l and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.7 Country Portfolio Basis Summary Statistics: 1990-2006

RET is the raw return and ExRET is the excess return and SD is the standard deviation and they are all in percentage. SHP is the sharp ratio and Z-statistic is Jobson-Korkie test statistic. Market the value-weighted S&P/Citigroup Global Broad Market return which is the benchmark for global market index. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents portfolio which contains exclusively cointegrated country indices.

Portfolio	RET(%)	ExRET(%)	SD(%)	SHP	Z-Statistic	Z-Statistics (INDE v.s. COINT)
Market	0.93%	0.59%	3.83%	0.16		
Global CINDE	1.22%	0.88%	4.20%	0.21	1.83*	1.96**
Global CCOINT	1.01%	0.68%	4.41%	0.15	-0.04	
EMU CINDE	1.26%	0.93%	4.59%	0.20	1.17	0.99
EMU CCOINT	1.12%	0.79%	4.97%	0.16	0.10	
Non-EMU CINDE	1.30%	0.97%	5.15%	0.19	0.74	0.59
Non-EMU CCOINT	1.04%	0.71%	4.45%	0.16	0.08	
Asian Pacific CINDE	1.22%	0.89%	5.19%	0.17	0.27	2.14**
Asian Pacific CCOINT	0.68%	0.35%	5.96%	0.06	-1.87	
North America	1.05%	0.71%	4.20%	0.17	0.40	
Citigroup 3M T-bill	0.33%		0.14%			

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.8 Country Portfolio Performance Summary

This table presents the results of the four-factor model regression**:**

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. UMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents portfolio which contains exclusively cointegrated country indices. North America "All" is the mean of CA and US indices returns.

Global	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.036	29.89***	1.089	29.08***	-0.053	-1.51
Size SMB	0.078	2.48**	0.124	3.64***	-0.046	-1.43
Valuation HML	0.059	2.02**	0.084	2.68***	-0.026	-0.86
Momentum UMD	0.006	0.21	-0.016	-0.53	0.022	0.77
Intercept a	0.002	1.91*	-0.000	-0.03	0.002	1.90*
R-Square	0.85		0.84		0.03	

EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.097	22.86***	1.062	17.83***	0.035	0.61
Size SMB	0.089	2.03**	0.106	1.95**	-0.017	-0.33
Valuation HML	0.164	4.07***	0.003	0.05	0.161	3.34***
Momentum UMD	0.083	2.14**	0.037	0.76	0.047	1.00
Intercept a	0.002	1.05	0.001	0.60	0.001	0.26
R-Square	0.75		0.67		0.06	

Non-EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.099	17.97***	1.041	20.52***	0.058	0.92
Size SMB	0.040	0.72	0.165	3.57***	-0.125	-2.16**
Valuation HML	-0.009	-0.17	0.211	4.95***	-0.219	-4.12***
Momentum UMD	0.076	1.53	0.080	1.94*	-0.004	-0.07
Intercept a	0.003	1.25	0.000	-0.16	0.003	1.34
R-Square	0.68		0.70		0.13	

Asian Pacific	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	0.995	13.16***	1.228	16.05***	-0.233	-2.84***
Size SMB	0.101	1.47	0.109	1.56	-0.008	-0.10
Valuation HML	0.075	1.18	0.098	1.53	-0.023	-0.34
Momentum UMD	-0.152	-2.49**	-0.290	-4.7***	0.139	2.09**
Intercept a	0.003	1.20	-0.003	-1.07	0.006	2.10**
R-Square	0.52		0.62		0.07	

North America	All	t-stat
Market Rm	0.910	22.37***
Size SMB	0.061	1.65
Valuation HML	-0.109	-3.19***
Momentum UMD	0.019	0.57
Intercept a	0.002	1.26
R-Square	0.79	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.9 Country Portfolio Risk Measures

Full market period is from October 1990 to September 2006 which includes 192 monthly observations. Rising market is defined as positive market risk premium months with 119 observations. Declining market is defined as negative market risk premium months with 73 observations. SD represents standard deviation which is a tradition total risk measurement. Beta is a systematic market risk measure based on CAPM model:

$$R_{pt} = a + \beta_1 R_{mt} + \upsilon_t$$

where R_{pt} is portfolio excess return. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents portfolio which contains exclusively cointegrated country indices. DIFF = CINDE-CCOINT. Since North America region does not have comparative portfolios, ALL represents an equally-weighted portfolio of CA and US.

Global		Raw Rt r	σ	*a*	β	EMU		Raw Rt r	σ	*a*	β
Full Mkt	CINDE	1.22%	4.20%	0.29%	1.01	Full Mkt	CINDE	1.26%	4.59%	0.32%	1.02
	CCOINT	1.01%	4.41%	0.06%	1.05		CCOINT	1.12%	4.97%	0.16%	1.06
	DIFF	0.21%	-0.21%	0.23%	-0.04		DIFF	0.13%	-0.38%	0.16%	-0.04
Rising Mkt	CINDE	3.63%	2.55%	0.56%	0.92	Rising Mkt	CINDE	3.62%	3.15%	0.29%	1.02
	CCOINT	3.44%	3.11%	-0.30%	1.15		CCOINT	3.58%	3.86%	-0.20%	1.16
	DIFF	0.19%	-0.56%	0.87%	-0.23		DIFF	0.04%	-0.71%	0.49%	-0.15
Declining Mkt	CINDE	-2.72%	3.30%	0.36%	1.05	Declining Mkt	CINDE	-2.59%	3.92%	0.62%	1.09
	CCOINT	-2.95%	3.19%	0.03%	1.01		CCOINT	-2.88%	3.86%	0.17%	1.04
	DIFF	0.23%	0.11%	0.33%	0.03		DIFF	0.28%	0.06%	0.44%	0.05
Non-EMU						Asian Pacific					
Full Mkt	CINDE	1.30%	5.15%	0.31%	1.10	Full Mkt	CINDE	1.22%	5.19%	0.32%	0.95
	CCOINT	1.04%	4.45%	0.15%	0.94		CCOINT	0.68%	5.96%	-0.35%	1.17
	DIFF	0.26%	0.70%	0.16%	0.17		DIFF	0.53%	-0.77%	0.66%	-0.22
Rising Mkt	CINDE	3.88%	3.77%	0.41%	1.06	Rising Mkt	CINDE	3.63%	4.14%	0.82%	0.84
	CCOINT	3.24%	3.37%	0.15%	0.93		CCOINT	3.39%	5.11%	-1.25%	1.45
	DIFF	0.64%	0.40%	0.26%	0.13		DIFF	0.24%	-0.97%	2.07%	-0.62
Declining Mkt	CINDE	-2.91%	4.25%	0.66%	1.20	Declining Mkt	CINDE	-2.71%	4.26%	-0.25%	0.86
	CCOINT	-2.54%	3.60%	0.34%	0.98		CCOINT	-3.73%	4.42%	-0.79%	1.00
	DIFF	-0.37%	0.65%	0.32%	0.21		DIFF	1.01%	-0.16%	0.54%	-0.14
North America											
Full Mkt	ALL	1.05%	4.20%	0.14%	0.96						
Rising Mkt	ALL	3.39%	2.47%	0.89%	0.73						
Declining Mkt	ALL	-2.78%	3.60%	0.47%	1.10						

Table 1.10 Country Portfolio Performance in Rising Markets

This table presents the results of the four-factor model regression during rising markets with 119 month in the sample. Rising market is defined as positive market risk premium period:

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}CUMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. UMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents portfolio which contains exclusively cointegrated country indices. North America "All" is the mean of CA and US indices returns.

Global	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	0.939	12.63***	1.165	13.81***	-0.226	-3.14***
Size SMB	0.124	3.20***	0.199	4.53***	-0.075	-2.01**
Valuation HML	0.048	1.34	0.079	1.95*	-0.031	-0.90
Momentum CUMD	0.009	0.28	-0.021	-0.58	0.030	0.96
Intercept a	0.005	2.01**	-0.003	-0.92	0.008	3.15***
R-Square	0.60		0.66		0.09	

EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.092	10.98***	1.166	8.77***	-0.075	-0.59
Size SMB	0.154	2.98***	0.200	2.89***	-0.046	-0.70
Valuation HML	0.118	2.45**	-0.034	-0.53	0.151	2.48**
Momentum CUMD	0.118	2.73***	0.037	0.63	0.081	1.48
Intercept a	0.001	0.21	-0.003	-0.60	0.004	0.79
R-Square	0.53		0.44		0.09	

Non-EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.074	7.80***	1.022	8.95***	0.052	0.36
Size SMB	0.118	1.65	0.243	4.09***	-0.125	-1.66
Valuation HML	-0.046	-0.70	0.226	4.10***	-0.272	-3.92***
Momentum CUMD	0.075	1.25	0.075	1.51	0.000	0.01
Intercept a	0.003	0.52	0.000	0.03	0.002	0.47
R-Square	0.37		0.47		0.13	

Asian Pacific	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	0.801	4.82***	1.377	7.98***	-0.576	-3.10***
Size SMB	0.147	1.69*	0.130	1.45	0.016	0.17
Valuation HML	0.103	1.28	0.143	1.71*	-0.040	-0.44
Momentum CUMD	-0.169	-2.33**	-0.310	-4.13***	0.141	1.75*
Intercept a	0.011	1.85*	-0.007	-1.12	0.018	2.70***
R-Square	0.24		0.46		0.12	

North America	All	t-stat
Market Rm	0.705	8.10***
Size SMB	0.034	0.74
Valuation HML	-0.079	-1.88*
Momentum CUMD	-0.009	-0.24
Intercept a	0.009	2.85***
R-Square	0.41	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.11 Country Portfolio Performance in Declining Markets

This table presents the results of the four-factor model regression during declining markets with 73 month in the sample. Declining market is defined as negative market risk premium period.

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}CUMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. UMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents portfolio which contains exclusively cointegrated country indices. North America "All" is the mean of CA and US indices returns.

Global	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.110	14.19***	1.085	14.61***	0.025	0.30
Size SMB	-0.020	-0.38	-0.024	-0.48	0.004	0.07
Valuation HML	0.106	2.08**	0.133	2.74***	-0.027	-0.48
Momentum CUMD	-0.019	-0.32	0.031	0.56	-0.049	-0.79
Intercept a	0.003	1.09	0.000	-0.12	0.004	1.10
R-Square	0.76		0.77		0.01	

EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.241	11.16***	1.089	8.87***	0.152	1.19
Size SMB	-0.071	-0.93	-0.098	-1.15	0.027	0.30
Valuation HML	0.269	3.69***	0.121	1.51	0.147	1.76
Momentum CUMD	0.003	0.04	0.095	1.05	-0.092	-0.98
Intercept a	0.005	1.20	0.001	0.17	0.005	0.88
R-Square	0.65		0.56		0.08	

Non-EMU	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	1.242	9.77***	1.099	10.24***	0.143	1.06
Size SMB	-0.137	-1.56	0.018	0.24	-0.154	-1.66
Valuation HML	0.113	1.35	0.225	3.20***	-0.112	-1.27
Momentum CUMD	0.098	1.05	0.085	1.08	0.013	0.14
Intercept a	0.006	1.14	0.002	0.45	0.004	0.71
R-Square	0.61		0.61		0.10	

Asian Pacific	CINDE	t-stat	CCOIN	t-stat	CHEDGE	t-stat
Market Rm	0.921	5.42***	1.055	6.41***	-0.134	-0.78
Size SMB	0.025	0.21	0.096	0.85	-0.071	-0.60
Valuation HML	0.060	0.54	0.024	0.22	0.036	0.32
Momentum CUMD	-0.157	-1.26	-0.212	-1.75*	0.055	0.43
Intercept a	-0.002	-0.24	-0.007	-1.02	0.005	0.74
R-Square	0.32		0.38		0.02	

North America	All	t-stat
Market Rm	1.001	11.08***
Size SMB	0.130	2.08**
Valuation HML	-0.154	-2.61***
Momentum CUMD	0.029	0.43
Intercept a	0.005	1.32
R-Square	0.73	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.12 Sector Cointegration Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Each data series has three different unit root tests: Dicky-Fuller (DF), Augmented Dicky-Fuller (ADF) and Zivot-Andrews (ZA), which have the null hypothesis of a unit root and nonstationary against the alternative hypothesis that no unit root is presented in the data series and stationary. DF test uses 1 lag based on Box- Ljung Q-statistic, ADF test allows for maximum 12 lags and ZA test use AIC criteria to decide the lag length from maximum 12 lags. COND- Consumer Discretionary; CONS-Consumer Staples; ENER-Energy; FINA-Financials; HEAL-Health Care; INDU-Industrials; INFO-Information Technology; MATE-Materials; TELE-Telecommunication Services; UTIL-Utilities. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. Significant large G(r) tests confirm the present of deterministic trend component. Insignificant G(r) leads to cointegration rank tests without a trend component. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics. G(r) test statistic has a $\chi 2$ distribution with r degrees of freedom. In Panel B, L-R test is the likelihood-ratio test with the null hypothesis that the variable is independent and therefore can be excluded from the cointegration relation. Corresponding p-value is shown under the L-R test statistics. Sectors are suggested to be excluded from its cointegration vector are in bold. L-R test statistic has a $\chi 2$ distribution with degrees of freedom equal to the number of restrictions in the system.

Panel A Sector Unit Root Test

Sector	COND	CONS	ENER	FINA	HEAL	INDU	INFO	MATE	TELE	UTIL
Dickey-Fuller	-1.44	-1.04	0.19	-0.68	-1.61	-0.77	-1.59	-0.05	-1.59	-0.15
ADF Z-test	-2.12	-1.05	0.06	-0.87	-1.54	-0.95	-2.64	-0.02	-2.48	-0.10
Zivot-Andrew	-4.08	-3.13	-3.70	-3.86	-3.01	-4.31	-4.43	-4.06	-3.87	-4.24

Panel B 10-Sector Cointegration Rank Test I(1)-Analysis

G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
N/A	10	0	0.36	393.09	361.96	277.44	0.00***	0.00***
3.36*	9	1	0.34	307.66	283.18	230.27	0.00***	0.00***
19.44***	8	2	0.26	227.56	149.28	188.74	0.00***	0.79

Panel C Exclusion Test on 10-Sector

	r	dgf	COND	**FINA**	INFO	TELE	UTIL	**CONS**	**HEAL**	ENER	INDU	MATE
L-R	1	1	5.09	0.09	3.78	2.96	1.18	0.08	0.25	5.15	4.67	4.95
P-Value			0.02**	**0.76**	0.05	0.09	0.28	**0.78**	**0.62**	0.02**	0.03**	0.03**
L-R	2	2	17.95	0.94	17.20	15.66	13.18	0.85	0.43	14.51	16.49	7.75
P-Value			0.00***	**0.63**	0.00***	0.00***	0.01***	**0.65**	**0.81**	0.00***	0.00***	0.02**

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Dickey-Fuller Unit Root Test Critical values: 1%= -3.466 and 5%= -2.877 and 10%= -2.575
Augmented Dickey-Fuller Z-test Critical values: 1%= -20.3 and 5%= -14.0 and 10%= -11.2
Zivot-Andrews Unit Root Test Critical Values are 1% -5.57 and 5% -5.08 and 10% -4.82

Table 1.13 Cointegrated Sector Industry Group Cointegration Tests

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Each data series has three different unit root tests: Dicky-Fuller (DF), Augmented Dicky-Fuller (ADF) and Zivot-Andrews (ZA), which have the null hypothesis of a unit root and nonstationary against the alternative hypothesis that no unit root is presented in the data series and stationary. DF test uses 1 lag based on Box- Ljung Q-statistic, ADF test allows for maximum 12 lags and ZA test use AIC criteria to decide the lag length from maximum 12 lags. AUCO-Automobiles & Components; BANK-Banks; CAPG-Capital Goods; COSS-Commercial Services & Supplies; CODA-Consumer Durables & Apparel; COSE-Consumer Services; DIFI-Diversified Financials; FSRE-Food & Staples Retailing; FBTO-Food, Beverage & Tobacco; HEES-Heal Care Equipment & Services; HOPP- Household & Personal Products; INSU-Insurance; MEDI-Media; PHBI- Pharmaceuticals & Biotechnology; REES-Real Estate; RETA-Retailing; SESE-Semiconductors & Semiconductor Equipment; SOFT-Software & Services; TEHE-Technology Hardware & Equipment; TRAN-Transportation; ENER-Energy; MATE-Materials; TELE-Telecommunication Services; UTIL-Utilities. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. Significant large G(r) tests confirm the present of deterministic trend component. Insignificant G(r) leads to cointegration rank tests without a trend component. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics. G(r) test statistic has a $\chi 2$ distribution with r degrees of freedom. L-R test is the likelihood-ratio test with the null hypothesis that the variable is independent and therefore can be excluded from the cointegration relation. Corresponding p-value is shown under the L-R test statistics. Industry groups are suggested to be excluded from its cointegration vector are in bold. L-R test statistic has a $\chi 2$ distribution with degrees of freedom equal to the number of restrictions in the system.

Panel A Industrial Group Unit Root Test

10 Sector	AUCO	BANK	CAPG	COSS	CODA	COSE	DIFI	FSRE	FBTO	HEES
Dickey-Fuller	-1.29	-0.69	-0.78	-1.28	-1.34	-1.01	-0.85	-1.39	-0.72	-1.17
ADF Z-test	-1.86	-0.92	-1.00	-2.01	-2.64	-1.50	-1.04	-1.58	-0.76	-1.68
Zivot-Andrew	-3.69	-3.88	-4.40	-3.98	-4.65	-3.78	-4.34	-3.01	-3.11	-3.79

10 Sector	HOPP	INSU	MEDI	PHBI	REES	RETA	SESE	SOFT	TEHE	TRAN
Dickey-Fuller	-1.32	-0.98	-1.91	-1.67	0.56	-1.14	-2.09	-2.09	-1.50	-0.31
ADF Z-test	-1.39	-1.39	-3.21	-1.60	1.01	-1.73	-3.10	-3.42	-2.56	-0.04
Zivot-Andrew	-4.14	-3.13	-4.50	-2.92	-3.34	-3.64	-4.67	-4.11	-4.47	-3.74

10 Sector	ENER	MATE	TELE	UTIL
Dickey-Fuller	0.19	-0.05	-1.59	-0.15
ADF Z-test	0.06	-0.02	-2.48	-0.10
Zivot-Andrew	-3.70	-4.06	-3.87	-4.24

Panel B Industrial Groups Rank Test I(1)-Analysis

p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
15	0	0.51	658.13	582.50	508.62	0.00***	0.00***
14	1	0.40	521.23	458.95	446.72	0.00***	0.02**
13	2	0.36	424.14	371.66	388.82	0.00***	0.17

Table 1.13 – continued

Panel C Industrial Groups Exclusion Test

	r	DGF	AUCO	CODA	COSE	MEDI	**RETA**	CAPG	COSS	TRAN	SOFT	TEHE	**SESE**	ENER	MATE	TELE	UTIL
L-R test	1	1	10.73	12.31	19.25	39.23	**0.33**	36.26	5.87	15.20	14.46	10.64	**1.83**	9.24	6.53	8.36	0.01
P-Value			0.00***	0.00***	0.00***	0.00***	**0.57**	0.00***	0.02**	0.00***	0.00***	0.00***	**0.18**	0.00***	0.01**	0.00***	0.93
L-R test	2	2	16.06	19.08	19.25	47.91	**3.19**	42.61	7.28	18.97	14.50	17.32	**4.97**	9.25	10.19	15.75	11.01
P-Value			0.00***	0.00***	0.00***	0.00***	**0.20**	0.00***	0.03**	0.00***	0.00***	0.00***	**0.08**	0.01**	0.01***	0.00***	0.00***

*significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.
Dickey-Fuller Unit Root Test Critical values: 1%= -3.466 and 5%= -2.877 and 10%= -2.575;
Augmented Dickey-Fuller Z-test Critical values: 1%= -20.3 and 5%= -14.0 and 10%= -11.2;
Zivot-Andrews Unit Root Test Critical Values are 1% -5.57 and 5% -5.08 and 10% -4.82

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Table 1.14 Robustness Test of Cointegrated Sector Industry Groups

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Lag length of cointegration rank test is determined by our AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion) test results. Significant large G(r) tests confirm the present of deterministic trend component. Insignificant G(r) leads to cointegration rank tests without a trend component. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics. G(r) test statistic has a $\chi2$ distribution with r degrees of freedom. L-R test is the likelihood-ratio test with the null hypothesis that the variable is independent and therefore can be excluded from the cointegration relation. Corresponding p-value is shown under the L-R test statistics. Industry groups are suggested to be excluded from its cointegration vector are in bold. L-R test statistic has a $\chi2$ distribution with degrees of freedom equal to the number of restrictions in the system. AUCO-Automobiles & Components; CODA-Consumer Durables & Apparel; COSE-Consumer Services; MEDI-Media; RETA-Retailing; CAPG-Capital Goods; COSS-Commercial Services & Supplies; TRAN-Transportation; SOFT-Software & Services; TEHE-Technology Hardware & Equipment; SESE-Semiconductors & Semiconductor Equipment.

Panel A. Rank Test on Consumer Discretionary (COND) Industrial Groups

G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
N/A	5	0	0.26	127.79	126.15	89.78	0.00***	0.00***
14.234***	4	1	0.18	70.75	70.04	64.80	0.01**	0.02**
21.315***	3	2	0.11	32.01	31.78	43.82	0.42	0.43

Panel B. Exclusion Test on Consumer Discretionary (COND) Industrial Groups

	r	DGF	AUCO	CODA	COSE	MEDI	**RETA**
L-R test	1	1	0.01	8.26	10.01	0.36	0.57
P-Value			0.92	0.00***	0.00***	0.55	0.45
L-R test	2	2	9.86	16.80	25.52	7.83	0.65
P-Value			0.00***	0.00***	0.00***	0.02**	0.72

Panel C. Cointegration Rank Test on Information Technology (INFO) Industrial Groups

G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
N/A	3	0	0.11	36.60	35.19	29.80	0.01	0.01**
0.042	2	1	0.06	14.60	13.15	15.41	0.07	0.11

Panel D. Exclusion Test on Information Technology (INFO) Industrial Groups

	r	DGF	SOFT	TEHE	**SESE**
L-R test	1	1	9.14	6.99	**1.51**
P-Value			0.00	0.01	**0.22**

Panel E. Cointegration Rank Test on Industrials (INDU) Industrial Groups

G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
N/A	3	0	0.13	54.80	53.44	56.40	0.07*	0.09*
7.712***	2	1	0.09	28.02	23.04	32.85	0.15	0.38

Panel F. Exclusion Test on Industrials (INDU) Industrial Groups

	r	DGF	CAPG	COSS	TRAN
L-R test	1	1	4.30	4.66	4.26
P-Value			0.04**	0.03**	0.04**

* significant at 10 percent leve l and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.15 Rank Test on Independent Series

Test period is from October 1990 to September 2006 which includes 192 monthly observations. Lag length of cointegration rank test is determined by our AIC and SBC test results. Significant large G(r) tests confirm the present of deterministic trend component. Insignificant G(r) leads to cointegration rank tests without a trend component. To ensure normality of residual, large standardized residual as found on 1998:08 and 2001:09, are controlled by dummy variables. Possible structural breaks, such as 1997 Asian financial crisis and 2000 U.S. internet bubble burst, are monitored by using likelihood-ratio exclusion test. Trace is a standard Johansen trace statistics and Bartlett Trace is a small sample correction for each cointegration rank test. CV is the critical value for trace statistics at a 5 percent level. P-Value is corresponding to Trace statistics while Bartlett P-Value is corresponding to Bartlett Trace statistics. G(r) test statistic has a $\chi 2$ distribution with r degrees of freedom.

I(1)-Analysis Rank Test

G(r)	p-r	r	Eig. Value	Trace	Bartlett Trace	CV	P-Value	Bartlett P-Value
N/A	5	0	0.16	62.78	61.98	69.61	0.16	0.18
0.554	4	1	0.08	29.90	29.60	47.71	0.73	0.74

* significant at 10 percent leve l and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.16 Industrial Portfolios Summary Statistics: 1990-2006

RET is the raw return and ExRET is the excess return and SD is the standard deviation and they are all in percentage. SHP is the sharp ratio and Z-statistic is Jobson-Korkie test statistic. Market the value-weighted S&P/Citigroup Global Broad Market return which is the benchmark for global market index. IGINDE contains exclusively independent industrial groups' indices and IGCOINT represents portfolio which contains exclusively cointegrated industrial groups indices.

Portfolio	RET(%)	ExRET(%)	S.D.(%)	SHP	Z-Statistic: vs BMI	Z-Statistics: IGINDE vs IGCOINT
BMI Global	0.93%	0.59%	3.83%	0.16	0	
IGINDE	1.14%	0.81%	3.55%	0.23	2.72***	2.21**
IGCOINT	0.94%	0.61%	4.03%	0.15	-0.27	
Citigroup 3M T-bill	0.33%	0.00%	0.14%			

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.17 Industrial Portfolio Risk Measures

Full market period is from October 1990 to September 2006 which includes 192 monthly observations. Rising market is defined as positive market risk premium months with 119 observations. Declining market is defined as negative market risk premium months with 73 observations. SD represents standard deviation which is a tradition total risk measurement. Beta is a systematic market risk measure based on CAPM model:

$$R_{pt} = a + \beta_{i1} R_{mt} + \upsilon_{t},$$

where R_{pt} is portfolio excess return. IGINDE represents portfolio which contains exclusively independent industrial indices, IGCOINT represents portfolio which contains exclusively cointegrated industrial indices, COINT1 represents portfolio which contains first vector of cointegrated industrial indices and IGCOINT2 represents portfolio which contains second vector of cointegrated industrial indices. DIFF = IHINDE-IGCOINT.

	PORTFOLIO	Raw Return r	SD σ	Alpha α	Beta β
Full Market	IGINDE	1.14%	3.55%	0.29%	0.866
	IGCOINT	0.94%	4.03%	0.00%	1.031
	DIFF	0.20%	-0.49%	0.30%	-0.165
Rising Market	IGINDE	3.13%	2.30%	0.04%	0.935
	IGCOINT	3.40%	2.29%	0.07%	1.013
	DIFF	-0.26%	0.01%	-0.03%	-0.079
Declining Market	IGINDE	-2.11%	2.73%	0.42%	0.877
	IGCOINT	-3.06%	2.89%	-0.06%	1.024
	DIFF	0.95%	-0.16%	0.48%	-0.147

Table 1.18 Industrial Groups Portfolio Performance Summary

This table presents the results of the four-factor model regression**.**

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}IGMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. IGUMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing industrial groups indices quartile 4 and short prior worst performing industrial groups indices quartile 1. IGINDE represents portfolio which contains exclusively independent industrial groups indices and IGCOINT represents portfolio which contains exclusively cointegrated industrial groups indices.

Performance Parameters

Full Market	IGINDE	t-stat	IGCOINT	t-stat	IGHEDGE	t-stat
Market Rm	0.913	38.34***	1.023	61.24***	-0.109	-3.26***
Size SMB	-0.057	-2.62***	0.089	5.86***	-0.145	-4.77***
Valuation HML	0.095	4.21***	-0.024	-1.49	0.118	3.73***
Momentum IGUMD	-0.021	-0.95	-0.036	-2.33**	0.015	0.49
Intercept a	0.003	2.97***	0.000	-0.13	0.003	2.17**
R-Square	0.90		0.96		0.28	

Rising Market	IGINDE	t-stat	IGCOINT	t-stat	IGHEDGE	t-stat
Market Rm	0.951	19.14***	0.999	25.94***	-0.048	-0.66
Size SMB	-0.100	-3.82***	0.075	3.68***	-0.175	-4.52***
Valuation HML	0.055	2.02**	-0.026	-1.26	0.081	2.02**
Momentum IGUMD	-0.001	-0.02	-0.031	-1.39	0.030	0.71
Intercept a	0.001	0.30	0.001	0.57	0.000	-0.10
R-Square	0.78		0.87		0.21	

Declining Market	IGINDE	t-stat	IGCOINT	t-stat	ICHEDGE	t-stat
Market Rm	0.978	18.69***	1.023	30.69***	-0.045	-0.63
Size SMB	-0.004	-0.10	0.113	4.87***	-0.117	-2.32**
Valuation HML	0.157	4.11***	-0.022	-0.91	0.179	3.39***
Momentum IGUMD	-0.036	-1.08	-0.044	-2.08**	0.008	0.18
Intercept a	0.004	1.84*	-0.001	-0.36	0.004	1.50
R-Square	0.84		0.94		0.26	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.19 Combined Portfolio Performance Summaries

This table presents the results of the four-factor model regression.

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}IGMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. CUMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. IGUMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing industrial groups indices quartile 4 and short prior worst performing industrial groups indices quartile 1. INDE represents a portfolio which contains exclusively independent industrial group and country indices while COINT represents a portfolio which contains exclusively cointegrated industrial group and country indices.

Performance Parameters

Full Market	INDE	t-stat	COINT	t-stat	HEDGE	t-stat
Market Rm	0.974	45.6***	1.054	49.17***	-0.080	-2.99***
Size SMB	0.010	0.49	0.108	5.5***	-0.099	-4.01***
Valuation HML	0.076	3.72***	0.025	1.24	0.050	1.97**
Momentum IGUMD	-0.010	-0.47	-0.029	-1.32	0.019	0.69
Momentum CUMD	-0.009	-0.46	-0.006	-0.31	-0.003	-0.12
Intercept a	0.003	3.30***	0.000	-0.07	0.003	2.68***
R-Square	0.93		0.94		0.17	

Rising Market	INDE	t-stat	COINT	t-stat	HEDGE	t-stat
Market Rm	0.940	20.13***	1.075	22.16***	-0.135	-2.33**
Size SMB	0.019	0.75	0.142	5.54***	-0.124	-4.03***
Valuation HML	0.037	1.42	0.013	0.47	0.024	0.74
Momentum IGUMD	-0.034	-1.17	-0.047	-1.52	0.012	0.33
Momentum CUMD	0.019	0.84	-0.005	-0.22	0.024	0.87
Intercept a	0.003	1.75*	-0.001	-0.52	0.004	1.85*
R-Square	0.79		0.83		0.20	

Declining Market	INDE	t-stat	COINT	t-stat	HEDGE	t-stat
Market Rm	1.049	23.48***	1.055	24.39***	-0.006	-0.11
Size SMB	-0.025	-0.79	0.041	1.35	-0.066	-1.60
Valuation HML	0.140	4.26***	0.065	2.06**	0.074	1.73*
Momentum IGUMD	0.022	0.74	-0.005	-0.15	0.027	0.68
Momentum CUMD	-0.072	-2.09**	0.014	0.43	-0.086	-1.91*
Intercept a	0.004	2.15**	-0.001	-0.30	0.004	1.87*
R-Square	0.89		0.91		0.14	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.20 Portfolio Risk Decomposition

The portfolio risk decomposition tests use a two-pass version of the Fama-MacBeth (1973) to compute risk components. Using the first 60 monthly observations (October 1990 – September 1995), the returns of the portfolios are regressed against a four-factor model :

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}IGMD_t + \upsilon_t$$

The country (industrial) portfolios use the country (industrial group) momentum CUMD (IGUMD) variable as the fourth factor. For each portfolio, its intercept, Rm, SMB, HML, CUMD or IGUMD slope coefficients, mean square error (MSE), and standard deviation (SD) of returns for October 1995 are recorded. The slope of Rm, MSE, and S.D. measures reflect systematic (market), unsystematic, and total risks, respectively. The test rolls the 60-observation regression forward one month and computes the risk coefficients for the next month (November, 1995). Continuing the process, we ultimately have a cross-sectional time series of 132 coefficients for each risk measure over the period October 1995 through September 2006. The time series of coefficients are then compared with two sample t-tests shown in the t-stat column.

Panel A Country Portfolios

	$Mean_{CNDE}$	**$Mean_{CCOINT}$**	**H_0:**	**t-stat**
Intercept	0.00186	0.00044	$a_{CINDE}=a_{CCOINT}$	8.67***
R_m	1.05624	1.06872	$b_{1CINDE} = b_{1CCOINT}$	-2.43**
SMB	0.05654	0.10001	$b_{2CINDE}=b_{2CCOINT}$	-5.05***
HML	0.08089	0.11306	$b_{3CINDE}=b_{3CCOINT}$	-3.72***
CUMD	0.02096	-0.02111	$b_{4CINDE}=b_{4CCOINT}$	4.58***
SD	0.04428	0.04509	$SD_{CINDE} = SD_{CCOINT}$	-7.18***
MSE	0.00028	0.00033	$MSE_{CINDE}=MSE_{CCOINT}$	-10.81***

Panel B Sector Portfolios

	$Mean_{IGINDE}$	**$Mean_{CCOINT}$**	**H_0:**	**t-stat**
Intercept	0.00188	0.00022	$a_{IGINDE}=a_{IGCOINT}$	14.65***
R_m	0.92226	1.01636	$b_{1IGINDE} = b_{1IGCOINT}$	-12.20***
SMB	-0.03094	0.09693	$b_{2IGINDE}=b_{2IGCOINT}$	-21.18***
HML	-0.01462	-0.02554	$b_{3IGINDE}=b_{3IGCOINT}$	0.68
IGUMD	-0.04139	-0.01621	$b_{4IGINDE}=b_{4IGCOINT}$	-4.68***
SD	0.03656	0.04175	$SD_{IGINDE}=SD_{IGCOINT}$	-9.89***
MSE	0.00009	0.00007	$MSE_{IGINDE}=MSE_{IGCOINT}$	12.96***

Panel C Combined Portfolios

	$Mean_{INDE}$	**$Mean_{COINT}$**	**H_0:**	**t-stat**
Intercept	0.00188	0.00038	$a_{INDE}=a_{COINT}$	16.59***
R_m	0.98821	1.04010	$b_{1INDE} = b_{1COINT}$	-9.47***
SMB	0.01420	0.09453	$b_{2INDE}=b_{2COINT}$	-11.76
HML	0.02483	0.02627	$b_{3INDE}=b_{3COINT}$	-0.11
CUMD	0.01309	-0.01400	$b_{4INDE}=b_{4COINT}$	5.00***
IGUMD	-0.03443	-0.02721	$b_{5INDE}=b_{5COINT}$	-2.27**
SD	0.03912	0.04234	$SD_{INDE}=SD_{COINT}$	-12.01***
MSE	0.00010	0.00011	$MSE_{INDE}=MSE_{COINT}$	-4.83***

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.21 Diversification Determinant Comparison

The portfolio risk decomposition tests use a two-pass version of the Fama-MacBeth (1973) to compute risk components. Using the first 60 monthly observations (October 1990 – September 1995), the returns of the portfolios are regressed against a four-factor model:

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}IGMD_t + \upsilon_t$$

The country (industrial) portfolios use the country (industrial group) momentum CUMD (IGUMD) variable as the fourth factor. For each portfolio, its intercept, Rm, SMB, HML, CUMD or IGUMD slope coefficients, mean square error (MSE), and standard deviation (SD) of returns for October 1995 are recorded. The slope of Rm, MSE, and S.D. measures reflect systematic (market), unsystematic, and total risks, respectively. The test rolls the 60-observation regression forward one month and computes the risk coefficients for the next month (November, 1995). Continuing the process, we ultimately have a cross-sectional time series of 132 coefficients for each risk measure over the period October 1995 through September 2006. The time series of coefficients are then compared with two sample t-tests shown in the t-stat column.

Panel A Independent Portfolios

	$Mean_{CINDE}$	**$Mean_{IGINDE}$**	**H_0:**	**t-stat**
Intercept	0.00186	0.00188	$a_{CINDE}=a_{IGINDE}$	-0.11
R_m	1.05624	0.92226	$b_{1CINDE}=b_{1IGINDE}$	23.43***
SMB	0.05654	-0.03094	$b_{2CINDE}=b_{2IGINDE}$	11.07***
HML	0.08089	-0.01462	$b_{3CINDE}=b_{3IGINDE}$	5.57***
UMD	0.02096	-0.04139	$b_{4CINDE}=b_{4IGINDE}$	13.98***
SD	0.04428	0.03656	$SD_{CINDE}=SD_{IGINDE}$	28.88***
MSE	0.00028	0.00009	$MSE_{CINDE}=MSE_{IGINDE}$	26.02***

Panel B Cointegrated Portfolios

	$Mean_{CCOINT}$	**$Mean_{IGCOINT}$**	**H_0:**	**t-stat**
Intercept	0.00044	0.00022	$a_{CCOINT}=a_{IGCOINT}$	1.22
R_m	1.06872	1.01636	$b_{1CCOINT}=b_{1IGCOINT}$	10.56***
SMB	0.10001	0.09693	$b_{2CCOINT}=b_{2IGCOINT}$	0.83
HML	0.11306	-0.02554	$b_{3CCOINT}=b_{3IGCOINT}$	14.04***
UMD	-0.02111	-0.01621	$b_{4CCOINT}=b_{4IGCOINT}$	-1.24
SD	0.04509	0.04175	$SD_{CCOINT}=SD_{IGCOINT}$	29.45***
MSE	0.00033	0.00007	$MSE_{CCOINT}=MSE_{IGCOINT}$	11.22***

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.22 Portfolio Institutional Flow Summary

Panel A and B presents the results of the five-factor model regression for a single dimension diversification level country or sector:

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}INST_t + \upsilon_t$$

The country industrial portfolios use the country industrial group momentum CUMD IGUMD variable as the fourth factor. Panel C presents the results of the six-factor model regression for a two-dimension diversification level country and sector:

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}CUCMD_t + b_{i5}IGUMD_t + b_{i6}INST_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. CUMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. IGUMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing industrial groups indices quartile 4 and short prior worst performing industrial groups indices quartile 1. CINDE represents portfolio which contains exclusively independent country indices and CCOINT represents a portfolio which contains exclusively cointegrated country indices. IGINDE represents a portfolio which contains exclusively independent industrial groups indices and IGCOINT represents portfolio which contains exclusively cointegrated industrial groups indices. INDE represents a portfolio which contains exclusively independent industrial group and country indices while COINT represents a portfolio which contains exclusively cointegrated industrial group and country indices.

Panel A

Country	CINDE	t-stat	CCOINT	t-stat	CHEDGE	t-stat
Market Rm	1.050	30.38***	1.079	28.64***	-0.029	-0.83
Size SMB	0.081	2.63***	0.131	3.90***	-0.050	-1.60
Valuation HML	0.061	2.13**	0.074	2.35**	-0.012	-0.42
Momentum CUMD	0.008	0.28	-0.016	-0.52	0.023	0.84
INST	-0.017	-0.33	-0.141	-2.55**	0.124	2.42**
Intercept a	0.003	1.99*	0.002	1.20	0.001	0.67
R-Square	0.85		0.84		0.05	

Panel B

Sector	IGINDE	t-stat	IGCOIN	t-stat	IGHEDGE	t-stat
Market Rm	0.921	38.41***	1.030	61.28***	-0.109	-3.18***
Size SMB	-0.061	-2.82***	0.088	5.87***	-0.149	-4.87***
Valuation HML	0.102	4.51***	-0.021	-1.34	0.123	3.83***
Momentum IGUMD	-0.021	-0.95	-0.039	-2.50**	0.018	0.57
INST	0.082	2.37**	0.030	1.22	0.053	1.06
Intercept a	0.001	1.52	0.000	-0.61	0.002	1.37
R-Square	0.90		0.96		0.29	

Panel C

Combined	INDE	t-stat	COINT	t-stat	HEDGE	t-stat
Market Rm	0.984	46.12***	1.053	48.63***	-0.068	-2.53**
Size SMB	0.010	0.52	0.112	5.71***	-0.102	-4.18***
Valuation HML	0.078	3.87***	0.021	1.01	0.057	2.26**
Momentum CNTRYUMD	-0.006	-0.33	-0.004	-0.23	-0.002	-0.07
Momentum IGUMD	-0.015	-0.71	-0.031	-1.46	0.016	0.61
INST	0.033	1.06	-0.056	-1.78*	0.088	2.26**
Intercept a	0.002	2.55**	0.001	0.83	0.001	1.35
R-Square	0.93		0.94		0.19	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.23 Canonical Variance Residuals Institutional Flow Tests

Mean square variance MSV is the cumulative variance under n dimensions under country or sector as shown in equation 31. $MSV_{Country}$ is the cumulative total variance between country CINDE and CCOIN; MSV_{Sector} is the cumulative total variance between sector IGINDE and IGCOIN. A summary of the residuals is presented in Panel A. In Panel B, MSV is regressed against a five-factor model:

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_{tt} + b_{i5}INST_t + \upsilon_t,$$

where INST is the monthly change in MMMF institution money flows. The country (industrial) level uses the country (industrial group) momentum CUMD (IGUMD) variable as the fourth factor.

Panel A. MSV Residual Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
$MSV_{Country}$	192	1.147	0.690	0.116	3.269
MSV_{Sector}	192	1.154	0.703	0.116	3.684

Panel B. MSV Residuals Five-Factor Performance

		a	Rm	SMB	HML	CUMD	INST	R-sqr
$MSV_{Country}$	Coef.	1.115	0.103	-1.321	0.402	-2.361	3.481	4.37%
	t-test	19.50***	0.07	-1.02	0.34	-2.06**	1.67*	
		a	**Rm**	**SMB**	**HML**	**IGUMD**	**INST**	**R-sqr**
MSV_{Sector}	Coef.	1.097	0.620	-1.118	1.537	3.498	4.273	5.20%
	t-test	18.98***	0.43	-0.85	1.11	2.58***	2.00**	

*significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

Table 1.24 Cointegrated Vector Residual Institutional Flow Tests

As described by Engle and Granger (1987), the CIV of the property market indices, I_{it}, takes a long-run equilibrium form $\beta_1^* I_{1t} + \beta_2^* I_{2t} + \ldots + \beta_n^* I_{nt} + \delta^* D = 0$. The CIV residual, or deviation from long-run equilibrium is a I(0) process which is equal to $\beta^* I_t$ where β and I_t denote the vectors $(\beta_1, \beta_2, \ldots, \beta_n)$ and $(I_{1t}, I_{2t}, \ldots, I_{nt})'$ respectively. ResidAP represents the CIV residual of Asian Pacific region cointegration relation; ResidEMU represents the CIV residual of EMU region cointegration relation; ResidNonEMU represents the CIV residual of NonEMU region cointegration relation. ResidIG1 represents the CIV residual of first industry group cointegration relation; ResidIG2 represents the CIV residual of second industry group cointegration relation. Each CIV residual series is regressed against a five-factor model,

$$\theta_{pt} = \; = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + b_{i5}INST_t + \upsilon.$$

The INST is the series of monthly changes in MMMF institutional flows. The country (industrial) level uses the country (industrial group) momentum CUMD (IGUMD) variable as the fourth factor.

		a	Rm	SMB	HML	CUMD	INST	R-sqr
ResidAP	Coef.	-196.789	-257.945	16.662	-88.892	-154.752	252.683	2.56%
	t-test	-29.96***	-1.59	0.11	-0.65	-1.18	1.05	
ResidEMU	Coef.	-398.412	-175.749	-1263.148	-429.758	516.201	342.050	3.84%
	t-test	-15.96***	-0.28	-2.24	-0.83	1.03	0.37	
ResidNonEMU	Coef.	58.809	-128.395	-108.813	-185.729	-21.845	309.200	5.57%
	t-test	14.31***	-1.26	-1.17	-2.17**	-0.27	2.05**	

		a	Rm	SMB	HML	IGUMD	INST	R-sqr
ResidIG1	Coef.	-152.695	259.191	-203.697	491.016	126.850	-766.934	7.89%
	t-test	-18.70***	1.26	-1.09	2.51**	0.66	-2.54**	
ResidIG2	Coef.	227.273	-323.612	-3.454	-1009.116	240.750	553.309	8.53%
	t-test	15.91***	-0.90	-0.01	-2.95***	0.72	1.05	

*significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

APPENDIX B

NEGATIVE COINTEGRATION RELATION

According to Markowitz portfolio theory, if I can find two assets whose returns are negatively correlated, then the covariance is negative which can reduce the portfolio total risk and the minimum value of zero. However, the average covariance term for N assets portfolio can never be negative, because

$$\sigma_p^2 = \frac{1}{N}(\textit{average}\ \text{variance}) + \frac{N-1}{N}(\textit{average}\ \text{covariance}) \geq 0$$

when $N \to \infty$, average variance term will become zero and the average covariance term must be a none negative term. Therefore, under a N assets portfolio, its average covariance is a none negative term.

Same logic can be applied to our cointegration analysis. I can possibly find a negative cointegration relation between two country funds, however having a N funds portfolio, the average cointegration relation can not be negative. Having an N funds portfolio and a negative average cointegration relation among all funds will violate the none negative total portfolio risk criteria. This is supported by our error correction model test and pair wise correlation results which show no negative cointegration relation between any two indices for country, industry and style in the long-run. For vector error correction model (VECM) test on relationships among countries and correlation test among countries, see Hassan and Naka (1996) and Longin and Solnik (1995) respectively.

APPENDIX C

VALUE-WEIGHTED COUNTRY PORTFOLIO PERFORMANCE

C.1. Country Mean Value Weight Distribution during 1990-2006

Test period is from October 1990 to September 2006 which includes 192 monthly observations. AS—Austria, BE—Belgium, FI—Finland, FR—France, GE—Germany, IR—Ireland, IT—Italy, NL—Netherlands, SP—Spain, DE—Denmark, NW—Norway, SW—Sweden, SZ—Switzerland, UK—United Kingdom, AU—Australia, HK—Hong Kong, JA—Japan, NZ—New Zealand, SI—Singapore, CA—Canada, US—United States.

Country	BMI Value Weight	Country	BMI Value Weight
AU	1.60%	GE	3.13%
HK	1.15%	IR	0.24%
JA	14.91%	IT	1.40%
NZ	0.10%	NL	2.09%
SI	0.37%	NW	0.19%
AS	0.12%	SP	1.10%
BE	0.49%	SW	0.91%
DE	0.33%	SZ	2.69%
FI	0.49%	UK	11.18%
FR	3.25%	CA	2.42%
US	51.82%	Total	100%

C.2. Value Weighted Country Portfolio 4-factor Performance

This table presents the results of the four-factor model regression**:**

$$R_{pt} = a + b_{i1}R_{mt} + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}UMD_t + \upsilon_t$$

R_{pt} is the monthly portfolio return in excess of the Citigroup 3-month T-bill return and the R_{mt} is the value-weighted S&P/Citigroup Global Broad Market excess return. *SMB* equals the difference between the average returns of the two EMI small-stock indices and the average returns of the two PMI large-stock indices. Similarly, each month, *HML* equals the difference between the average returns of the two high-BE/ME stock indices and the average returns of the two low-BE/ME stock indices. UMD is the return on a zero-investment factor mimicking portfolio that is long prior best performing country indices quartile 4 and short prior worst performing country indices quartile 1. INDE represents portfolio which contains exclusively value-weighted independent country indices and COINT represents portfolio which contains exclusively value-weighted cointegrated country indices. 21 Countries is the value-weighted portfolio of all 21 country indices.

Full Market

Performance Parameters

Global	INDE	t-stat	COIN	t-stat	HEDGE	t-stat
Market Rm	0.605	31.09***	0.396	19.98***	0.209	5.33***
Size SMB	-0.034	-1.91**	0.035	1.97**	-0.069	-1.94*
Valuation HML	-0.064	-3.94***	0.066	3.96***	-0.130	-3.96***
Country Momentum UMD	-0.003	-0.21	0.007	-0.42	-0.010	-0.32
Intercept a	0.000	-0.12	-0.003	-4.81***	0.004	2.49**
R-Square	0.87		0.69		0.29	

Rising Market

Performance Parameters

Global	INDE	t-stat	COIN	t-stat	HEDGE	t-stat
Market Rm	0.544	12.48***	0.469	10.53***	0.075	0.86
Size SMB	-0.048	-2.11**	0.052	2.22**	-0.099	-2.17**
Valuation HML	-0.054	-2.58***	0.061	2.83***	-0.115	-2.71***
Country Momentum UMD	0.001	-0.07	0.001	-0.07	0.000	-0.00
Intercept a	0.002	-1.12	-0.006	-3.41***	0.007	2.28**
R-Square	0.61		0.51		0.09	

Declining Market

Performance Parameters

Global	INDE	t-stat	COIN	t-stat	HEDGE	t-stat
Market Rm	0.692	17.60***	0.308	7.73***	0.383	4.86***
Size SMB	-0.004	-0.13	0.004	-0.15	-0.008	-0.14
Valuation HML	-0.092	-3.56***	0.084	3.22***	-0.176	-3.40***
Country Momentum UMD	-0.045	-1.56	0.051	1.73*	-0.096	-1.65
Intercept a	0.004	2.45**	-0.007	-4.32***	0.011	3.40***
R-Square	0.86		0.48		0.44	

* significant at 10 percent level and ** significant at 5 percent level and *** significant at 1 percent level.

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BIOGRAPHICAL INFORMATION

The author (Ying CLEMENT Zhang) was born in ShaoYang, Hunan Province, P.R. China on May 11th, 1979. He attended Ji Nan University at GuangZhou city, China, from 1997 to 2001, and graduated with a Bachelor of Science in Economics (concentration in international finance) in the summer of 2001. He subsequently obtained a Master of Science in information system from University of Texas at Arlington in 2004. He began his doctoral studies at the University of Texas at Arlington in finance with a minor in real estate. Under the supervision of Professor John G. Gallo, his research is mostly focused in the areas of time series analysis, international equity diversification, international property asset allocation, asset pricing and portfolio management. His researches also include online stock message board study, Valueline analyst forecasting and Chinese stock market. As of summer 2008, he will be an Assistant Professor of Economics and Finance at the Monmouth University, New Jersey, USA.